TEST REPORT

Report Number: 103436674MPK-003
Project Number: G103436674
April 05, 2018

Testing performed on
Readers
Model: FAST-60-601-000001
FCC ID: 2APK7-9705082V1-0
IC: 23979-9705082V10

to

FCC Part 15 Subpart C (15.247)
Industry Canada RSS-247 Issue 2
FCC Part 15, Subpart B
Industry Canada ICES-003

For

Fastenal Company

Test Performed by:	Test Authorized by:
Intertek	Fastenal Company
1365 Adams Court	2001 Theurer Blvd.
Menlo Park, CA 94025 USA	Winona, MN 55987 USA

Prepared by: _____ **Date:** April 05, 2018
Aaron Chang

Reviewed by: _____ **Date:** April 05, 2018
Krishna K Vemuri

Report No. 103436674MPK-003

Equipment Under Test:	Readers
Trade Name:	Fastenal Company
Model Number:	FAST-60-601-000001
Applicant:	Fastenal Company
Contact:	Lee Zenke
Address:	Fastenal Company 2001 Theurer Blvd. Winona, MN 55987
Country	USA
Tel. Number:	(317) 429-4773
Email:	Lee.zenke@fastenal.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) Industry Canada RSS-247 Issue 2 FCC Part 15, Subpart B Industry Canada ICES-003 Issue 6
Date of Test:	March 5-27, 2018

We attest to the accuracy of this report:

Aaron Chang
Project Engineer

Krishna K Vemuri
Engineering Team Lead

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1.0 Summary of Tests

Test	Reference FCC	Reference Industry Canada	Result
RF Output Power	15.247(b)(3)	RSS-247, 5.4.4	Complies
6 dB Bandwidth	15.247(a)(2)	RSS-247, 5.2.1	Complies
Power Density	15.247(e)	RSS-247, 5.2.2	Complies
Out of Band Antenna Conducted Emission	15.247(d)	RSS-247, 5.5	Complies
Transmitter Radiated Emissions	15.247(d), 15.209, 15.205	RSS-247, 5.5	Complies
AC Line Conducted Emission	15.207	RSS-GEN	Complies
Antenna Requirement	15.203	RSS-GEN	Complies (Internal Antenna)
RF Exposure	15.247(i), 2.1093(d)	RSS-102	Complies
Radiated Emissions	15.109	ICES-003	Complies
AC Line Conducted Emission	15.107	ICES-003	Complies

EUT receive date: March 05, 2018

EUT receive condition: The pre-production version of the EUT was received in good condition with no apparent damage. As declared by the Applicant, it is identical to the production units.

Test start date: March 5, 2018

Test completion date: March 27, 2018

The test results in this report pertain only to the item tested.

2.0 General Information

2.1 Product Description

Fastenal Company supplied the following description of the EUT:

Device that takes an inventory of RFID tagged Bins and forwards this data to an in-range Controller via LoRa.

Information about the LoRa radio is presented below:

For more information, refer to the following product specification, declared by the manufacturer.

Information about the 900 MHz radio is presented below:

Applicant	Fastenal Company
Model No.	FAST-60-601-000001
FCC Identifier	2APK7-9705082V1-0
IC Identifier	23979-9705082V10
Type of transmission	Digital Transmission System (DTS)
Rated RF Output	17.58 dBm
Antenna(s) & Gain	PCB Antenna, Gain: 5.1 dBi
Frequency Range	903 – 914.2 MHz (Tx); 923.3 – 927.5 MHz (Rx)
Type of modulation	LoRa® Technology
Data rate	1760 bps
Number of Channel(s)	16 Total (8 Tx and 8 Rx)
Applicant Name & Address	Fastenal Company 2001 Theurer Blvd. Winona, MN 55987 USA

2.2 Related Submittal(s) Grants

None.

2.3 Test Facility

The test site used to collect the radiated data is site 1 (10-m semi-anechoic chamber). This test facility and site measurement data have been fully placed on file with the FCC, IC and A2LA accredited.

2.4 Test Methodology

Antenna conducted measurements were performed according to the FCC documents "Guidance for Performing Compliance Measurement on Digital Transmission Systems (DTS) Operating under §15.247" (KDB 558074 D01 DTS Meas Guidance v04), and RSS-247, RSS-GEN Issue 4.

Radiated emissions and AC mains conducted emissions measurements were performed according to the procedures in ANSI C63.10: 2013. Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "Data Sheet" of this report.

2.5 Measurement Uncertainty

Compliance with the limits was based on the results of the measurements and doesn't take into account the measurement uncertainty.

Estimated Measurement Uncertainty

Measurement	Expanded Uncertainty (k=2)		
	0.15 MHz – 1 GHz	1 GHz – 2.5 GHz	> 2.5 GHz
RF Power and Power Density – antenna conducted	-	0.7 dB	-
Unwanted emissions - antenna conducted	1.1 dB	1.3 dB	1.9 dB
Bandwidth – antenna conducted	-	30 Hz	-

Measurement	Expanded Uncertainty (k=2)			
	0.15 MHz – 30MHz	30 – 200 MHz	200 MHz – 1 GHz	1 GHz – 18 GHz
Radiated emissions	-	4.7	4.6	5.1 dB
AC mains conducted emissions	2.1 dB	-	-	-

3.0 System Test Configuration

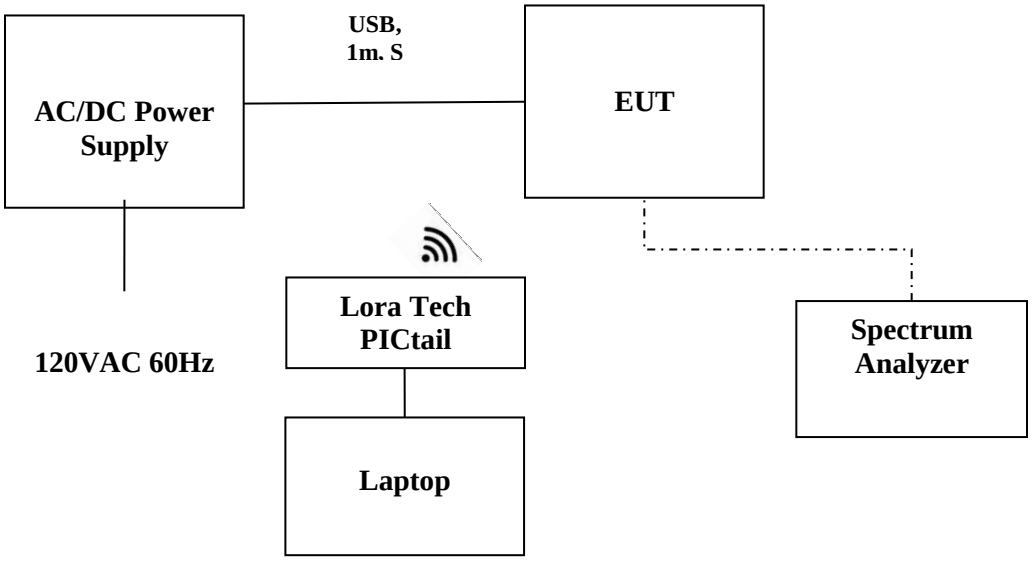
3.1 Support Equipment

Description	Manufacturer	Model Number
Laptop	HP	ProBook 430
LoRa Tech PICtail	MicroChip	MTI160581148

3.2 Block Diagram of Test Setup

Equipment Under Test			
Description	**Manufacturer**	**Model Number**	**Serial Number**
Readers	Fastenal Company	FAST-60-601-000001	Rd-0000014
AC/DC Power Supply	CUI Inc	SWI12-5-N	No markings

Antenna was removed and co-axial connector with a cable was installed for Conducted Measurements.



S = Shielded **U** = Unshielded	**F** = With Ferrite **m** = Length in Meters

3.3 Justification

For radiated emission measurements the EUT is placed on a non-conductive table.

3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was provided by Fastenal Company

3.5 Mode of Operation during Test

During transmitter testing, the transmitter was setup to transmit at maximum RF power on low, middle and high frequencies/channels.

3.5 Modifications Required for Compliance

No modifications were made by the manufacturer or Intertek to the EUT in order to bring the EUT into compliance.

3.6 Additions, Deviations and Exclusions from Standards

No additions, deviations or exclusions from the standard were made.

4.0 Measurement Results

4.1 6-dB Bandwidth and 99% Occupied Bandwidth
FCC Rule: 15.247(a)(2); RSS-247 A8.2 and RSS-GEN;

4.1.1 Requirement

The minimum 6-dB bandwidth shall be at least 500 kHz

4.1.2 Procedure

A spectrum analyzer was connected to the antenna port of the transmitter.

For FCC 6dB Channel Bandwidth the Procedure described in the FCC Publication 558074 D01 DTS Meas Guidance v04 was used to determine the DTS occupied bandwidth. Section 8.1 Option 1 was used.

