




TEST REPORT

Test Report No. : UL-RPT-RP11001706JD02A V3.0

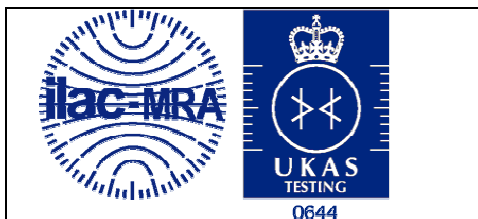
Manufacturer : Telensa Ltd
Model No. : T2A1P-G-3
FCC ID : XYD-2NPD
Technology : FHSS
Test Standard(s) : FCC Parts 15.209(a), 15.247(b)(2) & 15.247(d)

1. This test report shall not be reproduced in full or partial, without the written approval of UL VS LTD.
2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 3.0 supersedes all previous versions.

Date of Issue: 15 April 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.

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1. Customer Information






Company Name:	Telensa Ltd
Address:	Plextek Building London Road Great Chesterford Essex CB10 1NY United Kingdom

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.209
Site Registration:	FCC: 209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	23 October 2015 to 04 April 2016

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.247(b)(2)	Transmitter Maximum Peak Output Power	
Part 15.247(d)/15.209(a)	Transmitter Radiated Emissions	
Part 15.247(d)/15.209(a)	Transmitter Band Edge 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

Only testing of transmitter output power and radiated spurious emissions within the range 1 GHz to 9.3 GHz requested.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Telensa
Model Name or Number:	T2A1P-G-3
Test Sample Serial Number:	8589 <i>(With External Connector)</i>
Hardware Version:	09
Software Version:	MS6.2
FCC ID:	XYD-2NPD

3.2. Description of EUT

The Equipment Under Test was a public lighting control unit. It contains an FHSS transceiver operating over six sub-bands in the 902–928 MHz band.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Tested Technology:	Frequency hopping system with a 20 dB bandwidth of less than 250 kHz and hopping on at least 50 frequencies		
Power Supply Requirement:	Nominal	120 VAC 60 Hz	
Type of Unit:	Transceiver		
Channel Spacing:	25 kHz		
Modulation:	2 level FSK		
Data Rates (bit/s):	62.5 & 500		
Maximum Conducted Output Power:	17.2 dBm		
Antenna Gain:	2.0 dBi		
Transmit Frequency Range:	902 MHz to 928 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	Sub-band 0 Channel 0	910.500
	Middle	Sub-band 2 Channel 58	915.000
	Top	Sub-band 5 Channel 58	919.975

3.5. Support Equipment

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

Description:	Representative road lighting luminaire
Brand Name:	Ledway
Model Name or Number:	XIL0F03C^U
Serial Number:	120509

Description:	Linux PC
Brand Name:	Jetway
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	1.5 metre cable with USB connector at one end and 6 pin connector at the other end
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Power supply
Brand Name:	Raspberry Pi PSU
Model Name or Number:	KSAS0060500100VKD
Serial Number:	Not marked or stated

Description:	External antenna attached to 83 cm length coaxial cable
Brand Name:	Panorama
Model Name or Number:	IN1608
Serial Number:	Not marked or stated

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

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

- Constantly transmitting at maximum power with a modulated carrier on fixed frequencies.
- Constantly transmitting at maximum power with a modulated carrier in hopping mode.

4.2. Configuration and Peripherals

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

- Controlled using the test application 'icstest' on the Linux PC supplied by the customer. The application was used to enable a suitable transmission mode and to select the test channels and data rates. The EUT was connected to the Linux PC via a cable with USB connector at one end and 6 pin connector at the other end. Once the appropriate transmit mode was enabled, the PC was disconnected from the EUT.
- During all testing the EUT was connected to a representative road lighting luminaire. The luminaire was connected to a 120 VAC 60 Hz single phase supply.
- Radiated spurious emissions were performed with the EUT transmitting with a data rate of 62.5 bit/s. This was found to be the worst case with regards to emissions after preliminary investigations.
- The EUT was fitted with the supplied external antenna. The antenna was mounted on a 12 cm square ground plane which in turn was mounted on 50 cm long, 5 cm diameter steel tube. The steel tube was fitted into the housing and secured using the supplied grub screws. The customer supplied the EUT with an SMA connector fitted in the side of the radome. This allowed the external antenna to be connected with the attached 83 cm coaxial cable.
- The EUT was only tested in the one orientation (luminaire facing downwards), as this is representative of the orientation in which the complete configuration would be, in its operational mode.

