Report on the Radio Testing

For

Gas Control Equipment Limited

on

Zeno Clarity 4G

Report no. TRA-047787-47-05C

10 March 2021

Report Number: TRA-047787-47-05C
Issue: C

REPORT ON THE TESTING OF A
Gas Control Equipment Limited
Zeno Clarity 4G
WITH RESPECT TO SPECIFICATIONS
47CFR PARTS 22H, 24E, 27

TEST DATE: 2020-06-23 to 2020-12-02

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Date:	10 March 2021	

Disclaimers:

[1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
[2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	2020-08-04	Original
B	2021-03-08	Added results for GSM850, GSM1900, WCDMA bands 2, 4 and 5 and updated conducted power results – general updates.
C	2021-03-10	Updated GSM power measurements in section 12 and RSE in section 11

2 Summary

TEST REPORT NUMBER:	TRA-047787-47-05C
WORKS ORDER NUMBER:	TRA-047787-01
PURPOSE OF TEST:	Class II Permissive Change
TEST SPECIFICATION(S):	47CFR Parts 22H, 24E, 27
EQUIPMENT UNDER TEST (EUT):	Zeno Clarity 4G containing FCCID: 2AOL9-RS500C4G1
EUT SERIAL NUMBER:	ZC101001
MANUFACTURER/AGENT:	Gas Control Limited
ADDRESS:	Farrington Way Eastwood Nottingham Nottinghamshire NG16 3AG United Kingdom
CLIENT CONTACT:	Will Turner ☎ 01942 292962 ✉ will.turner@gcegroup.com
ORDER NUMBER:	UK-1929
TEST DATE:	2020-06-23 to 2020-12-02
TESTED BY:	Steven Garwell Element

2.1 Test Summary

Test Method and Description	*Requirement Clause 47CFR*	*Applicable to this equipment*	*Result / Note*
Spurious emissions	24.238, 24.232, 22.917, 22.913, 27.53, 2.1051	☒	*PASS*
Output power	22.913, 24.232, 27.50	☒	*Information Only*

Notes:

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

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4 Introduction

This report TRA-047787-47-05C presents the results of the Radio testing on a Gas Control Equipment Limited, Zeno Clarity 4G to the selected parts of specifications FCC CFR 47 Parts 22H, 24E & 27.

The Zeno Clarity 4G contains a cellular module FCCID: 2AOL9-RS500C4G1.

The testing was carried out for Gas Control equipment Limited by Element, at the address detailed below.

☐ Element Hull
Unit E
South Orbital Trading Park
Hedon Road
Hull
HU9 1NJ
UK

☒ Element Skelmersdale
Unit 1
Pendle Place
Skemersdale
West Lancashire
WN8 9PN
UK

This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

Throughout this report EUT denotes equipment under test.

FCC Site Listing:
Element is accredited for the above sites under the US-EU MRA, Designation number UK0009.

The test site requirements of ANSI C63.4-2014 are met up to 1GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Glossary of Terms

§	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
C	Celsius
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada
ITU	International Telecommunication Union
LBT	Listen Before Talk
m	metre
max	maximum
MIMO	Multiple Input and Multiple Output
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
Pt-mpt	Point-to-multipoint
Pt-pt	Point-to-point
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
SVSWR	Site Voltage Standing Wave Ratio
Tx	transmitter
UKAS	United Kingdom Accreditation Service
V	volt
W	watt
Ω	ohm

6 Equipment Under Test

6.1 EUT Identification

- Name: Zeno Clarity 4G
- Serial Number: ZC101001
- Model Number: RS-00500C
- Software Revision: Not Stated
- Build Level / Revision Number: Prototype

Module Details: LTE

- Manufacturer: Gas Control Equipment Limited
- Model Number: RS500C4G1
- FCC ID: 2AOL9-RS500C4G1

6.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

1: CMW 500 Wideband Communications Tester – Serial Number: 112969
2: Laptop

6.3 EUT Mode of Operation

6.3.1 Transmission

The mode of operation for transmitter tests was as follows:

EUT was operated with worst case modes of operation for each cellular band as derived from original filing reports.

6.4 EUT Description

The EUT is a portable oxygen concentrator for patients requiring supplementary oxygen. The device has multiple wireless connections. This report covers limited testing of the LTE module only.

7 EUT Radio Parameters

7.1 General

Radio:	GSM	WCDMA	LTE
Band(s) / Frequencies of operation:	GSM850, GSM1900	2,4 and 5	2, 4, 5, 7 and 12
Modulation type:	GMSK, 8PSK	QPSK	OFDM
Channel bandwidth:	200 kHz	5 MHz	10 MHz
Declared output power:	30 dBm	24 dBm	24 dBm
Nominal Supply Voltage:	24 Vdc	24 Vdc	24 Vdc

7.2 Antennas

Manufacturer:	Antenova
Type:	2 x Moseni Antenna for LTE applications
Model number:	SRFL029
Frequency ranges:	698 MHz – 798 MHz 824 MHz – 960 MHz 1710 MHz – 2170 MHz 2300 MHz – 2400 MHz 2500 MHz – 2690 MHz
Impedance:	50 Ω
Polarisation:	Linear
Connector type:	IPEX
Length:	110.0 x 20.0 x 0.15 (mm)
Dimensions (Antenna):	< 0.5 g
Environmental limits:	-40°C to +85°C
Mounting:	FPC Self-adhesive 3M 468P

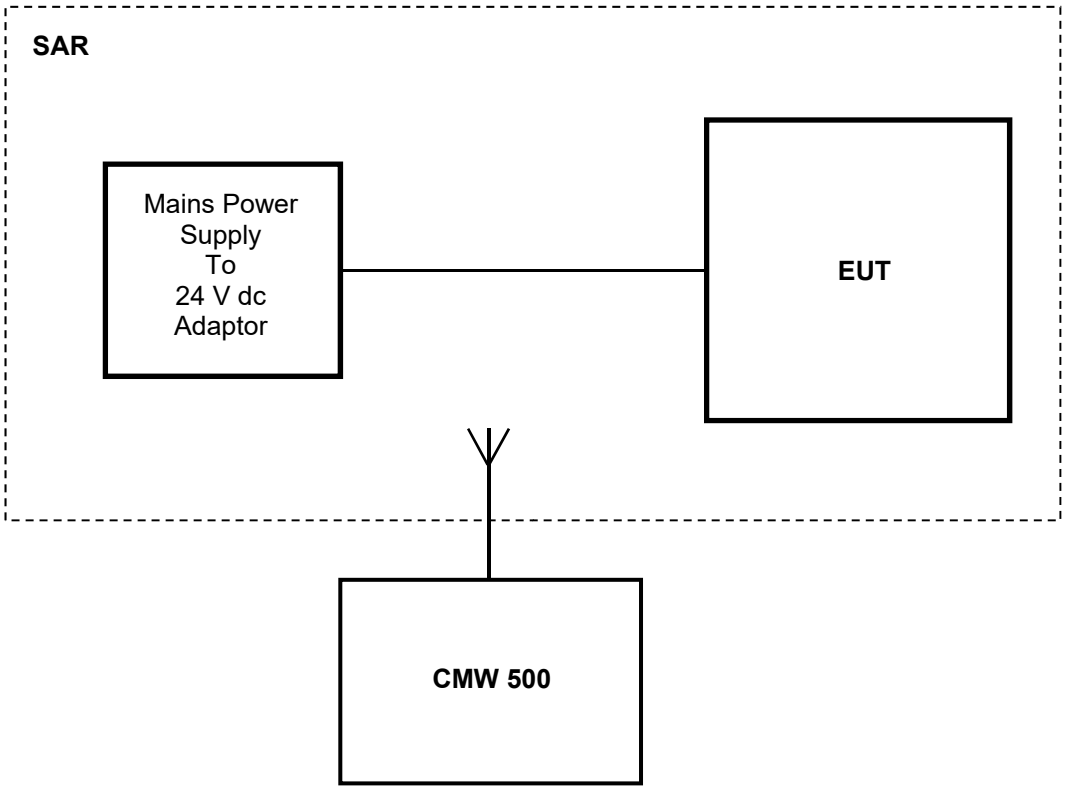
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

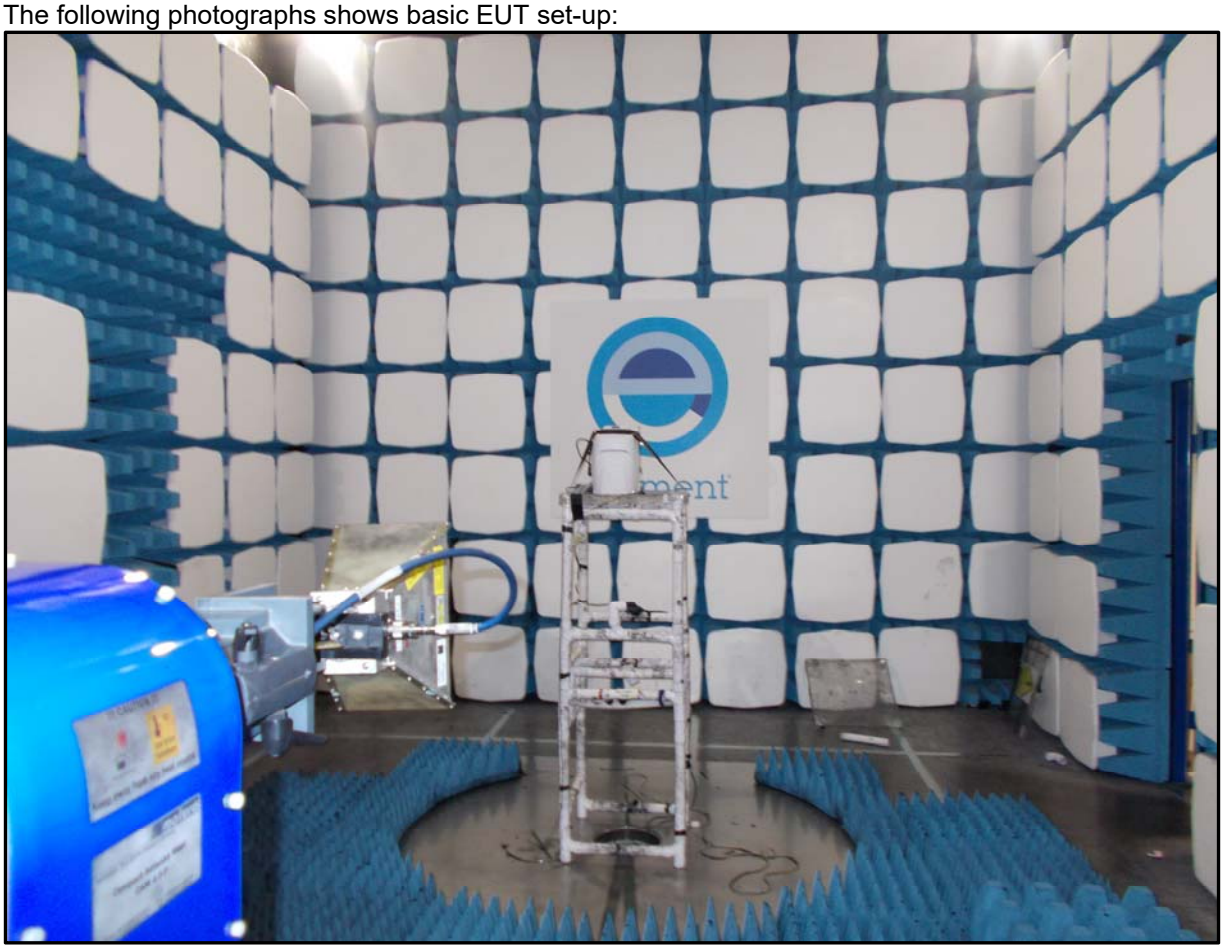
9.1 Block Diagram

The following diagram shows basic EUT interconnections:



9.2 General Set-up Photograph

The following photographs shows basic EUT set-up:



9.1 Measurement software

Where applicable, the following software was used to perform measurements contained within this report.

