

FCC and Industry Canada Testing of the GamesOnTrack A/S, Model: GT-XConnect

In accordance with FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN

Prepared for: GamesOnTrack A/S
Uhresovej 35
Holstebro
dk-750
UNITED KINGDOM

FCC ID: 2AK9NGTX17263X
IC: 22454GTX17263X



Product Service

Choose certainty.
Add value.

COMMERCIAL-IN-CONFIDENCE

Date: October 2017
Document Number: 75937369-01 | Issue 02

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Steven White	12 October 2017	
Authorised Signatory	Matthew Russell	12 October 2017	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15C and Industry Canada RSS-247 and Industry Canada RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Graeme Lawler	12 October 2017	
Testing	Mehadi Choudhury	12 October 2017	

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

Industry Canada Accreditation
IC2932B-1 Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15C: 2016, Industry Canada RSS-247: Issue 2 (2017-02) and Industry Canada RSS-GEN: Issue 4 (2014-11).



DISCLAIMER AND COPYRIGHT

This non-binding report has been prepared by TÜV SÜD Product Service with all reasonable skill and care. The document is confidential to the potential Client and TÜV SÜD Product Service. No part of this document may be reproduced without the prior written approval of TÜV SÜD Product Service. © 2017 TÜV SÜD Product Service.

ACCREDITATION

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation. Results of tests not covered by our UKAS Accreditation Schedule are marked NUA (Not UKAS Accredited).

TÜV SÜD Product Service
is a trading name of TÜV SÜD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TÜV SÜD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuv-sud.co.uk

TÜV SÜD Product Service
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom



Contents

1	Report Summary	2
1.1	Report Modification Record.....	2
1.2	Introduction.....	2
1.3	Brief Summary of Results	3
1.4	Application Form	5
1.5	Product Information	7
1.6	Deviations from the Standard.....	7
1.7	EUT Modification Record	7
1.8	Test Location.....	7
2	Test Details	9
2.1	AC Power Line Conducted Emissions	9
2.2	Maximum Conducted Output Power	13
2.3	Frequency Hopping Systems - Average Time of Occupancy	19
2.4	Frequency Hopping Systems - Channel Separation.....	22
2.5	Frequency Hopping Systems - Number of Hopping Channels	25
2.6	Frequency Hopping Systems - 20 dB Bandwidth	28
2.7	Authorised Band Edges	32
2.8	Restricted Band Edges	36
2.9	Spurious Radiated Emissions	41
3	Measurement Uncertainty	49

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	03 October 2017
2	Conducted power measurements added, to cover operation without booster	12 October 2017

Table 1

1.2 Introduction

Applicant	GamesOnTrack A/S
Manufacturer	GamesOnTrack A/S
Model Number(s)	GT-XConnect
Serial Number(s)	Not serialised (75937369-TSR0018)
Brand Name (s)	GT-XConnect and Faller Car System Digital Master
Hardware Version(s)	REV B date 2013-12-17
Software Version(s)	2.1.31
Number of Samples Tested	1
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2016 Industry Canada RSS-247: Issue 2 (2017-02) Industry Canada RSS-GEN Issue 4 (2014-11)
Order Number	PO is not numbered
Date	28-November-2016
Date of Receipt of EUT	15-June-2017
Start of Test	06-September-2017
Finish of Test	11-October-2017
Name of Engineer(s)	Graeme Lawler and Mehadi Choudhury
Related Document(s)	ANSI C63.10 (2013)

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN is shown below.

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	FCC Part 15C	RSS-247	RSS-GEN			
Configuration and Mode: GT-X Connect + Booster - Transmit with Modulation						
2.1	15.207	-	8.8	AC Power Line Conducted Emissions	Pass	ANSI C63.10 (2013)
2.2	15.247 (b)	5.4	6.12	Maximum Conducted Output Power*	Pass	ANSI C63.10 (2013)
2.3	15.247 (a)(1)	5.1	-	Frequency Hopping Systems - Average Time of Occupancy	Pass	ANSI C63.10 (2013)
2.4	15.247 (a)(1)	5.1	-	Frequency Hopping Systems - Channel Separation	Pass	ANSI C63.10 (2013)
2.5	15.247 (a)(1)(iii)	5.1	-	Frequency Hopping Systems - Number of Hopping Channels	Pass	ANSI C63.10 (2013)
2.6	15.247 (a)(1)	5.1	-	Frequency Hopping Systems - 20 dB Bandwidth	Pass	ANSI C63.10 (2013)
2.7	15.247 (d)	5.5	-	Authorised Band Edges	Pass	ANSI C63.10 (2013)
2.8	15.205	-	8.10	Restricted Band Edges	Pass	ANSI C63.10 (2013)
2.9	15.247 (d) and 15.205	5.5	6.13	Spurious Radiated Emissions	Pass	ANSI C63.10 (2013)

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	FCC Part 15	RSS-247	RSS-GEN			
Configuration and Mode: GT-X Connect Standalone - Transmit with Modulation						
2.2	15.247 (b)	5.4	6.12	Maximum Conducted Output Power*	Pass	ANSI C63.10 (2013)

Table 2

*Maximum conducted output power tests were performed on the GT-Xconnect with the booster fitted and standalone, all other testing was performed with the booster fitted as this provides maximum power.



1.4 Application Form

EQUIPMENT DESCRIPTION									
Model Name/Number		GT-Xconnect							
Part Number		1302630 / 161355							
Hardware Version		REV B date 2014-12-17							
Software Version		2.1.31							
FCC ID (if applicable)				2AK9NGTX17263X					
Industry Canada ID (if applicable)				22454GTX17263X					
Technical Description (Please provide a brief description of the intended use of the equipment)				The GT-Xconnect runs our indoor position- and controlsystem for model trains, robots, modelcars, drones, etc.					

INTENTIONAL RADIATORS									
Technology	Frequency Band (MHz)	Conducted Declared Output Power (dBm)	Antenna Gain (dBi)	Supported Bandwidth (s) (MHz)	Modulation Scheme(s)	ITU Emission Designator	Test Channels (MHz)		
							Bottom	Middle	Top
FSK	915MHz	+24dBm	+2dBi	500kHz	FHSS		903,42	915,20	926,58

UN-INTENTIONAL RADIATOR	
Highest frequency generated or used in the device or on which the device operates or tunes	

EXTREME CONDITIONS			
Maximum temperature	40	°C	Minimum temperature
			10 °C

Ancillaries
Please list all ancillaries which will be used with the device.



Product Service

ANTENNA CHARACTERISTICS				
<input checked="" type="checkbox"/>	Antenna connector	State impedance	50	Ohm
<input type="checkbox"/>	Temporary antenna connector	State impedance		Ohm
<input type="checkbox"/>	Integral antenna	Type		
<input checked="" type="checkbox"/>	External antenna	Type	1/4 wave Dipole	

I hereby declare that the information supplied is correct and complete.

Name: Niels Bo Theilgaard
Position held: CEO Date: 23-02-2017

1.5 Product Information

1.5.1 Technical Description

The GT-Xconnect runs our indoor position- and control system for model trains, robots, model cars, drones, etc.

1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Serial Number: Serial Number: Not serialised (75937369-TSR0018)			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 3

1.8 Test Location

TÜV SÜD Product Service conducted the following tests at our Fareham Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: GT-X Connect + Booster - Transmit with Modulation		
AC Power Line Conducted Emissions	Graeme Lawler	UKAS
Maximum Conducted Output Power	Mehadi Choudhury	UKAS
Frequency Hopping Systems - Average Time of Occupancy	Mehadi Choudhury	UKAS
Frequency Hopping Systems - Channel Separation	Mehadi Choudhury	UKAS
Frequency Hopping Systems - Number of Hopping Channels	Mehadi Choudhury	UKAS
Frequency Hopping Systems - 20 dB Bandwidth	Mehadi Choudhury	UKAS
Authorised Band Edges	Graeme Lawler	UKAS
Restricted Band Edges	Graeme Lawler	UKAS
Spurious Radiated Emissions	Graeme Lawler	UKAS
Configuration and Mode: GT-X Connect Standalone - Transmit with Modulation		
Maximum Conducted Output Power	Mehadi Choudhury	UKAS

Table 4



Product Service

Office Address:

Octagon House
Concorde Way
Segensworth North
Fareham
Hampshire
PO15 5RL
United Kingdom

2 Test Details

2.1 AC Power Line Conducted Emissions

2.1.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.207
Industry Canada RSS-GEN, Clause 8.8

2.1.2 Equipment Under Test and Modification State

GT-Xconnect, S/N: Not serialised (75937369-TSR0018) - Modification State 0

2.1.3 Date of Test

11-September-2017

2.1.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.2.

2.1.5 Environmental Conditions

Ambient Temperature 19.0 °C
Relative Humidity 56.0 %

2.1.6 Test Results

GT-X Connect + Booster - Transmit with Modulation

Applied supply Voltage: 60 Hz
Applied supply frequency: 120 Vac

Frequency (MHz)	QP Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Level (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
1.158	44.8	56.0	-11.2	41.4	46.0	-4.6
2.256	43.6	56.0	-12.4	39.2	46.0	-6.8
3.361	41.7	56.0	-14.3	33.7	46.0	-12.3
3.975	37.2	56.0	-18.8	29.4	46.0	-16.6
4.450	40.7	56.0	-15.3	33.4	46.0	-12.6
5.038	46.1	60.0	-13.9	40.1	50.0	-9.9
6.216	52.9	60.0	-7.1	42.1	50.0	-7.9
6.567	53.1	60.0	-6.9	44.6	50.0	-5.4
6.922	52.1	60.0	-7.9	47.4	50.0	-2.6
7.157	54.5	60.0	-5.5	49.8	50.0	-0.2
7.509	53.4	60.0	-6.6	48.4	50.0	-1.6
7.627	53.2	60.0	-6.8	48.8	50.0	-1.2

