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ACCREDITED
TESTING CERT#2750.01

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EMC testing of the Copperstone Technologies Ltd. G900

in accordance with FCC Part 15.247, ANSI C63.4: 2014 and ANSI C63.10: 2013 as referenced by FCC OET KDB 558074 D01 DTS Measurement Guidance v04.

FCC ID: 2AQV2G900D01

Prepared for: Copperstone Technologies Ltd.

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REVISION RECORD

ISSUE	DATE	AUTHOR	REVISIONS
DRAFT 1	2018-09-04	I. Akram	Initial draft submitted for review.
DRAFT2	2018-11-06	I. Akram	Updated FCC ID#
Release 1	2018-12-04	M. Rousseau	Sign off

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1.0 INTRODUCTION

1.1 Scope

The purpose of this report is to present the results of compliance testing performed in accordance with FCC Part 15.247, ANSI C63.4-2014 and ANSI C63.10-2013 to gain FCC Certification Authorization for Low-Power License-Exempt transmitters. All test procedures, limits, criteria, and results described in this report apply only to the Copperstone Technologies Ltd. G900 test sample, referred to herein as the EUT (Equipment Under Test).

The sample has been provided by the customer.

This report does not imply product endorsement by the Electronics Test Centre, A2LA, nor any Canadian Government agency.

1.2 Applicant

This test report has been prepared for Copperstone Technologies Ltd., located in Calgary, Alberta, Canada.

1.3 Test Sample Description

As provided to ETC (Airdrie) by Copperstone Technologies Ltd.

Product Name:		G900
LoRa Radio	**Frequency Band**	902 – 928 MHz
	Type of Modulation	Chirp Spread Spectrum
	BW/Frequency Range	500KHz DTS, 903 – 927 MHz
	Associated Antenna	ISM 915MHz Chip Antenna, mfr: Taoglas, p/n ILA.09, Gain = 0.39 dBi, isotropic
	Detachable/ Non-Detachable	PCB soldered chip antenna (non-detachable)
Model# / Serial#		G900 / 00006
Firmware version		D01
Power supply:		Replaceable D cell internal battery

1.4 General Test Conditions and Assumptions

The EUT was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. All inputs and outputs to and from other equipment associated with the EUT were adequately simulated.

The environmental conditions are recorded during each test and are reported in the relevant sections of this document.

1.5 Scope of Testing

Tests were performed in accordance with FCC Part 15.247, ANSI C63.4: 2014, ANSI C63.10: 2013 as referenced in FCC KDB 558074 D01 v04.

1.5.1 Test Methodology

Test methods are specified in the Basic Standard as referenced and/or modified by the Product Standard in the part of Section 2 of this report associated with each particular test case.

1.5.2 Variations in Test Methodology

Any variance in methodology or deviation from the reference Standard is documented in the part of Section 2 of this report associated with each particular Test Case.

1.5.3 Test Sample Verification, Configuration & Modifications

EUT setup, configuration, protocols for operation and monitoring of EUT functions, and any modifications performed in order to meet the requirements, are detailed in each Test Case of Section 2 of this report.

Modulation mode: DTS 500 kHz:
DTS modulation system operating in non-frequency hopping. The channels used for the tests are:

Low = 903 MHz

MID = 915 MHz

High = 927 MHz

2.0 TEST CONCLUSION

STATEMENT OF COMPLIANCE

The customer equipment referred to in this report was found to comply with the requirements, as summarized below.

The EUT was subjected to the following tests. Compliance status is reported as **Compliant** or **Non-compliant**. **N/A** indicates the test was Not Applicable to the EUT.

> **Note:** Maintenance of compliance is the responsibility of the Manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the EUT with respect to the standards detailed in this test report.

The following table summarizes the tests performed in terms of the specification, class or performance criterion applied, and the EUT modification state.

Test Case	Test Type	Specification	Test Sample	Modifications	Config.	Result
Frequency Range = 903 – 927 MHz 500 KHz DTS Mode Max. Conducted Tx Power = dBm (Watt)						
2.1	AC Conducted Emissions (Tx)	15.207	G900	none	see § 2.1	**N/A Internal Battery powered**
2.2	Occupied Bandwidth	15.247(a)(1) 15.247(2)(2)	G900	none	see § 2.2	**Compliant**
2.3	Max Output Power Conducted	15.247(b)	G900	none	see § 2.3	**Compliant**
2.4	Power Spectral Density	15.247(e) 15.247(f)	G900	none	see § 2.4	**Compliant**
2.5	Band Edge	15.247(d)	G900	none	see § 2.5	**Compliant**
2.6	Conducted Spurious	15.247(d)	G900	none	see § 2.6	**Compliant**
2.7	EUT Position	ANSI C63.4	G900	none	see § 2.10	**Assessed**
2.8	Radiated Spurious (Tx Mode)	15.205, 15.209 15.247(d)	G900	none	see § 2.11	**Compliant**
2.9	RF Exposure	15.247(i)	G900	none	see § 2.13	**Exempt**

Refer to the test data for applicable test conditions.

2.1 AC Power Line Conducted Emissions: Transmit Mode

Test Lab: Electronics Test Centre, Airdrie	**EUT: G900**
Test Personnel:	**Standard: FCC Part 15.207**
Date:	**Basic Standard: ANSI C63.4: 2014**
EUT status: N/A	
Comments: EUT is powered with an internal replaceable battery.	

2.2 Channel Occupied Bandwidth

Test Lab: Electronics Test Centre, Airdrie	**EUT: G900**
Test Personnel: Imran Akram	**Standard: FCC PART 15.247**
Date: 2018-08-13/14 (25.6°C,28.7 % RH)	**Basic Standard: ANSI C63.10-2013** **FCC OET KDB 558074**

EUT status: Compliant

Specification: FCC Part 15.247 (a, 2), FCC 15.215 (c)

Criteria: Systems using digital modulation techniques may operate in the 902-928 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

2.2.1 Test Guidance: FCC OET KDB 558074 Section 8 Option 2

This measurement is performed at low, mid and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

For DTS the spectrum analyzer is set for a frequency span ≥ (2 * OBW), ≤ (5 * OBW), selected to clearly display the channel. The RBW is set to 100 kHz. The VBW is set to ≥ (3 * RBW). The Peak detector is used, with the trace set to Max Hold.

The automated 99% BW function of the spectrum analyzer is engaged, and the 6 dB OBW is measured with the x dB function.

2.2.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.2.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Interval	Cal. Due
Signal Analyzer	Agilent	N9010A	6678	2018-07-16	1 year	2019-07-16
Temp/Humidity	Extech	42270	5892	2018-04-13	1 year	2019-04-13
Attenuator	JFW	50FH-020-10	-	2018-01-15	1 year	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	1 year	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	1 year	2019-01-15

2.2.4 Test Sample Verification, Configuration & Modifications

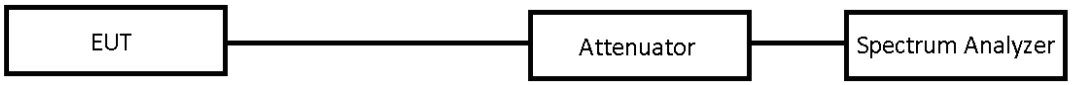
The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation. The EUT modified to provide the direct access to antenna trace for conducted measurements.

For compliance purposes EUT met requirements without any modification

There is no Deviation and exclusions from test specifications.

Test setup diagrams for Occupied Bandwidth testing:

Conducted:

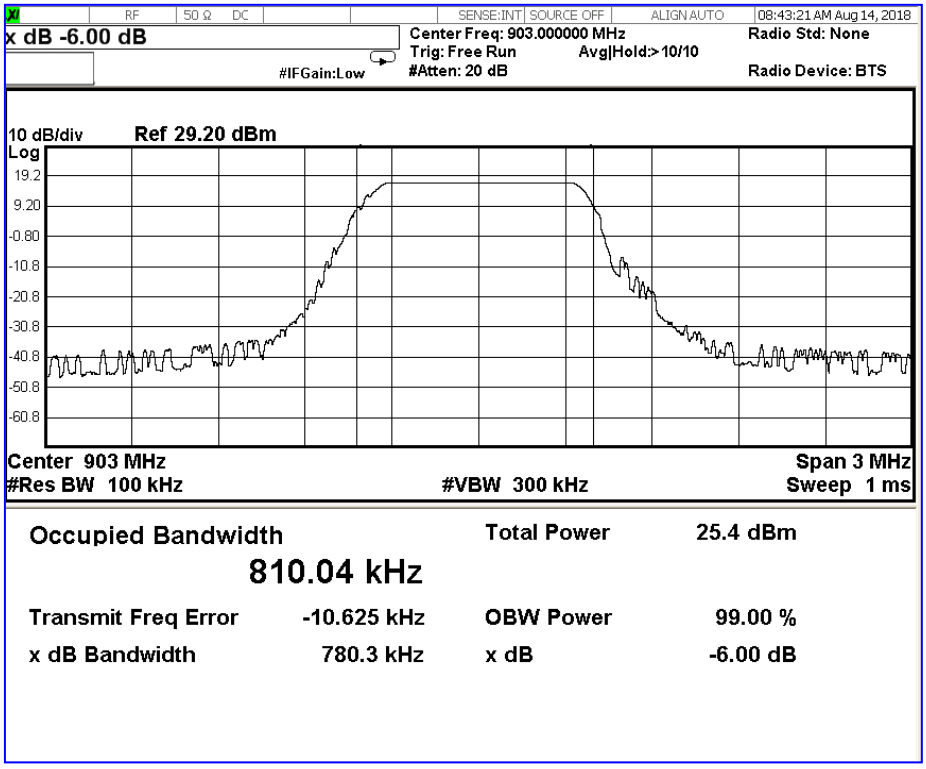


2.2.5 Channel Occupied Bandwidth Data: (DTS Mode)

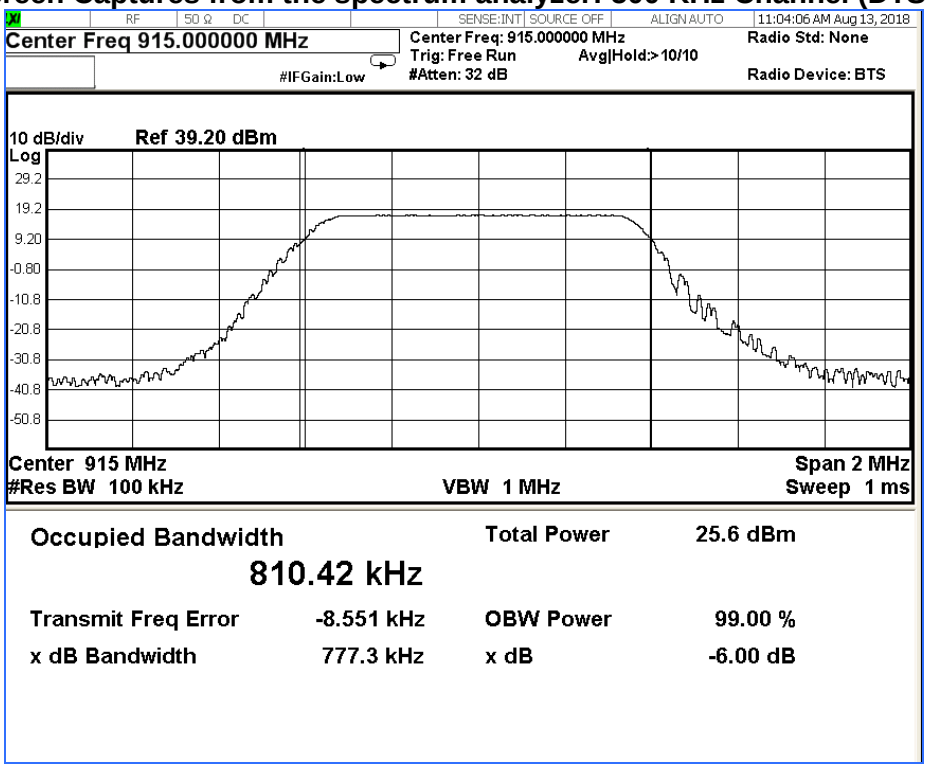
Lora 500 KHz Channels

Channel	Freq. [MHz]	6 dB OBW [kHz]	99% OBW [KHz]	Limit 6 dB OBW
Low	903	780.3	810.04	≥ 500 KHz
Mid	915	777.3	810.42	≥ 500 KHz
High	927	777.8	804.24	≥ 500 KHz

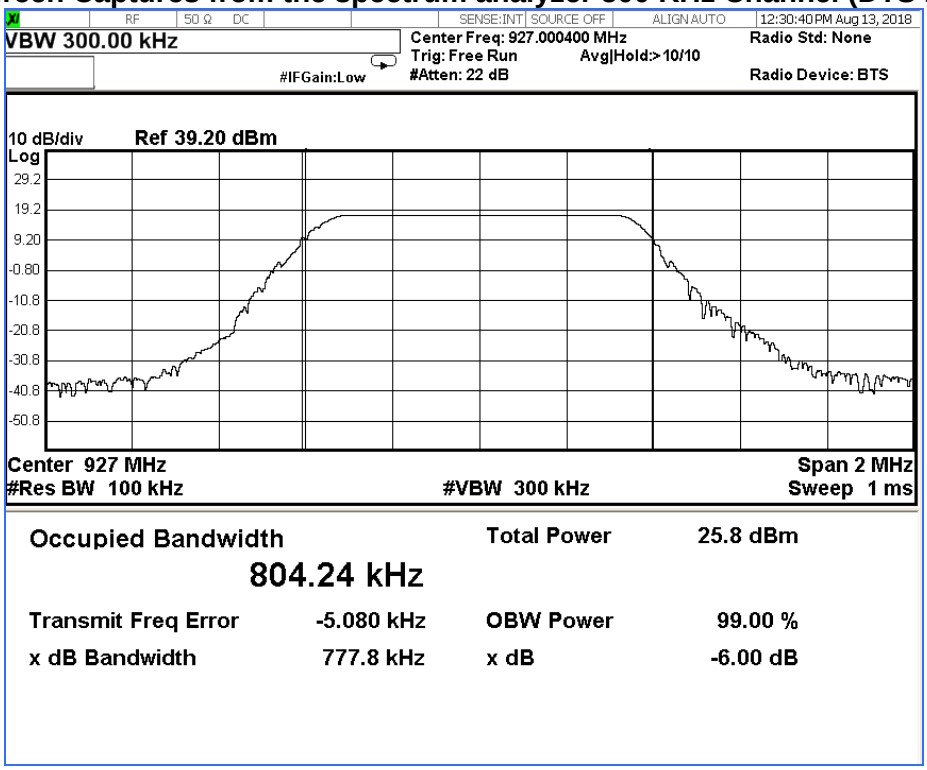
Screen Captures from the spectrum analyzer: 500 KHz Channel (DTS Mode)



Screen Captures from the spectrum analyzer: 500 KHz Channel (DTS Mode)



Screen Captures from the spectrum analyzer 500 KHz Channel (DTS Mode)



2.3 Max Average Output Power (DTS Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: G900**
Test Personnel: Imran Akram	**Standard: FCC PART 15.247**
Date: 2018-08-13/14 (25.6°C,28.7 % RH)	**Basic Standard: ANSI C63.10: 2013 FCC OET KDB 558074**

EUT status: Compliant

Specification: FCC Part 15.247(b, 3)

Criteria	For systems using digital modulation in the 902-928 MHz bands: 1 Watt.

2.3.1 Test Guidance: FCC OET KDB 558074 Section 9.2.2.4

This measurement is performed at low, mid and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

2.3.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.3.3 Test Equipment

Testing was performed with the following equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Interval	Cal. Due
Signal Analyzer	Agilent	N9010A	6678	2018-07-16	1 year	2019-07-16
Temp/Humidity	Extech	42270	5892	2018-04-13	1 year	2019-04-13
Attenuator	JFW	50FH-020-10	-	2018-01-15	1 year	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	1 year	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	1 year	2019-01-15

2.3.4 Test Sample Verification, Configuration & Modifications

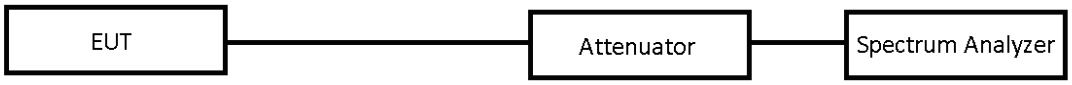
The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation.