Element Emissions R5 (See Note)
Element Transmitter Bench Test (See Note)
ETS Lindgren EMPower V1.0.4.2

Note:

The version of the Element software used is recorded in the results sheets contained within this report.

10 General Technical Parameters

10.1 Normal Conditions

The Zeno Clarity 4G was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was mains via a 24 Vdc adaptor.

11 Radiated emissions

11.1 Definitions

Spurious emissions
Emissions on a frequency or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Intermodulation products
Emissions of two or more electromagnetic waves transmitted simultaneously through a nonlinear electronic system.

11.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	SK03 Radio Chamber
Test Standard and Clause:	TIA 603-D, clause 2.2.12
EUT Operating Channels Tested:	Mid
Deviations From Standard:	N/A
Measurement BW:	30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz
Measurement Detector:	Up to 1 GHz: quasi-peak Above 1 GHz: Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 53 %RH	20%RH to 75%RH (as declared)
Supply: 24 Vdc	24 Vdc (as declared)

11.3 Test Limits

FCC 47CFR22
22.917(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.

FCC 47CFR24
24.238(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.

FCC 47CFR27
27.53(c) For operations in the 746–758 MHz band and the 776–788 MHz band, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On any frequency outside the 746– 758 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;
(2) On any frequency outside the 776– 788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;
(3) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations;
(4) On all frequencies between 763–775 MHz and 793–805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations;
(5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed;
(6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

27.53(f) For operations in the 746–758 MHz, 775–788 MHz, and 805–806 MHz bands, emissions in the band 1559–1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

27.53(g) For operations in the 698–746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB.
Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

27.53(h) *AWS emission limits*—(1) *General protection levels.* Except as otherwise specified below, for operations in the 1695–1710 MHz, 1710–1755 MHz, 1755–1780 MHz, 1915–1920 MHz, 1995–2000 MHz, 2000–2020 MHz, 2110–2155 MHz, 2155–2180 MHz, and 2180–2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 $\log_{10}$ (P) dB.

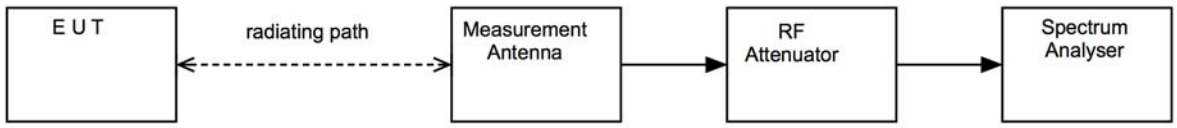
11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure viii the emissions from the EUT were measured on a spectrum analyzer / EMI receiver. The EUT was rotated in three orthogonal planes and the measurement antenna height scanned (below 1GHz, from 1 to 4 m; above 1GHz as necessary) in order to maximise emissions.
The measurements were performed with EUT set at its maximum gain. All modulation schemes, data rates and power settings were used to observe the worst-case configuration at each frequency.
The EUT was substituted with a known generator and antenna and for the same level achieved at the analyser, the effective radiated power was recorded.
Pre-scan plots are shown with a peak detector and 100kHz RBW.
The following formula may be used to convert field strength (FS) in volts/metre to transmitter output power (TP) in watts:

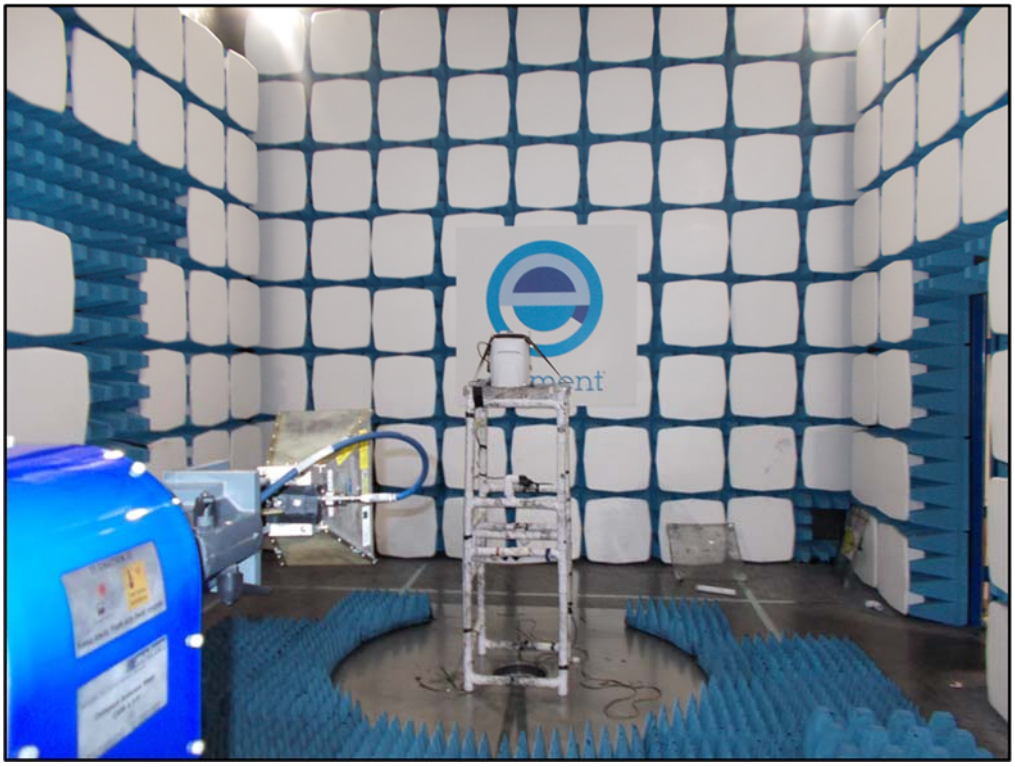
$$TP = (FS \times D)^2 / (30 \times G)$$

where D is the distance in metres between the two antennas and G is the antenna numerical gain referenced to isotropic gain.

Figure viii Test Setup



Test Setup Photograph

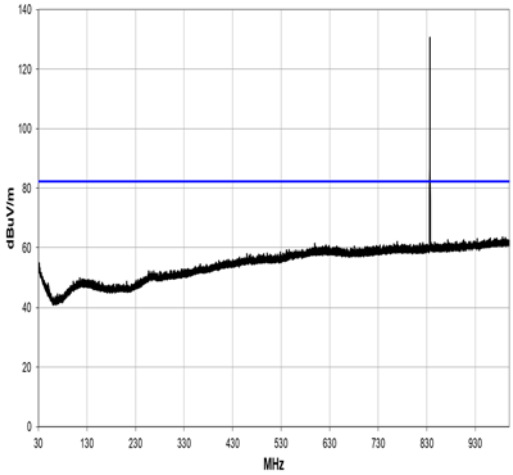


11.5 Test Equipment

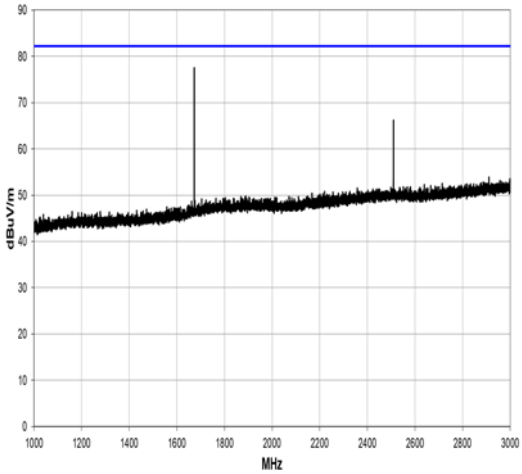
Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Due For Calibration*
EMI Receiver	R&S	ESR26	U489	2020-12-18
Bilog	Chase	CBL611/A	U573	2021-09-19
Log Periodic Ant	Schwarzbeck	UALP 9108	U028	2021-07-02
Pre Amp	Watkins Johnson	6201-69	U372	2021-02-26
Pre Amp	Agilent	8449	L572	2021-10-19
1-18GHz Horn	EMCO	3115	L139	2021-07-16
1-18GHz Horn	EMCO	3115	U223	2021-11-05
Horn 18-26GHz (&U330)	Flann	20240-20	L300	2022-04-23
High Pass Filter	Atlantic Microwave	AFH-07000	U558	2021-01-22
High Pass Filter	MiniCircuits	VHF-1500+	U519	2021-01-22
High Pass Filter	BSC	SH4141	REF977	2021-01-22
Radio Chamber - PP	Rainford EMC	ATS	REF940	2021-12-09

11.6 Test Results

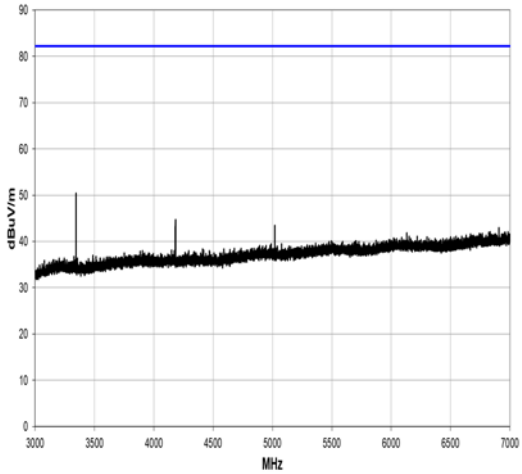
GSM BAND: 850 (GPRS): UL ARFCN: 190; FREQ: 836.5 MHz



