TEST REPORT
FROM
RFI GLOBAL SERVICES LTD

Test of: GEMTAG x501

FCC ID: ZW2X501USB

To: FCC Part 15.225: 2011 Subpart C

Test Report Serial No:
RFI-RPT-RP81486JD06A

This Test Report Is Issued Under The Authority Of Chris Guy, Head of Global Approvals:	
Checked By:	Ian Watch
Signature:	
Date of Issue:	30 January 2012

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Table of Contents

1. Customer Information

Company Name:	Gemini 2000 Ltd.
Address:	Peartree Business Park Ferndown Industrial Park Wimborne Dorset BH21 7PT United Kingdom

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.225
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications) 2011: Part 15 Subpart C (Radio Frequency Devices) - Section 15.225
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications) 2011: Part 15 Subpart C (Intentional Radiators) – Sections 15.207 and 15.209
Site Registration:	209735
Location of Testing:	RFI Global Services Ltd, Wade Road, Basingstoke, Hampshire, RG24 8AH.
Test Dates:	26 July 2011 to 18 January 2012

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.207	Transmitter AC Conducted Emissions	✓
Part 15.225(a)(b)(c)(d)	Transmitter Fundamental Field Strength	✓
Part 15.209(a)/15.225(d)	Transmitter Radiated Emissions	✓
Part 15.209(a)/15.225(c)(d)	Transmitter Band Edge Radiated Emissions	✓
Part 2.1049	Transmitter 20 dB Bandwidth	✓
Part 15.225(e)	Transmitter Frequency Stability (Temperature & Voltage Variation)	✓
Key to Results ✓ = Complied ✗ = Did not comply		

2.3. Methods and Procedures

Reference:	ANSI C63.4 (2009)
Title:	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
Reference:	ANSI C63.10 (2009)
Title:	American National Standard for Testing Unlicensed Wireless Devices

2.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	GEMTAG
Model Name or Number:	GEMTAG x501
Serial Numbers:	31015 (Radiated Sample) 30457 (AC conducted with 50Ω load fitted to antenna)
Hardware Version Number:	3.1
Software Version Number:	3.3
FCC ID:	ZW2X501USB

3.2. Description of EUT

The equipment under test was a contactless smart card reader.

3.3. Modifications Incorporated in the EUT

The following modifications were applied to the EUT during testing:

The RFID antenna was disconnected and replaced with a 50Ω dummy load in order to comply with the requirements of the AC conducted emissions test in transmit mode. The standard antenna was connected for all other tests.

3.4. Additional Information Related to Testing

Tested Technology:	RFID	
Category of Equipment:	Transceiver	
Channel Spacing:	Single channel device	
Transmit Frequency Range:	13.56 MHz	
Power Supply Requirement:	Nominal	5.0 VDC
	Minimum	4.25 VDC
	Maximum	5.75 VDC
Tested Temperature Range:	Minimum	-20°C
	Maximum	50°C

3.5. Support Equipment

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

Description:	Laptop PC
Brand Name:	Dell
Model Name or Number:	D600
Serial Number:	RFI Asset Number PC353NT

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 with a modulated carrier in RFID test mode.

4.2. Configuration and Peripherals

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

- The unit was normally powered by the 5 V supply from a USB cable. For all tests not requiring voltage variation, the EUT was connected to a support laptop computer via a USB cable.
- For voltage and temperature variation tests, a modified USB cable with DC breakout was used to power the EUT. The DC breakout cables were connected to a bench power supply and the voltage monitored using a calibrated voltmeter.
- The EUT is designed to constantly transmit and receive in its' normal mode of operation. It was not possible to turn the transmitter off, therefore no receiver tests were performed.
- AC conducted emission tests were performed with the EUT connected to the USB port on a laptop PC. The power supply of the laptop PC was connected to the LISN.

5. Measurements, Examinations and Derived Results

5.1. General Comments

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to *Section 6: Measurement Uncertainties* for details.