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

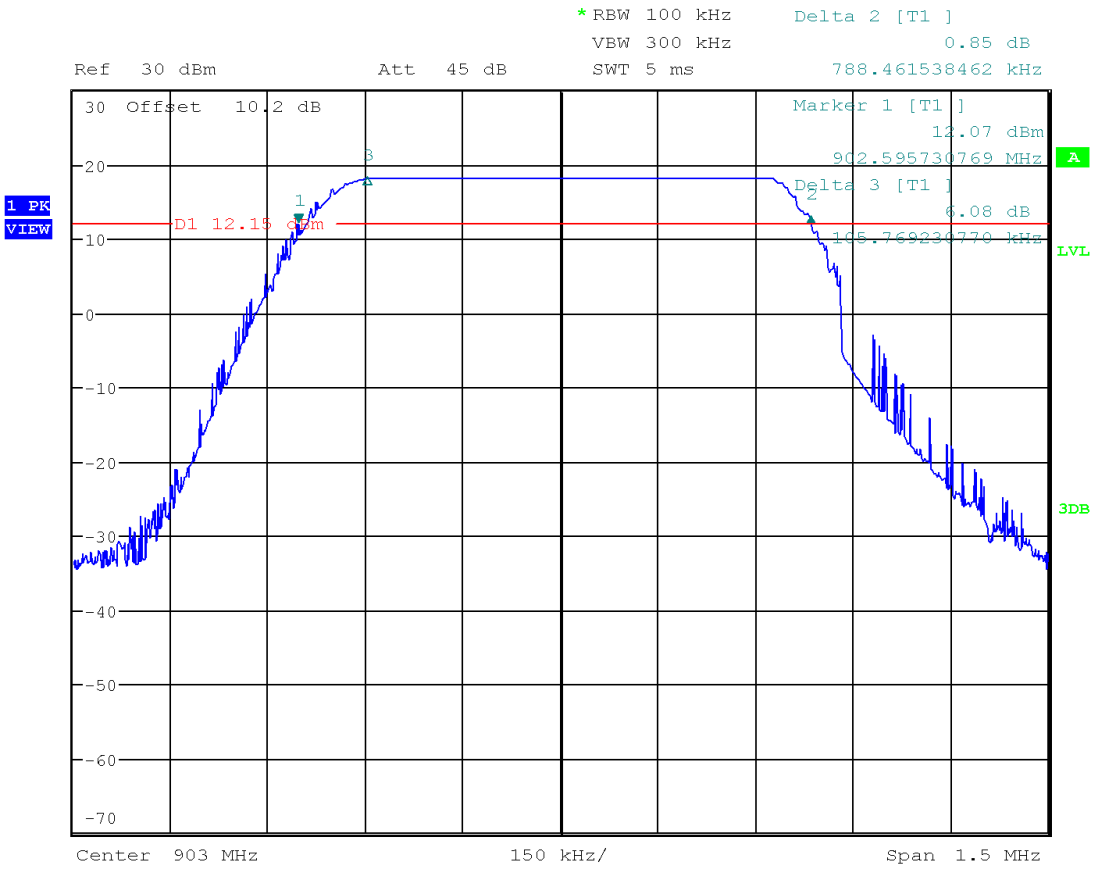
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

4.1.3 Test Result

Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN, kHz	Occupied bandwidth, RSS-GEN, kHz	Plot
903	788.461	--	1.1
	--	632.000	1.4
907.8	798.077	--	1.2
	--	632.000	1.5
914.2	777.692	--	1.3
	--	640.000	1.6

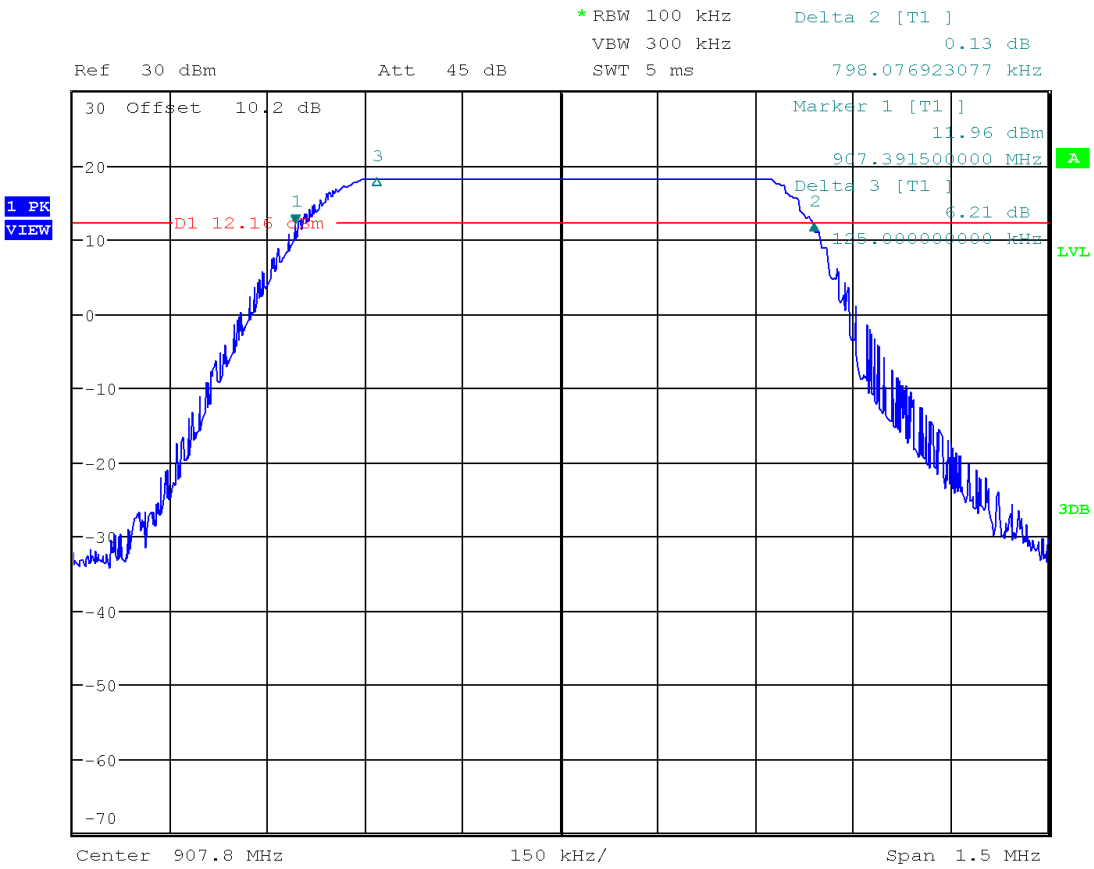
Date of Test:	March 15, 2018
Results	**Complies**

