



TEST REPORT

Test Report No. : UL-RPT-RP11241886JD07AE V4.0

Manufacturer : Apple Inc.
Model No. : A1779
FCC ID : BCG-E3086A
Technology : CDMA BC10
Test Standard(s) : FCC Part 90 Subpart S

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 4.0 supersedes all previous versions.

Date of Issue: 03 August 2016

Checked by:

Ian Watch
Senior Engineer, Radio Laboratory

Company Signatory:

Steven White
Service Lead, Radio Laboratory
UL VS LTD



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

UL VS LTD

Pavilion A, Ashwood Park, Ashwood Way, Basingstoke, Hampshire, RG23 8BG, UK
Telephone: +44 (0)1256 312000
Facsimile: +44 (0)1256 312001

This page has been left intentionally blank.

Table of Contents

1. Customer Information.....	4
2. Summary of Testing.....	5
2.1. General Information	5
2.2. Summary of Test Results	5
2.3. Methods and Procedures	5
2.4. Deviations from the Test Specification	5
3. Equipment Under Test (EUT)	6
3.1. Identification of Equipment Under Test (EUT)	6
3.2. Description of EUT	7
3.3. Modifications Incorporated in the EUT	7
3.4. Additional Information Related to Testing	8
3.5. Support Equipment	9
4. Operation and Monitoring of the EUT during Testing	10
4.1. Operating Modes	10
4.2. Configuration and Peripherals	10
5. Measurements, Examinations and Derived Results.....	11
5.1. General Comments	11
5.2. Test Results	12
5.2.1. Transmitter E.R.P. - LAT	12
5.2.2. Transmitter E.R.P. - UAT	15
5.2.3. Transmitter Occupied Bandwidth	18
5.2.4. Transmitter Out of Band Radiated Emissions - LAT	23
5.2.5. Transmitter Out of Band Radiated Emissions - UAT	27
5.2.6. Transmitter Radiated Emissions at Band Edges - LAT	30
5.2.7. Transmitter Radiated Emissions at Band Edges - UAT	34
5.2.8. Transmitter Frequency Stability (Temperature Variation)	38
5.2.9. Transmitter Frequency Stability (Voltage Variation)	40
6. Measurement Uncertainty	42
7. Report Revision History	43

1. Customer Information

Company Name:	Apple Inc.
Address:	1 Infinite Loop Cupertino, CA 95014 U.S.A

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR90
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 90 Subpart S – Regulations Governing Licensing and Use of Frequencies in the 806-824, 851-869, 896-901 and 935-940 MHz Bands
Site Registration:	209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	17 June 2016 to 26 July 2016

2.2. Summary of Test Results

FCC Reference	Measurement	Result
Part 90.635(b) / 2.1046	Transmitter Output Power and E.R.P.	
2.1049	Transmitter Occupied Bandwidth	
Part 90.691 / 2.1053	Transmitter Out of Band Radiated Emissions	
Part 90.691 / 2.1053	Transmitter Band Edge Radiated Emissions	
Part 90.213 / 2.1055	Transmitter Frequency Stability (Temperature and Voltage Variation)	
Key to Results  = Complied  = Did not comply		

2.3. Methods and Procedures

Reference:	FCC KDB 971168 D01 v02r02, October 17 2014
Title:	Measurement Guidance for Certification of Licensed Digital Transmitters

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:	Apple
Model Name or Number:	A1779
Test Sample ESN:	802CBA76 (<i>Conducted sample #1</i>)
Test Sample MEID:	Not Available
Hardware Version:	REV1.0
Software Version:	iOS: 14A241z BB FW: 0.16.04
FCC ID:	BCG-E3086A

Brand Name:	Apple
Model Name or Number:	A1779
Test Sample ESN:	80605FD5 (<i>Conducted sample #63</i>)
Test Sample MEID:	35864007009801
Hardware Version:	REV1.0
Software Version:	iOS: 14A241z BB FW: 0.16.04
FCC ID:	BCG-E3086A

Brand Name:	Apple
Model Name or Number:	A1779
Test Sample ESN:	8009F1B2 (<i>Radiated sample #36</i>)
Test Sample MEID:	35864007003321
Hardware Version:	REV1.0
Software Version:	iOS: 14A241z BB FW: 0.16.04
FCC ID:	BCG-E3086A

Brand Name:	Apple
Model Name or Number:	A1779
Test Sample ESN:	8010C1F5 (<i>Radiated sample #38</i>)
Test Sample MEID:	35864007000102
Hardware Version:	REV1.0
Software Version:	iOS: 14A241z BB FW: 0.16.04
FCC ID:	BCG-E3086A
Brand Name:	Apple

Model Name or Number:	A1779
Test Sample ESN:	803ADADF (<i>Conducted sample #62</i>)
Test Sample MEID:	35864007009804
Hardware Version:	REV1.0
Software Version:	iOS: 14A241z BB FW: 0.16.04
FCC ID:	BCG-E3086A

3.2. Description of EUT

The Equipment Under Test was a mobile phone with GSM/GPRS/EGPRS/UMTS/LTE/TD-SCDMA and CDMA technologies. It also supports IEEE 802.11a/b/g/n/ac, Bluetooth®, GPS and NFC. The rechargeable battery is not user accessible.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Technology Tested:	CDMA BC10		
Type of Radio Device:	Transceiver		
Modes:	1xRTT, EV-DO Rev 0 & EV-DO Rev A		
Modulation Type:	O-QPSK & H-PSK		
Power Supply Requirement(s):	Nominal	3.8 VDC	
	Minimum	3.5 VDC	
	Maximum	4.4 VDC	
Transmit Frequency Range:	816 to 824 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	450	817.25
	Middle	560	820.0
	Top	670	822.75

3.5. Support Equipment

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

Description:	Laptop PC
Brand Name:	Thinkpad
Model Name or Number:	Lenovo L440
Serial Number:	R9-019EA2 14/4

Description:	USB diagnostic cable
Brand Name:	Not stated
Model Name or Number:	Kong
Serial Number:	2074F9

Description:	Personal Hands Free (PHF)
Brand Name:	Apple
Model Name or Number:	Apple Ear Plugs
Serial Number:	Not stated

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

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

- Constantly transmitting at full power on bottom, middle and top channels as required.
- Occupied bandwidth, conducted power and band edge tests were performed with the EUT in 1xRTT and EV-DO modes.
- Transmitter radiated spurious emissions were checked in all modes during pre-scans. 1xRTT RC 1/1 was found to be the worst case and all final measurements were performed with the EUT in this mode.

4.2. Configuration and Peripherals

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

- The EUT was placed into a non-ui mode by using the teraterm application on a UL laptop PC. Instructions were provided by the customer to enable the baseband and radio (*Cellular_RSE_setup_V3.0.doc*). This enabled the EUT to connect via a radiated link with the Rohde & Schwarz CMW 500 system simulator operating in transceiver mode. The CMW 500 was used to configure the EUT operating mode.
- Transmitter radiated spurious emissions tests were performed with the PHF connected to the EUT as the declared by the customer. The EUT was placed in three orthogonal orientations X, Y and Z to determine the worst case orientation for radiated spurious emissions. The worst case orientation for the LAT was Z and for the UAT was Z. Measurements at band edges were performed with the PHF removed as this was found to be the worst case.
- The worst-case radiated emission among all accessories, is determined by the manufacturer to be with the headset connected. The compliance lab performed final testing only with the headset attached.
- Testing for frequency stability and measurements at temperature and voltage extremes was performed using a conducted sample supplied by the customer. Short 4-wire DC flying leads were connected internally to the device in place of the battery, and exited through a hole in the casing. These leads were then extended to a DC power supply for testing purposes.
- For conducted cellular measurements, the RF conducted port was created by removing a micro connector from the pcb antenna and extending it with a short flexible microstrip supplied by the customer. This microstrip exited the device through a hole in the casing and was terminated in a proprietary micro-coax to SMA adaptor.
- The device contains two cellular antennas which do not transmit simultaneously.
 - o LAT – Lower Antenna (Primary)
 - o UAT – Upper Antenna (Secondary)
- Where applicable, both antennas have been tested to demonstrate compliance

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 E.R.P. - LAT

Test Summary:

Test Engineer:	John Ferdinand	Test Date:	26 July 2016
Test Sample ESN:	803ADADF		

FCC Reference:	Part 90.635(b) / 2.1046
Test Method Used:	KDB 971168 D01 Section 2.2 footnote 1 & notes below

