



TEST REPORT

Test Report No. : UL-RPT-RP11108939JD03A

Manufacturer : Continental Automotive GmbH

Model No. : TIS-07

FCC ID : KR5TIS-07

Technology : SRD

Test Standard(s) : FCC 15.209(a) & 15.231

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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 1.0.

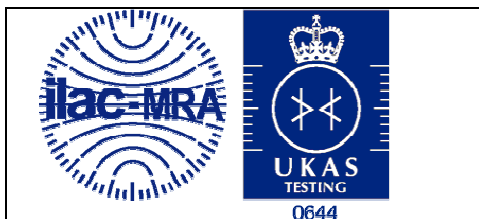
Date of Issue: 29 January 2016

Checked by:

Sarah Williams
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

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1. Customer Information

Company Name:	Continental Automotive GmbH
Address:	Siemensstrasse 12 Regensburg D-93055 Germany

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.231
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Radio Frequency Devices) - Section 15.231
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.209
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:	08 January 2016 to 26 January 2016

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.231(b)	Transmitter Fundamental Field Strength	
Part 15.231(c)	Transmitter 20 dB Bandwidth	
Part 15.231(a)(1)	Transmitter Timeout	
Part 15.35(c)	Transmitter Duty Cycle	
Part 15.231(b) / 15.209	Transmitter Radiated Emissions	
Key to Results  = Complied  = Did not comply		

2.3. Methods and Procedures

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

2.4. Deviations from the Test Specification

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

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Continental
Model Name or Number:	TIS-07
Test Sample Serial Number:	3155EF73
Hardware Version:	TIS-07
Software Version:	Application software
FCC ID:	KR5TIS-07

3.2. Description of EUT

The Equipment Under Test was a tyre guard wheel unit. It contains pressure, temperature and acceleration sensors and an RF transmitter. The EUT is powered from an internal 3.0 Volt battery.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Power Supply Requirement:	Nominal	3.0 V
Type of Unit:	Transmitter	
Transmit Frequency:	433.92 MHz	

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:	D610
Serial Number:	UL VS LTD Asset No. PC379NT

Description:	USB type 'A' to USB Type 'B' cable (1.1 metres)
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Trigger Tool
Brand Name:	Not marked or stated
Model Name or Number:	ANUM:01
Serial Number:	V0.2

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

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

- Transmitting with a modulated carrier at maximum output power on a fixed frequency of 433.92 MHz.

4.2. Configuration and Peripherals

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

- Fitted with an internal CR2050 lithium battery. A fully charged battery was used for all tests.
- Controlled using the test application GeneMod supplied by the customer. The application was used to enable the required transmission mode. The EUT was connected to the test laptop via a USB cable connected to the Trigger Tool. Commands were relayed to the EUT via the Trigger Tool and this was placed adjacent to the EUT. The instructions to control this application are supplied in document "LF trigger tool – user manual_4Jan2016" dated 4th January 2016.
- All measurements were performed as radiated tests.

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 Fundamental Field Strength

Test Summary:

Test Engineer:	David Doyle	Test Date:	26 January 2016
Test Sample Serial Number:	3155EF73		

FCC Reference:	Part 15.231(b)
Test Method Used:	ANSI C63.10 Section 7.6.1 and Sections 6.3 & 6.5 (see note below)

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	36

Note(s):

1. To obtain the average limit at the test frequency the values given in the table of FCC part 15.231(b) have to be linear interpolated and then converted to dBμV/m. The limit at 260 MHz is 3750 μV/m and at 470 MHz it is 12500 μV/m. Limit at 433.92 MHz is calculated as shown in ANSI C63.10 Section 7.6.2:

$$\text{Limit } [\mu\text{V/m}] = \text{Lim}_{\text{lower}} + \Delta F [(\text{Lim}_{\text{upper}} - \text{Lim}_{\text{lower}}) / (f_{\text{upper}} - f_{\text{lower}})]$$