Plot 1. 1



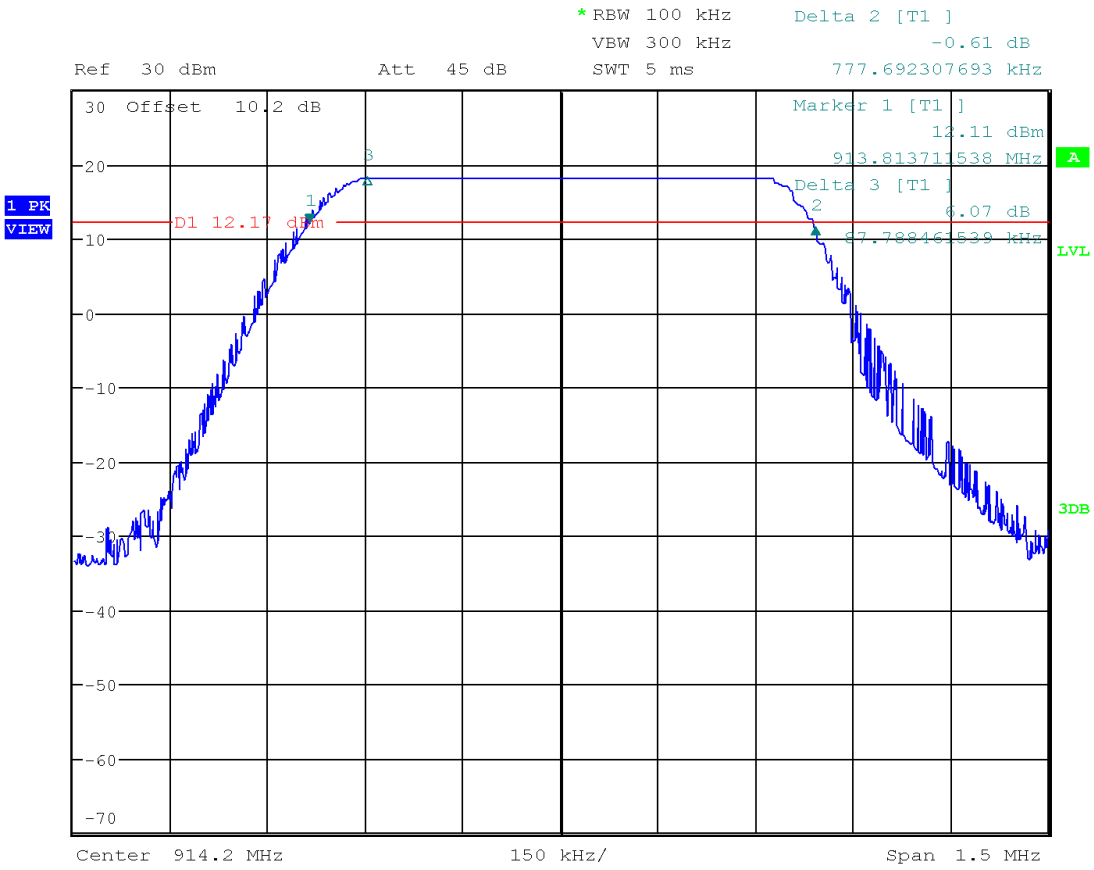
Date: 15.MAR.2018 05:24:13

Plot 1. 2



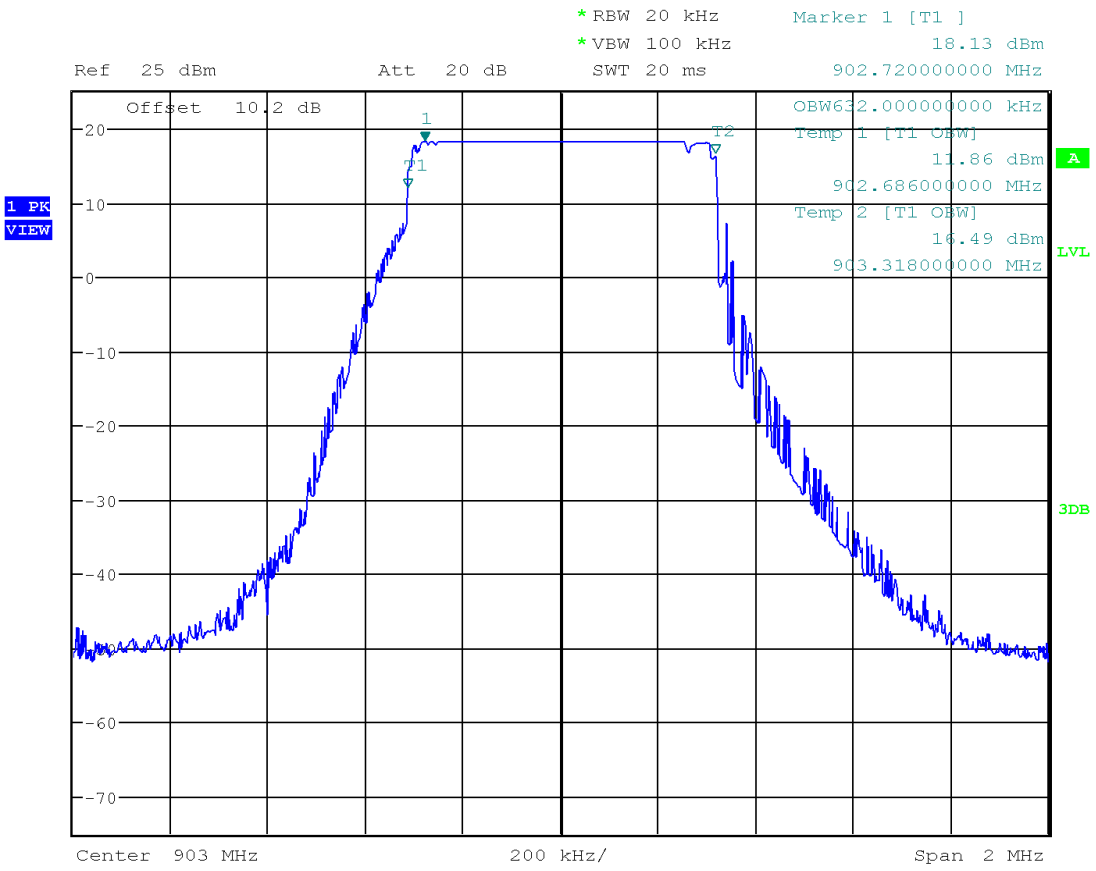
Date: 15.MAR.2018 05:20:18

Plot 1. 3

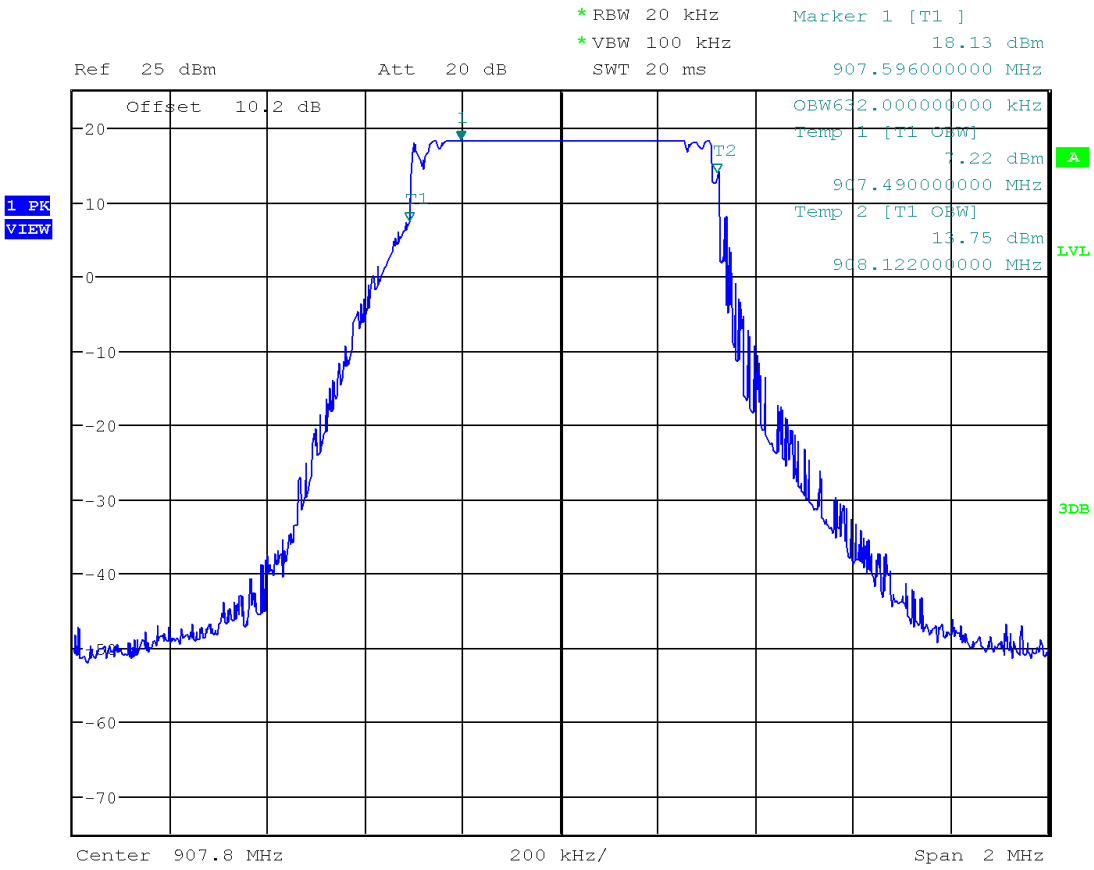


Date: 15.MAR.2018 05:14:30

Plot 1. 4

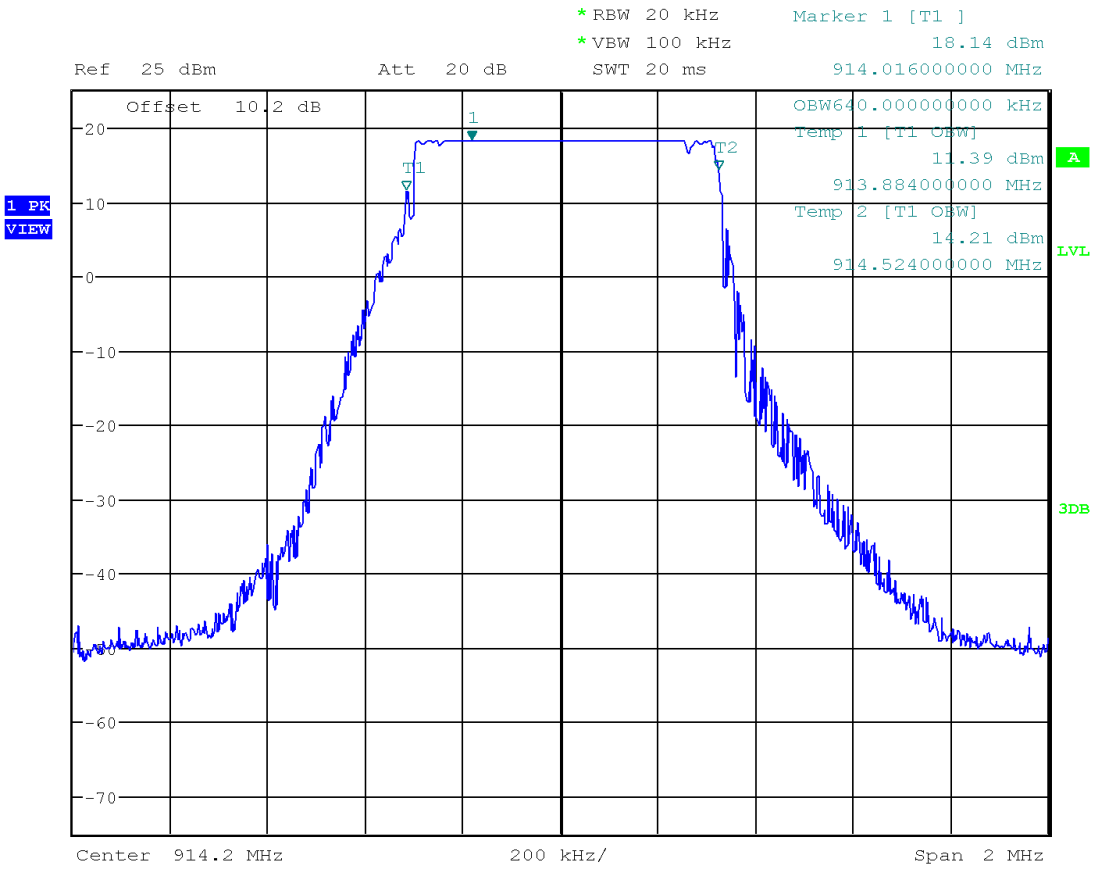

* RBW 20 kHz
* VBW 100 kHz
SWT 20 ms
Marker 1 [T1]
18.13 dBm
902.720000000 MHz
Ref 25 dBm
Att 20 dB
Offset 10.2 dB
OBW632.000000000 kHz
Temp 1 [T1 OBW]
11.86 dBm
902.686000000 MHz
Temp 2 [T1 OBW]
16.49 dBm
903.318000000 MHz
1 PK
VIEW
A
LVL
3DB
20
10
0
-10
-20
-30
-40
-60
-70
Center 903 MHz
200 kHz/
Span 2 MHz
Date: 15.MAR.2018 05:44:57

Plot 1.5



Date: 15.MAR.2018 05:47:14

Plot 1.6



Date: 15.MAR.2018 05:50:08

4.2 Maximum Peak Conducted Output Power at Antenna Terminals
FCC Rule: 15.247(b)(3); RSS-247 A8.4;

4.2.1 Requirement

For antennas with gains of 6 dBi or less, maximum allowed transmitter output is 1 watt or 30 dBm.
For antennas with gains greater than 6 dBi, transmitter output level must be decreased appropriately, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.2.2 Procedure

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v04 was used.
Specifically, section 9.2.2.1 Method AVGSA-1 Alternative (RMS detection with slow sweep and EUT transmitting continuously at full power) was utilized.

1. Set span to at least 1.5 x OBW.
2. Set RBW = 1 % to 5 % of the OBW, not to exceed 1 MHz.
3. Set VBW ≥ 3 x RBW.
4. Number of points in sweep ≥ 2 x span / RBW.
5. Manually set sweep time ≥ 10 x (number of points in sweep) x (transmission symbol period), but not less than the automatic default sweep time.
6. Detector = RMS
7. The EUT shall be operated at ≥ 98 % duty cycle or sweep triggering/signal gating shall be employed such that the sweep time is less than or equal to the transmission duration T.
8. Perform a single sweep.
9. Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function, with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

A spectrum analyzer was connected to the antenna port of the transmitter.

