TEST REPORT

Test Report No. : UL-RPT-RP10991967JD05A V2.0

Manufacturer	:	CBF Networks, Inc. (doing business as Fastback Networks)
Model No.	:	Liberator V1000 Dual Port
FCC ID	:	2AAEH-LIB-V1000E2
Test Standard(s)	:	FCC Parts 15.207, 15.209 & 15.255

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(s) 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 2.0 supersedes all previous versions.

Date of Issue: 07 April 2016

Checked by:

Sarah Williams
Engineer, Radio Laboratory

Company Signatory:

Steven White
Service Lead, Radio Laboratory
UL VS LTD

0644

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

UL VS LTD

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1. Customer Information

Company Name:	CBF Networks, Inc. (doing business as Fastback Networks)
Address:	Fastback Networks – 2460 N First St., Suite 200, San Jose, CA 95131, U.S.A

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.255
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Radio Frequency Devices) - Section 15.255
Site Registration:	FCC: 209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	04 January 2016 to 11 March 2016

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.207	Transmitter AC Conducted Emissions	✓
Part 15.255(b)(1)(ii)	Transmitter EIRP	✓
Part 15.255(e)	Transmitter Peak Output Power	✓
Part 15.255(e)(1)	Transmitter 6 dB Bandwidth	✓
Part 15.255(c) / 15.209	Transmitter Radiated Emissions	✓
Part 15.255(f)	Transmitter Frequency Stability (Temperature & Voltage Variation)	✓

Key to Results

✓ = Complied ✗ = Did not comply

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

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)

Brand Name:	Liberator
Model Name or Number:	V1000 Dual Port (Terminal A)
Test Sample Serial Number:	S1000805A431500020 *(Conducted Sample)*
Hardware Version:	1
Software Version:	2.1.4.5
FCC ID:	2AAEH-LIB-V1000E2

Brand Name:	Liberator
Model Name or Number:	V1000 Dual Port (Terminal A)
Test Sample Serial Number:	S1000805A021600023 *(Radiated Sample #1)*
Hardware Version:	1
Software Version:	2.1.4.5
FCC ID:	2AAEH-LIB-V1000E2

Brand Name:	Liberator
Model Name or Number:	V1000 Dual Port (Terminal A)
Test Sample Serial Number:	S1000805A071600029 *(Radiated Sample #2)*
Hardware Version:	1
Software Version:	2.1.4.5
FCC ID:	2AAEH-LIB-V1000E2

3.2. Description of EUT

The equipment under test was a millimetre wave point-to-point transceiver operating in the 57-64 GHz band, using FDD and digital modulation. The EUT was powered by a PoE injector connected to a 120 VAC mains supply.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Category of Equipment:	Transceiver		
Channel Spacing:	500 MHz		
Modulation Type:	QPSK & 8PSK		
Antenna Type:	Integrated flat panel		
Antenna Gain:	38.0 dBi		
Transmit Frequency Range:	57250 MHz to 59750 MHz		
Transmit Channels Tested:	**Channel ID**		**Channel Frequency (MHz)**
	Bottom		57500.000
	Middle		58500.000
	Top		59500.000
Power Supply Requirement:	Nominal	120 VAC	
	Minimum	102 VAC	
	Maximum	138 VAC	
Tested Temperature Range:	Minimum	-40°C	
	Maximum	55°C	

3.5. Support Equipment

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

Description:	PoE Supply
Brand Name:	PhiHong
Model Name or Number:	POE61W-560DG-S2
Serial Number:	P42900004A0

Description:	Laptop
Brand Name:	Dell
Model Name or Number:	Latitude D610
Serial Number:	UL VS LTD Asset No. PC329NT

Description:	Laptop
Brand Name:	Dell
Model Name or Number:	Latitude D610
Serial Number:	UL VS LTD Asset No. PC379NT

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

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

- Transmitting with the following modulation types: QPSK and 8PSK.
- Operating on bottom, middle and top channels with a 500 MHz channel bandwidth.
- Transmitting at maximum output power.

4.2. Configuration and Peripherals

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

- A laptop PC with the customer's browser based software was used to configure the EUT during the testing. Telnet commands were used to set the channel and modulation. The laptop was connected to the EUT via Ethernet.
- The EUT was powered by a PoE supply connected to 120 VAC mains.
- Testing at voltage extremes was performed with the PoE supply connected to a variable AC power supply.

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 Uncertainties* 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 AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Adam Brown	**Test Date:**	04 January 2016
Test Sample Serial Number:	S1000805A431500020		

FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2

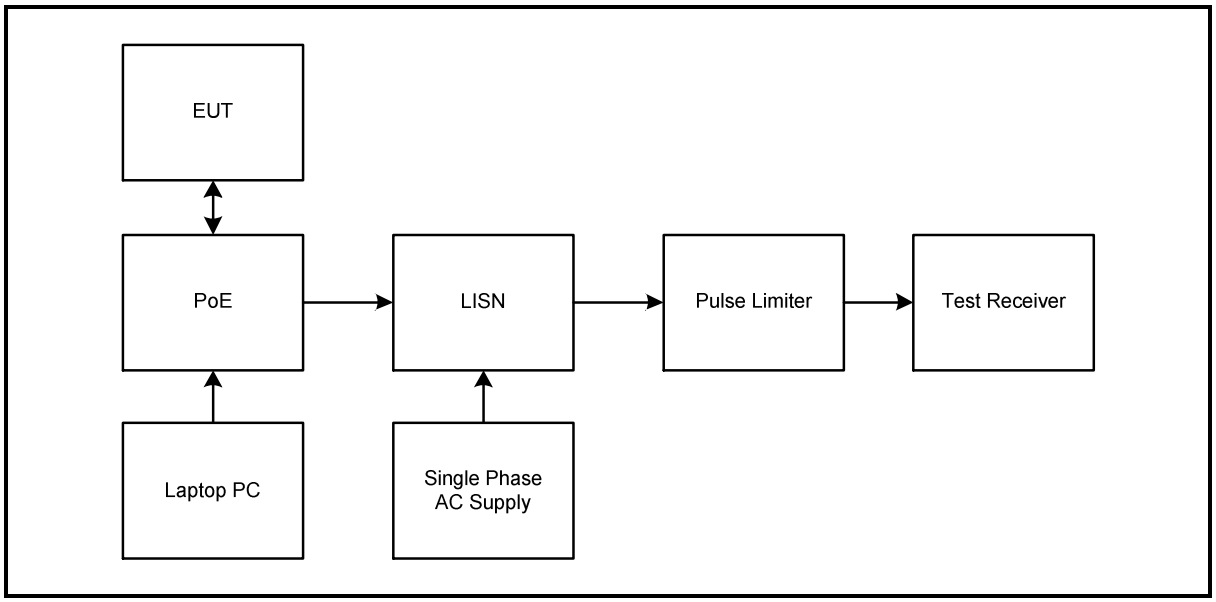
Environmental Conditions:

Temperature (°C):	18
Relative Humidity (%):	50

Note(s):

1. The EUT was connected to a PoE adapter via ethernet cable. The AC charger was connected to 120 VAC 60 Hz single phase supply via a LISN.
2. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.
3. A pulse limiter was fitted between the LISN and the test receiver.

Test setup:



Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.150	Live	38.5	66.0	27.5	Complied
0.506	Live	35.4	56.0	20.6	Complied
9.447	Live	19.6	60.0	40.4	Complied
11.999	Live	19.6	60.0	40.4	Complied
14.082	Live	25.5	60.0	34.5	Complied
20.999	Live	38.7	60.0	21.3	Complied

Results: Live / Average

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.155	Live	26.1	55.8	29.7	Complied
0.465	Live	30.2	46.6	16.4	Complied
9.438	Live	15.1	50.0	34.9	Complied
11.999	Live	13.7	50.0	36.3	Complied
14.447	Live	19.5	50.0	30.5	Complied
20.976	Live	32.6	50.0	17.4	Complied

Transmitter AC Conducted Spurious Emissions (continued)

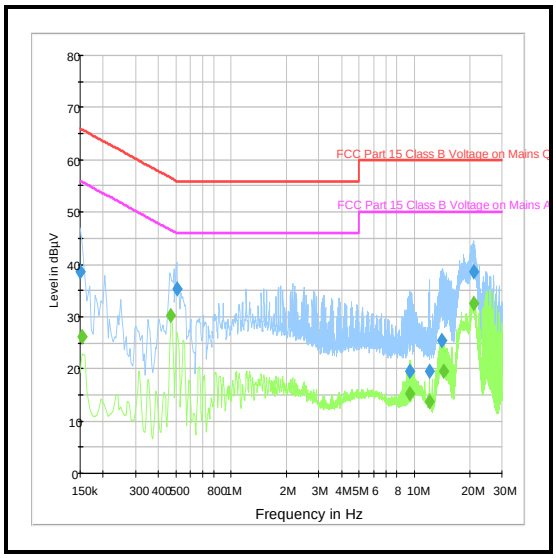
Results: Neutral / Quasi Peak

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.155	Neutral	37.7	65.8	28.1	Complied
0.159	Neutral	32.0	65.5	33.5	Complied
0.506	Neutral	36.5	56.0	19.5	Complied
11.999	Neutral	20.7	60.0	39.3	Complied
13.997	Neutral	26.0	60.0	34.0	Complied
21.368	Neutral	40.1	60.0	19.9	Complied

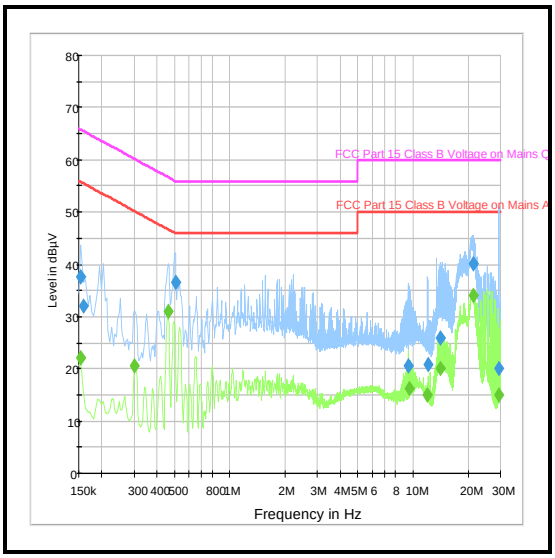
Results: Neutral / Average

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.155	Neutral	22.1	55.8	33.7	Complied
0.303	Neutral	20.6	50.2	29.6	Complied
0.461	Neutral	31.0	46.7	15.7	Complied
9.546	Neutral	16.1	50.0	33.9	Complied
14.019	Neutral	20.1	50.0	29.9	Complied
21.336	Neutral	34.0	50.0	16.0	Complied