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 Maximum Peak Output Power

Test Summary:

Test Engineer:	David Doyle	Test Date:	04 April 2016
Test Sample Serial Number:	8589		

FCC Reference:	Part 15.247(b)(2)
Test Method Used:	ANSI C63.10 Section 7.8.5 & Notes below

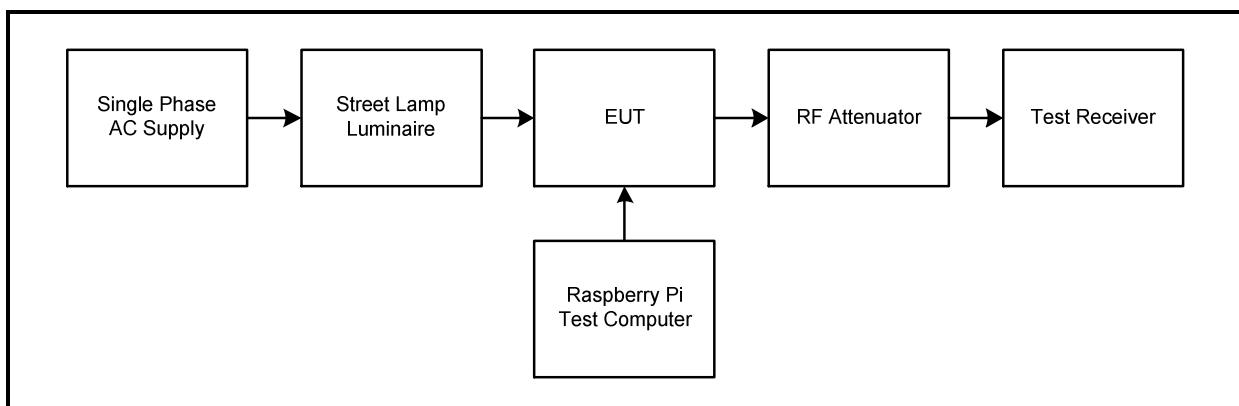
Environmental Conditions:

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

Note(s):

1. For frequency hopping systems employing at least 50 hopping channels.
2. For the data rate of 62.5 bit/s, the test receiver's resolution bandwidth was set to 1 kHz and the video bandwidth to 3 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 3 kHz. A marker was placed at the peak of the signal and the results recorded in the table below.
3. For the data rate of 500 bit/s, the test receiver's resolution bandwidth was set to 2 kHz and the video bandwidth to 10 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 5 kHz. A marker was placed at the peak of the signal and the results recorded in the table below.
4. The test receiver was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF offset level was entered on the test receiver to compensate for the loss of the attenuator and RF cable.