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	37

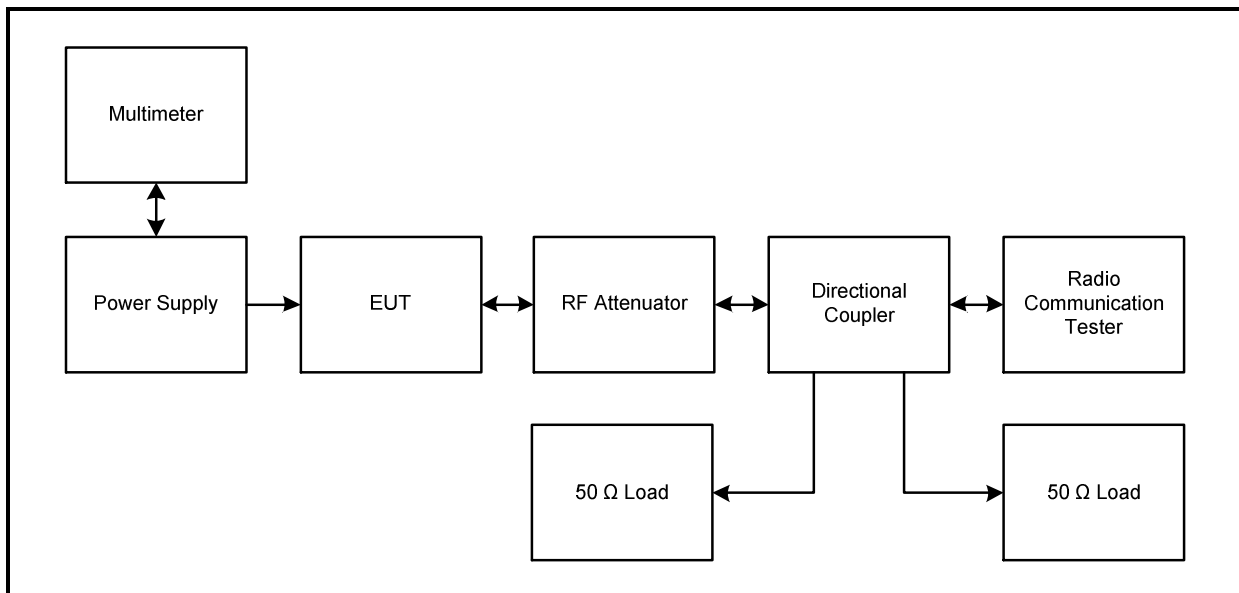
Note(s):

1. Transmitter average output power was measured using a Rohde & Schwarz CMW 500 following current Rohde & Schwarz measurement procedures. An RF level offset was entered on the CMW 500 to compensate for the loss of the directional coupler, attenuators and RF cables.
2. The manufacturer stated a maximum antenna gain of -3.74 dBi. The gain in dBi has been converted to gain in dBd for E.R.P. calculation. The gain in dBd was calculated as:

$$-3.74 \text{ dBi} - 2.15 \text{ dB} = -5.89 \text{ dBd.}$$

3. The antenna gain was added to the conducted output power to obtain the radiated power. The highest power recorded was subtracted from the limit to show the margin.

Test setup:



Transmitter E.R.P. (continued)**Results: 1xRTT**

Radio Configuration (RC)	Service Option (SO)	Conducted Output Power (dBm)		
		Ch. 450 / 817.25 MHz	Ch. 560 / 820.0 MHz	Ch. 670 / 822.75
		Average	Average	Average
RC1	2 (Loopback)	25.0	24.7	24.8
	55 (Loopback)	25.0	24.7	24.8
RC2	9 (Loopback)	25.0	24.9	24.8
	55 (Loopback)	25.0	24.9	24.8
RC3	2 (Loopback)	25.0	24.9	24.8
	55 (Loopback)	25.0	24.9	24.8
	32 (Test Data)	25.0	24.9	24.9
RC4	2 (Loopback)	25.0	24.9	24.9
	55 (Loopback)	25.0	24.9	24.9
	32 (Test Data)	25.0	24.9	24.9
RC5	55 (Loopback)	24.8	24.9	24.9

Channel	Frequency (MHz)	Highest Conducted Output Power (dBm)	Antenna Gain (dBd)	ERP (dBm)	ERP Limit (dBm)	Margin (dB)	Result
Bottom	817.25	25.0	-5.89	19.11	50.0	30.89	Complied
Middle	820.0	24.9	-5.89	19.01	50.0	30.99	Complied
Top	822.75	24.9	-5.89	19.01	50.0	30.99	Complied

Transmitter E.R.P. (continued)**Results: EV-DO Rev. 0**

FTAP Rate	RTAP Rate	Average Conducted Output Power (dBm)		
		Ch. 450 / 817.25 MHz	Ch. 560 / 820.0 MHz	Ch. 670 / 822.75
307.2 kbit/s	153.6 kbit/s	24.9	25.0	25.0

Channel	Frequency (MHz)	Conducted Output Power (dBm)	Antenna Gain (dBd)	ERP (dBm)	ERP Limit (dBm)	Margin (dB)	Result
Bottom	817.25	24.9	-5.89	19.01	50.0	30.99	Complied
Middle	820.0	25.0	-5.89	19.11	50.0	30.89	Complied
Top	822.75	25.0	-5.89	19.11	50.0	30.89	Complied

Results: EV-DO Rev. A

FETAP Format	RETAP Data Payload Size	Average Conducted Output Power (dBm)		
		Ch. 450 / 817.25 MHz	Ch. 560 / 820.0 MHz	Ch. 670 / 822.75
307.2 kbit/s	4096 bits	24.9	25.0	24.9

Channel	Frequency (MHz)	Conducted Output Power (dBm)	Antenna Gain (dBd)	ERP (dBm)	ERP Limit (dBm)	Margin (dB)	Result
Bottom	817.25	24.9	-5.89	19.01	50.0	30.99	Complied
Middle	820.0	25.0	-5.89	19.11	50.0	30.89	Complied
Top	822.75	25.0	-5.89	19.11	50.0	30.89	Complied

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	#1	02 Apr 2017	12
A2502	Directional Coupler	AtlanTecRF	CDC-003060	22501837	Calibrated before use	-
M1876	Radio Comms Tester	Rohde & Schwarz	CMW500	145919	Calibrated before use	-
M1869	Radio Comms Tester	Rohde & Schwarz	CMW500	145923	05 Apr 2017	12
M1883	Signal Analyser	Rohde & Schwarz	FSV	103003	09 May 2017	12
A2924	Attenuator	AtlanTecRF	AN18W5-20	None Stated	Calibrated before use	-

5.2.2. Transmitter E.R.P. - UAT**Test Summary:**

Test Engineer:	John Ferdinand	Test Date:	01 July 2016
Test Sample ESN:	80605FD5		

FCC Reference:	Part 90.635(b) / 2.1046
Test Method Used:	KDB 971168 D01 Section 2.2 footnote 1 & notes below

Environmental Conditions:

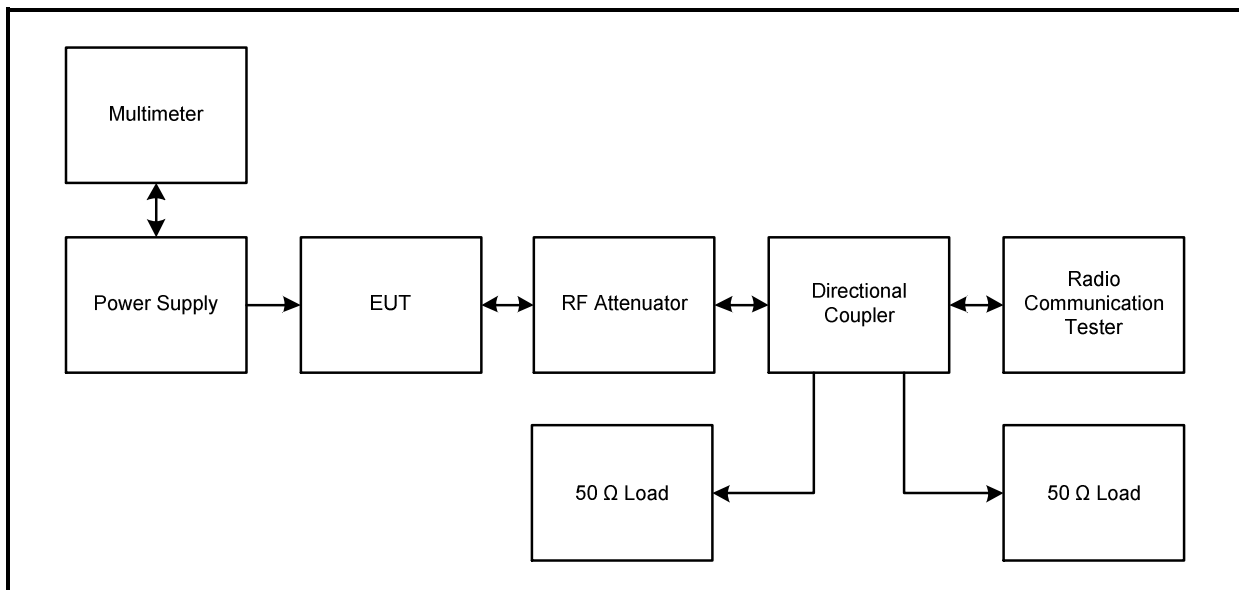
Temperature (°C):	22
Relative Humidity (%):	41

Note(s):

1. Transmitter average output power was measured using a Rohde & Schwarz CMW 500 following current Rohde & Schwarz measurement procedures. An RF level offset was entered on the CMW 500 to compensate for the loss of the directional coupler, attenuators and RF cables.
2. The manufacturer stated a maximum antenna gain of -2.89 dBi. The gain in dBi has been converted to gain in dBd for E.R.P. calculation. The gain in dBd was calculated as:

$$-2.89 \text{ dBi} - 2.15 \text{ dB} = -5.04 \text{ dBd}$$

3. The antenna gain was added to the conducted output power to obtain the radiated power. The highest power recorded was subtracted from the limit to show the margin.