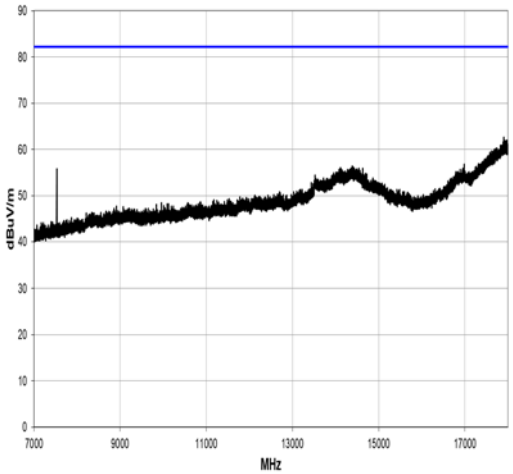
30 MHz to 1 GHz



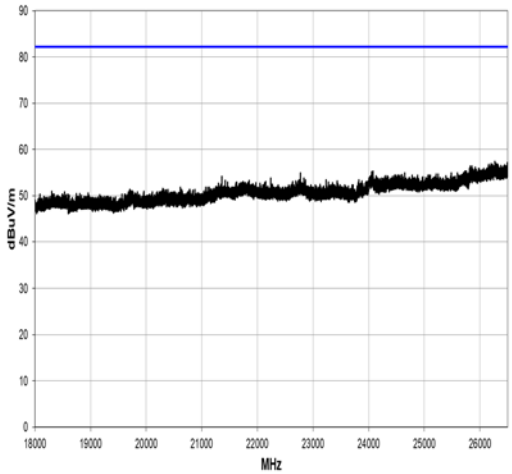
1 GHz to 3 GHz



3 GHz to 7 GHz



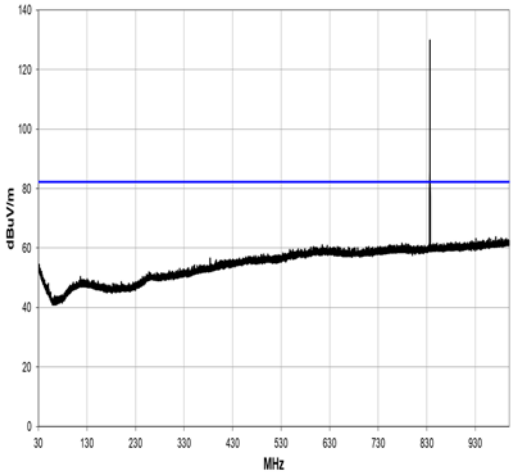
7 GHz to 18 GHz



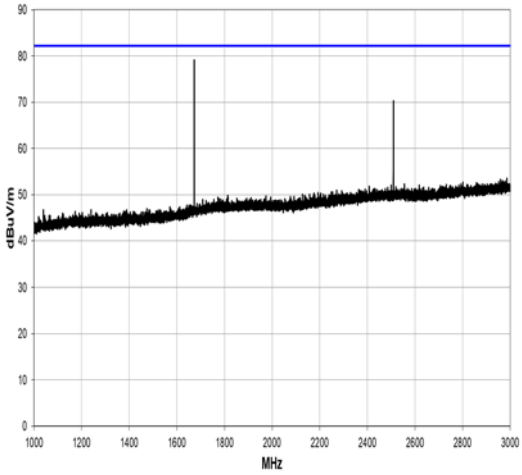
18 GHz to 26.5 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
1673.275	70.3	-6.9	1.68	155.9	3.0	16.0	Horz	PK	0.0	79.4	82.2	-2.8
1673.308	70.3	-6.9	1.73	81.9	3.0	16.0	Vert	PK	0.0	79.4	82.2	-2.8

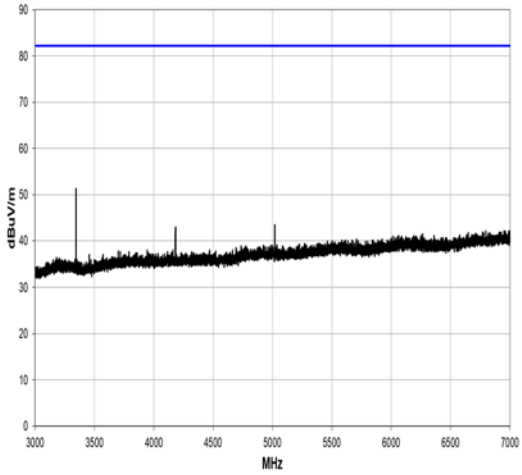
GSM BAND: 850 (EDGE): UL ARFCN: 190; FREQ: 836.5 MHz



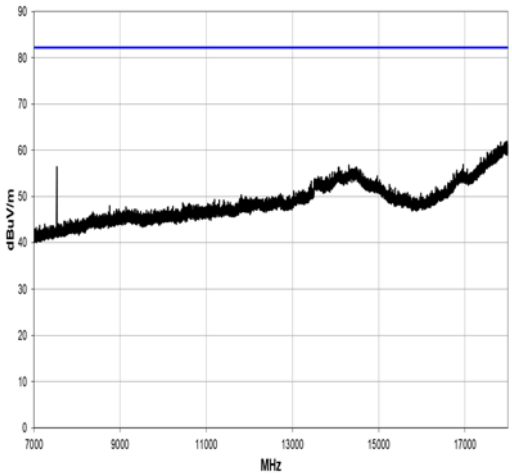
30 MHz to 1 GHz



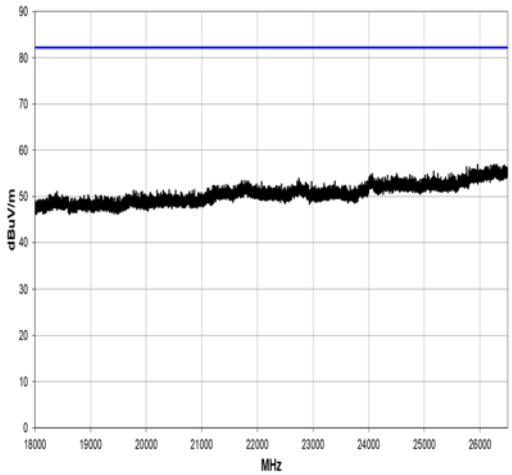
1 GHz to 3 GHz



3 GHz to 7 GHz



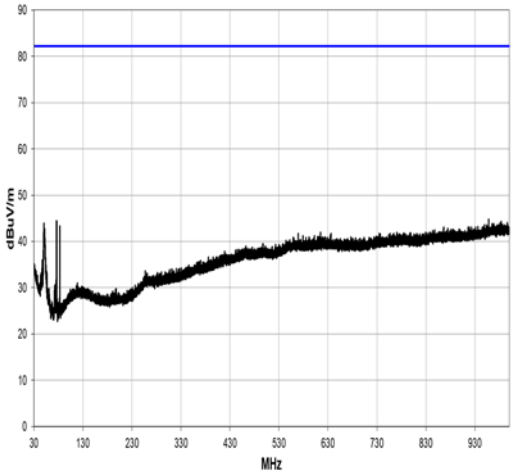
7 GHz to 18 GHz



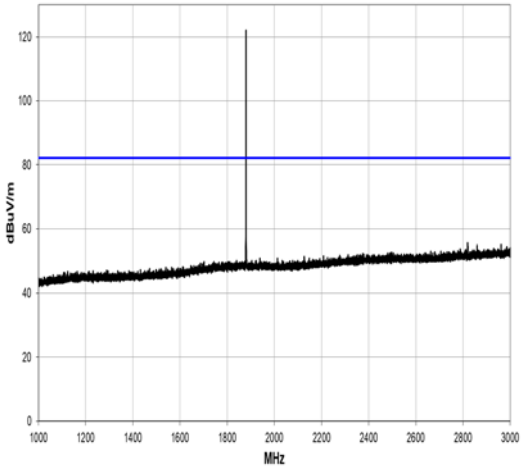
18 GHz to 26.5 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
1673.333	70.8	-6.9	1.8	90.0	3.0	16.0	Vert	PK	0.0	79.9	82.2	-2.3
1673.108	70.6	-6.9	1.69	222.1	3.0	16.0	Horz	PK	0.0	79.7	82.2	-2.5

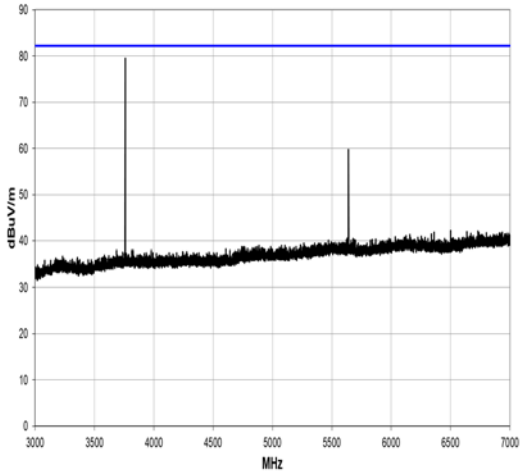
GSM BAND: 1900 (GPRS): UL ARFCN: 661; FREQ: 1880 MHz



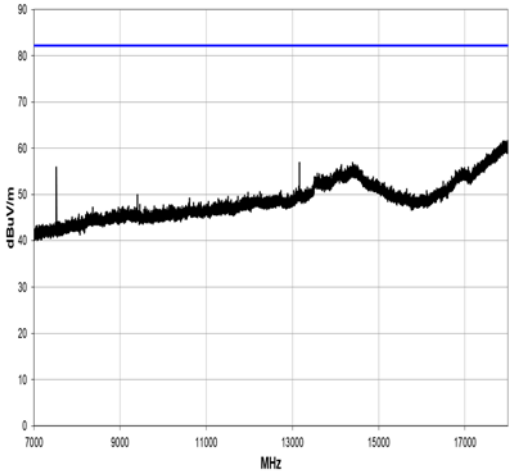
30 MHz to 1 GHz



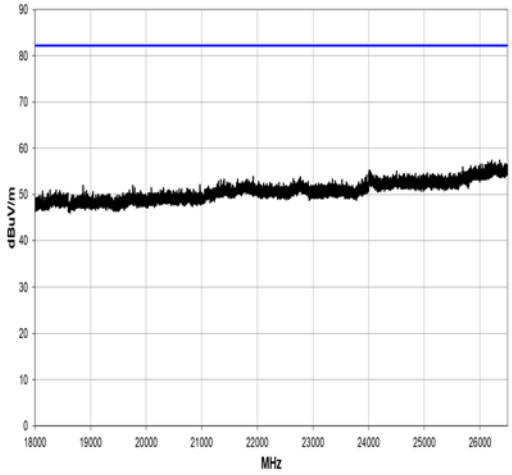
1 GHz to 3 GHz



3 GHz to 7 GHz



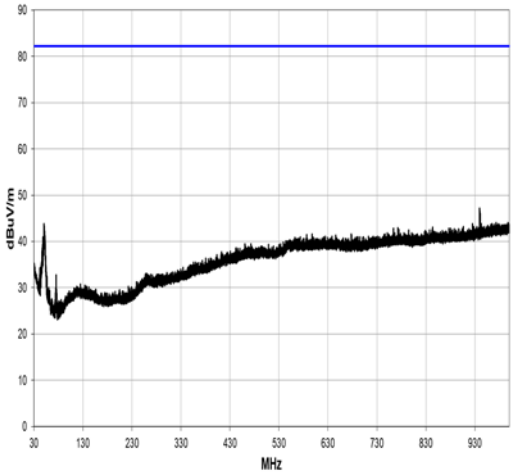
7 GHz to 18 GHz



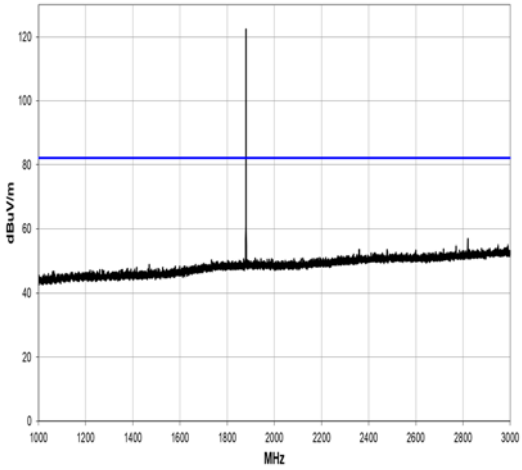
18 GHz to 26.5 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
3760.066	78.5	1.8	1.88	97.9	3.0	0.0	Horz	PK	0.0	80.3	82.2	-1.9
3759.991	72.6	1.8	1.46	153.1	3.0	0.0	Vert	PK	0.0	74.4	82.2	-7.8