Transmitter AC Conducted Spurious Emissions (continued)



Live



Neutral

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1625	Thermohygrometer	JM Handelspunkt	30.5015.06	None stated	07 Jan 2016	12
A2086	LISN	Rohde & Schwarz	ESH3-Z5	101033	05 Oct 2016	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	02 Mar 2016	12
M1263	Test Receiver	Rohde & Schwarz	ESIB7	100265	16 Oct 2016	12

5.2.2. Transmitter EIRP

Test Summary:

Test Engineer:	Ben Mercer	**Test Date:**	21 January 2016
Test Sample Serial Number:	S1000805A431500020		

FCC Reference:	Part 15.255(b)(1)(ii)
Test Method Used:	ANSI C63.10 Section 9.11

Environmental Conditions:

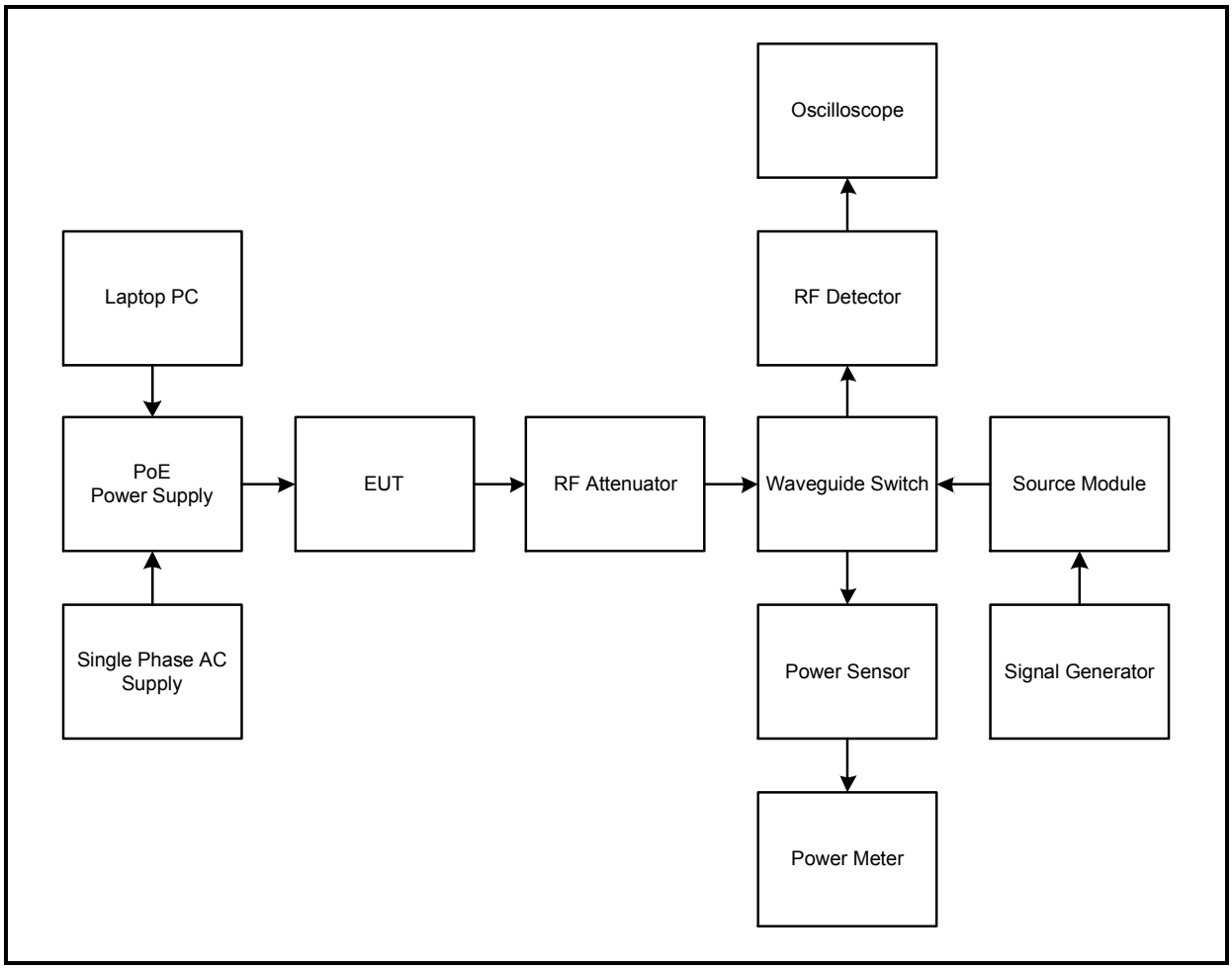
Temperature (°C):	23
Relative Humidity (%):	31

Note(s):

1. The antenna port of the EUT was connected to an RF detector via a 4 way waveguide switch. A CW signal generator and wideband thermocouple power sensor were connected to the remaining two ports.
2. The RF detector was connected to the 50 Ω input of a digital storage oscilloscope.
3. The EUT peak and average voltages were measured on the oscilloscope. The waveguide switch was then rotated to connect the signal generator to the RF detector, and the signal generator output was adjusted to match the previously measured voltages. The waveguide switch was then rotated to connect the signal generator output to the thermocouple power sensor, and the signal generator output power was measured.
4. The substituted levels recorded below include the calibrated path loss of the waveguide switch and attenuator.

Transmitter EIRP (continued)

Test setup:



Transmitter EIRP (continued)

Results: Bottom Channel / QPSK / Peak

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
57.500	10.7	10.5	38.0	48.5	59.0	10.5	Complied

Results: Bottom Channel / QPSK / Average

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
57.500	2.9	6.3	38.0	44.3	56.0	11.7	Complied

Results: Middle Channel / QPSK / Peak

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
58.500	9.8	11.0	38.0	49.0	59.0	10.0	Complied

Results: Middle Channel / QPSK / Average

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
58.500	3.0	7.3	38.0	45.3	56.0	10.7	Complied

Results: Top Channel / QPSK / Peak

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
59.500	17.0	11.8	38.0	49.8	59.0	9.2	Complied

Results: Top Channel / QPSK / Average

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
59.500	5.8	8.0	38.0	46.0	56.0	10.0	Complied

Transmitter EIRP (continued)

Results: Bottom Channel / 8PSK / Peak

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
57.500	3.7	5.9	38.0	43.9	59.0	15.1	Complied

Results: Bottom Channel / 8PSK / Average

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
57.500	1.1	2.3	38.0	40.3	56.0	15.7	Complied

Results: Middle Channel / 8PSK / Peak

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
58.500	4.3	7.7	38.0	45.7	59.0	13.3	Complied

Results: Middle Channel / 8PSK / Average

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
58.500	1.4	4.4	38.0	42.4	56.0	13.6	Complied

Results: Top Channel / 8PSK / Peak

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
59.500	9.0	8.9	38.0	46.9	59.0	12.1	Complied

Results: Top Channel / 8PSK / Average

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
59.500	2.8	5.3	38.0	43.3	56.0	12.7	Complied

Transmitter EIRP (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	None stated	23 Apr 2016	12
M1368	Oscilloscope	Tektronix	TDS3054B	B040692	17 Sep 2016	12
L1172	Waveguide RF Detector	Millitech	DET-15-RPFWI	A16216	Calibrated before use	-
L1173	Waveguide 4 Way Switch Assembly	Millitech	None stated	None stated	Calibrated before use	-
M281	Power Meter	Hewlett Packard	E4418A	GB37170210-01	29 Jan 2017	12
M291	Waveguide Power Sensor	Hewlett Packard	V8486A	US39010039	30 Oct 2016	24
G085	Signal Generator	Hewlett Packard	83650L	3614A00104	11 Nov 2016	24
G094	Source Module	Hewlett Packard	83557A	2948A00475	Calibrated before use	-
A2328	Attenuator	Flann	26081-06	194950	Calibrated before use	-
A2329	Attenuator	Flann	26081-10	207002	Calibrated before use	-

5.2.3. Transmitter Peak Conducted Output Power

Test Summary:

Test Engineer:	Ben Mercer	**Test Date:**	21 January 2016
Test Sample Serial Number:	S1000805A431500020		

FCC Reference:	Part 15.255(e)
Test Method Used:	ANSI C63.10 Section 9.11

Environmental Conditions:

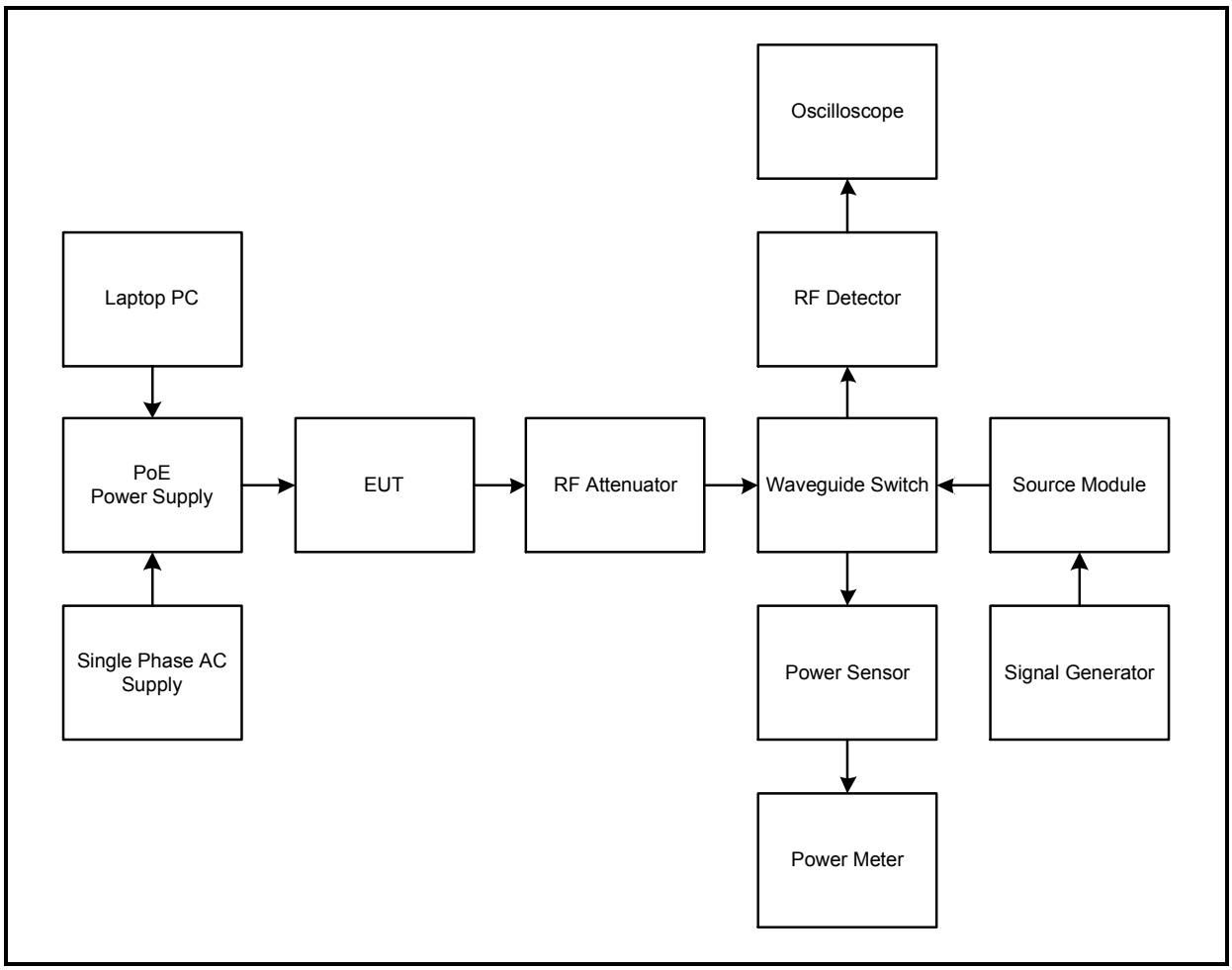
Temperature (°C):	23
Relative Humidity (%):	31

Note(s):

1. The antenna port of the EUT was connected to an RF detector via a 4 way waveguide switch. A CW signal generator and wideband thermocouple power sensor were connected to the remaining two ports.
2. The RF detector was connected to the 50 Ω input of a digital storage oscilloscope.
3. The EUT peak and average voltages were measured on the oscilloscope. The waveguide switch was then rotated to connect the signal generator to the RF detector, and the signal generator output was adjusted to match the previously measured voltages. The waveguide switch was then rotated to connect the signal generator output to the thermocouple power sensor, and the signal generator output power was measured.
4. The substituted levels recorded below include the calibrated path loss of the waveguide switch and attenuator.

Transmitter Peak Conducted Output Power (continued)

Test setup:



Transmitter Peak Conducted Output Power (continued)

Results: Bottom Channel / QPSK

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Substituted Level (mW)	Limit (mW)	Margin (mW)	Result
57.500	10.7	10.5	11.2	500.0	488.8	Complied

Results: Middle Channel / QPSK

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Substituted Level (mW)	Limit (mW)	Margin (mW)	Result
58.500	9.8	11.0	12.6	500.0	487.4	Complied

Results: Top Channel / QPSK

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Substituted Level (mW)	Limit (mW)	Margin (mW)	Result
59.500	17.0	11.8	15.1	500.0	484.9	Complied

Results: Bottom Channel / 8PSK

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Substituted Level (mW)	Limit (mW)	Margin (mW)	Result
57.500	3.7	5.9	3.9	500.0	496.1	Complied

Results: Middle Channel / 8PSK

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Substituted Level (mW)	Limit (mW)	Margin (mW)	Result
58.500	4.3	7.7	5.9	500.0	494.1	Complied

Results: Top Channel / 8PSK

Frequency (GHz)	Level (mV)	Substituted Level (dBm)	Substituted Level (mW)	Limit (mW)	Margin (mW)	Result
59.500	9.0	8.9	7.8	500.0	492.2	Complied

Transmitter Peak Conducted Output Power (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	None stated	23 Apr 2016	12
M1368	Oscilloscope	Tektronix	TDS3054B	B040692	17 Sep 2016	12
L1172	Waveguide RF Detector	Millitech	DET-15-RPFWI	A16216	Calibrated before use	-
L1173	Waveguide 4 Way Switch Assembly	Millitech	None stated	None stated	Calibrated before use	-
M281	Power Meter	Hewlett Packard	E4418A	GB37170210-01	29 Jan 2017	12
M291	Waveguide Power Sensor	Hewlett Packard	V8486A	US39010039	30 Oct 2016	24
G085	Signal Generator	Hewlett Packard	83650L	3614A00104	11 Nov 2016	24
G094	Source Module	Hewlett Packard	83557A	2948A00475	Calibrated before use	-
A2328	Attenuator	Flann	26081-06	194950	Calibrated before use	-
A2329	Attenuator	Flann	26081-10	207002	Calibrated before use	-

5.2.4. Transmitter 6 dB Bandwidth

Test Summary:

Test Engineer:	Ben Mercer	**Test Date:**	05 February 2016
Test Sample Serial Number:	S1000805A431500020		

FCC Reference:	Part 15.255(e)(1)
Test Method Used:	ANSI C63.10 Section 9.3

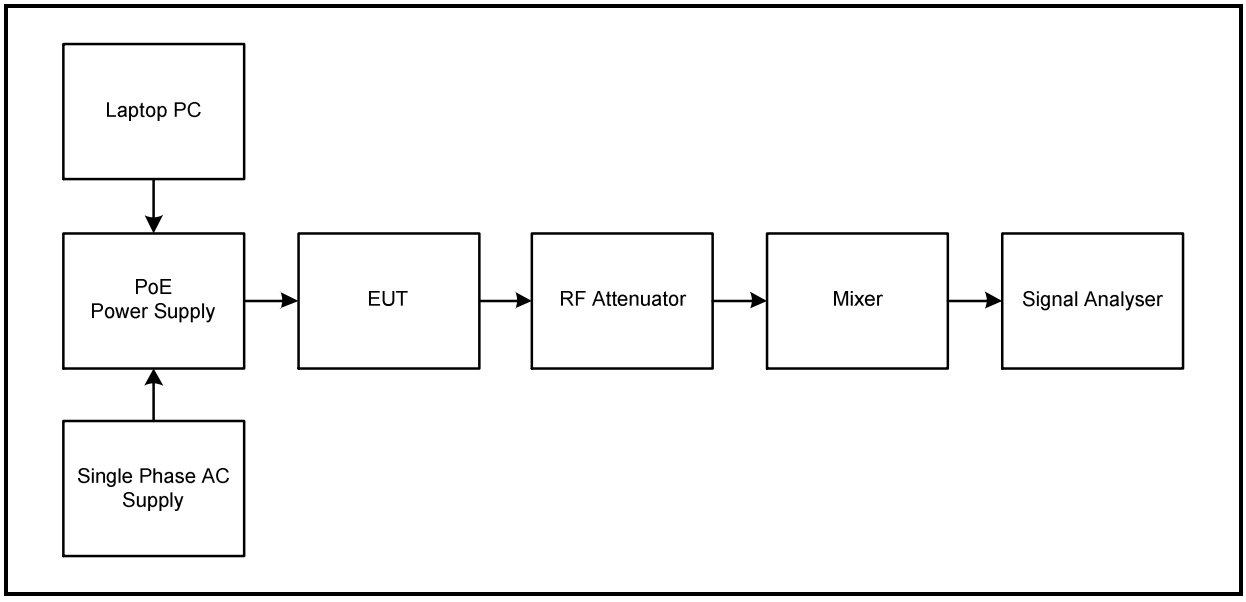
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	39

Note(s):

1. The antenna port of the EUT was connected to a signal analyser via a variable attenuator and a harmonic mixer.
2. The analyser span was set to between two and three times the emission bandwidth. The RBW was set to 100 kHz, and the VBW was set to three times the RBW. The marker delta function was used to measure 6 dB down from the peak on both sides of the emission. The resulting frequency delta between the two markers was recorded as the emission bandwidth.

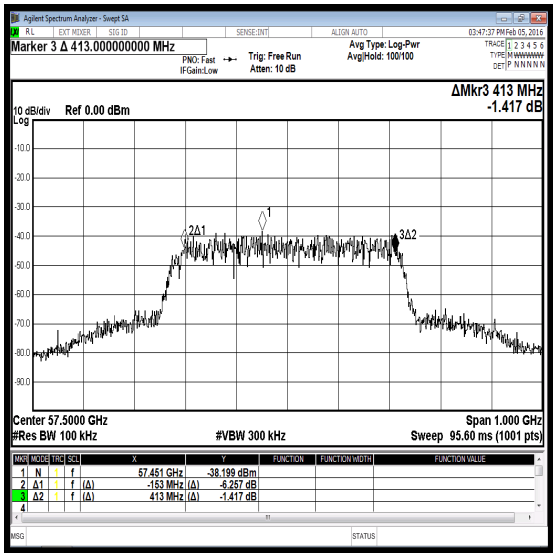
Test setup:



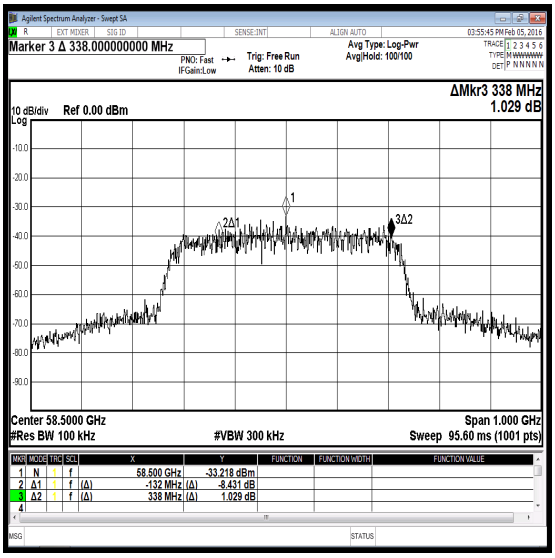
Transmitter 6 dB Bandwidth (continued)

