TEST REPORT

Test Report No. : UL-RPT-RP11181251JD09A

Manufacturer	:	Telensa Ltd
Model No.	:	T2A1T-G-1
FCC ID	:	XYD-2TXD
Technology	:	FHSS
Test Standard(s)	:	FCC Parts 15.207, 15.209(a) & 15.247

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 1.0

Date of Issue: 03 May 2016

Checked by:

Sarah Williams
Engineer, Radio Laboratory

Company Signatory:

Steven White
Service Lead, Radio Laboratory
UL VS LTD

0644

This laboratory is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

UL VS LTD

Pavilion A, Ashwood Park, Ashwood Way, Basingstoke, Hampshire, RG23 8BG, UK
Telephone: +44 (0)1256 312000
Facsimile: +44 (0)1256 312001

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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:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 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:	14 April 2016 to 28 April 2016

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.207	Transmitter AC Conducted Emissions	✓
Part 15.247(a)(1)(i)	Transmitter 20 dB Bandwidth	✓
Part 15.247(a)(1)	Transmitter Carrier Frequency Separation	✓
Part 15.247(a)(1)(i)	Transmitter Number of Hopping Frequencies and Average Time of Occupancy	✓
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

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:	Telensa
Model Name or Number:	T2A1T-G-1
Test Sample Serial Number:	8587
Hardware Version:	13
Software Version:	2.13.9
FCC ID:	XYD-2TXD

3.2. Description of EUT

The Equipment Under Test was a two-part telecell with dimming control. 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:	17.8 dBm		
Maximum Declared 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:	Ruud
Model Name or Number:	XIL0F03C^UCY7
Serial Number:	031610

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 directly to luminaire
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 customer's test instructions are contained in the document *'Instructions 6LT04306.docx'*. 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.
- AC conducted spurious emissions and radiated spurious emissions were performed with the EUT transmitting a data rate of 62.5 bit/s. This was found to be the worst case with regards to emissions after preliminary investigations and, as this mode emits the highest output power level, it was deemed to be the worst case.
- For radiated and ac conducted emissions tests, the EUT was fitted with the supplied external antenna. The antenna was mounted directly to a mounting point on the luminaire.
- 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 AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	David Doyle	**Test Date:**	28 April 2016
Test Sample Serial Number:	8587		

FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2

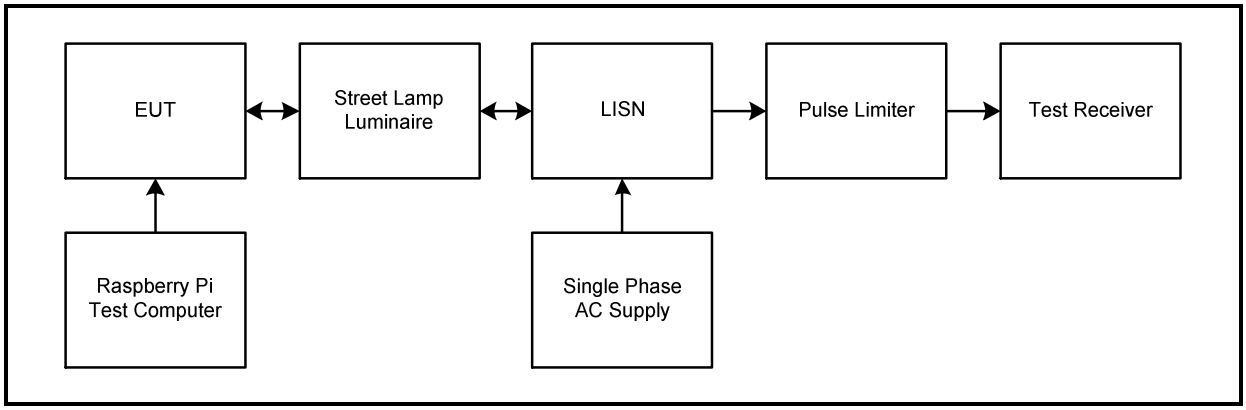
Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	32

Note(s):

1. The EUT was mounted in a representative road lighting luminaire which was connected to 120 VAC 60 Hz single phase supply via a LISN.
2. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.
3. A pulse limiter was fitted between the LISN and the test receiver.

Test setup:



Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.150	Live	48.7	66.0	17.3	Complied
0.173	Live	45.0	64.8	19.8	Complied
0.402	Live	38.6	57.8	19.2	Complied
0.600	Live	41.6	56.0	14.4	Complied
0.798	Live	36.0	56.0	20.0	Complied
1.199	Live	38.4	56.0	17.6	Complied
1.599	Live	36.7	56.0	19.3	Complied

Results: Live / Average

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.150	Live	43.8	56.0	12.2	Complied
0.195	Live	41.5	53.8	12.3	Complied
0.402	Live	35.4	47.8	12.4	Complied
0.600	Live	39.8	46.0	6.2	Complied
1.199	Live	36.3	46.0	9.7	Complied
1.401	Live	35.8	46.0	10.2	Complied
1.802	Live	34.3	46.0	11.7	Complied
4.799	Live	32.9	46.0	13.1	Complied

Transmitter AC Conducted Spurious Emissions (continued)

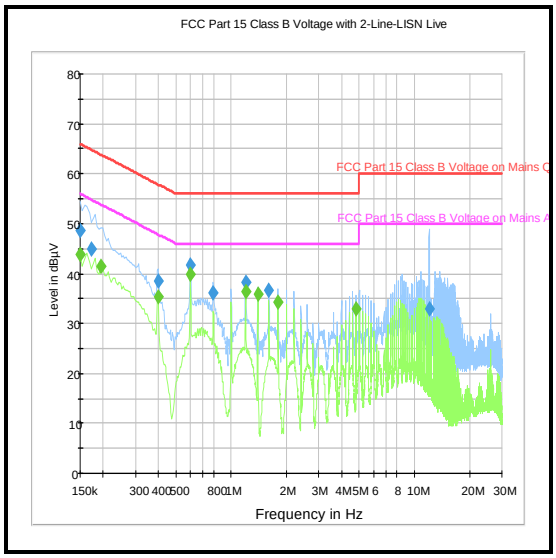
Results: Neutral / Quasi Peak

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.150	Neutral	47.3	66.0	18.7	Complied
0.402	Neutral	38.2	57.8	19.6	Complied
0.600	Neutral	41.4	56.0	14.6	Complied
1.199	Neutral	35.8	56.0	20.2	Complied
11.999	Neutral	37.2	60.0	22.8	Complied
13.000	Neutral	38.2	60.0	21.8	Complied
13.610	Neutral	38.4	60.0	21.6	Complied

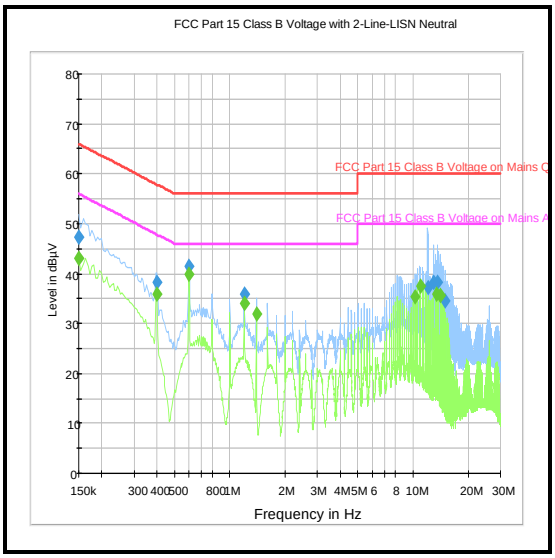
Results: Neutral / Average

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.150	Neutral	43.1	56.0	12.9	Complied
0.402	Neutral	35.9	47.8	11.9	Complied
0.600	Neutral	40.0	46.0	6.0	Complied
1.199	Neutral	33.9	46.0	12.1	Complied
1.401	Neutral	32.0	46.0	14.0	Complied
10.199	Neutral	35.5	50.0	14.5	Complied
11.000	Neutral	37.6	50.0	12.4	Complied
13.407	Neutral	35.9	50.0	14.1	Complied
14.001	Neutral	35.7	50.0	14.3	Complied

Transmitter AC Conducted Spurious Emissions (continued)