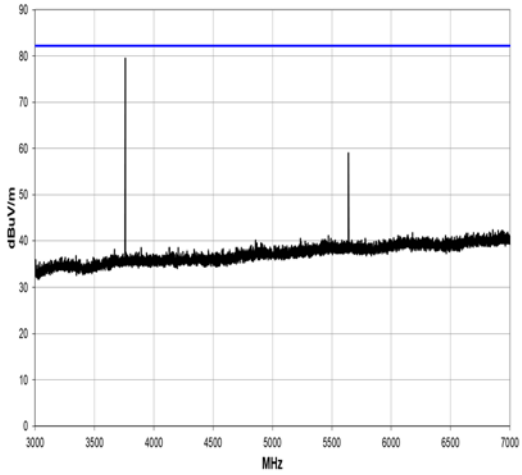
GSM BAND: 1900 (EDGE): UL ARFCN: 661; FREQ: 1880 MHz



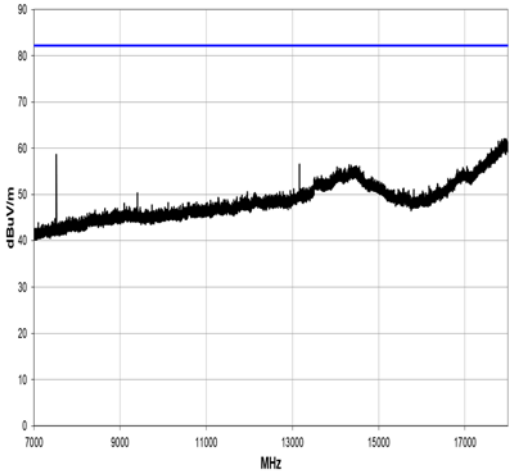
30 MHz to 1 GHz



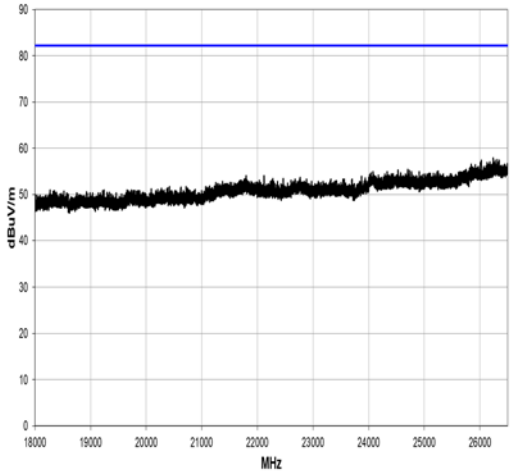
1 GHz to 3 GHz



3 GHz to 7 GHz



7 GHz to 18 GHz

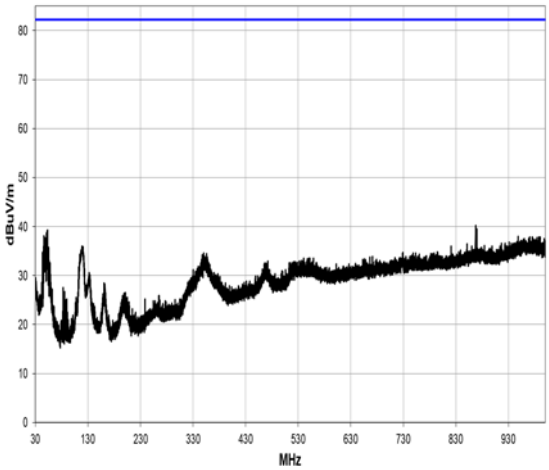


18 GHz to 26.5 GHz

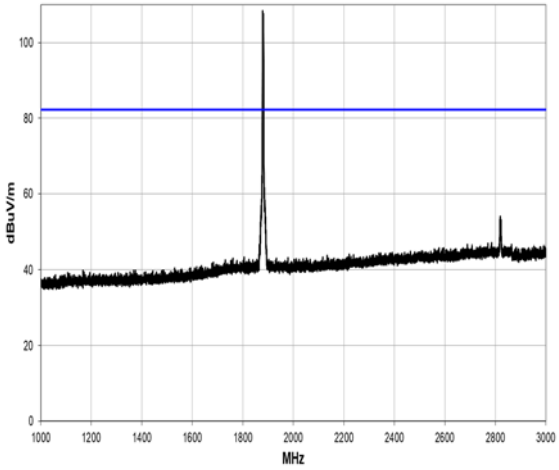
Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
3760.000	77.0	1.8	1.51	117.1	3.0	0.0	Horz	PK	0.0	78.8	82.2	-3.4
3760.050	73.9	1.8	1.42	90.1	3.0	0.0	Vert	PK	0.0	75.7	82.2	-6.5

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
7520.017	54.6	8.2	1.5	194.0	3.0	0.0	Vert	PK	0.0	62.8	82.2	-19.4

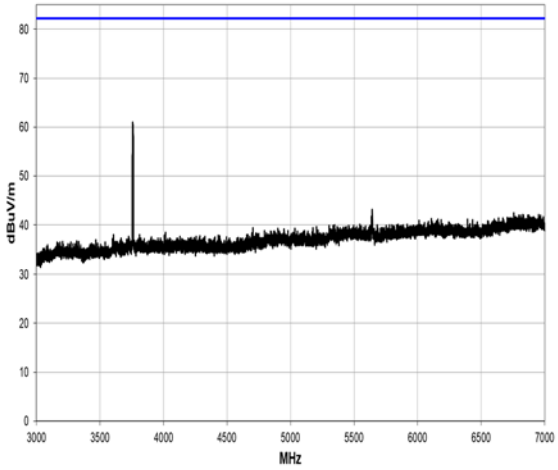
WCDMA BAND: 2; UL ARFCN: 9400; FREQ: 1880 MHz



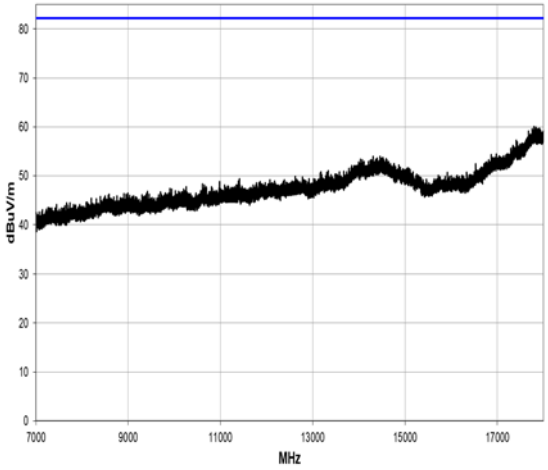
30 MHz to 1 GHz



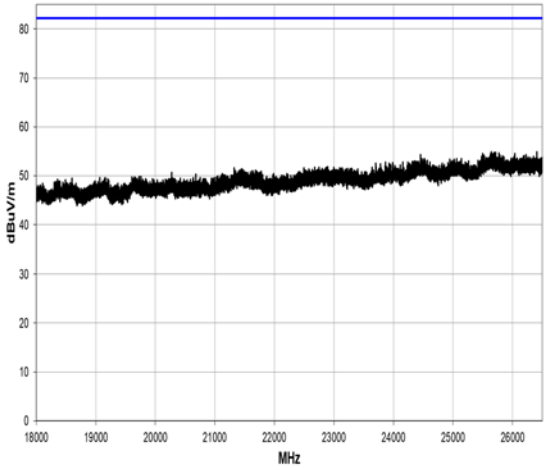
1 GHz to 3 GHz



3 GHz to 7 GHz



7 GHz to 18 GHz

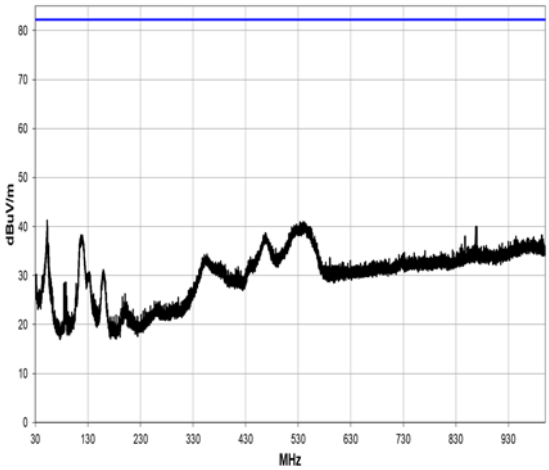


18 GHz to 26.5 GHz

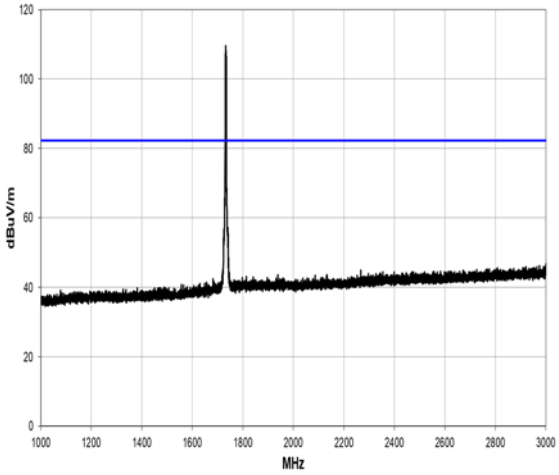
Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
2818.299	59.1	-2.4	1.5	124.8	3.0	10.0	Horz	PK	0.0	66.7	82.2	-15.5

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
3762.354	68.7	1.7	1.24	188.9	3.0	0.0	Horz	PK	0.0	70.4	82.2	-11.8
3762.437	66.6	1.7	1.52	187.8	3.0	0.0	Vert	PK	0.0	68.3	82.2	-13.9

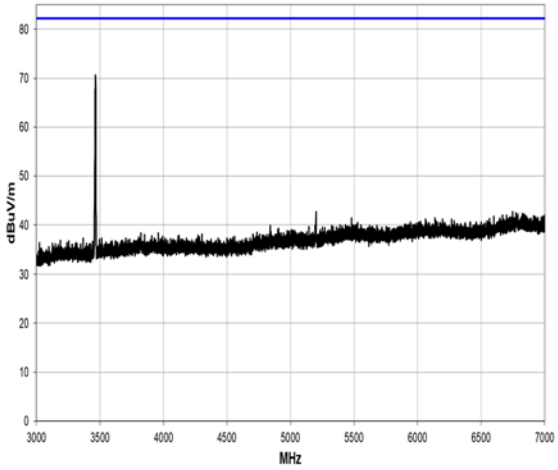
WCDMA BAND: 4; UL ARFCN: 1413; FREQ: 1732.6 MHz



