

RF Test Report:

Altistar Networks PCS Band iRM4451 RRH

FCC ID: NXP-44510200

SC_TR_201_A

Prepared for:

Altistar Inc.
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1 Revision History

Revision	Originator	Date	Comment
Draft	C Blackham	12 Jul 2016	Draft version pending final RSE results and CSE > 13 GHz
A	C Blackham	18 July 2016	Issued following completion of tests

2 Purpose

This document details the FCC RF testing performed on the AltioStar PCS Band iRM4451 RRH (Remote Radio Head), model number iRM44510200, designed to transmit in the 1930-1990 MHz band.

3 Reference Documents

[Ref 1]	47CFR2	Title 47 Code of Federal Regulations Part 2: frequency allocations and radio treaty matters; general rules and regulations
[Ref 2]	47 CRF24	Title 47 Code of Federal Regulations Part 24: Personal Communications Services
[Ref 3]	TIA-603-D	Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards
[Ref 4]	KDB 662911 D01 v02r01	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Emissions Testing of Transmitters with Multiple Outputs in the Same Band (e.g., MIMO, Smart Antenna, etc)
[Ref 5]	KDB971168 DO1 v02r02	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Measurement guidance for certification of licensed digital transmitters.

4 Test Information

4.1 Client

Altiostar Inc.
100 Ames Pond Drive
Tewksbury
MA 01876
USA

4.2 Test personnel

Antenna port tests

Testing was performed by Charlie Blackham of Sulis Consultants Ltd at Altiostar UK offices on 11th July 2016 and at Hursley EMC on 15th July 2016.

Radiated Spurious Emissions (section 12)

Testing was performed by Richard Pennell of Hursley EMC services Ltd, at their FCC Registered test facility, UK designation number UK0006, on 15th July 2016 under job 16R356.

4.3 Test sample

The results herein only refer to sample detailed in section 6

5 Product Description

The basestation supports operation with 5, 10, 15 and 20 MHz bandwidths, with Digital OFDMA modulation at the following modulation rates:

- QPSK: testing done using 3GPP test model E-TM1.1
- 16 QAM: testing done using 3GPP test model E-TM3.2
- 64 QAM: testing done using 3GPP test model E-TM3.1

The unit is fitted with four RF transceiver RF ports, Ant1, ANT2, ANT3 and Ant4. These are designed to support MIMO operation and are connected to external antennas. Typically these would be two cross polarised 2T2R antennas or a single xx-polarised 4T4R. These are provided by the licensee and gain dealt with at time of licensing.

Transmit power was set to maximum permitted target power of 30 W (44.7 dBm) per port.

Channels for measurement were selected from the following channels within the band of operation:

Bandwidth (MHz)	Bottom channel (MHz)	Middle channel (MHz)	Top channel (MHz)
5	1932.5	1960.0	1987.5
10	1935.0	1960.0	1985.0
15	1937.5	1960.0	1982.5
20	1940.0	1960.0	1980.0

The test waveforms have a 100% duty cycle so no gating or allowance for duty cycle was required when taking measurements

6 Test Configuration

6.1 Test sample and Operating mode

The equipment under test (EUT) was:

Manufacturer	Model Number	Serial Number
Altiostar	iRM44510200-0	PLW01160008

Table 1: Equipment under test

6.2 Equipment set-up

Equipment was configured as per figure 1:

- The iRM4451 system was configured using a web browser application that allowed the unit to be placed into a test mode and the required frequency, bandwidth and power to be set
- All 4 ports were set to transmit on maximum power with the same modulation and channel bandwidth
- For conducted measurements, the insertion loss of the Attenuator and Co-ax cables were measured before testing and their combined path-loss was programmed into the analyser as a negative external gain¹.