Test setup:

Transmitter E.R.P. (continued)**Results: 1xRTT**

Radio Configuration (RC)	Service Option (SO)	Conducted Output Power (dBm)		
		Ch. 450 / 817.25 MHz	Ch. 560 / 820.0 MHz	Ch. 670 / 822.75
		Average	Average	Average
RC1	2 (Loopback)	21.1	20.9	20.9
	55 (Loopback)	21.1	20.9	20.9
RC2	9 (Loopback)	21.1	20.9	20.9
	55 (Loopback)	21.1	20.9	20.9
RC3	2 (Loopback)	21.1	20.9	20.9
	55 (Loopback)	21.1	20.9	20.9
	32 (Test Data)	21.1	20.9	20.9
RC4	2 (Loopback)	21.1	20.9	20.9
	55 (Loopback)	21.1	20.9	20.9
	32 (Test Data)	21.1	20.9	20.9
RC5	9 (Loopback)	21.1	20.9	20.9
	55 (Loopback)	21.1	20.9	20.9

Channel	Frequency (MHz)	Highest Conducted Output Power (dBm)	Antenna Gain (dBd)	ERP (dBm)	ERP Limit (dBm)	Margin (dB)	Result
Bottom	817.25	21.1	-5.04	16.06	50.0	33.94	Complied
Middle	820.0	20.9	-5.04	15.86	50.0	34.14	Complied
Top	822.75	20.9	-5.04	15.86	50.0	34.14	Complied

Transmitter E.R.P. (continued)**Results: EV-DO Rev. 0**

FTAP Rate	RTAP Rate	Average Conducted Output Power (dBm)		
		Ch. 450 / 817.25 MHz	Ch. 560 / 820.0 MHz	Ch. 670 / 822.75
307.2 kbit/s	153.6 kbit/s	21.5	21.3	21.3

Channel	Frequency (MHz)	Conducted Output Power (dBm)	Antenna Gain (dBd)	ERP (dBm)	ERP Limit (dBm)	Margin (dB)	Result
Bottom	817.25	21.5	-5.04	16.46	50.0	33.54	Complied
Middle	820.0	21.3	-5.04	16.26	50.0	33.74	Complied
Top	822.75	21.3	-5.04	16.26	50.0	33.74	Complied

Results: EV-DO Rev. A

FETAP Format	RETAP Data Payload Size	Average Conducted Output Power (dBm)		
		Ch. 450 / 817.25 MHz	Ch. 560 / 820.0 MHz	Ch. 670 / 822.75
307.2 kbit/s	4096 bits	21.4	21.3	21.4

Channel	Frequency (MHz)	Conducted Output Power (dBm)	Antenna Gain (dBd)	ERP (dBm)	ERP Limit (dBm)	Margin (dB)	Result
Bottom	817.25	21.4	-5.04	16.36	50.0	33.64	Complied
Middle	820.0	21.3	-5.04	16.26	50.0	33.74	Complied
Top	822.75	21.4	-5.04	16.36	50.0	33.64	Complied

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	#1	02 Apr 2017	12
A2502	Directional Coupler	AtlanTecRF	CDC-003060	22501837	Calibrated before use	-
M1876	Radio Comms Tester	Rohde & Schwarz	CMW500	145919	Calibrated before use	-
M1869	Radio Comms Tester	Rohde & Schwarz	CMW500	145923	05 Apr 2017	12
M1883	Signal Analyser	Rohde & Schwarz	FSV	103003	09 May 2017	12
A2924	Attenuator	AtlanTecRF	AN18W5-20	None Stated	Calibrated before use	-

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

Test Engineer:	John Ferdinand	Test Dates:	17 June 2016 & 01 July 2016
Test Sample ESN:	802CBA76		

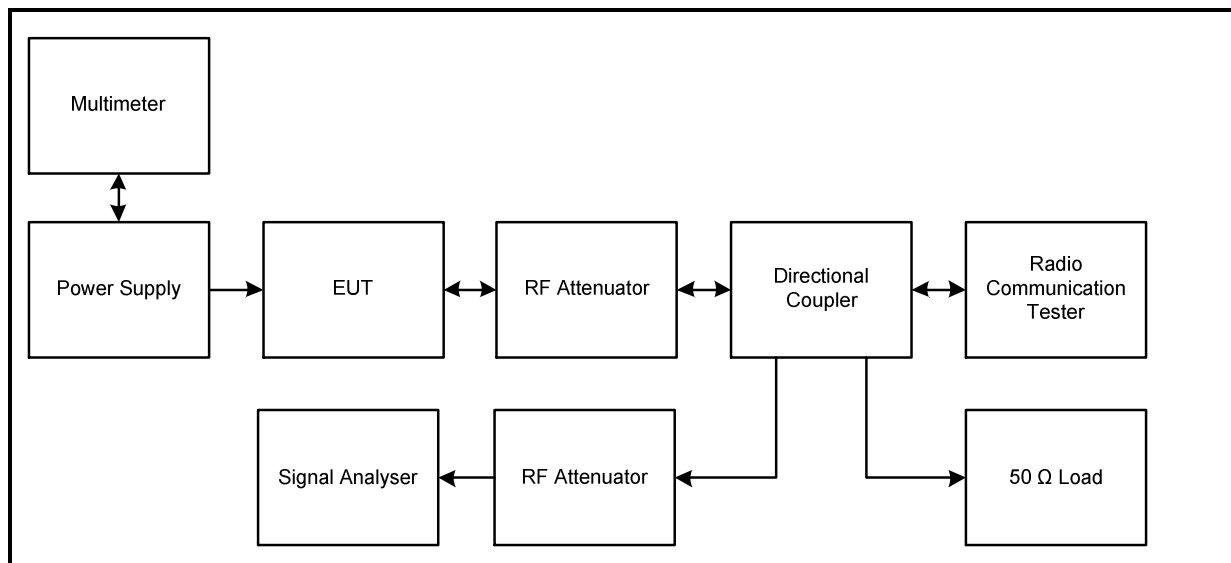
FCC Reference:	2.1049
Test Method Used:	FCC KDB 971168 D01 Sections 4.1 & 4.2

Environmental Conditions:

Temperature (°C):	20 to 24
Relative Humidity (%):	38 to 43

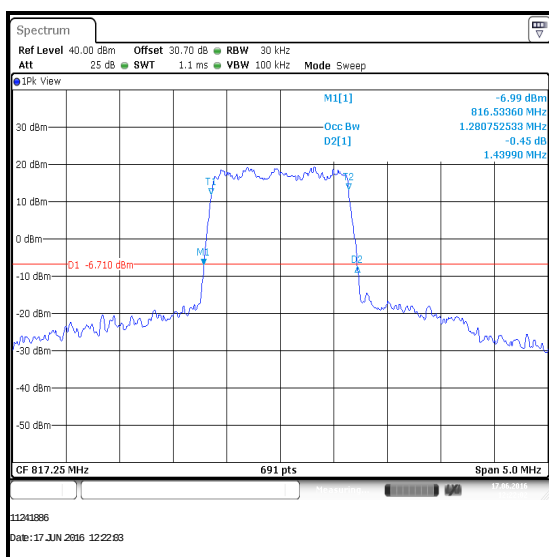
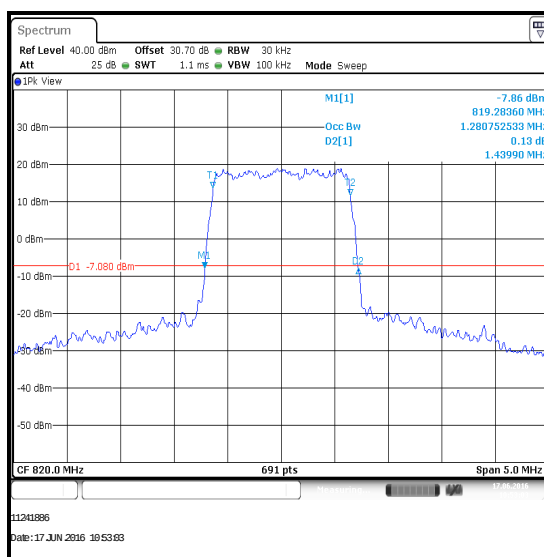
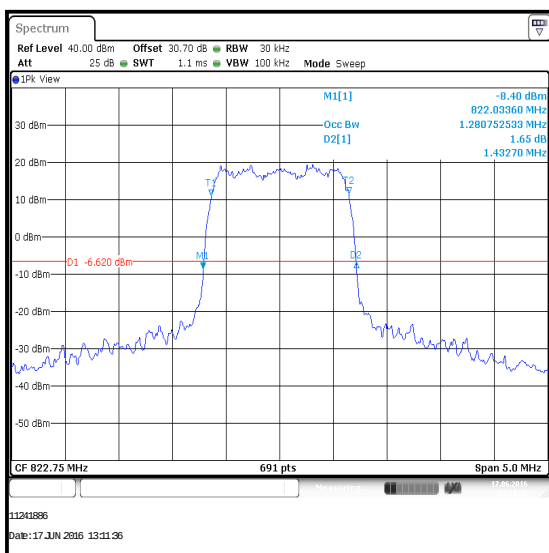
Note(s):

1. Occupied bandwidth (99% bandwidth) was measured using a signal analyser occupied bandwidth function. -26 dB bandwidths were also measured and recorded.
2. The RF port of the EUT was connected to the signal analyser via RF cables, directional coupler and suitable attenuation.