The EUT modified to provide the direct access to antenna trace for conducted measurements.

For compliance purposes EUT met requirements without any modification

Test setup diagrams for Peak Power testing:

Conducted:



2.3.5 Max Average Output Power Data (DTS Mode)

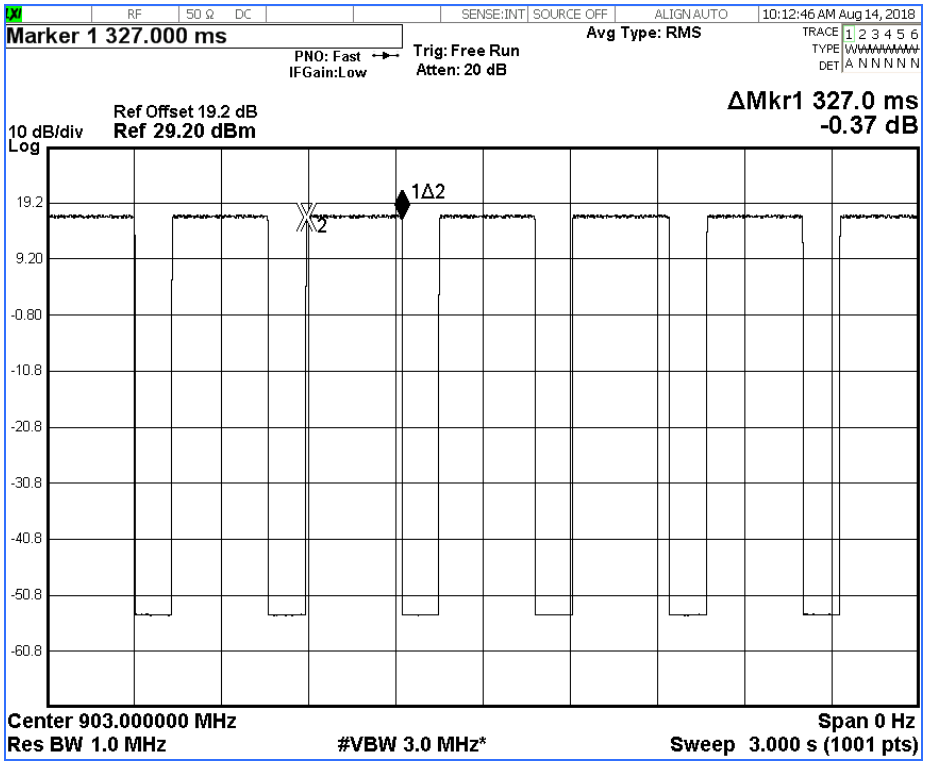
LoRa 500 KHz

Channel	Freq. [MHz]	Out Put Power (dBm)	Out Put Power Limit (dBm	Margin (dB)
Low	903	16.9	30	13.1
Mid	915	17.09	30	12.91
High	927	17.36	30	12.64

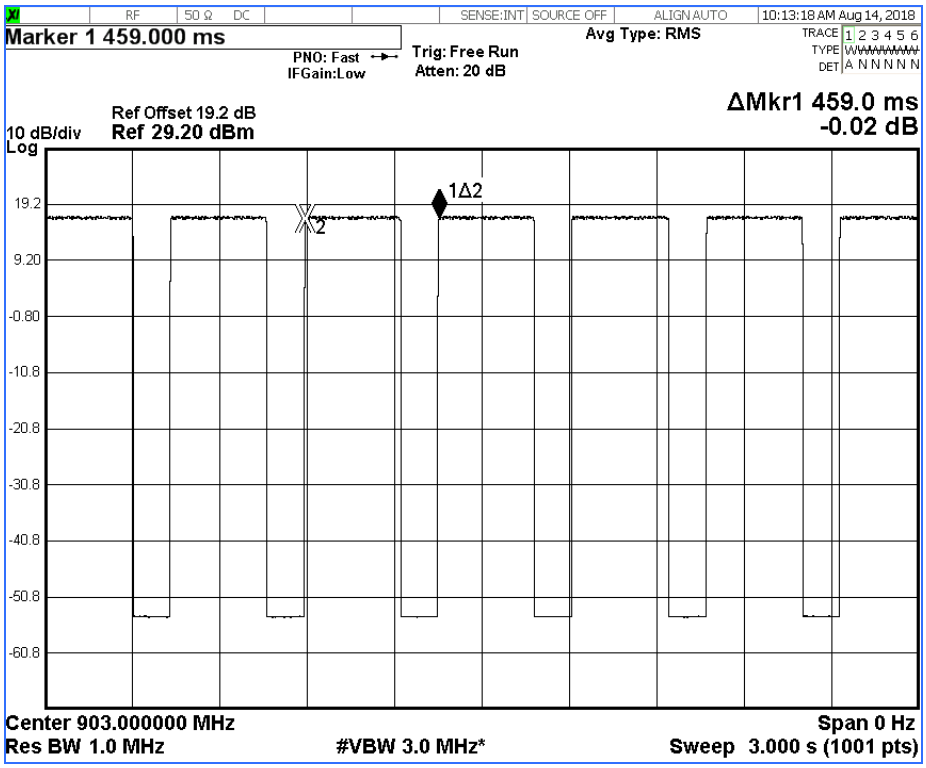
Output Power Method (9.2.2.4) Method AVGSA-2	
Duty Cycle	Measure the duty cycle, x, of the transmitter output signal
Span	≥ 1.5 times the OBW
RBW	1 – 5 % of the OBW, ≤ 1 MHz
VBW	≥ 3 x RBW
Number of Points in sweep	≥ 2 x Span / RBW
Sweep time	Auto
Detector	RMS (Power Averaging)
Sweep trigger	Free Run
Trace Average	≥100 traces in power Averaging (RMS)
Power measured	Integrated the spectrum across the OBW of the signal using the S/A band power measurement function, with band limit set equal to the OBW band edge.
Corrected Max Average Power	Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on- and off-times of the transmission).

Measurement of Duty Cycle: 903 MHz

Pulse Width

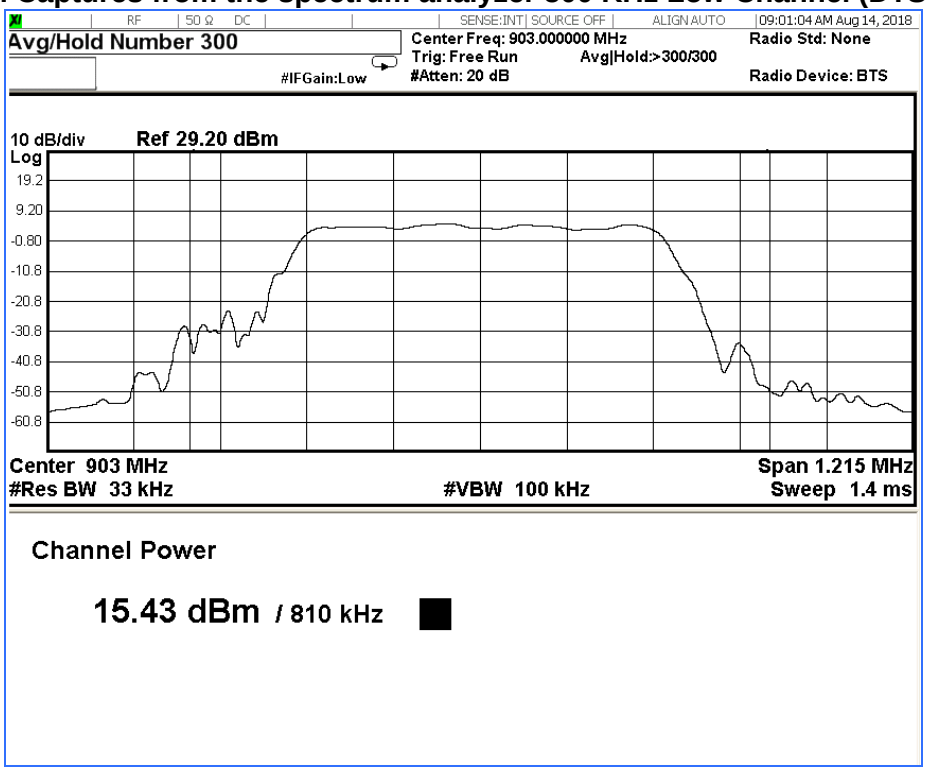


Period



Duty Cycle = PW / Period = (Pulse Width / Pulse Period)
Duty Cycle = (327ms / 459ms) x 100
Duty Cycle = 71.24183007 %

Screen Captures from the spectrum analyzer 500 KHz Low Channel (DTS Mode)



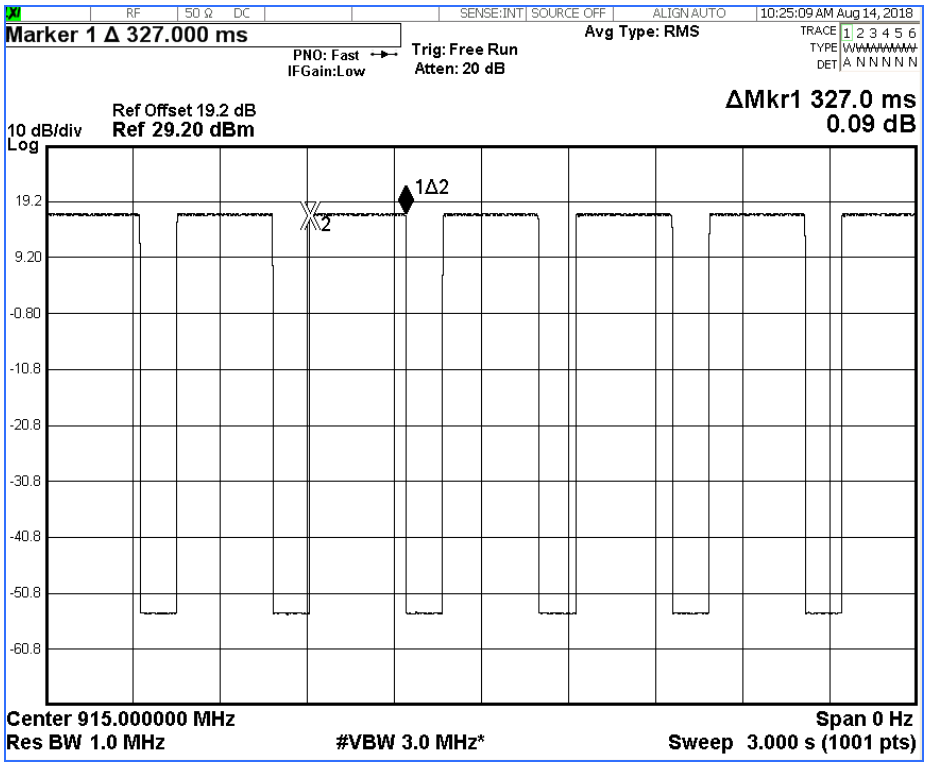
Duty Cycle = 0.7124183007 = 0.7123
Duty Cycle Factor = 10 x log(1/x) where x is duty cycle
Duty Cycle Factor = 10 x log(1/0.7123)
Duty Cycle Factor = 1.47

Corrected Max Average Power = Measured Value + Duty Cycle Factor
Corrected Max Average Power = 15.43dBm + 1.47 dB

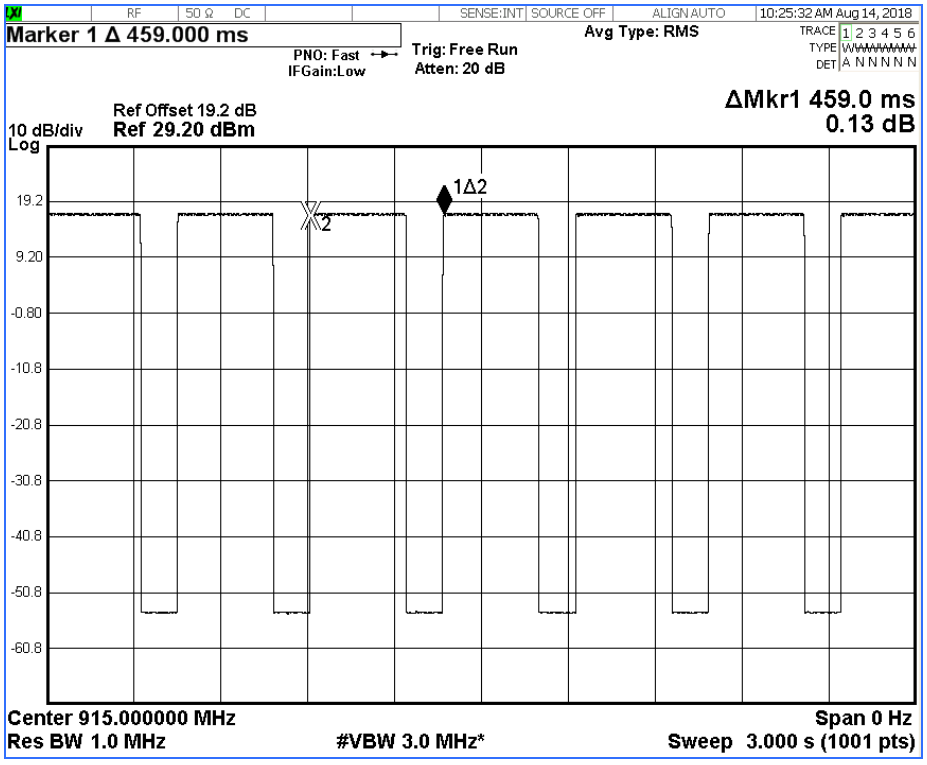
Corrected Max Average Power = 16.9 dBm

Measurement of Duty Cycle: 915 MHz

Pulse Width



Period



Duty Cycle = PW / Period = (Pulse Width / Pulse Period)
Duty Cycle = (327ms / 459ms) x 100
Duty Cycle = 71.24183007 %

Screen Captures from the spectrum analyzer 500 KHz Low Channel (DTS Mode)

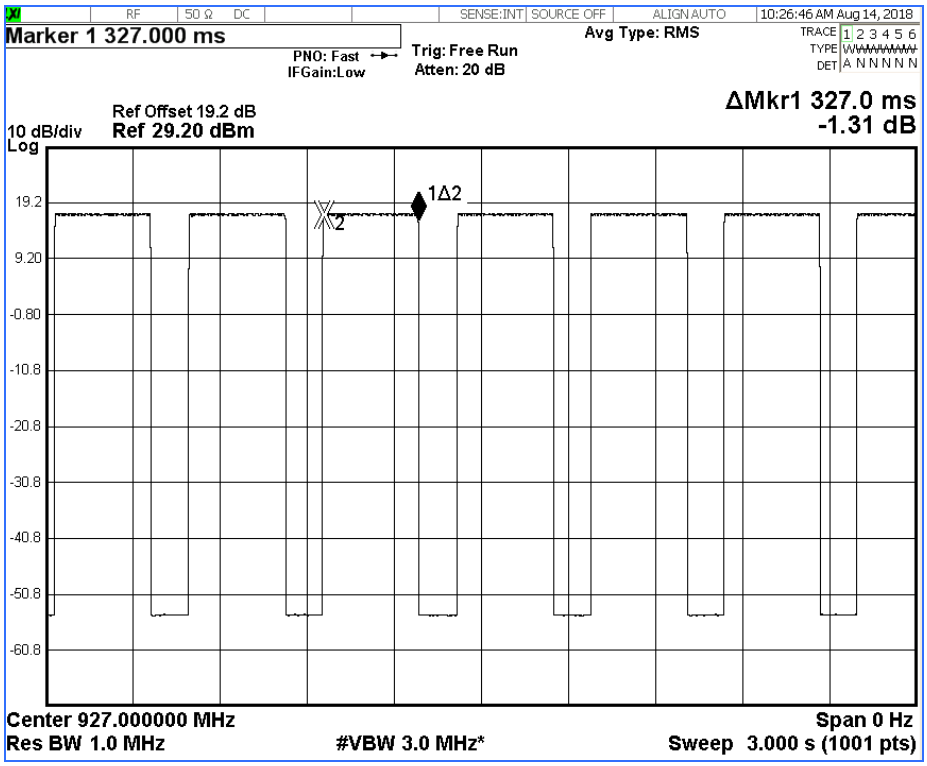
Duty Cycle = 0.7124183007 = 0.7123
Duty Cycle Factor = 10 x log (1/x) where x is duty cycle
Duty Cycle Factor = 10 x log (1/0.7123)
Duty Cycle Factor = 1.47