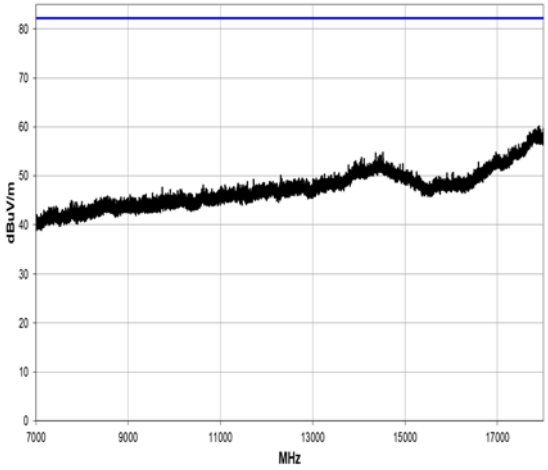
30 MHz to 1 GHz



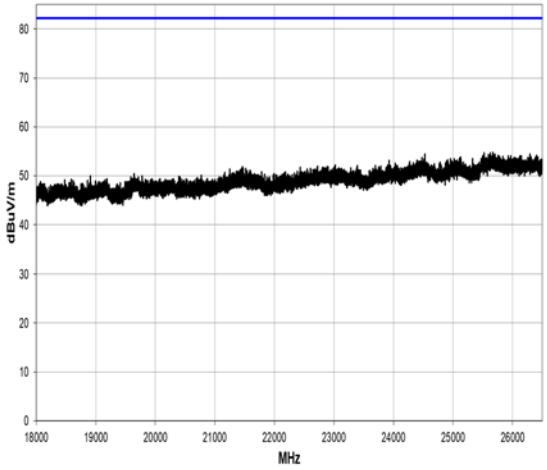
1 GHz to 3 GHz



3 GHz to 7 GHz



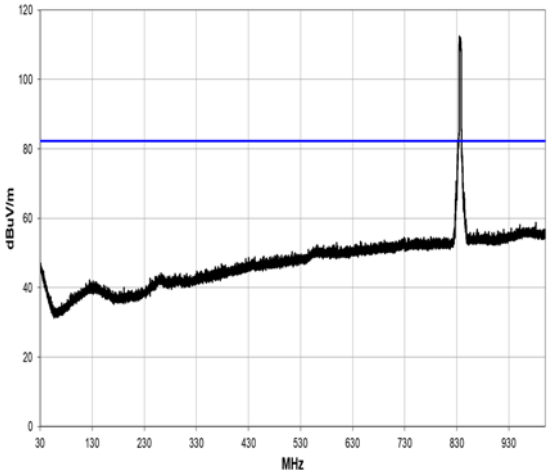
7 GHz to 18 GHz



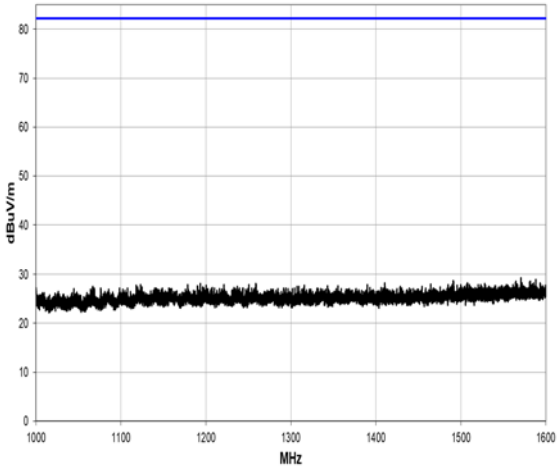
18 GHz to 26.5 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
3467.175	77.5	0.3	1.5	33.0	3.0	0.0	Vert	PK	0.0	77.8	82.2	-4.4
3467.175	76.7	0.3	1.35	99.9	3.0	0.0	Horz	PK	0.0	77.0	82.2	-5.2

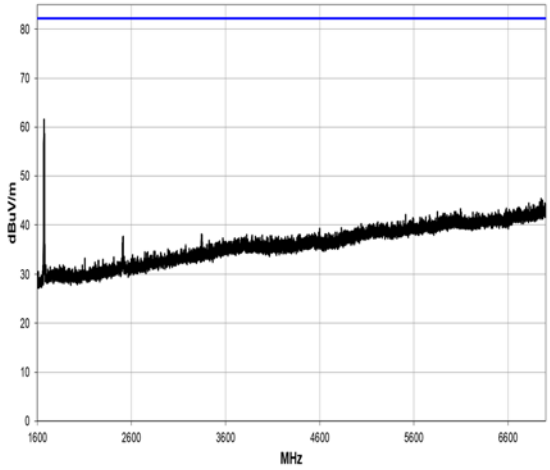
WCDMA BAND: 5; UL ARFCN: 4183; FREQ: 836.6 MHz



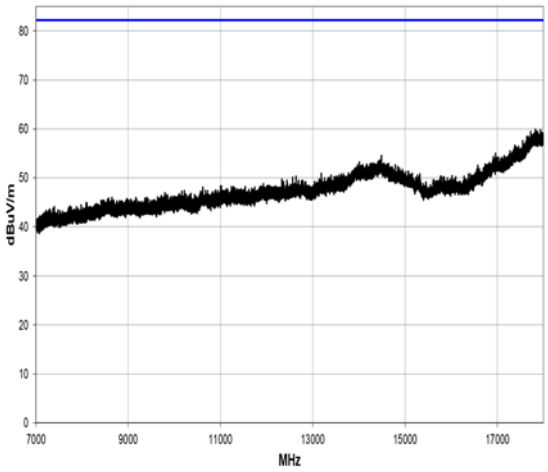
30 MHz to 1 GHz



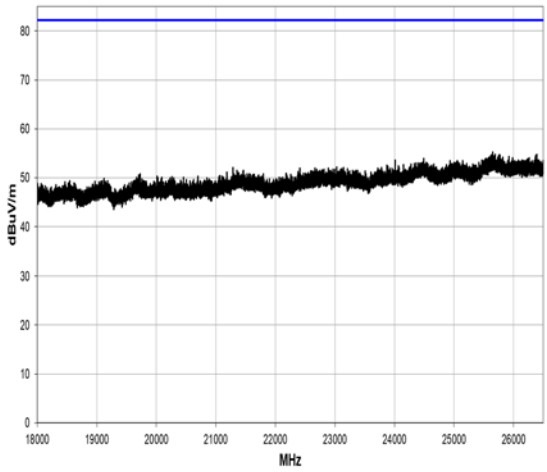
1 GHz to 1.6 GHz



1.6 GHz to 7 GHz



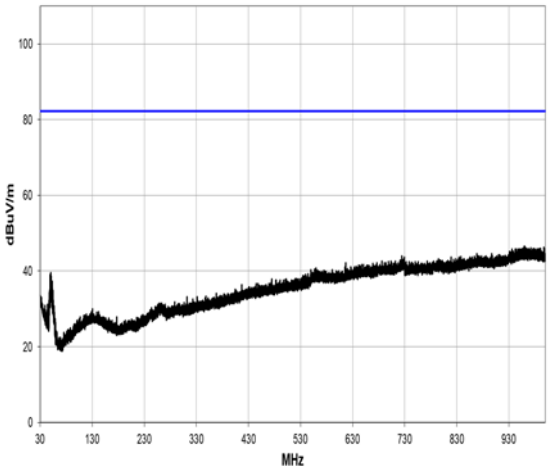
7 GHz to 18 GHz



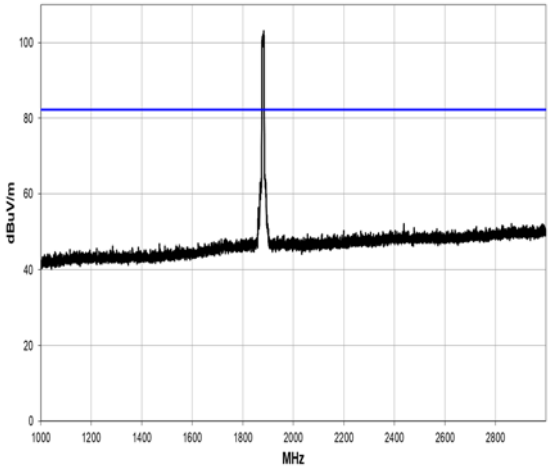
18 GHz to 26.5 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
1671.155	78.3	-5.8	2.33	165.8	3.0	0.0	Horz	PK	0.0	72.5	82.2	-9.7
1671.197	78.1	-5.8	1.88	69.8	3.0	0.0	Vert	PK	0.0	72.3	82.2	-9.9

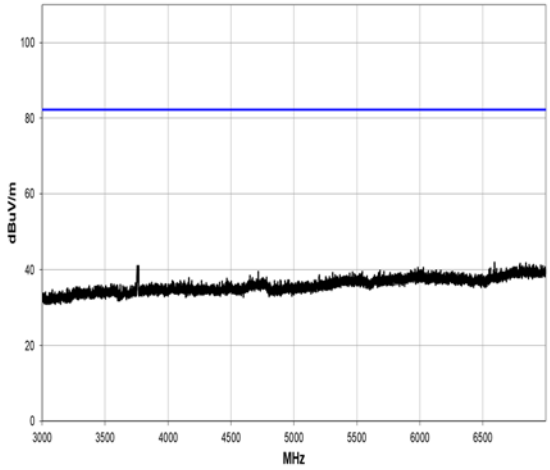
LTE BAND: 2; UL ARFCN: 18900; FREQ: 1880 MHz