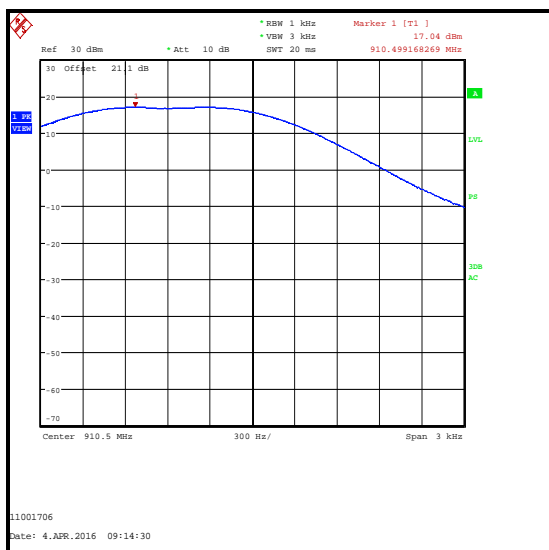
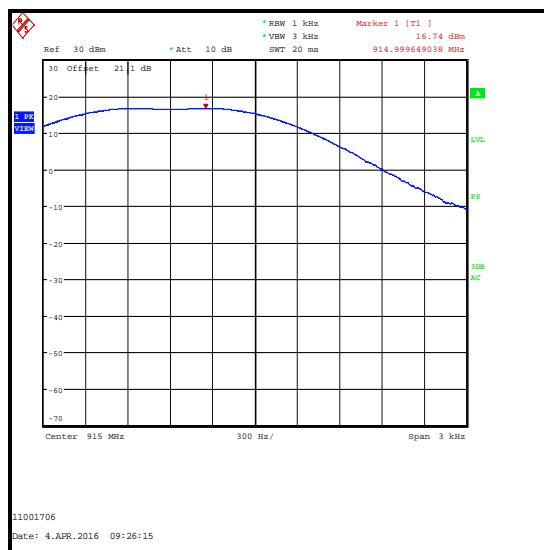
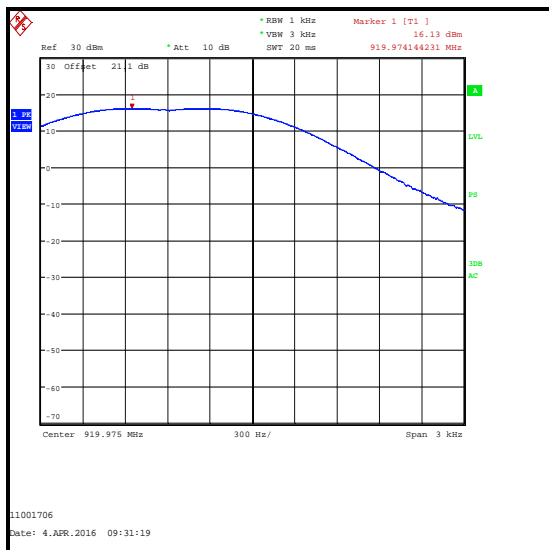
Test setup:



Transmitter Maximum Peak Output Power (continued)**Results: 62.5 bit/s**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Note	Result
Bottom	17.0	30.0	13.0	1	Complied
Middle	16.7	30.0	13.3	1	Complied
Top	16.1	30.0	13.9	1	Complied

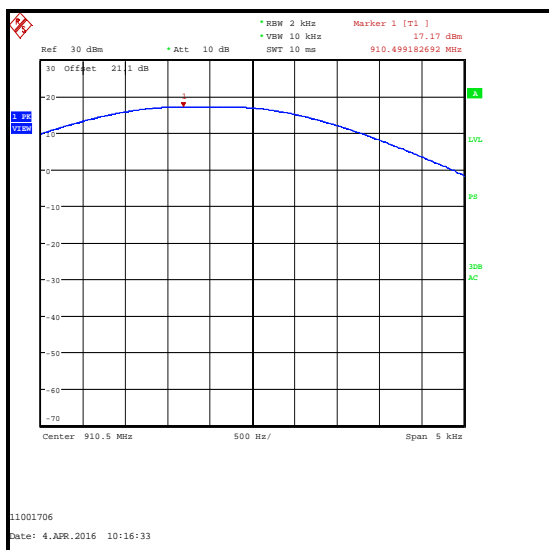
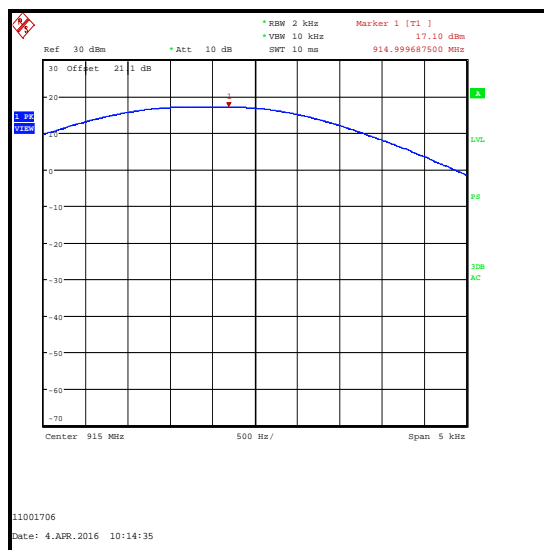
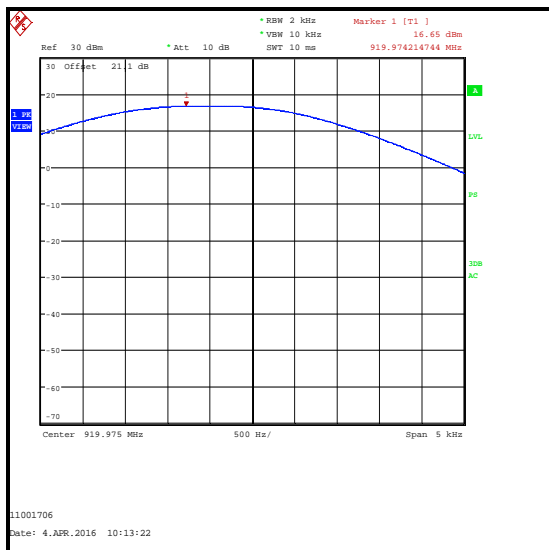
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Note	Result
Bottom	17.0	2.0	19.0	36.0	17.0	1	Complied
Middle	16.7	2.0	18.7	36.0	17.3	1	Complied
Top	16.1	2.0	18.1	36.0	17.9	1	Complied