Live



Neutral

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

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1623	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	11 Jan 2017	12
A067	LISN	Rohde & Schwarz	ESH3-Z5	890603/002	27 Aug 2016	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	08 Mar 2017	12
M1263	Test Receiver	Rohde & Schwarz	ESIB7	100265	16 Oct 2016	12

5.2.2. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	David Doyle	**Test Date:**	25 April 2016
Test Sample Serial Number:	8587		

FCC Reference:	Part 15.247(a)(1)(i)
Test Method Used:	ANSI C63.10 Section 6.9.2

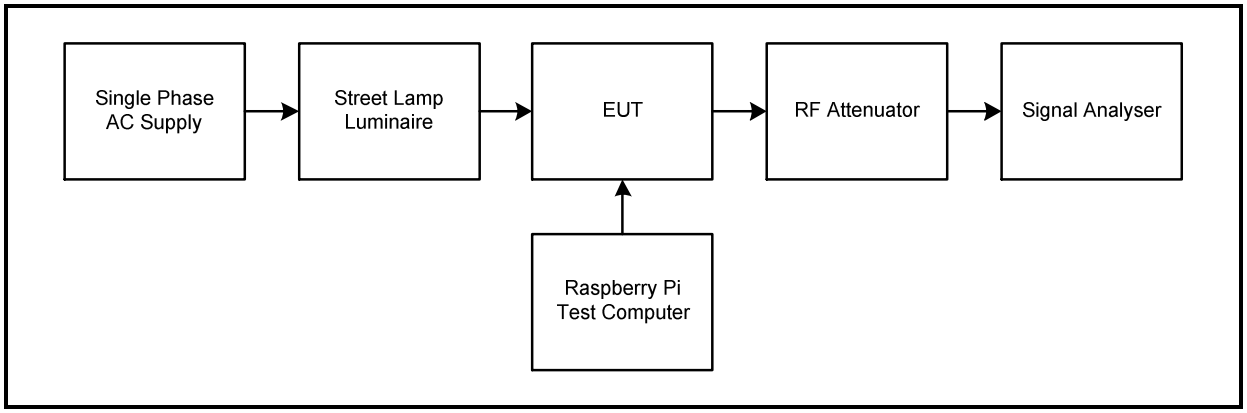
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	31

Note(s):

1. For the data rate of 62.5 bit/s, the signal analyser's resolution bandwidth was set to 10 Hz and the video bandwidth was set to 30 Hz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 2.5 kHz and the centre frequency was set to the nominal channel centre frequencies. Normal and delta markers were placed 20 dB down from the peak of the carrier. These results are documented in the table below.
2. For the data rate of 500 bit/s, the signal analyser's resolution bandwidth was set to 30 Hz and the video bandwidth was set to 100 Hz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 5 kHz and the centre frequency was set to the nominal channel centre frequencies. Normal and delta markers were placed 20 dB down from the peak of the carrier. These results are documented in the table below.
3. The test receiver was connected to the RF port on the EUT using suitable attenuation and RF cable.

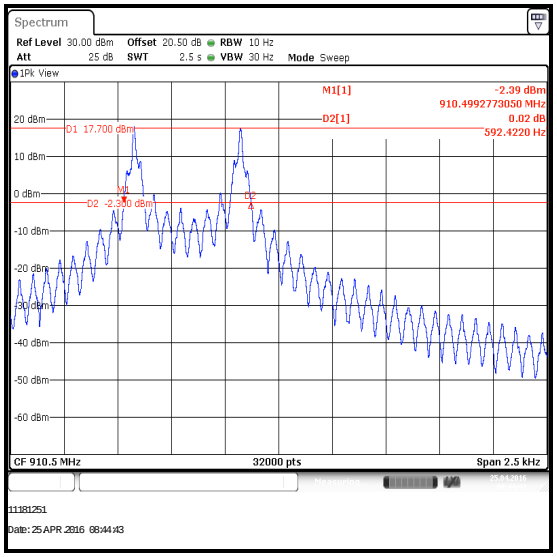
Test setup:



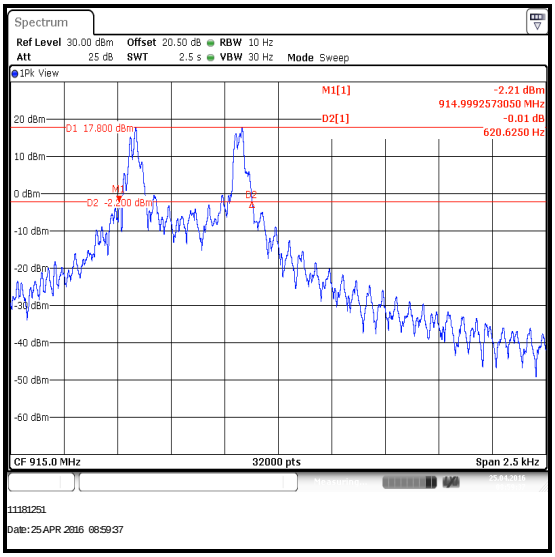
Transmitter 20 dB Bandwidth (continued)

Results: 62.5 bit/s

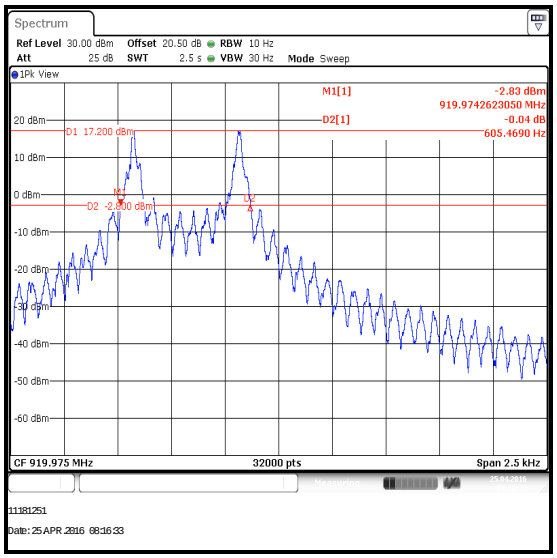
Channel	20 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	0.592	≤500	499.408	Complied
Middle	0.621	≤500	499.379	Complied
Top	0.605	≤500	499.395	Complied



Bottom Channel



Middle Channel

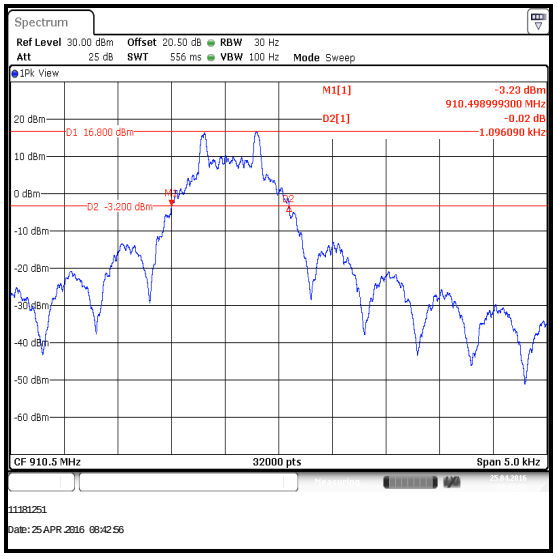


Top Channel

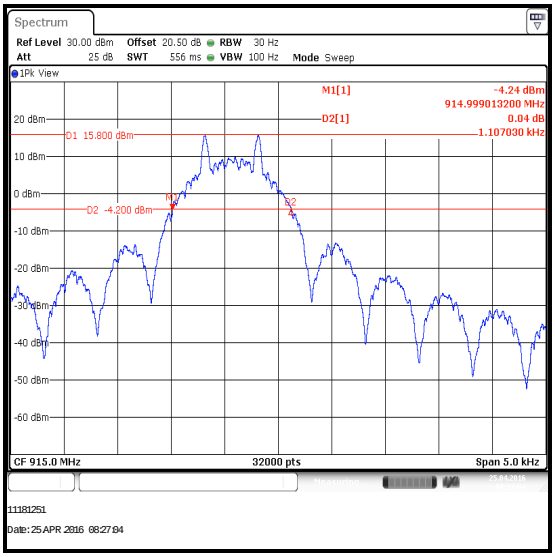
Transmitter 20 dB Bandwidth (continued)