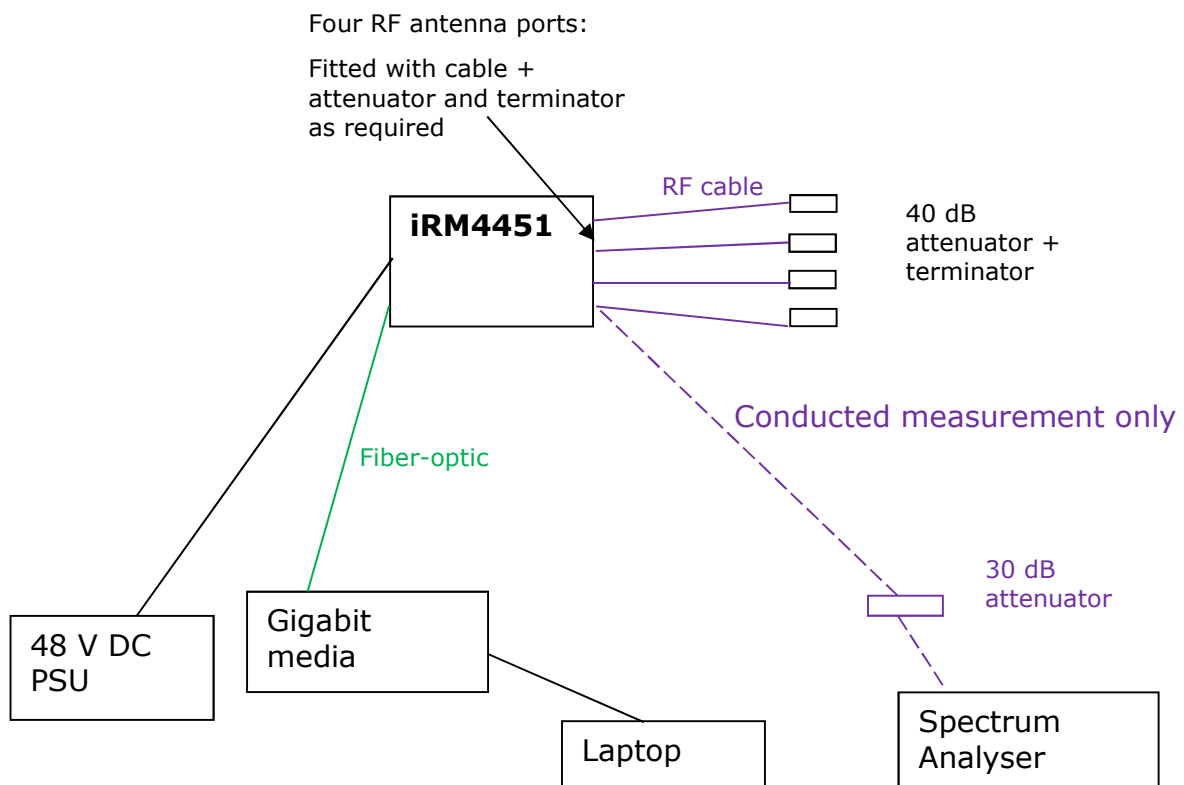


Figure 1: Configuration for test

¹ Except for the 13-20 GHz Conducted Spurious Emission measurement where insertion loss was loaded into analyser as a Transducer Factor.

6.3 Support equipment

The support equipment was:

Description	Manufacturer	Model	Serial Number
Laptop	HP	250	Dvt-mobile altiostar
USB/Ethernet adapter	Startech		13320402522
Gigabit media converter	TP-Link	MC220L	2158186001559
48 V DC PSU	Agilent	N8737A	US14C3870M
40dB attenuator (Quantity 4)	Fairview microwave	SA3N1007-40	AN00125; AN00126; AN00127; AN00128