Transmitter Maximum Peak Output Power (continued)**Results: 62.5 bit/s****Bottom Channel****Middle Channel****Top Channel**

Transmitter Maximum Peak Output Power (continued)**Results: 500 bit/s**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Note	Result
Bottom	17.2	30.0	12.8	1	Complied
Middle	17.1	30.0	12.9	1	Complied
Top	16.7	30.0	13.3	1	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Note	Result
Bottom	17.2	2.0	19.2	36.0	16.8	1	Complied
Middle	17.1	2.0	19.1	36.0	16.9	1	Complied
Top	16.7	2.0	18.7	36.0	17.3	1	Complied

Transmitter Maximum Peak Output Power (continued)**Results: 500 bit/s****Bottom Channel****Middle Channel****Top Channel****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	23 Apr 2016	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 Mar 2017	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	05 May 2016	12
G513	Signal Generator	Rohde & Schwarz	SMH	839858/001	17 Apr 2016	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	08 Apr 2016	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	23 Apr 2016	24

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

Test Engineer:	David Doyle	Test Date:	23 October 2015
Test Sample Serial Number:	8589		

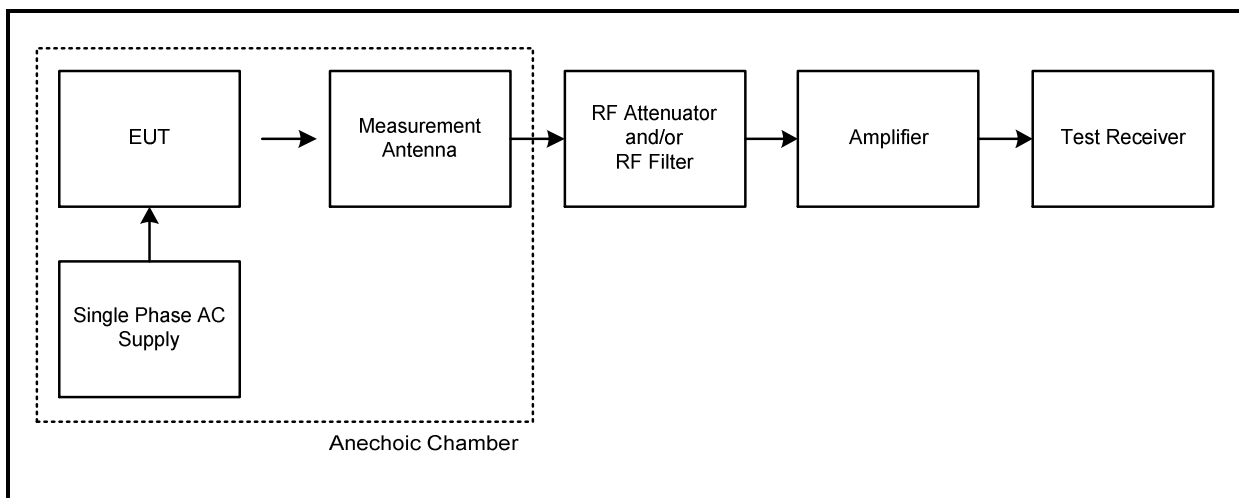
FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.6
Frequency Range	1 GHz to 9.3 GHz

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	43

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 EUT was transmitting at full power with a data rate of 62.5 bit/s.
3. 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.
4. 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.
5. 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 metres 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.
6. Pre-scans were performed and markers were placed on the highest measured levels of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto. Peak and average measurements were performed with their own appropriate detectors during the pre-scan measurements.
7. Radiated spurious emissions were performed with the EUT transmitting at fixed frequencies. The field strength in hopping mode was investigated and found to be less than the field strength in static mode. Therefore transmitting in a single channel was deemed as worst case. Pre-scan plots with the EUT in hopping mode are archived on the UL VS LTD IT server and are available for inspection upon request.