Results: 500 bit/s

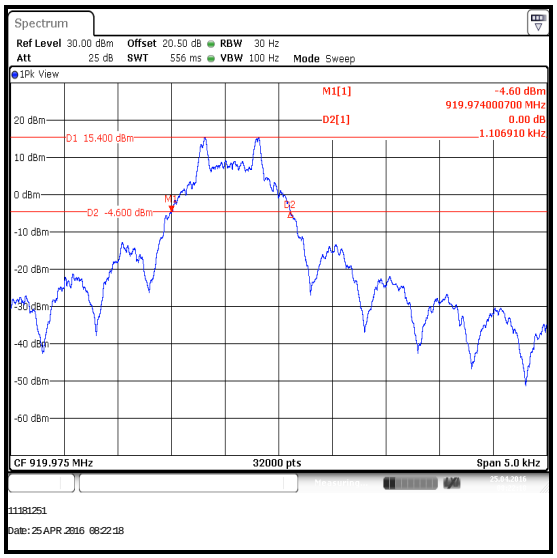
Channel	20 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	1.096	≤500	498.904	Complied
Middle	1.107	≤500	498.893	Complied
Top	1.107	≤500	498.893	Complied



Bottom Channel



Middle Channel



Top Channel

Transmitter 20 dB Bandwidth (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	None stated	02 Apr 2017	12
M1835	Signal Analyser	Rohde & Schwarz	FSV30	103050	26 Feb 2017	12
A2522	Attenuator	AtlanTecRF	AN18-20	832797#3	Calibrated before use	-
G0628	Signal Generator	Rohde & Schwarz	SMBV100A	261847	25 Jan 2017	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	11 Apr 2018	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	15 Apr 2018	24

5.2.3. Transmitter Carrier Frequency Separation

Test Summary:

Test Engineer:	David Doyle	**Test Date:**	25 April 2016
Test Sample Serial Number:	8587		

FCC Reference:	Part 15.247(a)(1)
Test Method Used:	ANSI C63.10 Section 7.8.2

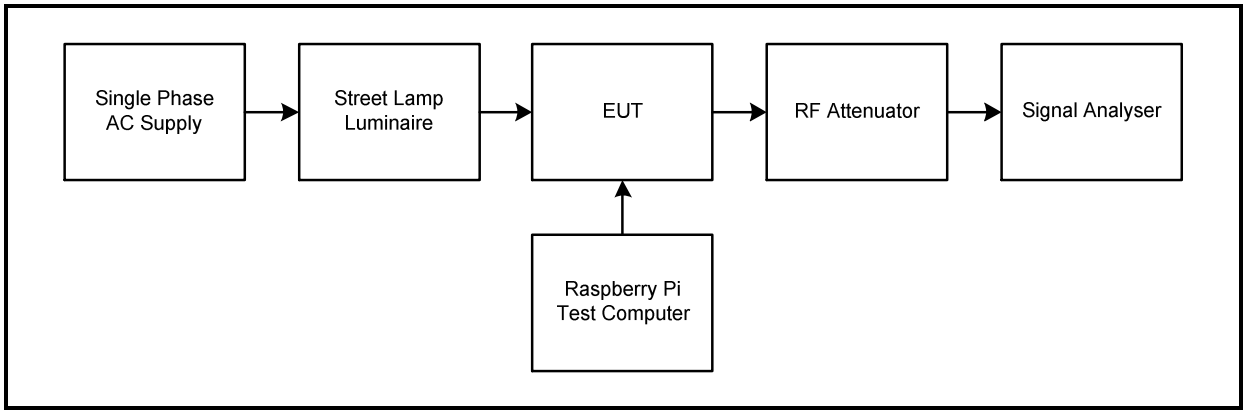
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	31

Note(s):

1. *The limit is a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. The 20 dB bandwidth has been measured as <25 kHz, therefore the applicable limit is ≥25 kHz.
2. The test receiver resolution bandwidth was set to 300 Hz and video bandwidth of 1 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 60 kHz. A marker was placed at the centre of one carrier frequency and then a delta marker was placed at the centre of the second carrier frequency. The results are recorded in the table below.
3. The EUT was set to hop in sub-band 2.
4. The test receiver was connected to the RF port on the EUT using suitable attenuation and RF cable.

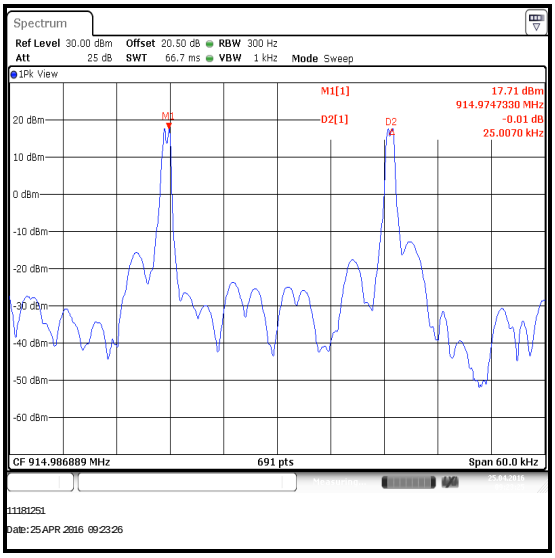
Test setup:



Transmitter Carrier Frequency Separation (continued)

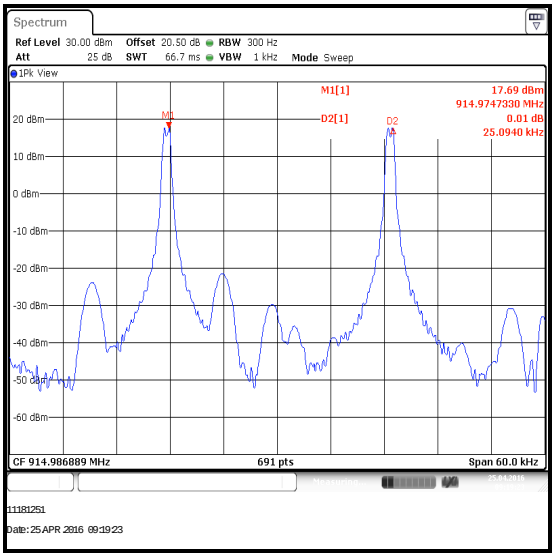
Results: 62.5 bit/s

Carrier Frequency Separation (kHz)	Limit* (kHz)	Margin (kHz)	Result
25.007	25.0	0.007	Complied



Results: 500 bit/s

Carrier Frequency Separation (kHz)	Limit* (kHz)	Margin (kHz)	Result
25.094	25.0	0.094	Complied



Transmitter Carrier Frequency Separation (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	None stated	02 Apr 2017	12
M1835	Signal Analyser	Rohde & Schwarz	FSV30	103050	26 Feb 2017	12
A2522	Attenuator	AtlanTecRF	AN18-20	832797#3	Calibrated before use	-
G0628	Signal Generator	Rohde & Schwarz	SMBV100A	261847	25 Jan 2017	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	11 Apr 2018	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	15 Apr 2018	24

5.2.4. Transmitter Number of Hopping Frequencies and Average Time of Occupancy

Test Summary:

Test Engineer:	David Doyle	**Test Date:**	25 April 2016
Test Sample Serial Number:	8587		

FCC Reference:	Part 15.247(a)(1)(i)
Test Method Used:	ANSI C63.10 Sections 7.8.3 and 7.8.4