Table 2: Support Equipment

7 Summary of Tests performed

Test	47 CFR Part	Result	Section
Transmit Power	24.232 / 2.1046	Pass	8
Modulation Characteristics	2.1047	Pass	5 ²
Occupied Bandwidth (99%) Emission Bandwidth (26dB)	24.238(b) / 2.1049	Pass	9
Conducted Spurious Emissions	24.238(a) / 2.1051	Pass	10
Conducted Spurious Emissions – band edge	24.238(a) / 2.1051	Pass	11
Radiated Spurious Emissions	24.238(a) / 2.1053	Pass	12
Frequency Stability	24.235 / 2.1055	Pass	See report SC_TR_202_A

Table 3: Summary of tests performed

² Device uses digital modulation as described in section 5

8 Transmit Power

8.1 Requirement and test method

§24.232 Power limits and duty cycle.

(a)(1) Base stations with an emission bandwidth of 1 MHz or less are limited to 1640 watts equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT, except as described in paragraph (b) below.

(2) Base stations with an emission bandwidth greater than 1 MHz are limited to 1640 watts/MHz equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT, except as described in paragraph (b) below

(d) Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (e) of this section. In both instances, equipment employed must be authorized in accordance with the provisions of §24.51. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

Measurement made using KDB971168 DO1, section 5.2

Pre-testing had showed that all ports delivered the same transmit power.

The total power was summed in accordance with KDB662911D01 and the result compared against the limit. Specifically, the power was measured at Antenna port 1 and then $10\log(4)$ dB, or 6 dB, was added to show total power from all four ports.

8.2 Test results: Transmit Power

Pre-testing had shown that highest power was found on centre channel

Channel Bandwidth	Modulation	TX power (dBm)	Summed TX power (dBm)	TX power (W)	Limit (W)	Result
5	QPSK	44.68	50.68	116.9	None	Pass
	16 QAM	44.73	50.73	118.3	None	Pass
	64 QAM	44.82	50.82	120.8	None	Pass
10	QPSK	44.91	50.91	123.3	None	Pass
	16 QAM	44.85	50.85	121.6	None	Pass
	64 QAM	44.89	50.89	122.7	None	Pass
15	QPSK	44.82	50.82	120.8	None	Pass
	16 QAM	44.78	50.78	119.7	None	Pass
	64 QAM	44.87	50.87	122.2	None	Pass
20	QPSK	44.81	50.81	120.5	None	Pass
	16 QAM	44.83	50.83	121.1	None	Pass
	64 QAM	44.87	50.87	122.2	None	Pass

Table 4: Transmit power

Plots are provided in SC_TR_201-plots, figure 3.

Note: there is no "limit" applied during equipment authorisation as it is applied by the FCC at time of licensing.

8.3 Test results: Peak to Average power

The Peak to average waveform is related to modulation and not to frequency of operation of bandwidth. Results are presented for worst case mode of 5 MHz channels and are valid for all bandwidths as the same test model waveforms are used.

Peak to Average (PAR) ratio is controlled using crest factor reduction techniques and worst case is 7.23dB.

Channel Bandwidth	Modulation	0.1% PAR	Limit	Result
5	QPSK	7.18	13.00	Pass
	16 QAM	7.22	13.00	Pass
	64 QAM	7.23	13.00	Pass

Table 5: Peak-to-average measurements



Figure 2: Peak-to-Average plots

9 Occupied Bandwidth

9.1 Requirement and test method

The Occupied Bandwidth is defined in 2.1049 as:

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission

§24.238 Emission limitations for Broadband PCS equipment.

(b).....The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

The occupied bandwidth was measured in accordance with KDB971168 DO1 section 4.1 using the inbuilt function on the Signal Analyser which simultaneously measured the 99% power bandwidth and the -26 dB emission bandwidth. Measurement was made using a peak detector.

The limit is taken to be the desired licensed channel bandwidth.

9.2 Test results: Occupied Bandwidth

The table below shows results for plots in SC_TR_201-plots, figure 4.