Corrected Max Average Power = Measured Value + Duty Cycle Factor
Corrected Max Average Power = 15.62dBm + 1.47 dB

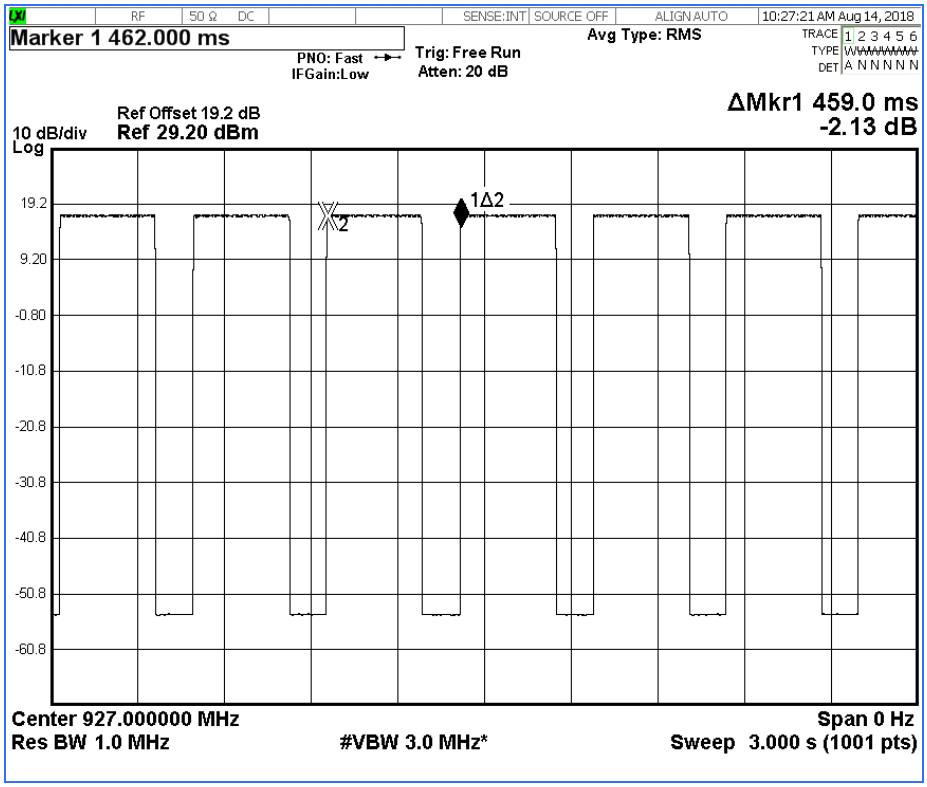
Corrected Max Average Power = 17.09 dBm

Measurement of Duty Cycle: 927 MHz

Pulse Width

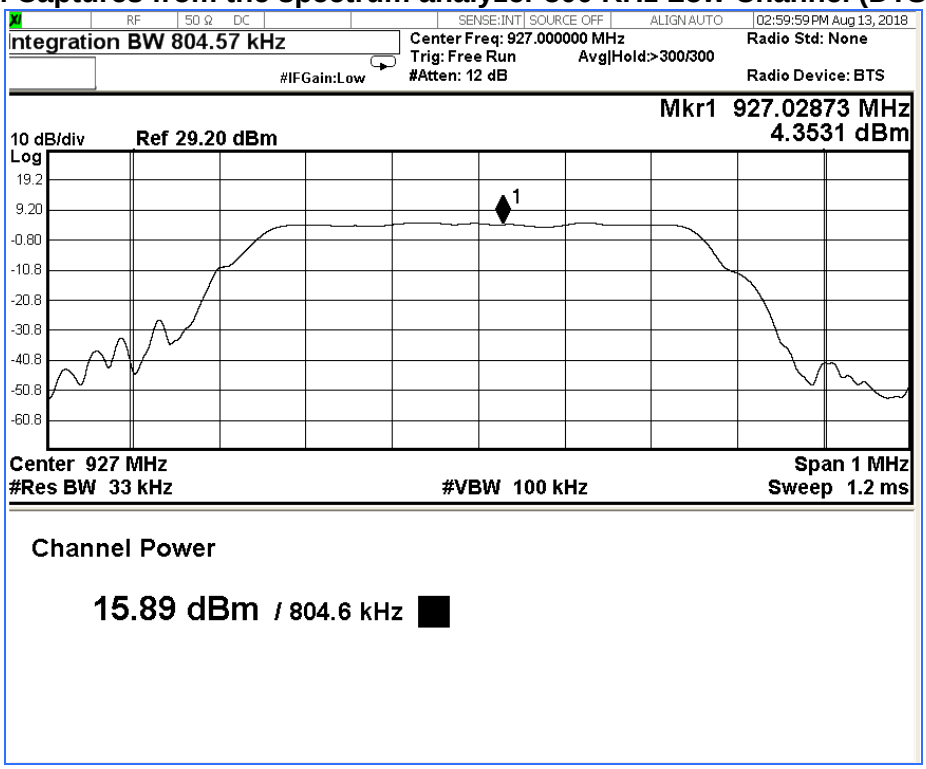


Period



Duty Cycle = PW / Period = (Pulse Width / Pulse Period)
Duty Cycle = (327ms / 459ms) x 100
Duty Cycle = 71.24183007 %

Screen Captures from the spectrum analyzer 500 KHz Low Channel (DTS Mode)



Duty Cycle = 0.7124183007 = 0.7123
Duty Cycle Factor = 10 x log (1/x) where x is duty cycle
Duty Cycle Factor = 10 x log (1/0.7123)
Duty Cycle Factor = 1.47

Corrected Max Average Power = Measured Value + Duty Cycle Factor
Corrected Max Average Power = 15.89dBm + 1.47 dB

Corrected Max Average Power = 17.36 dBm

2.4 Power Spectral Density (DTS Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: G900**
Test Personnel: Imran Akram	**Standard: FCC PART 15.247**
Date: 2018-08-13/14 (25.6°C,28.7 % RH)	**Basic Standard: ANSI C63.10: 2013** **FCC OET KDB 558074**

EUT status: Compliant

Specification: FCC Part 15.247(e)

Criteria For digitally modulated systems the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

2.4.1 Test Guidance: ANSI C63.10-2013, Cl. 11.10.3 / FCC OET KDB 558074 10.5

This measurement is performed at low, mid and high frequencies, in continuous transmission, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

Method AVGPSD-2 or AVGPSD-2 Alternative (averaging across on- and off-times of the EUT transmissions, followed by duty cycle correction) shall be applied if the duty cycle < 98 %), and the transmissions exhibit a constant duty cycle during the measurement duration. Duty cycle will be considered to be constant if variations are less than ± 2 %.
Measure the duty cycle (x) of the transmitter output signal. The spectrum analyzer is set for a frequency span of at least (1.5*OBW)) centered on a channel. The RBW is set to 3 kHz and VBW is set to 10 kHz. The RMS average detector is used, with the trace set to average Hold. The marker is placed on the highest peak of the resulting trace. Add 10 log (1/x), where x is the duty cycle measured

2.4.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.4.3 Test Equipment

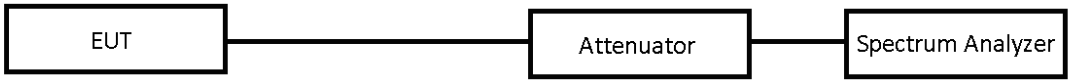
Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Cal. Date	Interval	Cal. Due
Signal Analyzer	Agilent	N9010A	6678	2018-07-16	1 year	2019-07-16
Temp/Humidity	Extech	42270	5892	2018-04-13	1 year	2019-04-13
Attenuator	JFW	50FH-020-10	-	2018-01-15	1 year	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	1 year	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	1 year	2019-01-15

2.4.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

Test setup diagrams for Peak Power Spectral Density testing:
Conducted:

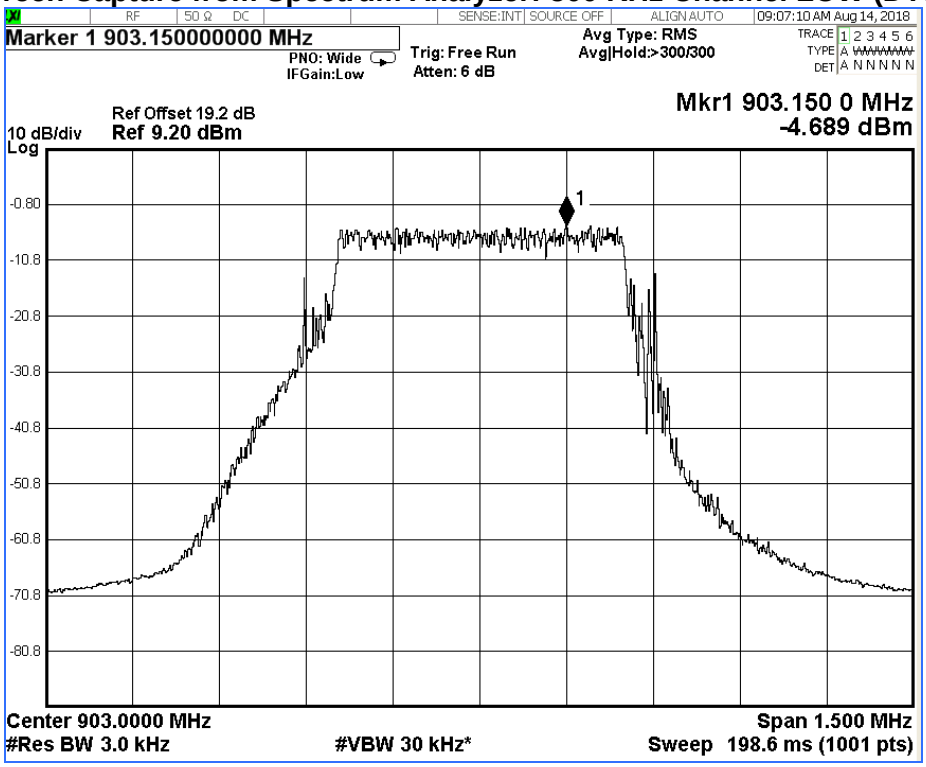


2.4.5 Peak PSD Data (DTS MODE)

500 KHZ Channels

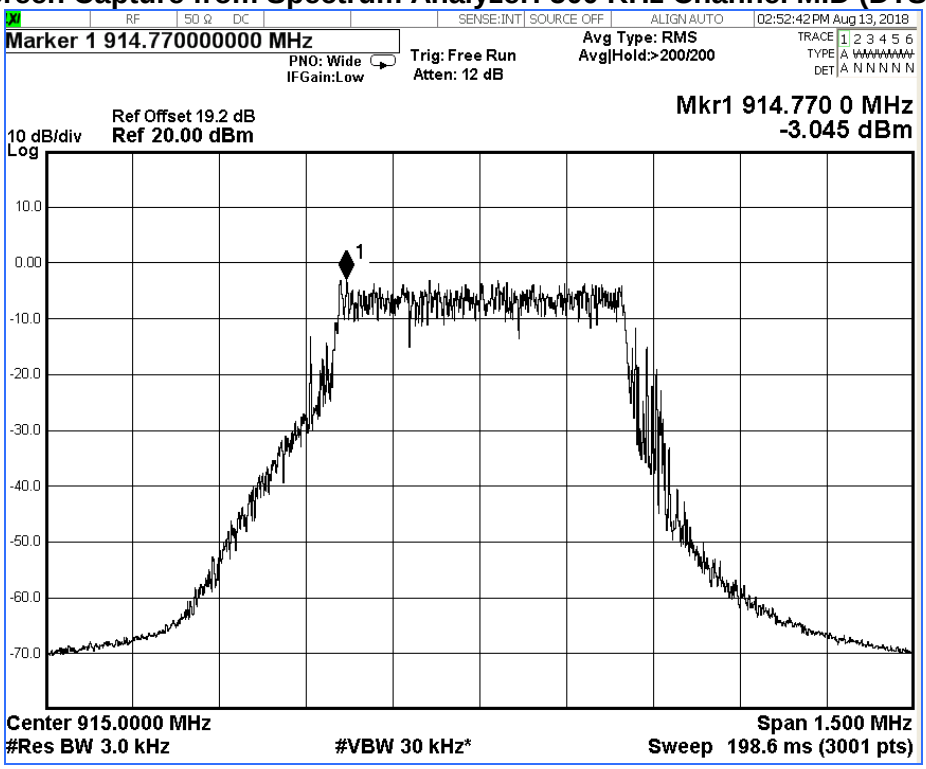
Channel	Freq. [MHz]	PSD (dBm/3KHz)	PSD Limit (dBm/3KHz)
Low	903	-3.219	8
Mid	915	-1.575	8
High	927	-1.36	8

Screen Capture from Spectrum Analyzer: 500 KHz Channel LOW (DTS Mode)



Duty Cycle Correction Factor = 1.47dB
Corrected Value of PSD = - 4.689dBm + 1.47dB = -3.219 dBm

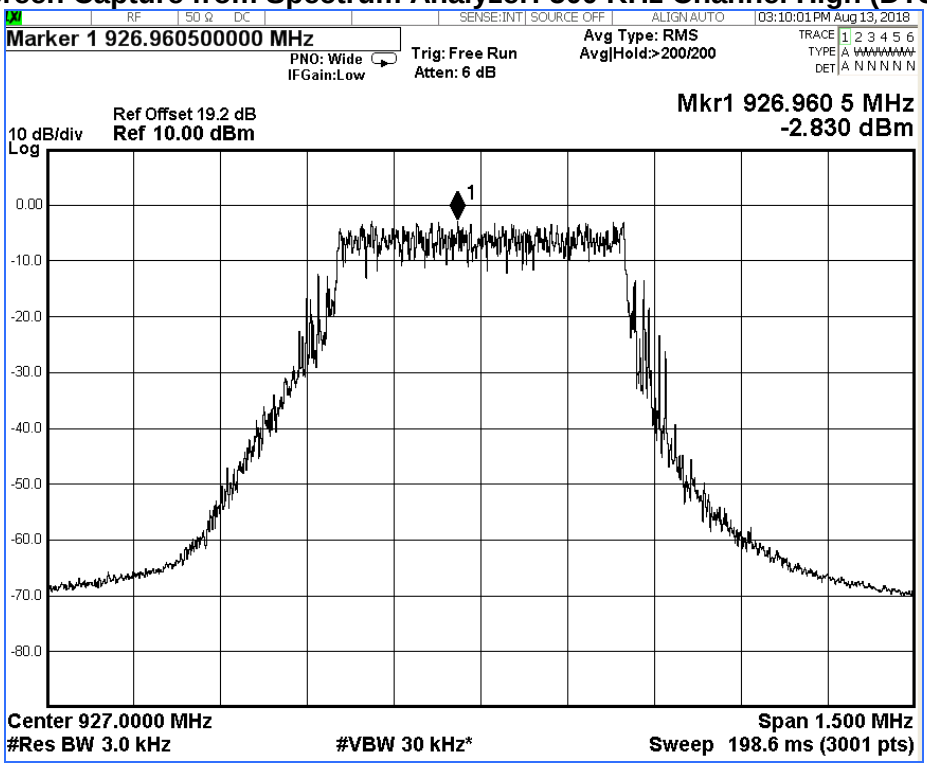
Screen Capture from Spectrum Analyzer: 500 KHz Channel MID (DTS Mode)



Duty Cycle Correction Factor = 1.47dB

Corrected Value of PSD = - 3.045dBm + 1.47dB = -1.575 dBm

Screen Capture from Spectrum Analyzer: 500 KHz Channel High (DTS Mode)



Duty Cycle Correction Factor = 1.47dB

Corrected Value of PSD = - 2.830dBm + 1.47dB = -1.36 dBm

2.5 Band Edge Attenuation (DTS Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: G900**
Test Personnel: Imran Akram	**Standard: FCC PART 15.247**
Date: 2018-08-13/14 (25.6°C,28.7 % RH)	**Basic Standard: ANSI C63.10: 2013**

EUT status: Compliant

Specification: FCC Part 15.247(d)

Criteria: 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) (see §15.205(c)).