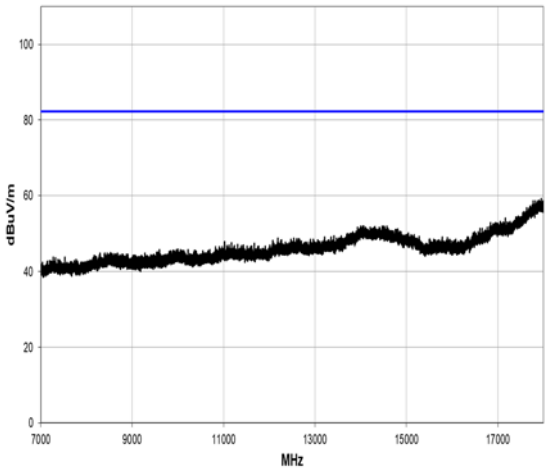
30 MHz to 1 GHz



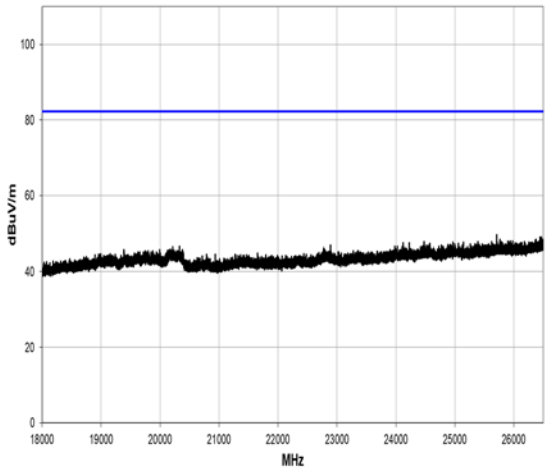
1 GHz to 3 GHz



3 GHz to 7 GHz



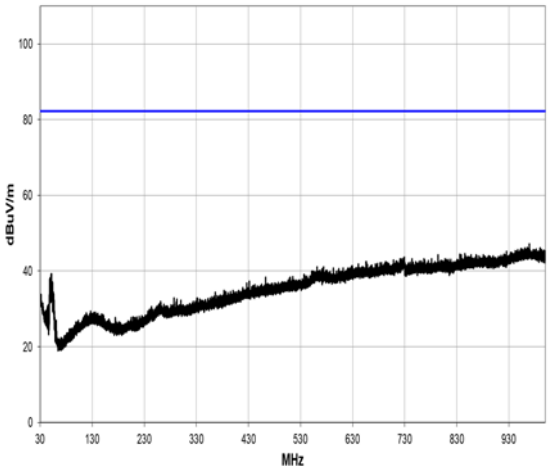
7 GHz to 18 GHz



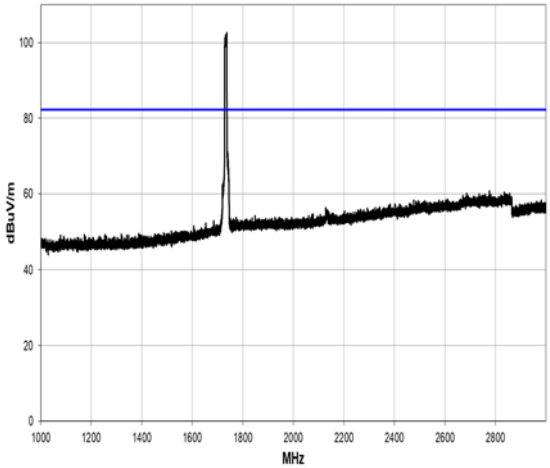
18 GHz to 26.5 GHz

UL ARFCN: 18900; FREQ: 1880 MHz					
Emission	***Frequency (MHz)***	***Emission level (dBm)***	***Limit (dBm)***	***Margin (dB)***	***Result***
No significant emissions within 20 dB of the limit					PASS

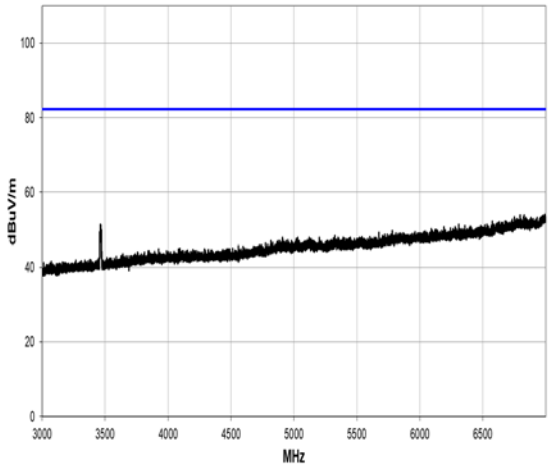
LTE BAND: 4; UL ARFCN: 20175; FREQ: 1732.5 MHz



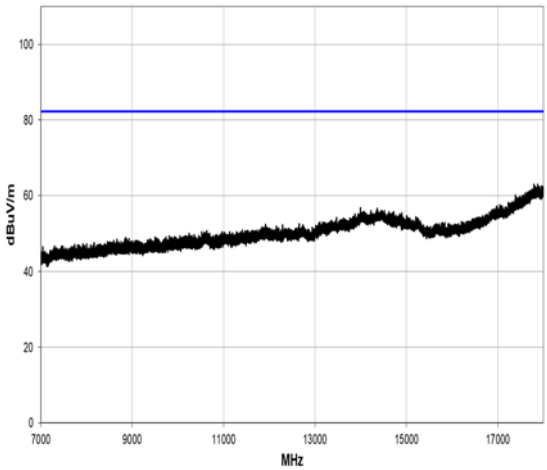
30 MHz to 1 GHz



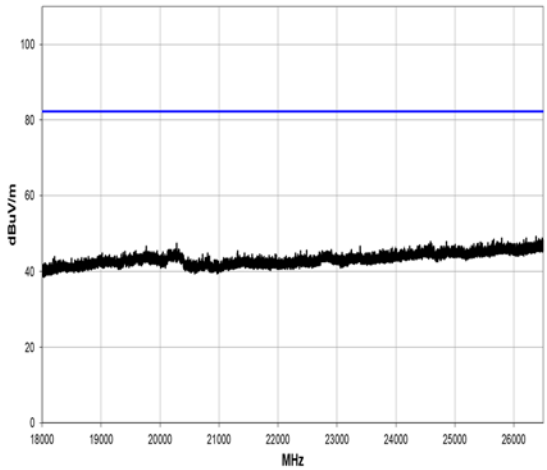
1 GHz to 3 GHz



3 GHz to 7 GHz



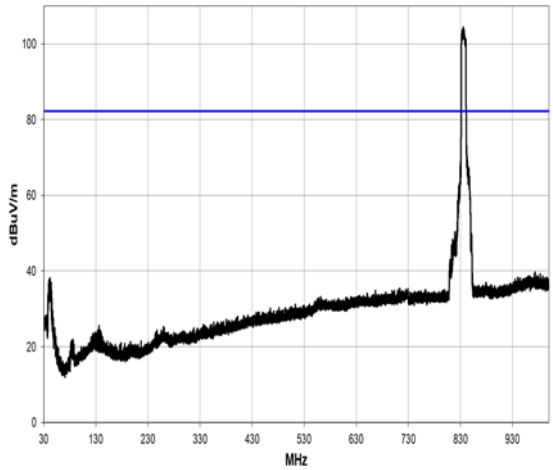
7 GHz to 18 GHz



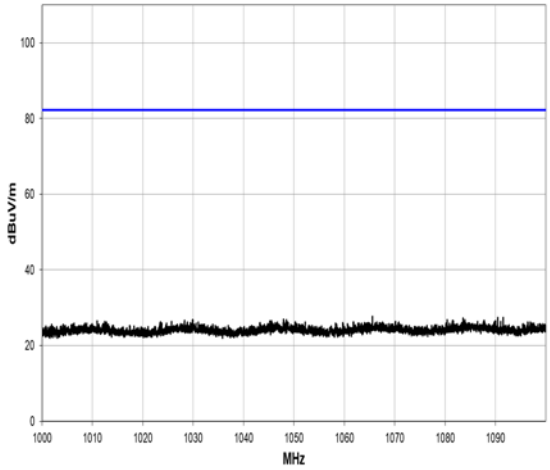
18 GHz to 26.5 GHz

UL ARFCN: 20175; FREQ: 1732.5 MHz					
Emission	***Frequency (MHz)***	***Emission level (dBm)***	***Limit (dBm)***	***Margin (dB)***	***Result***
No significant emissions within 20 dB of the limit					PASS

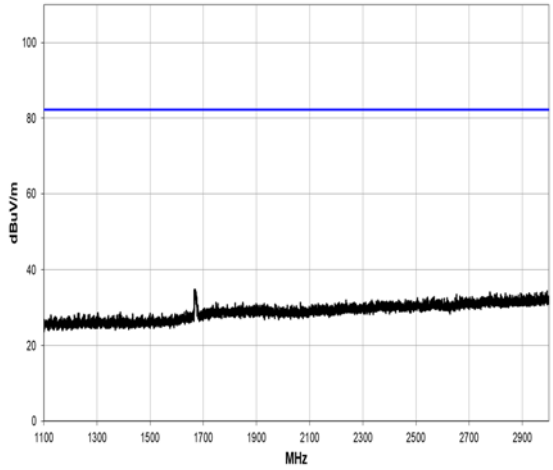
LTE BAND: 5; UL ARFCN: 20525; FREQ: 836.5 MHz



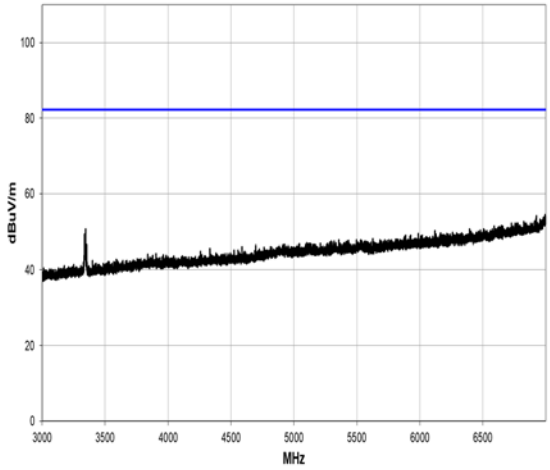
30 MHz to 1 GHz



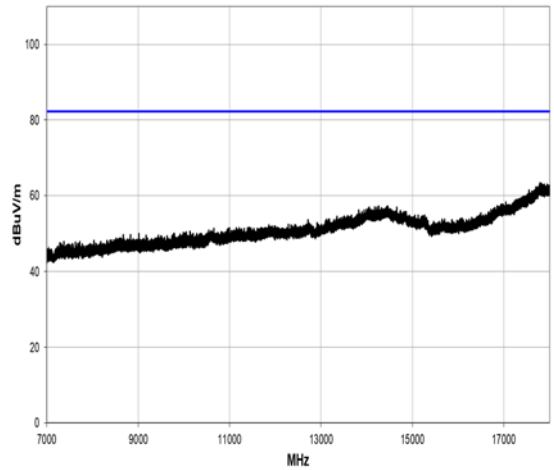
1 GHz to 1.1 GHz



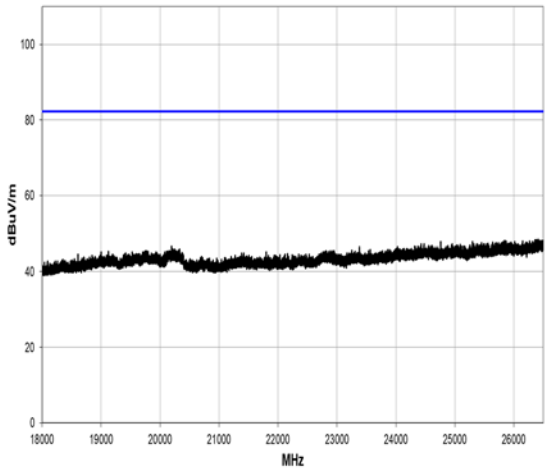
1.1 GHz to 3 GHz



3 GHz to 7 GHz



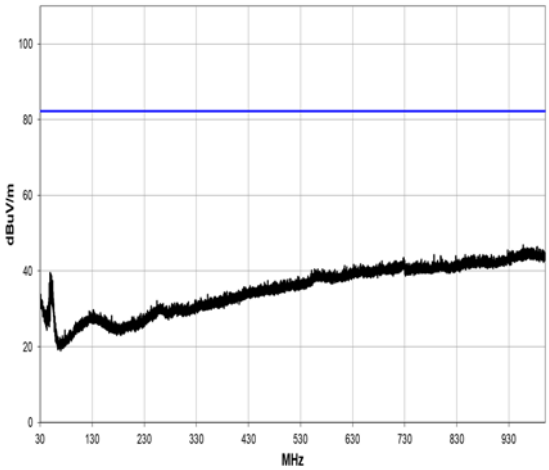
7 GHz to 18 GHz



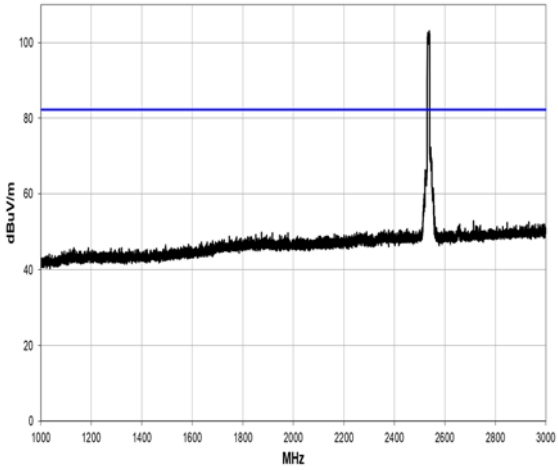
18 GHz to 26.5 GHz

UL ARFCN: 20525; FREQ: 836.5 MHz					
Emission	***Frequency (MHz)***	***Emission level (dBm)***	***Limit (dBm)***	***Margin (dB)***	***Result***
No significant emissions within 20 dB of the limit					PASS