Test setup:

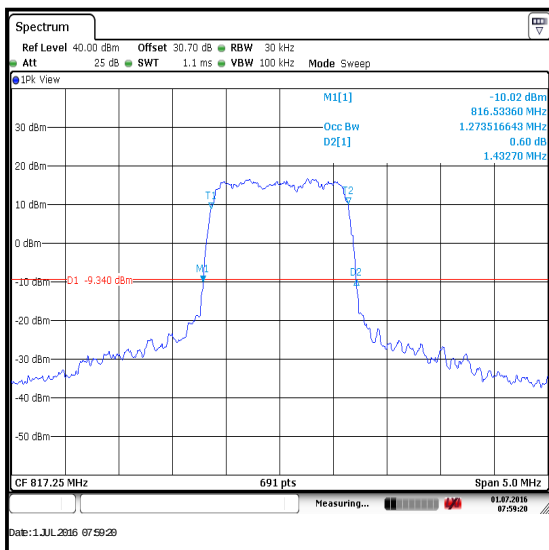
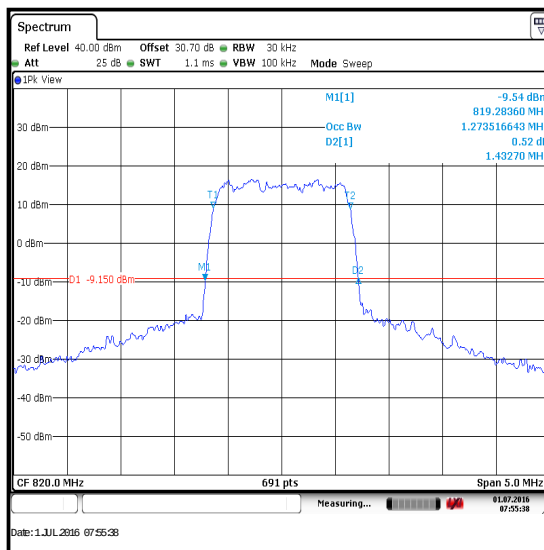
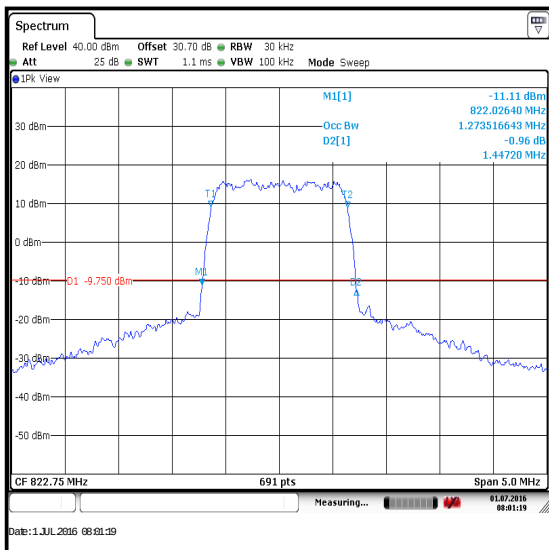
Transmitter Occupied Bandwidth (continued)**Results: 1xRTT**

Channel	Frequency (MHz)	99% Occupied Bandwidth (kHz)	-26 dB Bandwidth (kHz)
Bottom	817.25	1280.753	1439.900
Middle	820.0	1280.753	1439.900
Top	822.75	1280.753	1432.700

**Bottom Channel****Middle Channel****Top Channel**

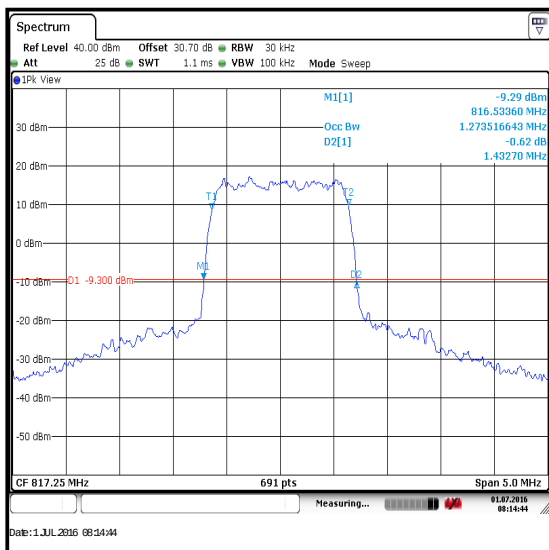
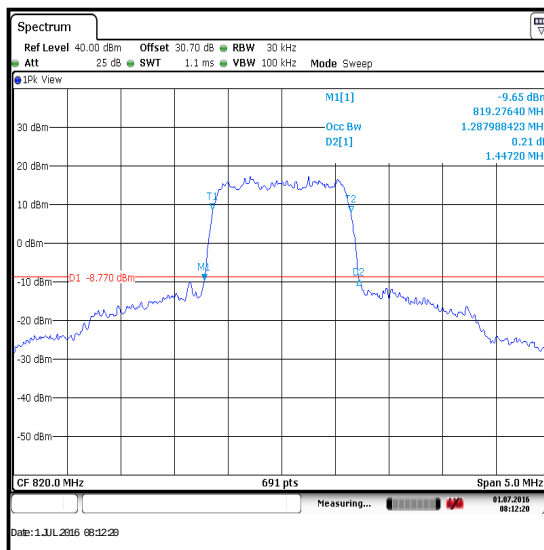
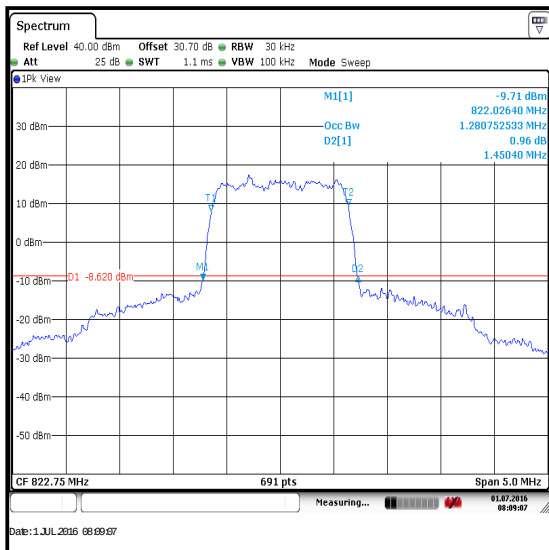
Transmitter Occupied Bandwidth (continued)**Results: EV-DO Rev. 0**

Channel	Frequency (MHz)	99% Occupied Bandwidth (kHz)	-26 dB Bandwidth (kHz)
Bottom	817.25	1273.517	1432.700
Middle	820.0	1273.517	1432.700
Top	822.75	1273.517	1447.200

**Bottom Channel****Middle Channel****Top Channel**

Transmitter Occupied Bandwidth (continued)**Results: EV-DO Rev. A**

Channel	Frequency (MHz)	99% Occupied Bandwidth (kHz)	-26 dB Bandwidth (kHz)
Bottom	817.25	1273.517	1432.700
Middle	820.0	1287.988	1447.200
Top	822.75	1280.753	1450.400

**Bottom Channel****Middle Channel****Top Channel**

Transmitter Occupied Bandwidth (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	#1	02 April 2017	12
A2502	Directional Coupler	AtlanTecRF	CDC-003060	22501837	Calibrated before use	-
M1883	Signal Analyser	Rohde & Schwarz	FSV	103003	09 May 2017	12
A2920	Attenuator	AlanTecRF	AN18W5-20	None Stated	Calibrated before use	-

5.2.4. Transmitter Out of Band Radiated Emissions - LAT**Test Summary:**

Test Engineer:	John Ferdinand	Test Dates:	18 June 2016 & 20 June 2016
Test Sample ESN:	8009F1B2		

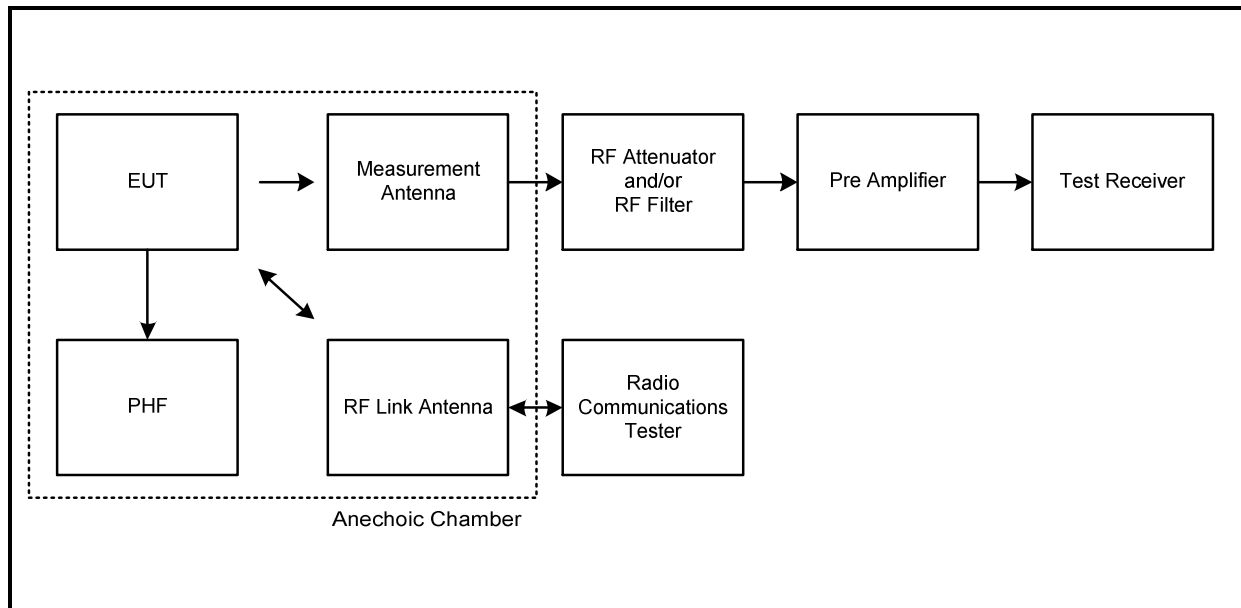
FCC Reference:	Part 90.691 / 2.1053
Test Method Used:	KDB 971168 D01 Section 6, Section 7 & Notes below
Frequency Range:	30 MHz to 9 GHz
Configuration:	1xRTT RC1/1