5.2. Test Results

5.2.1. Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Patrick Jones	**Test Date:**	18 January 2012
Test Sample Serial No:	30457		

FCC Part:	15.207
Test Method Used:	As detailed in ANSI C63.10 Section 6.2 referencing ANSI C63.4

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	26

Results: Live / Quasi Peak

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.195000	Live	45.7	63.8	18.1	Complied
0.199500	Live	50.3	63.6	13.3	Complied
4.911000	Live	28.6	56.0	27.4	Complied
10.491000	Live	38.3	60.0	21.7	Complied
11.026500	Live	36.8	60.0	23.2	Complied

Results: Live / Average

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.199500	Live	39.2	53.6	14.4	Complied
0.267000	Live	31.1	51.2	20.1	Complied
10.491000	Live	34.7	50.0	15.3	Complied
11.026500	Live	30.6	50.0	19.4	Complied
11.323500	Live	29.1	50.0	20.9	Complied

Transmitter AC Conducted Spurious Emissions (continued)

Results: Neutral / Quasi Peak

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.199500	Neutral	48.6	63.6	15.0	Complied
10.437000	Neutral	34.7	60.0	25.3	Complied
10.585500	Neutral	37.7	60.0	22.3	Complied
10.779000	Neutral	37.5	60.0	22.5	Complied
10.981500	Neutral	38.0	60.0	22.0	Complied

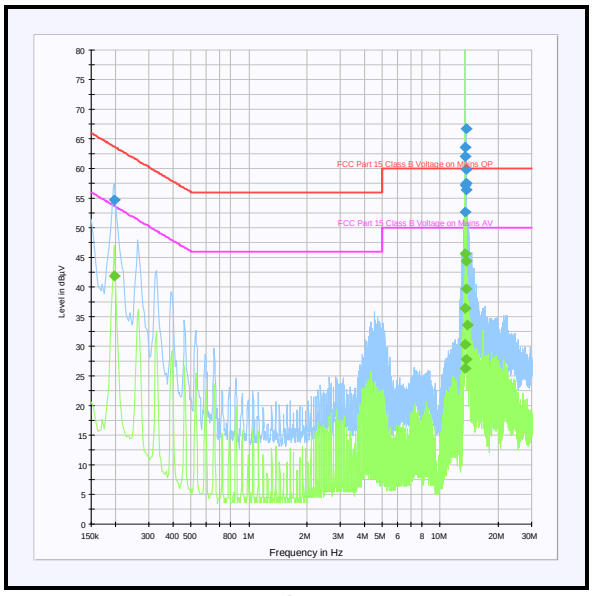
Results: Neutral / Average

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
10.468500	Neutral	31.7	50.0	18.3	Complied
10.518000	Neutral	33.5	50.0	16.5	Complied
10.590000	Neutral	33.3	50.0	16.7	Complied
10.648500	Neutral	33.6	50.0	16.4	Complied
10.981500	Neutral	33.6	50.0	16.4	Complied

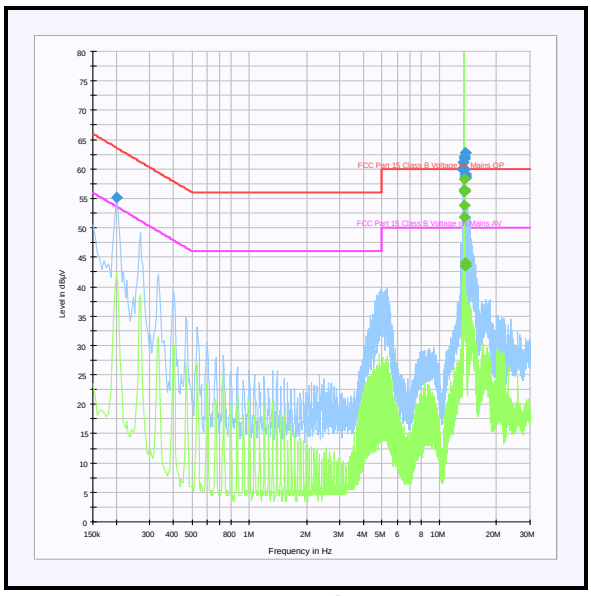
Note(s):

1. The EUT was initially tested with the standard antenna connected on sample 31015. The carrier at 13.56 MHz was found to be non-compliant as it exceeded the test limit. The customer modified sample 30457 by disconnecting the standard antenna and fitting a load with the same electrical properties in accordance with ANSI C63.10 Section 6.2.5 and FCC KDB174176. The test was then repeated and the EUT was found to be compliant.
2. The highest emission levels were recorded in the above tables. All other emissions on the pre-scan plots were investigated and found to be >30 dB below the specified limits.