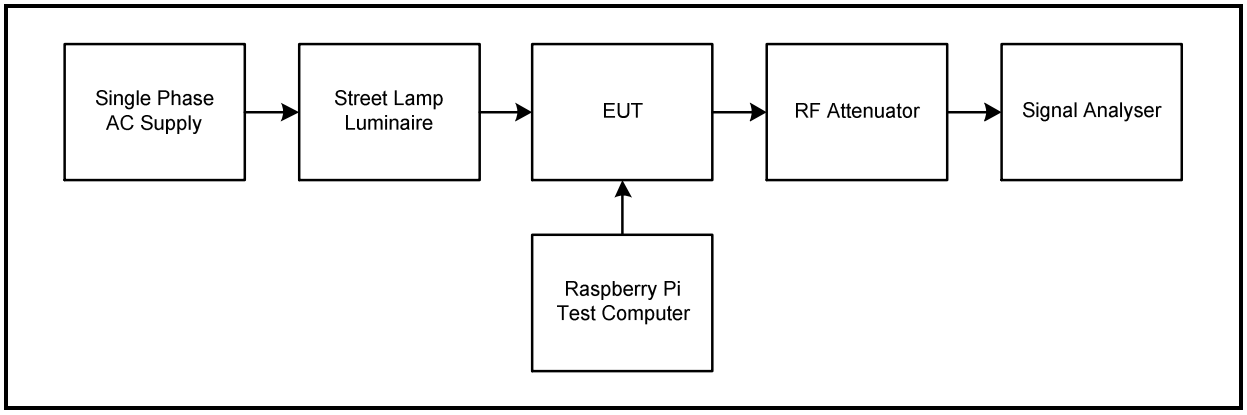
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	31

Note(s):

1. For a hopping channel with a 20 dB bandwidth of less than 250 kHz.
2. *In a 20 second period.
3. The EUT could be set to hop in one of six hopping sub-bands. The test was performed with the EUT transmitting in sub-band 2 which is the only sub-band that incorporates the channel in the centre of the 902-928 MHz band.
4. For the number of hopping frequencies tests, the signal analyser's resolution bandwidth was set to less than the 20 dB bandwidth.
5. The test receiver was connected to the RF port on the EUT using suitable attenuation and RF cable.

Test setup:



Transmitter Number of Hopping Frequencies and Average Time of Occupancy (continued)

Results: Number of Hopping Frequencies / 62.5 bit/s

Number of Hops	Limit (Hops)	Note	Result
59	≥50	1	Complied

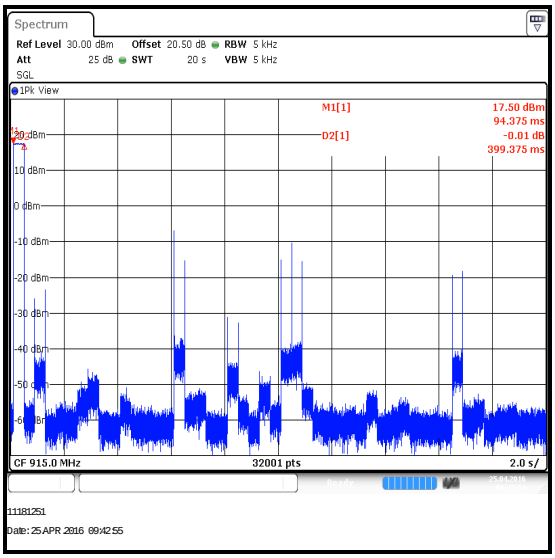
Results: Average Time of Occupancy / 62.5 bit/s

Emission Width (ms)	Average Time of Occupancy* (s)	Limit (s)	Margin (s)	Note	Result
399.359	0.399	0.4	0.001	3	Complied

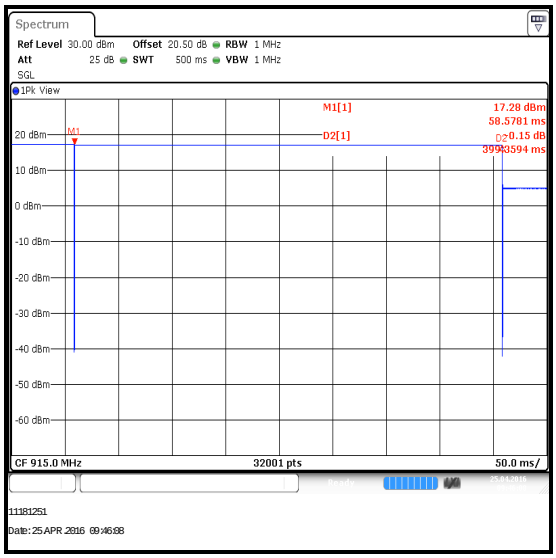
Limit:

If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

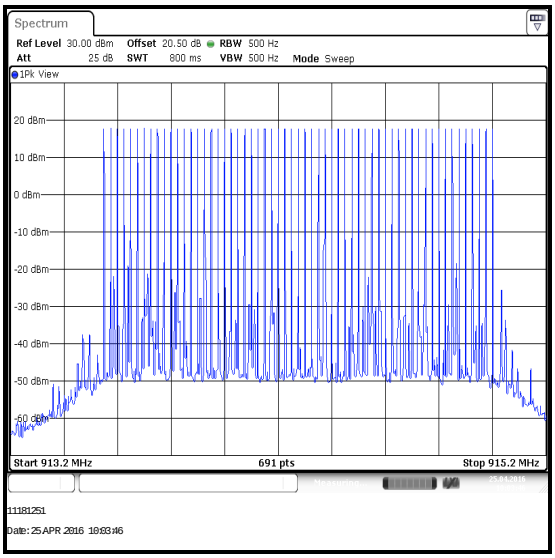
Transmitter Number of Hopping Frequencies and Average Time of Occupancy (continued)



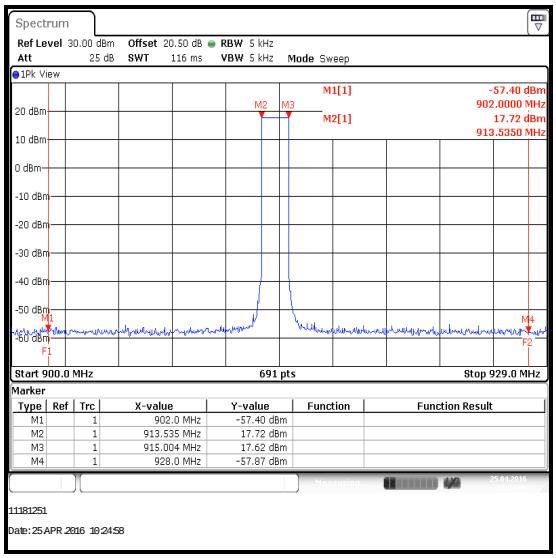
TX on time in 20 second period (Sub-band 2)



TX on period (Sub-band 2)



Number of hopping channels (Sub-band 2)



Number of hopping channels (Showing sub-band 2 within 902 to 928 MHz operating band)

Transmitter Number of Hopping Frequencies and Average Time of Occupancy (continued)

Results: Number of Hopping Frequencies / 500 bit/s

Number of Hops	Limit (Hops)	Note	Result
59	≥50	1	Complied

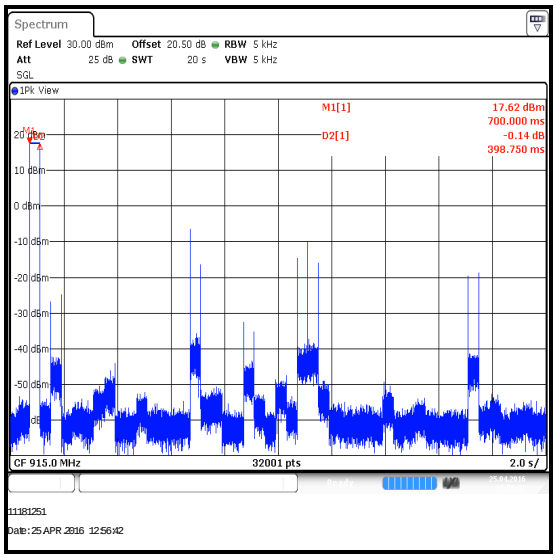
Results: Average Time of Occupancy / 500 bit/s

Emission Width (ms)	Average Time of Occupancy* (s)	Limit (s)	Margin (s)	Note	Result
399.359	0.398	0.4	0.002	3	Complied

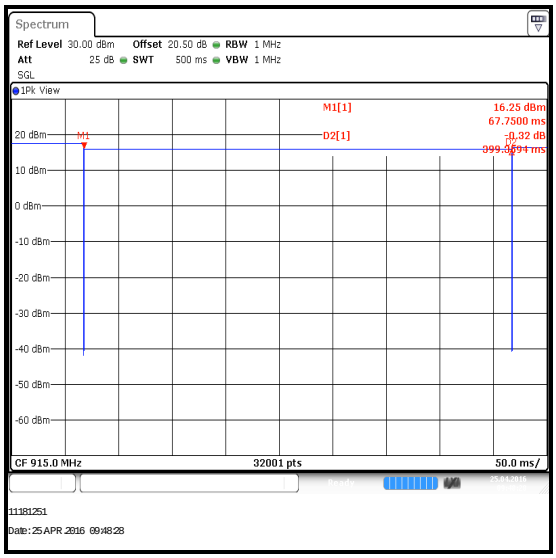
Limit:

If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

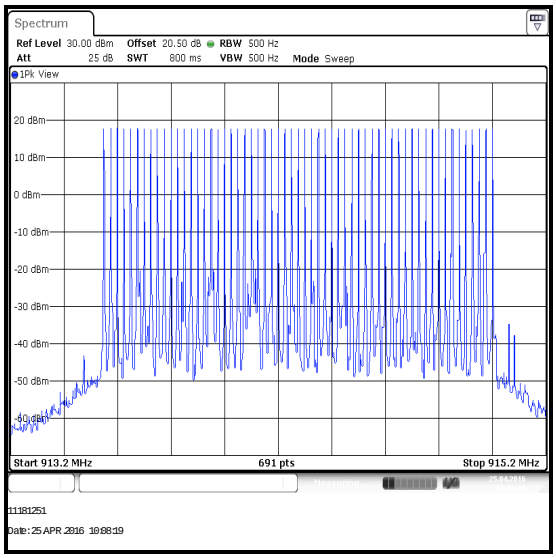
Transmitter Number of Hopping Frequencies and Average Time of Occupancy (continued)



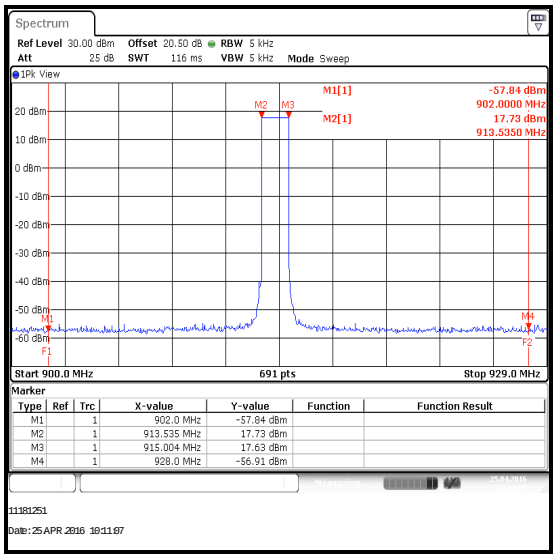
TX on time in 20 second period (Sub-band 2)



TX on period (Sub-band 2)



Number of hopping channels (Sub-band 2)



Number of hopping channels (Showing sub-band 2 within 902 to 928 MHz operating band)

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	02 Apr 2017	12
M1835	Signal Analyser	Rohde & Schwarz	FSV30	103050	26 Feb 2017	12
A2522	Attenuator	AtlanTecRF	AN18-20	832797#3	Calibrated before use	-
G0628	Signal Generator	Rohde & Schwarz	SMBV100A	261847	25 Jan 2017	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	11 Apr 2018	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	15 Apr 2018	24

5.2.5. Transmitter Maximum Peak Output Power

Test Summary:

Test Engineer:	David Doyle	**Test Date:**	25 April 2016
Test Sample Serial Number:	8587		

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

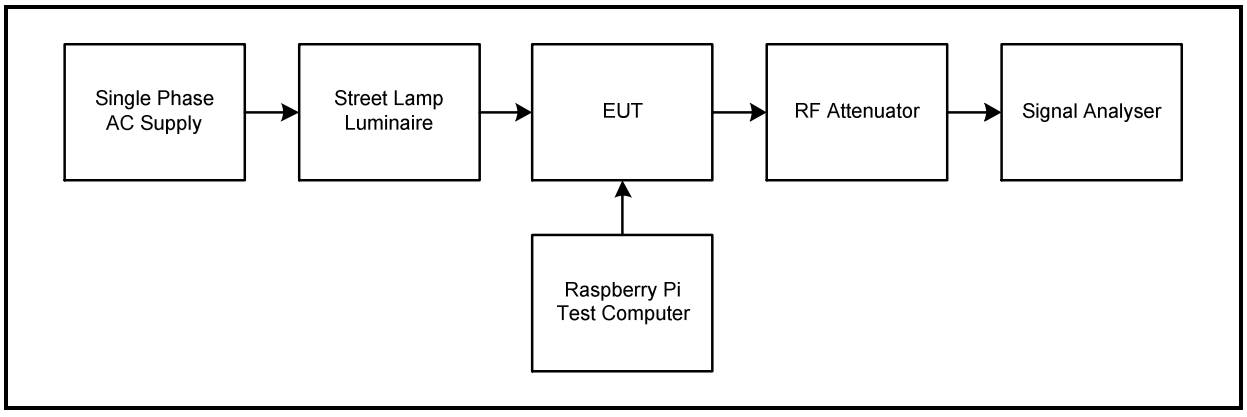
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	31

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 5 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:



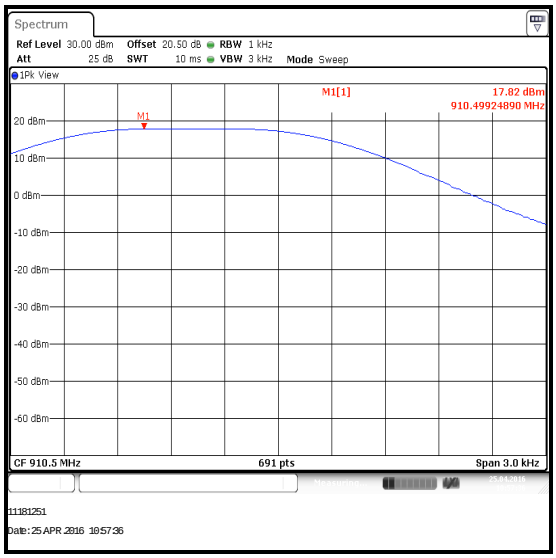
Transmitter Maximum Peak Output Power (continued)

Results: 62.5 bit/s

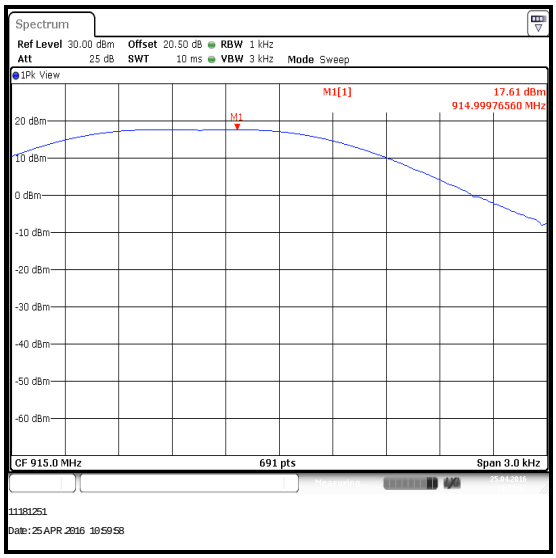
Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Note	Result
Bottom	17.8	30.0	12.2	1	Complied
Middle	17.6	30.0	12.4	1	Complied
Top	17.3	30.0	12.7	1	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Note	Result
Bottom	17.8	2.0	19.8	36.0	16.2	1	Complied
Middle	17.6	2.0	19.6	36.0	16.4	1	Complied
Top	17.3	2.0	19.3	36.0	16.7	1	Complied

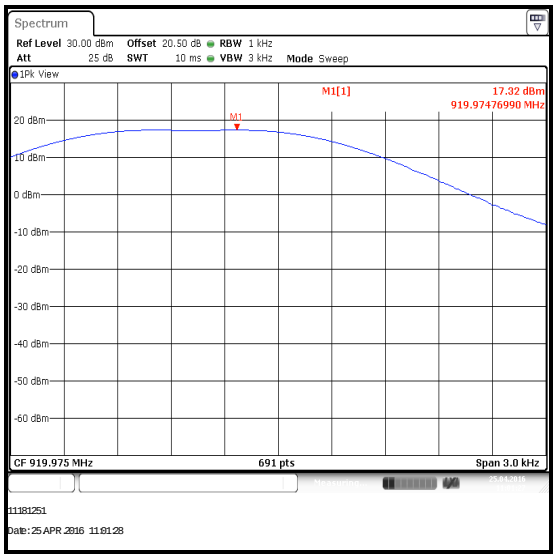
Transmitter Maximum Peak Output Power (continued)