Table 5 - Neutral Line Emissions Results

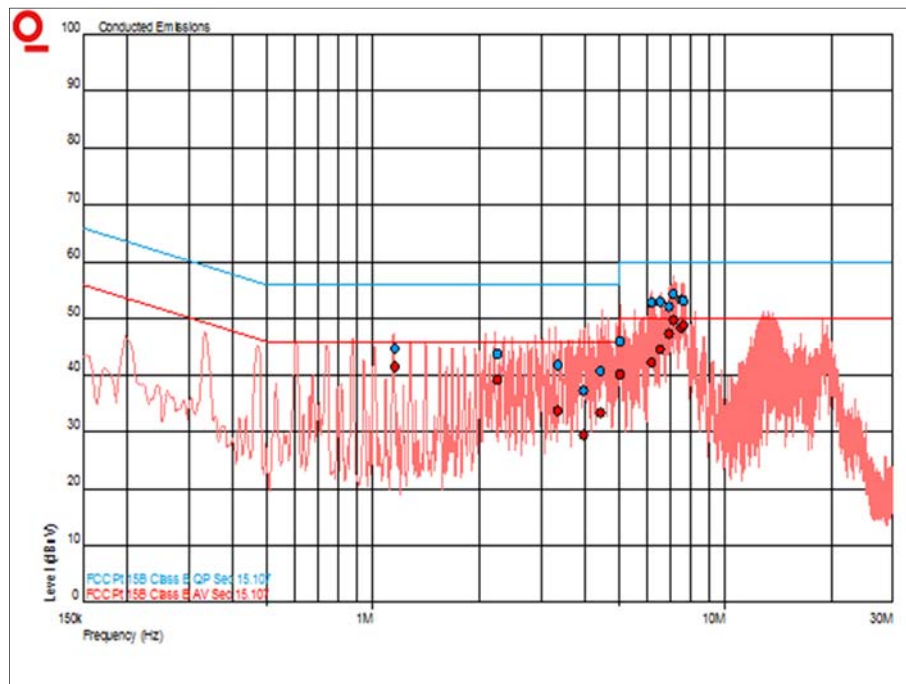


Figure 1 - Neutral Line - 150 kHz to 30 MHz

Frequency (MHz)	QP Level (dBuV)	QP Limit (dBuV)	QP Margin (dBuV)	AV Level (dBuV)	AV Limit (dBuV)	AV Margin (dBuV)
0.757	45.2	56.0	-10.8	42.1	46.0	-3.9
1.036	45.3	56.0	-10.7	42.6	46.0	-3.4
1.450	44.5	56.0	-11.5	41.5	46.0	-4.5
3.168	45.8	56.0	-10.2	40.3	46.0	-5.7
3.639	45.9	56.0	-10.1	39.7	46.0	-6.3
3.990	48.2	56.0	-7.8	41.7	46.0	-4.3
4.340	48.2	56.0	-7.8	40.7	46.0	-5.3
4.342	47.8	56.0	-8.2	40.7	46.0	-5.3
4.694	49.3	56.0	-6.7	41.6	46.0	-4.4
5.046	47.3	60.0	-12.7	39.3	50.0	-10.7
6.007	47.5	60.0	-12.5	37.9	50.0	-12.1
6.215	56.6	60.0	-3.4	41.9	50.0	-8.1
6.636	52.6	60.0	-7.4	46.7	50.0	-3.3
6.992	54.7	60.0	-5.3	49.6	50.0	-0.4
7.107	54.8	60.0	-5.2	49.5	50.0	-0.5
13.002	41.2	60.0	-18.8	24.4	50.0	-25.6

Table 6 - Live Line Emissions Results

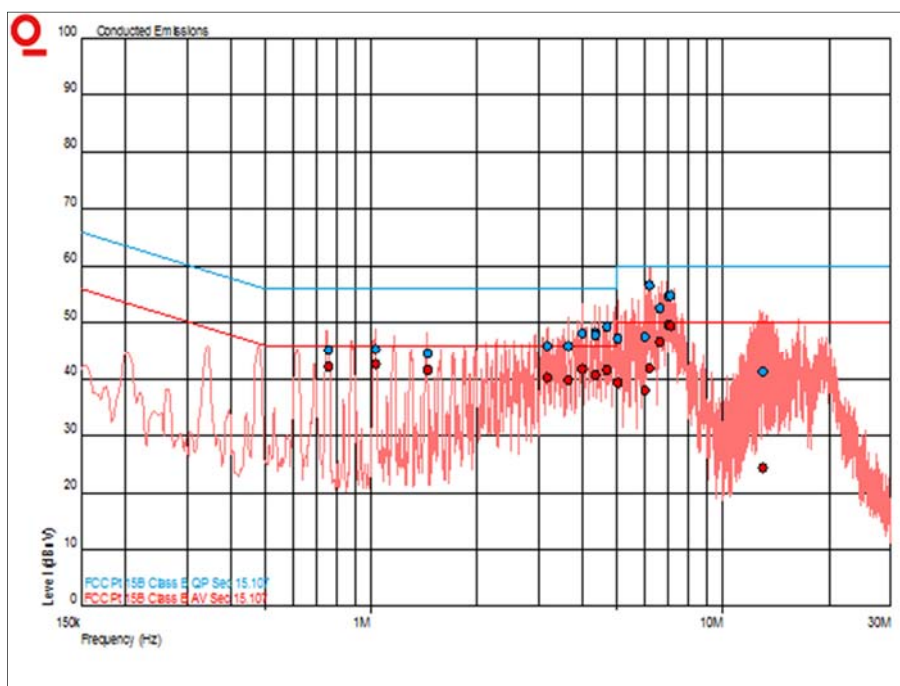


Figure 2 - Live Line - 150 kHz to 30 MHz

FCC 47 CFR Part 15, Limit Clause 15.207 and Industry Canada RSS-GEN, Limit Clause 8.8

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-Peak	Average
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

Table 7

*Decreases with the logarithm of the frequency.



2.1.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Transient Limiter	Hewlett Packard	11947A	15	12	30-May-2018
LISN (1 Phase)	Chase	MN 2050	336	12	07-Apr-2018
Screened Room (5)	Rainford	Rainford	1545	36	20-Dec-2017
Multimeter	Iso-tech	IDM 101	2118	12	07-Feb-2018
Hygrometer	Rotronic	A1	2138	12	02-Feb-2018
Transient Limiter	Hewlett Packard	11947A	2378	12	06-Jul-2017
Multimeter	Iso-tech	IDM101	2417	12	30-Sep-2017
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	12-Nov-2017
Hygrometer	Rotronic	HP21	4741	12	22-Aug-2018

Table 8

2.2 Maximum Conducted Output Power

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (b)
Industry Canada RSS-247, Clause 5.4
Industry Canada RSS-GEN, Clause 6.12

2.2.2 Equipment Under Test and Modification State

GT-Xconnect, S/N: Not serialised (75937369-TSR0018) - Modification State 0

2.2.3 Date of Test

06-September-2017 and 11 October 2017

2.2.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 7.8.5.

2.2.5 Environmental Conditions

Ambient Temperature 22.7 °C
Relative Humidity 22.8 %

2.2.6 Test Results

GT-X Connect + Booster - Transmit with Modulation

Frequency (MHz)	Maximum Output Power	
	dBm	mW
903.42	19.46	88.39
915.20	19.85	96.61
926.58	19.99	99.82

Table 9 - Maximum Conducted Output Power Results

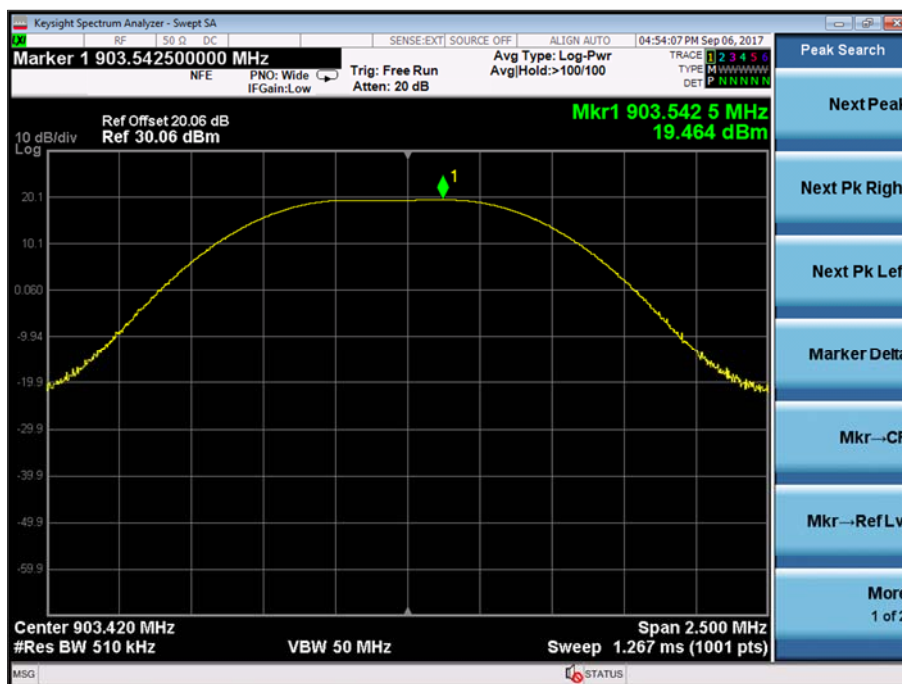


Figure 3 - 903.42 MHz - Maximum Output Power

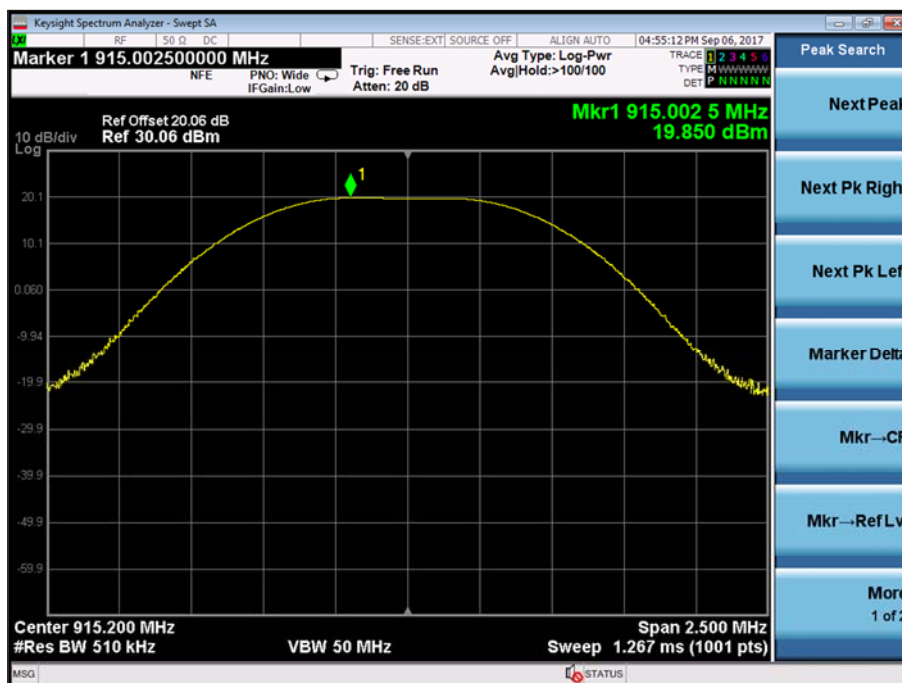


Figure 4 - 915.20 MHz - Maximum Output Power

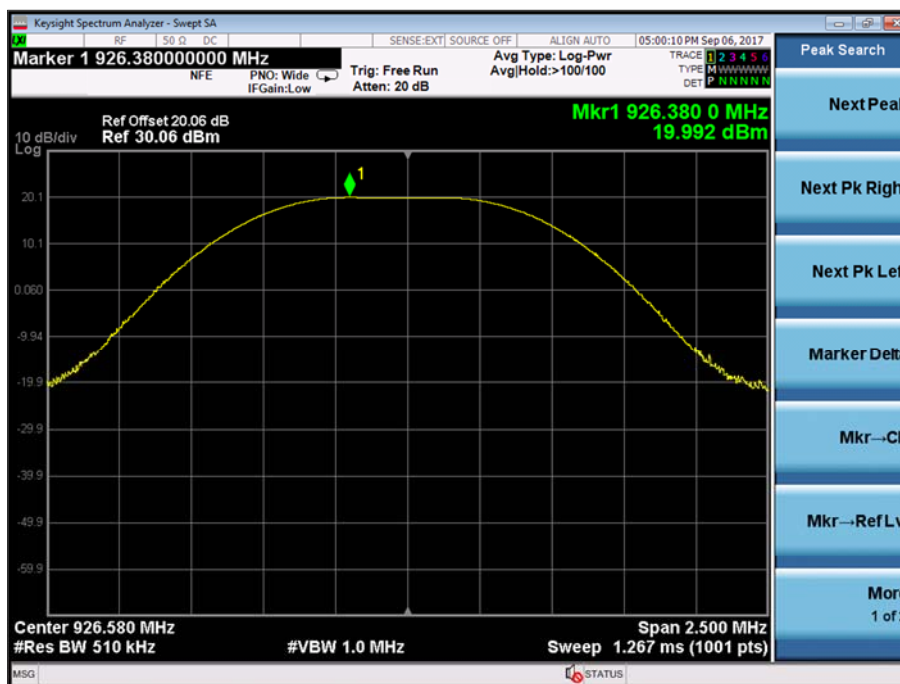


Figure 5 - 926.58 MHz - Maximum Output Power

FCC 47 CFR Part 15, Limit Clause 15.247 (b)(2)

For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels.