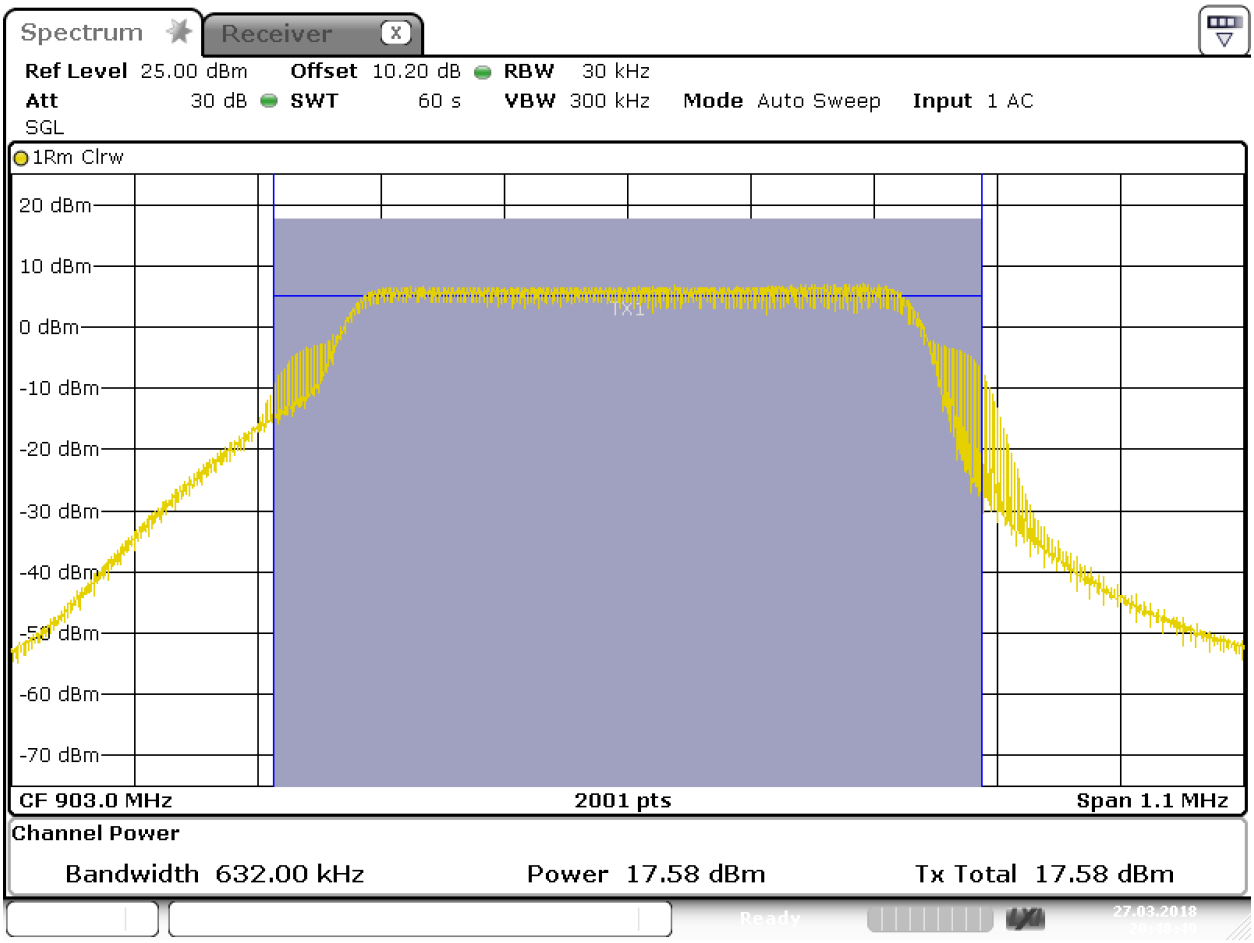
4.3.3 Test Result

Refer to the following plots 2.1 – 2.3 for the test details.

Frequency, MHz	Conducted Power (peak), dBm	Conducted Power (peak), mW	Plot
903	17.58	57.28	2.1
907.8	17.56	57.02	2.2
914.2	17.53	56.62	2.3

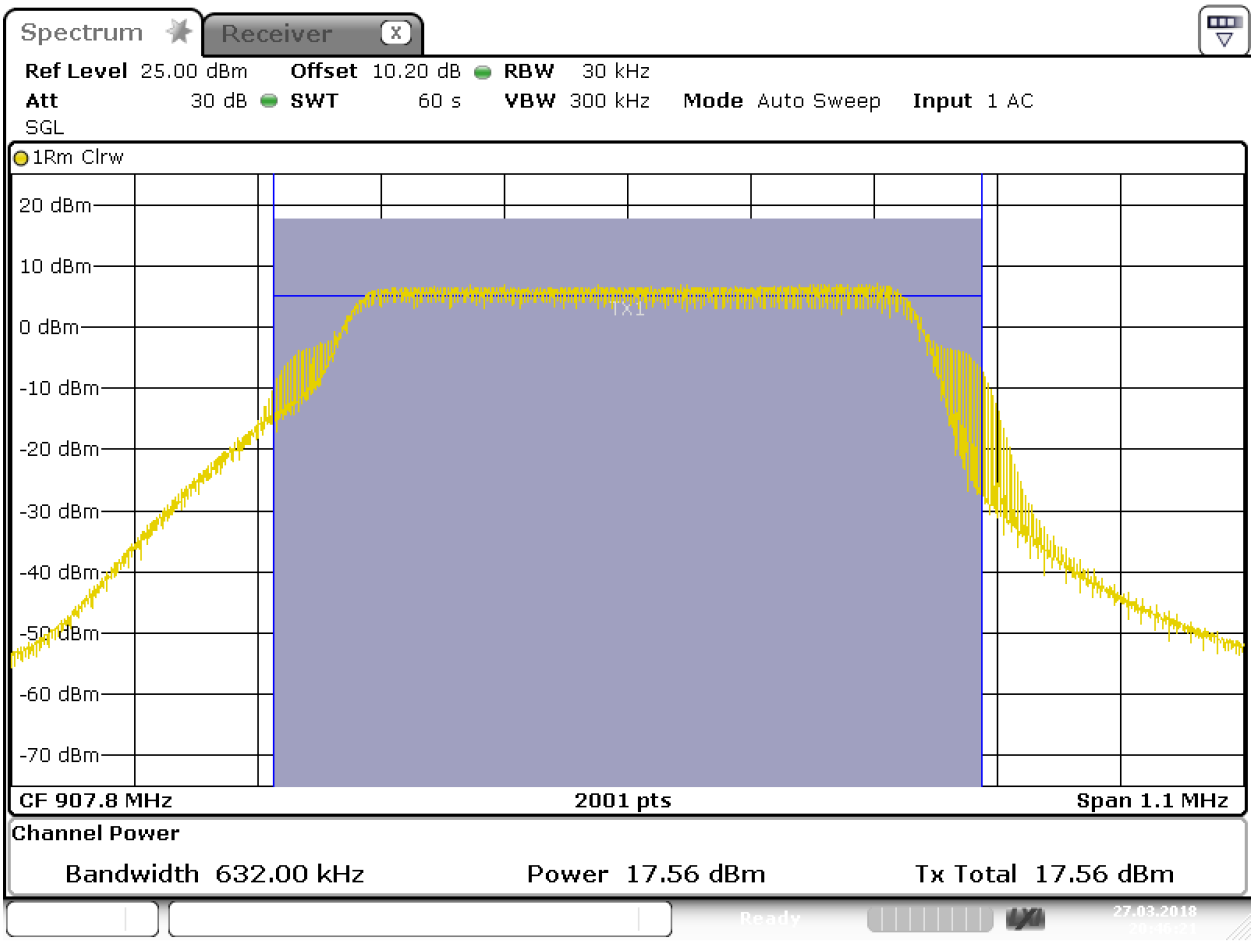
Date of Test:	March 27, 2018
Results	**Complies**