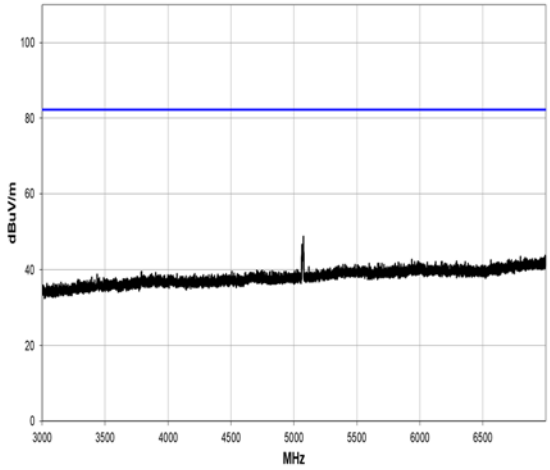
LTE BAND: 7; UL ARFCN: 21100; FREQ: 2535 MHz



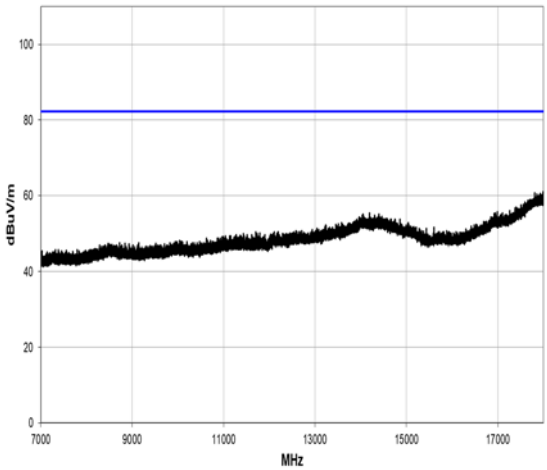
30 MHz to 1 GHz



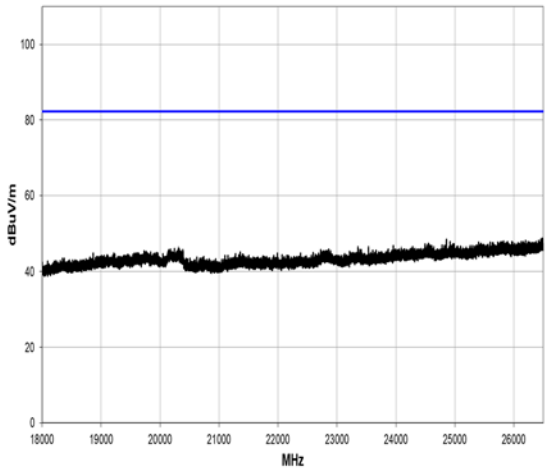
1 GHz to 3 GHz



3 GHz to 7 GHz



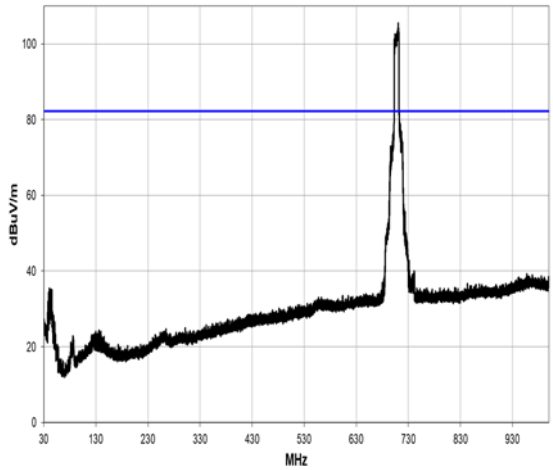
7 GHz to 18 GHz



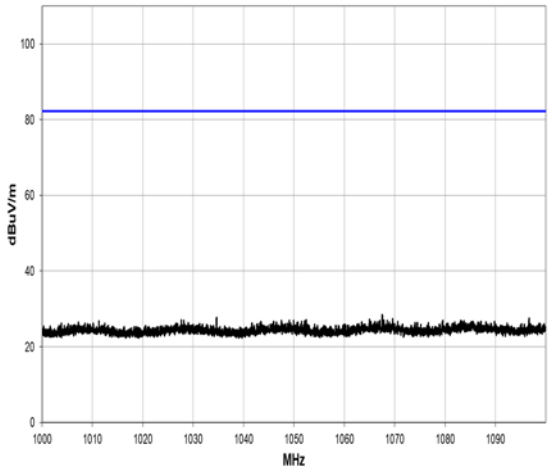
18 GHz to 26.5 GHz

UL ARFCN: 21100; FREQ: 2535 MHz					
Emission	***Frequency (MHz)***	***Emission level (dBm)***	***Limit (dBm)***	***Margin (dB)***	***Result***
No significant emissions within 20 dB of the limit					PASS

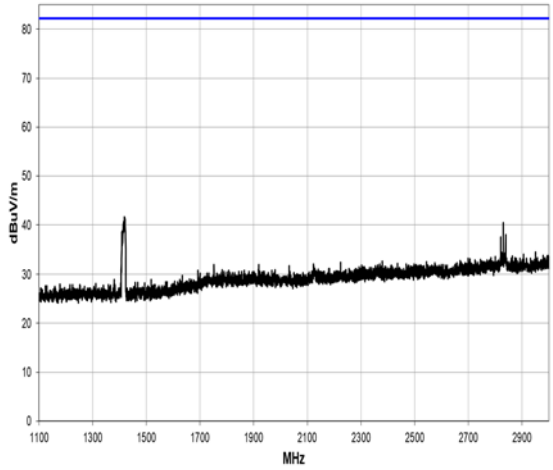
LTE BAND: 12; UL ARFCN: 23095; FREQ: 707.5 MHz



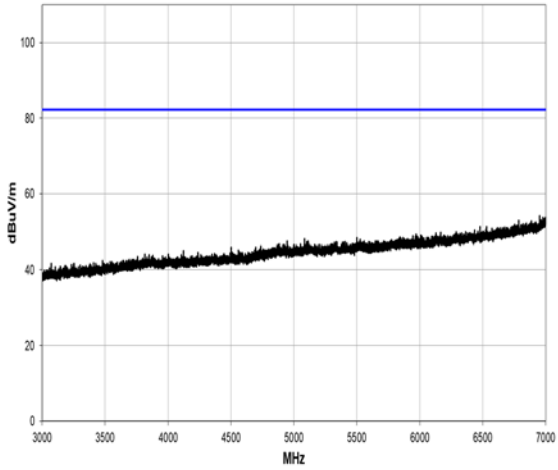
30 MHz to 1 GHz



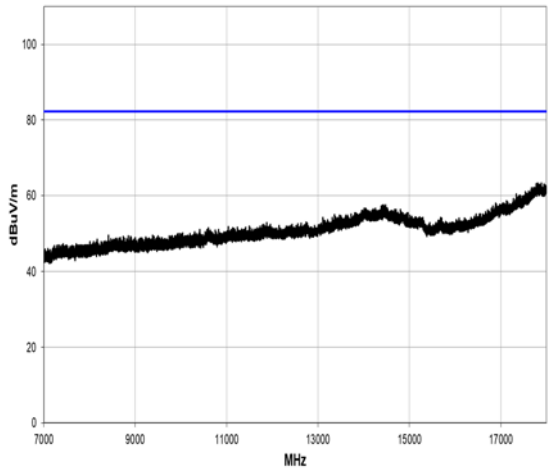
1 GHz to 1.1 GHz



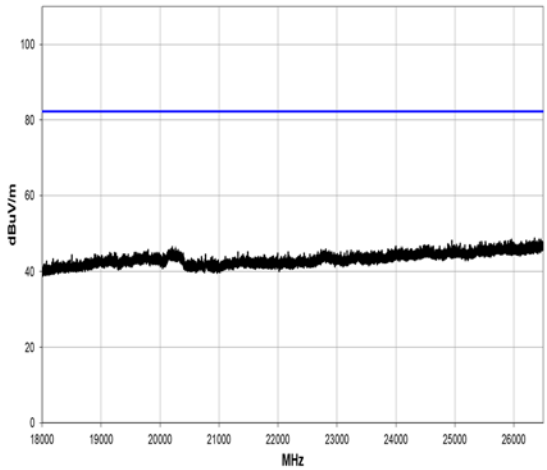
1.1 GHz to 3 GHz



3 GHz to 7 GHz



7 GHz to 18 GHz



18 GHz to 26.5 GHz

UL ARFCN: 23095; FREQ: 707.5 MHz					
Emission	***Frequency (MHz)***	***Emission level (dBm)***	***Limit (dBm)***	***Margin (dB)***	***Result***
No significant emissions within 20 dB of the limit					PASS

12 RF output power (mean output power)

12.1 Definition

The average power supplied to the antenna transmission line by a transmitter during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation taken under normal operating conditions

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	SK03 Radio Chamber
Test Standard and Clause:	KDB 935210 D05 v01, clause 3.5 KDB 971168, clause 5.2
EUT Channels Measured:	Mid
Deviations From Standard:	None
Measurement BW:	10 MHz
Measurement Detector:	Mean
Voltage Extreme Environment Test Range:	Mains Power = 85 % and 115 % of Nominal (FCC only requirement); Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 ºC to +35 ºC (as declared)
Humidity: 53 % RH	20 % RH to 75 % RH (as declared)

12.3 Test Limit

FCC 47CFR22
22.913(a) *Maximum ERP.* In general, the effective radiated power (ERP) of base transmitters and cellular repeaters must not exceed 500 Watts. However, for those systems operating in areas more than 72 km (45 miles) from international borders that:

(1) Are located in counties with population densities of 100 persons or fewer per square mile, based upon the most recently available population statistics from the Bureau of the Census; or,
(2) Extend coverage on a secondary basis into cellular unserved areas, as those areas are defined in §22.949,

the ERP of base transmitters and cellular repeaters of such systems must not exceed 1000 Watts. The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

FCC 47CFR24
24.232(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.

