



# TEST REPORT

**Test Report No. : UL-RPT-RP12648032-516A V2.0**

**Customer** : Grundfos Holding A/S

**PMN** : RADIOMODULE 2G4

**HVIN** : RADIOMODULE 2G4

**FCC ID** : OG3-RADIOMO1-2G4

**ISED Certification No.** : IC: 10447A-RA2G4M01

**Technology** : GLoWPAN (IEEE 802.15.4)

**Test Standard(s)** : FCC Parts 2.1053, 15.33, 15.209(a), 15.247(d), 22.917(a), 24.238(a), 27.53(c)(2), 27.53(g) & 27.53(h)(1)  
Innovation, Science and Economic Development Canada  
RSS-247 Issue 2 section 5.5, RSS-132 Issue 3 section 5.5,  
RSS-133 Issue 6 section 6.5, RSS-139 Issue 3 section 6.6  
RSS-130 Issue 2 section 4.7 & RSS-Gen Issue 5 Sections 6.13

**Test Laboratory** : UL VS LTD, Basingstoke, Hampshire, RG24 8AH, United Kingdom

1. This test report shall not be reproduced except in full, 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 2.0 supersedes all previous versions.

**Date of Issue:** 09 January 2020

**Checked by:**

Ben Mercer  
Senior Test Engineer, Radio Laboratory

**Company Signatory:**

Sarah Williams  
Senior Test Engineer, Radio Laboratory  
UL VS LTD



---

## UL VS LTD

Unit 1-3 Horizon, Kingsland Business Park, Wade Road, Basingstoke, Hampshire, RG24 8AH, UK  
Telephone: +44 (0)1256 312000  
Facsimile: +44 (0)1256 312001

**Customer Information**

<b>Company Name:</b>	Grundfos Holding A/S
<b>Address:</b>	Poul Due Jensens Vej 7, Bjerringbro, DK-8850, Denmark

**Report Revision History**

<b>Version Number</b>	<b>Issue Date</b>	<b>Revision Details</b>	<b>Revised By</b>
1.0	06/01/2020	Initial Version	Ben Mercer
2.0	09/01/2020	Admin update	Ben Mercer

## **Table of Contents**

<b>Customer Information.....</b>	<b>2</b>
<b>Report Revision History .....</b>	<b>2</b>
<b>Table of Contents.....</b>	<b>3</b>
<b>1. Attestation of Test Results.....</b>	<b>4</b>
1.1. Description of EUT	4
1.2. General Information	4
1.3. Summary of Test Results	5
1.4. Deviations from the Test Specification	5
<b>2. Summary of Testing.....</b>	<b>6</b>
2.1. Facilities and Accreditation	6
2.2. Methods and Procedures	6
2.3. Calibration and Uncertainty	7
2.4. Test and Measurement Equipment	8
<b>3. Equipment Under Test (EUT) .....</b>	<b>9</b>
3.1. Identification of Equipment Under Test (EUT)	9
3.2. Modifications Incorporated in the EUT	9
3.3. Additional Information Related to Testing	10
3.4. Description of Available Antennas	11
3.5. Description of Test Setup	12
<b>4. Radiated Test Results.....</b>	<b>16</b>
4.1. Transmitter Out of Band Radiated Emissions (GLoWPAN & UMTS Band V)	16
4.2. Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 2)	20
4.3. Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 4)	24
4.4. Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 12)	28
4.5. Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 13)	32

# 1. Attestation of Test Results








## 1.1. Description of EUT

The equipment under test was a GLoWPAN/IEEE 802.15.4 communication interface module (FCC ID: OG3-RADIOMO1-2G4 / ISED Certification No: IC: 10447A-RA2G4M01), which is integrated together with a UMTS/LTE cellular module (FCC ID: OG3-CIM2X0-3G-4G / ISED Certification No: IC: 10447A-CIM2X034G) in Grundfos pump MAGNA3.

## 1.2. General Information

<b>Specification Reference:</b>	47CFR15.247
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
<b>Specification Reference:</b>	47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.209
<b>Specification Reference:</b>	47CFR22
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 22 Subpart H (Cellular Radiotelephone Service)
<b>Specification Reference:</b>	47CFR24
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 24 Subpart E (Broadband Personal Communication Services)
<b>Specification Reference:</b>	47CFR27
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 27 Subpart C (Technical Standards)
<b>Specification Reference:</b>	RSS-Gen Issue 5 April 2018
<b>Specification Title:</b>	General Requirements for Compliance of Radio Apparatus
<b>Specification Reference:</b>	RSS-247 Issue 2 February 2017
<b>Specification Title:</b>	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
<b>Specification Reference:</b>	RSS-132 Issue 3, January 2013
<b>Specification Title:</b>	Cellular Telephone Systems Operating in the Bands 824-849 MHz and 869-894 MHz
<b>Specification Reference:</b>	RSS-133 Issue 6, Amendment 1, January 2018
<b>Specification Title:</b>	2 GHz Personal Communications Services
<b>Specification Reference:</b>	RSS-139 Issue 3, July 2015
<b>Specification Title:</b>	Advanced Wireless Services Equipment Operating in the Bands 1710-1755 MHz and 2110-2155 MHz
<b>Specification Reference:</b>	RSS-130 Issue 2, February 2019
<b>Specification Title:</b>	Equipment Operating in the Frequency Bands 617-652 MHz, 663-698 MHz, 698-756 MHz and 777-787 MHz
<b>Site Registration:</b>	FCC: 621311 ISED: 3245B
<b>Location of Testing:</b>	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
<b>Test Dates:</b>	24 September 2019 to 26 September 2019

**1.3. Summary of Test Results**

FCC Reference (47CFR)	ISED Canada Reference	Measurement	Result
<b>Transmit Mode: GLoWPAN &amp; UMTS Band V</b>			
15.209(a) / 15.247(d) / 2.1053 / 22.917(a)	RSS-Gen 6.13 / RSS-247 5.5 / RSS-132 5.5	Transmitter Out of Band Radiated Emissions	
<b>Transmit Mode: GLoWPAN &amp; LTE Band 2</b>			
15.209(a) / 15.247(d) / 2.1053 / 24.238(a)	RSS-Gen 6.13 / RSS-247 5.5 / RSS-133 6.5	Transmitter Out of Band Radiated Emissions	
<b>Transmit Mode GLoWPAN &amp; LTE Band 4</b>			
15.209(a) / 15.247(d) / 2.1053 / 27.53(h)(1)	RSS-Gen 6.13 / RSS-247 5.5 / RSS-139 6.6	Transmitter Out of Band Radiated Emissions	
<b>Transmit Mode GLoWPAN &amp; LTE Band 12</b>			
15.209(a) / 15.247(d) / 2.1053 / 27.53(g)	RSS-Gen 6.13 / RSS-247 5.5 / RSS-130 4.7	Transmitter Out of Band Radiated Emissions	
<b>Transmit Mode: GLoWPAN &amp; LTE Band 13</b>			
15.209(a) / 15.247(d) / 2.1053 / 27.53(c)(2)	RSS-Gen 6.13 / RSS-247 5.5 / RSS-130 4.7	Transmitter Out of Band Radiated Emissions	
<b>Key to Results</b>			
 = Complied  = Did not comply			

**1.4. 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.

## **2. Summary of Testing**

### **2.1. Facilities and Accreditation**

The test site and measurement facilities used to collect data are located at Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom. The following table identifies which facilities were utilised for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

Site 1	
Site 2	
Site 17	X

UL VS LTD is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

### **2.2. Methods and Procedures**

<b>Reference:</b>	ANSI C63.10-2013
<b>Title:</b>	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
<b>Reference:</b>	ANSI C63.4-2014
<b>Title:</b>	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.
<b>Reference:</b>	ANSI C63.26-2015
<b>Title:</b>	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
<b>Reference:</b>	KDB 558074 D01 15.247 Meas Guidance v05r02, April 2, 2019
<b>Title:</b>	Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules
<b>Reference:</b>	KDB 971168 D01 v03r01 April 9, 2018
<b>Title:</b>	Procedure for Measurements on Wideband Licensed DTS
<b>Reference:</b>	KDB 442401 June 12 2017
<b>Title:</b>	Radiated emission measurements for licensed radio service equipment

## **2.3. Calibration and Uncertainty**

### **Measuring Instrument Calibration**

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.

### **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 measured (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
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±3.30 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±2.54 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.