Industry Canada RSS-247, Limit Clause 5.4 (a)

For FHSS operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.



GT-X Connect Standalone - Transmit with Modulation

Frequency (MHz)	Maximum Output Power	
	dBm	mW
903.42	-2.94	0.51
915.20	-2.91	0.51
926.58	-2.50	0.56

Table 10 - Maximum Conducted Output Power Results

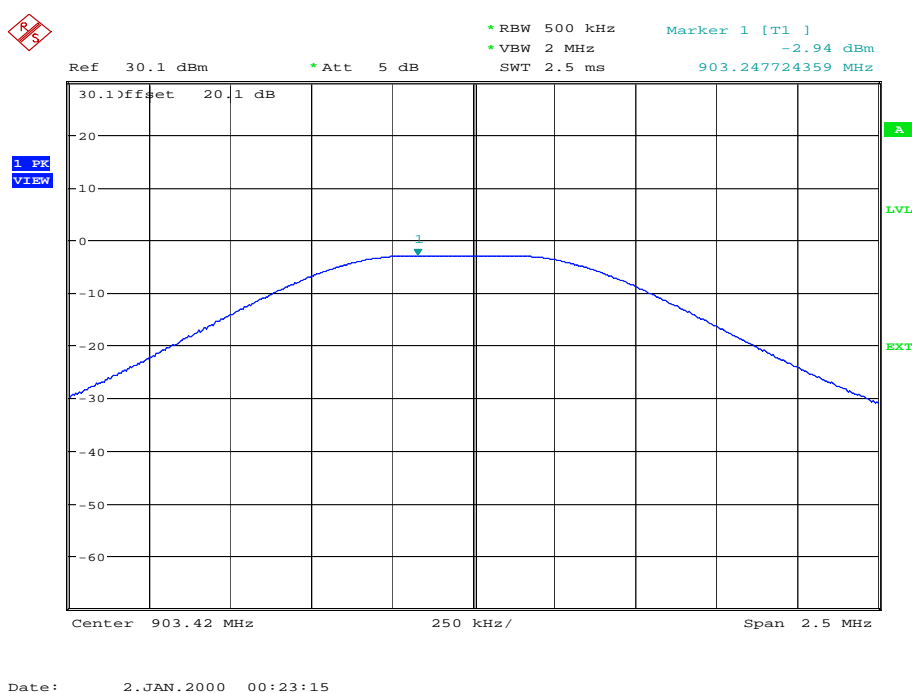


Figure 6 - 903.42 MHz - Maximum Output Power



Product Service

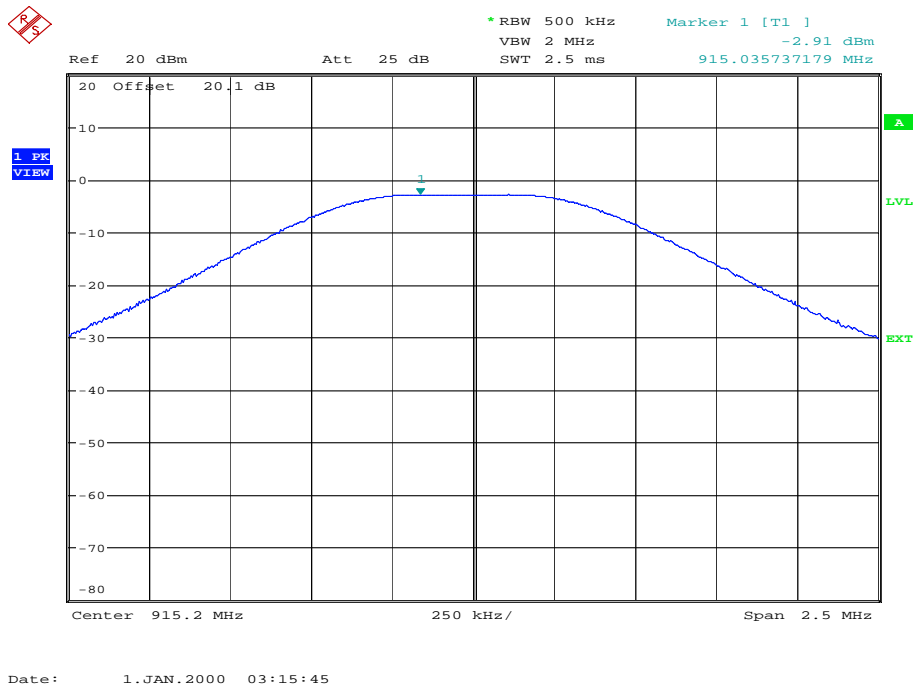


Figure 7 - 915.20 MHz - Maximum Output Power

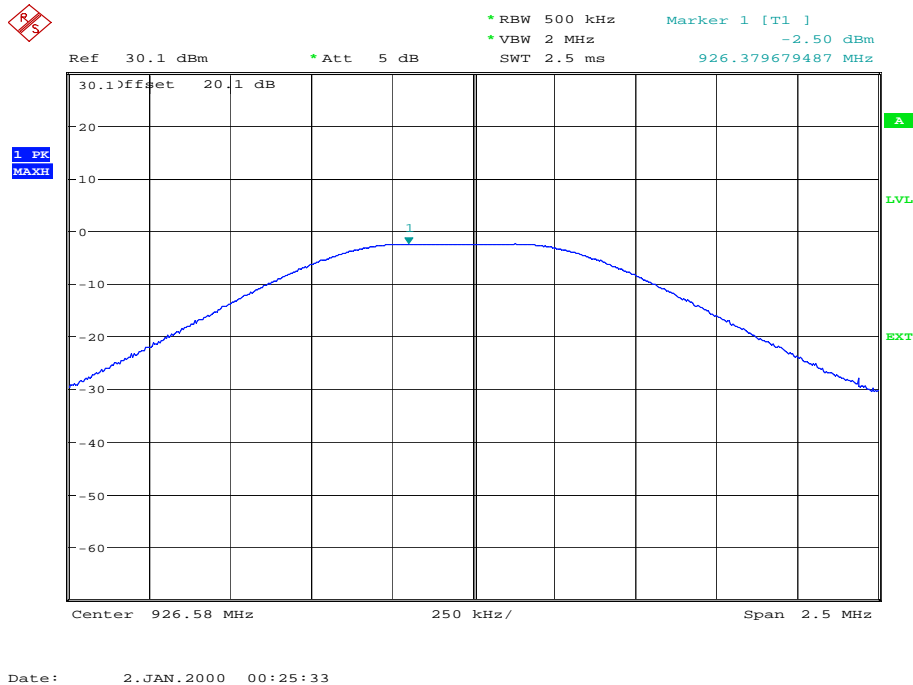


Figure 8 - 926.58 MHz - Maximum Output Power

FCC 47 CFR Part 15, Limit Clause 15.247 (b)(2)

For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels.

Industry Canada RSS-247, Limit Clause 5.4 (a)

For FHSS operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Attenuator (10dB, 1W)	Sealectro	60-674-1010-89	1224	12	30-Jun-2018
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	02 Feb 2018
Attenuator	Pasternack	PE7004-20	2943	12	04 April 2018
Hygrometer	Rotronic	I-1000	3220	12	30 Aug 2018
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	02 Oct 2018
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	19 Sept 2018
Frequency Standard	Spectracom	Secure Sync 1200-0408-0601	4393	6	12 Mar 2018
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	12-Jan-2018

Table 11



2.3 Frequency Hopping Systems - Average Time of Occupancy

2.3.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
Industry Canada RSS-247, Clause 5.1

2.3.2 Equipment Under Test and Modification State

GT-Xconnect, S/N: Not serialised (75937369-TSR0018) - Modification State 0

2.3.3 Date of Test

28-September-2017

2.3.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.4.

2.3.5 Environmental Conditions

Ambient Temperature 22.1 °C
Relative Humidity 63.5 %

2.3.6 Test Results

GT-X Connect + Booster - Transmit with Modulation

Dwell Time (ms)	Number of Transmissions	Average Occupancy Time (ms)
9.56	5	47.80

Table 12

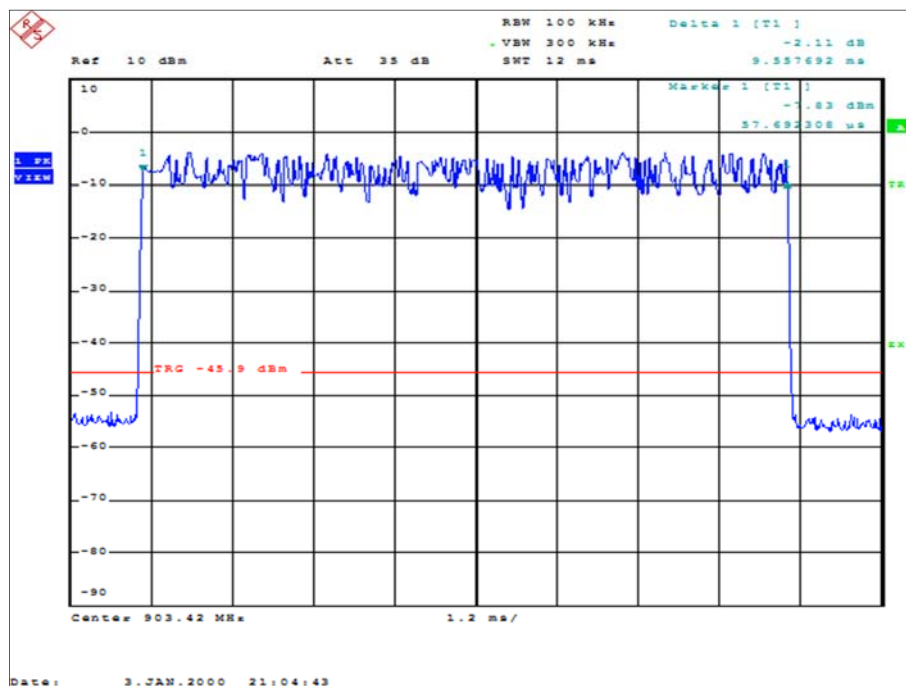


Figure 9 - Dwell Time

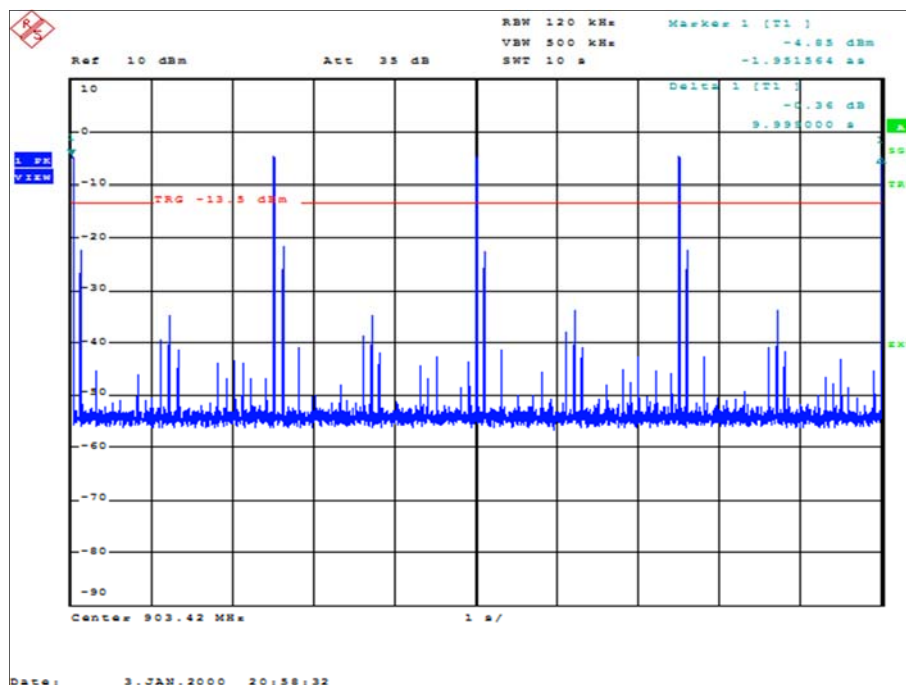


Figure 10 - Total Average Time of Occupancy

FCC 47 CFR Part 15, Limit Clause (a)(1)(i)

For frequency hopping systems operating in the 902–928 MHz band: 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; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Industry Canada RSS-247, Limit Clause 5.1 (c)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period.