Bottom Channel



Middle Channel



Top Channel

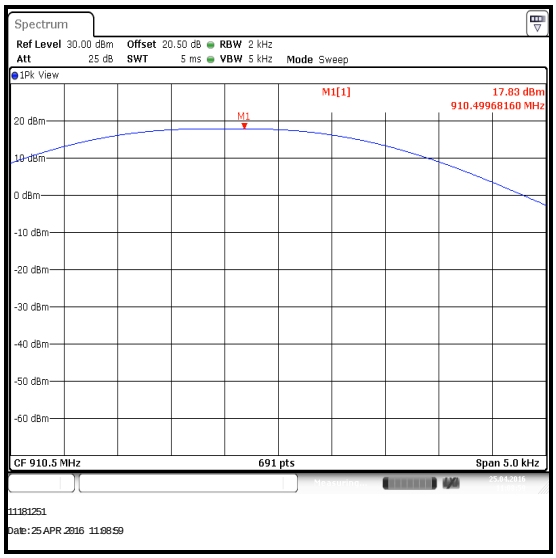
Transmitter Maximum Peak Output Power (continued)

Results: 500 bit/s

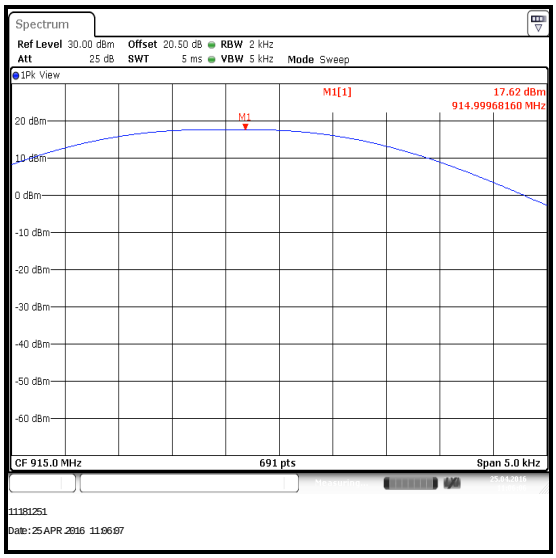
Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Note	Result
Bottom	17.8	30.0	12.2	1	Complied
Middle	17.6	30.0	12.4	1	Complied
Top	17.4	30.0	12.6	1	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Note	Result
Bottom	17.8	2.0	19.8	36.0	16.2	1	Complied
Middle	17.6	2.0	19.6	36.0	16.4	1	Complied
Top	17.4	2.0	19.4	36.0	16.6	1	Complied

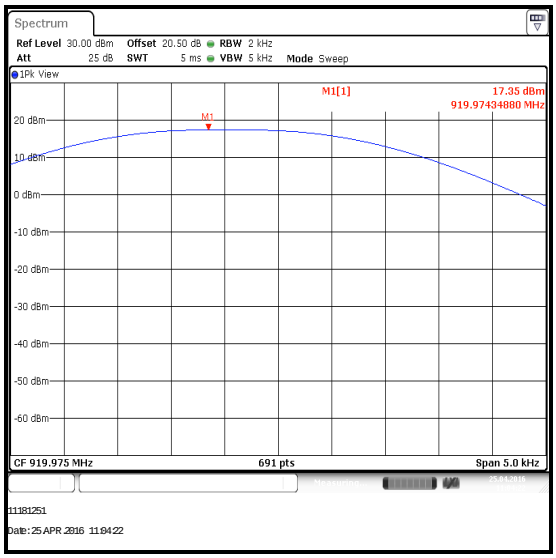
Transmitter Maximum Peak Output Power (continued)



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	02 Apr 2017	12
M1835	Signal Analyser	Rohde & Schwarz	FSV30	103050	26 Feb 2017	12
A2522	Attenuator	AtlanTecRF	AN18-20	832797#3	Calibrated before use	-
G0628	Signal Generator	Rohde & Schwarz	SMBV100A	261847	25 Jan 2017	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	11 Apr 2018	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	15 Apr 2018	24

5.2.6. Transmitter Radiated Emissions

Test Summary:

Test Engineer:	David Doyle	**Test Date:**	15 April 2016
Test Sample Serial Number:	8587		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.5
Frequency Range	30 MHz to 1000 MHz

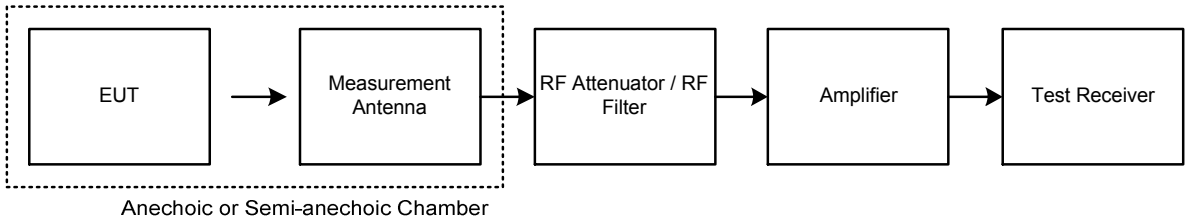
Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	32

Note(s):

1. The EUT was transmitting at full power with a data rate of 62.5 bit/s.
2. The emission at approximately 915 MHz shown on the 30 MHz to 1 GHz plot is the EUT fundamental.
3. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
4. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the middle channel only.
5. All other emissions shown on the pre-scan plots were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
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.
7. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. The sweep time was set to auto. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
8. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 120 kHz, using a CISPR quasi-peak detector and span wide enough to see the whole emission.
9. *20 dBc limit applicable as the emission falls in the non-restricted bands.

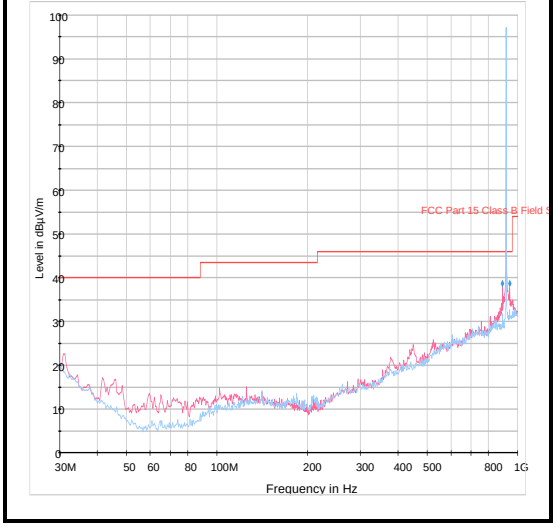
Test setup:



Transmitter Radiated Emissions (continued)

Results: Peak

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
888.898	Vertical	38.8	95.3*	56.5	Complied



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)
M1625	Thermohygrometer	JM Handelspunkt	30.5015.06	None stated	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
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046	18 Nov 2016	12
G0543	Amplifier	Sonoma	310N	230801	29 May 2016	3
A1834	Attenuator	Hewlett Packard	8491B	10444	30 Mar 2017	12

5.2.7. Transmitter Radiated Emissions

Test Summary:

Test Engineer:	David Doyle	**Test Date:**	14 April 2016
Test Sample Serial Number:	8587		

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):	24
Relative Humidity (%):	34

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 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.
6. Pre-scans were performed and markers were placed on the highest measured levels of the appropriate plots. 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)

Results: Peak Bottom Channel

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2731.508	Horizontal	48.5	54.0	5.5	Complied
4552.487	Vertical	42.1	54.0	11.9	Complied
8194.439	Vertical	42.9	54.0	11.1	Complied

Results: Peak / Middle Channel

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2744.984	Horizontal	49.6	54.0	4.4	Complied
4574.800	Vertical	43.9	54.0	10.1	Complied
8234.896	Vertical	43.8	54.0	10.2	Complied