$$\text{where } \Delta F = f_c - f_{\text{lower}} = 433.92 - 260 = 173.92$$

$$\text{Limit} = 3750 + 173.92 * [(12500 - 3750) / (470 - 260)]$$

$$= 3750 + 173.92 * [8750 / 210]$$

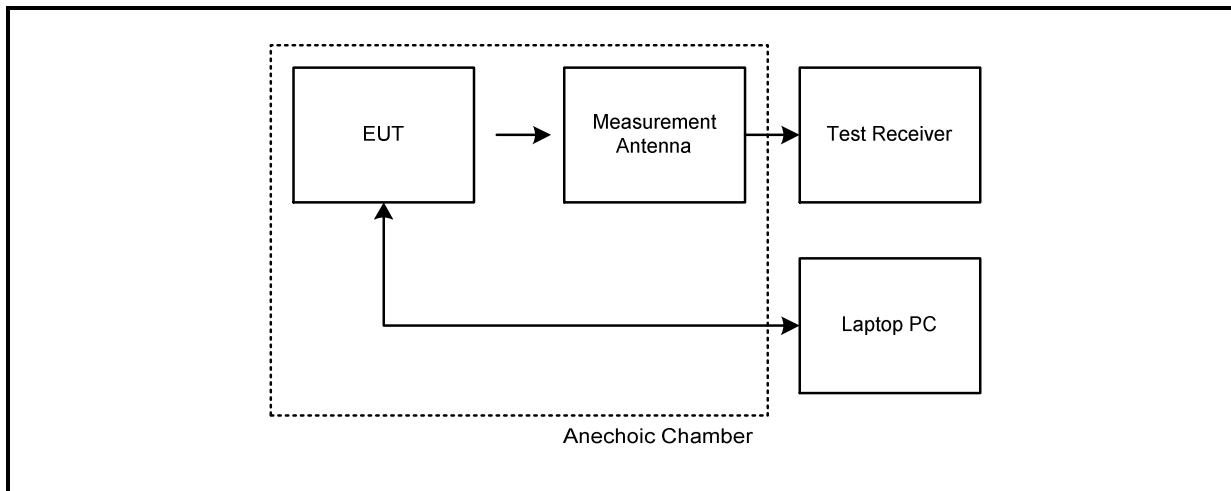
$$= 10996.7 \mu\text{V/m}$$

$$\text{dB}\mu\text{V/m} = 20 * \log (\mu\text{V/m})$$

$$= 20 * \log (10996.7)$$

$$\text{Average Limit at 433.92 MHz} = 80.8 \text{ dB}\mu\text{V/m}$$

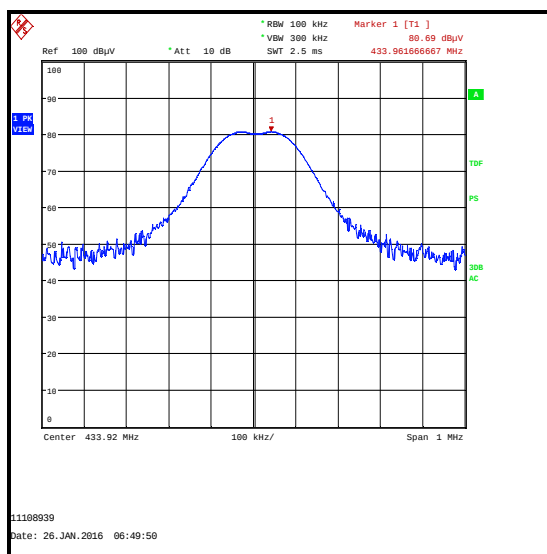
2. If the average limit is specified for the EUT, the peak limit is 20 dB above the average limit as specified in FCC 15.35 (b)
3. The average level was determined by subtracting the duty cycle correction factor from the measured peak level. The duty cycle correction factor of 12.0 dB was calculated using formula $20 \log (\text{On Time}/100\text{ms})$ as stated in FCC Part 15.35(c). For further detail see section 5.2.4.
4. Measurements were made with the test antenna in the horizontal and vertical planes and the EUT in the X, Y and Z planes. The highest level was recorded in the table below.