2.5.1 Test Guidance: ANSI C63.10-2013 Clause 11.13.2 & 6.10.4, 6.10.6 / FCC OET KDB 558074 Clause10.3

This measurement is performed at the low and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.

The spectrum analyzer is set for a frequency span to show the band edge and the nearest channel. The RBW is set to ≥ 100 kHz. The VBW is set to ≥ (RBW * 3). The Peak detector is used, with the trace set to Max Hold.

The attenuation is measured with the Marker Delta function.

2.5.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.5.3 Test Equipment

Testing was performed with the following equipment:

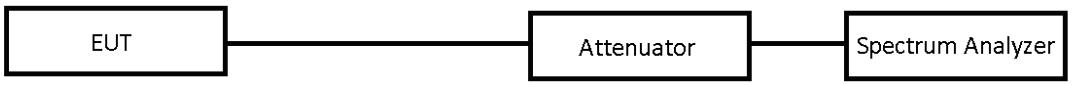
Equipment	Manufacturer	Model #	Asset #	Cal. Date	Interval	Cal. Due
Signal Analyzer	Agilent	N9010A	6678	2018-07-16	1 year	2019-07-16
Temp/Humidity	Extech	42270	5892	2018-04-13	1 year	2019-04-13
Attenuator	JFW	50FH-020-10	-	2018-01-15	1 year	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	1 year	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	1 year	2019-01-15

2.5.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

Test setup diagrams for Band Edge Attenuation testing:

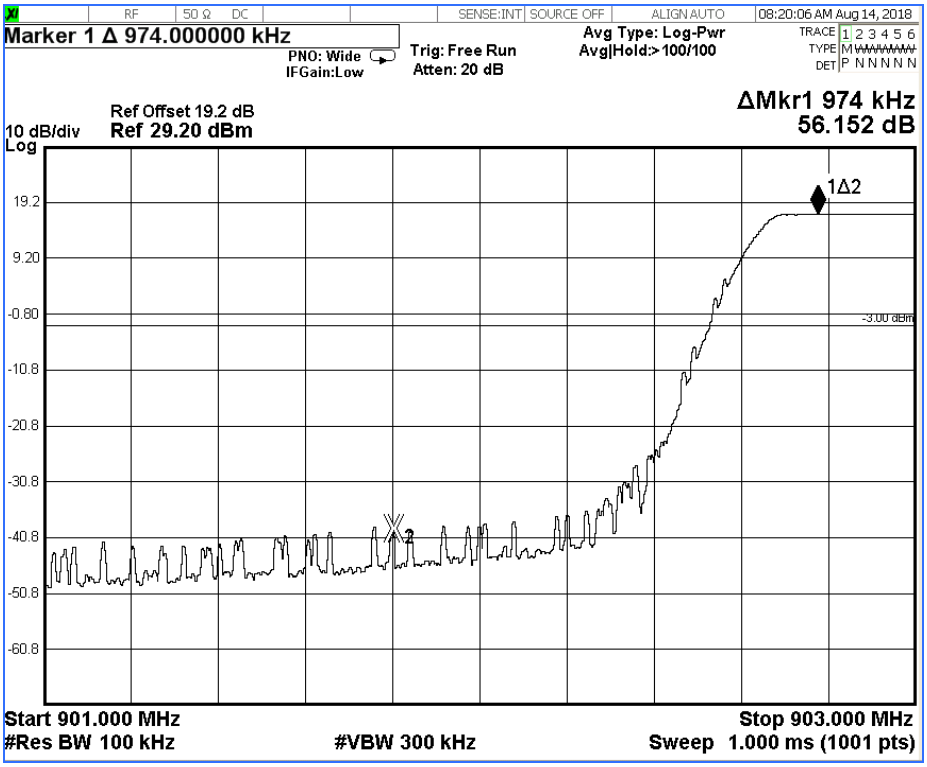
Conducted:



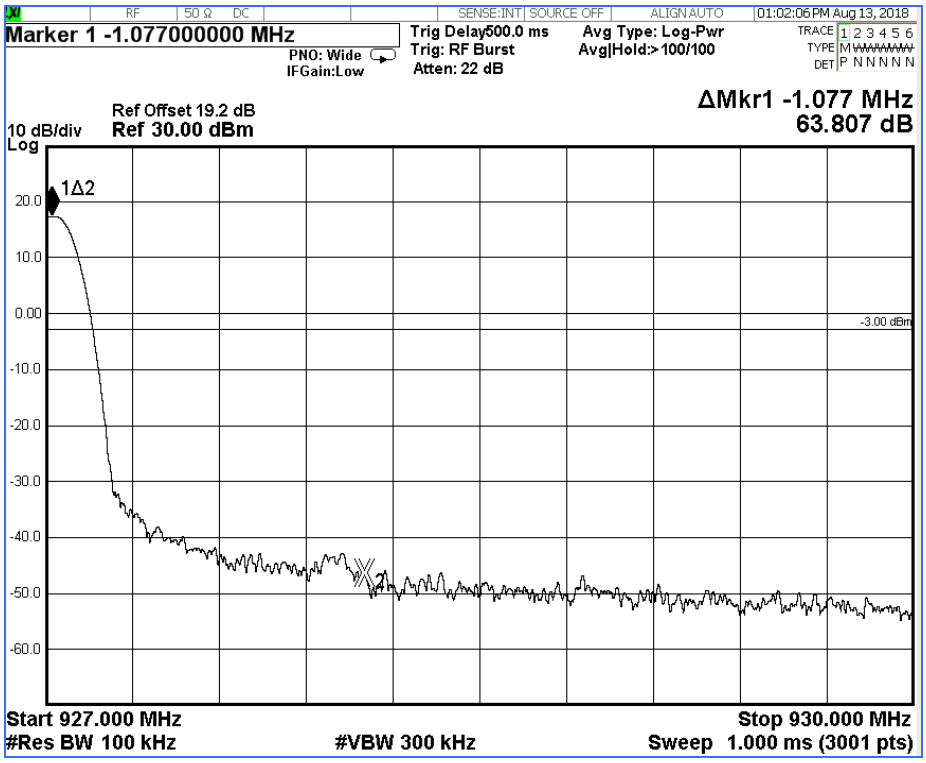
2.5.5 Band Edge Data (DTS MODE)

Modulation	Channel	Attenuation at Band Edge	Attenuation Limit at Band Edge
Lora 500KHz Channels	903	56.152 dBc	20 dBc
	927	63.807 dBc	20 dBc

Screen Capture from the spectrum analyzer: Lower Band Edge (500 KHz DTS Mode)



Screen Capture from the spectrum analyzer: Upper Band Edge (500 KHz DTS Mode)



2.6 Conducted Harmonic and Spurious Emissions (DTS Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: G900**
Test Personnel: Imran Akram	**Standard: FCC PART 15.247**
Date: 2018-08-14 (25.6°C,28.7 % RH)	**Basic Standard: ANSI C63.4-2014** **FCC OET KDB 558470 v04 DTS**

EUT status: Compliant

Specification: FCC Part 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.

2.6.1 Test Guidance: ANSI C63.10-2013, Clause 6.7, FCC OET KDB 558470 v04 DTS Clause 12.0

This measurement is performed at the low, mid and high frequencies, with modulation.
The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. The loss from the cable and the attenuator were added on the analyzer as gain offset setting there by allowing direct measurements, without the need for any further corrections.
The spectrum analyzer is stepped through the spectrum in frequency spans selected to ensure acceptable frequency resolution. The RBW is set to 100 kHz. The VBW is set to ≥ 300 kHz. The Peak detector is used, with the trace set to Max Hold.

2.6.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.6.3 Test Equipment

Testing was performed with the following equipment:

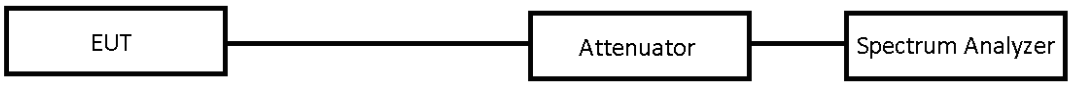
Equipment	Manufacturer	Model #	Asset #	Cal. Date	Interval	Cal. Due
Signal Analyzer	Agilent	N9010A	6678	2018-07-16	1 year	2019-07-16
Temp/Humidity	Extech	42270	5892	2018-04-13	1 year	2019-04-13
Attenuator	JFW	50FH-020-10	-	2018-01-15	1 year	2019-01-15
DC Blocker	MCL	BLK-89-S+	-	2018-01-15	1 year	2019-01-15
CE Cable (50cm length)	Huber+Suhner	Enviroflex 400	-	2018-01-15	1 year	2019-01-15

2.6.4 Test Sample Verification, Configuration & Modifications

The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

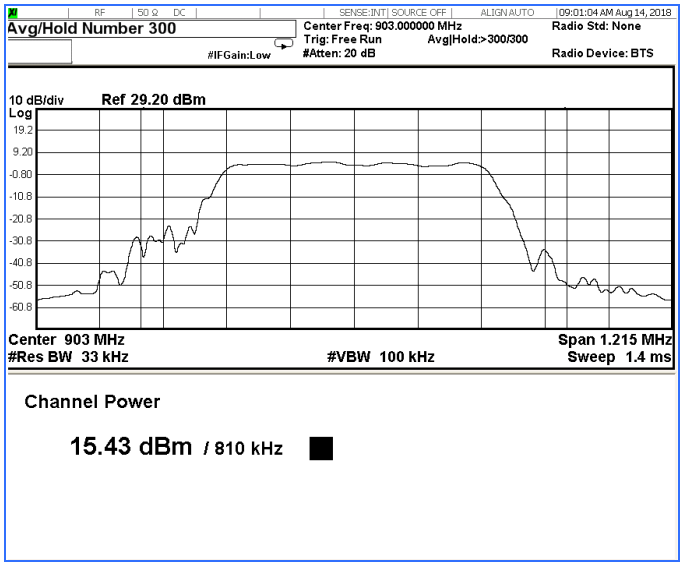
The EUT modified to provide the direct access to antenna trace for conducted measurements.

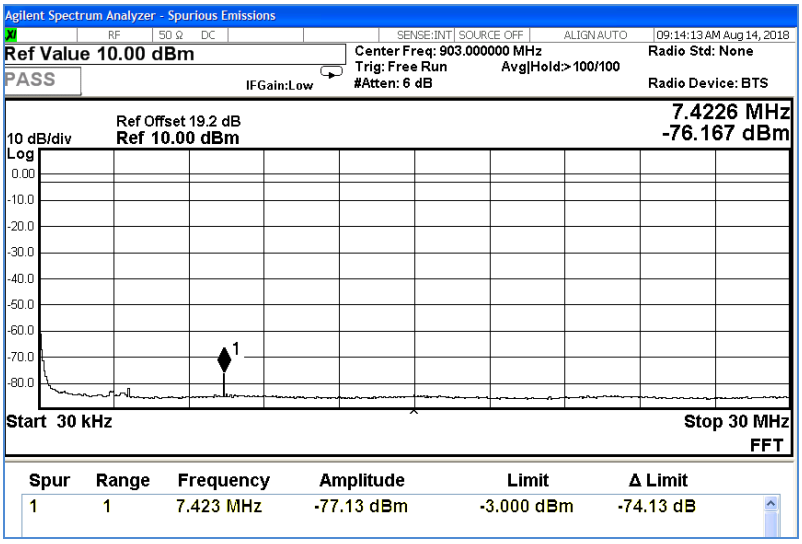
Test setup diagram for Conducted Spurious Emissions testing:

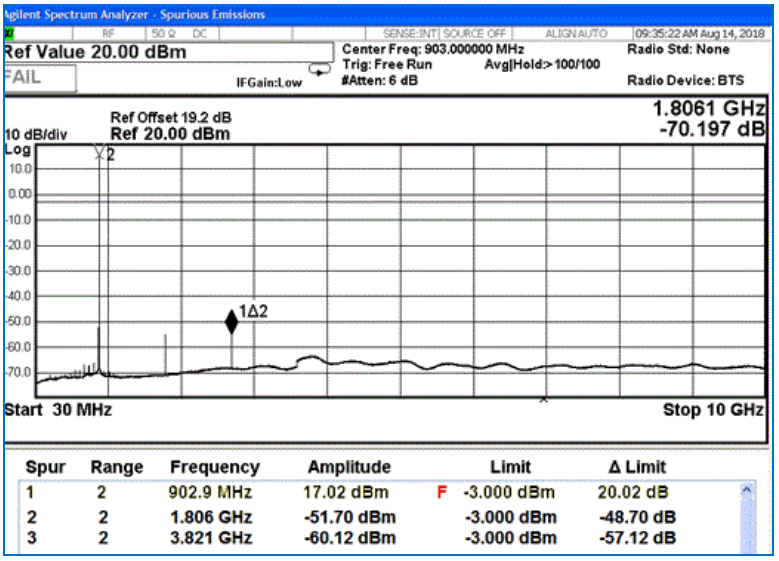


2.6.5 Conducted Emissions Data:

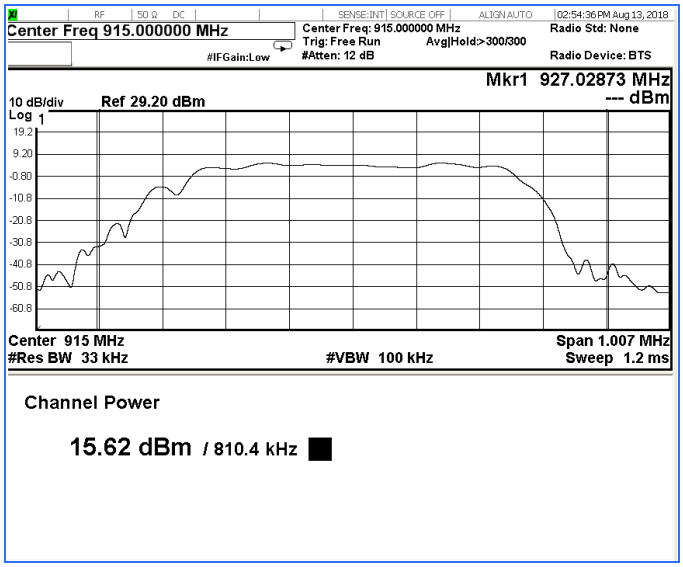
500 KHz Low Channel Corrected Power = 16.9dBm