Results: Peak / Top Channel

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2759.925	Horizontal	48.6	54.0	5.4	Complied
4599.939	Vertical	45.6	54.0	8.4	Complied
8279.887	Vertical	41.1	54.0	12.9	Complied

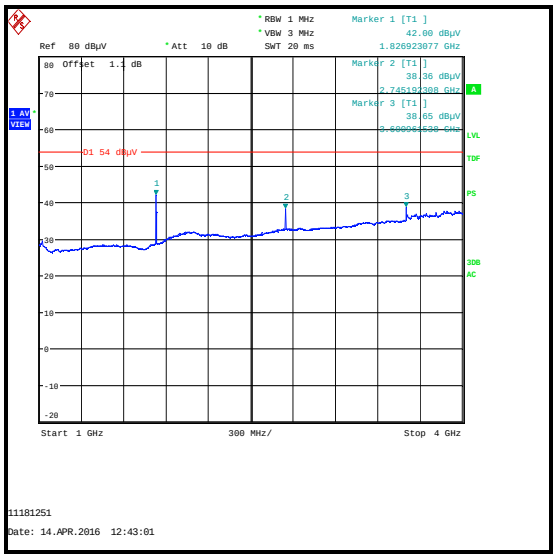
Results: Peak / Hopping Mode

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

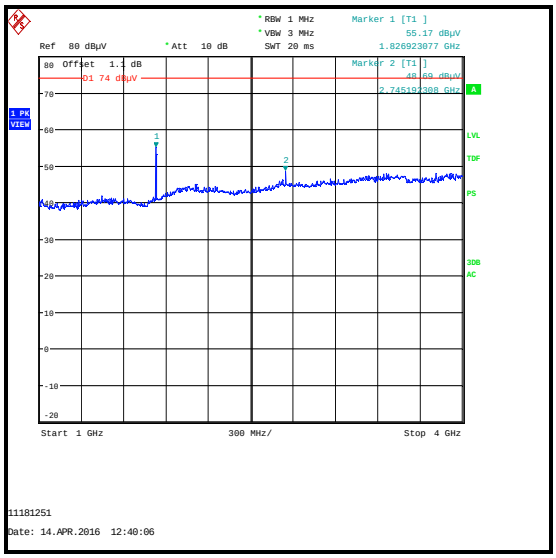
Results: Average / Hopping Mode

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

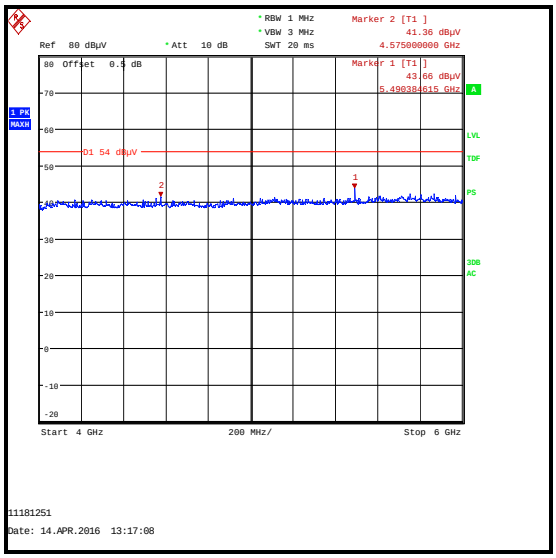
Transmitter Radiated Emissions (continued)

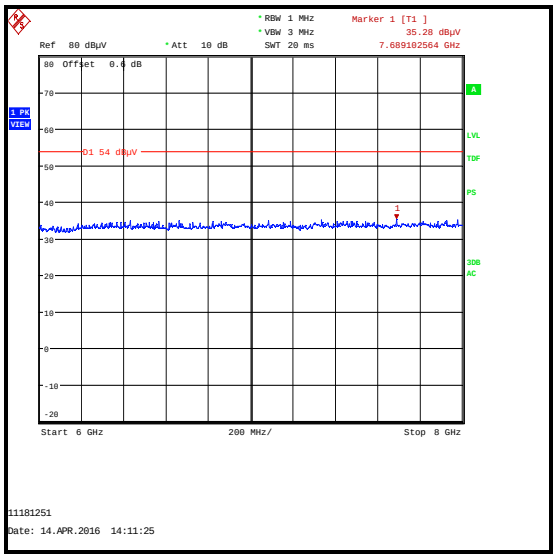


Average Detector

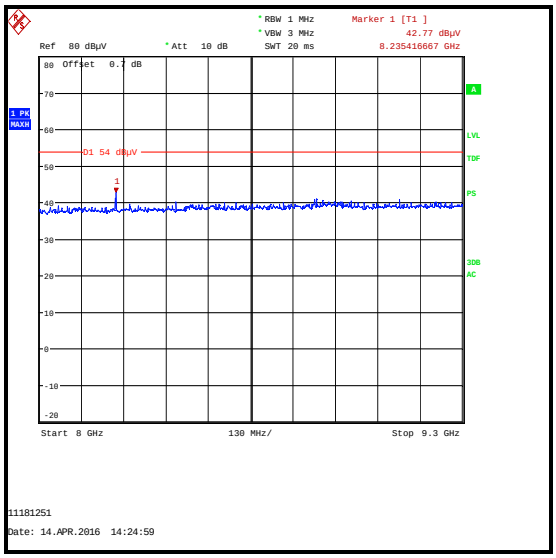


Peak Detector





Transmitter Radiated Emissions (continued)



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

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
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
A254	Antenna	Flann Microwave	14240-20	139	17 Dec 2016	12
A255	Antenna	Flann Microwave	16240-20	519	17 Dec 2016	12
A2467	High Pass Filter	Wainwright Instruments GmbH	WHJE5-920-1000-4000-60EE	2	09 Mar 2017	12
A1975	High Pass Filter	AtlanTecRF	AFH-03000	090424010	17 Apr 2016	12

5.2.8. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	David Doyle	**Test Date:**	14 April 2016
Test Sample Serial Number:	8587		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.10 Section 6.10.4

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	34

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.
3. The plot for upper band edge, static mode, 500 bit/s has the wrong limit line of -30 dBc shown. The tables show the correct limit of -20 dBc.

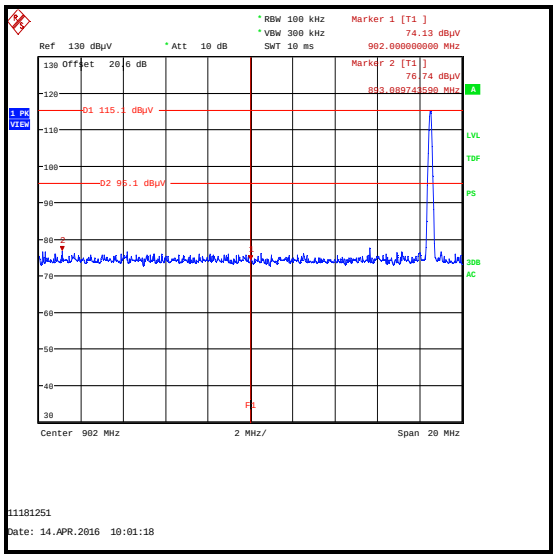
Results: Static Mode / 62.5 bit/s

Frequency (MHz)	Peak Level (dBµV/m)	-20 dBc Limit (dBµV/m)	Margin (dB)	Result
893.090	76.7	95.1	18.4	Complied
902	74.1	95.1	21.0	Complied
928	74.1	95.3	21.2	Complied
937.679	76.9	95.3	18.4	Complied

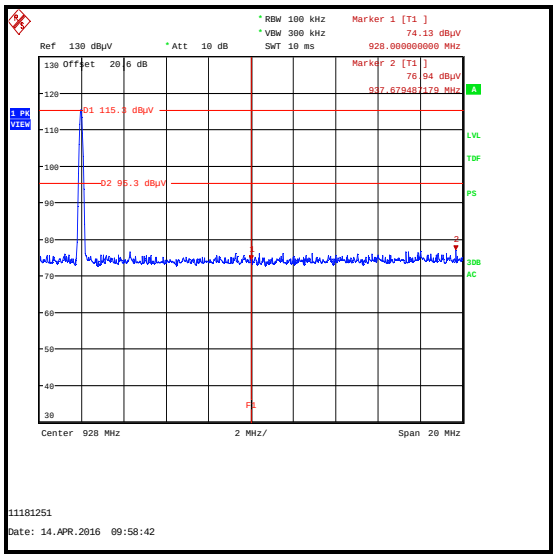
Results: Hopping Mode / 62.5 bit/s

Frequency (MHz)	Peak Level (dBµV/m)	-20 dBc Limit (dBµV/m)	Margin (dB)	Result
893.314	77.3	95.1	17.8	Complied
902	75.8	95.1	19.3	Complied
928	73.7	95.4	21.7	Complied
937.840	76.7	95.4	18.7	Complied