Transmitter Fundamental Field Strength (continued)**Test setup:****Results: Average Level**

Frequency (MHz)	Average Level (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)	Result
433.92	68.7	80.8	12.1	Complied

Results: Peak Level

Frequency (MHz)	Peak Level (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)	Result
433.92	80.7	100.8	20.1	Complied



Transmitter Fundamental Field Strength (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	Not stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Dec 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	12 Jun 2016	12
A259	Antenna	Chase	CBL6111	1513	09 Apr 2016	12

5.2.2. Transmitter 20 dB Bandwidth**Test Summary:**

Test Engineer:	David Doyle	Test Date:	26 January 2016
Test Sample Serial Number:	3155EF73		

FCC Reference:	Part 15.231(c)
Test Method Used:	ANSI C63.10 Section 6.9.2

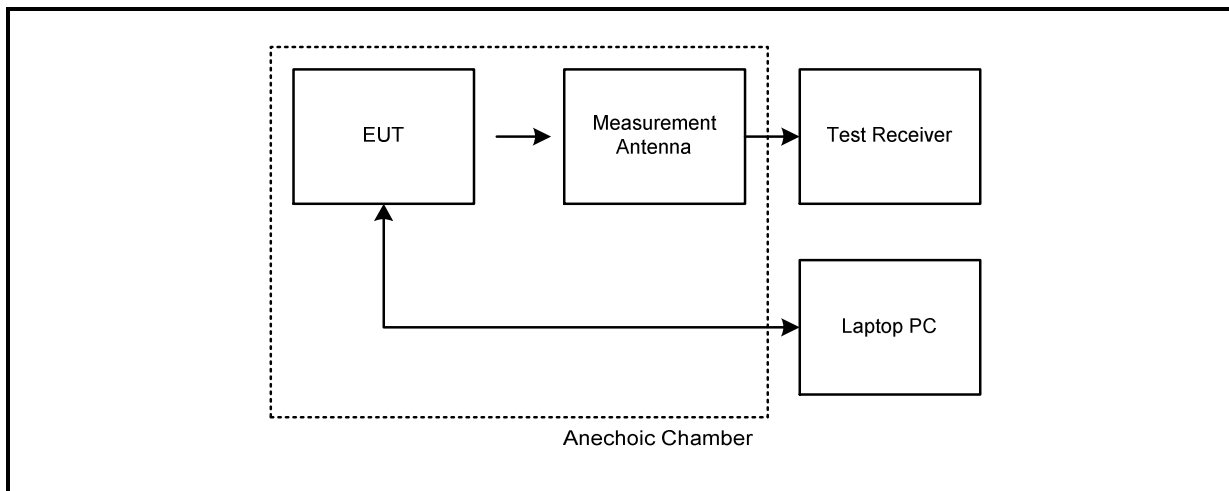
Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	36

Note(s):

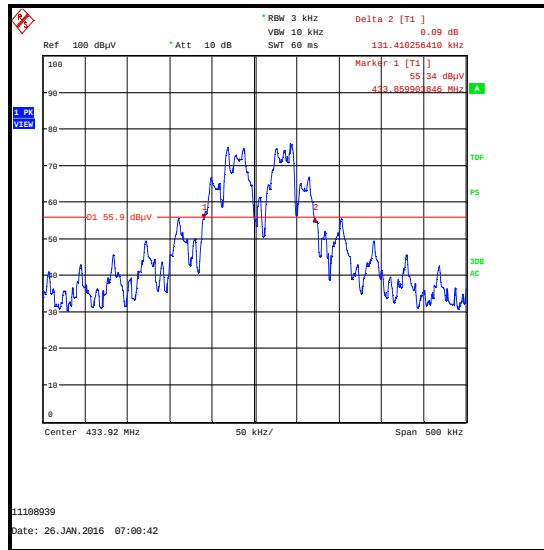
1. The 20 dB bandwidth of the emission shall be no wider than 0.25% of the centre frequency of the EUT.
2. The limit has been calculated as:

$$0.0025 * 433.92 \text{ MHz} = 1.0848 \text{ MHz}$$

Test setup:

Transmitter 20 dB Bandwidth (continued)**Results:**

Transmitter 20 dB Bandwidth (MHz)	Limit (MHz)	Margin (MHz)	Result
0.1314	1.0848	0.9534	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	Not stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Dec 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	12 Jun 2016	12
A259	Antenna	Chase	CBL6111	1513	09 Apr 2016	12

5.2.3. Transmitter Timeout**Test Summary:**

Test Engineer:	David Doyle	Test Date:	26 January 2016
Test Sample Serial Number:	3155EF73		

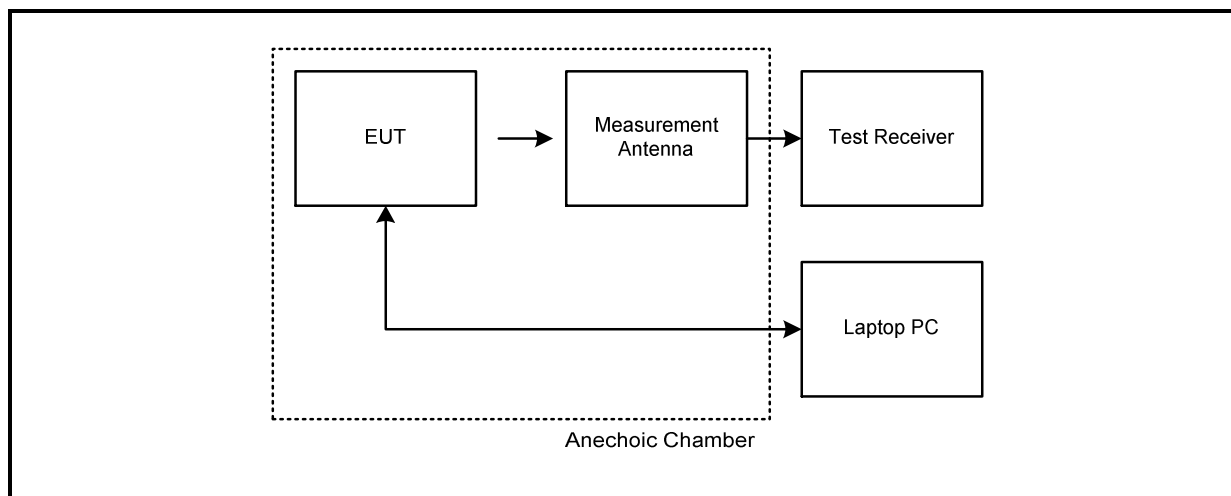
FCC Reference:	Part 15.231(a)
Test Method Used:	The EUT transmitter was activated and monitored using a spectrum analyser for a period of 10 seconds.

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	36

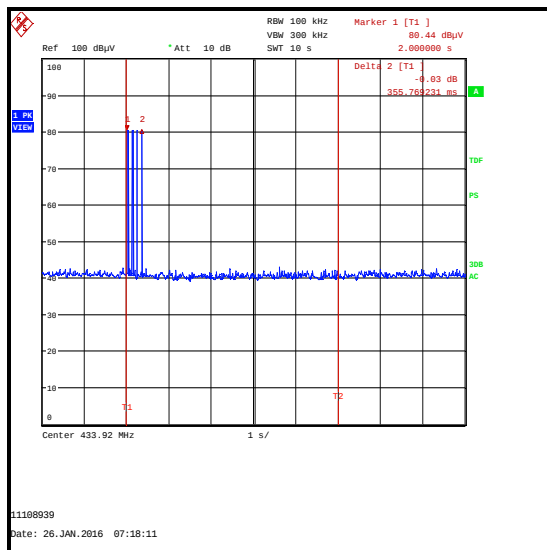
Note(s):

1. A transmission burst was sent from the EUT at time T1, as shown on the plot. The plot shows that the transmitter stopped transmitting after 0.356 seconds.