2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
10dB/1W SMA Attenuator dc -18GHz	Sealectro	60-674-1010-89	3	12	30-Jun-2018
Spectrum Analyser	Rohde & Schwarz	FSU26	2747	12	02-Feb-2018
Hygrometer	Rotronic	I-1000	3220	12	30-Aug-2018
Frequency Standard	Spectracom	Secure Sync 1200-0408-0601	4393	6	12-Mar-2018
2 metre SMA Cable	IW Microwave	3PS-1806LC-788-3PS	4829	12	24-Jan-2018
1 metre K type Cable	IW Microwave	KPS-1501LC-394-KPS-R	꺆꺆 꺆꺆 꺆꺆	12	24-Jan-2018

Table 13



2.4 Frequency Hopping Systems - Channel Separation

2.4.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
Industry Canada RSS-247, Clause 5.1

2.4.2 Equipment Under Test and Modification State

GT-Xconnect, S/N: Not serialised (75937369-TSR0018) - Modification State 0

2.4.3 Date of Test

07-September-2017

2.4.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.2.

2.4.5 Environmental Conditions

Ambient Temperature 21.9 °C
Relative Humidity 55.4 %

2.4.6 Test Results

GT-X Connect + Booster - Transmit with Modulation

Channel Separation (MHz)
0.42

Table 14



Figure 11

FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)

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; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Industry Canada RSS-247, Limit Clause 5.1 (c)

For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

2.4.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
10dB/1W SMA Attenuator dc -18GHz	Sealectro	60-674-1010-89	3	12	30-Jun-2018
Attenuator (10dB, 1W)	Sealectro	60-674-1010-89	1224	12	30-Jun-2018
Hygrometer	Rotronic	I-1000	3220	12	30-Aug-2018
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	15-Sep-2017
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	08-Sep-2017
Frequency Standard	Spectracom	Secure Sync 1200-0408-0601	4393	6	09-Sep-2017
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	12-Jan-2018
2 metre SMA Cable	IW Microwave	3PS-1806LC-788-3PS	4829	12	24-Jan-2018

Table 15

2.5 Frequency Hopping Systems - Number of Hopping Channels

2.5.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)(iii)
Industry Canada RSS-247, Clause 5.1

2.5.2 Equipment Under Test and Modification State

GT-Xconnect, S/N: Not serialised (75937369-TSR0018) - Modification State 0

2.5.3 Date of Test

07-September-2017

2.5.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.3.

The EUT supports two hopset sequences, which are identical except for the channels used within the hopset pattern, therefore this test was repeated for both hopset sequences. The manufacturer identified these two hopset sequences as FCC1 and FCC2 to the test laboratory.

2.5.5 Environmental Conditions

Ambient Temperature 21.9 °C
Relative Humidity 55.4 %

2.5.6 Test Results

GT-X Connect + Booster - Transmit with Modulation

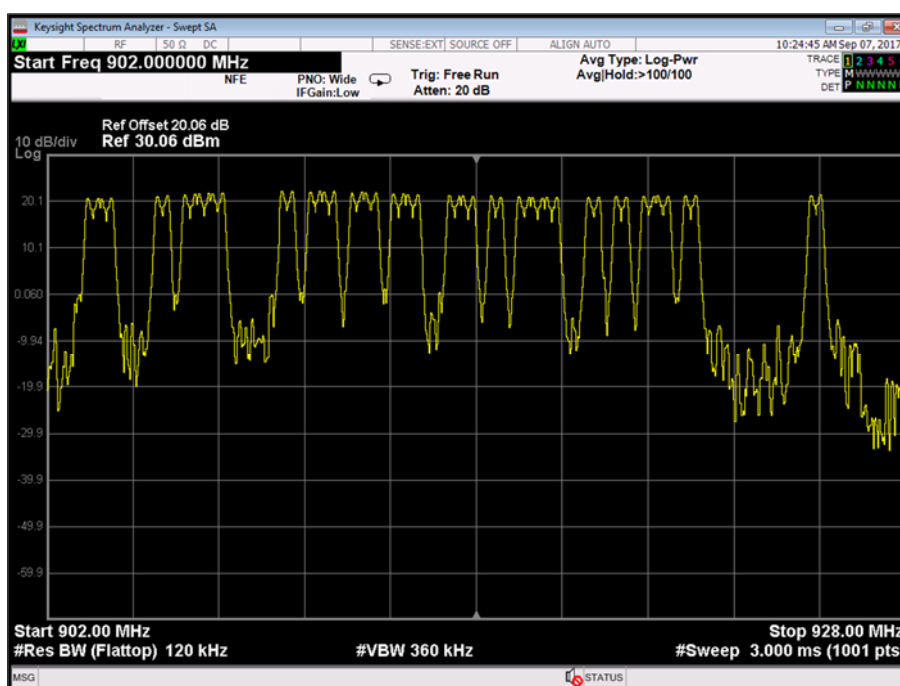


Figure 12 - Measurement Frequency Range: 902 MHz to 928 MHz - FCC1

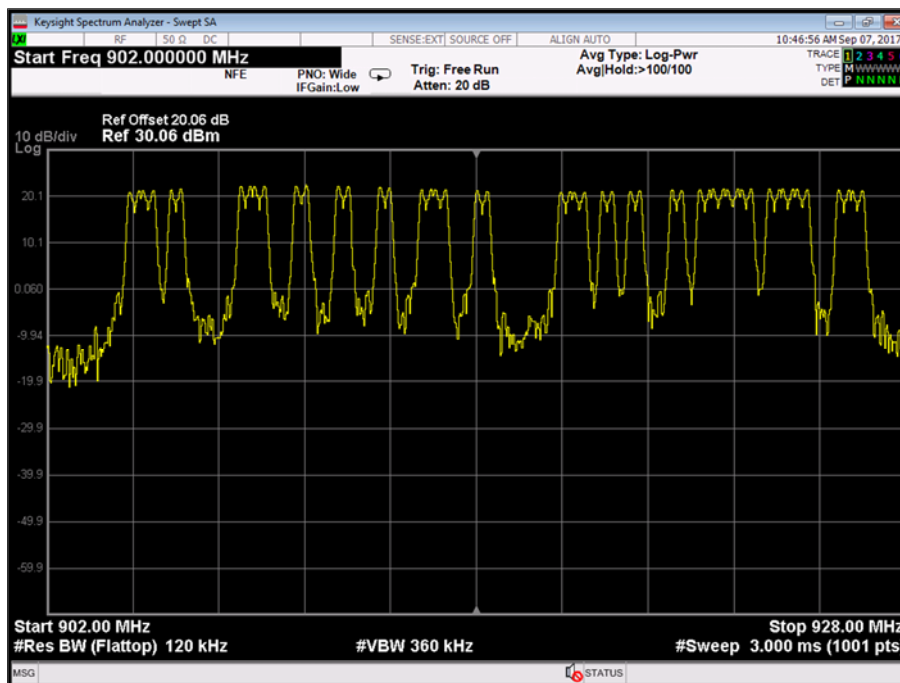


Figure 13 - Measurement Frequency Range: 902 MHz to 928 MHz - FCC2

Number of Hopping Channels: 25

FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)(i) and Industry Canada RSS-247, Limit Clause 5.1 (3)

If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.

If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies.

2.5.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
10dB/1W SMA Attenuator dc -18GHz	Sealectro	60-674-1010-89	3	12	30-Jun-2018
Attenuator (10dB, 1W)	Sealectro	60-674-1010-89	1224	12	30-Jun-2018
Hygrometer	Rotronic	I-1000	3220	12	30-Aug-2018
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	15-Sep-2017
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	08-Sep-2017
Frequency Standard	Spectracom	Secure Sync 1200-0408-0601	4393	6	09-Sep-2017
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	12-Jan-2018
2 metre SMA Cable	IW Microwave	3PS-1806LC-788-3PS	4829	12	24-Jan-2018

Table 16



2.6 Frequency Hopping Systems - 20 dB Bandwidth

2.6.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
Industry Canada RSS-247, Clause 5.1

2.6.2 Equipment Under Test and Modification State

GT-Xconnect, S/N: Not serialised (75937369-TSR0018) - Modification State 0

2.6.3 Date of Test

06-September-2017

2.6.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.9.1.