Environmental Conditions:

Temperature (°C):	20 to 24
Relative Humidity (%):	38 to 43

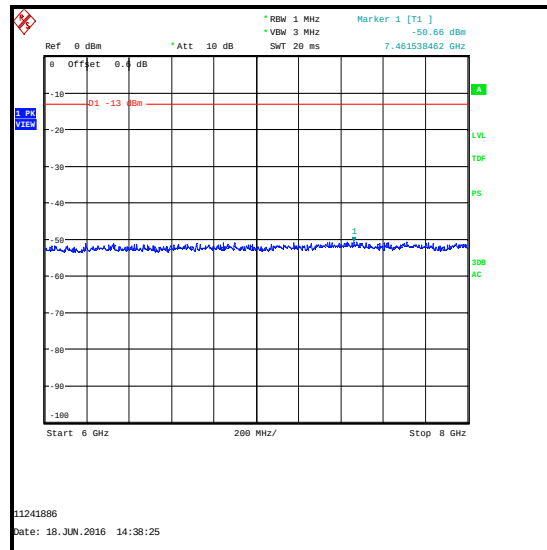
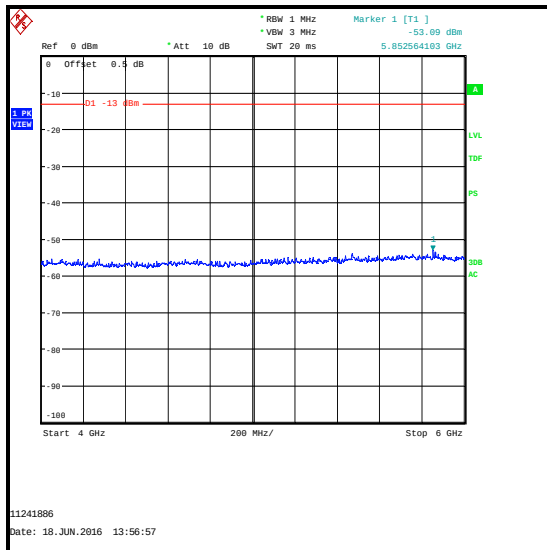
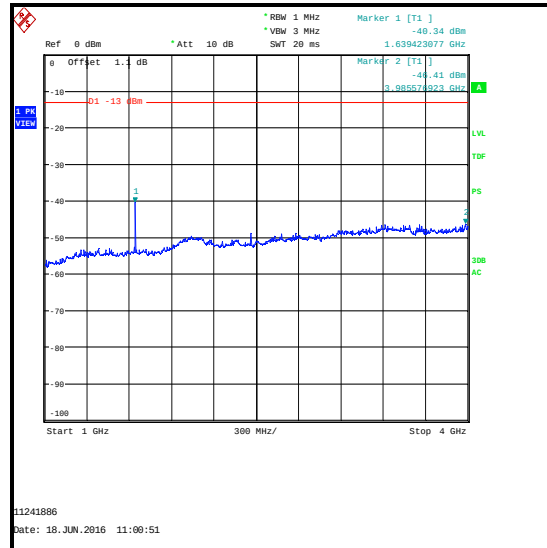
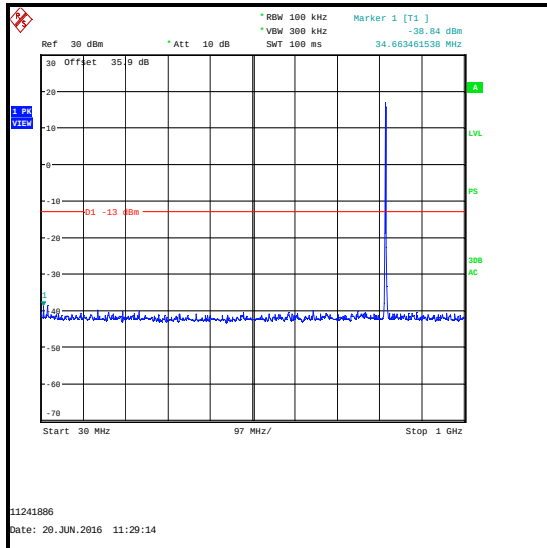
Note(s):

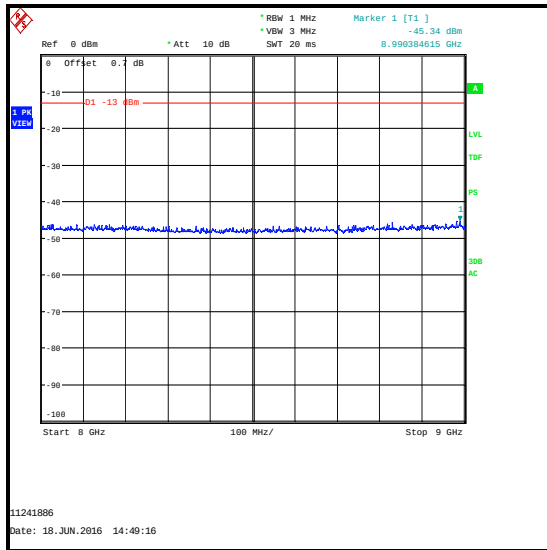
1. The uplink traffic channel is shown on the 30 MHz to 1 GHz plot.
2. All emissions shown on the pre-scan plots were investigated. The highest peak reading was > 20 dB below the applicable limit and recorded in the table below. All other emissions shown on the pre-scan plots were found to be below the measurement system noise floor or ambient or > 20 dB below the applicable limit.
3. Middle channel results are recorded in this report and are representative of bottom and top channel results which are held on the UL IT server and available for inspection on request.
4. Pre-scans 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. A peak detector and trace mode of Max Hold were used to perform pre-scans, with markers placed on the highest measured levels.
5. Radiated spurious emission testing between 150 kHz and 30 MHz was performed for support of the NFC test report. No spurious emissions were observed above the noise floor of the measurement system.

Transmitter Out of Band Radiated Emissions (continued)**Test setup:**

Transmitter Out of Band Radiated Emissions (continued)**Results: 1xRTT RC1/1 - Middle Channel**

Frequency (MHz)	Peak Level (dBm)	Limit (dBm)	Margin (dB)	Result
1639.423	-40.3	-13.0	27.3	Complied

Transmitter Out of Band Radiated Emissions (continued)

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	#1	02 Apr 2017	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Dec 2016	12
A1534	Pre-Amplifier	Hewlett Packard	8449B	3008A00405	19 Dec 2016	12
A288	Antenna	Chase	CBL6111A	1589	27 Aug 2016	12
A1818	Antenna	EMCO	00075692	3118	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
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 Mar 2017	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	30 Apr 2017	12
A1975	High Pass Filter	AtlanTecRF	AFH-03000	090424010	26 Apr 2017	12
A2467	High Pass Filter	Wainwright Instruments	WHJE5-920	SN2	09 Mar 2017	12

5.2.5. Transmitter Out of Band Radiated Emissions - UAT**Test Summary:**

Test Engineer:	John Ferdinand	Test Dates:	18 June 2016 & 20 June 2016
Test Sample ESN:	8010C1F5		

FCC Reference:	Part 90.691 / 2.1053
Test Method Used:	KDB 971168 D01 Section 6, Section 7 & Notes below
Frequency Range:	30 MHz to 9 GHz
Configuration:	1xRTT RC1/1

Environmental Conditions:

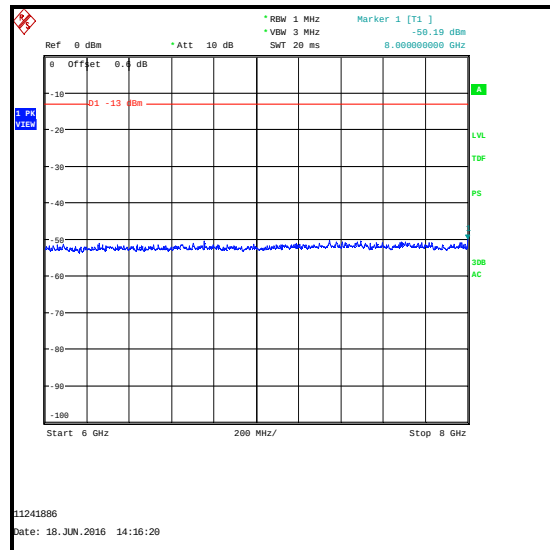
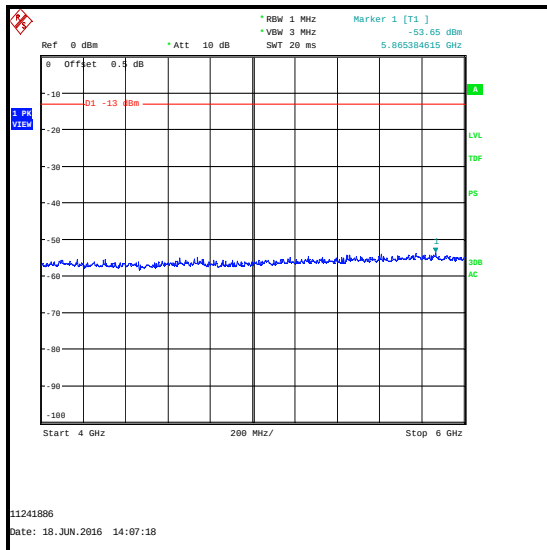
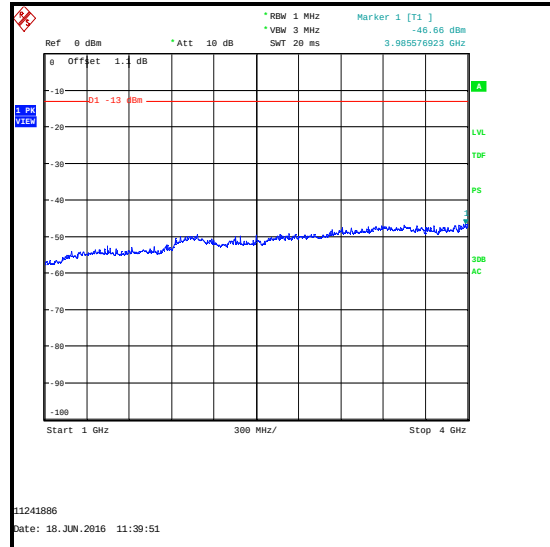
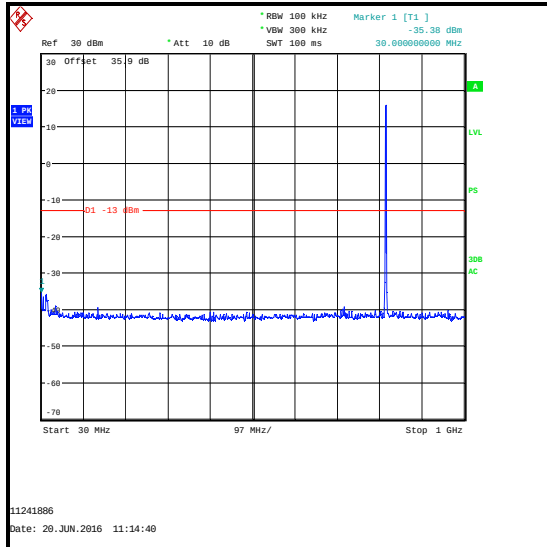
Temperature (°C):	20 to 24
Relative Humidity (%):	38 to 43

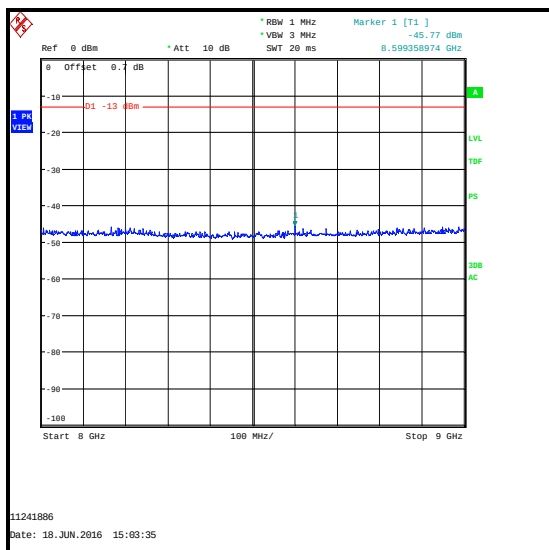
Note(s):

1. The uplink traffic channel is shown on the 30 MHz to 1 GHz plot.
2. All emissions shown on the pre-scan plots were found to be below the measurement system noise floor or ambient or > 20 dB below the applicable limit. The highest noise floor level was recorded.
3. Middle channel results are recorded in this report and are representative of bottom and top channel results which are held on the UL IT server and available for inspection on request.
4. Pre-scans 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. A peak detector and trace mode of Max Hold were used to perform pre-scans, with markers placed on the highest measured levels.
5. Radiated spurious emission testing between 150 kHz and 30 MHz was performed for support of the NFC test report. No spurious emissions were observed above the noise floor of the measurement system.

Transmitter Out of Band Radiated Emissions (continued)**Results: 1xRTT RC1/1 - Middle Channel**

Frequency (MHz)	Peak Level (dBm)	Limit (dBm)	Margin (dB)	Result
30.000	-35.4	-13.0	22.4	Complied



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	#1	02 Apr 2017	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Dec 2016	12
A1534	Pre-Amplifier	Hewlett Packard	8449B	3008A00405	19 Dec 2016	12
A288	Antenna	Chase	CBL6111A	1589	27 Aug 2016	12
A1818	Antenna	EMCO	00075692	3118	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
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 Mar 2017	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	30 Apr 2017	12
A1975	High Pass Filter	AtlanTecRF	AFH-03000	090424010	26 Apr 2017	12
A2467	High Pass Filter	Wainwright Instruments	WHJE5-920	SN2	09 Mar 2017	12

5.2.6. Transmitter Radiated Emissions at Band Edges - LAT**Test Summary:**

Test Engineer:	John Ferdinand	Test Dates:	29 June 2016 & 30 June 2016
Test Sample ESN:	8009F1B2		

FCC Reference:	Part 90.691 / 2.1053
Test Method Used:	KDB 971168 D01 Section 6, Section 7 & notes below

Environmental Conditions:

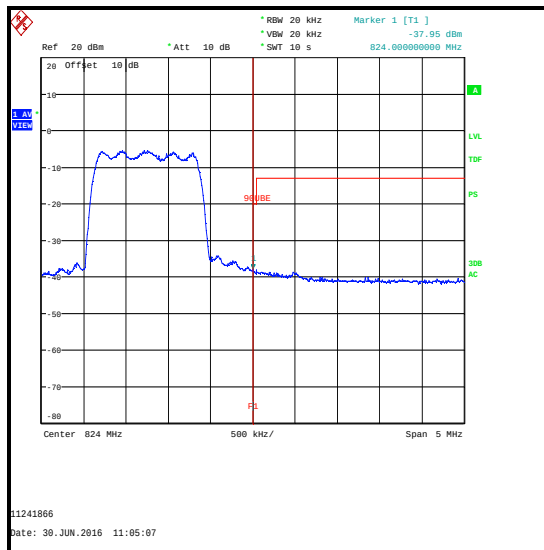
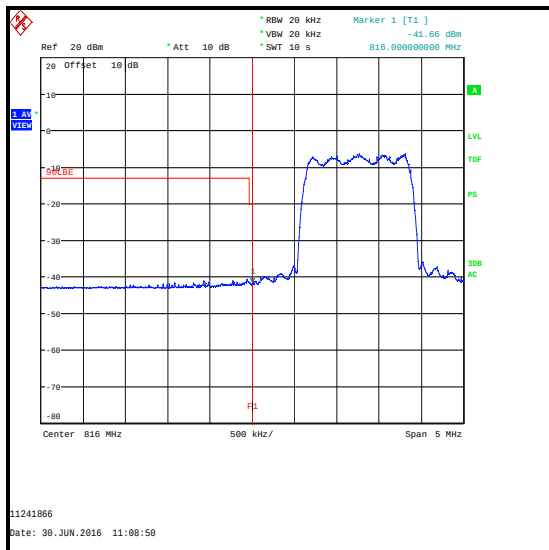
Temperature (°C):	21 to 23
Relative Humidity (%):	38 to 41

Note(s):

1. Measurements 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. The measurement antenna was placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT.

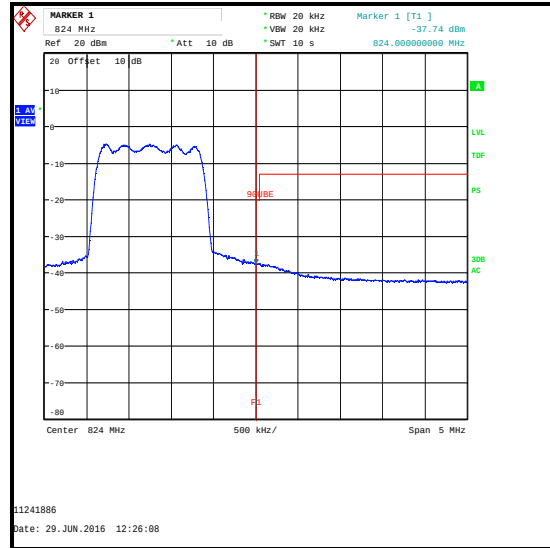
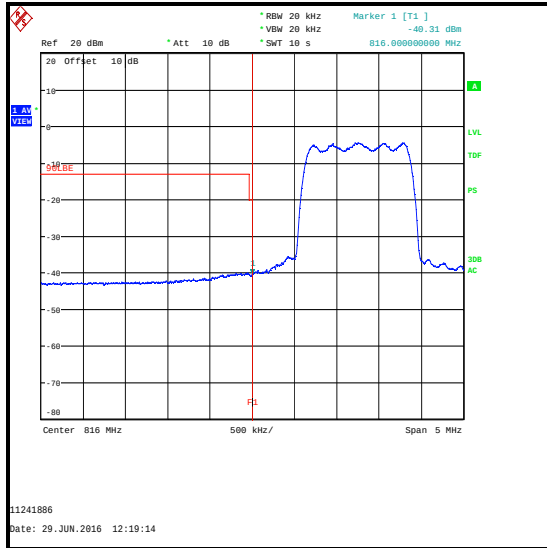
Transmitter Radiated Emissions at Band Edges (continued)**Results: 1xRTT**