Plot 2. 1



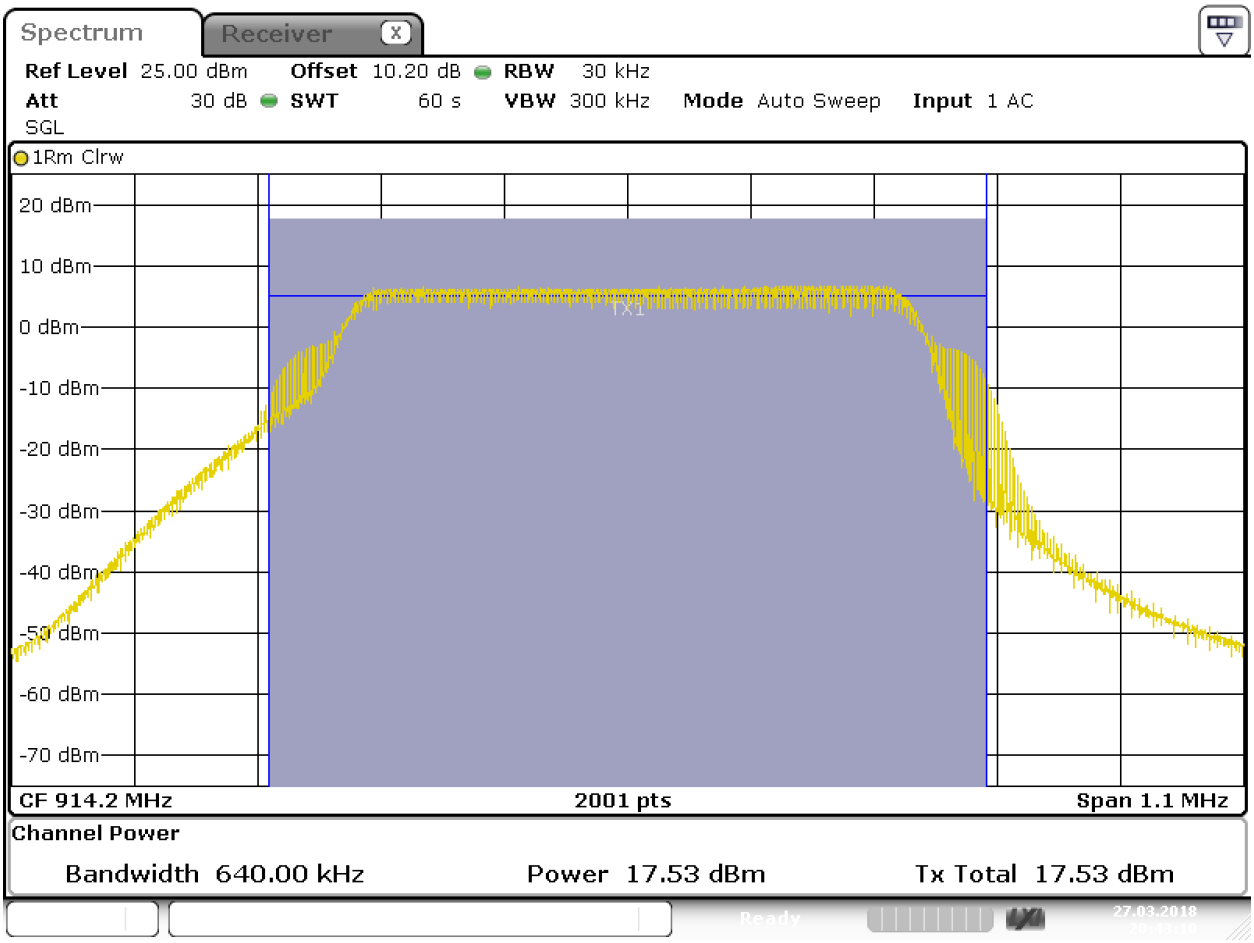
Date: 27.MAR.2018 20:48:49

Plot 2. 2



Date: 27.MAR.2018 20:46:21

Plot 2. 3



Date: 27.MAR.2018 20:43:10

4.3 Maximum Power Spectral Density
FCC: 15.247 (e); RSS-247 A8.2b;

4.3.1 Requirement

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

4.3.2 Procedure

A spectrum analyzer was connected to the antenna port of the transmitter.

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v04, specifically section 10.3 Method AVGPSD-1 (trace averaging with EUT transmitting at full power throughout each sweep).

1. Set instrument center frequency to DTS channel center frequency.
2. Set the span to at least 1.5 x OBW.
3. Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = power averaging (RMS) or sample detector (when RMS not available).
6. Ensure that the number of measurement points in the sweep ≥ 2 x span/RBW.
7. Sweep time = auto couple.
8. Employ trace averaging (RMS) mode over a minimum of 100 traces.
9. Use the peak marker function to determine the maximum amplitude level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span in order to meet the minimum measurement point requirement as the RBW is reduced).

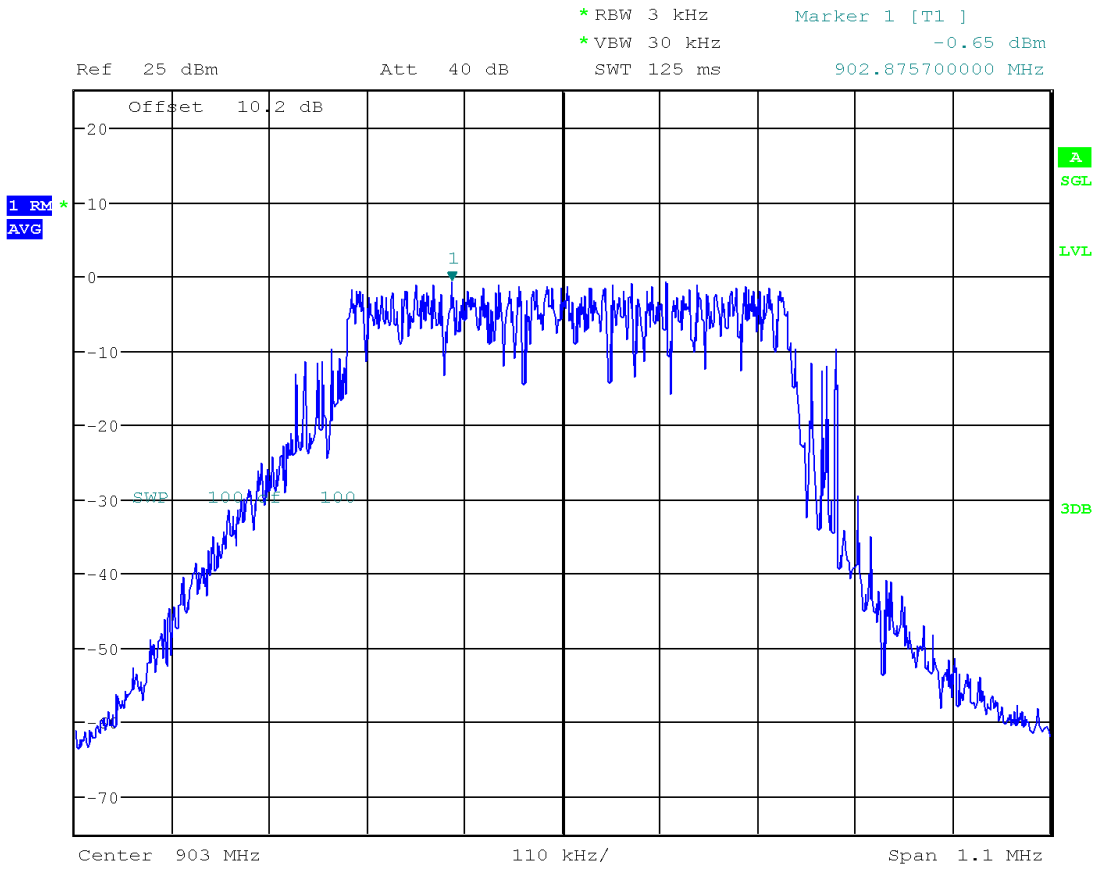
4.3.3 Test Result

Refer to the following plots for the test result

Frequency, MHz	Maximum Power Spectral Density, dBm	Maximum Power Spectral Density Limit, dBm	Margin, dB	Plot
903	-0.65	8.0	-8.65	3.1
907.8	-1.13	8.0	-9.13	3.2
914.2	0.06	8.0	-7.94	3.3

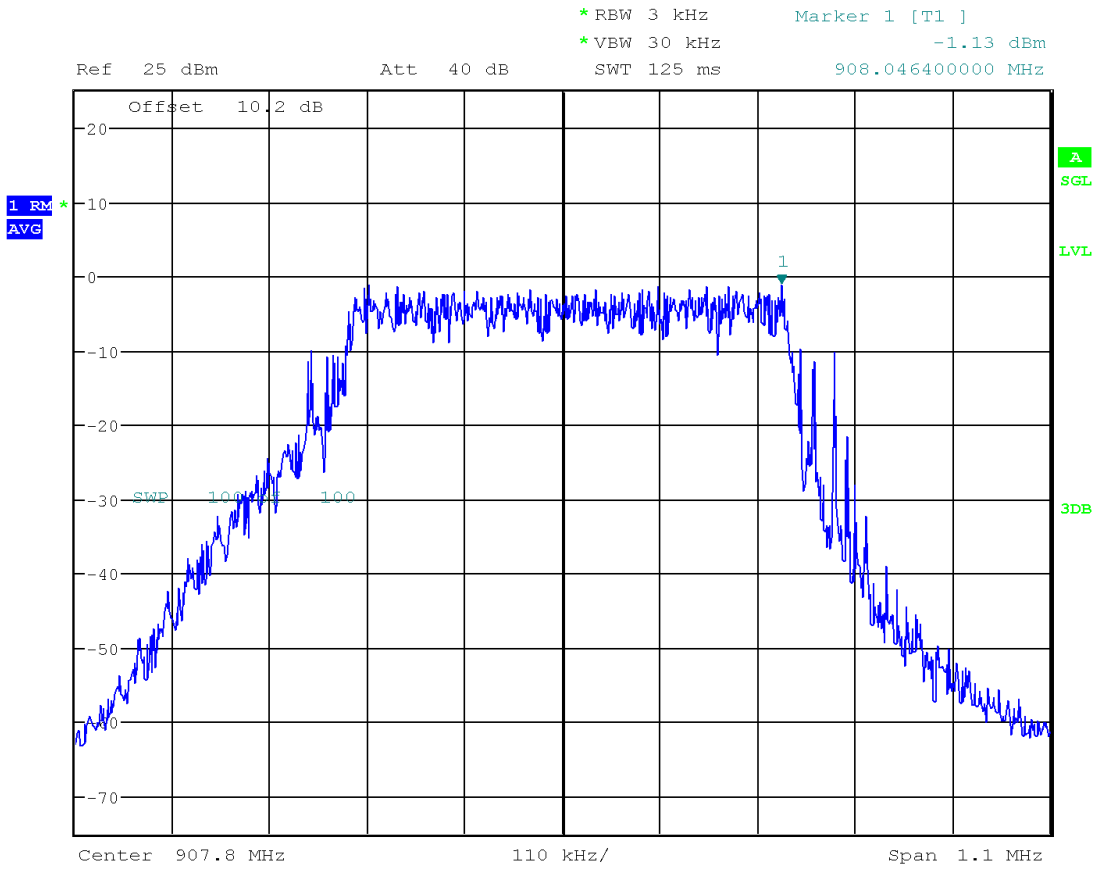
Date of Test:	March 15, 2018
Results	**Complies**