## 2.4. Test and Measurement Equipment

### Test Equipment Used for Transmitter Radiated Emissions Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	06 Jan 2020	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	01 Aug 2020	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	08 May 2020	12
A3167	Pre Amplifier	Com Power	PAM-103	18020010	14 Aug 2020	12
A2863	Pre Amplifier	Agilent	8449B	3008A02100	08 Aug 2020	12
A3142	Pre Amplifier	Schwarzbeck	BBV 9718 B	00020	08 Aug 2020	12
A2893	Pre Amplifier	Schwarzbeck	BBV 9721	9721-021	31 Jul 2020	12
A490	Antenna	Chase	CBL6111A	1590	21 May 2020	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	08 Aug 2020	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	08 Aug 2020	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	01 Aug 2020	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	20 Feb 2020	12
A2918	Attenuator	AtlanTecRF	AN18W5-20	832828#1	20 Feb 2020	12
A2926	Attenuator	AtlanTecRF	AN18W5-30	85850#2	20 Feb 2020	12
A3083	Low Pass Filter	AtlanTecRF	AFL-01000	18010900076	09 Apr 2020	12
A2908	High Pass Filter	Wainwright Instruments GmbH	WHJE5-920-1000-4000-60EE	3	20 Feb 2020	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	20 Feb 2020	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	20 Feb 2020	12
M1229	Digital Multimeter	Fluke	179	87640015	10 Apr 2020	12
S0580	DC Power Supply	TTI	EX1810R	444111	Calibrated before use	-
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	20 Apr 2020	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	20 Apr 2020	24
G0614	Signal Generator	Rohde & Schwarz	SMB100A	177687	08 May 2020	36
A3097	Antenna	Link Microtek	AM1-18HA	15275	30 Aug 2021	36
A2943	Attenuator	AtlanTecRF	AN18W5-06	208147#2	20 Feb 2020	12



### **3. Equipment Under Test (EUT)**

#### **3.1. Identification of Equipment Under Test (EUT)**

<b>Brand Name:</b>	Grundfos
<b>PMN:</b>	RADIOMODULE 2G4
<b>Test Sample Serial Number:</b>	99439337-03-829-00002
<b>Test Sample IMEI Number:</b>	358148061139965
<b>HVIN:</b>	RADIOMODULE 2G4
<b>Software Version Number:</b>	v01.03.00
<b>FCC ID:</b>	OG3-RADIOMO1-2G4
<b>ISED Certification Number:</b>	IC: 10447A-RA2G4M01

#### **3.2. Modifications Incorporated in the EUT**

No modifications were applied to the EUT during testing.

**3.3. Additional Information Related to Testing**

<b>Tested Technology:</b>	LTE Band 2		
<b>Type of Equipment</b>	Transceiver		
<b>Modulation Type:</b>	QPSK		
<b>Transmit Frequency Range:</b>	1850 to 1910 MHz		
<b>Channel Bandwidth</b>	15 MHz		
<b>Channels Tested:</b>	<b>Channel ID</b>	<b>N<sub>ul</sub></b>	<b>Frequency of Uplink (MHz)</b>
	Middle	18900	1880.0
<b>Tested Technology:</b>	LTE Band 4		
<b>Transmit Frequency Range:</b>	1710 to 1755 MHz		
<b>Channel Bandwidth</b>	1.4 & 5 MHz		
<b>Channels Tested:</b>	<b>Channel ID</b>	<b>N<sub>ul</sub></b>	<b>Frequency of Uplink (MHz)</b>
	Middle	20175	1732.5
<b>Tested Technology:</b>	LTE Band 12		
<b>Transmit Frequency Range:</b>	699 to 716 MHz		
<b>Channel Bandwidth</b>	3 MHz		
<b>Channels Tested:</b>	<b>Channel ID</b>	<b>N<sub>ul</sub></b>	<b>Frequency of Uplink (MHz)</b>
	Middle	23095	707.5
<b>Tested Technology:</b>	LTE Band 13		
<b>Transmit Frequency Range:</b>	777 to 787 MHz		
<b>Channel Bandwidth</b>	5 MHz		
<b>Channels Tested:</b>	<b>Channel ID</b>	<b>N<sub>ul</sub></b>	<b>Frequency of Uplink (MHz)</b>
	Middle	23230	782

<b>Technology Tested:</b>	UMTS850		
<b>Type of Radio Device:</b>	Transceiver		
<b>Mode:</b>	UMTS FDD V		
<b>Modulation Type:</b>	QPSK		
<b>Channel Spacing:</b>	5 MHz		
<b>Data Rate</b>	HSUPA Sub-Test 1		
<b>Transmit Frequency Range:</b>	824 to 849 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Middle	4183	836.6

**Additional Information Related to Testing (continued)**

<b>Technology Tested:</b>	GLoWPAN / IEEE 802.15.4 (Digital Transmission System)		
<b>Channel Spacing:</b>	5 MHz		
<b>Modulation:</b>	O-QPSK		
<b>Data Rate:</b>	250 kb/s		
<b>Transmit Frequency Range:</b>	2400 MHz to 2483.5 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Middle	18	2440

**3.4. Description of Available Antennas**

The radio utilizes integrated GLoWPAN antennas and external cellular antennas with the following maximum gains. The cellular antennas are connected to 5 m RF cables; the antenna gain below includes the cable loss.

**GLoWPAN**

Frequency Range (MHz)	Antenna Gain (dBi)
2400-2480	0.0

**Cellular**

Frequency Range (MHz)	Antenna Gain (dB)
700	0.0
850	0.6
1700	-1.5
1900	1.6

### **3.5. Description of Test Setup**

#### **Support Equipment**

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

<b>Description:</b>	Laptop PC
<b>Brand Name:</b>	Lenovo
<b>Model Name or Number:</b>	L440
<b>Serial Number:</b>	R9-019EA1

<b>Description:</b>	USB Hub
<b>Brand Name:</b>	Hama
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	USB Type A to Micro Type B. Quantity 1. Length 1m
<b>Brand Name:</b>	Not marked or stated
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	USB Extension Cable. Quantity 1. Length 10m
<b>Brand Name:</b>	Not marked or stated
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	USB Extension Cable. Quantity 1. Length 3m
<b>Brand Name:</b>	Not marked or stated
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	USB Type A to Type B. Quantity 1. Length 1m
<b>Brand Name:</b>	Not marked or stated
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

## **Operating Modes**

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

- Transmitting UMTS and GLoWPAN simultaneously at maximum power.
- Transmitting LTE and GLoWPAN simultaneously at maximum power.