Transmitter AC Conducted Spurious Emissions (continued)

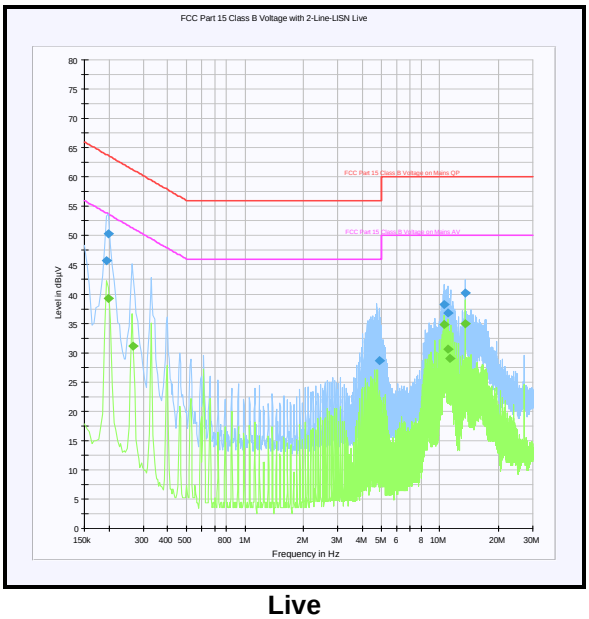


Live

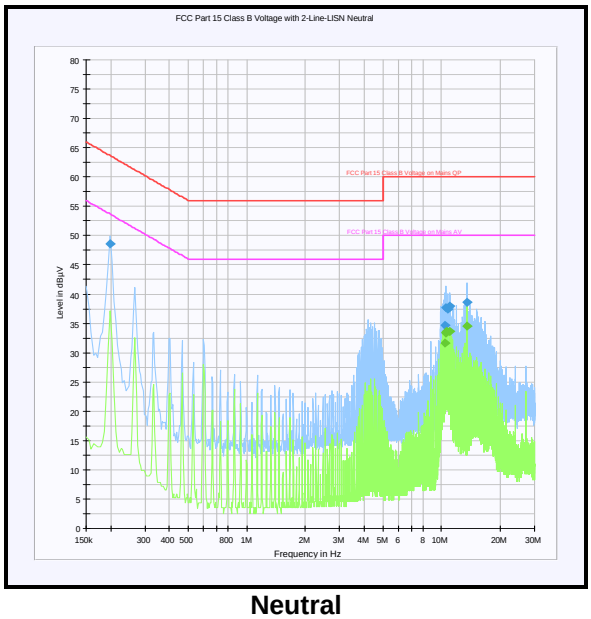


Neutral

Pre-scan test results prior to modification of the EUT (no dummy load)



Live



Neutral

Pre-scan test results after modification of the EUT (transmitter terminated into 50Ω load)

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

5.2.2. Transmitter Fundamental Field Strength

Test Summary:

Test Engineer:	Nick Steele	**Test Date:**	27 July 2011
Test Sample Serial No:	31015		

FCC Part:	15.225(a)(b)(c)(d)
Test Method Used:	As detailed in ANSI C63.10 Section 6.4

Environmental Conditions:

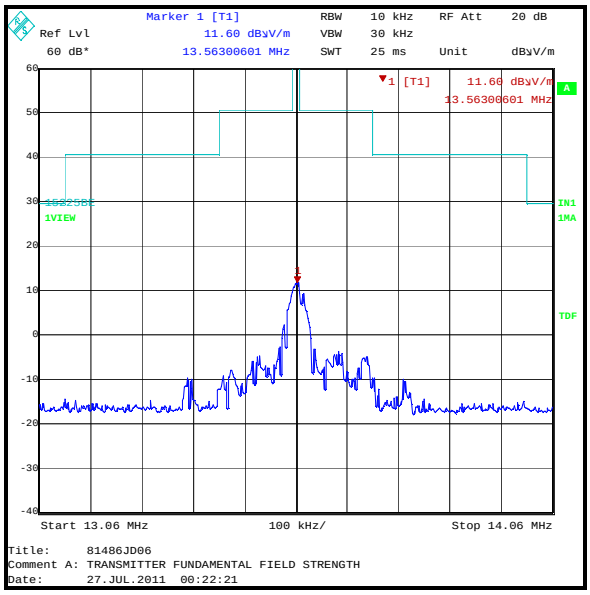
Temperature (℃):	29
Relative Humidity (%):	29