Transmitter Radiated Emissions (continued)**Test setups for Radiated measurements:**

Transmitter Radiated Emissions (continued)**Results: Peak Bottom Channel**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2731.484	Vertical	52.0	54.0	2.0	Complied
3642.011	Horizontal	50.8	54.0	3.2	Complied
4552.380	Horizontal	48.6	54.0	5.4	Complied
7283.878	Vertical	44.6	54.0	9.4	Complied

Results: Peak / Middle Channel

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2745.024	Vertical	51.0	54.0	3.0	Complied
3660.167	Horizontal	51.6	54.0	2.4	Complied
4574.040	Horizontal	48.5	54.0	5.5	Complied
7320.008	Vertical	45.0	54.0	9.0	Complied

Results: Peak / Top Channel

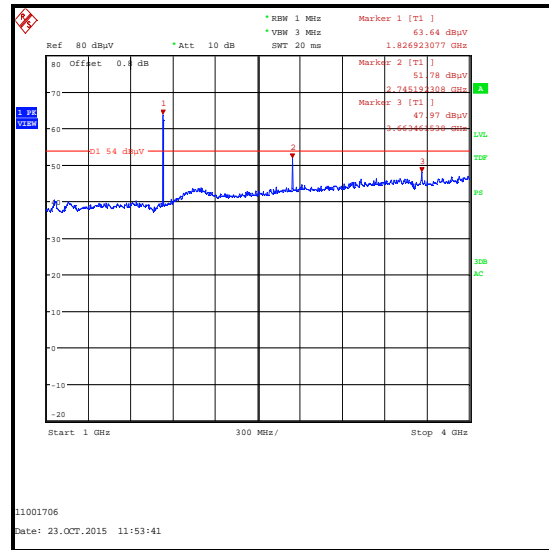
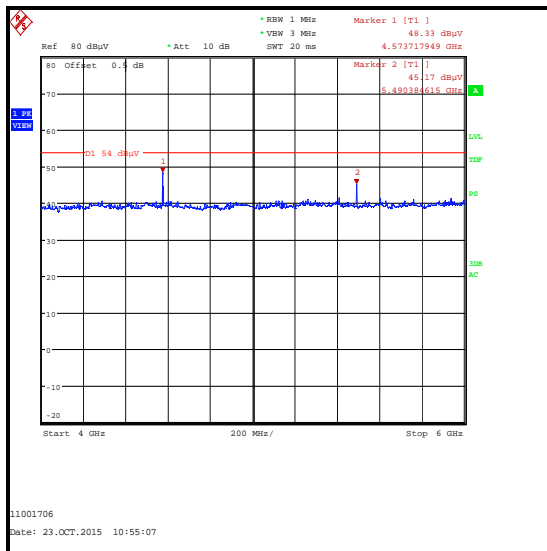
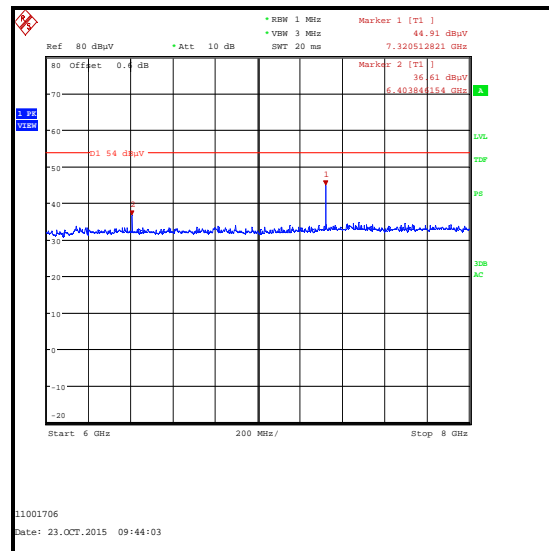
Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2759.867	Vertical	49.2	54.0	4.8	Complied
3679.800	Horizontal	48.8	54.0	5.2	Complied
4599.896	Horizontal	49.7	54.0	4.3	Complied
7359.759	Vertical	43.7	54.0	10.3	Complied
8279.744	Vertical	42.7	54.0	11.3	Complied