Results: QPSK

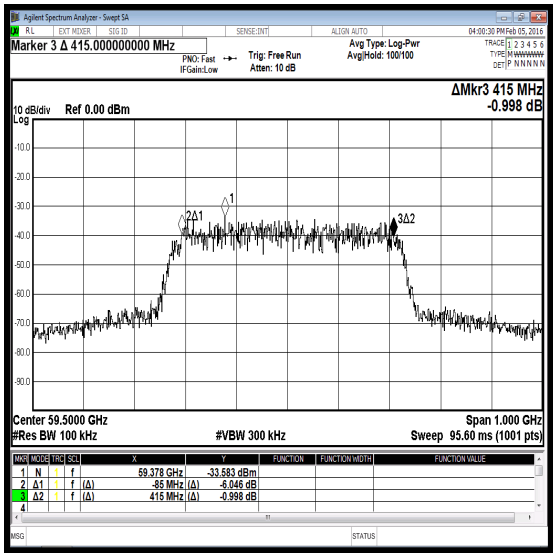
Channel	RBW (kHz)	VBW (kHz)	Emission Bandwidth (MHz)
Bottom	100	300	413.000
Middle	100	300	338.000
Top	100	300	415.000



Bottom Channel



Middle Channel

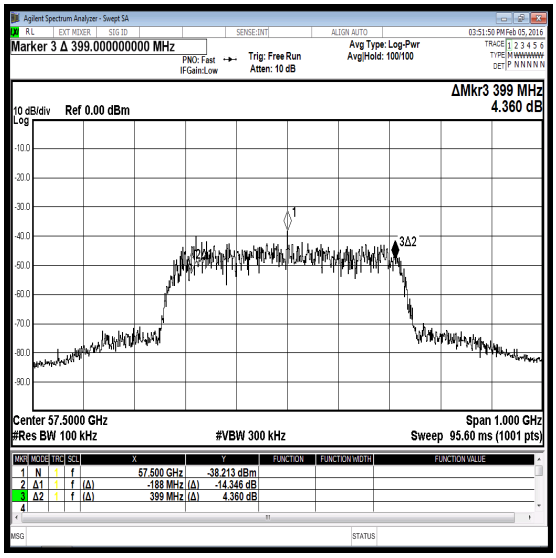


Top Channel

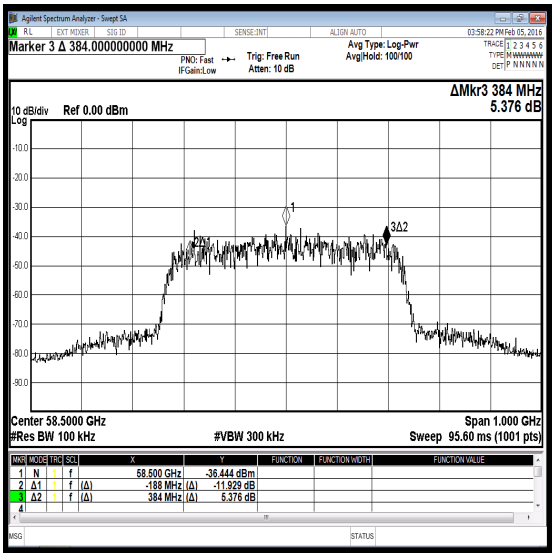
Transmitter 6 dB Bandwidth (continued)

Results: 8PSK

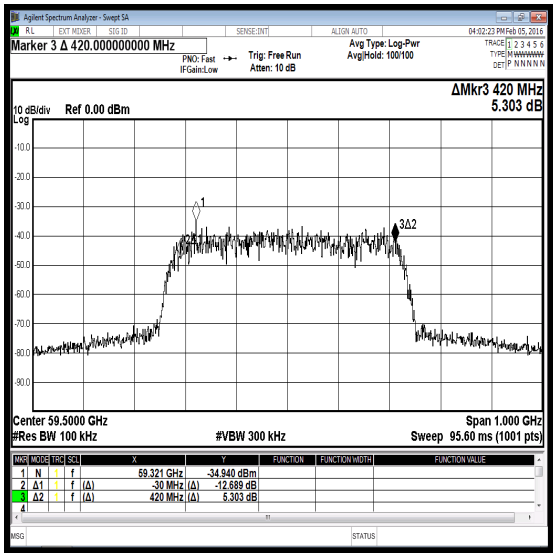
Channel	RBW (kHz)	VBW (kHz)	Emission Bandwidth (MHz)
Bottom	100	300	399.000
Middle	100	300	384.000
Top	100	300	420.000



Bottom Channel



Middle Channel



Top Channel

Transmitter 6 dB Bandwidth (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	None stated	23 Apr 2016	12
M1832	Signal Analyser	Agilent	N9010A	MY53470303	26 Mar 2016	24
M1776	Harmonic Mixer	Agilent	M1970V	MY51390800	03 Mar 2016	24
A470	Variable Attenuator	Flann	2502	49	Calibrated before use	-

5.2.5. Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineer:	Andrew Edwards	**Test Date:**	10 March 2016
Test Sample Serial Number:	S1000805A071600029		

FCC Reference:	Parts 15.255(c) & 15.209
Test Method Used:	ANSI C63.10 Sections 6.3, 6.5 & 9.13
Frequency Range:	30 MHz to 1000 MHz

Environmental Conditions:

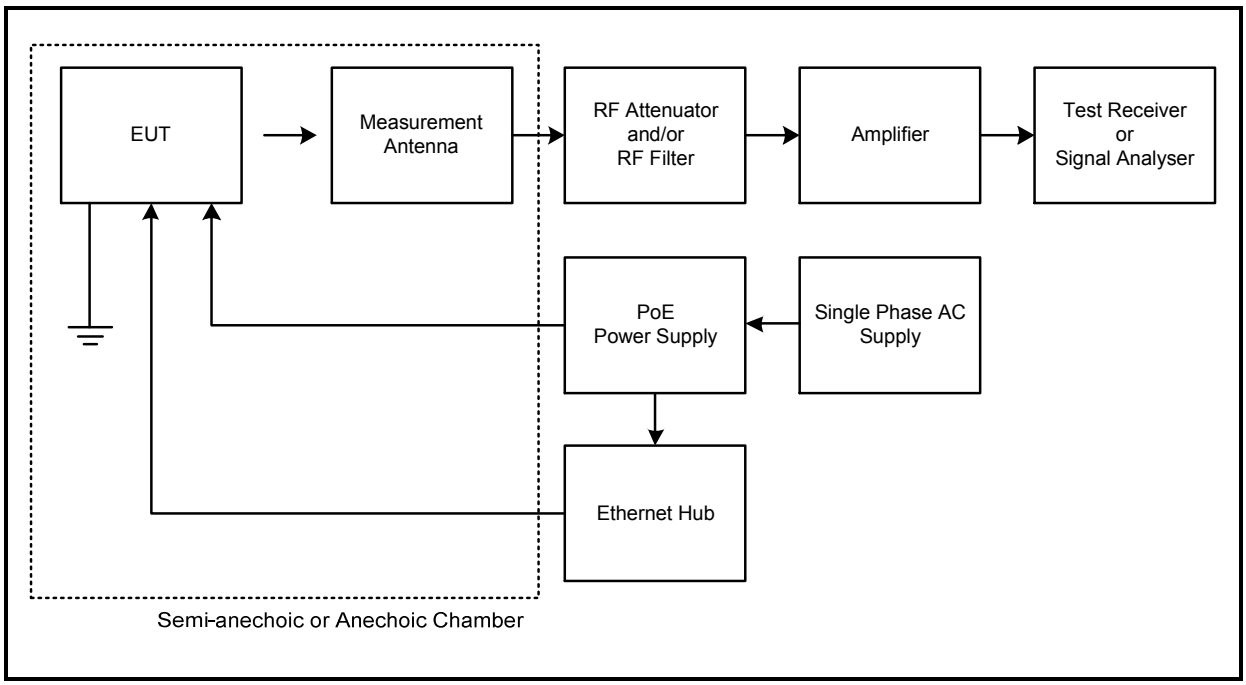
Temperature (°C):	25
Relative Humidity (%):	32

Note(s):

1. Transmitter radiated spurious emissions tests were performed with the EUT transmitting in QPSK mode, as this was found to transmit the highest power and therefore deemed worst case.
2. The EUT had the integral flat panel antenna connected during testing.
3. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
4. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements below 1 GHz were performed with the EUT set to the middle channel only.
5. 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.
6. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. The sweep time was set to auto. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
7. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 120 kHz, using a CISPR quasi-peak detector and a span wide enough to include the entire emission.

Transmitter Radiated Spurious Emissions (continued)

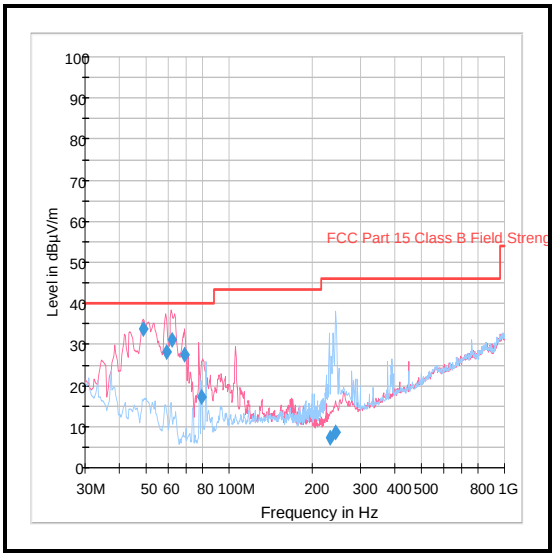
Test setup for radiated measurements:



Transmitter Radiated Spurious Emissions (continued)

Results: Quasi Peak

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
48.733	Vertical	33.7	40.0	6.3	Complied
59.071	Vertical	28.2	40.0	11.8	Complied
62.129	Vertical	31.2	40.0	8.8	Complied
68.910	Vertical	27.6	40.0	12.4	Complied
79.286	Vertical	17.3	40.0	22.7	Complied
244.187	Horizontal	8.5	46.0	37.5	Complied



Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying table.