Plot 3. 1

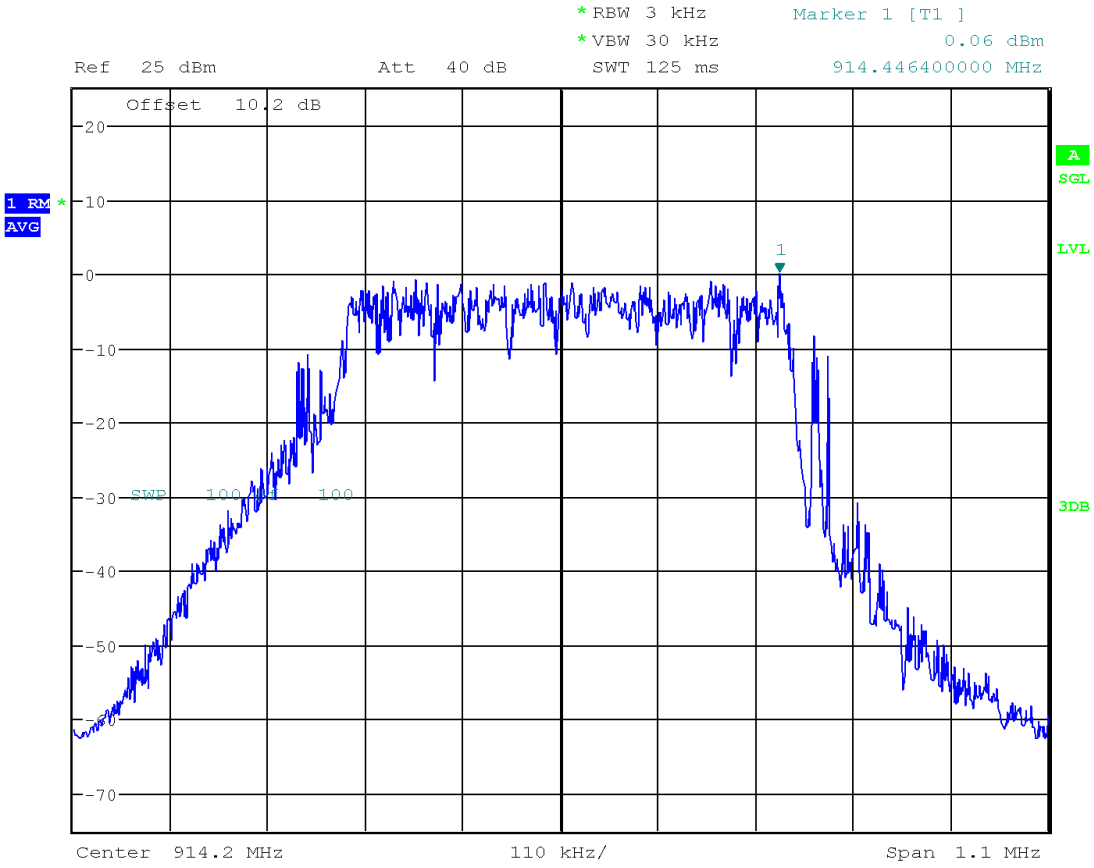


Date: 15.MAR.2018 06:05:49

Plot 3. 2


* RBW 3 kHz
* VBW 30 kHz
SWT 125 ms
Marker 1 [T1]
-1.13 dBm
908.046400000 MHz
Ref 25 dBm
Att 40 dB
Offset 10.2 dB
1 RM *
AVG
A
SGL
LVL
3DB
SWP 100 ms 100
Center 907.8 MHz
110 kHz/
Span 1.1 MHz
Date: 15.MAR.2018 06:03:36

Plot 3. 3


* RBW 3 kHz
* VBW 30 kHz
SWT 125 ms
Marker 1 [T1]
0.06 dBm
914.446400000 MHz
Ref 25 dBm
Att 40 dB
Offset 10.2 dB
1 RM
AVG
A
SGL
LVL
3DB
SWP 100
100
Center 914.2 MHz
110 kHz/
Span 1.1 MHz
Date: 15.MAR.2018 06:04:24

4.4 Unwanted Conducted Emissions
FCC: 15.247(d); RSS-247 A8.5;

4.4.1 Requirement

In any 100 kHz bandwidth outside the EUT pass-band, the RF power shall be below the maximum in-band 100 kHz emissions by at least 20 dB (if peak power of in-band emission is measured) or 30 dB (if average power of in-band emission is measured).

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)

4.4.2 Procedure

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v04, specifically section 11.0 Emissions in non-restricted frequency bands.

A spectrum analyzer was connected to the antenna port of the transmitter.

1. Set the RBW = 100 kHz.
2. Set the VBW ≥ 3 x RBW.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

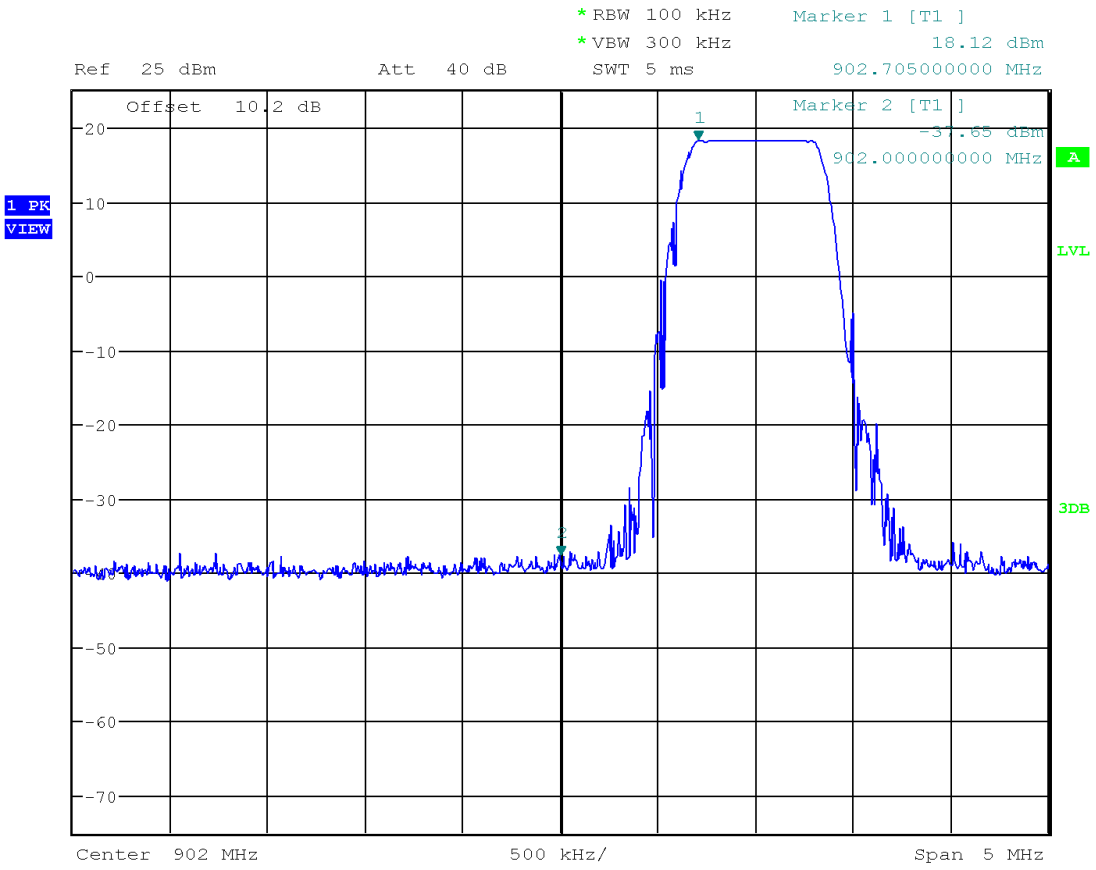
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

4.4.3 Test Result

Refer to the following plots 4.1 – 4.5 for unwanted conducted emissions. The plot shows -20dB attenuation limit line.

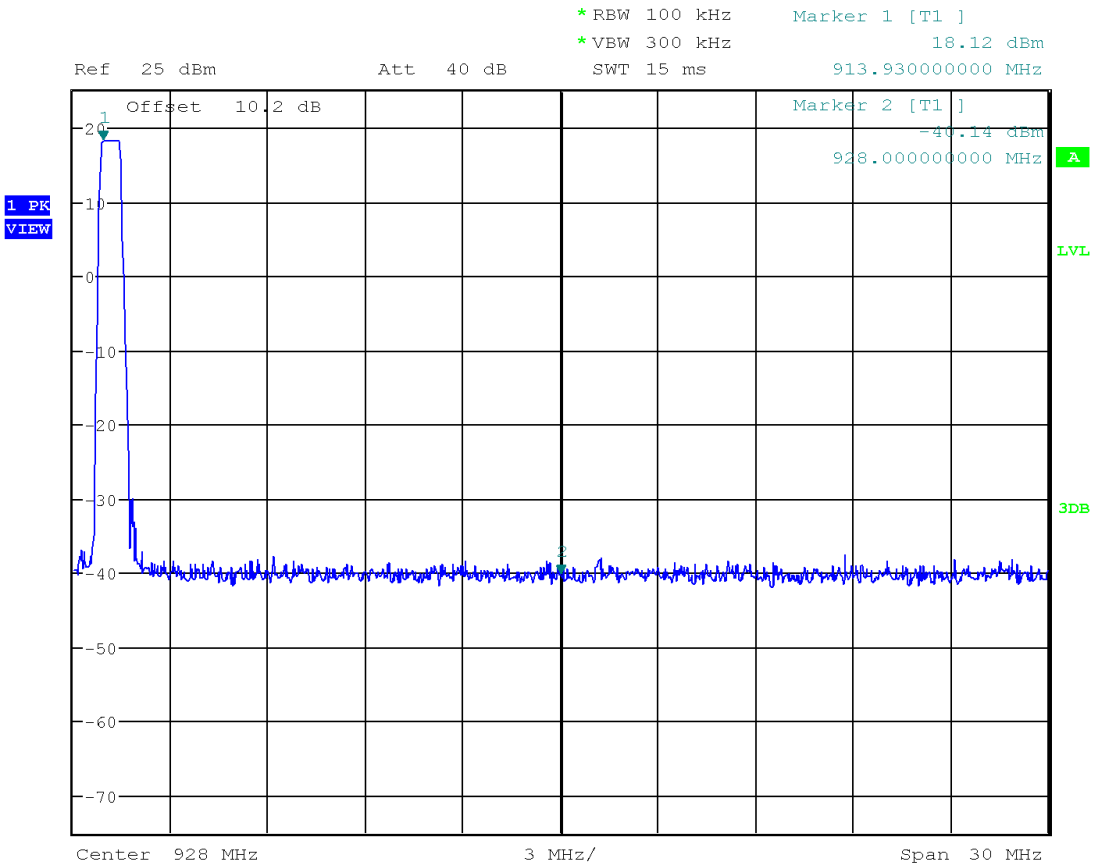
Date of Test:	March 15, 2018
Results	**Complies**