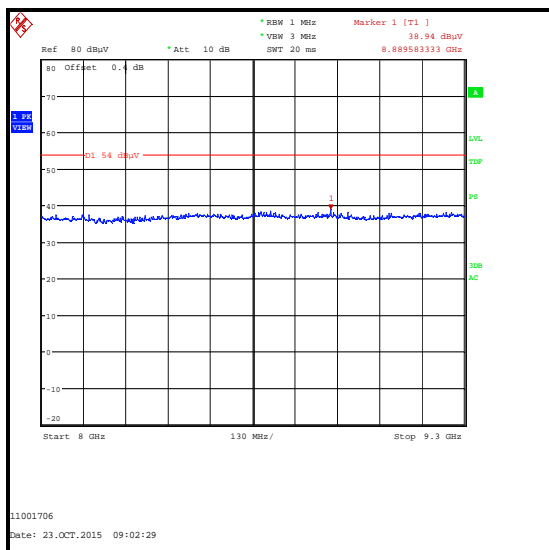
Results: Peak / Hopping Mode

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
Note 7					

Results: Average / Hopping Mode

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
Note 7					

Transmitter Radiated Emissions (continued)**Average Detector****Peak Detector**

Transmitter Radiated Emissions (continued)

Note: This plot is a pre-scan 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	01 May 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	12 Jun 2016	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	21 Dec 2015	12
A1818	Antenna	EMCO	3115	00075692	20 Dec 2015	12
A253	Antenna	Flann Microwave	12240-20	128	20 Dec 2015	12
A254	Antenna	Flann Microwave	14240-20	139	20 Dec 2015	12
A255	Antenna	Flann Microwave	16240-20	519	20 Dec 2015	12
A2467	High Pass Filter	Wainwright Instruments GmbH	WHJE5-920-1000-4000-60EE	2	13 Feb 2016	12
A1975	High Pass Filter	AtlanTecRF	AFH-03000	090424010	17 Apr 2016	12

5.2.3. Transmitter Band Edge Radiated Emissions**Test Summary:**

Test Engineer:	David Doyle	Test Date:	04 April 2016
Test Sample Serial Number:	8589		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.10.4

Environmental Conditions:

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

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. As both band edges fall within the non-restricted band, only peak measurements are required. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A reference level line was placed on the peak of the carrier and a second reference line was placed at -20 dBc. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission or noise floor level in the adjacent band. Marker frequencies and levels were recorded.

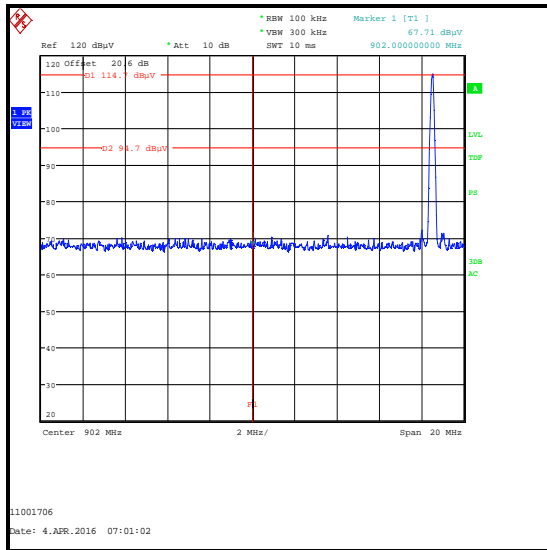
Results: Static Mode Mode / 62.5 bit/s

Frequency (MHz)	Peak Level (dBμV/m)	-20 dBc Limit (dBμV/m)	Margin (dB)	Result
902	67.7	94.7	27.0	Complied
928	68.2	93.6	25.4	Complied