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1958	Thermohygrometer	JM Handelspunkt	30.5015.10	None stated	11 Jan 2017	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	19 Mar 2016	12
G0543	Amplifier	Sonoma	310N	230801	29 May 2016	3
A259	Antenna	Chase	CBL6111A	1513	09 Apr 2016	12
A1834	Attenuator	Hewlett Packard	8491B	10444	Calibrated before use	-

Transmitter Radiated Spurious Emissions (continued)

Test Summary:

Test Engineers:	Andrew Edwards, David Doyle & Ben Mercer	**Test Dates:**	05 February 2016 to 11 March 2016
Test Sample Serial Numbers:	S1000805A021600023 & S1000805A071600029		

FCC Reference:	Parts 15.255(c) & 15.209
Test Method Used:	ANSI C63.10 Sections 6.3, 6.6, 9.8, 9.9, 9.12 & 9.13
Frequency Range:	1 GHz to 200 GHz

Environmental Conditions:

Temperature (°C):	22 to 25
Relative Humidity (%):	32 to 34

Transmitter Radiated Spurious Emissions (continued)

Note(s):

1. Pre-scans were performed with the EUT transmitting on middle channel in QPSK mode, as this was found to transmit the highest power and therefore deemed worst case.
2. The EUT had the integral flat panel antenna connected during testing.
3. The final measured value, for the given emission in the field strength result tables, incorporates the calibrated antenna factor and cable loss.
4. In accordance with ANSI C63.10 Section 6.6.4.3, the frequency and amplitude of the six highest spurious emissions relative to the limit were recorded in the result tables.
5. 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 1.5 m 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.
6. In accordance with ANSI C63.10 Section 6.6.4.3, Note 1, if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.
7. Emissions above 40 GHz not identified by markers were investigated and found to be false emissions generated by the harmonic mixer.
8. The emission identified by marker 2 on the 50 - 60 GHz plots is the fundamental.
9. Part 15.255(c)(3) defines a power density limit of 90pW/cm^2 at 3 metres for spurious emissions between 40 GHz and 200 GHz. This was converted to a field strength limit of 85.31 dBuV/m using the equations provided in section 9.6 of ANSI C63.10.
10. Measurements distances above 40 GHz were determined using the procedure defined in section 9.8 of ANSI C63.10. Measurements were made at the following distances:

    40 GHz to 75 GHz – 3 metres
    75 GHz to 110 GHz – 50 centimetres
    110 GHz to 170 GHz – 30 centimetres
    170 GHz to 200 GHz – 3 centimetres

11. Where measurements were performed at a distance other than that specified by the limit, a correction factor was calculated using the equation provided in section 9.4 of ANSI C63.10. This correction factor was included in the reference level offset entered on the signal analyser.
12. The test sample with serial number S1000805A071600029 was used for measurements from 1 GHz to 18 GHz.
13. The test sample with serial number S1000805A021600023 was used for measurements from 18 GHz to 200 GHz.

Transmitter Radiated Spurious Emissions (continued)

Results: Bottom Channel / Peak

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2250.034	Horizontal	46.3	54.0	7.7	Complied
3600.090	Horizontal	48.9	54.0	5.1	Complied
5390.895	Horizontal	44.5	54.0	9.5	Complied
5681.772	Horizontal	46.0	54.0	8.0	Complied
5765.622	Horizontal	46.1	54.0	7.9	Complied
6299.912	Horizontal	47.1	54.0	6.9	Complied

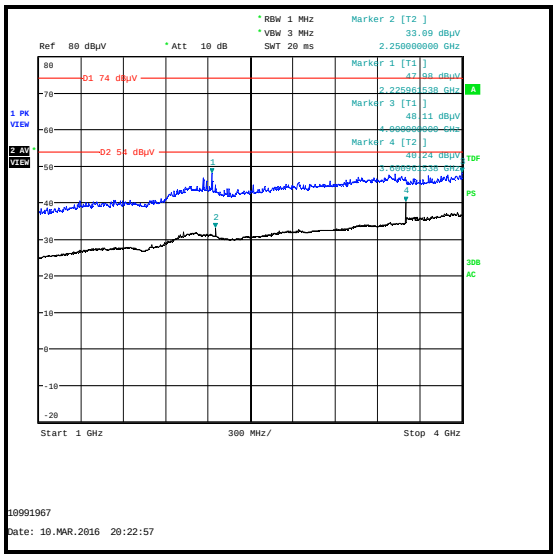
Results: Middle Channel / Peak

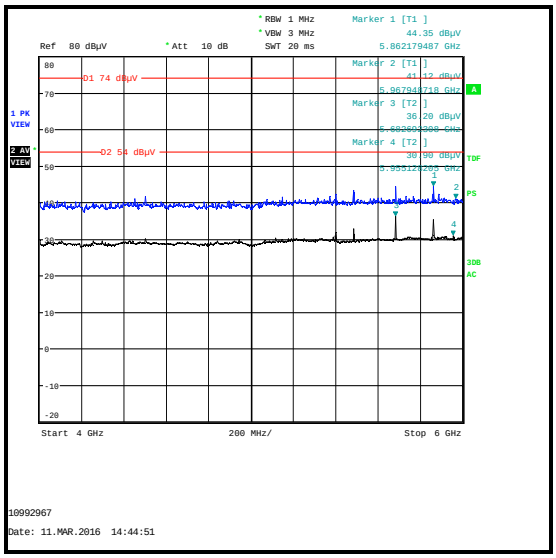
Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2250.583	Horizontal	46.7	54.0	7.3	Complied
3600.179	Horizontal	49.1	54.0	4.9	Complied
5484.245	Horizontal	45.2	54.0	8.8	Complied
5681.759	Vertical	47.0	54.0	7.0	Complied
5859.195	Horizontal	46.0	54.0	8.0	Complied
6299.280	Vertical	47.5	54.0	6.5	Complied

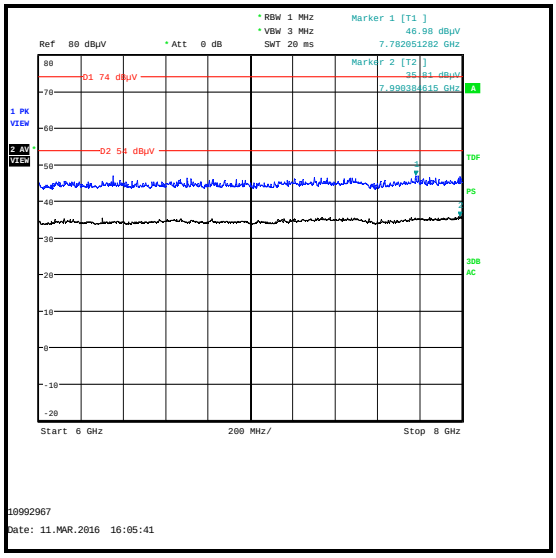
Results: Top Channel / Peak

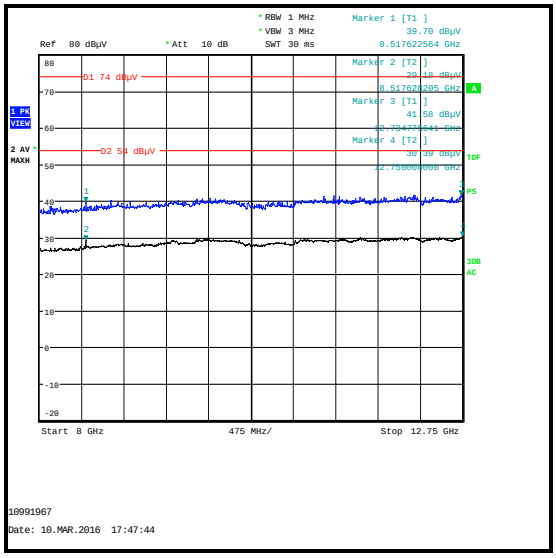
Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2249.910	Horizontal	46.6	54.0	7.4	Complied
3600.179	Horizontal	49.1	54.0	4.9	Complied
5578.163	Horizontal	45.5	54.0	8.5	Complied
5681.656	Horizontal	46.1	54.0	7.9	Complied
5953.285	Horizontal	45.4	54.0	8.6	Complied
6299.840	Vertical	47.3	54.0	6.7	Complied

Transmitter Out of Band Radiated Emissions (continued)



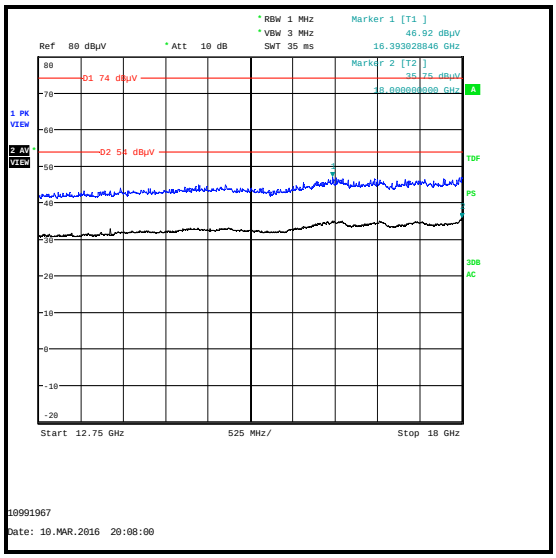


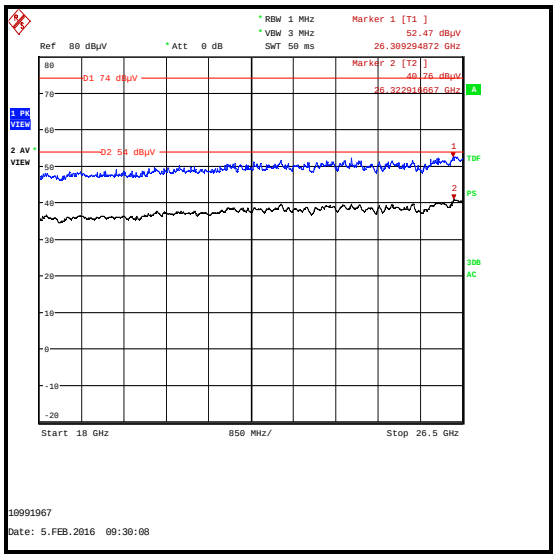


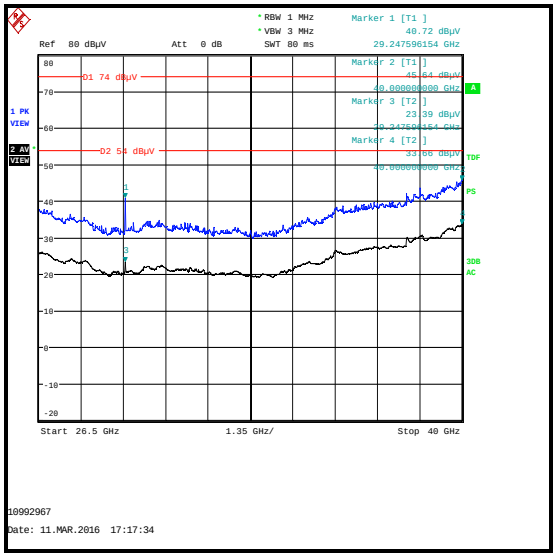


Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Out of Band Radiated Emissions (continued)