Results: Quasi Peak

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit at 30 m (dBµV/m)	Margin (dB)	Result
13.56	90°to EUT	11.6	84.0	72.4	Complied

Note(s):

1. The limit is specified at a test distance of 30 metres. However, as specified by FCC Section 15.31 (f)(2), measurements may be performed at a closer distance and the measured level corrected to the specified measurement distance by using the square of an inverse linear distance extrapolation factor (40dB/decade).
2. A transducer factor on the measuring instrument was used to extrapolate the results at 3 metres to a distance of 30 metres. A distance extrapolation factor of 40 dB was used.



5.2.3. Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineer:	Nick Steele & Andrew Edwards	**Test Date:**	26 July 2011 & 04 August 2011
Test Sample Serial No:	31015		

FCC Part:	15.225(d) & 15.209(a)
Test Method Used:	As detailed in ANSI C63.10 Sections 6.3, 6.4 and 6.5 referencing ANSI C63.4
Frequency Range:	9 kHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	27 to 31
Relative Humidity (%):	22 to 41

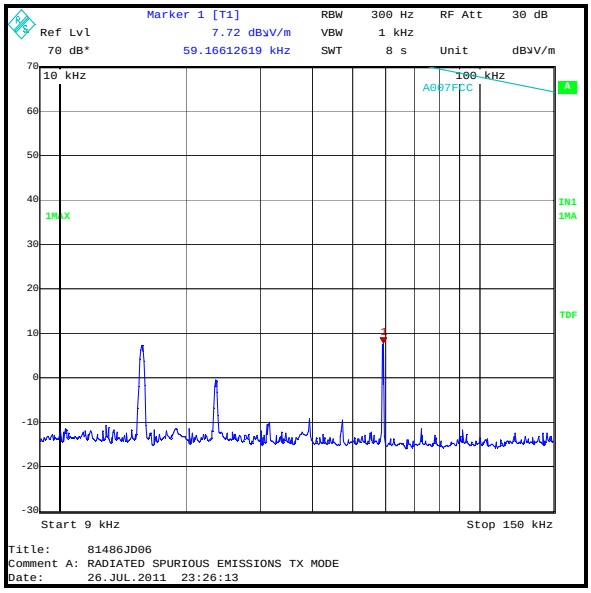
Results: Quasi Peak

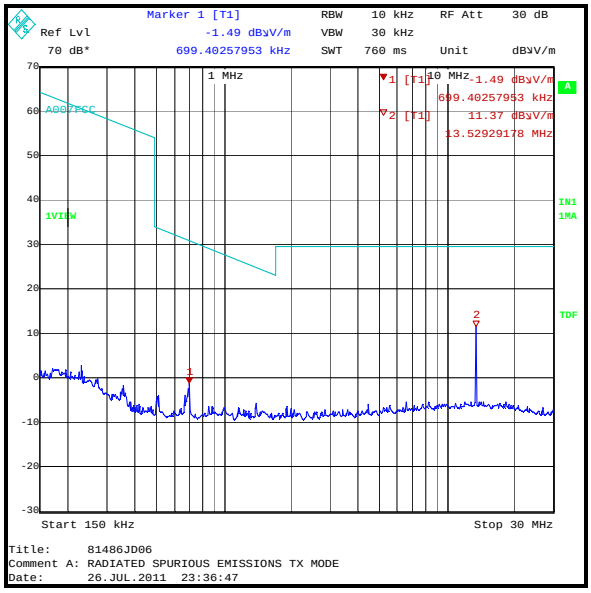
Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
162.718	Vertical	27.6	43.5	15.9	Complied
176.277	Horizontal	21.3	43.5	22.2	Complied
189.807	Horizontal	29.9	43.5	13.6	Complied
203.376	Horizontal	24.9	43.5	18.6	Complied
420.351	Vertical	21.3	46.0	24.7	Complied
946.596	Horizontal	23.2	46.0	22.8	Complied