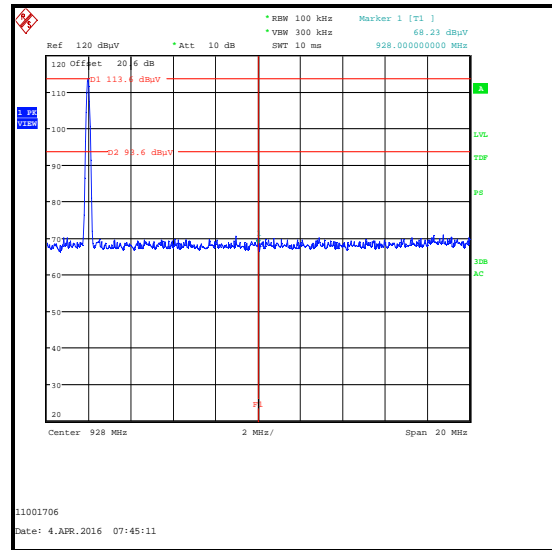
Results: Hopping Mode / 62.5 bit/s

Frequency (MHz)	Peak Level (dBμV/m)	-20 dBc Limit (dBμV/m)	Margin (dB)	Result
902	70.2	94.7	24.5	Complied
928	68.5	93.9	25.4	Complied

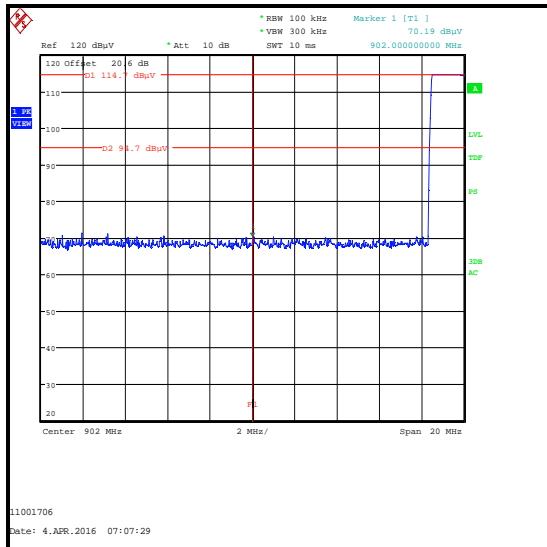
Transmitter Band Edge Radiated Emissions (continued)



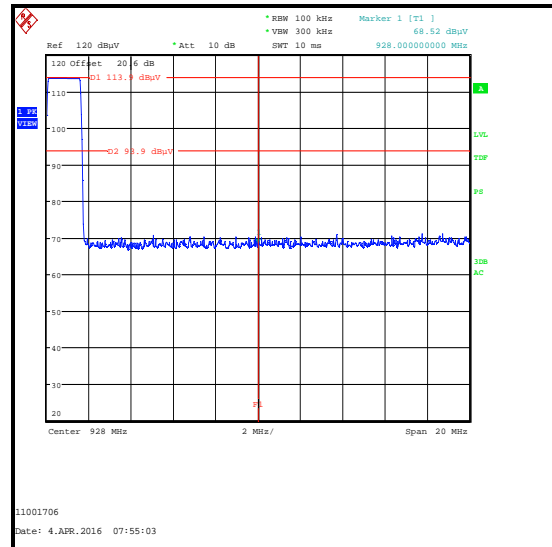
Lower Band Edge / Bottom Channel / Static