Channel Bandwidth	Modulation	99% Occupied Bandwidth (MHz)	Limit (MHz)	Result	-26dB Emissions Bandwidth (MHz)
5	QPSK	4.479	5.0	Pass	4.821
	16 QAM	4.476	5.0	Pass	4.782
	64 QAM	4.490	5.0	Pass	4.802
10	QPSK	8.949	10.0	Pass	9.632
	16 QAM	8.941	10.0	Pass	9.494
	64 QAM	8.970	10.0	Pass	9.664
15	QPSK	13.459	15.0	Pass	14.49
	16 QAM	13.458	15.0	Pass	14.38
	64 QAM	13.460	15.0	Pass	14.47
20	QPSK	17.915	20.0	Pass	19.27
	16 QAM	17.933	20.0	Pass	19.15
	64 QAM	17.924	20.0	Pass	19.21

Table 6: Occupied Bandwidth test results

Note: the PXA Signal analyser presents results for both "Occupied Bandwidth", which is the 99% measurement, and "-X dB Bandwidth", which is the -26 dB bandwidth as X is set to 26.

10 Conducted Spurious Emissions

10.1 Requirement and test method

§24.238 Emission limitations for Broadband PCS equipment.

(a) *Out of band emissions.* The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

(b) *Measurement procedure.* Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (*i.e.* 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

Transmit power was measured using an RMS detector so spurious emissions have also been measured using an RMS detector and trace averaging

Measurements have been performed on middle channel with an exclusion band of 3 MHz either side of the channel bandwidth. Results for measurement within 3 MHz of channel bandwidth are presented in the band-edge results in section 11.

Determination of total spurious emission was done by adding $10 \log(4)$, or 6.0 dB to the emission level measured on port Ant1 and this was compared with limit of -13dBm as per KDB 662911 section 3(a)(iii)

10.2 CSE results

Conducted Spurious emissions were investigated on middle channel from 10 MHz to 20 GHz at frequencies ≥ 3 MHz from the channel bandedge, the worst case results are shown in table 10 and accompanying plots in SC_TR_201-plots_A figures 5, 6, 7, and 8.

Channel Bandwidth	Worst case emission	Summed TX power (dBm)	Limit (dBm)	Result
5	-22.79	-16.79	-13.0	Pass
10	-23.47	-17.47	-13.0	Pass
15	-22.74	-16.74	-13.0	Pass
20	-20.89	-14.89	-13.0	Pass

Table 7: CSE results except bandedge

11 Conducted Spurious Emissions - Band Edge

11.1 Requirement and test method

§24.238 Emission limitations for Broadband PCS equipment.

(a) *Out of band emissions.* The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

(b) *Measurement procedure.* Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (*i.e.* 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

Emissions within 1 MHz of the bandedge were measured using a narrow resolution bandwidth as permitted above

Transmit power was measured using an RMS detector so spurious emissions have also been measured using an RMS detector and trace averaging

Emissions between 1 and 3 MHz from the band edge were measured using adjacent channel power measurement capability of the spectrum analyser to provide power in a 1MHz band whilst using a lower resolution bandwidth to simultaneously measure the 1 MHz block adjacent to band edge.

Determination of total spurious emission was done by adding $10 \log(4)$, or 6.0 dB to the emission level measured on port Ant1 and this was compared with limit of -13dBm as per KDB 662911 section 3(a)(iii)

11.2 Band edge results

Plots for band-edge compliance are shown in SC_TR_181-plots.