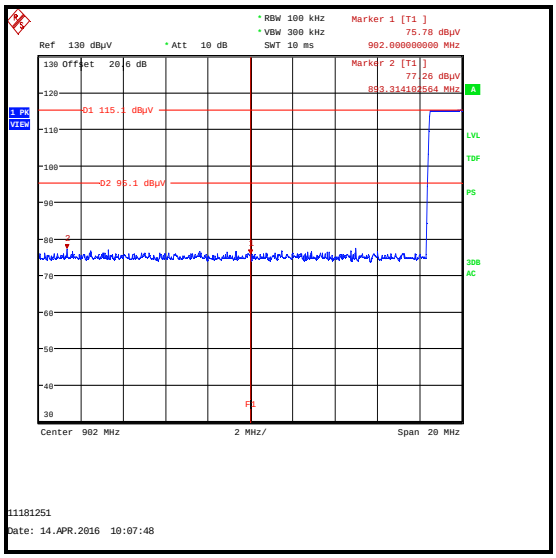
Transmitter Band Edge Radiated Emissions (continued)



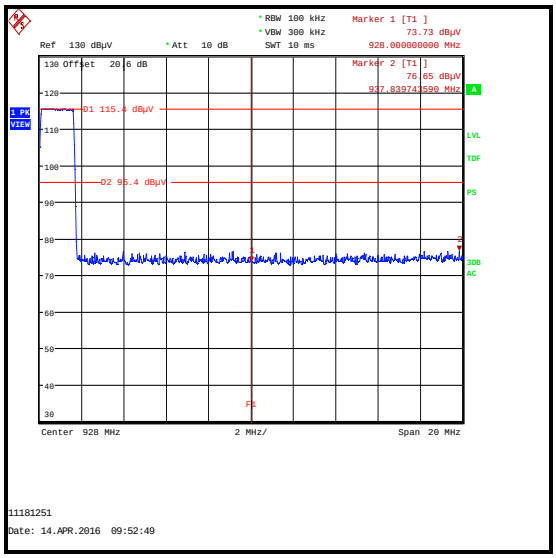
Lower Band Edge / Static Mode



Upper Band Edge / Static Mode



Lower Band Edge / Hopping Mode



Upper Band Edge / Hopping Mode

Transmitter Band Edge Radiated Emissions (continued)

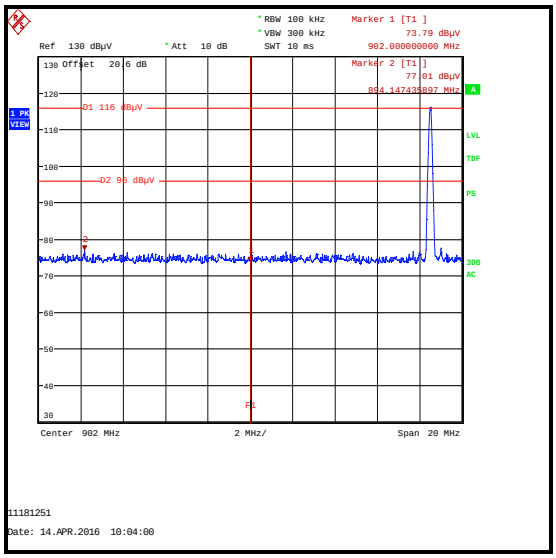
Results: Static Mode / 500 bit/s

Frequency (MHz)	Peak Level (dBµV/m)	-20 dBc Limit (dBµV/m)	Margin (dB)	Result
894.147	77.0	96.0	19.0	Complied
902	73.8	96.0	22.2	Complied
928	74.1	95.3	21.2	Complied
937.679	76.9	95.3	18.4	Complied

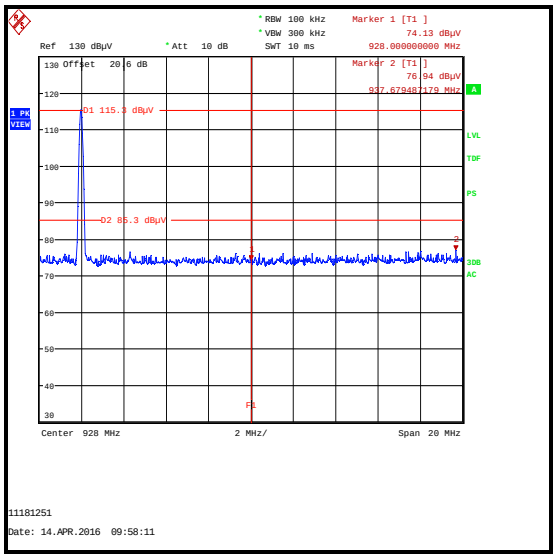
Results: Hopping Mode / 500 bit/s

Frequency (MHz)	Peak Level (dBµV/m)	-20 dBc Limit (dBµV/m)	Margin (dB)	Result
895.942	77.7	95.1	17.4	Complied
902	75.6	95.1	19.5	Complied
928	74.1	95.3	21.2	Complied

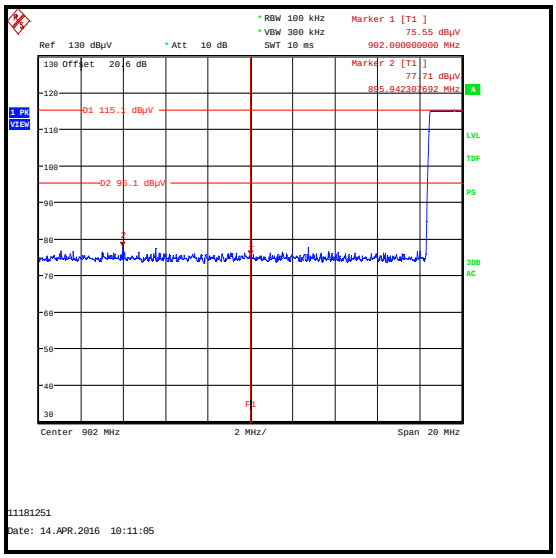
Transmitter Band Edge Radiated Emissions (continued)



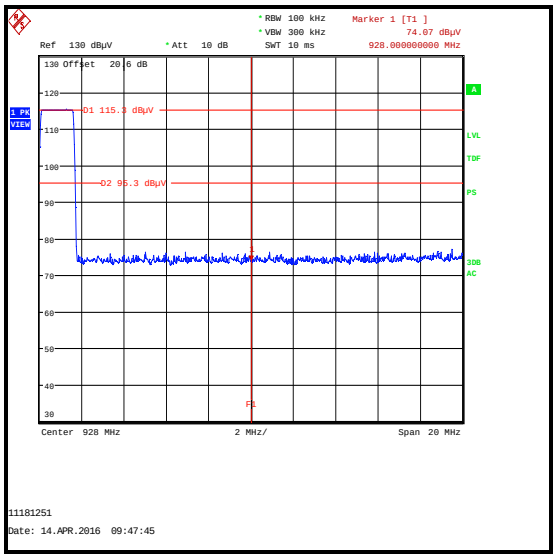
Lower Band Edge / Static Mode



Upper Band Edge / Static Mode



Lower Band Edge / Hopping Mode



Upper Band Edge / Hopping Mode

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
A288	Antenna	Chase	CBL6111A	1589	27 Aug 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
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±4.69 dB
Conducted Maximum Peak Output Power	902 MHz to 928 MHz	95%	±1.13 dB
Carrier Frequency Separation	902 MHz to 928 MHz	95%	±3.92 %
Average Time of Occupancy	902 MHz to 928 MHz	95%	±3.53 ns
20 dB Bandwidth	902 MHz to 928 MHz	95%	±3.92 %
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

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