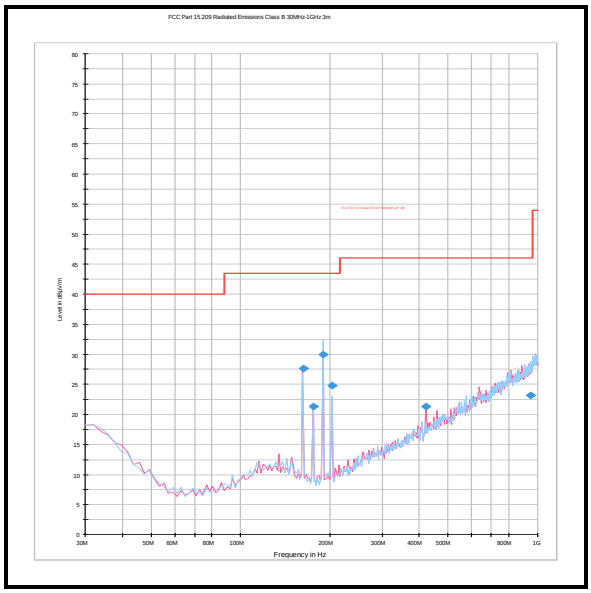
Note(s):

1. Limits below 30 MHz are specified at a test distance of 30 metres, whilst below 0.49 MHz they are specified at a test distance of 300 metres. However, as specified by FCC Section 15.31 (f)(2), measurements may be performed at a closer distance and the measured level corrected to the specified measurement distance by using the square of an inverse linear distance extrapolation factor (40dB/decade).
2. A transducer factor on the measuring instrument was used to extrapolate the results at 3 metres to a distance of 30 metres where required. A distance extrapolation factor of 40 dB was used.
3. Final measurement values include corrections for antenna factor and cable losses.
4. The emission shown at approximately 13.56 MHz is the fundamental.
5. All emissions on the 9 kHz to 150 kHz plot were investigated and found to be radiating from the test site turntable.
6. All other emissions shown on the pre-scan plots were investigated and found to be >20 dB below the applicable limit or below the measurement system noise floor.
7. Measurements in the range 30 MHz to 1 GHz were performed in a semi-anechoic chamber (RFI Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

Transmitter Radiated Spurious Emissions (continued)







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

5.2.4. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Nick Steele	**Test Date:**	27 July 2011
Test Sample Serial No:	31015		

FCC Part:	15.225(c)(d) & 15.209(a)
Test Method Used:	As detailed in ANSI C63.10 Section 6.9.2

Environmental Conditions:

Temperature (°C):	29
Relative Humidity (%):	29

Results: Quasi Peak Lower Band Edge

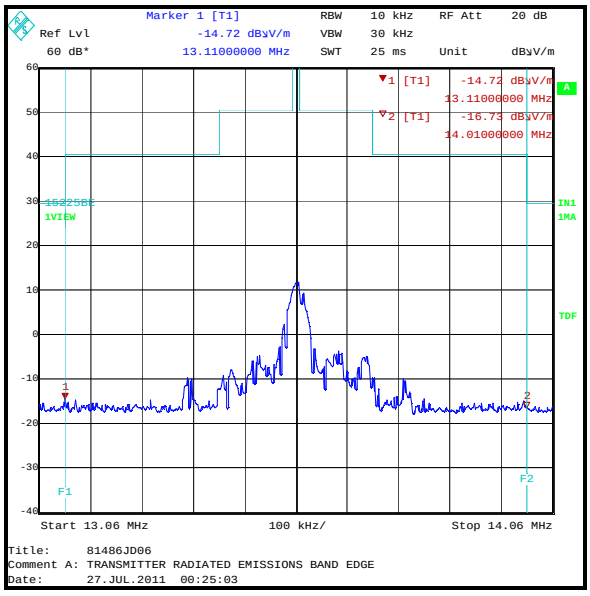
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
13.11	-14.7	29.5	44.2	Complied

Results: Quasi Peak Upper Band Edge

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
14.01	-16.7	29.5	46.2	Complied

Note(s):

1. A transducer factor on the measuring instrument was used to extrapolate the results at 3 metres to a distance of 30 metres where required.
2. A transducer factor on the measuring instrument was used to extrapolate the results at 3 metres to a distance of 30 metres where required. A distance extrapolation factor of 40 dB was used.