Worst case emission is the highest emission within 3 MHz of the upper or lower bandedge that is:

- Either the narrow RBW peak search within 0-1 MHz of band edge
- **Or** Integrated power measurement for the next two 1 MHz blocks

Channel Bandwidth	Modulation	Worst case emission	Summed TX power (dBm)	Limit (dBm)	Result
5	QPSK	-22.57	-16.57	-13.0	Pass
	16 QAM	-20.99	-14.99	-13.0	Pass
	64 QAM	-22.49	-16.49	-13.0	Pass
10	QPSK	-21.45	-15.45	-13.0	Pass
	16 QAM	-22.09	-16.09	-13.0	Pass
	64 QAM	-20.02	-14.02	-13.0	Pass
15	QPSK	-22.73	-16.73	-13.0	Pass
	16 QAM	-21.07	-15.07	-13.0	Pass
	64 QAM	-22.53	-16.53	-13.0	Pass
20	QPSK	-21.64	-15.64	-13.0	Pass
	16 QAM	-20.15	-14.15	-13.0	Pass
	64 QAM	-21.66	-15.66	-13.0	Pass

Table 8: CSE Band edge results

12 Radiated Spurious Emissions

12.1 Requirement and test method

§24.238 Emission limitations for Broadband PCS equipment.

(a) *Out of band emissions.* The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

(b) *Measurement procedure.* Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (*i.e.* 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

Attenuation of $43+10\log(P)$ dBm equates to an absolute limit of -13dBm.

All measurements below 18 GHz were performed at 3m distance and emissions above 18 GHz were measured at 1m.

Pre-scan measurements were performed with a spectrum analyser, using a peak detector with 100 kHz RBW for frequencies below 1 GHz and 1 MHz for frequencies above 1 GHz.

The cabinet radiation was performed while antenna ports were terminated with attenuators and 50Ω loads. Since all ports were transmitting, no summation of spurious emissions is required for radiated tests.

Initial pre-scan measurements were performed against a field strength limit determined by

$$E = \text{EIRP} - 20\log D + 104.8$$

Where pre-scans showed emissions within 20dB of the limit (or 30dB for emissions below 1 GHz), final measurement was made using substitution method, with results presented in section 12.3.