2.6.5 Environmental Conditions

Ambient Temperature 22.7 °C
Relative Humidity 42.8 %

2.6.6 Test Results

Transmit with Modulation

20 dB Bandwidth (kHz)		
903.42 MHz	915.20 MHz	926.58 MHz
443.92	441.58	444.71

Table 17 – 20 dB Bandwidth Results



Product Service

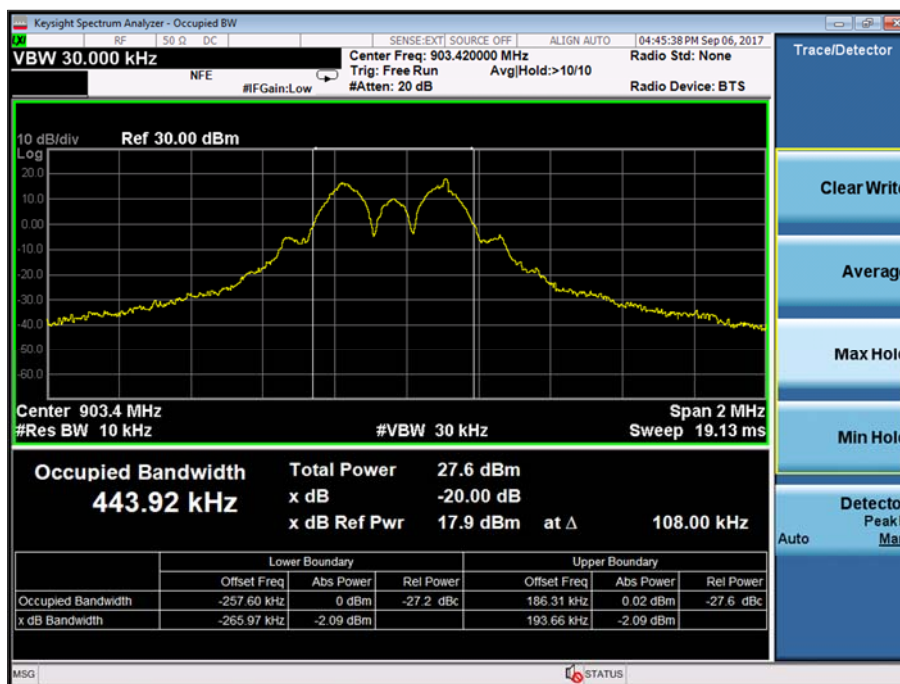


Figure 14 - 903.42 MHz

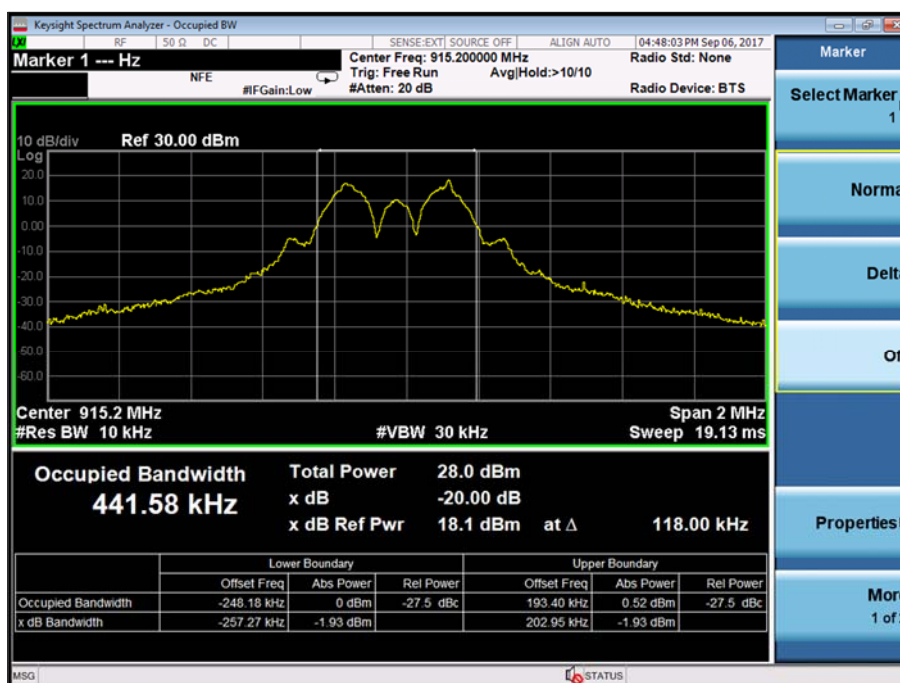


Figure 15 - 915.20 MHz



Product Service

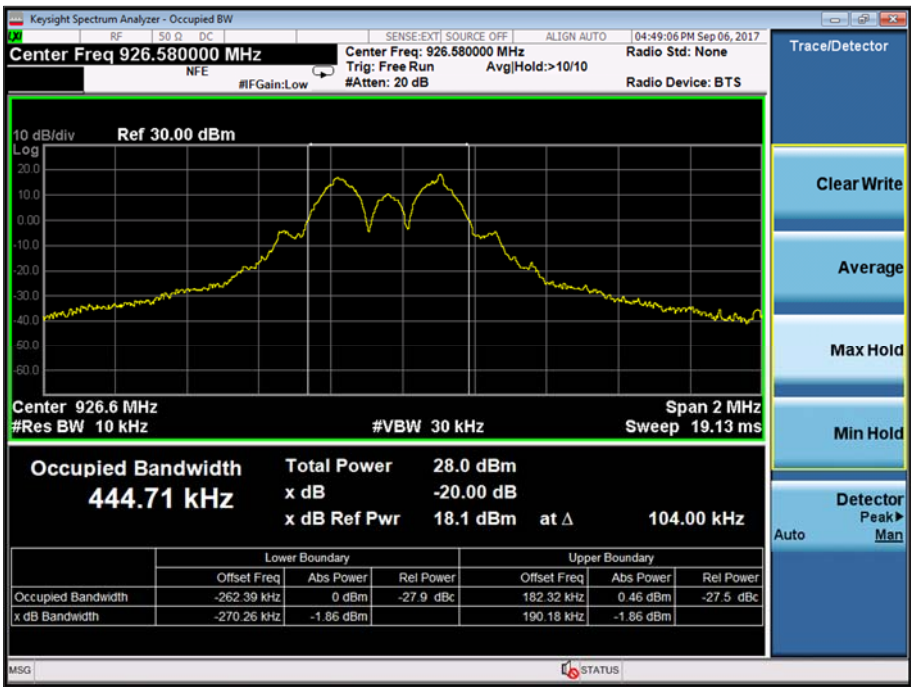


Figure 16 - 926.58 MHz

FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)(i) and Industry Canada RSS-247, Limit Clause 5.1 (3)

The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
10dB/1W SMA Attenuator dc -18GHz	Sealectro	60-674-1010-89	3	12	30-Jun-2018
Attenuator (10dB, 1W)	Sealectro	60-674-1010-89	1224	12	30-Jun-2018
Hygrometer	Rotronic	I-1000	3220	12	23-Aug-2017
Hygrometer	Rotronic	I-1000	3220	12	30-Aug-2018
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	15-Sep-2017
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	08-Sep-2017
Frequency Standard	Spectracom	Secure Sync 1200-0408-0601	4393	6	12-Mar-2018
EMI Receiver	Keysight Technologies	N9038A MXE	4629	12	06-Sep-2017
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	12-Jan-2018
2 metre SMA Cable	IW Microwave	3PS-1806LC-788-3PS	4829	12	24-Jan-2018
1 metre K type Cable	IW Microwave	KPS-1501LC-394-KPS-R	4830	12	24-Jan-2018

Table 18



2.7 Authorised Band Edges

2.7.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (d)
Industry Canada RSS-247, Clause 5.5

2.7.2 Equipment Under Test and Modification State

GT-Xconnect, S/N: Not serialised (75937369-TSR0018) - Modification State 0

2.7.3 Date of Test

06-September-2017

2.7.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.10.4.

2.7.5 Environmental Conditions

Ambient Temperature 20.8 °C
Relative Humidity 46.0 %

2.7.6 Test Results

GT-X Connect + Booster - Transmit with Modulation

Mode	Frequency (MHz)	Measured Frequency (MHz)	Peak Level (dBμV/m)
Static	903.42	902.0	49.14
Static	926.58	928.0	37.81
Hopping	N/A	902.0	53.62
Hopping	N/A	928.0	38.71