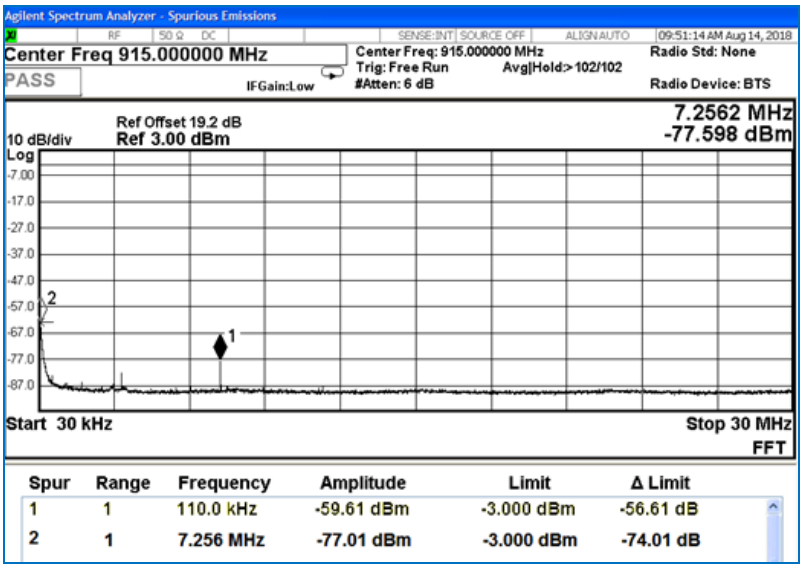


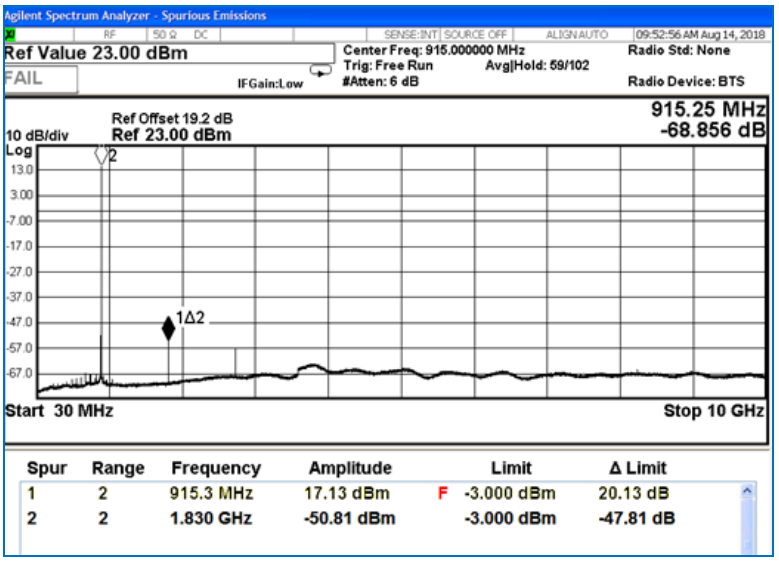




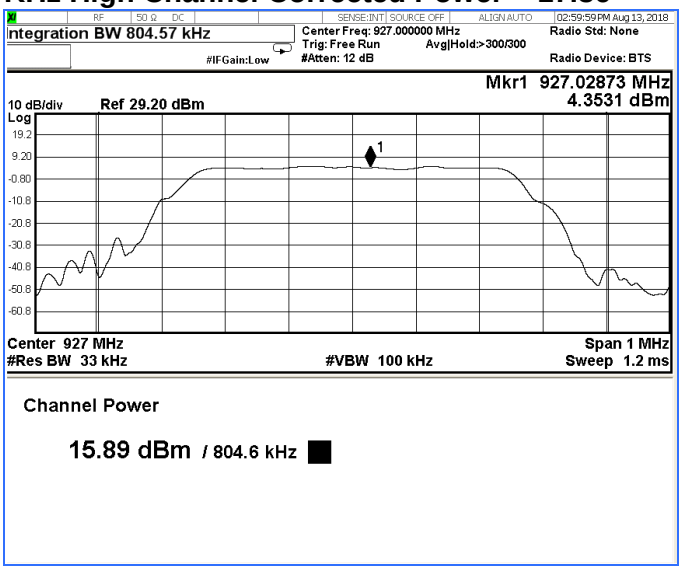
500 KHz MID Channel Corrected Power = 17.09

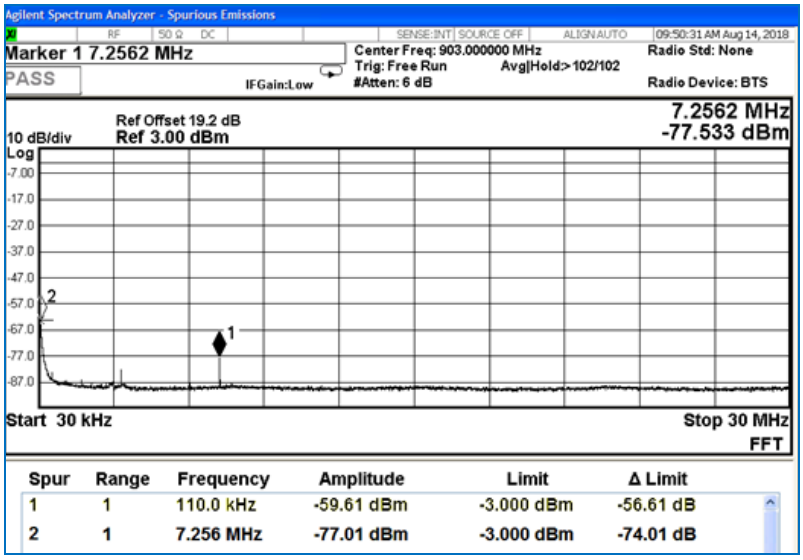




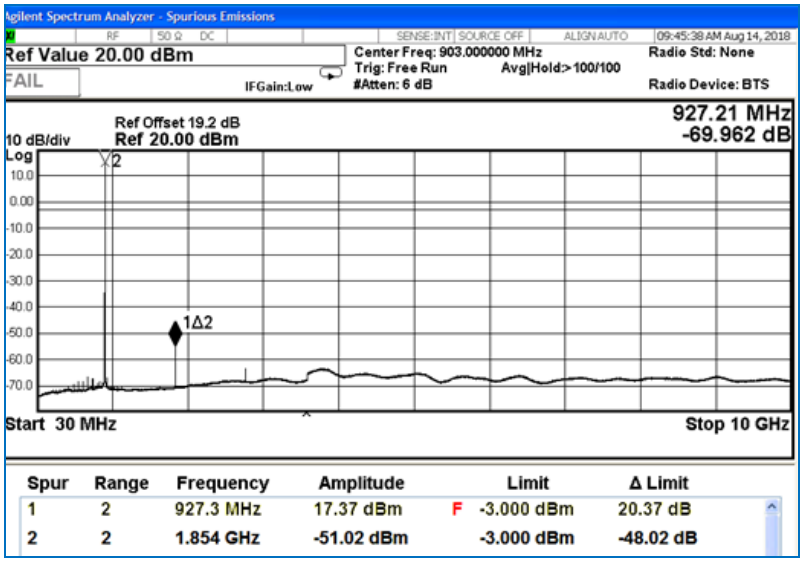


500 KHz High Channel Corrected Power = 17.36





Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	1	110.0 kHz	-59.61 dBm	-3.000 dBm	-56.61 dB
2	1	7.256 MHz	-77.01 dBm	-3.000 dBm	-74.01 dB



Spur	Range	Frequency	Amplitude		Limit	Δ Limit
1	2	927.3 MHz	17.37 dBm	F	-3.000 dBm	20.37 dB
2	2	1.854 GHz	-51.02 dBm		-3.000 dBm	-48.02 dB

2.7 EUT Positioning Assessment

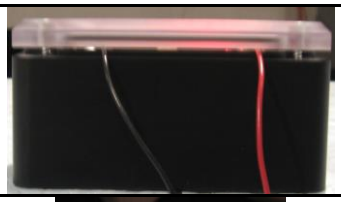
Test Lab: Electronics Test Centre, Airdrie	**EUT: G900**
Test Personnel: Imran Akram **Bushra Muharram**	**Standard: FCC PART 15.247**
Date: 2018-08-09(26.7°C,31.7 % RH)	**Basic Standard: ANSI C63.4-2014**

3rd Axis@927 MHz Found worse

Comments: EUT oriented in three axis's and 3rd axis found to be worse emission axis. .

Specification: ANSI C63.4-2014, Clause 6.3.2.1

Portable, small, lightweight, or modular devices that may be handheld, worn on the body, or placed on a table during operation shall be positioned on a non-conducting platform, the top of which is 80 cm above the reference ground plane. The preferred area occupied by the EUT arrangement is 1 m by 1.5 m, but it may be larger or smaller to accommodate various sized EUTs (see Figure 6, Figure 7, and Figure 9). For testing purposes, ceiling- and wall-mounted devices also shall be positioned on a tabletop (see also 6.3.4 and 6.3.5). In making any tests involving handheld, body-worn, or ceiling-mounted equipment, it is essential to recognize that the measured levels may be dependent on the orientation (attitude) of the three orthogonal axes of the EUT. Thus, exploratory tests as specified in 8.3.1 shall be carried out for various axes orientations to determine the attitude having maximum or near-maximum emission level.

1st Axis	
2nd Axis	
3rd Axis	

2.8 Radiated Spurious Emissions (Tx Mode)

Test Lab: Electronics Test Centre, Airdrie	**EUT: G900**
Test Personnel: Imran Akram **Bushra Muharram**	**Standard: FCC PART 15.247** **Basic Standard: ANSI C63.10-2013**
Date: 2018-08-9/10 (24.4°C,27.7 % RH)	

EUT status: Compliant

Specification: FCC PART 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) (see §15.205(c)).

Restricted Bands of Operation:

MHz	MHz	MHz	MHz	MHz	GHz	GHz
0.0900000 – 0.1100000	8.2910000 - 8.2940000	16.804250 - 16.804750	162.01250 - 167.17000 *	1660.0000 – 1710.0000	3.6000000 – 4.4000000	14.470000 – 14.500000
0.4950000 - 0.5050000 *	8.3620000 - 8.3660000	25.500000 - 25.670000	167.72000 - 173.20000 *	1718.8000 – 1722.2000	4.5000000 – 5.1500000	15.350000 – 16.200000
2.1735000 - 2.1905000	8.3762500 - 8.3867500	37.500000 - 38.250000	240.00000 – 285.00000	2200.0000 – 2300.0000	5.3500000 – 5.4600000	17.700000 – 21.400000
4.1250000 - 4.1280000	8.4142500 - 8.4147500	73.000000 - 74.600000	322.00000 - 335.40000	2310.0000 – 2390.0000	7.2500000 – 7.7500000	22.010000 – 23.120000
4.1772500 - 4.1777500	12.290000 - 12.293000	74.800000 - 75.200000	399.90000 – 410.00000	2483.5000 – 2500.0000 *	8.0250000 – 8.5000000	23.600000 – 24.000000
4.2072500 - 4.2077500	12.519750 - 12.520250	108.00000 - 121.94000 **	608.00000 – 614.00000	2655.0000 – 2900.0000	9.0000000 – 9.2000000	31.200000 – 31.800000
5.6770000 - 5.6830000	12.576750 - 12.577250	123.00000 - 138.00000 **	960.00000 – 1240.0000 ***	3260..0000 – 3267.0000	9.3000000 – 9.5000000	36.430000 – 36.500000
6.2150000 - 6.2180000	13.360000 - 13.410000	149.90000 - 150.05000 *	1300.0000 – 1427.0000 ***	3332.0000 – 3339.0000	10.600000 – 12.700000	Above 38.600000
6.2677500 - 6.2682500	16.420000 - 16.423000	156.52475- 156.52525	1435.0000 – 1626.5000	3345.8000 – 3358.0000	13.250000 – 13.400000	
6.3117500 - 6.3122500	16.694750 - 16.695250	156.70000 - 156.90000	1645.5000 – 1646.5000	3500.0000 – 3600.0000 ****		

* US only ** Canada 108 – 138 MHz *** Canada 960 – 1427 MHz **** Canada only

2.8.1 Test Guidance: ANSI C63.10-2013, Clause 13.4.2

From 9 kHz to 150 kHz (resolution bandwidth of 200 Hz) and from 150 kHz to 30 MHz (resolution bandwidth 9 kHz) measurements are performed with a loop antenna (as per KDB 460108).

From 30 MHz to 1000 MHz, measurements are performed with a broadband biconilog antenna and a resolution bandwidth of 120 kHz.

Above 1000 MHz, measurements are performed with a DRG Horn antenna or a Standard Gain horn, and a resolution bandwidth of 1 MHz The EUT is raised to 150 cm above the ground plane, and the area between the EUT and the antenna mast is covered with RF absorbent material.

The scan is performed at discrete increments of turntable azimuth and antenna height, which are selected in accordance with the applicable standard in order to assure capture of frequencies of interest. Optimization is performed based on the scan data.

Frequencies having peak emissions within 10dB of the limits are optimized. The EUT is rotated in azimuth over 360 degrees and the direction of maximum emission is noted.

Antenna height is varied from 1 – 4 meters at this azimuth to obtain the maximum emission. Then the maximum level is measured with the appropriate detector and recorded. Up to 1 GHz, measurements are performed with a Quasi-Peak detector. Above 1 GHz, measurements are recorded with Peak and/or Average detectors, as applicable.

2.8.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.8.3 Uncertainty of Measurement:

The factors contributing to uncertainty of measurement are identified and calculated in accordance with UKAS (United Kingdom Accreditation Service) document “Lab 34, The Expression of Uncertainty in EMC Testing, Aug 2002.” as based on the “ISO Guide to the Expression of Uncertainty in Measurement, 1995.”

This uncertainty estimate represents an expended uncertainty expressed at approximately 95% confidence using a coverage factor of k = 2.

Test Method	Frequency	Uncertainty
Radiated Emissions Level	30 MHz – 1 GHz	±4.6 dB
Radiated Emissions Level	1 GHz – 26.5 GHz	±5.31 dB

2.8.4 Test Equipment

Testing was performed with the following equipment:

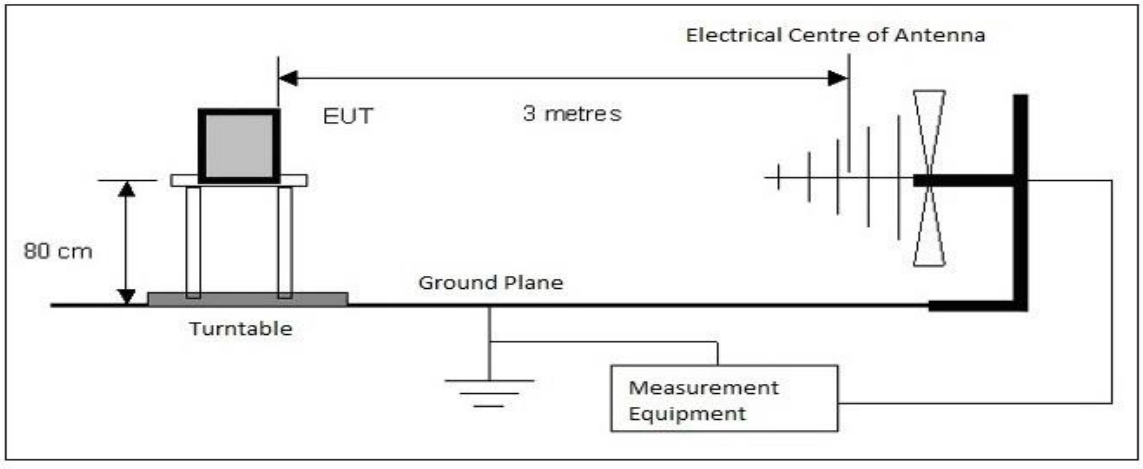
Equipment	Manufacturer	Model #	Asset #	Calibration Date	Interval	Calibration Due
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A		
EMI receiver	Agilent	N9038A	6130	2018-05-23	1yr	2019-05-23
Loop Antenna	EMCO	6502	10868	2017-03-29	2yr	2019-03-29
Biconilog Antenna	ARA	LPB-2520/A	4281	2018-04-23	1yr	2019-04-23
DRG Horn	EMCO	3115	19357	2016-08-24	2yr	2018-08-24
Humidity/Temp Logger	Extech Ins. Corp.	42270	5892	2018-04-13	1yr	2019-04-13
Low Noise Amplifier (1 – 18 GHz)	MITEQ	JS43-01001800-21-5P	4354	2018-01-03	1yr	2019-01-03
Pre-Amplifier (30 – 1300 MHz)	hp	8447D	9291	2018-01-03	1yr	2019-01-03
RE Cable below 1GHz	Insulated Wire Inc.	KPS-1501A-3600-KPA-01102006	4419	2018-01-03	1yr	2019-01-03
Re Cable Above 1 GHz	A.H. System Inc.	SAC-26G-8.23	6187	2018-01-03	1yr	2019-01-03

2.8.5 Test Sample Verification, Configuration & Modifications

The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation.

The EUT met the requirements without modification.

Test setup diagram for Radiated Spurious Emissions testing (below 1GHz):



Above 1GHz, the EUT is raised using a low permittivity material (polystyrene) to a height of 1.5m.

2.8.6 Radiated Emissions Data:

The emissions data are presented in tabular form, showing turntable azimuth, antenna height and polarization, the uncorrected spectrum analyzer reading, the correction factors applied, the net result, the value of the limit at the frequency investigated, and the Delta between the result and the limit.

Meter Reading in dBμV + Antenna Factor in dB/m + Gain/Loss Factor in dB = Corrected Field Strength in dbμV/m.

Delta = Field Strength - Limit

Notes:

- When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.
- Measurements reported are the result of adjusting the turntable azimuth and antenna height to obtain the maximum EUT emission. This may produce a different reading than the plot trace. The plot is a Peak Hold function obtained at discrete increments of height and azimuth, while the reported measurement is obtained with the appropriate Quasi Peak or Average detector after the height and azimuth have been adjusted for maximum emission.
- Preliminary scans were performed for all channels in Transmit modes. The MID band channel 908.6 MHz was selected as the worst-case condition for detailed examination.
- In Transmit mode, the EUT was assessed up to 10.0 GHz.