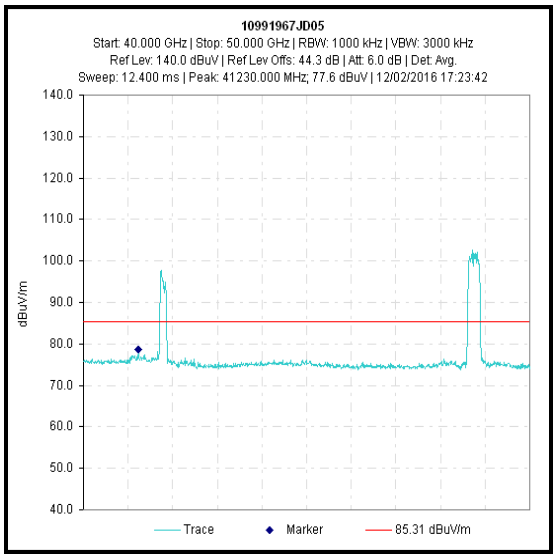


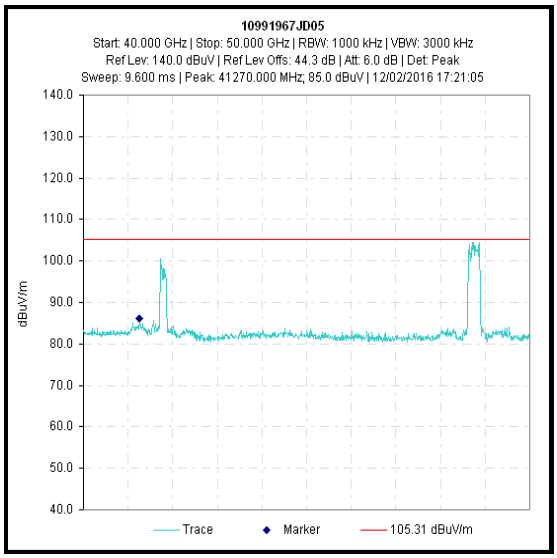


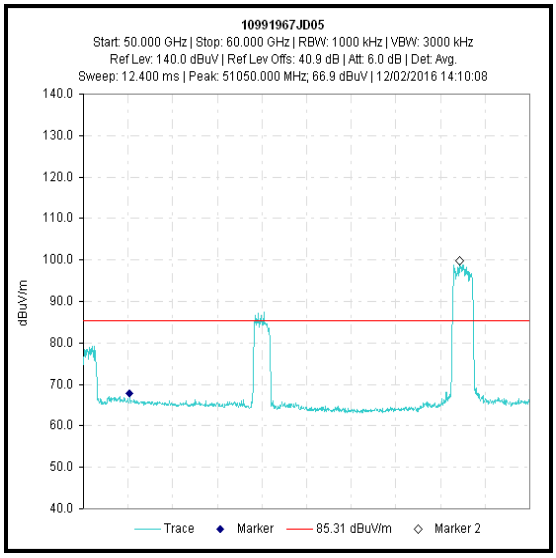


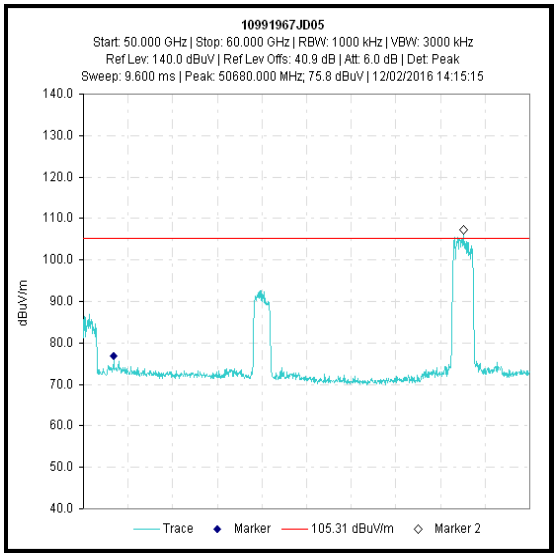
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Out of Band Radiated Emissions (continued)



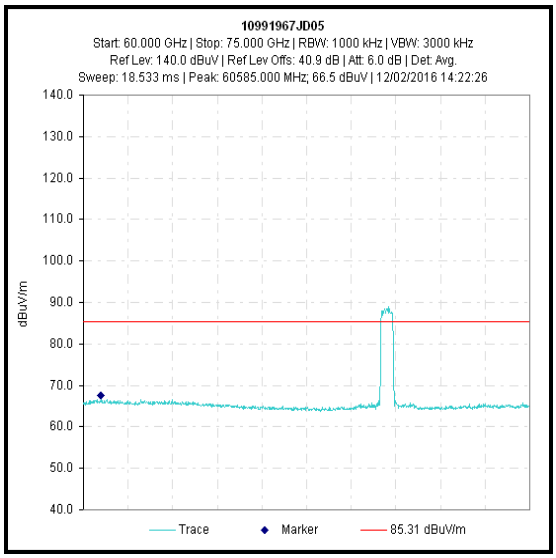


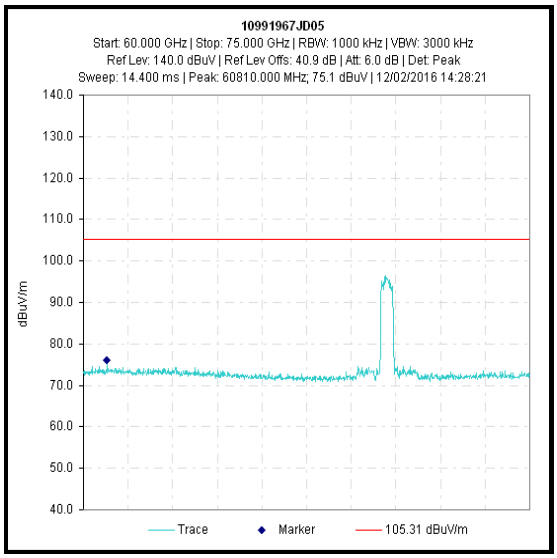


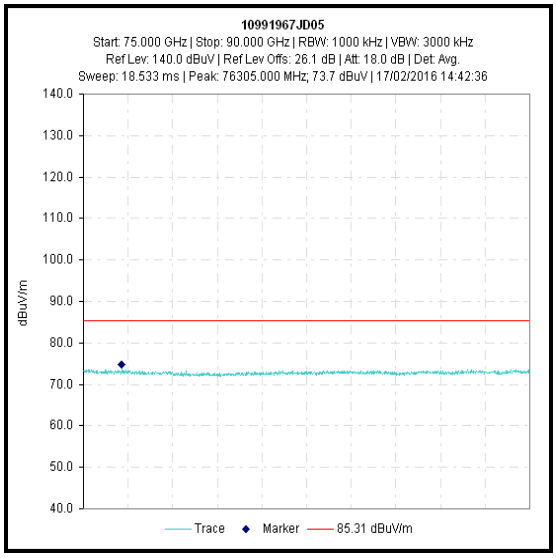


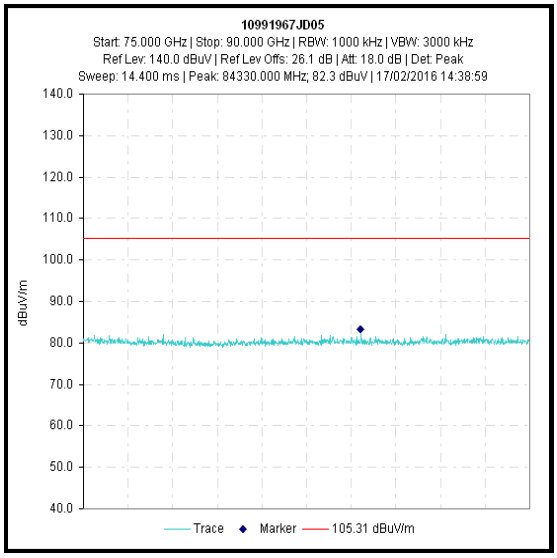
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Out of Band Radiated Emissions (continued)