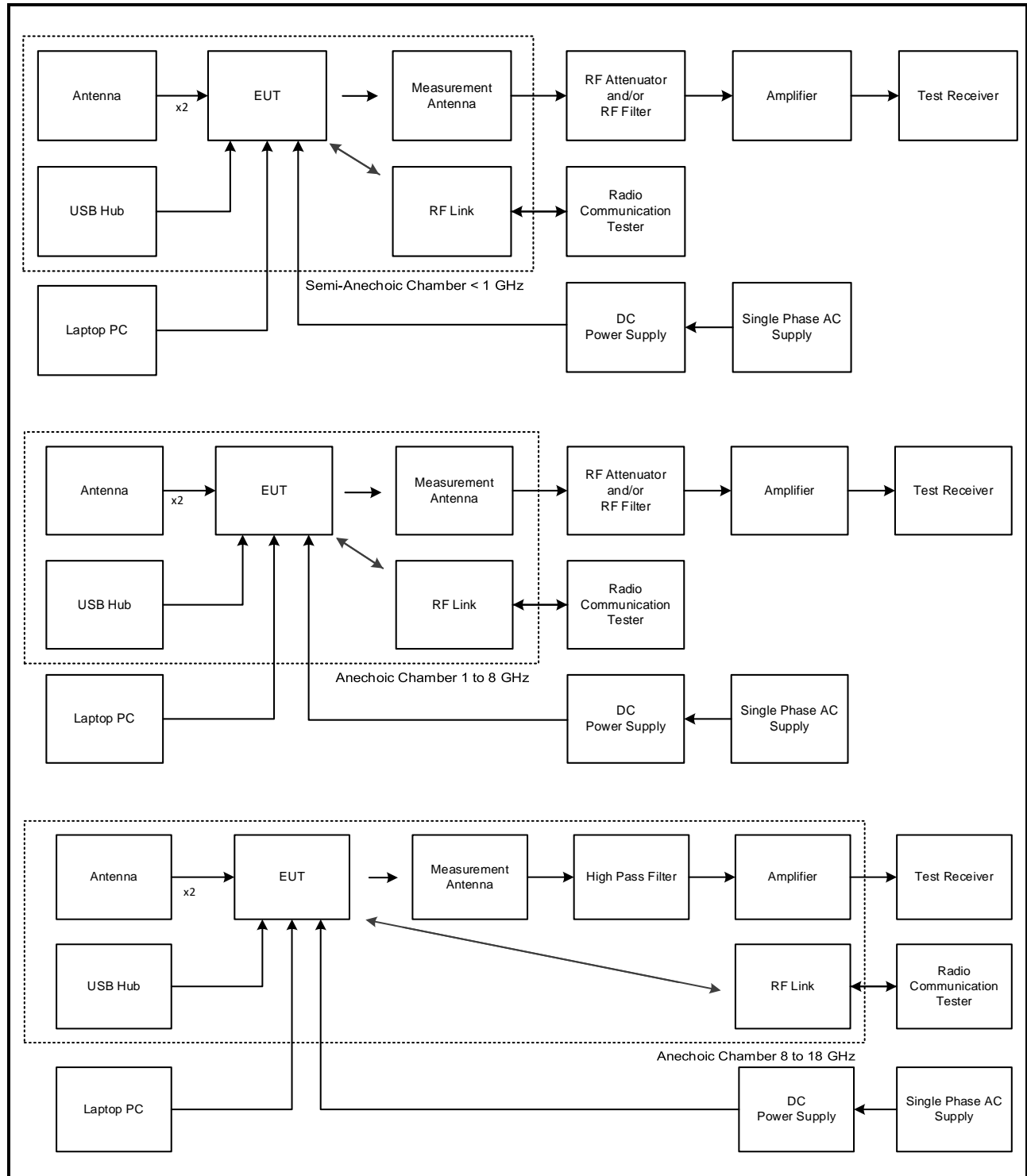
## **Configuration and Peripherals**

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

- The EUT was controlled with a test laptop and a third party test software application using commands supplied by the customer. Channel, packet length and other settings were then set using this software application as required. The customer supplied a document containing the setup instructions '2 Setup\_approval\_lab\_Magna.PDF' & '3 CIM260 Approval Mode.PDF'
- The cellular link was controlled using a Rohde & Schwarz CMW500 UMTS / LTE system simulator.
- UMTS 850 and GLoWPAN co-location, with EUT configured to simultaneously transmit two signals at maximum output power (UMTS 850 HSDPA Sub test 1 on middle channel 4183 / 836.6 MHz and GLoWPAN on middle channel 18 / 2440 MHz).
- LTE Band 2 and GLoWPAN co-location, with EUT configured to simultaneously transmit two signals at maximum output power (LTE Band 2 QPSK / 15 MHz Channel bandwidth / 1RB offset 0 on middle channel 18900 / 1880 MHz and GLoWPAN on middle channel 18 / 2440 MHz).
- LTE Band 4 and GLoWPAN co-location, with EUT configured to simultaneously transmit two signals at maximum output power (LTE Band 4 QPSK / 1.4 MHz Channel bandwidth / 1RB offset 0 on middle channel 20175 / 1732.5 MHz and GLoWPAN on middle channel 18 / 2440 MHz).
- LTE Band 12 and GLoWPAN co-location, with EUT configured to simultaneously transmit two signals at maximum output power (LTE Band 12 QPSK / 3 MHz Channel bandwidth / 1RB offset 0 on middle channel 23095 / 707.5 MHz and GLoWPAN on middle channel 18 / 2440 MHz).
- LTE Band 13 and GLoWPAN co-location, with EUT configured to simultaneously transmit two signals at maximum output power (LTE Band 13 QPSK / 5 MHz Channel bandwidth / 1RB offset 0 on middle channel 23230 / 782 MHz and GLoWPAN on middle channel 18 / 2440 MHz).
- Transmitter radiated measurements were performed with the EUT placed in the worst case orientation with respect to emissions. The cellular module was connected to a USB hub, and the GLoWPAN module was connected to a laptop PC. The EUT was powered by a 5.25 VDC supply. The laptop PC and DC power supply were placed outside of the anechoic chamber.
- Pre-scans were performed for each combination of GLoWPAN and cellular band. All final measurements were initially performed on all possible channel bandwidths using resource allocations of 1 RB offset 0 and full RB. Only the worst case combination was reported.

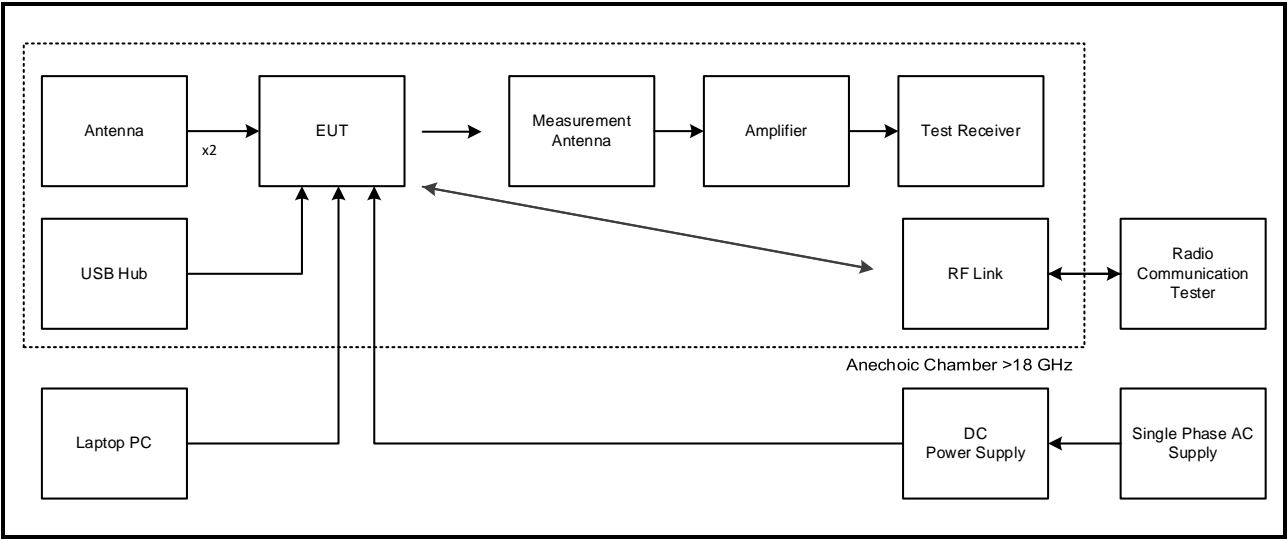
## Test Setup Diagrams

### Transmitter Radiated Emissions



Test Setup Diagrams (continued)

Transmitter Radiated Emissions



## 4. Radiated Test Results

### 4.1. Transmitter Out of Band Radiated Emissions (GLoWPAN & UMTS Band V)

#### Test Summary:

Test Engineer:	Andrew Edwards	Test Dates:	24 September 2019 & 25 September 2019
Test Sample Serial Number:	99439337-03-829-00002		

FCC Reference:	Parts 2.1053 / 15.209(a) / 15.247(d) / 22.917(a)
ISED Canada Reference:	RSS-Gen 6.13 / RSS-247 5.5 / RSS-132 5.5
Test Method Used:	ANSI C63.26 section 5.5, KDB971168 Section 6.1 referencing ANSI C63.4 KDB 558074 Sections 8.1 c)3), 8.5 & 8.6 referencing ANSI C63.10 Sections 6.3, 6.5, 6.6, 11.11 & 11.12
Frequency Range:	30 MHz to 25 GHz
Configuration:	GLoWPAN middle channel / UMTS HSDPA sub test 1 middle channel

#### Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	45 to 48

#### Results: GLoWPAN middle channel / UMTS Band V middle channel

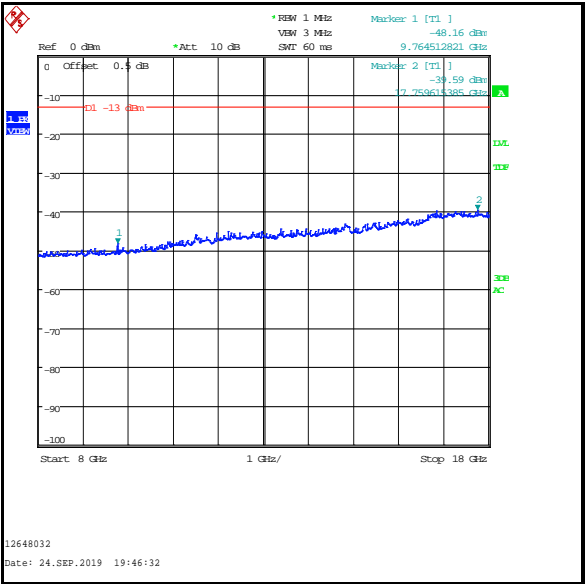
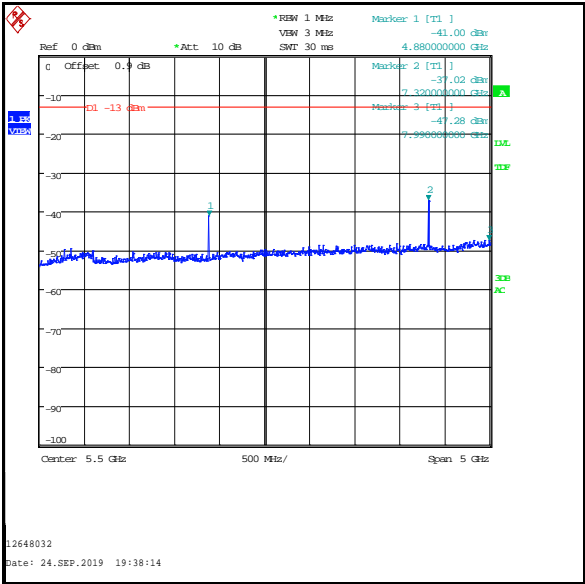
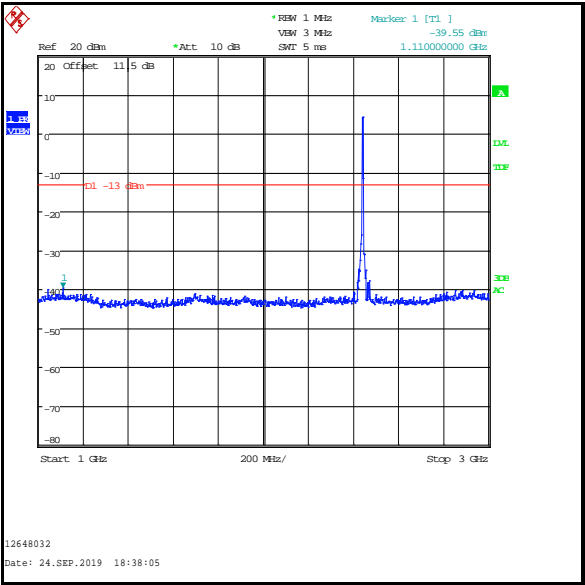
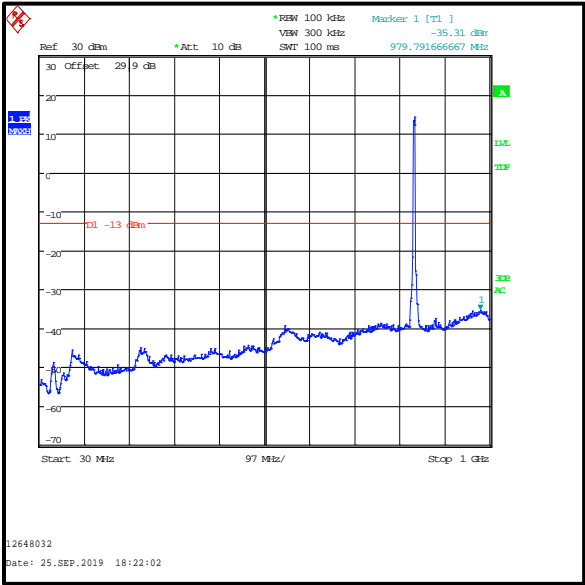
Frequency (MHz)	Antenna Polarity	Emission Level	Applicable Limit	Margin (dB)	Result
See note 1					



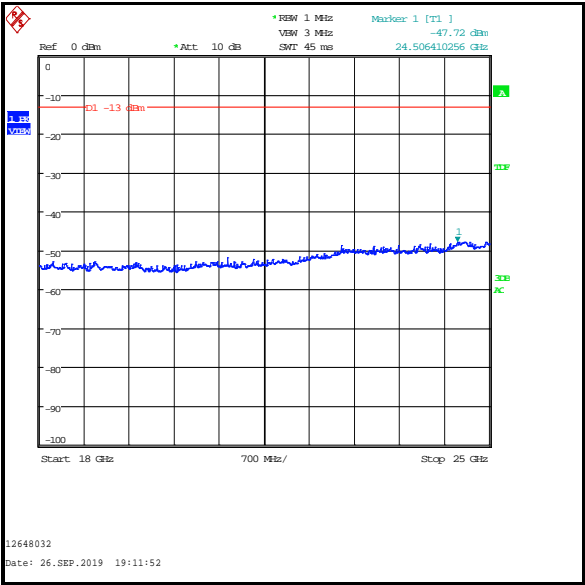
**Transmitter Out of Band Radiated Emissions (GLoWPAN & UMTS Band V) (continued)****Note(s):**

1. All intermodulation products were below the noise floor level or greater than 20 dB from the specification limit.
2. The UMTS Band V uplink is shown on the 30 MHz to 1 GHz plot.
3. The GLoWPAN fundamental is shown on the 1 GHz to 3 GHz plot.
4. The emission at approximately 4880 MHz is the 2<sup>nd</sup> harmonic of the GLoWPAN signal and was therefore not measured.
5. The emission at approximately 7320 MHz is the 3<sup>rd</sup> harmonic of the GLoWPAN signal and was therefore not measured.
6. The emission at approximately 9760 MHz is the 4<sup>th</sup> harmonic of the GLoWPAN signal and was therefore not measured.
7. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz, for measurements below 1 GHz. For measurements above 1 GHz resolution bandwidth was set 1 MHz and video bandwidth 3 MHz, with the sweep time set to auto. Markers were placed on the highest measured level.
8. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0017) 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.
9. Measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) 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.

Transmitter Out of Band Radiated Emissions (GLoWPAN & UMTS Band V) (continued)



Transmitter Out of Band Radiated Emissions (GLoWPAN & UMTS Band V) (continued)



**4.2. Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 2)****Test Summary:**

<b>Test Engineer:</b>	Andrew Edwards	<b>Test Dates:</b>	24 September 2019, 25 September 2019 & 26 September 2019
<b>Test Sample Serial Number:</b>	99439337-03-829-00002		

<b>FCC Reference:</b>	Parts 2.1053 / 15.209(a) / 15.247(d) / 24.238(a)
<b>ISED Canada Reference:</b>	RSS-Gen 6.13 / RSS-247 5.5 / RSS-133 6.5
<b>Test Method Used:</b>	ANSI C63.26 section 5.5, KDB971168 Section 6.1 referencing ANSI C63.4 KDB 558074 Sections 8.1 c)3), 8.5 & 8.6 referencing ANSI C63.10 Sections 6.3, 6.5, 6.6, 11.11 & 11.12
<b>Frequency Range:</b>	30 MHz to 25 GHz
<b>Configuration:</b>	GLoWPAN middle channel / LTE Band 2 (QPSK / 15 MHz channel Bandwidth / 1RB offset 0) middle channel