Table 19



Product Service

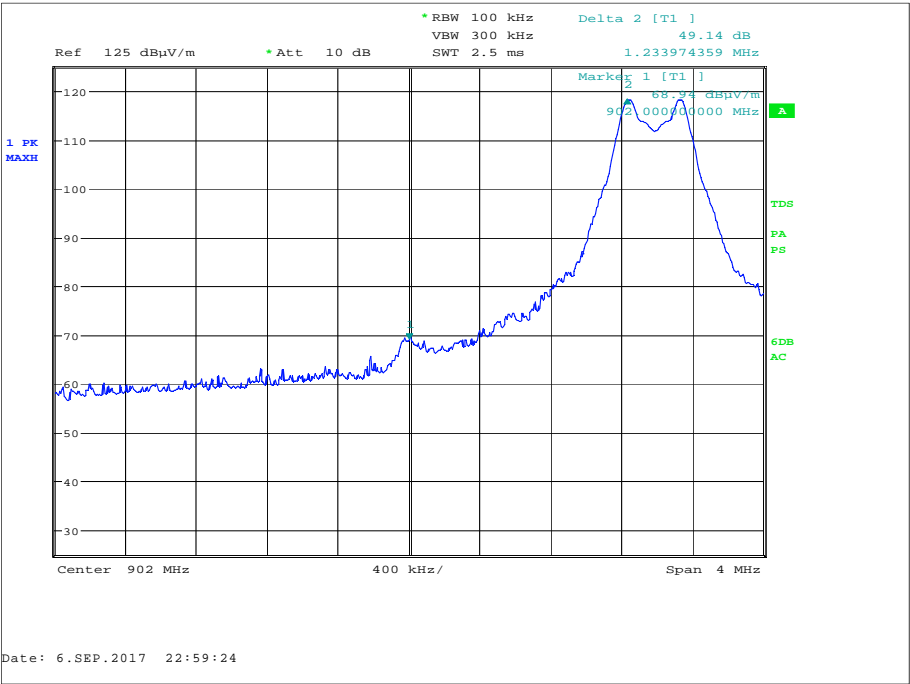


Figure 17 - Static - 903.42 MHz - Measured Frequency 902 MHz

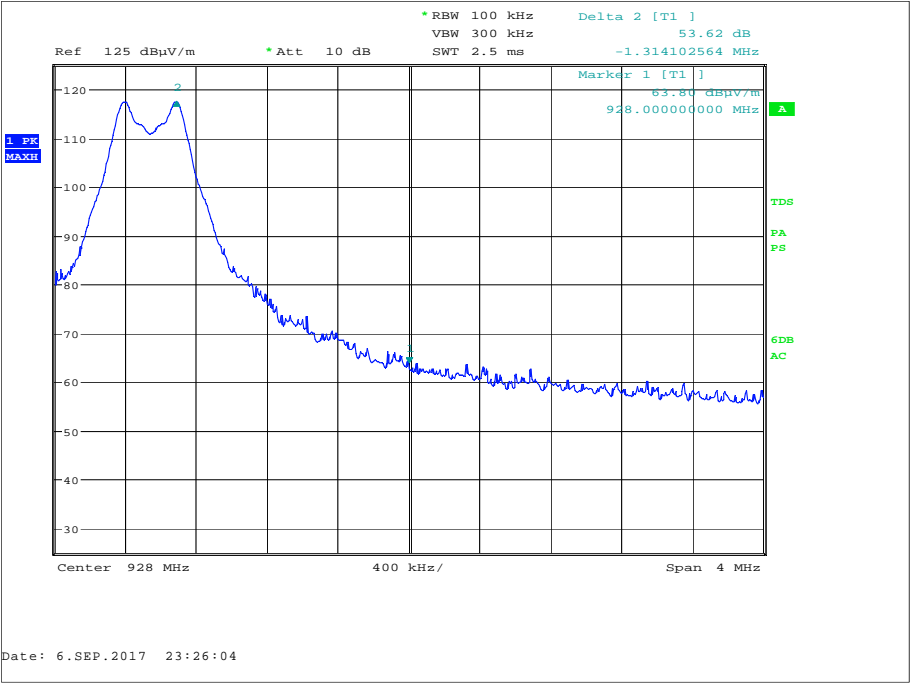


Figure 18 - Static - 926.58 MHz - Measured Frequency 928 MHz

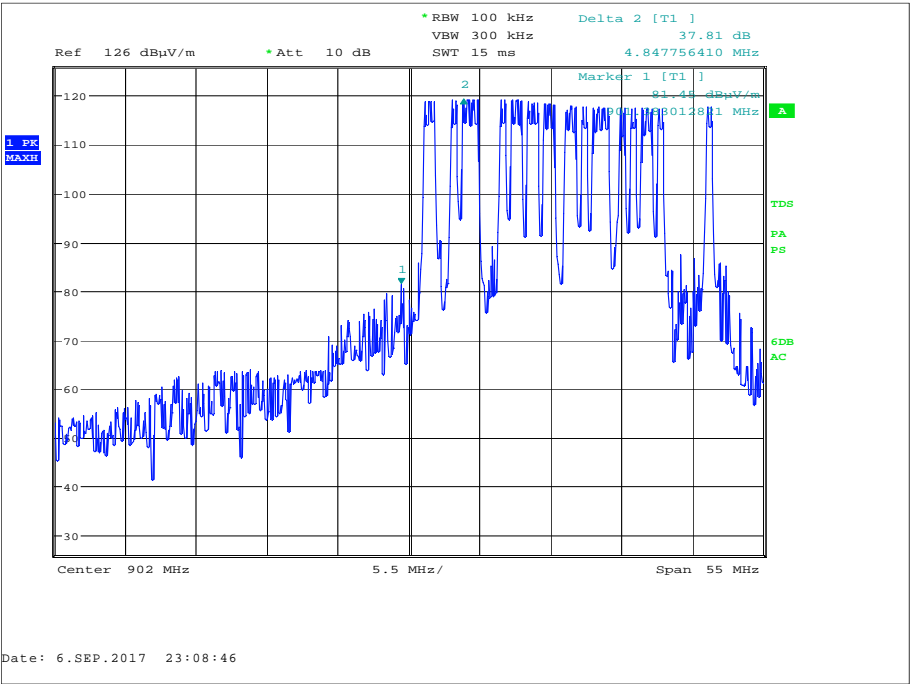


Figure 19 - Hopping - Measured Frequency 902 MHz

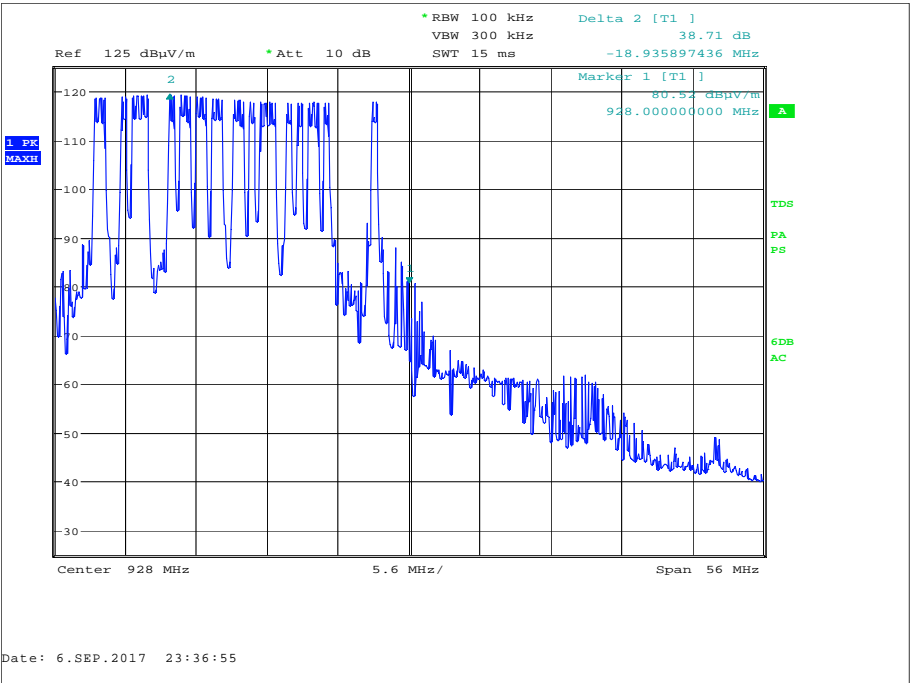


Figure 20 - Hopping - Measured Frequency 928 MHz

FCC 47 CFR Part 15, Limit Clause 15.247 (d)

20 dB below the fundamental measured in a 100 kHz bandwidth using a peak detector. If the transmitter complies with the conducted power limits, based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB below the fundamental instead of 20 dB.

Industry Canada RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

2.7.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Antenna (Bilog)	Schaffner	CBL6143	287	24	18-Apr-2018
Screened Room (5)	Rainford	Rainford	1545	36	20-Dec-2017
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Hygrometer	Rotronic	A1	2138	12	02-Feb-2018
Multimeter	Iso-tech	IDM101	2417	12	30-Sep-2017
Cable (N-N, 8m)	Rhophase	NPS-2302-8000-NPS	3248	12	02-May-2018
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	12-Nov-2017
Tilt Antenna Mast	maturo GmbH	TAM 4.0-P	3916	-	TU
Mast Controller	maturo GmbH	NCD	3917	-	TU
Hygropalm Temperature and Humidity Meter	Rotronic	HP21	4410	12	04-May-2018
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	23-Jul-2017
Cable (Yellow, Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4527	6	04-Nov-2017

Table 20

TU - Traceability Unscheduled

2.8 Restricted Band Edges

2.8.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.205
Industry Canada RSS-GEN, Clause 8.10

2.8.2 Equipment Under Test and Modification State

GT-Xconnect, S/N: Not serialised (75937369-TSR0018) - Modification State 0

2.8.3 Date of Test

06-September-2017

2.8.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 6.10.5.

Plots for average measurements were taken in accordance with ANSI C63.10 clause 4.1.4.2.3. These are shown for information purposes and were used to determine the worst case measurement point. Final average measurements were then taken in accordance with ANSI C63.10 clause 4.1.4.2.2. to obtain the measurement result recorded in the test results tables.

The following conversion can be applied to convert from dB μ V/m to μ V/m:
 $10^{(\text{Field Strength in dB}\mu\text{V/m}/20)}$.

2.8.5 Environmental Conditions

Ambient Temperature 20.8 °C
Relative Humidity 46.0 %

2.8.6 Test Results

GT-X Connect + Booster - Transmit with Modulation

Mode	Frequency (MHz)	Measured Frequency (MHz)	Peak Level (dB μ V/m)
Static	903.42	614	36.60
Static	926.58	960	40.67
Hopping	N/A	614	39.26
Hopping	N/A	960	40.73