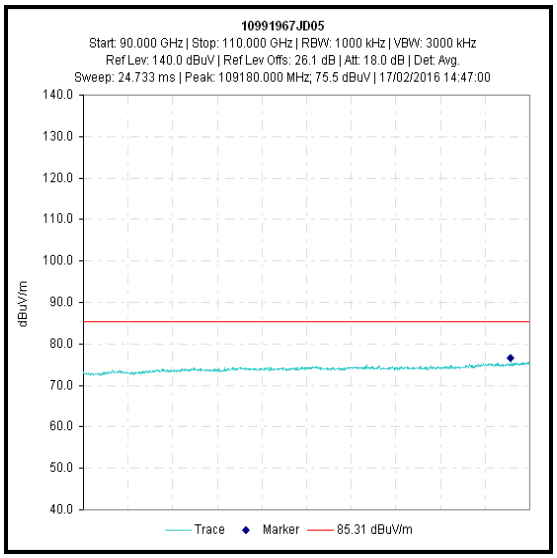


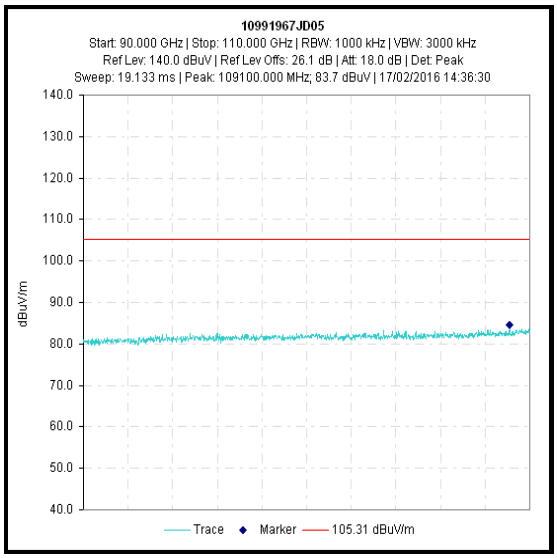


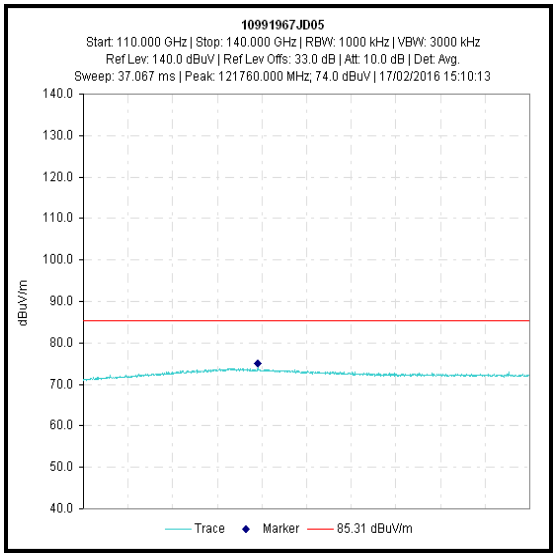


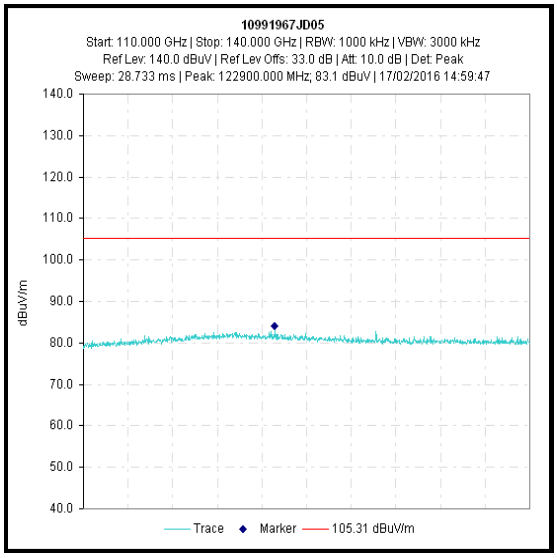
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Out of Band Radiated Emissions (continued)



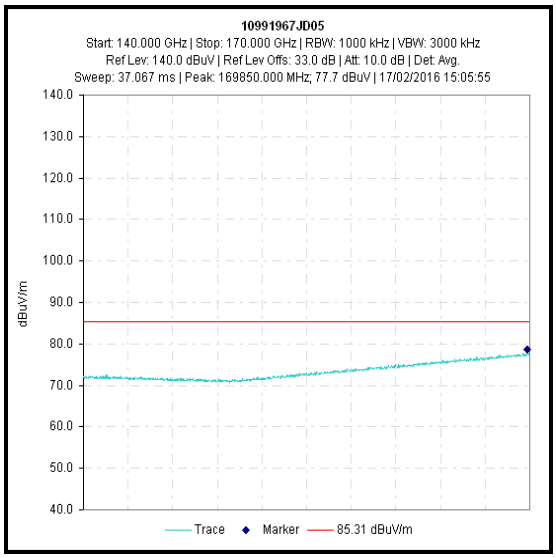


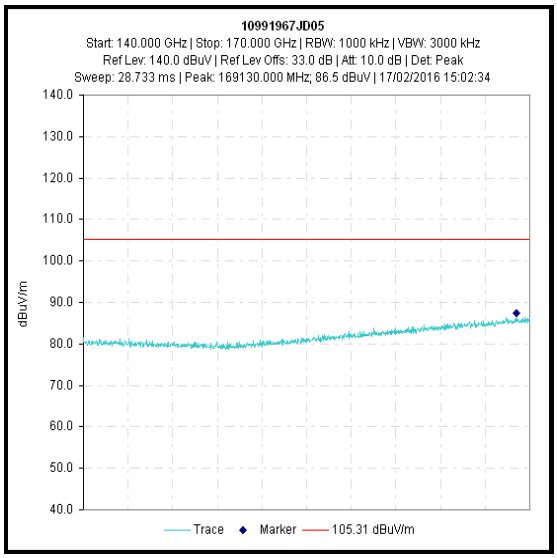


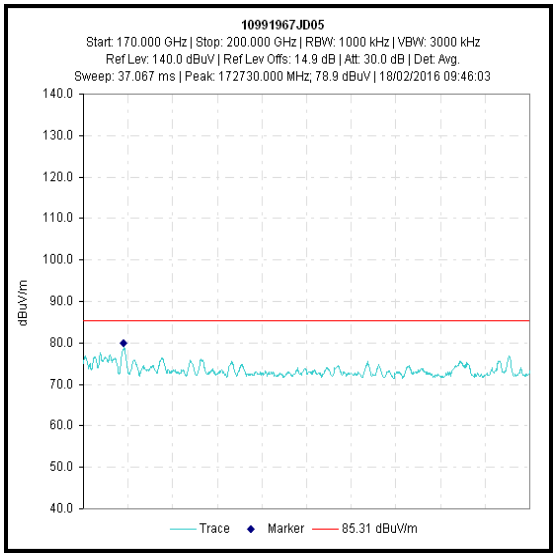


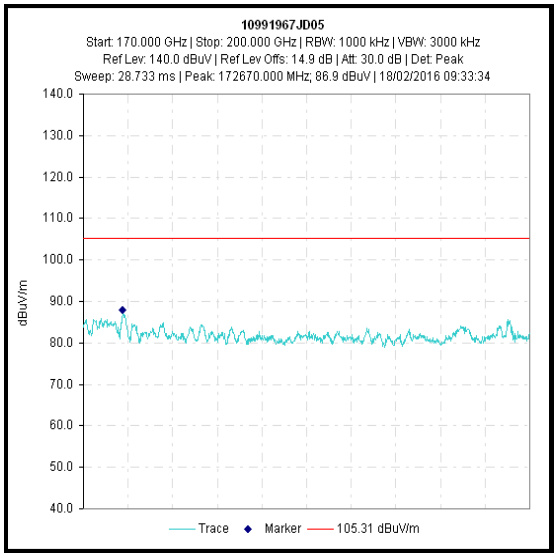
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Out of Band Radiated Emissions (continued)









Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Out of Band Radiated Emissions (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Dec 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	12 Jun 2016	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	19 Dec 2016	12
A1818	Antenna	EMCO	3115	00075692	17 Dec 2016	12
A253	Antenna	Flann Microwave	12240-20	128	17 Dec 2016	12
A254	Antenna	Flann Microwave	14240-20	139	17 Dec 2016	12
A255	Antenna	Flann Microwave	16240-20	519	17 Dec 2016	12
A256	Antenna	Flann Microwave	18240-20	400	17 Dec 2016	12
A436	Antenna	Flann Microwave	20240-20	330	19 Dec 2016	12
M1630	Test Receiver	Rohde & Schwarz	ESU40	100233	17 Feb 2017	12
A203	Antenna	Flann Microwave	22240-20	343	19 May 2016	36
A1785	Pre Amplifier	Farran Technology	FLNA-28-30	FTL 6483	12 Jan 2017	12
S0537	DC Power Supply	TTi	EL302D	249928	Calibrated before use	-
M122	Multimeter	Fluke	77	64910017	22 Apr 2016	-
M1623	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	11 Jan 2017	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	19 Mar 2016	12
G0543	Amplifier	Sonoma	310N	230801	29 May 2016	3
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	19 Mar 2016	12
A259	Antenna	Chase	CBL6111	1513	09 Apr 2016	12
M1832	Signal Analyser	Agilent	N9010A	MY53470303	26 Mar 2016	24
M197	Harmonic Mixer	Hewlett Packard	11970U	2332A00782	30 Sep 2017	36
A202	Horn Antenna	Flann	24240-20	116	15 May 2018	36
M1776	Harmonic Mixer	Agilent	M1970V	MY51390800	03 Mar 2016*	24
A1916	Horn Antenna	Flann	25240-25	166399	15 May 2016	36
M1167	Harmonic Mixer	Hewlett Packard	11970W	2521A01524	31 Oct 2017	36
A1245	Horn Antenna	Dorado	GH-10-25	200010	15 May 2016	36
M1734	Harmonic Mixer	Farran	WHMB-06-0002	FTL9100	03 Mar 2016*	36
A1928	Horn Antenna	Flann	29240-20	166411	15 May 2016	36
M1517	Harmonic Mixer	Farran	WHM-04	FTL7153	10 Jan 2017	36
A1930	Horn Antenna	Link Microtek	None stated	None stated	15 May 2016	36

**Note: All equipment was within its calibration period at the time of test.*

5.2.6. Transmitter Frequency Stability (Temperature Variation)

Test Summary:

Test Engineer:	Ben Mercer	**Test Dates:**	05 February 2016 & 08 February 2016
Test Sample Serial Number:	S1000805A431500020		

FCC Reference:	Parts 15.255(f), 15.215(c) & 2.1055
Test Method Used:	ANSI C63.10 Section 9.14

Environmental Conditions:

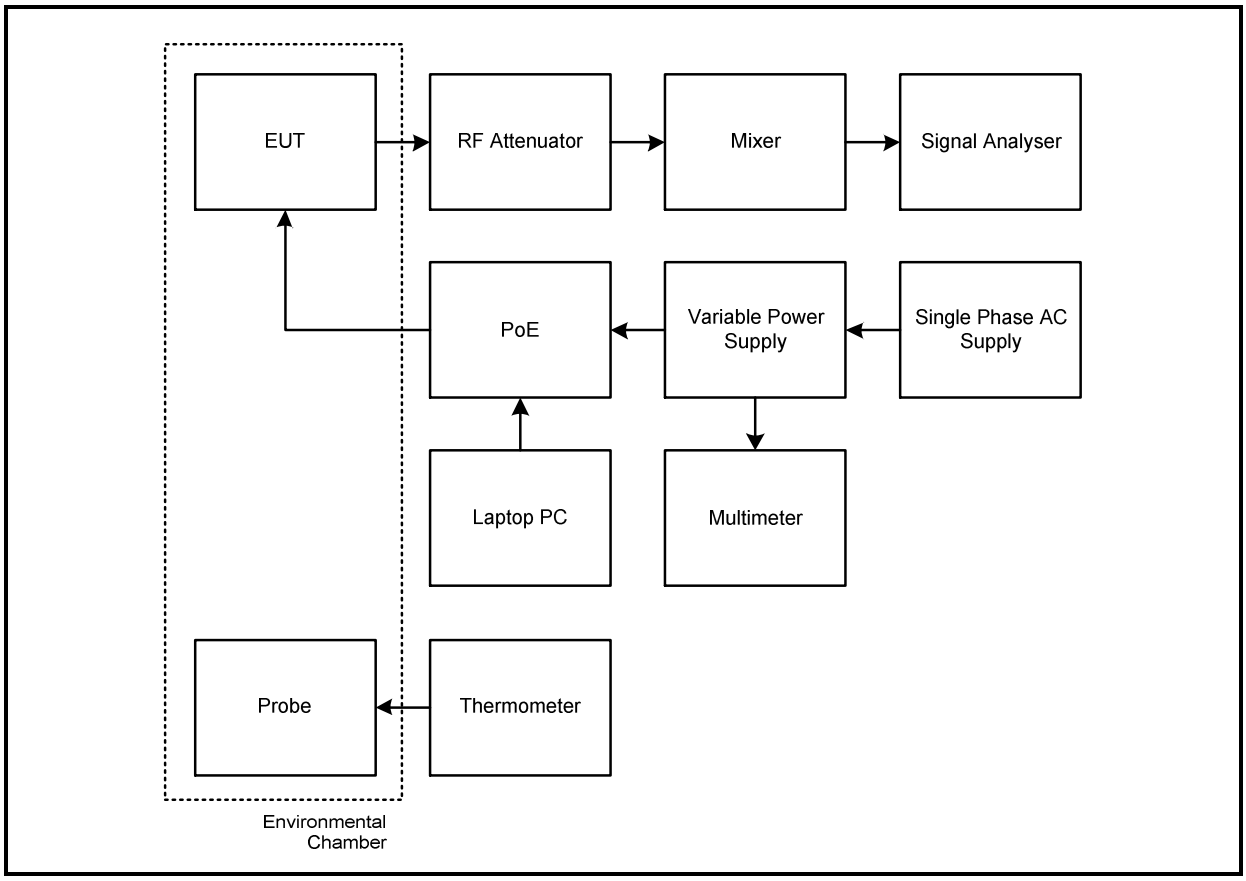
Ambient Temperature (°C):	24
Ambient Relative Humidity (%):	36 to 39

Note(s):

1. Frequency stability was measured using a signal analyser. The emission mask was recorded on the signal analyser at bottom and top channel, and a marker placed 20 dB below the peak on the lower and upper emission edges respectively. The marker frequency value was then compared to the band edge. An inquiry was made to the FCC OET regarding this test method, and the response confirmed this method is acceptable.
2. Plots for all measurements are archived on the Company server and available for inspection upon request.
3. Frequency stability was measured at 10°C intervals between the customer's declared operating range of -40°C to 55°C.
4. Temperature was monitored throughout the test with a calibrated digital thermometer.

Transmitter Frequency Stability (Temperature Variation) (continued)

Test setup:



Transmitter Frequency Stability (Temperature Variation) (continued)

Results: QPSK / Bottom Channel / Lower Band Edge

Temperature (ºC)	Lower Band Edge Frequency (MHz)	Lower Emission Bandwidth Frequency (MHz)	Lower Emission Bandwidth Frequency to Band Edge Margin (MHz)	Result
-40	57000	57262	262	Complied
-30	57000	57262	262	Complied
-20	57000	57262	262	Complied
-10	57000	57261	261	Complied
0	57000	57259	259	Complied
10	57000	57259	259	Complied
20	57000	57256	256	Complied
30	57000	57256	256	Complied
40	57000	57256	256	Complied
50	57000	57257	257	Complied
55	57000	57257	257	Complied

Results: QPSK / Top Channel / Upper Band Edge

Temperature (ºC)	Upper Band Edge Frequency (MHz)	Upper Emission Bandwidth Frequency (MHz)	Upper Emission Bandwidth Frequency to Band Edge Margin (MHz)	Result
-40	64000	59740	4260	Complied
-30	64000	59740	4260	Complied
-20	64000	59740	4260	Complied
-10	64000	59740	4260	Complied
0	64000	59740	4260	Complied
10	64000	59740	4260	Complied
20	64000	59739	4261	Complied
30	64000	59739	4261	Complied
40	64000	59738	4262	Complied
50	64000	59738	4262	Complied
55	64000	59738	4262	Complied

Transmitter Frequency Stability (Temperature Variation) (continued)

Results: 8PSK / Bottom Channel / Lower Band Edge

Temperature (ºC)	Lower Band Edge Frequency (MHz)	Lower Emission Bandwidth Frequency (MHz)	Lower Emission Bandwidth Frequency to Band Edge Margin (MHz)	Result
-40	57000	57259	259	Complied
-30	57000	57259	259	Complied
-20	57000	57259	259	Complied
-10	57000	57259	259	Complied
0	57000	57258	258	Complied
10	57000	57258	258	Complied
20	57000	57257	257	Complied
30	57000	57258	258	Complied
40	57000	57259	259	Complied
50	57000	57259	259	Complied
55	57000	57259	259	Complied

Results: 8PSK / Top Channel / Upper Band Edge

Temperature (ºC)	Upper Band Edge Frequency (MHz)	Upper Emission Bandwidth Frequency (MHz)	Upper Emission Bandwidth Frequency to Band Edge Margin (MHz)	Result
-40	64000	59741	4259	Complied
-30	64000	59740	4260	Complied
-20	64000	59740	4260	Complied
-10	64000	59739	4261	Complied
0	64000	59739	4261	Complied
10	64000	59737	4263	Complied
20	64000	59738	4262	Complied
30	64000	59738	4262	Complied
40	64000	59738	4262	Complied
50	64000	59738	4262	Complied
55	64000	59738	4262	Complied

Transmitter Frequency Stability (Temperature Variation) (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	None stated	23 Apr 2016	12
M1832	Signal Analyser	Agilent	N9010A	MY53470303	26 Mar 2016	24
M1776	Harmonic Mixer	Agilent	M1970V	MY51390800	03 Mar 2016	24
A2328	Attenuator	Flann	26081-06	194950	Calibrated before use	-
A2329	Attenuator	Flann	26081-10	207002	Calibrated before use	-
E0513	Environmental Chamber	TAS	LT600 Series 3	23900506	Calibrated before use	-
M1249	Thermometer	Fluke	52II	88800049	27 May 2016	12
A2331	Waveguide Straight	Flann	26441	210595	Calibrated before use	-
A2332	Waveguide Straight	Flann	26441	210596	Calibrated before use	-

5.2.7. Transmitter Frequency Stability (Voltage Variation)

Test Summary:

Test Engineer:	Ben Mercer	**Test Date:**	05 February 2016
Test Sample Serial Number:	S1000805A431500020		

FCC Reference:	Parts 15.255(f), 15.215(c) & 2.1055
Test Method Used:	ANSI C63.10 Section 9.14

Environmental Conditions:

Ambient Temperature (°C):	24
Ambient Relative Humidity (%):	39

Note(s):

1. Frequency stability was measured using a signal analyser. The emission mask was recorded on the signal analyser at bottom and top channel, and a marker placed 20 dB below the peak on the lower and upper emission edges respectively. The marker frequency value was then compared to the band edge. An inquiry was made to the FCC OET regarding this test method, and the response confirmed this method is acceptable.
2. Plots for all measurements are archived on the Company server and available for inspection upon request.
3. The input voltage to the PoE supply was varied between 85% and 115% using a variable AC power supply.
4. Voltage was monitored throughout the test with a calibrated digital voltmeter.

Transmitter Frequency Stability (Voltage Variation) (continued)

Results: QPSK / Bottom Channel / Lower Band Edge

Supply Voltage (VAC)	Lower Band Edge Frequency (MHz)	Lower Emission Bandwidth Frequency (MHz)	Lower Emission Bandwidth Frequency to Band Edge Margin (MHz)	Result
102.0	57000	57256	256	Complied
138.0	57000	57256	256	Complied

Results: QPSK / Top Channel / Upper Band Edge

Supply Voltage (VAC)	Upper Band Edge Frequency (MHz)	Upper Emission Bandwidth Frequency (MHz)	Upper Emission Bandwidth Frequency to Band Edge Margin (MHz)	Result
102.0	64000	59739	4261	Complied
138.0	64000	59739	4261	Complied

Results: 8PSK / Bottom Channel / Lower Band Edge

Supply Voltage (VAC)	Lower Band Edge Frequency (MHz)	Lower Emission Bandwidth Frequency (MHz)	Lower Emission Bandwidth Frequency to Band Edge Margin (MHz)	Result
102.0	57000	57259	259	Complied
138.0	57000	57259	259	Complied

Results: 8PSK / Top Channel / Upper Band Edge

Supply Voltage (VAC)	Upper Band Edge Frequency (MHz)	Upper Emission Bandwidth Frequency (MHz)	Upper Emission Bandwidth Frequency to Band Edge Margin (MHz)	Result
102.0	64000	59738	4262	Complied
138.0	64000	59738	4262	Complied

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	23 Apr 2016	12
M1832	Signal Analyser	Agilent	N9010A	MY53470303	26 Mar 2016	24
M1776	Harmonic Mixer	Agilent	M1970V	MY51390800	03 Mar 2016	24
A2328	Attenuator	Flann	26081-06	194950	Calibrated before use	-
A2329	Attenuator	Flann	26081-10	207002	Calibrated before use	-
S0539	Variable AC Power Supply	Kikusui	PCR 1000L	13010170	Calibrated before use	-
M1251	Digital Voltmeter	Fluke	175	89170179	26 May 2016	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”.

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Transmitter EIRP	57 to 64 GHz	95%	±0.99 dB
Transmitter Peak Output Power	57 to 64 GHz	95%	±0.99 dB
Transmitter 6 dB Bandwidth	57 to 64 GHz	95%	±3.92 %
Transmitter Radiated Emissions	30 MHz to 1 GHz	95%	±5.65 dB
Transmitter Radiated Emissions	1 GHz to 40 GHz	95%	±2.94 dB
Transmitter Radiated Emissions	40 GHz to 200 GHz	95%	±4.38 dB
Transmitter Frequency Stability	57 to 64 GHz	95%	±3.92 %

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	-	-	Sections 3.4 & 3.5 updated AC Conducted Spurious Emissions results added

--- END OF REPORT ---