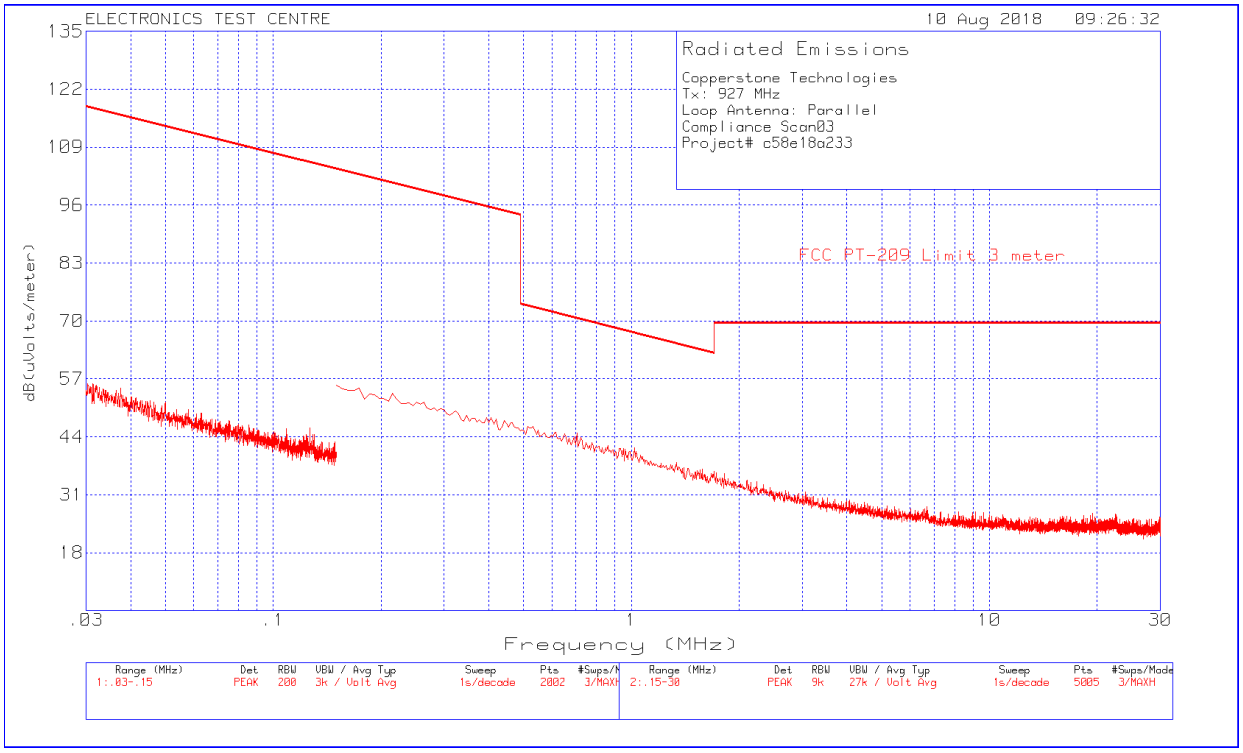
Freq. Marker	Freq. [MHz]	Raw reading [dBμv]	Det	Antenna Factor [dB/m]	Pre amp Gain [dB]	Corrected Reading [dBμv/m]	FCC 15.209 Limit [dBμv/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
1	927	108.52	PK	26.5	-18.5	116.52	125.23	-8.71	0	100	Horizontal
2	927	103.45	PK	26.5	-18.5	111.45	125.23	-13.78	276	102	Vertical
Frequency Range 1 – 3.6 GHz											
1	1854.1	60.49	PK	27.6	-34.4	53.69	-20dBc	-62.83	0	186	Horizontal
1	1854.1	57.33	AV	27.6	-34.4	50.33	-30dBc	-66.19	0	186	Horizontal
2	*2781.0	55.17	PK	29.3	-34.4	51.07	74	-22.93	88	187	Horizontal
2	*2781.0	49.83	AV	29.3	-34.4	45.73	54	-8.27	88	187	Horizontal
3	1854.1	58.28	PK	27.6	-34.4	51.48	-20dBc	-59.97	97	177	Vertical
3	1854.1	51.32	AV	27.6	-34.4	44.52	-30dBc	-66.93	97	177	Vertical
4	*2781.0	58.14	PK	29.3	-34.4	54.04	74	-19.96	155	163	Vertical
4	*2781.0	53.15	AV	29.3	-34.4	49.05	54	-4.95	155	163	Vertical
Frequency Range 3.6 – 10.0 GHz											
1	*3707.8	52.53	PK	32.1	-32.6	52.03	74	-21.97	127	291	Horizontal
1	*3707.8	41.7	AV	32.1	-32.6	41.2	54	-12.8	127	291	Horizontal
2	*4635.0	50.38	PK	32.8	-21.6	61.58	74	-12.42	281	100	Horizontal
2	*4635.0	40.75	AV	32.8	-21.6	51.95	54	-2.05	281	100	Horizontal
3	5563.1	49.97	PK	34.1	-29.8	54.27	-20dBc	-62.25	18	260	Horizontal
3	5563.1	34.39	AV	34.1	-29.8	38.69	-30dBc	-77.83	18	260	Horizontal
4	6489.0	49.96	PK	34.5	-28.9	55.56	-20dBc	-60.96	315	162	Horizontal
4	6489.0	37.14	AV	34.5	-28.9	42.74	-30dBc	-73.78	315	162	Horizontal
5	*7415.7	42.04	PK	36.5	-27.2	51.34	74	-22.66	337	152	Horizontal
5	*7415.7	28.44	AV	36.5	-27.2	37.74	54	-16.26	337	152	Horizontal
6	*8342.0	42.37	PK	37.1	-26.5	52.97	74	-21.03	321	176	Horizontal
6	*8342.0	28.88	AV	37.1	-26.5	39.48	54	-14.52	321	176	Horizontal
7	9269.2	41.72	PK	37.4	-26.4	52.72	-20dBc	-63.8	55	187	Horizontal
7	9269.2	27.41	AV	37.4	-26.4	38.41	-30dBc	-78.11	55	187	Horizontal
8	*3707.8	51.83	PK	32.1	-32.6	51.33	74	-22.67	40	110	Vertical
8	*3707.8	44.1	AV	32.1	-32.6	43.6	54	-10.4	40	110	Vertical

Freq. Marker	Freq. [MHz]	Raw reading [dBµv]	Det	Antenna Factor [dB/m]	Pre amp Gain [dB]	Corrected Reading [dBµv/m]	FCC 15.209 Limit [dBµv/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
Frequency Range 3.6 – 10.0 GHz											
9	*4635.0	52.23	PK	32.8	-21.6	63.43	74	-10.57	95	240	Vertical
9	*4635.0	41.99	AV	32.8	-31.3	53.19	54	-0.81	95	240	Vertical
10	5563.1	51.22	PK	34.1	-29.8	55.52	-20dBc	-55.93	160	109	Vertical
10	5563.1	39.83	AV	34.1	-29.8	44.13	-30dBc	-67.32	160	109	Vertical
11	6489.0	43.16	PK	34.5	-28.9	48.76	-20dBc	-62.69	142	149	Vertical
11	6489.0	24.98	AV	34.5	-28.9	30.58	-30dBc	-80.87	142	149	Vertical
12	*7415.7	37.83	PK	36.5	-27.2	47.13	74	-26.87	312	192	Vertical
12	*7415.7	24.44	AV	36.5	-27.2	33.74	54	-20.26	312	192	Vertical
13	*8342.0	39.93	PK	37.1	-26.5	50.33	74	-23.67	274	110	Vertical
13	*8342.0	25.82	AV	37.1	-26.5	36.42	54	-17.58	274	110	Vertical

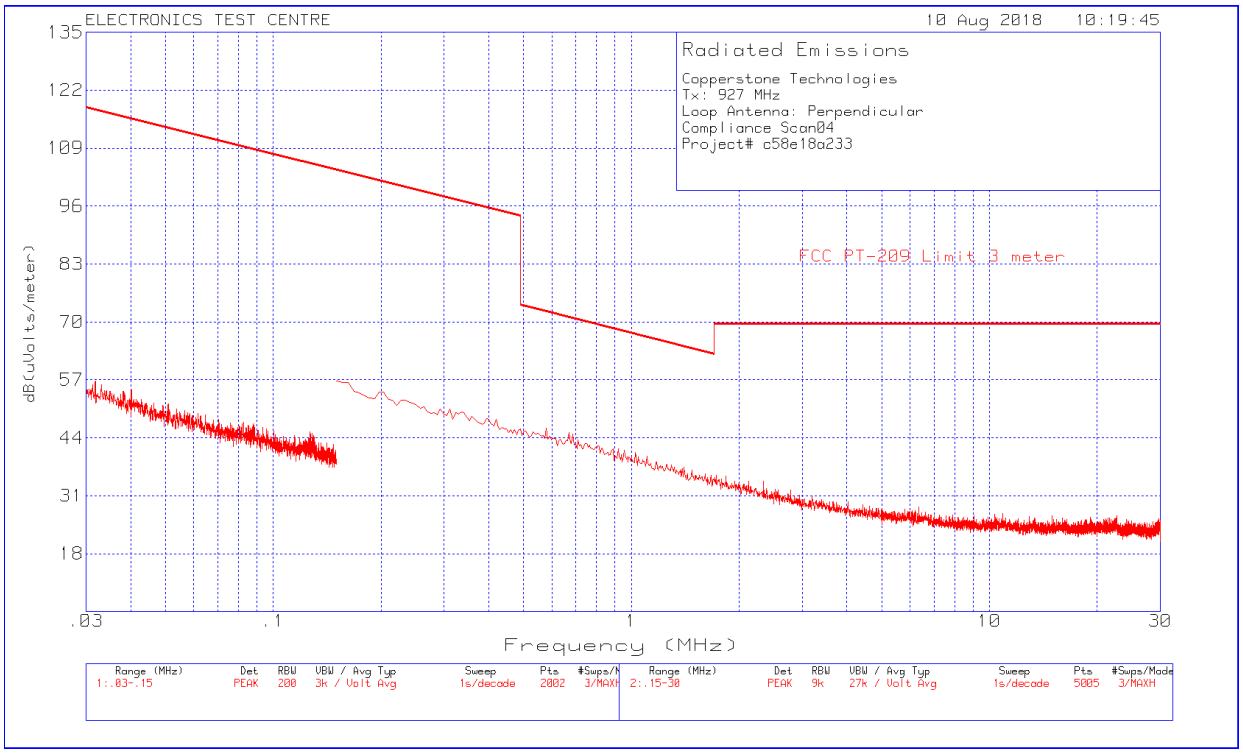
*** Restricted Band**

Negative values for Delta indicate compliance.

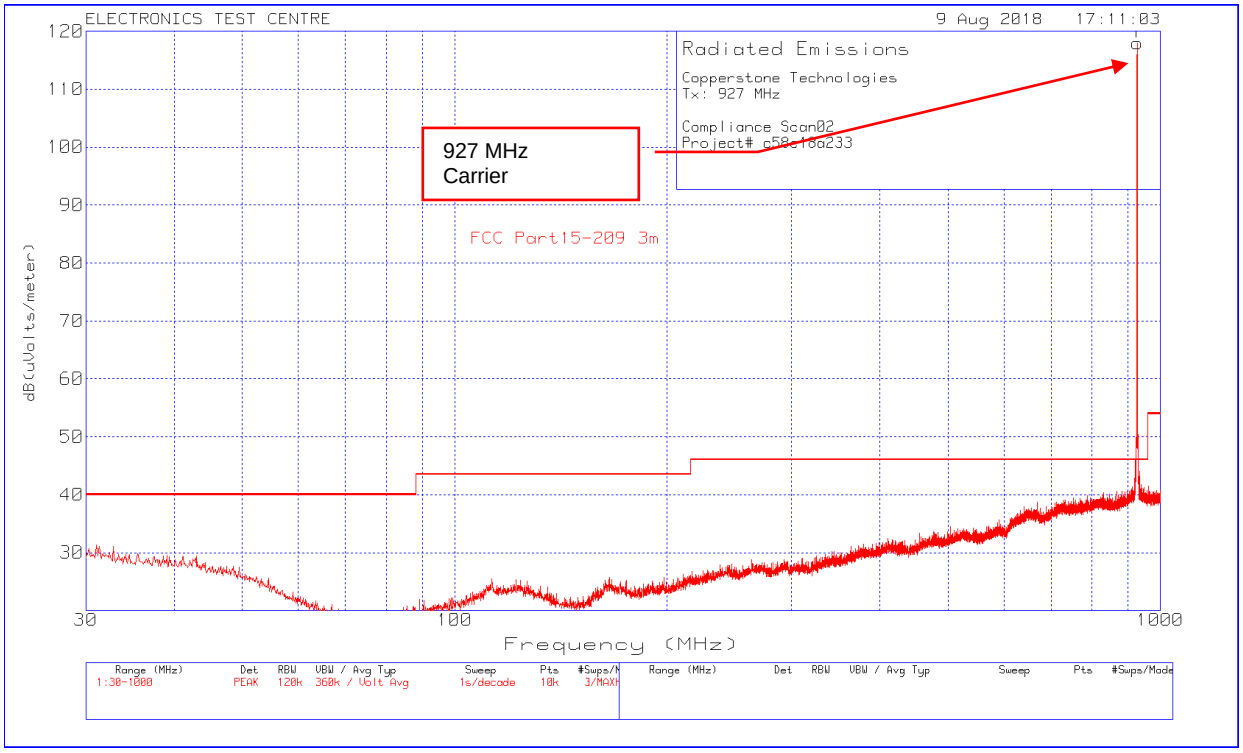
Plot of Radiated Emissions: Measuring Antenna Parallel



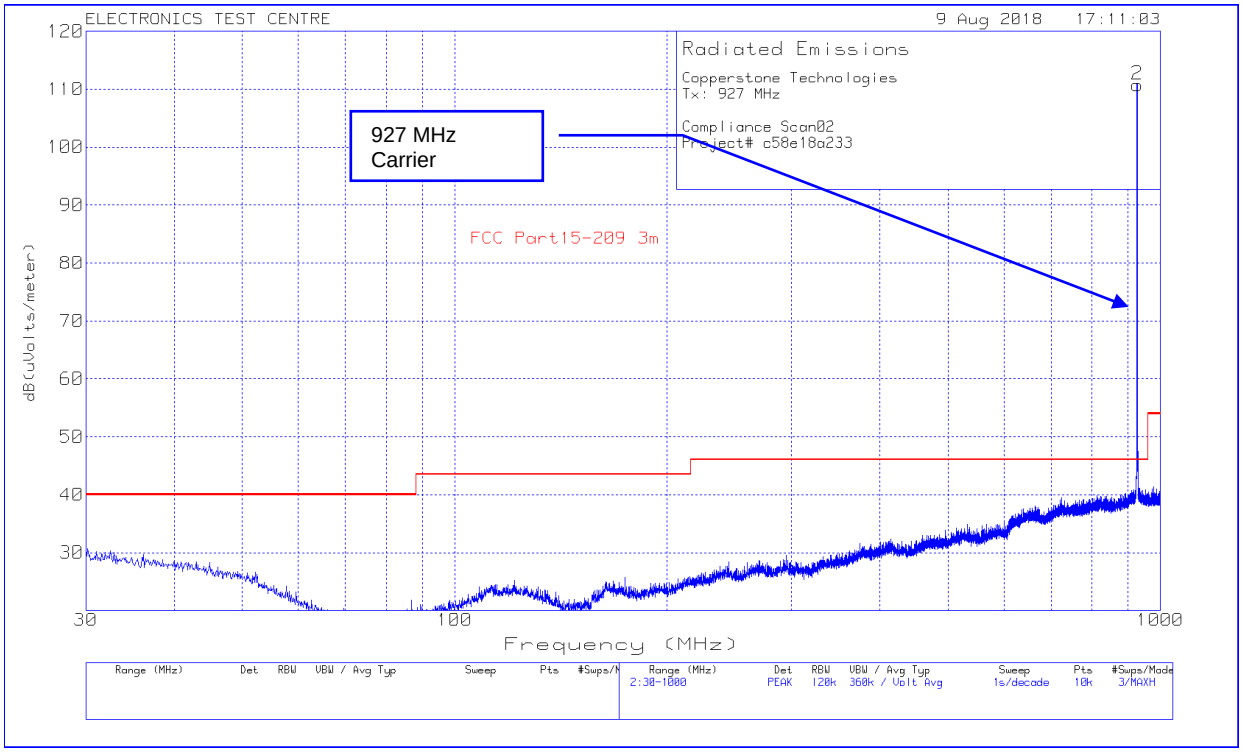
Plot of Radiated Emissions: Measuring Antenna Perpendicular