Frequency (MHz)	Peak Level (dBm)	Limit (dBm)	Margin (dB)	Result
816	-41.7	-20.0	21.7	Complied
824	-38.0	-20.0	18.0	Complied



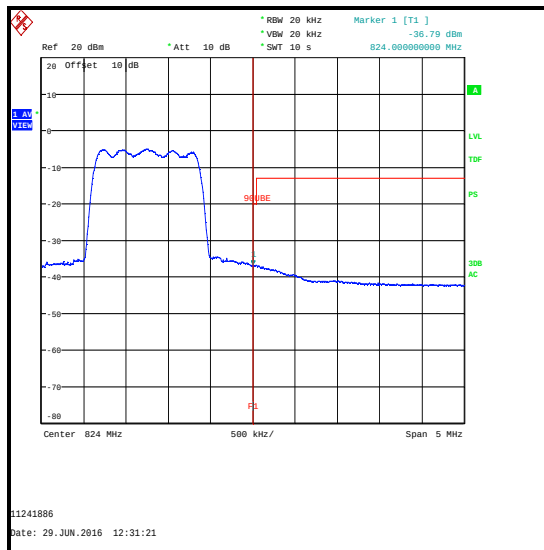
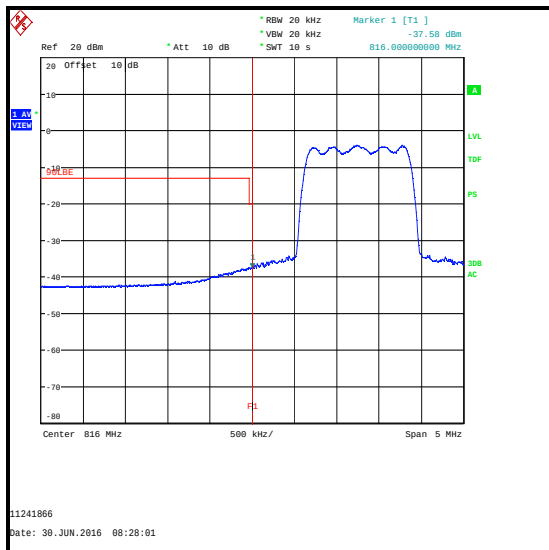
Transmitter Radiated Emissions at Band Edges (continued)**Results: EV-DO Rev. 0**

Frequency (MHz)	Peak Level (dBm)	Limit (dBm)	Margin (dB)	Result
816	-40.3	-20.0	20.3	Complied
824	-37.7	-20.0	17.7	Complied



Transmitter Radiated Emissions at Band Edges (continued)**Results: EV-DO Rev. A**

Frequency (MHz)	Peak Level (dBm)	Limit (dBm)	Margin (dB)	Result
816	-37.6	-20.0	17.6	Complied
824	-36.8	-20.0	16.8	Complied

**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	02 Apr 2017	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Dec 2016	12
A288	Antenna	Chase	CBL6111A	1589	27 Aug 2016	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 Mar 2017	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	30 Apr 2017	12

5.2.7. Transmitter Radiated Emissions at Band Edges - UAT**Test Summary:**

Test Engineer:	John Ferdinand	Test Date:	30 June 2016
Test Sample ESN:	8010C1F5		

FCC Reference:	Part 90.691 / 2.1053
Test Method Used:	KDB 971168 D01 Section 6, Section 7 & Notes below

Environmental Conditions:

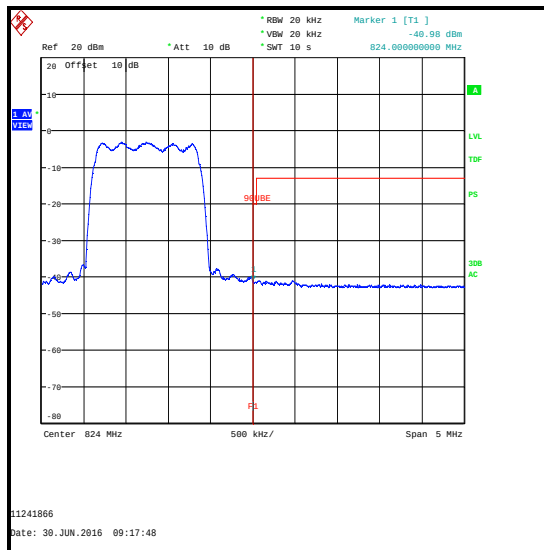
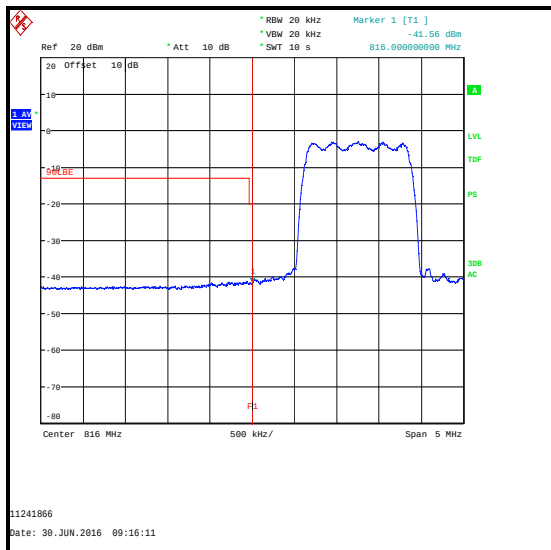
Temperature (°C):	24
Relative Humidity (%):	41

Note(s):

1. Measurements 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. The measurement antenna was placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT.

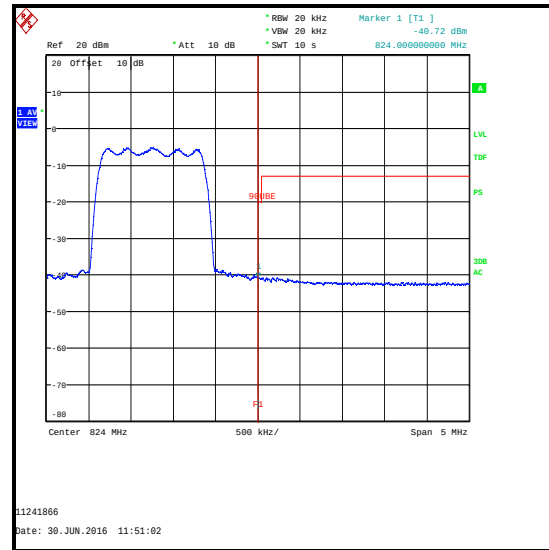
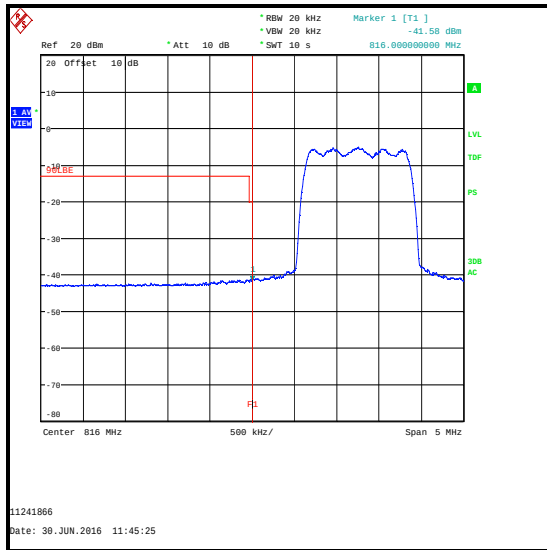
Transmitter Radiated Emissions at Band Edges (continued)**Results: 1xRTT**

Frequency (MHz)	Peak Level (dBm)	Limit (dBm)	Margin (dB)	Result
816	-41.6	-20.0	21.6	Complied
824	-41.0	-20.0	21.0	Complied



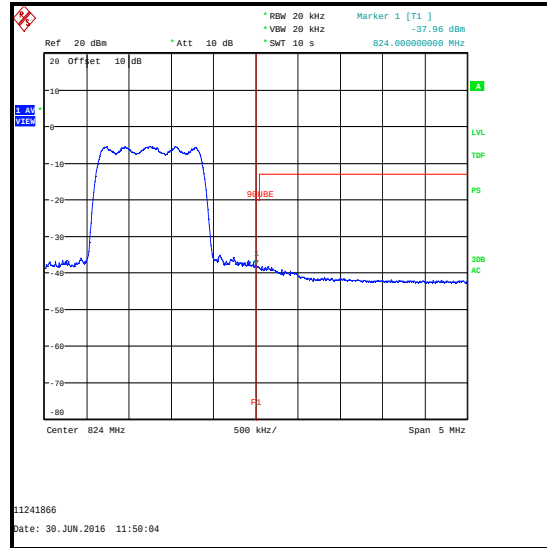
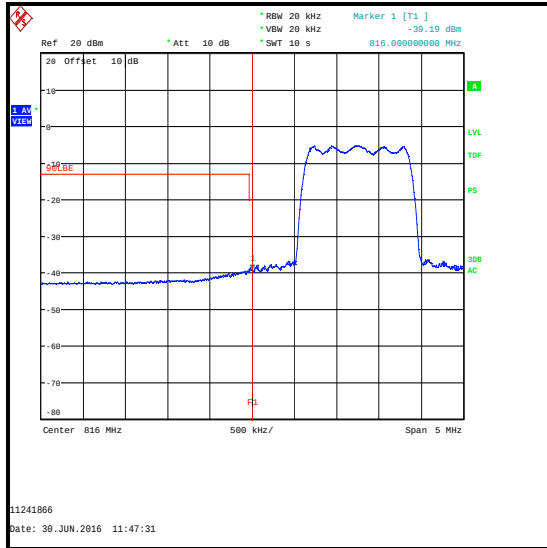
Transmitter Radiated Emissions at Band Edges (continued)**Results: EV-DO Rev. 0**