Test setup:

Transmitter Timeout (continued)**Results:**

Deactivation Time (seconds)	Limit (seconds)	Margin (seconds)	Result
0.356	5.000	4.644	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	Not stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Dec 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	12 Jun 2016	12
A259	Antenna	Chase	CBL6111	1513	09 Apr 2016	12

5.2.4. Transmitter Duty Cycle

Test Summary:

Test Engineer:	David Doyle	Test Date:	26 January 2016
Test Sample Serial Number:	3155EF73		

FCC Reference:	Part 15.35(c)
Test Method Used:	ANSI C63.10 Section 7.5

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	36

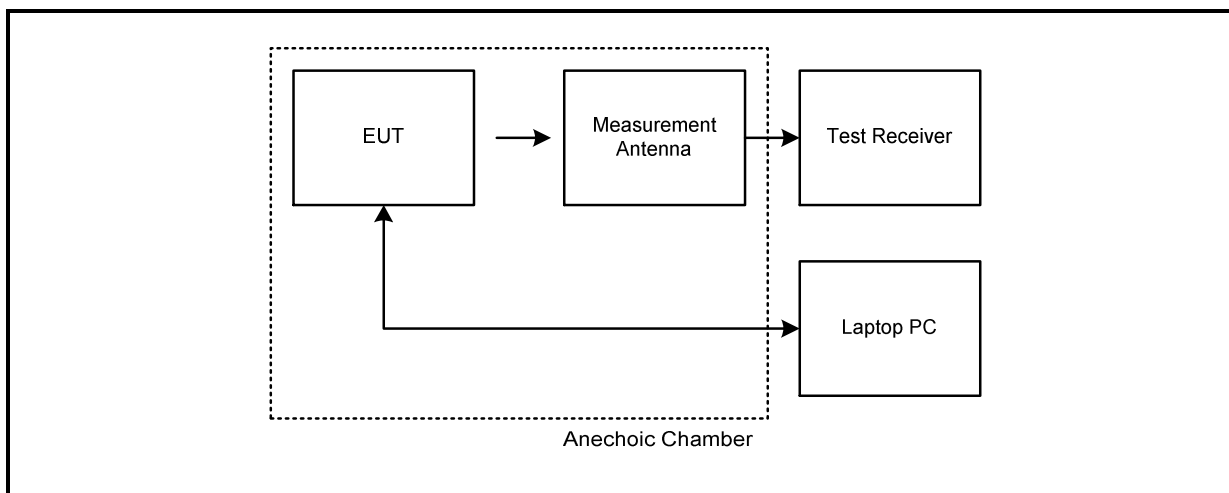
Note(s):

1. In order to assist with the determination of the average level of fundamental and spurious emissions field strength, measurements were made of duty cycle to determine the transmission duration and the silent period time of the transmitter. The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by $20 \log(\text{On Time} / [\text{Period or } 100 \text{ ms whichever is the lesser}])$.
2. The EUT transmits for a period of 25.0 milliseconds within the specified 100 ms period.

$$20 \log (1 / (\text{On Time} / [\text{Period or } 100 \text{ ms whichever is the lesser}]))$$