5.2.5. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	Crawford Lindsay	**Test Date:**	01 August 2011
Test Sample Serial No:	31015		

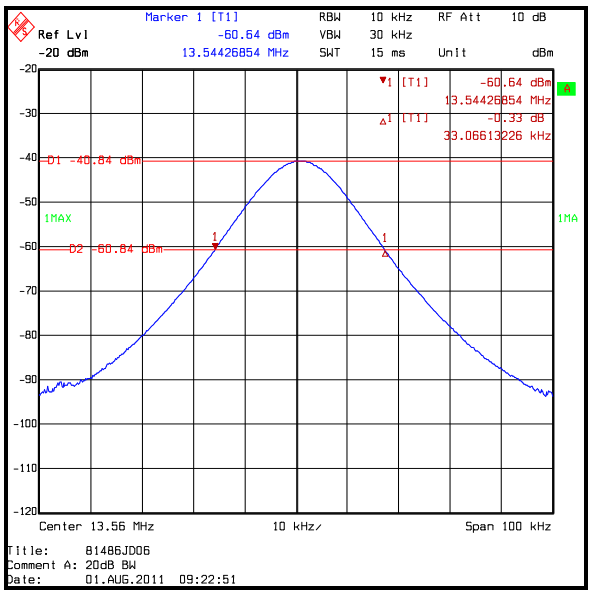
FCC Part:	2.1049
Test Method Used:	As detailed in ANSI C63.10 Section 6.9.1

Environmental Conditions:

Temperature (℃):	26
Relative Humidity (%):	31

Results:

20 dB Bandwidth (kHz)
33.066



5.2.6. Transmitter Frequency Stability (Temperature & Voltage Variation)

Test Summary:

Test Engineer:	Crawford Lindsay	**Test Date:**	01 August 2011
Test Sample Serial No:	31015		

FCC Part:	15.225(e)
Test Method Used:	As detailed in ANSI C63.10 Section 6.8.1 and 6.8.2

Environmental Conditions:

Ambient Temperature (℃):	26
Ambient Relative Humidity (%):	31

Results: Maximum frequency error of the EUT with variations in ambient temperature

Temperature (°C)	Time after Start-up			
	0 minutes	2 minutes	5 minutes	10 minutes
	Frequency (MHz)			
-20	13.560154	13.560174	13.560190	13.560197
20	13.560329	13.560334	13.560336	13.560337
50	13.560398	13.560408	13.560415	13.560419

Frequency with Worst Case Deviation (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (%)	Result
13.560419	419	0.0031	0.01	0.0069	Complied

Results: Maximum frequency error of the EUT with variations in nominal operating voltage at an ambient temperature of 20°C

Supply Voltage (V)	Nominal Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (%)	Result
4.25	13.56	13.560313	313	0.0023	0.01	0.0077	Complied
5.00	13.56	13.560347	347	0.0026	0.01	0.0074	Complied
5.75	13.56	13.560383	383	0.0028	0.01	0.0072	Complied

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
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±3.25 dB
20 dB Bandwidth	13 MHz to 14 MHz	95%	±0.92 ppm
Frequency Stability	13 MHz to 14 MHz	95%	±0.92 ppm
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	±3.53 dB
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	±2.94 dB
Transmitter Fundamental Field Strength	13 MHz to 14 MHz	95%	±3.53 dB

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.

Appendix 1. Test Equipment Used

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
A007	Antenna	Rohde & Schwarz	HFH2-Z2	880 458/020	02 Apr 2012	12
A1834	Attenuator	Hewlett Packard	8491B	10444	26 Jul 2012	12
A553	Antenna	Chase	CBL6111A	1593	26 Mar 2012	12
E013	Environmental Chamber	Sanyo	ATMOS chamber	None	Calibrated Before Use	-
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	29 May 2012	12
M1068	Thermometer	Iso-Tech	RS55	93102884	10 Nov 2011	12
M1229	Digital Multimeter	Fluke	179	87640015	21 Jun 2012	12
M1242	Spectrum Analyser	Rohde & Schwarz	FSEM30	845986/022	03 Dec 2011	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	04 Feb 2012	12
S011	DC Power Supply Unit	INSTEK	PR-3010H	9401270	Calibrated Before Use	-
M1379	Test Receiver	Rohde & Schwarz	ESIB 7	100330	20 Sep 2012	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	05 Mar 2012	12
A067	LISN	Rohde & Schwarz	ESH3-Z5	890603/002	02 Jun 2012	12

NB In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period or the previous calibration period on the date of testing.