Table 21

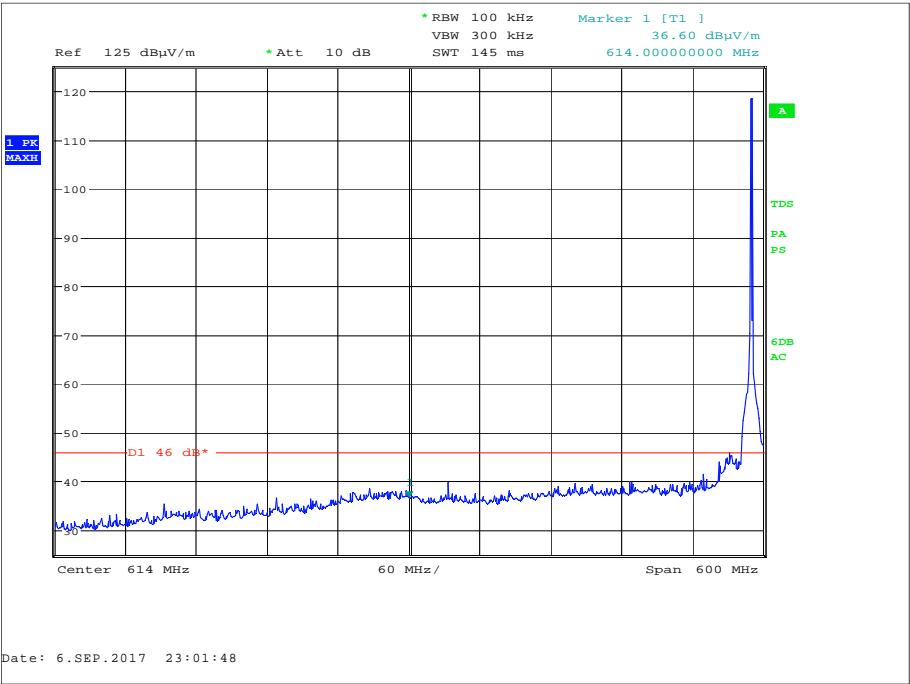


Figure 21 - Static - 903.42 MHz - Measured Frequency 614 MHz - Peak

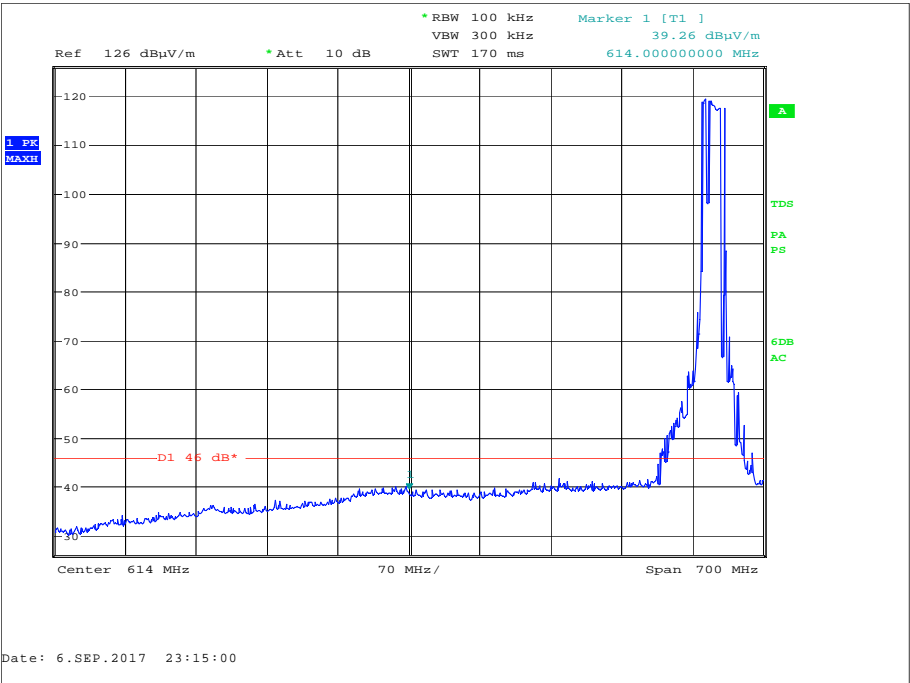


Figure 22 - Static - 926.58 MHz - Measured Frequency 960 MHz - Peak

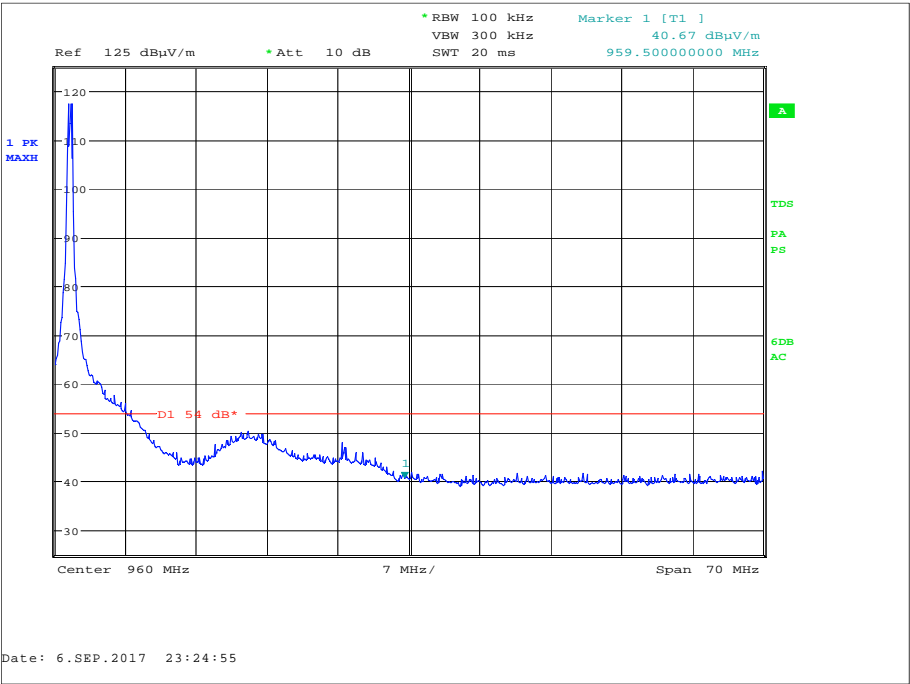


Figure 23 - Hopping - Measured Frequency 614 MHz - Peak

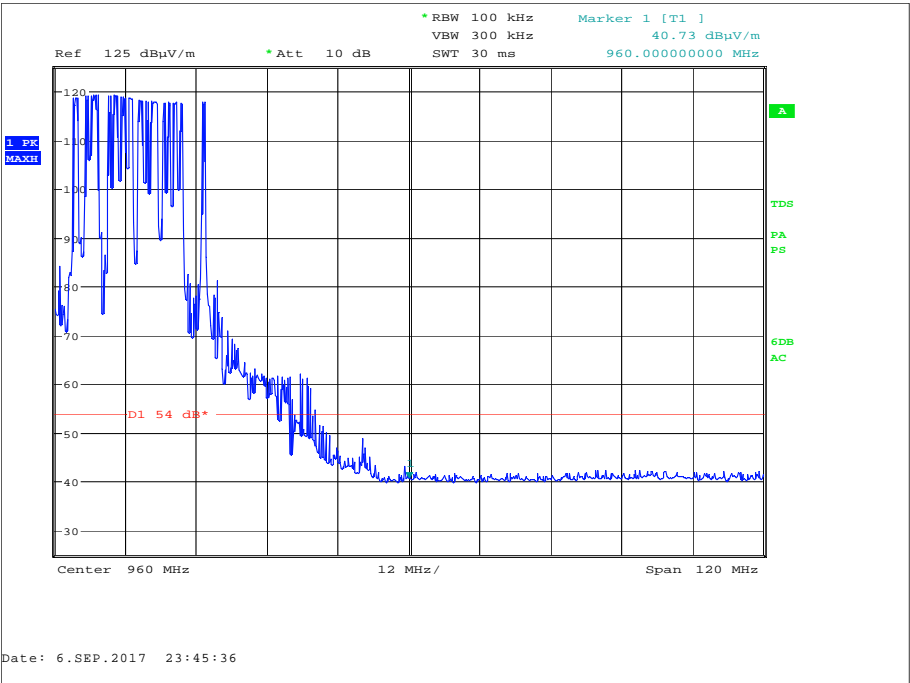


Figure 24 - Hopping - Measured Frequency 960 MHz - Peak

FCC 47 CFR Part 15, Limit Clause 15.209

Frequency (MHz)	Field Strength ($\mu\text{V}/\text{m}$ at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

Table 22

Industry Canada RSS-GEN, Limit Clause 8.9

Frequency (MHz)	Field Strength ($\mu\text{V}/\text{m}$ at 3 metres)
30-88	100
88-216	150
216-960	200
Above 960*	500

Table 23

*Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

2.8.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Antenna (Bilog)	Schaffner	CBL6143	287	24	18-Apr-2018
Screened Room (5)	Rainford	Rainford	1545	36	20-Dec-2017
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Hygrometer	Rotronic	A1	2138	12	02-Feb-2018
Multimeter	Iso-tech	IDM101	2417	12	30-Sep-2017
Cable (N-N, 8m)	Rhophase	NPS-2302-8000-NPS	3248	12	02-May-2018
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	12-Nov-2017
Tilt Antenna Mast	maturo GmbH	TAM 4.0-P	3916	-	TU
Mast Controller	maturo GmbH	NCD	3917	-	TU
Hygropalm Temperature and Humidity Meter	Rotronic	HP21	4410	12	04-May-2018
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	23-Jul-2017
Cable (Yellow, Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4527	6	04-Nov-2017

Table 24

TU - Traceability Unscheduled

2.9 Spurious Radiated Emissions

2.9.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (d), 15.205
Industry Canada RSS-247, Clause 5.5
Industry Canada RSS-GEN, Clause 6.13

2.9.2 Equipment Under Test and Modification State

GT-Xconnect, S/N: Not serialised (75937369-TSR0018) - Modification State 0

2.9.3 Date of Test

06-September-2017 to 11-September-2017

2.9.4 Test Method

Testing was performed in accordance with ANSI C63.10-2013 clause 6.3, 6.5 and 6.6.

Plots for average measurements were taken in accordance with ANSI C63.10-2013 clause 4.1.4.2.3 to characterize the EUT. Where emissions were detected, final average measurements were taken in accordance with ANSI C63.10-2013 clause 4.1.4.2.2.

The plots shown are the characterization of the EUT. The limits on the plots represent the most stringent case for restricted bands, (54/74 dBuV/m) when compared to 20 dBc outside restricted bands. The limits shown have been used as a threshold to determine where further measurements are necessary. Where results are within 10 dB of the limits shown on the plots, further investigation was carried out and reported in results tables.

The following conversion can be applied to convert from dBuV/m to uV/m:
 $10^{(\text{Field Strength in dBuV/m}/20)}$

2.9.5 Environmental Conditions

Ambient Temperature 19.0 - 20.8 °C
Relative Humidity 46.0 - 56.0 %

2.9.6 Test Results

GT-X Connect + Booster - Transmit with Modulation

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
37.500	31.2	40.0	-8.8	342	1.00	Vertical
38.250	30.4	40.0	-9.6	42	1.00	Vertical
73.000	24.1	40.0	-15.9	121	1.00	Vertical
74.600	26.9	40.0	-13.1	91	1.00	Vertical
75.200	29.3	40.0	-10.7	360	1.00	Vertical
108.000	20.6	43.5	-22.9	19	1.00	Vertical

Table 25 - 903.42 MHz - 30 MHz to 1 GHz Emissions Results

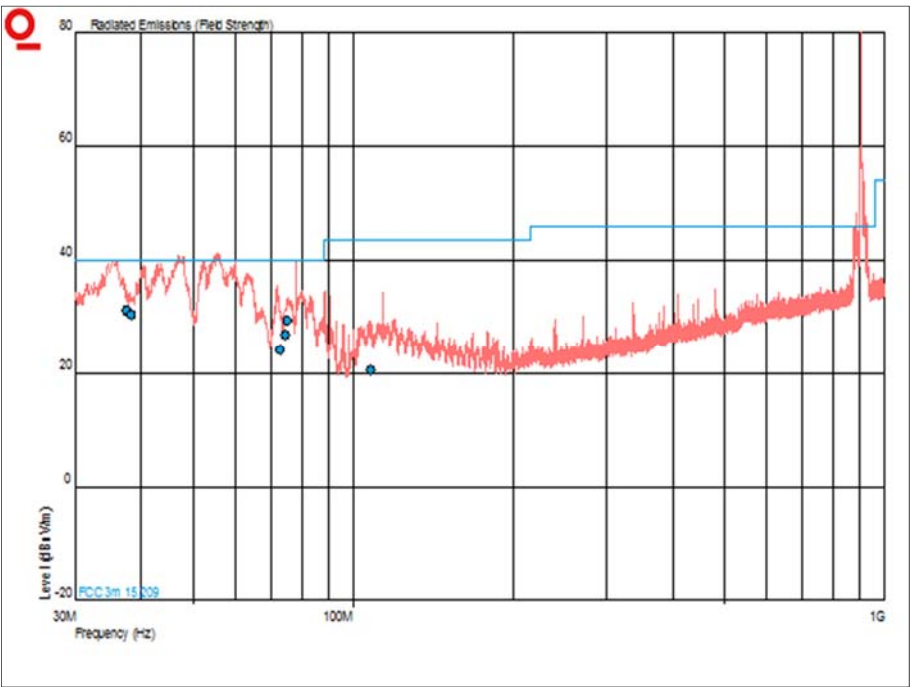


Figure 25 - 903.42 MHz - 30 MHz to 1 GHz - Horizontal and Vertical

Frequency (MHz)	Result (µV/m)		Limit (µV/m)		Margin (µV/m)	
	Peak	Average	Peak	Average	Peak	Average
*						

Table 26 - 903.42 MHz - 1 GHz to 10 GHz Emissions Results

*No emissions were detected within 10 dB of the limit.



Product Service

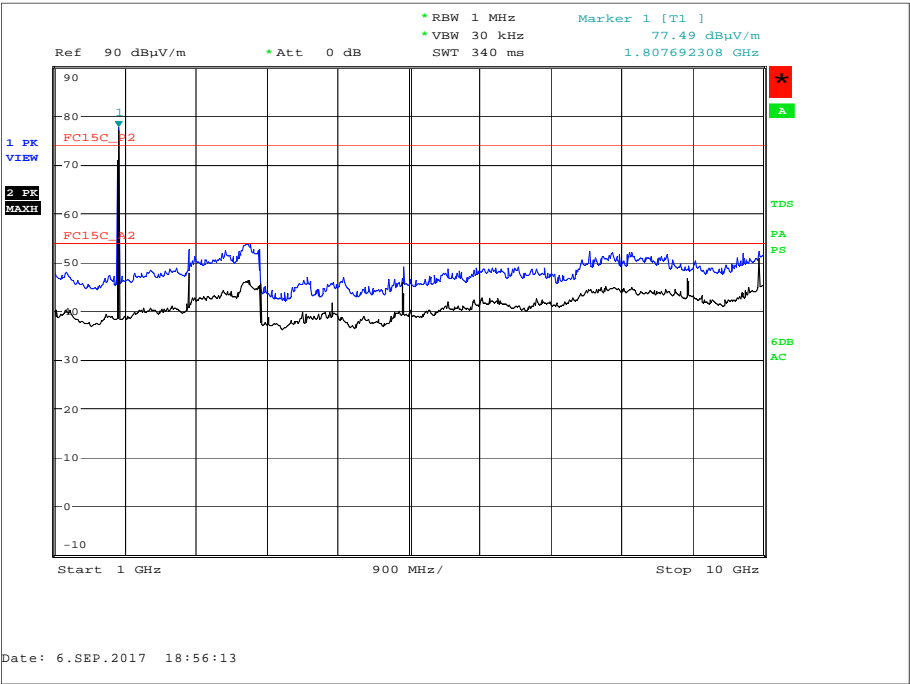


Figure 26 - 903.42 MHz - 1 GHz to 10 GHz - Horizontal and Vertical

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
37.500	30.1	40.0	-9.9	270	1.00	Vertical
38.250	28.2	40.0	-11.8	291	1.00	Vertical
73.000	25.2	40.0	-14.8	52	1.00	Vertical
74.600	23.1	40.0	-16.9	62	1.00	Vertical
75.200	23.5	40.0	-16.5	356	1.00	Vertical
108.000	26.3	43.5	-17.2	115	1.00	Vertical