Frequency (MHz)	Peak Level (dBm)	Limit (dBm)	Margin (dB)	Result
816	-41.6	-20.0	21.6	Complied
824	-40.7	-20.0	20.7	Complied



Transmitter Radiated Emissions at Band Edges (continued)**Results: EV-DO Rev. A**

Frequency (MHz)	Peak Level (dBm)	Limit (dBm)	Margin (dB)	Result
816	-39.2	-20.0	19.2	Complied
824	-38.0	-20.0	18.0	Complied

**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	02 Apr 2017	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Dec 2016	12
A288	Antenna	Chase	CBL6111A	1589	27 Aug 2016	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 Mar 2017	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	30 Apr 2017	12

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

Test Engineer:	Stefan Ho	Test Date:	28 June 2016
Test Sample ESN:	80BE0350		

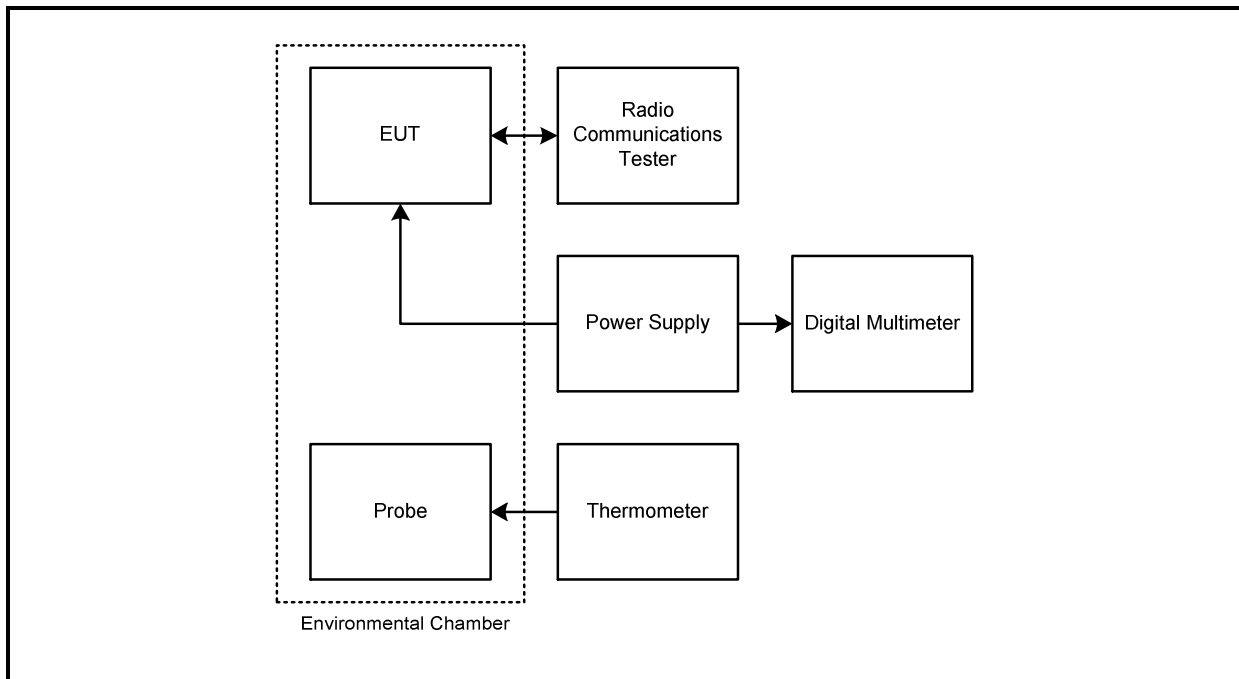
FCC Reference:	Part 90.213 / 2.1055
Test Method Used:	KDB 971168 D01 Section 9, FCC Part 2.1055 and notes below
Test Mode:	RC1/1 with Service Option 2

Environmental Conditions:

Ambient Temperature (°C):	20
Ambient Relative Humidity (%):	42

Note(s):

1. Flying leads were connected internally to the EUT in place of the battery. These leads were extended and connected to a bench power supply.
2. Frequency error was measured using a calibrated Rohde & Schwarz CMW 500 Universal Radio Communications Tester in accordance with current Rohde & Schwarz application notes. The EUT was connected by suitable RF cables to the CMW 500. A bi-directional communications link was established between the EUT and CMW 500. The frequency meter value was recorded.
3. Temperature was monitored throughout the test with a calibrated digital thermometer. Nominal voltage was monitored throughout the test with a calibrated digital voltmeter.

Test setup:

Transmitter Frequency Stability (Temperature Variation) (continued)**Results: Middle Channel (820.0 MHz)**

Temperature (°C)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)	Limit (ppm)	Margin (ppm)	Result
-30	820.000004	4	0.0049	2.5	2.4951	Complied
-20	820.000007	7	0.0085	2.5	2.4915	Complied
-10	820.000008	8	0.0098	2.5	2.4902	Complied
0	820.000007	7	0.0085	2.5	2.4915	Complied
10	820.000005	5	0.0061	2.5	2.4939	Complied
20	820.000004	4	0.0049	2.5	2.4951	Complied
30	819.999996	4	0.0049	2.5	2.4951	Complied
40	819.999994	6	0.0073	2.5	2.4927	Complied
50	819.999993	7	0.0085	2.5	2.4915	Complied

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2001	Thermohygrometer	Testo	608-H1	45041824	02 Apr 2017	12
M1869	Radio Comms Tester	Rohde & Schwarz	CMW500	145923	05 Apr 2017	12
S0564	DC power supply	Thurlby Thandar	PL330P	062941	Calibrated before use	-
M1642	Thermometer	Fluke	52II	18890119	25 Apr 2017	12
M122	Multimeter	Fluke	77	64910017	21 Apr 2017	12
M1674	Environmental Chamber	Espec	SU-241	92013139	Calibrated before use	-

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

Test Engineer:	Stefan Ho	Test Date:	28 June 2016
Test Sample ESN:	80BE0350		

FCC Reference:	Part 90.213 / 2.1055
Test Method Used:	KDB 971168 D01 Section 9, FCC Part 2.1055 and notes below
Test Mode:	RC1/1 with Service Option 2

Environmental Conditions:

Temperature (°C):	20
Ambient Relative Humidity (%):	42

Note(s):

1. Flying leads were connected internally to the EUT in place of the battery. These leads were extended and connected to a bench power supply.
2. Frequency error was measured using a calibrated Rohde & Schwarz CMW 500 Universal Radio Communications Tester in accordance with current Rohde & Schwarz application notes. The EUT was connected by suitable RF cables to the CMW 500. A bi-directional communications link was established between the EUT and CMW 500. The frequency meter value was recorded.
3. Voltage was monitored throughout the test with a calibrated digital voltmeter.

Transmitter Frequency Stability (Voltage Variation) (continued)**Results: Middle Channel (820.0 MHz)**

Supply Voltage (V)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)	Limit (ppm)	Margin (ppm)	Result
3.5	820.000004	4	0.0049	2.5	2.4951	Complied
4.4	820.000004	4	0.0049	2.5	2.4951	Complied

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2001	Thermohygrometer	Testo	608-H1	45041824	02 Apr 2017	12
M1869	Radio Comms Tester	Rohde & Schwarz	CMW500	145923	05 Apr 2017	12
S0564	DC power supply	Thurlby Thandar	PL330P	062941	Calibrated before use	-
M1642	Thermometer	Fluke	52II	18890119	25 Apr 2017	12
M122	Multimeter	Fluke	77	64910017	21 Apr 2017	12
M1674	Environmental Chamber	Espec	SU-241	92013139	Calibrated before use	-

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
Conducted Output Power	816 MHz to 824 MHz	95%	±1.36 dB
Occupied Bandwidth	816 MHz to 824 MHz	95%	±3.92 %
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±5.65 dB
Radiated Spurious Emissions	1 GHz to 9 GHz	95%	±2.94 dB
Frequency Stability	816 MHz to 824 MHz	95%	±23 Hz

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	12 & 13	-	Updated 1xRTT results after retest
3.0	- 7 10 12 to 14 All 23 & 27	- - - - -	At the request of the TCB: Changed 'RFID' reference to 'NFC' Updated Section 4.2 Updated LAT power results after retest Changed 'KDB 971168' references to 'KDB 971168 D01' Inserted Notes 3 & 5
4.0	-	- 10	At the request of the TCB: Section 4.2. Inserted Bullet 3

--- END OF REPORT ---