Tx @ Low Channel, 902 MHz Band Edge
Plot 4.1



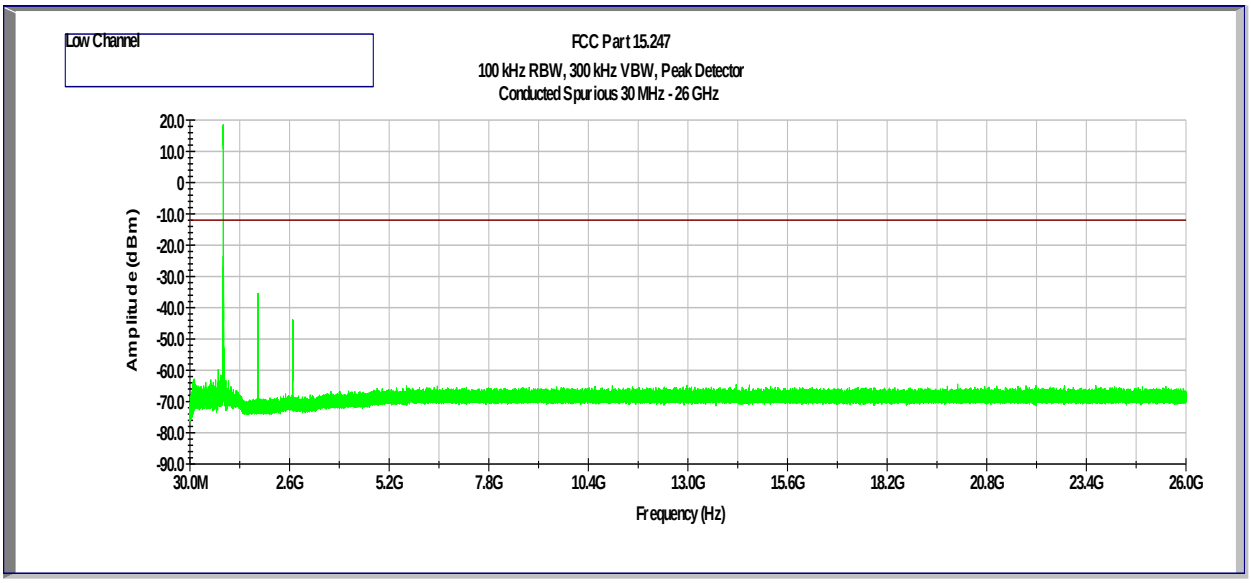
Date: 15.MAR.2018 06:08:01

Tx @ High Channel, 928 MHz Band Edge
Plot 4.2

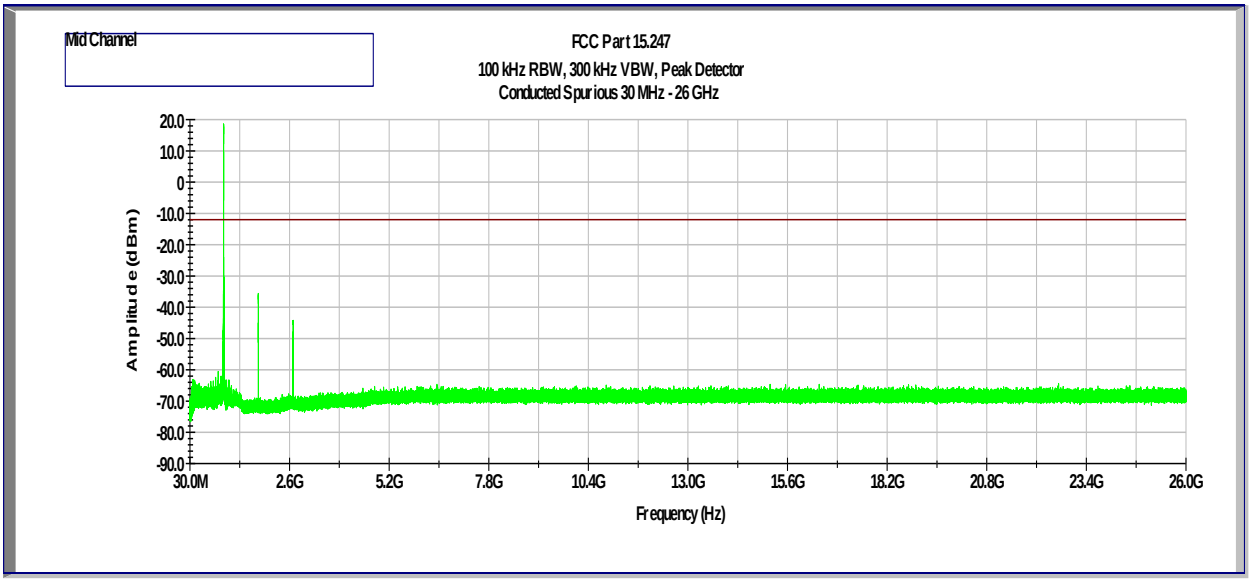


Date: 15.MAR.2018 06:09:22

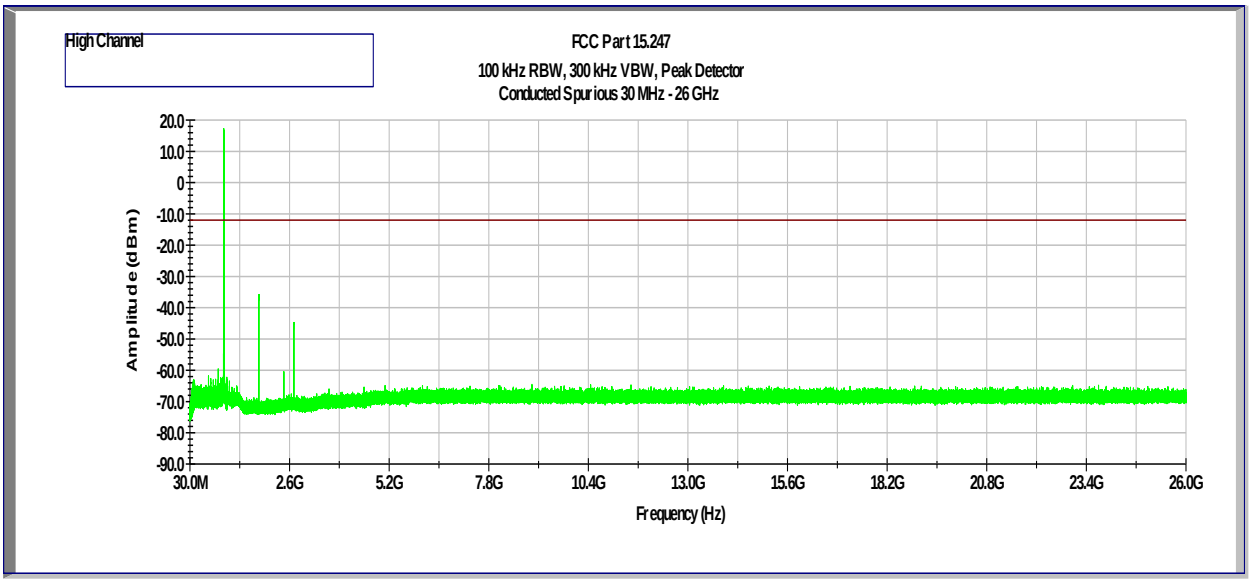
Tx @ Low Channel, 903 MHz
30MHz -26GHz Conducted Spurious
Plot 4.3



Tx @ Mid Channel, 907.8 MHz
30MHz -26GHz Conducted Spurious
Plot 4.4



Tx @ High Channel, 914.2 MHz
30MHz -26GHz Conducted Spurious
Plot 4.5



4.5 Transmitter Radiated Emissions
FCC Rules: 15.247(d), 15.209, 15.205; RSS-247;

4.5.1 Requirement

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)).

For out of band radiated emissions (except for frequencies in restricted bands), in any 100 kHz bandwidths outside the EUT pass-band, the RF power shall be at least 20dB (peak) or 30 dB (average) below that of the maximum in-band 100 kHz emissions.

4.5.2 Procedure

Radiated emission measurements were performed from 30 MHz to 25 GHz according to the procedure described in ANSI C63.10: 2013. Spectrum Analyzer Resolution Bandwidth is 100 kHz or greater for frequencies 30 MHz to 1000 MHz, 1 MHz for frequencies above 1000 MHz. Above 1000 MHz Peak and Average measurements were performed.

The EUT is placed on a plastic turntable that is 80 cm in height for below 1000MHz and 1.5m in height for above 1GHz. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables were manipulated to produce worst-case emissions. The signal is maximized through rotation. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

Radiated emissions are taken at 3 meters for frequencies above 1 GHz and at 10 meters for frequencies below 1 GHz.

A preamp was used from 30MHz to 26GHz.

All measurements were made with a Peak Detector and compared to QP limits for 30MHz – 1GHz and Average limits for 1GHz – 26GHz.

Data is included of the worst-case configuration (the configuration which resulted in the highest emission levels).

4.5.3 Field Strength Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF – AG; if measurement is performed at a distance other than specified in the rule, a Distance Correction Factor (DCF) shall be added.

Where FS = Field Strength in dB(μV/m)
RA = Receiver Amplitude (including preamplifier) in dB(μV); AF = Antenna Factor in dB(1/m)
CF = Cable Attenuation Factor in dB; AG = Amplifier Gain in dB

Assume a receiver reading of 52.0 dB(μV) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving field strength of 32 dB(μV/m). This value in dB(μV/m) was converted to its corresponding level in μV/m.
RA = 52.0 dB(μV)
AF = 7.4 dB(1/m)
CF = 1.6 dB
AG = 29.0 dB
FS = 52.0+7.4+1.6-29.0 = 32 dB(μV/m).
Level in μV/m = Common Antilogarithm [(32 dBμV/m)/20] = 39.8 μV/m.

4.5.4 Antenna-port conducted measurements

Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

4.5.6 General Procedure for conducted measurements in restricted bands

a) Measure the conducted output power (in dBm) using the detector specified for determining quasi-peak, peak, and average conducted output power, respectively.

b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)

c) Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).

d) For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (*e.g.*, Watts, mW).

e) Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:
E = EIRP – 20log D + 104.8+DCF (DCF for Average measurements)
where:
E = electric field strength in dBμV/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.
DCF = Duty Cycle Correction Factor
f) Compare the resultant electric field strength level to the applicable limit.
g) Perform radiated spurious emission test

4.5.7 Test Results

The data on the following pages list the significant emission frequencies, the limit and the margin of compliance where emissions are within 3dB of the limit.

All conducted antenna port plots are corrected with the consideration of a 5.1 dBi Antenna Gain.