$$20 \log (1 / (25/100)) = 12.0 \text{ dB}$$

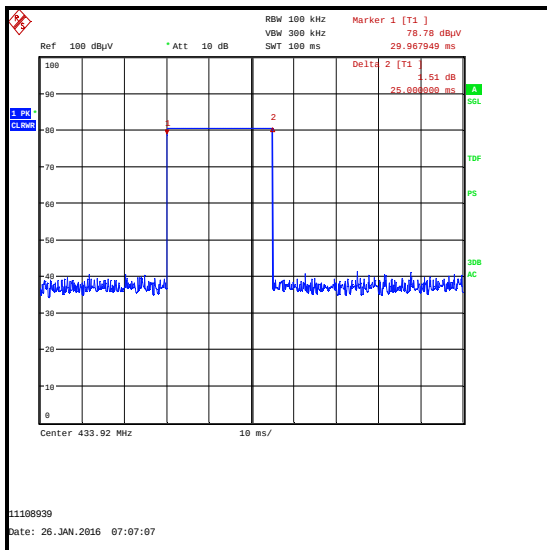
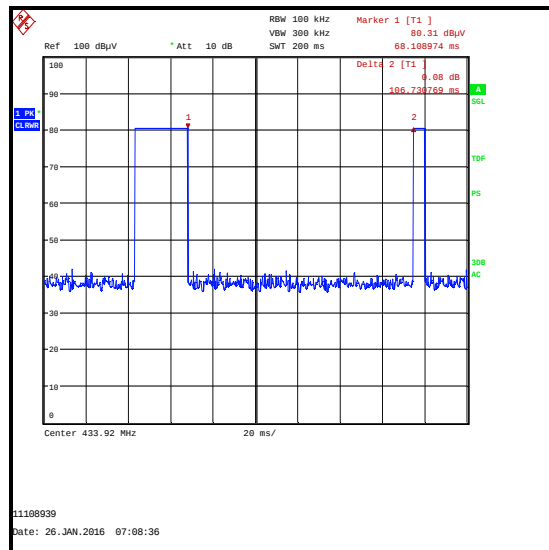
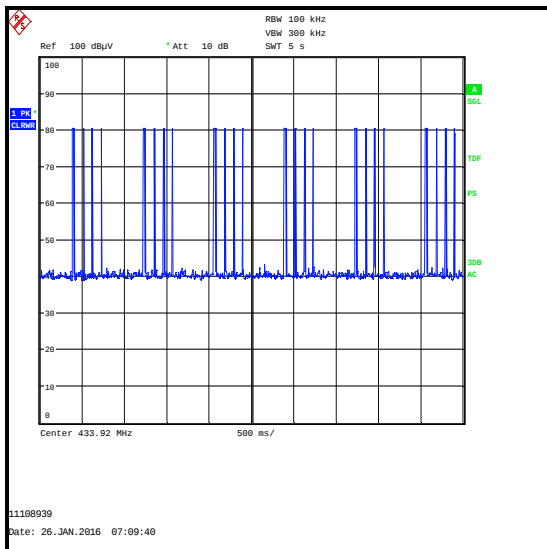
Test setup:



Transmitter DutyCycle (continued)**Results:**

Pulse Duration (ms)	Duty Cycle (dB)
25.0	12.0

Silent Period (ms)
106.410

**Time On****Time Off****Full Sequence**

Transmitter Duty Cycle (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	Not stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Dec 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	12 Jun 2016	12
A259	Antenna	Chase	CBL6111	1513	09 Apr 2016	12

5.2.5. Transmitter Radiated Emissions**Test Summary:**

Test Engineer:	David Doyle	Test Date:	20 January 2016
Test Sample Serial Number:	3155EF73		