24.232(b)

(1) Base stations that are located in counties with population densities of 100 persons or fewer per square mile, based upon the most recently available population statistics from the Bureau of the Census, with an emission bandwidth of 1 MHz or less are limited to 3280 watts equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT.
(2) Base stations that are located in counties with population densities of 100 persons or fewer per square mile, based upon the most recently available population statistics from the Bureau of the

Census, with an emission bandwidth greater than 1 MHz are limited to 3280 watts/MHz equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT.

24.232(c) Mobile and portable stations are limited to 2 watts EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications.

FCC 47CFR27

27.50(a) The following power limits and related requirements apply to stations transmitting in the 2305–2320 MHz band or the 2345–2360 MHz band.

(1) *Base and fixed stations.*

(i) For base and fixed stations transmitting in the 2305–2315 MHz band or the 2350–2360 MHz band:

(A) The average equivalent isotropically radiated power (EIRP) must not exceed 2,000 watts within any 5 megahertz of authorized bandwidth and must not exceed 400 watts within any 1 megahertz of authorized bandwidth.

(ii) For base and fixed stations transmitting in the 2315–2320 MHz band or the 2345–2350 MHz band, the peak EIRP must not exceed 2,000 watts.

27.50(b) The following power and antenna height limits apply to transmitters operating in the 746–758 MHz, 775–788 MHz and 805–806 MHz bands:

(1) Fixed and base stations transmitting a signal in the 757–758 and 775–776 MHz bands must not exceed an effective radiated power (ERP) of 1000 watts and an antenna height of 305 m height above average terrain (HAAT), except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts ERP in accordance with Table 1 of this section.

(2) Fixed and base stations transmitting a signal in the 746–757 MHz and 776–787 MHz bands with an emission bandwidth of 1 MHz or less must not exceed an ERP of 1000 watts and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts ERP in accordance with Table 1 of this section.

(3) Fixed and base stations located in a county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, and transmitting a signal in the 746–757 MHz and 776–787 MHz bands with an emission bandwidth of 1 MHz or less must not exceed an ERP of 2000 watts and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 2000 watts ERP in accordance with Table 2 of this section.

(4) Fixed and base stations transmitting a signal in the 746–757 MHz and 776–787 MHz bands with an emission bandwidth greater than 1 MHz must not exceed an ERP of 1000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts/MHz ERP in accordance with Table 3 of this section.

(5) Fixed and base stations located in a county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, and transmitting a signal in the 746–757 MHz and 776–787 MHz bands with an emission bandwidth greater than 1 MHz must not exceed an ERP of 2000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 2000 watts/MHz ERP in accordance with Table 4 of this section.

(9) Control stations and mobile stations transmitting in the 746–757 MHz, 776–788 MHz, and 805–806 MHz bands and fixed stations transmitting in the 787– 788 MHz and 805–806 MHz bands are limited to 30 watts ERP.

27.50(c) The following power and antenna height requirements apply to stations transmitting in the 698–746 MHz band

(1) Fixed and base stations transmitting a signal with an emission bandwidth of 1 MHz or less must not exceed an effective radiated power (ERP) of 1000 watts and an antenna height of 305 m height above average terrain (HAAT), except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts ERP in accordance with Table 1 of this section;

(2) Fixed and base stations located in a county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, and transmitting a signal with an emission bandwidth of 1 MHz or less must not exceed an ERP of 2000 watts and an antenna height of 305 m HAAT, except that antenna heights greater

than 305 m HAAT are permitted if power levels are reduced below 2000 watts ERP in accordance with Table 2 of this section;
(3) Fixed and base stations transmitting a signal with an emission bandwidth greater than 1 MHz must not exceed an ERP of 1000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts/MHz ERP in accordance with Table 3 of this section;
(4) Fixed and base stations located in a county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, and transmitting a signal with an emission bandwidth greater than 1 MHz must not exceed an ERP of 2000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 2000 watts/MHz ERP in accordance with Table 4 of this section;
(7) A licensee authorized to operate in the 710–716 or 740–746 MHz bands may operate a fixed or base station at an ERP up to a total of 50 kW within its authorized, 6 megahertz spectrum block if the licensee complies with the provisions of §27.55(b). The antenna height for such stations is limited only to the extent required to satisfy the requirements of § 27.55(b).
(9) Control and mobile stations are limited to 30 watts ERP;
(12) A licensee authorized to operate in the 716–722 or 722–728 MHz bands may operate a fixed or base station at an ERP up to a total of 50 kW within its authorized, 6 megahertz spectrum block if the licensee complies with the provisions of §27.55(b), obtains written concurrences from all affected licensees in the 698–746 MHz bands within 120 km of the proposed high power site, and files a copy of each written concurrences with the Wireless Telecommunications Bureau on FCC Form 601. The antenna height for such stations is limited only to the extent required to satisfy the requirements of § 27.55(b).

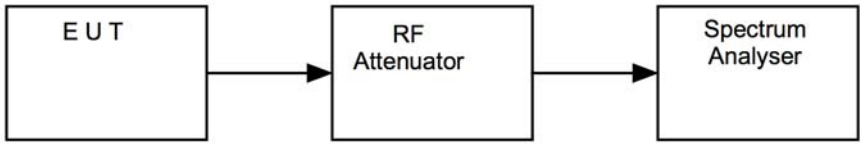
27.50(d) The following power and antenna height requirements apply to stations transmitting in the 1695–1710 MHz, 1710– 1755 MHz, 1755–1780 MHz, 1915–1920 MHz, 1995–2000 MHz, 2000–2020 MHz, 2110–2155 MHz, 2155–2180 MHz and 2180–2200 MHz bands:
(1)The power of each fixed or base station transmitting in the 1995–2000 MHz, 2110–2155 MHz, 2155–2180 MHz or 2180–2200 MHz band and located in any county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, is limited to:
(i) An equivalent isotropically radiated power (EIRP) of 3280 watts when transmitting with an emission bandwidth of 1 MHz or less;
(ii) An EIRP of 3280 watts/MHz when transmitting with an emission bandwidth greater than 1 MHz.
(2) The power of each fixed or base station transmitting in the 1995–2000 MHz, the 2110–2155 MHz 2155–2180 MHz band, or 2180–2200 MHz band and situated in any geographic location other than that described in paragraph (d)(1) of this section is limited to:
(i) An equivalent isotropically radiated power (EIRP) of 1640 watts when transmitting with an emission bandwidth of 1 MHz or less;
(ii) An EIRP of 1640 watts/MHz when transmitting with an emission bandwidth greater than 1 MHz.
(4) Fixed, mobile, and portable (handheld) stations operating in the 1710–1755 MHz band and mobile and portable stations operating in the 1695–1710 MHz and 1755–1780 MHz bands are limited to 1 watt EIRP. Fixed stations operating in the 1710–1755 MHz band are limited to a maximum antenna height of 10 meters above ground. Mobile and portable stations operating in these bands must employ a means for limiting power to the minimum necessary for successful communications.
(9) Fixed, mobile and portable (handheld) stations operating in the 1915–1920 MHz band are limited to 300 milliwatts EIRP.

12.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the resolution bandwidth of the spectrum analyser was increased above the EUT occupied bandwidth and the peak emission data noted.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure iv Test Setup



12.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Due For Calibration*
Spectrum Analyser	R&S	FSU46	REF910	2021-11-16
Attenuator	AtlanTechRF Microwave	20dB SMA	U632	Cal in use
Attenuator	AtlanTechRF Microwave	10dB SMA	U633	Cal in use
Attenuator	Radiall	6dB	U332	Cal in use

12.6 Test Results

GSM850 (GPRS); UL ARFCN: 190; FREQ: 836.5 MHz; Power setting: High			
Channel Frequency (MHz)	**Output Power (dBm)**	**Max. Power (W)**	**Result**
836.5	32.15	1.641	PASS

GSM850 (EDGE); UL ARFCN: 190; FREQ: 836.5 MHz; Power setting: High			
Channel Frequency (MHz)	**Output Power (dBm)**	**Max. Power (W)**	**Result**
836.5	27.79	0.601	PASS

GSM1900 (GPRS); ; UL ARFCN: 661; FREQ: 1880 MHz; Power setting: High			
Channel Frequency (MHz)	**Output Power (dBm)**	**Max. Power (W)**	**Result**
1880	29.17	0.826	PASS

GSM1900 (EDGE); ; UL ARFCN: 661; FREQ: 1880 MHz; Power setting: High			
Channel Frequency (MHz)	**Output Power (dBm)**	**Max. Power (W)**	**Result**
1880	24.47	0.280	PASS

WCDMA; BAND: 2; UL ARFCN: 9400; FREQ: 1880 MHz; Power setting: High			
Channel Frequency (MHz)	**Output Power (dBm)**	**Max. Power (W)**	**Result**
1880	22.30	0.170	PASS

WCDMA; BAND: 4; UL ARFCN: 1413; FREQ: 1732.6 MHz; Power setting: High			
Channel Frequency (MHz)	**Output Power (dBm)**	**Max. Power (W)**	**Result**
1732.6	22.10	0.162	PASS

WCDMA; BAND: 5; UL ARFCN: 4183; FREQ: 836.6 MHz; Power setting: High			
Channel Frequency (MHz)	**Output Power (dBm)**	**Max. Power (W)**	**Result**
836.6	22.20	0.166	PASS

LTE; BAND: 2; UL ARFCN: 18900; FREQ: 1880 MHz; Power setting: High			
Channel Frequency (MHz)	***Output Power (dBm)***	***Max. Power (W)***	***Result***
1880	21.16	0.131	PASS

LTE; BAND: 4; UL ARFCN: 20175; FREQ: 1732.5 MHz; Power setting: High			
Channel Frequency (MHz)	***Output Power (dBm)***	***Max. Power (W)***	***Result***
1732.5	20.30	0.107	PASS

LTE; BAND: 5; UL ARFCN: 20525; FREQ: 836.5 MHz; Power setting: High			
Channel Frequency (MHz)	***Output Power (dBm)***	***Max. Power (W)***	***Result***
836.5	20.96	0.125	PASS

LTE; BAND: 7; UL ARFCN: 21100; FREQ: 2535 MHz; Power setting: High			
Channel Frequency (MHz)	***Output Power (dBm)***	***Max. Power (W)***	***Result***
2535	21.16	0.131	PASS

LTE; BAND: 12; UL ARFCN: 23095; FREQ: 707.5 MHz; Power setting: High			
Channel Frequency (MHz)	***Output Power (dBm)***	***Max. Power (W)***	***Result***
707.5	21.30	0.135	PASS

13 Measurement Uncertainty

Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence:

[1] Radiated spurious emissions

Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**
Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

[2] Carrier Power

Uncertainty in test result (Power Meter) = **1.08dB**
Uncertainty in test result (Spectrum Analyser) = **2.48dB**