**Environmental Conditions:**

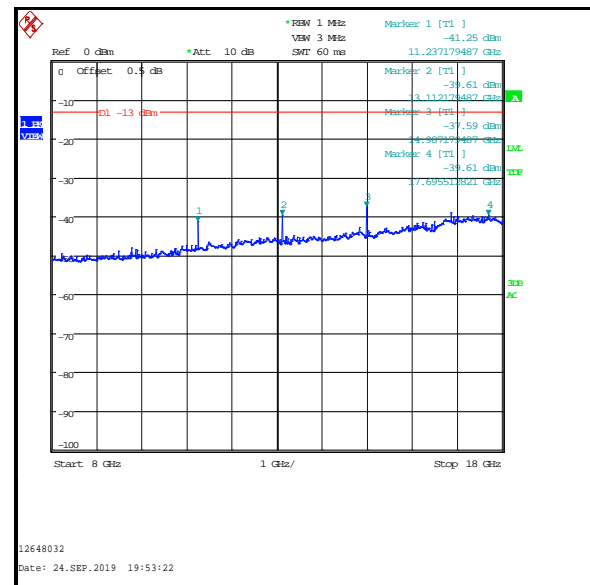
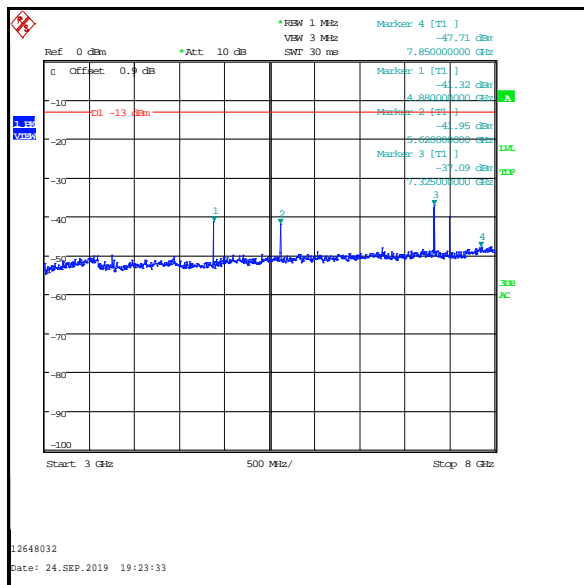
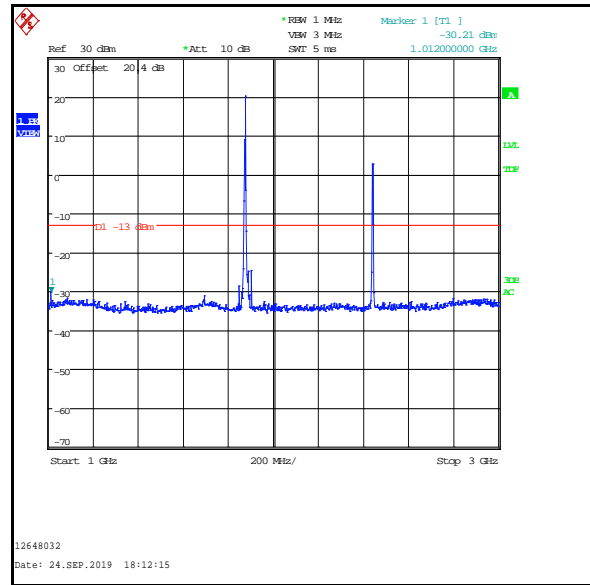
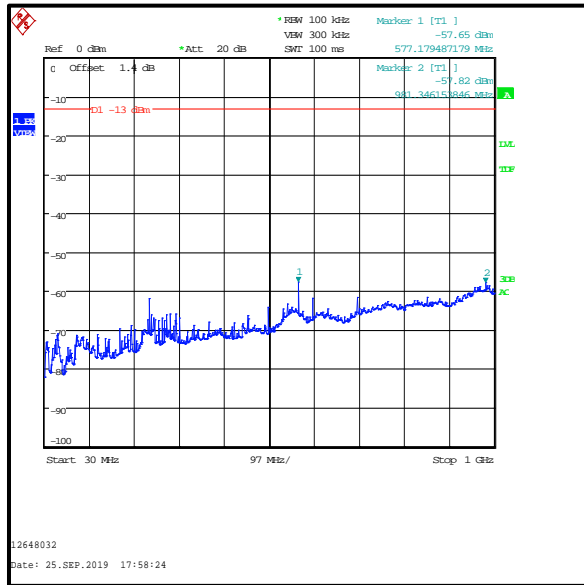
<b>Temperature (°C):</b>	23 to 24
<b>Relative Humidity (%):</b>	45 to 49

**Results: GLoWPAN middle channel / LTE Band 2 middle channel**

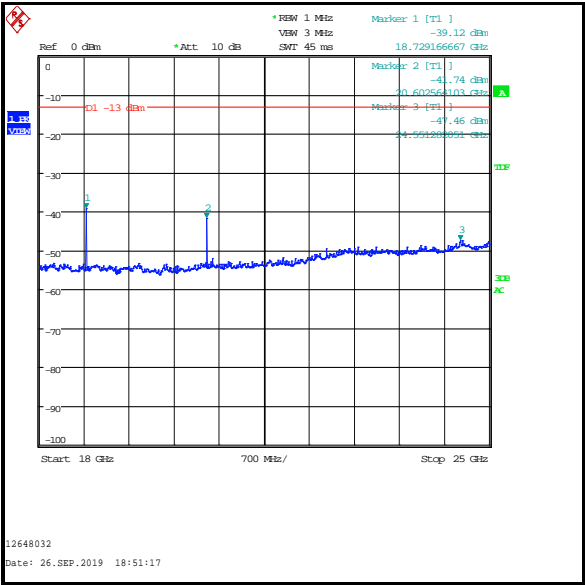
Frequency (MHz)	Antenna Polarity	Emission Level	Applicable Limit	Margin (dB)	Result
See note 1					

**Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 2) (continued)****Note(s):**

1. All intermodulation products were below the noise floor level or greater than 20 dB from the specification limit.
2. The GLoWPAN fundamental is shown on the 1 GHz to 3 GHz plot.
3. The LTE Band 2 uplink and downlink are shown on the 1 GHz to 3 GHz plot.
4. The emission at approximately 4880 MHz is the 2<sup>nd</sup> harmonic of the GLoWPAN signal and was therefore not measured.
5. The emission at approximately 5640 MHz is the 3<sup>rd</sup> harmonic of the LTE Band 2 signal and was therefore not measured.
6. The emission at approximately 7320 MHz is the 3<sup>rd</sup> harmonic of the GLoWPAN signal and was therefore not measured.
7. The emission at approximately 7520 MHz is the 5<sup>th</sup> harmonic of the LTE Band 2 signal and was therefore not measured.
8. The emission at approximately 11280 MHz is the 6<sup>th</sup> harmonic of the LTE Band 2 signal and was therefore not measured.
9. The emission at approximately 13112 MHz is the 7<sup>th</sup> harmonic of the LTE Band 2 signal and was therefore not measured.
10. The emission at approximately 14988 MHz is the 8<sup>th</sup> harmonic of the LTE Band 2 signal and was therefore not measured.
11. The emission at approximately 18729 MHz is the 10<sup>th</sup> harmonic of the LTE Band 2 signal and was therefore not measured.
12. The emission at approximately 20603 MHz is the 11<sup>th</sup> harmonic of the LTE Band 2 signal and was therefore not measured.
13. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz, for measurements below 1 GHz. For measurements above 1 GHz resolution bandwidth was set 1 MHz and video bandwidth 3 MHz, with the sweep time set to auto. Markers were placed on the highest measured level.
14. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0017) 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.
15. Measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) 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.

**Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 2) (continued)**

Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 2) (continued)



**4.3. Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 4)****Test Summary:**

<b>Test Engineer:</b>	Andrew Edwards	<b>Test Dates:</b>	24 September 2019, 25 September 2019 & 26 September 2019
<b>Test Sample Serial Number:</b>	99439337-03-829-00002		

<b>FCC Reference:</b>	Parts 2.1053 / 15.209(a) / 15.247(d) / 27.53(h)(1)
<b>ISED Canada Reference:</b>	RSS-Gen 6.13 & 8.9 / RSS-247 5.5 / RSS-139 6.6
<b>Test Method Used:</b>	ANSI C63.26 section 5.5, KDB971168 Section 6.1 referencing ANSI C63.4 KDB 558074 Sections 8.1 c)3), 8.5 & 8.6 referencing ANSI C63.10 Sections 6.3, 6.5, 6.6, 11.11 & 11.12
<b>Frequency Range:</b>	30 MHz to 25 GHz
<b>Configuration:</b>	GLoWPAN middle channel / LTE Band 4 (QPSK / 1.4 MHz channel Bandwidth / 1RB offset 0) middle channel