Plot of Radiated Emissions: Horizontal polarization

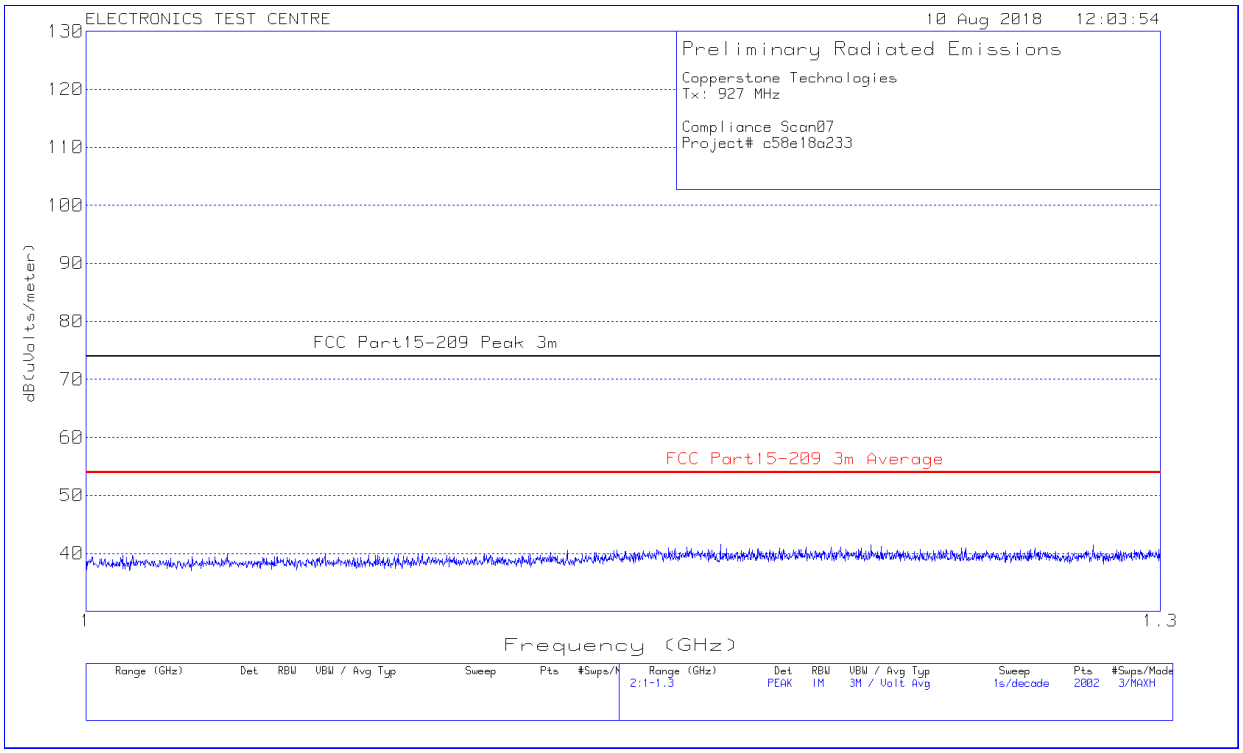


Plot of Radiated Emissions: Vertical polarization

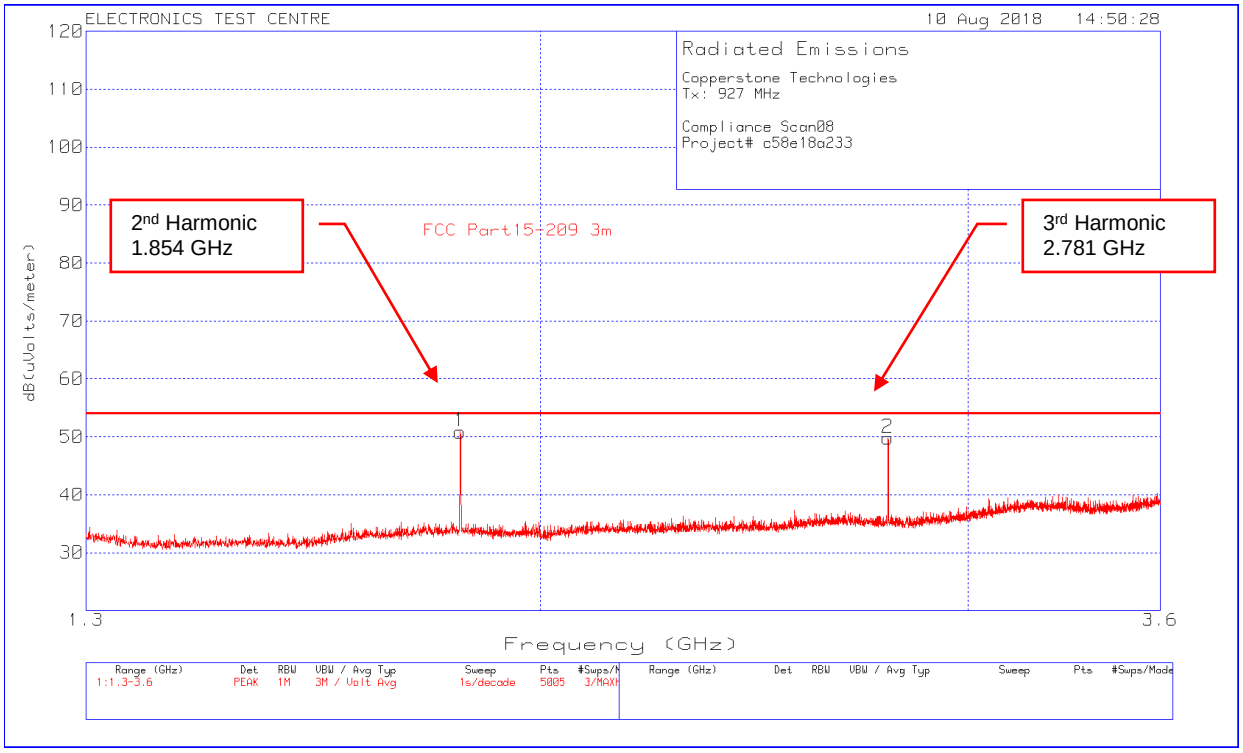


Plot of Radiated Emissions: Horizontal polarization

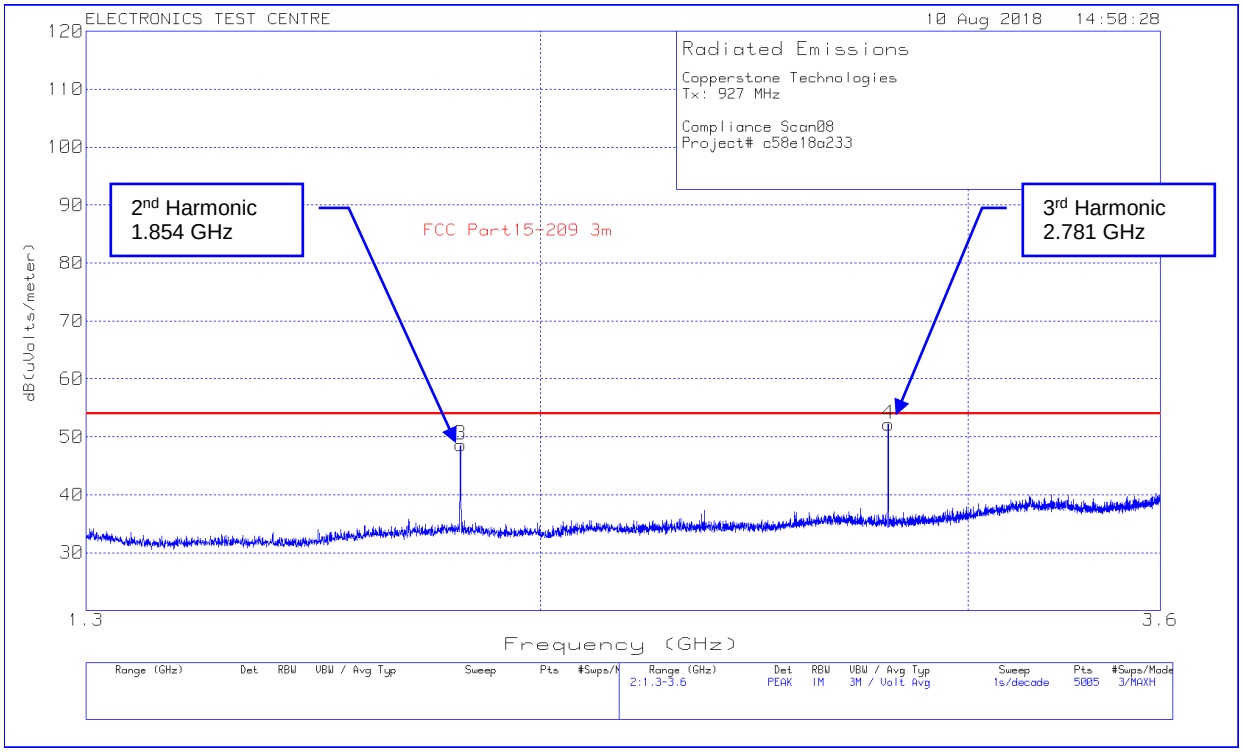
Plot of Radiated Emissions: Vertical polarization



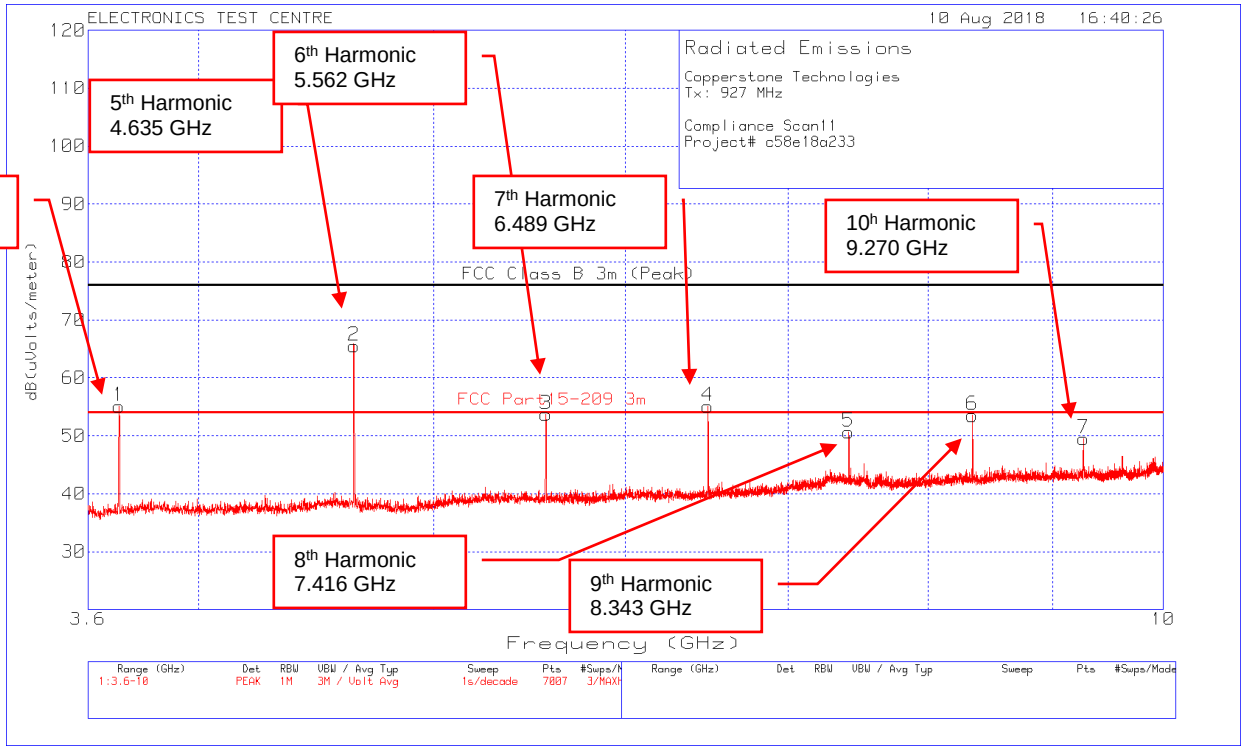
Plot of Radiated Emissions: Horizontal polarization



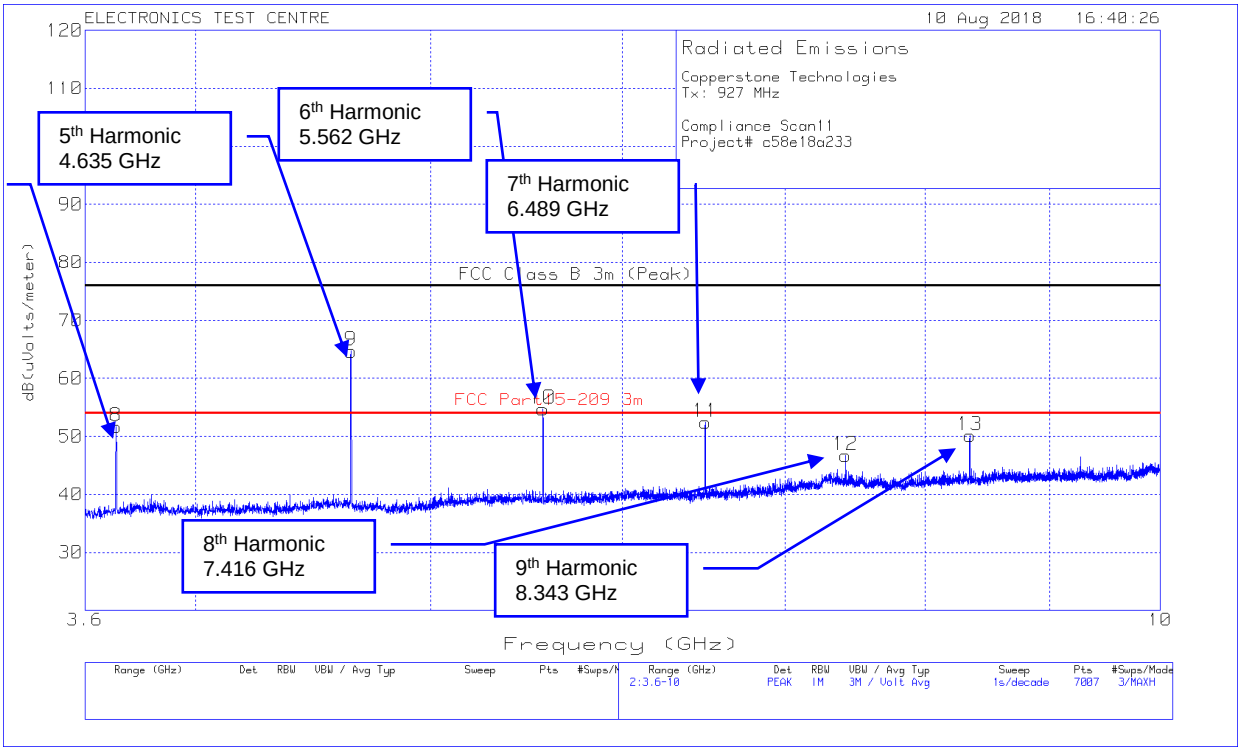
Plot of Radiated Emissions: Vertical polarization



Plot of Radiated Emissions: Horizontal polarization



Plot of Radiated Emissions: Vertical polarization



2.9 RF Exposure

Test Lab: Electronics Test Centre, Airdrie	**EUT: G900**
Test Personnel:	**Standard: FCC PART 15.247**
Date:	

EUT status: Exempt

Compliant: RF exposure assessment to be provided in a separate Exhibit.