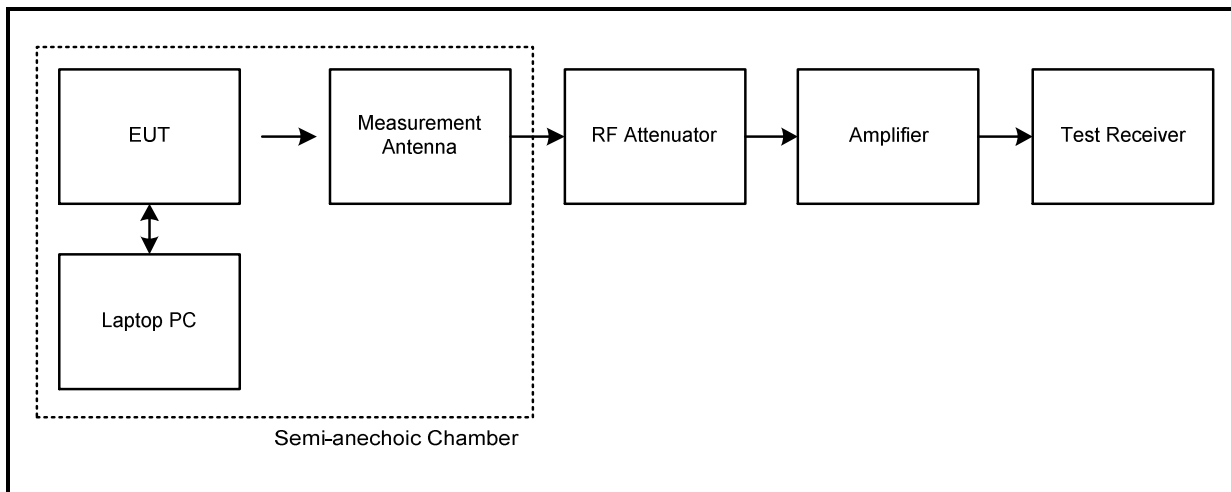
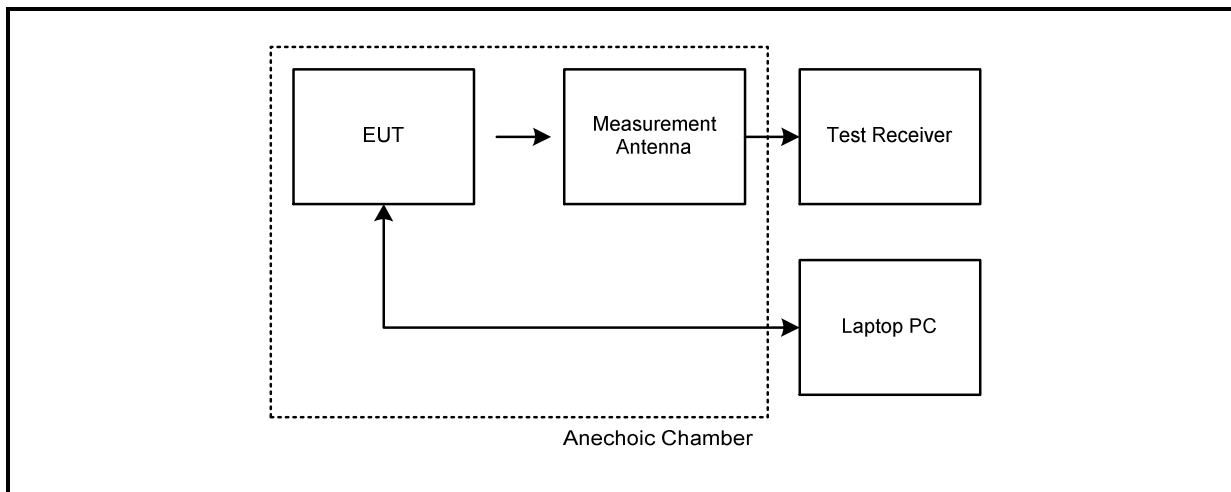
FCC Reference:	Parts 15.231(b) / 15.209
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.5
Frequency Range	30 MHz to 1 GHz

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	32

Note(s):

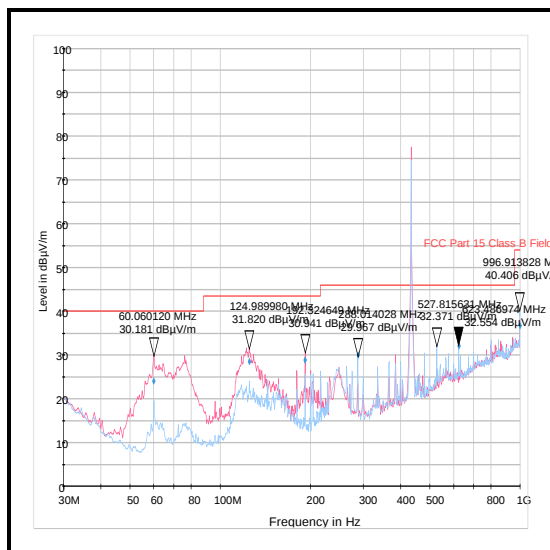
1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The fundamental is shown on the plot at approximately 433.92 MHz.
3. FCC Part 15.209 general limits are shown on the pre-scan plot.
4. All other emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
5. In accordance with ANSI C63.10 Section 6.6.4.3 (Note 1), if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.
6. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

Transmitter Radiated Emissions (continued)**Test setup for radiated measurements:****Semi-anechoic chamber****Anechoic chamber**

Transmitter Radiated Emissions (continued)

Results:

Frequency (MHz)	Antenna Polarity	Peak Level (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)	Result
124.990	Vertical	31.8	43.5	11.7	Complied
192.325	Vertical	30.9	51.5	20.6	Complied
996.914	Horizontal	40.4	54.0	13.6	Complied



Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1623	Thermohygrometer	JM Handelspunkt	30.5015.13	0	11 Jan 2017	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
A490	Antenna	Chase	CBL6111A	1590	30 Apr 2016	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	19 Mar 2016	12
G0543	Amplifier	Sonoma	310N	230801	10 Feb 2016	3
A1834	Attenuator	Hewlett Packard	8491B	10444	05 Mar 2016	12

Transmitter Radiated Spurious Emissions (continued)**Test Summary:**

Test Engineer:	David Doyle	Test Date:	08 January 2016
Test Sample Serial Number:	3155EF73		

FCC Reference:	Parts 15.231(b) / 15.209
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.6
Frequency Range	1 GHz to 4.4 GHz

Environmental Conditions:

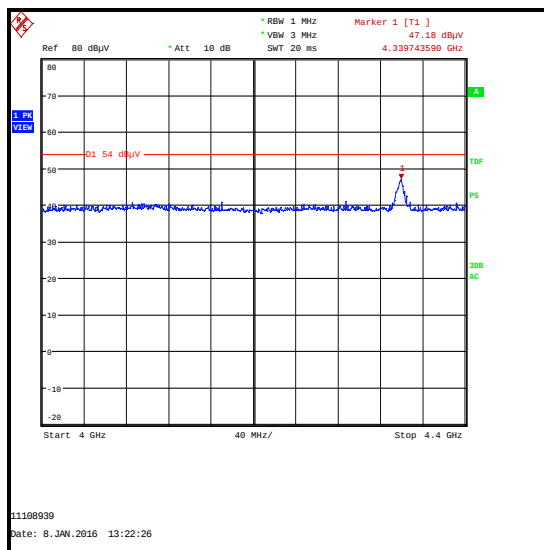
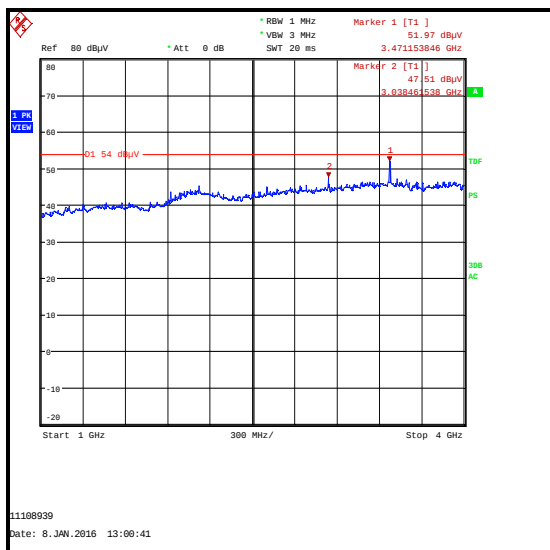
Temperature (°C):	23
Relative Humidity (%):	37

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All other emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
3. FCC Part 15.209 general limits are shown on the pre-scan plots.
4. Pre-scans above 1 GHz 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. Final measurements above 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 1.5 m above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
5. In accordance with ANSI C63.10 Section 6.6.4.3 (Note 1), if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.

Transmitter Radiated Spurious Emissions (continued)**Results:**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
3037.260	Horizontal	45.2	61.9	16.7	Complied
3471.115	Horizontal	50.7	61.9	11.2	Complied
4338.830	Horizontal	48.8	54.0	5.2	Complied



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

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Dec 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	12 Jun 2016	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	19 Dec 2016	12
A1818	Antenna	EMCO	3115	00075692	17 Dec 2016	12
A253	Antenna	Flann Microwave	12240-20	128	17 Dec 2016	12

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
Fundamental Field Strength	433.92 MHz	95%	±2.94 dB
20 dB Bandwidth	433.92 MHz	95%	±3.92 %
Transmitter Timeout / Duty Cycle	433.92 MHz	95%	± 0.29 ms
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±5.65 dB
Radiated Spurious Emissions	1 GHz to 4.4 GHz	95%	±2.94 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.

7. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	-	-	Initial Version

--- END OF REPORT ---