**Environmental Conditions:**

<b>Temperature (°C):</b>	23 to 24
<b>Relative Humidity (%):</b>	45 to 48

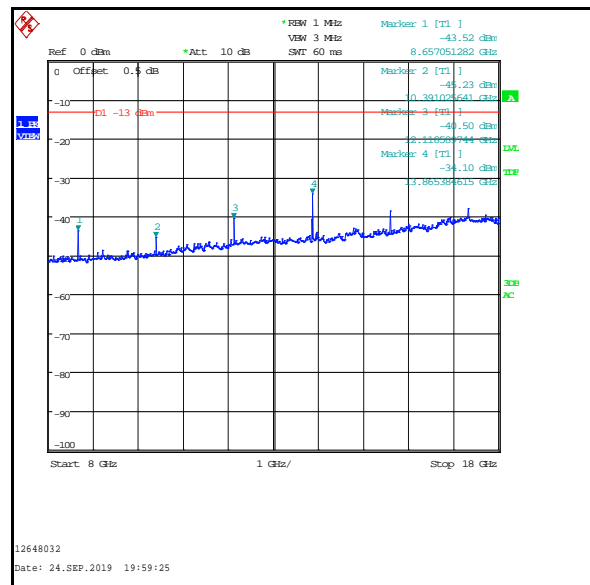
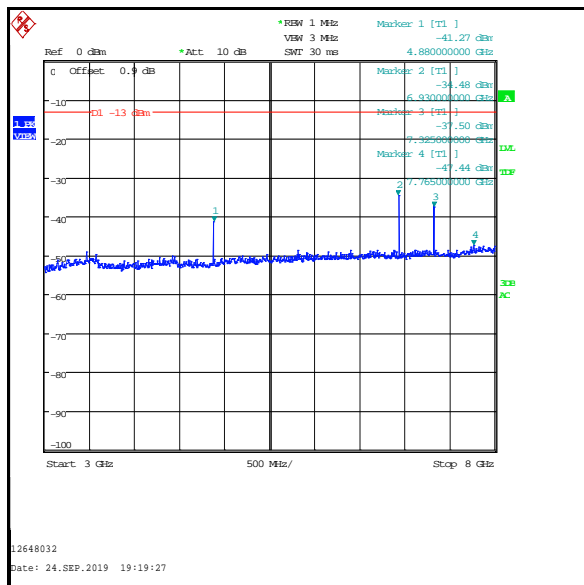
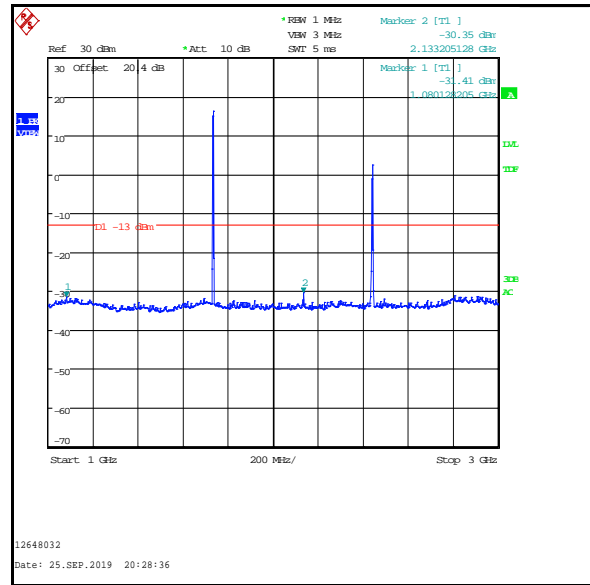
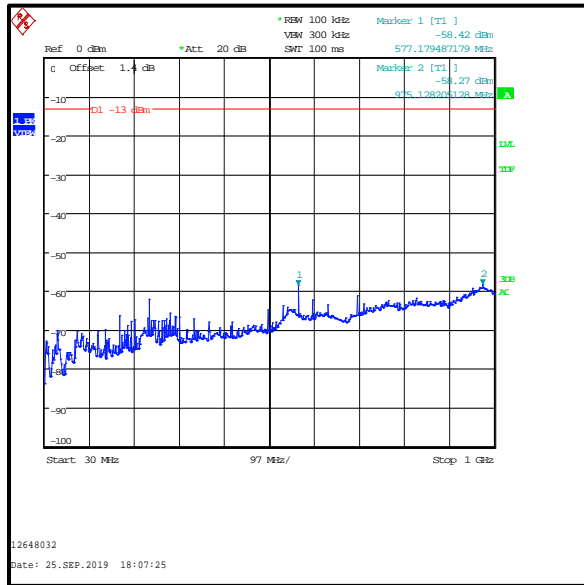
**Results: GLoWPAN middle channel / LTE Band 4 middle channel**

Frequency (MHz)	Antenna Polarity	Emission Level (dBm)	Applicable Limit (dBm)	Margin (dB)	Result
2131.994	Horizontal	-25.3	-13.0	12.3	Complied

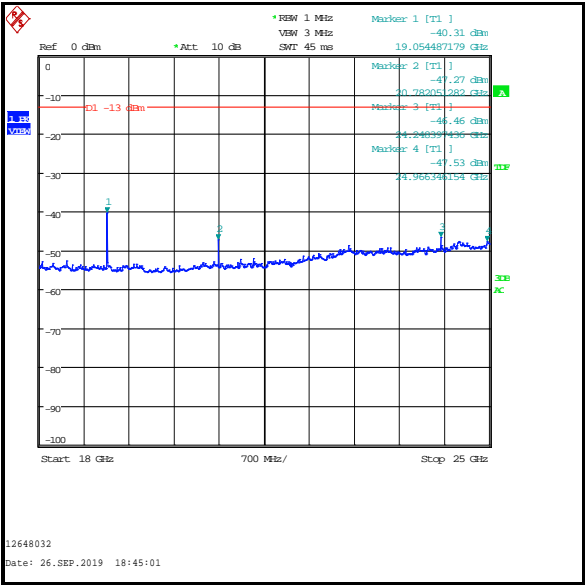


**Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 4) (continued)****Note(s):**

1. All other intermodulation products were below the noise floor level or greater than 20 dB from the specification limit.
2. The GLoWPAN fundamental is shown on the 1 GHz to 3 GHz plot.
3. The LTE Band 4 uplink is shown on the 1 GHz to 3 GHz plot.
4. The emission at approximately 2132 MHz is an intermodulation generated between the 3<sup>rd</sup> harmonic of the GLoWPAN signal minus 3<sup>rd</sup> harmonic of the LTE Band 4 signal.
5. Pre-scans were performed using GLoWPAN middle channel / LTE Band 4, 1.4 MHz channel bandwidth 1RB offset 0 middle channel. Final measurements were performed using GLoWPAN middle channel / LTE Band 4, 5 MHz channel bandwidth 1RB offset 0 middle channel as it was found to be the worst case with respect to emissions.
6. The emission at approximately 4880 MHz is the 2<sup>nd</sup> harmonic of the GLoWPAN signal and was therefore not measured.
7. The emission at approximately 6930 MHz is the 4<sup>th</sup> harmonic of the LTE Band 4 signal and was therefore not measured.
8. The emission at approximately 7320 MHz is the 3<sup>rd</sup> harmonic of the GLoWPAN signal and was therefore not measured.
9. The emission at approximately 8657 MHz is the 5<sup>th</sup> harmonic of the LTE Band 4 signal and was therefore not measured.
10. The emission at approximately 10391 MHz is the 6<sup>th</sup> harmonic of the LTE Band 4 signal and was therefore not measured.
11. The emission at approximately 12118 MHz is the 7<sup>th</sup> harmonic of the LTE Band 4 signal and was therefore not measured.
12. The emission at approximately 13865 MHz is the 8<sup>th</sup> harmonic of the LTE Band 4 signal and was therefore not measured.
13. The emission at approximately 15599 MHz is the 9<sup>th</sup> harmonic of the LTE Band 4 signal and was therefore not measured.
14. The emission at approximately 19054 MHz is the 11<sup>th</sup> harmonic of the LTE Band 4 signal and was therefore not measured.
15. The emission at approximately 20782 MHz is the 12<sup>th</sup> harmonic of the LTE Band 4 signal and was therefore not measured.
16. The emission at approximately 24253 MHz is the 14<sup>th</sup> harmonic of the LTE Band 4 signal and was therefore not measured.
17. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz, for measurements below 1 GHz. For measurements above 1 GHz resolution bandwidth was set 1 MHz and video bandwidth 3 MHz, with the sweep time set to auto. Markers were placed on the highest measured level.
18. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0017) 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.
19. Measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) 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.

**Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 4) (continued)**

Transmitter Out of Band Radiated (GLoWPAN & LTE Band 4) (continued)



**4.4. Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 12)****Test Summary:**

<b>Test Engineer:</b>	Andrew Edwards	<b>Test Dates:</b>	25 September 2019 & 26 September 2019
<b>Test Sample Serial Number:</b>	99439337-03-829-00002		

<b>FCC Reference:</b>	Parts 2.1053 / 15.209(a) / 15.247(d) / 27.53(g)
<b>ISED Canada Reference:</b>	RSS-Gen 6.13 / RSS-247 5.5 / RSS-130 4.7
<b>Test Method Used:</b>	ANSI C63.26 section 5.5, KDB971168 Section 6.1 referencing ANSI C63.4 KDB 558074 Sections 8.1 c)3), 8.5 & 8.6 referencing ANSI C63.10 Sections 6.3, 6.5, 6.6, 11.11 & 11.12
<b>Frequency Range:</b>	30 MHz to 25 GHz
<b>Configuration:</b>	GLoWPAN middle channel / LTE Band 12 (QPSK / 3 MHz channel Bandwidth / 1RB offset 0) middle channel

**Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	48 to 49

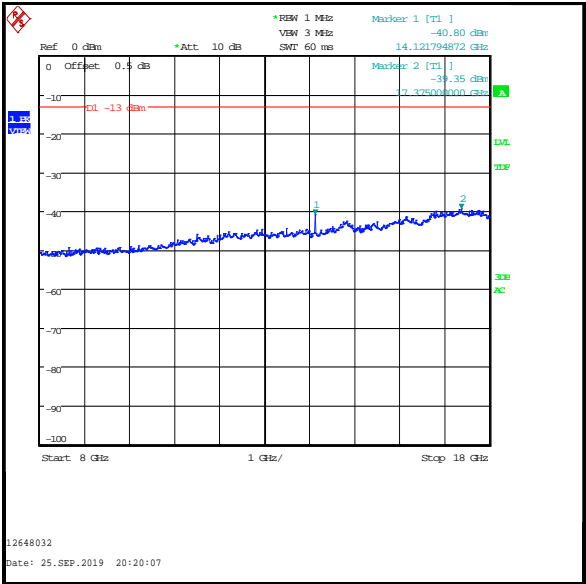
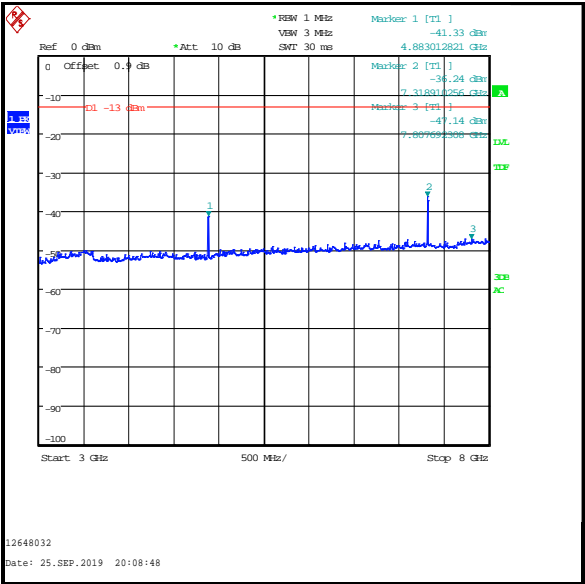
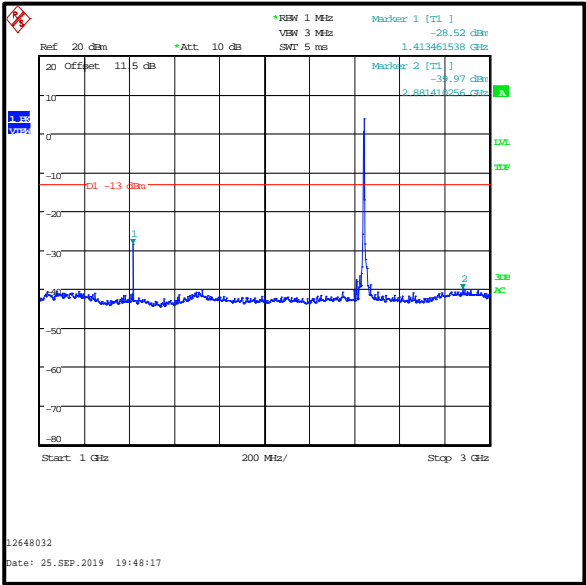
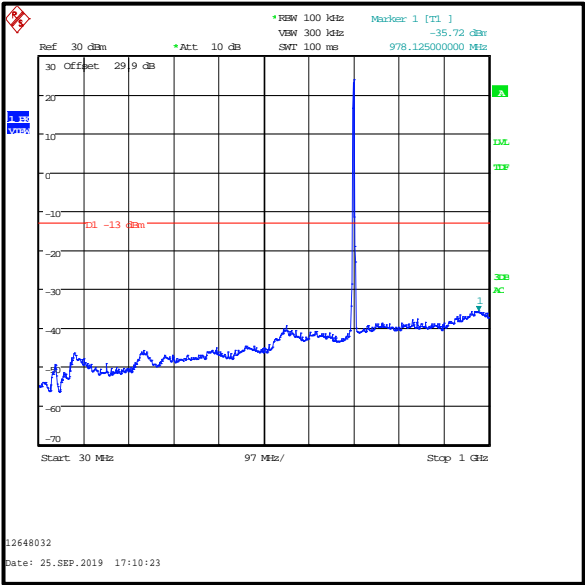
**Results: GLoWPAN middle channel / LTE Band 12 middle channel**

Frequency (MHz)	Antenna Polarity	Emission Level	Applicable Limit	Margin (dB)	Result
See note 1					

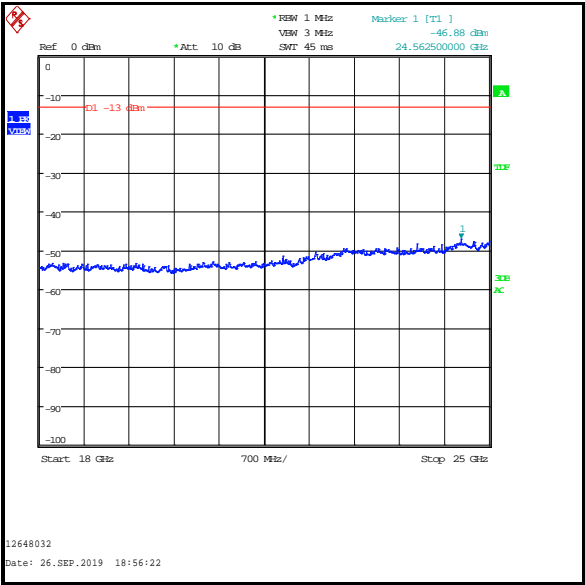
**Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 12) (continued)****Note(s):**

1. All intermodulation products were below the noise floor level or greater than 20 dB from the specification limit.
2. The LTE Band 12 uplink is shown on the 30 MHz to 1 GHz plot.
3. The GLoWPAN fundamental is shown on the 1 GHz to 3 GHz plot.
4. The emission at approximately 1413 MHz is the 2<sup>nd</sup> harmonic of the LTE Band 12 signal and was therefore not measured.
5. The emission at approximately 4880 MHz is the 2<sup>nd</sup> harmonic of the GLoWPAN signal and was therefore not measured.
6. The emission at approximately 7320 MHz is the 3<sup>rd</sup> harmonic of the GLoWPAN signal and was therefore not measured.
7. The emission at approximately 14150 MHz is the 20<sup>th</sup> harmonic of the LTE Band 12 signal and was therefore not measured.
8. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz, for measurements below 1 GHz. For measurements above 1 GHz resolution bandwidth was set 1 MHz and video bandwidth 3 MHz, with the sweep time set to auto. Markers were placed on the highest measured level.
9. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0017) 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.
10. Measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) 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.

Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 12) (continued)



Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 12) (continued)



**4.5. Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 13)****Test Summary:**

<b>Test Engineer:</b>	Andrew Edwards	<b>Test Dates:</b>	24 September 2019, 25 September 2019 & 26 September 2019
<b>Test Sample Serial Number:</b>	99439337-03-829-00002		

<b>FCC Reference:</b>	Parts 2.1053 / 15.209(a) / 15.247(d) / 27.53(c)(2)
<b>ISED Canada Reference:</b>	RSS-Gen 6.13 & 8.9 / RSS-247 5.5 / RSS-130 4.7
<b>Test Method Used:</b>	ANSI C63.26 section 5.5, KDB971168 Section 6.1 referencing ANSI C63.4 KDB 558074 Sections 8.1 c)3), 8.5 & 8.6 referencing ANSI C63.10 Sections 6.3, 6.5, 6.6, 11.11 & 11.12
<b>Frequency Range:</b>	30 MHz to 25 GHz
<b>Configuration:</b>	GLoWPAN middle channel / LTE Band 13 (QPSK / 5 MHz channel Bandwidth / 1RB offset 0) middle channel

**Environmental Conditions:**

<b>Temperature (°C):</b>	23 to 24
<b>Relative Humidity (%):</b>	45 to 49

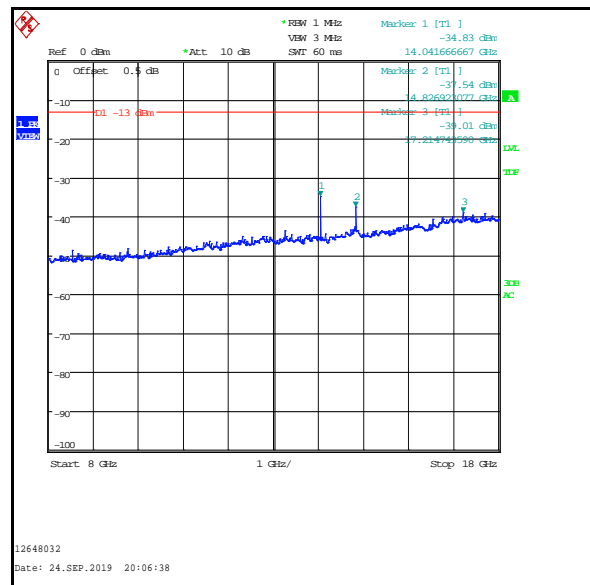
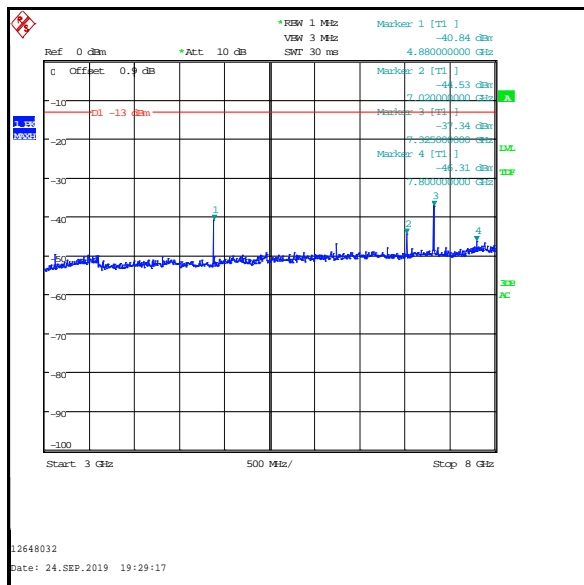
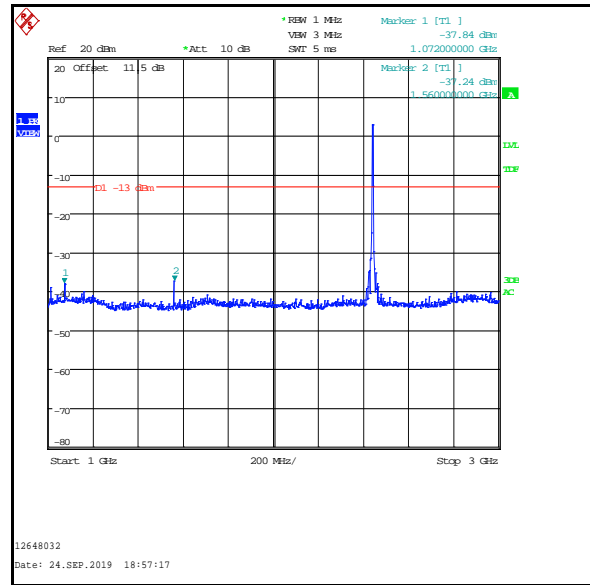
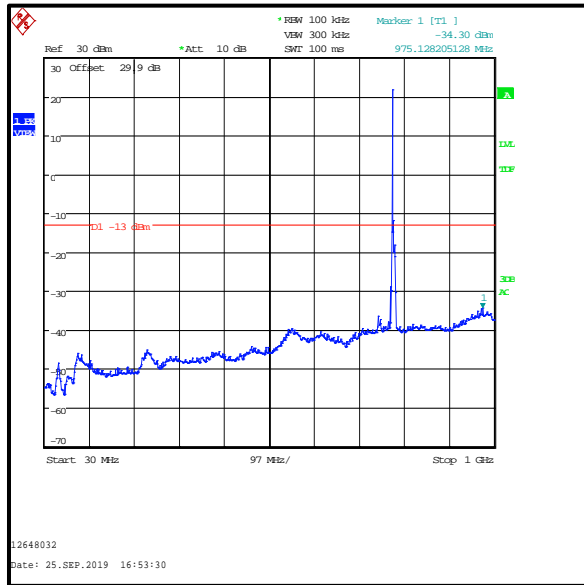
**Results: GLoWPAN middle channel / LTE Band 13 middle channel**

Frequency (MHz)	Antenna Polarity	Emission Level	Applicable Limit	Margin (dB)	Result
See note 1					

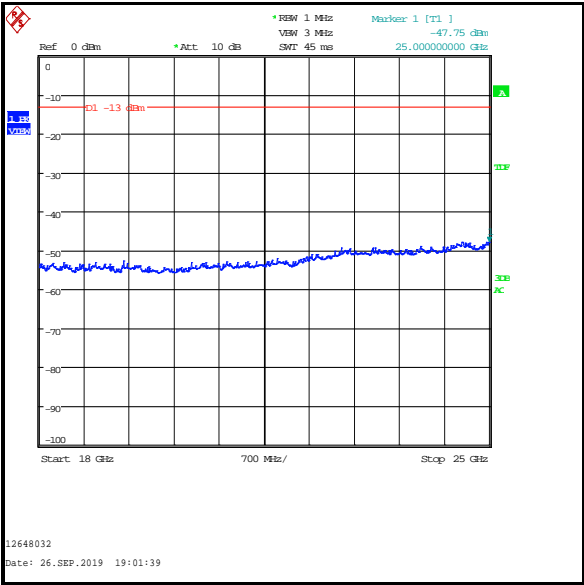


**Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 13) (continued)****Note(s):**

1. All intermodulation products were below the noise floor level or greater than 20 dB from the specification limit.
2. The LTE Band 13 uplink and downlink are shown on the 30 MHz to 1 GHz plot.
3. The GLoWPAN fundamental is shown on the 1 GHz to 3 GHz plot.
4. The emission at approximately 1564 MHz is the 2<sup>nd</sup> harmonic of the LTE Band 13 signal and was therefore not measured.
5. The emission at approximately 4880 MHz is the 2<sup>nd</sup> harmonic of the GLoWPAN signal and was therefore not measured.
6. The emission at approximately 7038 MHz is the 9<sup>th</sup> harmonic of the LTE Band 13 signal and was therefore not measured.
7. The emission at approximately 7320 MHz is the 3<sup>rd</sup> harmonic of the GLoWPAN signal and was therefore not measured.
8. The emission at approximately 14042 MHz is the 18<sup>th</sup> harmonic of the LTE Band 13 signal and was therefore not measured.
9. The emission at approximately 14827 MHz is the 19<sup>th</sup> harmonic of the GLoWPAN signal and was therefore not measured.
10. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz, for measurements below 1 GHz. For measurements above 1 GHz resolution bandwidth was set 1 MHz and video bandwidth 3 MHz, with the sweep time set to auto. Markers were placed on the highest measured level.
11. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0017) 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.
12. Measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) 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.

**Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 13) (continued)**

Transmitter Out of Band Radiated Emissions (GLoWPAN & LTE Band 13) (continued)



--- END OF REPORT ---