**Upper Band Edge / Top Channel /
Static**



Lower Band Edge / Hopping



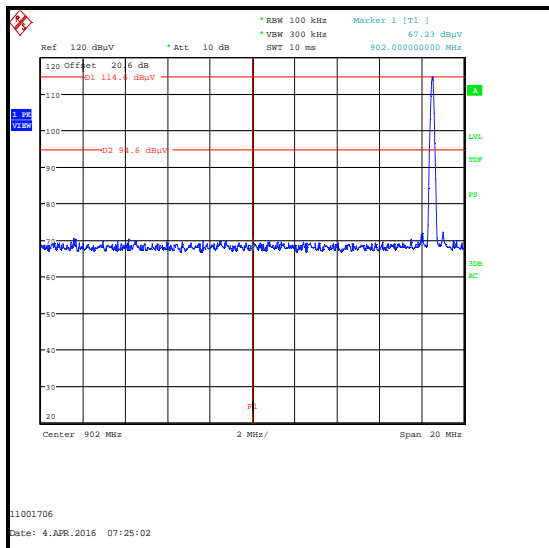
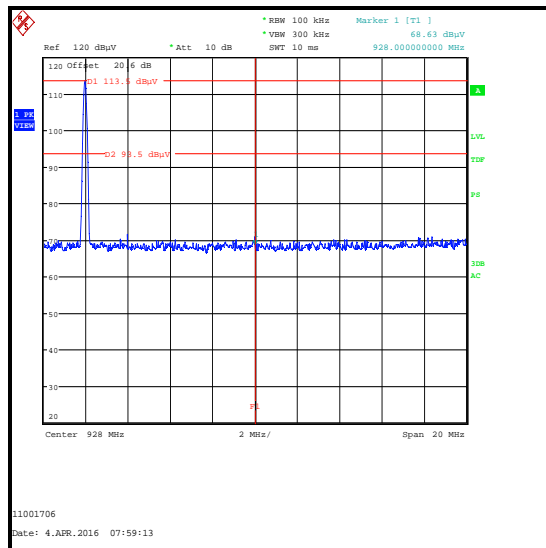
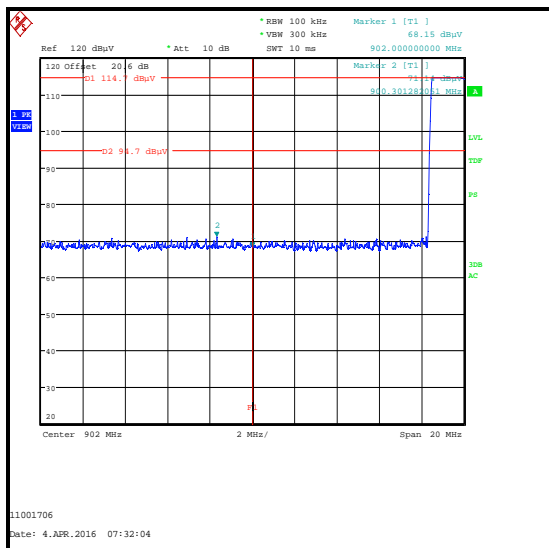
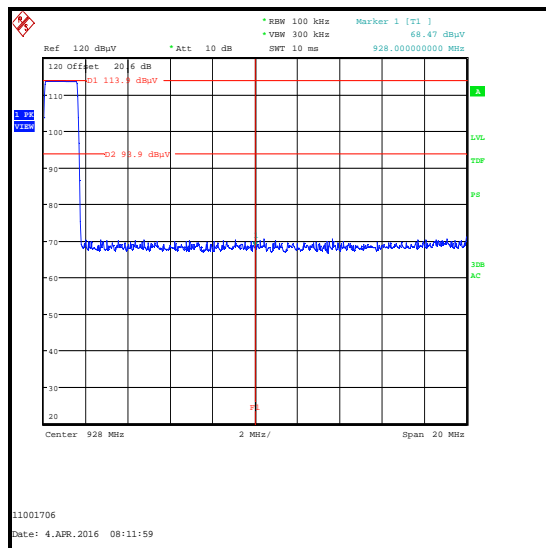
Upper Band Edge / Hopping

Transmitter Band Edge Radiated Emissions (continued)**Results: Static Mode / 500 bit/s**

Frequency (MHz)	Peak Level (dB μ V/m)	-20 dBc Limit (dB μ V/m)	Margin (dB)	Result
902	67.2	94.6	27.4	Complied
928	68.6	93.5	24.9	Complied

Results: Hopping Mode / 500 bit/s

Frequency (MHz)	Peak Level (dB μ V/m)	-20 dBc Limit (dB μ V/m)	Margin (dB)	Result
900.301	71.1	94.7	23.6	Complied
902	68.2	94.7	26.5	Complied
928	68.5	93.9	25.4	Complied

Transmitter Band Edge Radiated Emissions (continued)**Lower Band Edge / Bottom Channel / Static****Upper Band Edge / Top Channel / Static****Lower Band Edge / Hopping****Upper Band Edge / Hopping****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
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 Mar 2017	12
A259	Antenna	Chase	CBL6111	1513	09 Apr 2016	12
A1393	Attenuator	Huber & Suhner	6820.17.B	757456	05 May 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
Conducted Maximum Peak Output Power	902 MHz to 928 MHz	95%	± 1.13 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	± 5.65 dB
Radiated Spurious Emissions	1 GHz to 9.3 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
2.0	1 & 7	-	Changed model number and FCC ID at the request of the customer
3.0	10 to 14 & 19 to 23		Inserted maximum output power and band edge measurements at the request of the TCB

--- END OF REPORT ---