Table 27 - 915.20 MHz - 30 MHz to 1 GHz Emissions Results

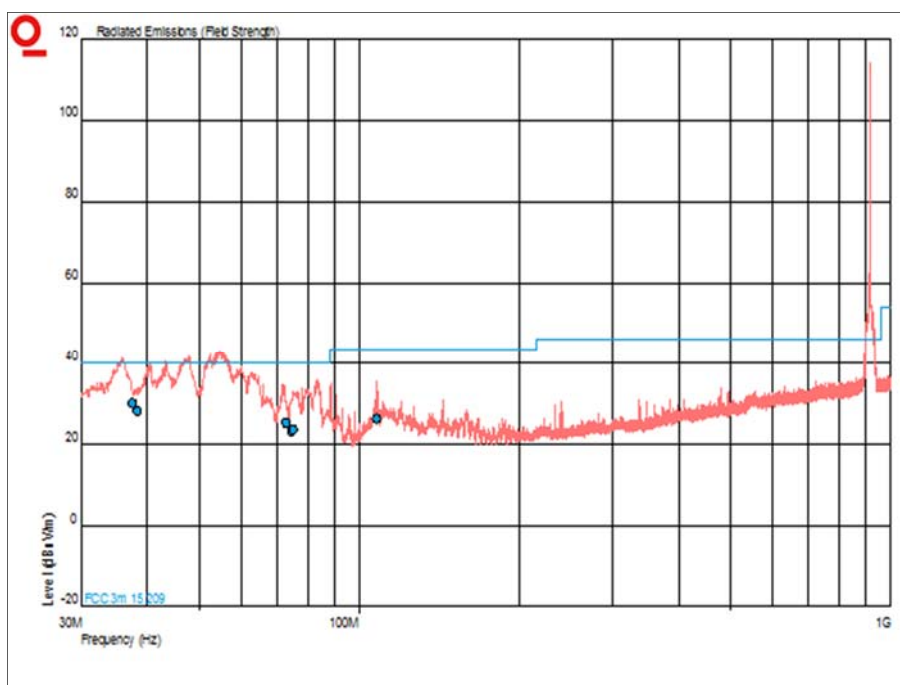


Figure 27 - 915.20 MHz - 30 MHz to 1 GHz - Horizontal and Vertical

Frequency (MHz)	Result (μV/m)		Limit (μV/m)		Margin (μV/m)	
	Peak	Average	Peak	Average	Peak	Average
2.745192	529.66	176.20	5000	500	4470.34	323.80

Table 28 - 915.20 MHz - 1 GHz to 10 GHz Emissions Results

No other emissions were detected within 10 dB of the limit.



Product Service

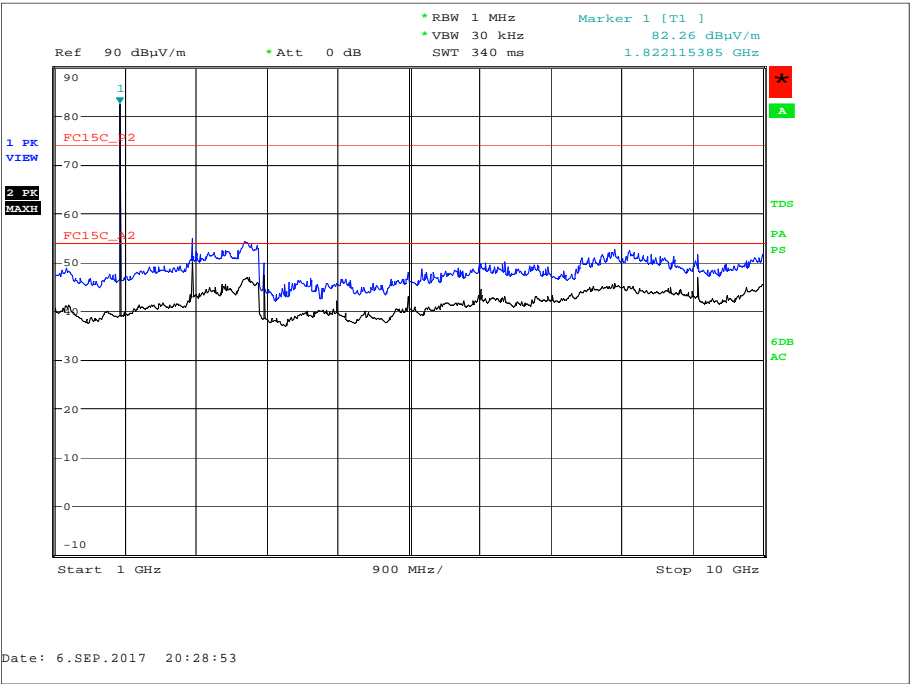


Figure 28 - 915.20 MHz - 1 GHz to 10 GHz - Horizontal and Vertical

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle(Deg)	Height(m)	Polarity
37.500	31.0	40.0	-9.0	186	1.00	Vertical
38.250	30.7	40.0	-9.3	178	1.00	Vertical
73.000	28.3	40.0	-11.7	62	1.00	Vertical
74.800	29.0	40.0	-11.0	360	1.00	Vertical
75.200	31.4	40.0	-8.6	0	1.00	Vertical
138.000	22.2	43.5	-21.3	328	1.00	Vertical

Table 29 - 926.58 MHz - 30 MHz to 1 GHz Emissions Results

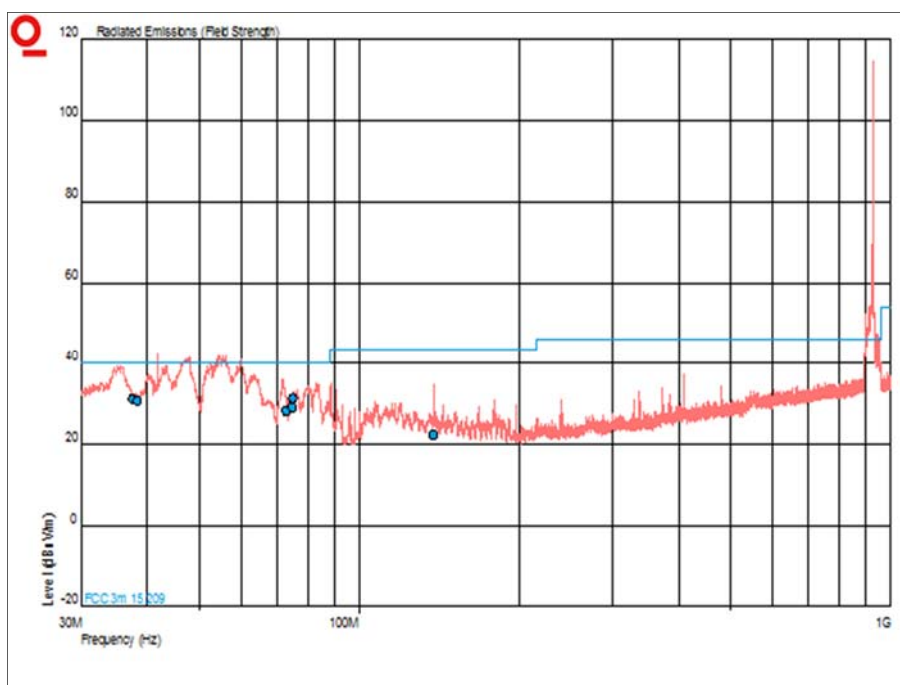


Figure 29 - 926.58 MHz - 30 MHz to 1 GHz - Horizontal and Vertical

Frequency (MHz)	Result (μV/m)		Limit (μV/m)		Margin (μV/m)	
	Peak	Average	Peak	Average	Peak	Average
2.779216	516.42	168.27	5000	500	4483.58	331.73

Table 30 - 926.58 MHz - 1 GHz to 10 GHz Emissions Results

No other emissions were detected within 10 dB of the limit.

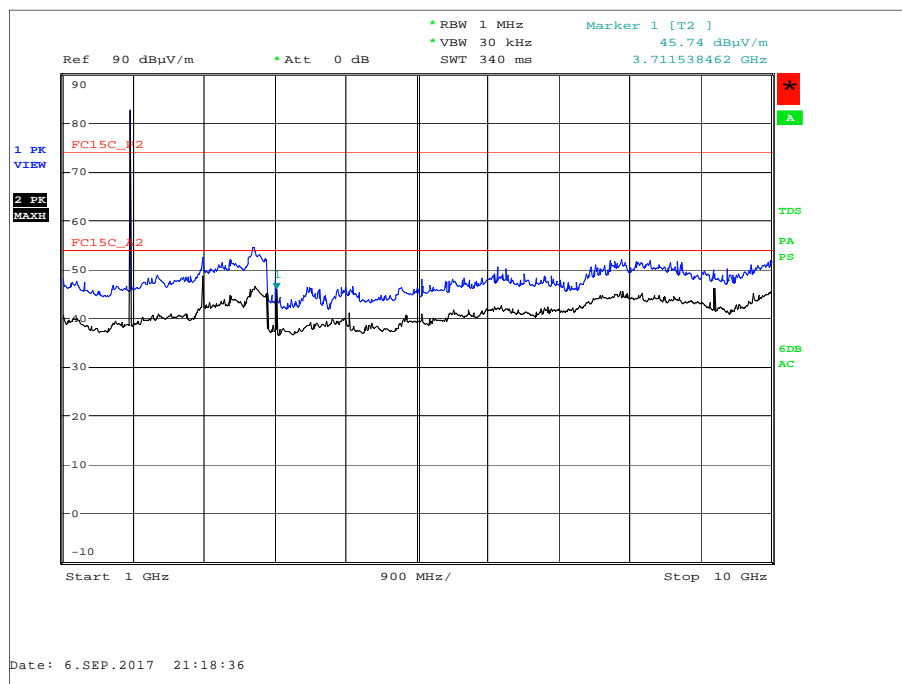


Figure 30 - 926.58 MHz - 1 GHz to 10 GHz - Horizontal and Vertical

FCC 47 CFR Part 15, Limit Clause 15.247 (d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in 15.209(a)

Industry Canada RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

2.9.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Antenna (Bilog)	Schaffner	CBL6143	287	24	18-Apr-2018
Screened Room (5)	Rainford	Rainford	1545	36	20-Dec-2017
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Hygrometer	Rotronic	A1	2138	12	02-Feb-2018
Multimeter	Iso-tech	IDM101	2417	12	30-Sep-2017
Comb Generator	Schaffner	RSG1000	3034	-	TU
Cable (N-N, 8m)	Rhophase	NPS-2302-8000-NPS	3248	12	02-May-2018
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	12-Nov-2017
Tilt Antenna Mast	matur GmbH	TAM 4.0-P	3916	-	TU
Mast Controller	matur GmbH	NCD	3917	-	TU
Hygropalm Temperature and Humidity Meter	Rotronic	HP21	4410	12	04-May-2018
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	23-Jul-2017
Cable (Yellow, Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4527	6	04-Nov-2017
Hygrometer	Rotronic	HP21	4741	12	22-Aug-2018
Double Ridge Broadband Horn Antenna	Schwarzbeck	BBHA 9120 B	4848	12	17-Feb-2018

Table 31

TU - Traceability Unscheduled

3 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
AC Power Line Conducted Emissions	150 kHz to 30 MHz, LISN, ± 3.7 dB
Maximum Conducted Output Power	± 3.2 dB
Frequency Hopping Systems - Average Time of Occupancy	-
Frequency Hopping Systems - Channel Separation	± 16.74 kHz
Frequency Hopping Systems - Number of Hopping Channels	-
Frequency Hopping Systems - 20 dB Bandwidth	± 16.74 kHz
Authorised Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Restricted Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Spurious Radiated Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB

Table 32