12.2 Results

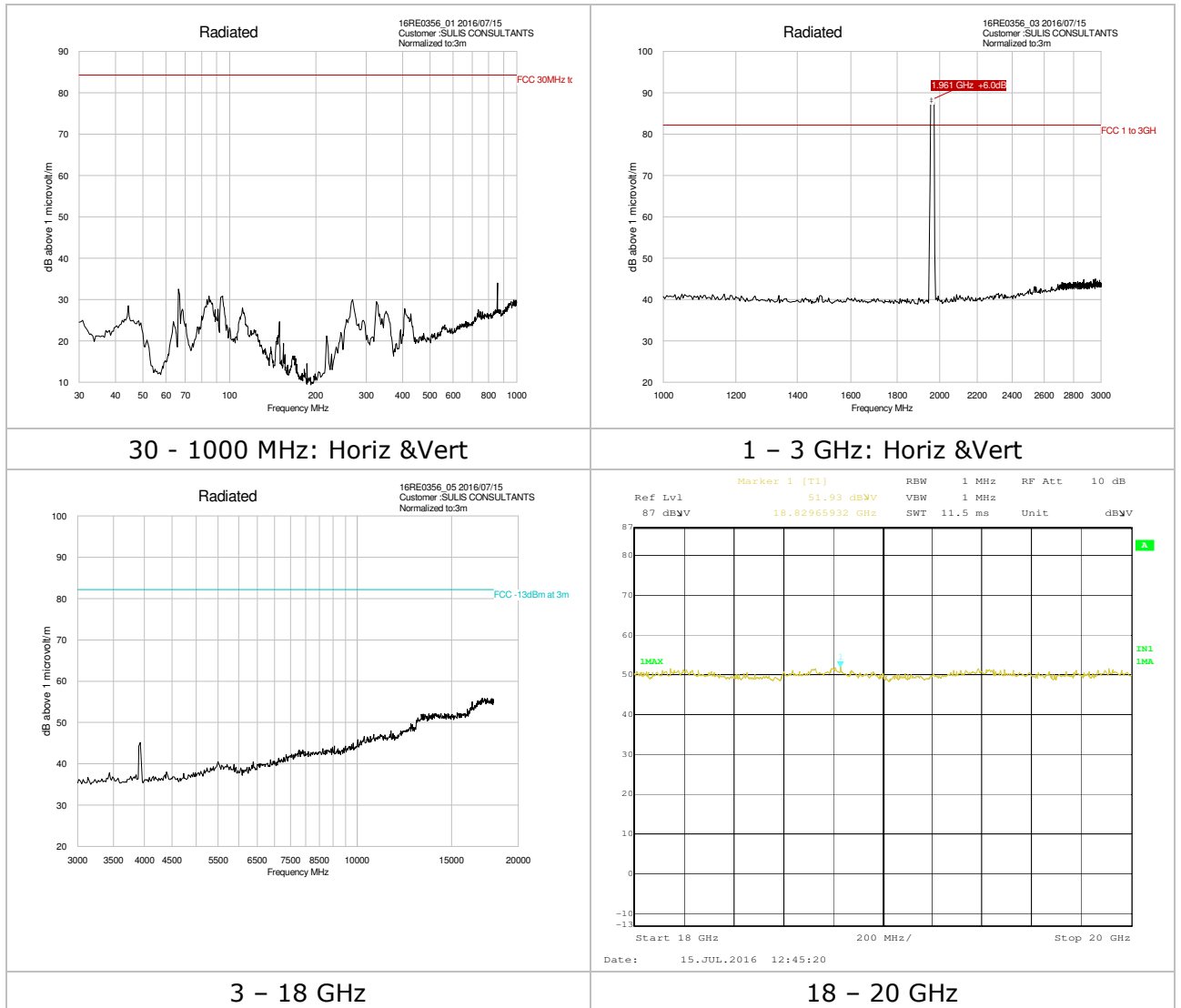


Figure 3: RSE pre-scans, 20 MHz channel; 64 QAM

There were no emissions of note that required further investigation as the only emission observed was the fundamental frequency of transmission.

13 Test equipment

Description	Manufacturer	Name	Serial Number	Calibration certificate / due date
Testing at Altiostar				
PXA Signal Analyser	Agilent	N9030A	MY541702228	Keysight 1-7749397106-1 Due 7-apr-17
Network Analyser	HP	8719D	US38110410	Electroservices T469471R Due 15/10/16
Attenuator	Fairview Microwave	SA18N100-30	None	Calibrated before test using Network Analyser
RF cable	Times Microwave	SLU18-SMNM-01.50m	3155 3950	
Testing at Hursley³				
1 metre	Semflex	clear gold Ntype	0	06/05/2017
Synthesized sweeper	HP	8341B	2819A1509	14/10/2016
1-10GHz Horn	Schwarzbeck	BBHA 9120 571	571	24/02/2019
Test Receiver	R&S	ESCI7	1166595007	20/05/2017
Spectrum analyser	HP	8593EM	3726U00203	22/09/2016
Test Receiver	R&S	ESI26	833362/006	14/07/2017
Horn antenna	Schwarzbeck	BBHA9120B	391	28/01/2018
Horn antenna	Q-par Angus	WBH218HN	5367	22/06/2019
18 to 40GHz Horn	Q-par Angus	WBH18-40k	10300	12/01/2019
0.1 to 1300MHz pre amp	HP	8447D	2944A07388	20/05/2017
1.0-26.5GHz pre-amp + 0.5m cable	HP	8449B	3008A00481	03/02/2017
Pink 30M-2G Antenna	CHASE	CBL 6141	4013	01/10/2018
30 dB attenuator	Fairview Microwave	SA18N100-30	None	Calibrated before use
40 dB attenuators	Fairview Microwave	SA3N1007-40	AN00125; AN00126; AN00127; AN00128	Not required
RF cables to attenuators	Times Microwave	SLU18-NMNM-01.50m	#3828; #3947; #3950; #4355	

Table 9: Test Equipment

³ Calibration data held by Hursley EMC Services Ltd under their UKAS accreditation, no. 1871