3.0 TEST FACILITY

3.1 Location

The G900 was tested for emissions at the Electronics Test Centre laboratory located in Airdrie, Alberta, Canada. The Radio Frequency Anechoic Chamber (RFAC), identified as Chamber 1, has a usable working space measuring 10.6 m long x 7.3 m wide x 6.5 m high.

Measurements taken at this site are accepted by Industry Canada as evidence of conformity per registration file # 2046A. This site is also listed with the FCC under Registration Number CA2046.

The floor, walls and ceiling consist of annealed steel panels. The walls and ceiling are covered with ferrite tile, augmented by RF absorbant foam material on the end wall nearest the turntable, and on the adjacent walls and the ceiling. The chamber floor supports a 15 cm high internal floor, constructed of annealed steel panels, that forms the ground plane, and is bonded to the chamber walls.

The 3-m diameter turntable is flush-mounted with the floor. A sub-floor cable-way is provided to route cables between the turntable pit and EUT support equipment located in the Control Room. Cables reach the EUT through an opening in the centre of the turntable.

Test instrumentation and EUT support equipment is located in the Control Room, consisting of two shielded vestibules joined together at the side of the main room. Cables are routed through bulkhead panels between the rooms and the test chamber as required. Power feeds are routed into the main room and vestibules through line filters providing at least 100 dB of attenuation between 10 kHz and 10 GHz.

Either floor mounted or table-top equipment can be tested at this facility.

3.2 Grounding Plan

The G900 was placed at the centre of the test chamber turntable on top of an 80-cm high polystyrene foam table. The EUT was grounded according to Copperstone Technologies Ltd. specifications.

3.3 Power Supply

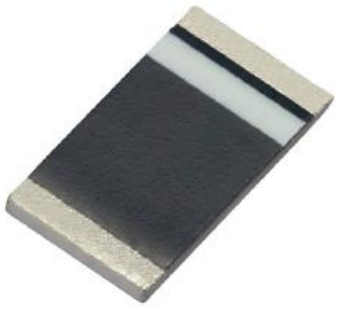
All EUT power was supplied by an internal rechargeable battery. There is no EUT function while the battery is charging.

Appendix A – Antenna

taoglas
antenna solutions

SPECIFICATION

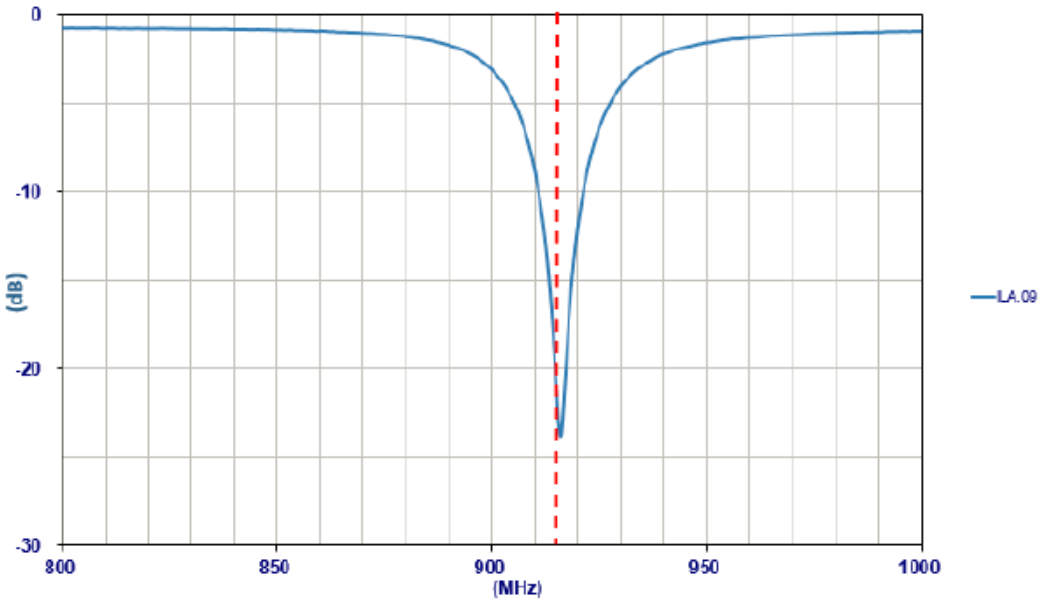
Part No.	:	**ILA.09**
Description	:	ISM 915MHz Chip Antenna for ISM / LoRa / LPWAN / Sigfox
Features	:	5.0mm *3.0mm * 0.5mm High Efficiency Omni-Directional Low Profile Compact Size Surface-Mount RoHS Compliant



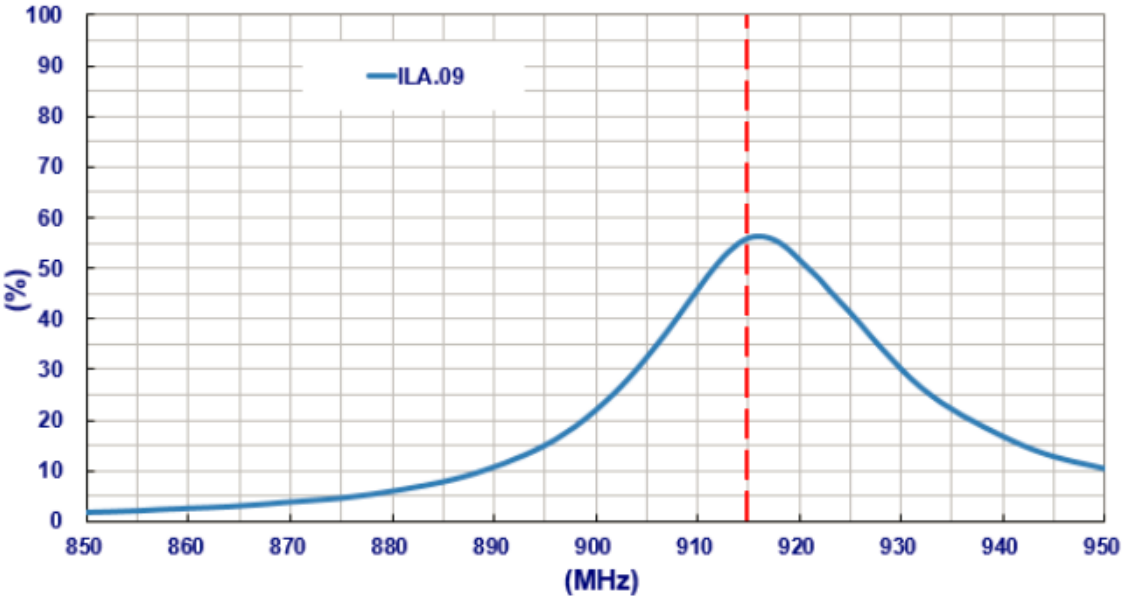
ELECTRICAL*			
Center Frequency (MHz)	902	915	928
Peak Gain (dBi)	-3.00	0.39	-1.78
Efficiency (%)	25.66	55.93	34.45
Return Loss (dB)	< -3	< -10	<-3
Impedance (Ω)	50		
Polarization	Linear		
Input Power	2W		
MECHANICAL			
Dimensions (mm)	5.0 x 3.0 x 0.5		
Ground plane (mm)	80 x 40 (Standard Evaluation Board)		
Weight (g)	0.02		
ENVIRONMENTAL			
Operating Temperature	-40°C to 85°C		
Storage Temperature	-25°C to 85°C		
Relative Humidity	20% to 70%		

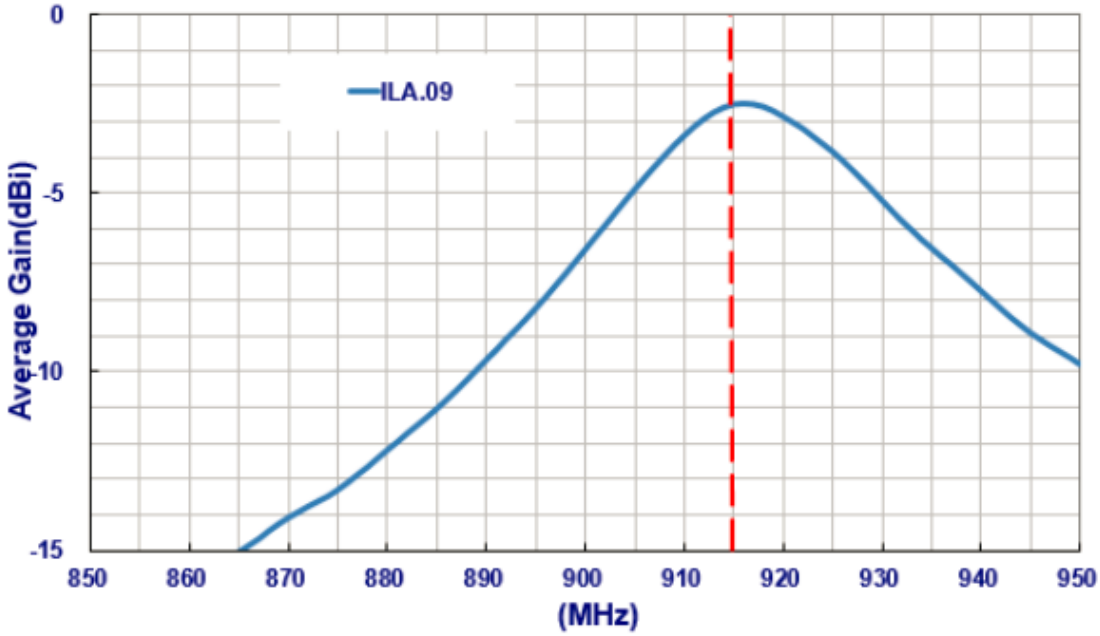
* Tested on 80*40mm evaluation board.

3.1 Return Loss

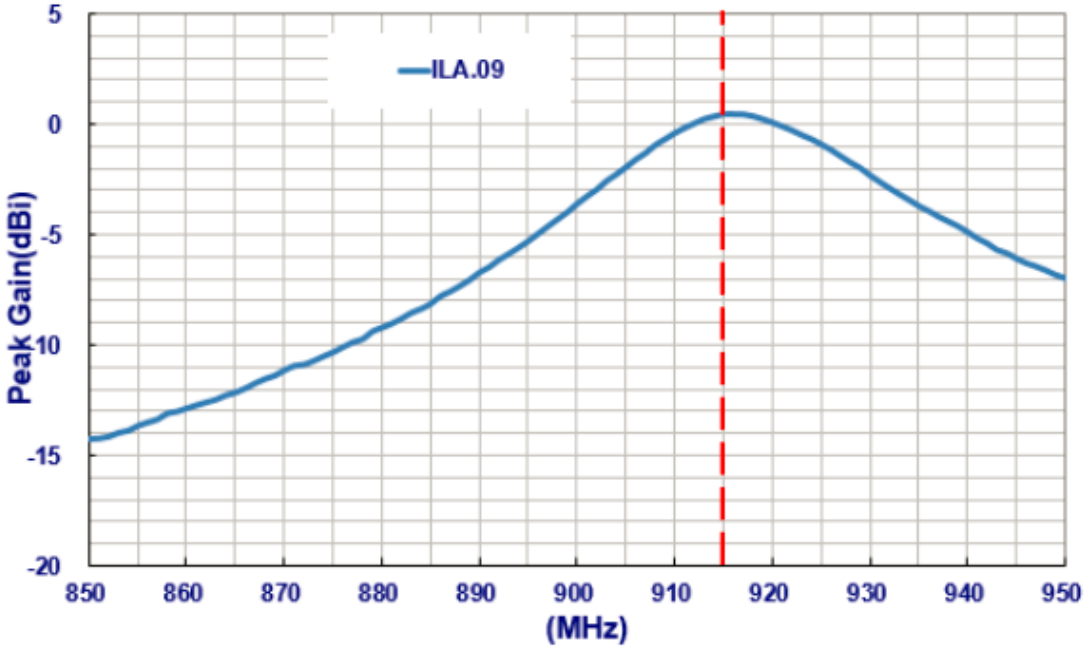


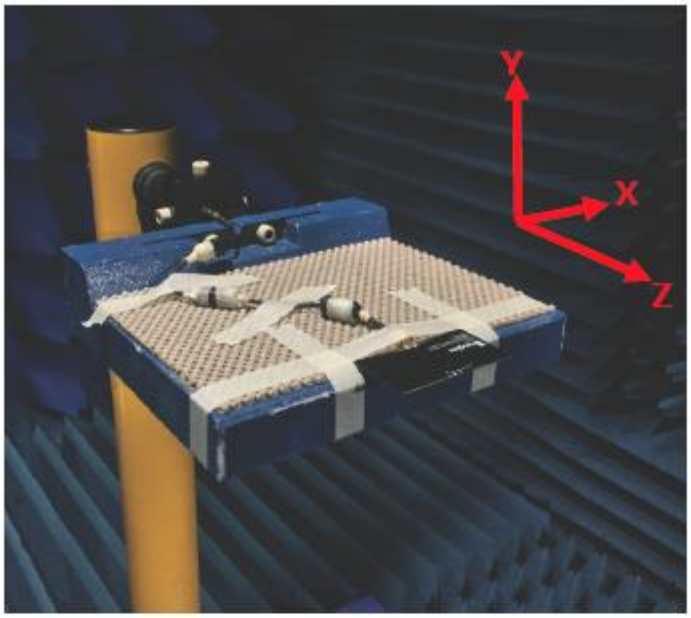
3.2 Efficiency



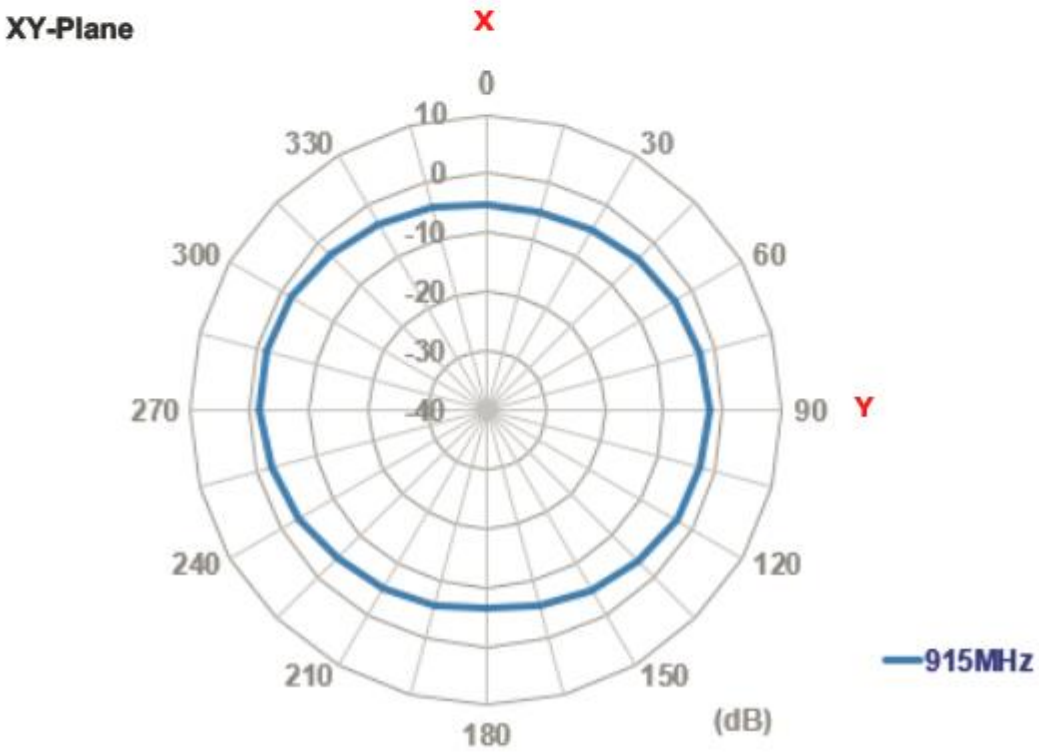

ILA.09
Average Gain(dBi)
0
-5
-10
-15
850
860
870
880
890
900
910
920
930
940
950
(MHz)

3.4 Peak Gain


ILA.09
Peak Gain(dBi)
5
0
-5
-10
-15
-20
850
860
870
880
890
900
910
920
930
940
950
(MHz)



4.1 2D Radiation Pattern



End of Document