All radiated measurements were conducted with the AC adapter. The worst case data was reported.

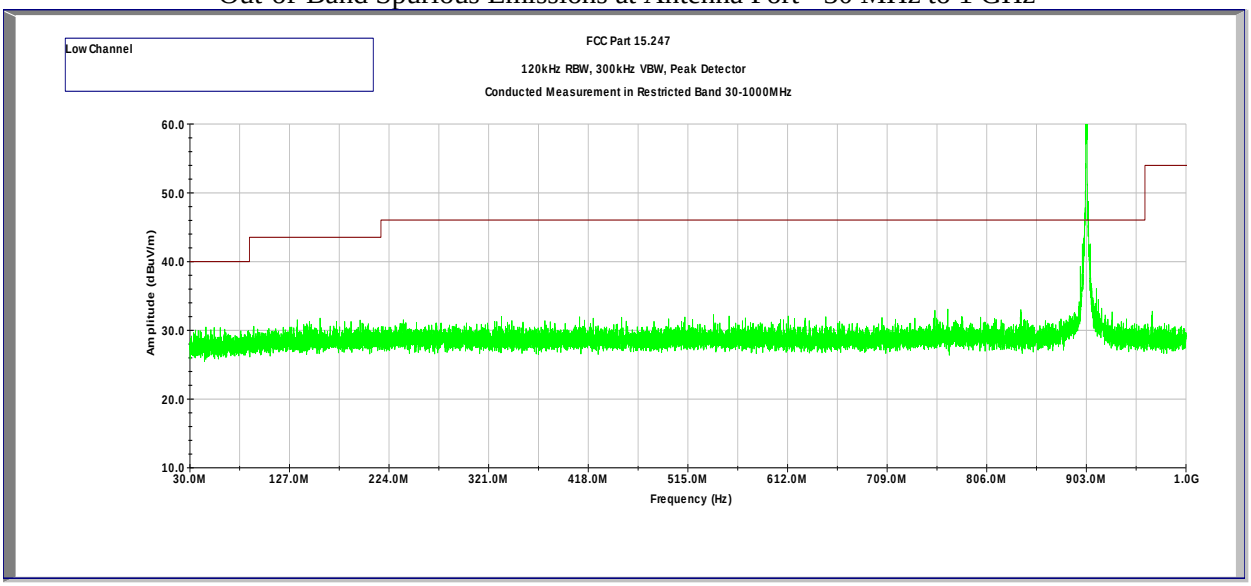
Date of Test:	March 4 - 5, 2018
Results	**Complies**

Test Results: 15.209/15.205 Restricted Band Emissions at Antenna Port

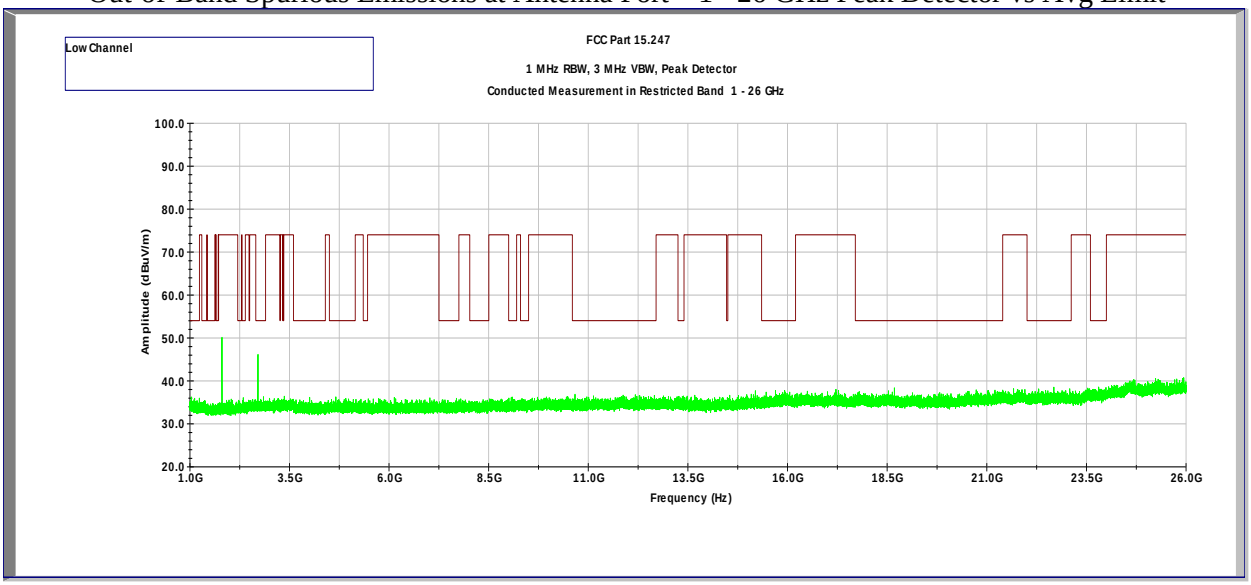
Out-of-Band Conducted Spurious Emissions (at Antenna Port)

Tx @ 903 MHz

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz



Out-of-Band Spurious Emissions at Antenna Port – 1 - 26 GHz Peak Detector vs Avg Limit

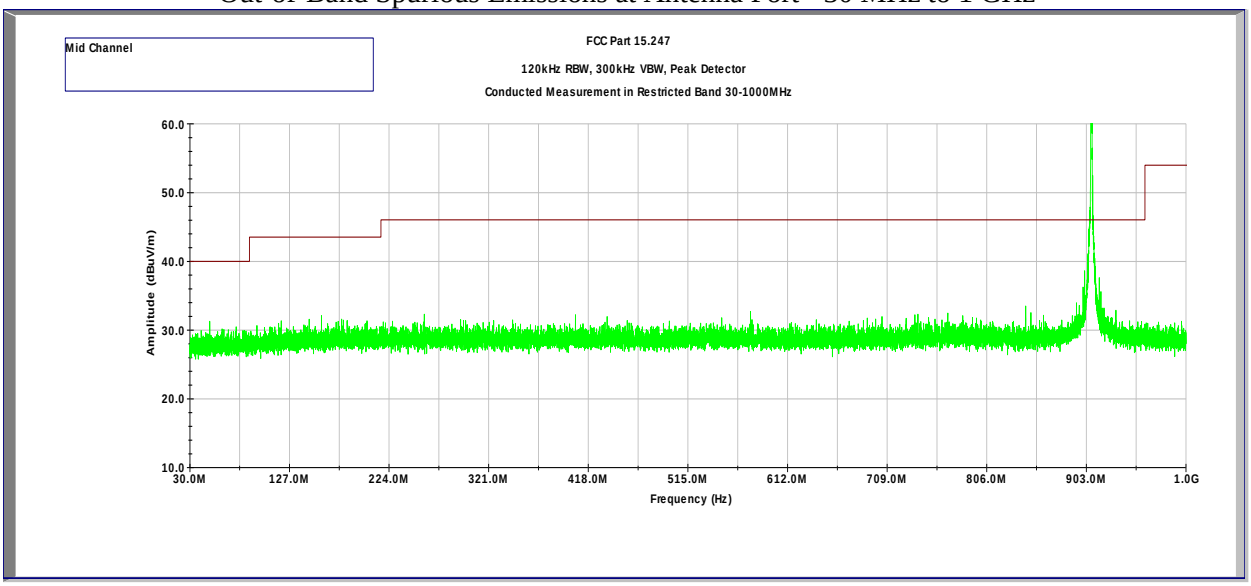


Frequency	Corrected Amplitude	Avg Limit	Margin	Detector	Results
GHz	dBµV/m	dBµV/m	dB		
2.709	46.2	54	-7.8	Peak	Pass

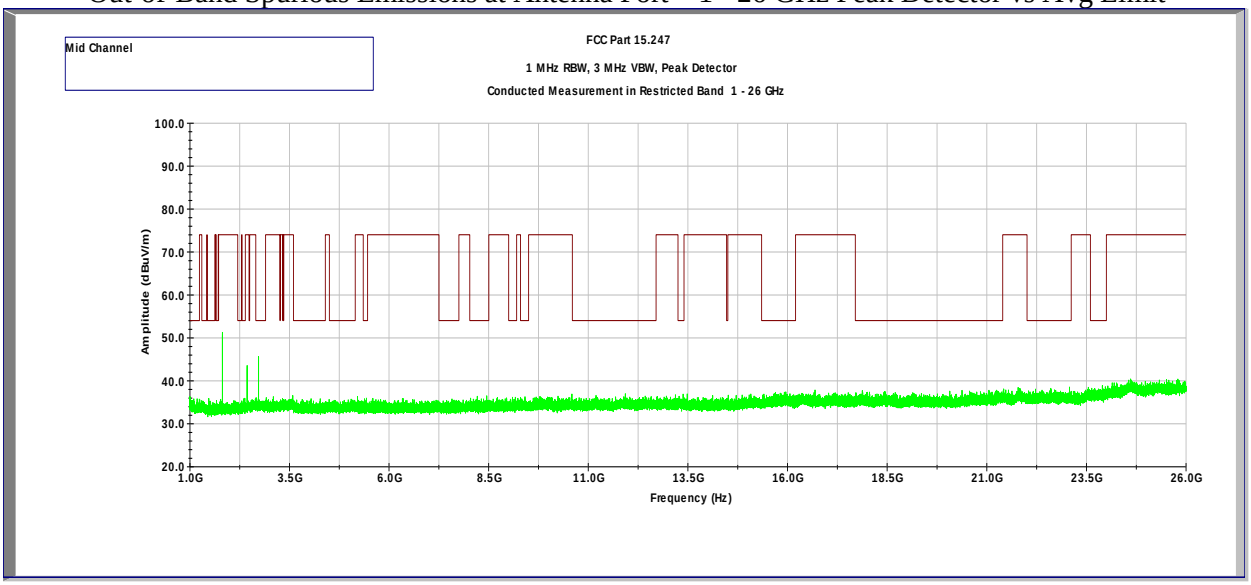
Out-of-Band Conducted Spurious Emissions (at Antenna Port)

Tx @ 907.8 MHz

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz



Out-of-Band Spurious Emissions at Antenna Port – 1 - 26 GHz Peak Detector vs Avg Limit

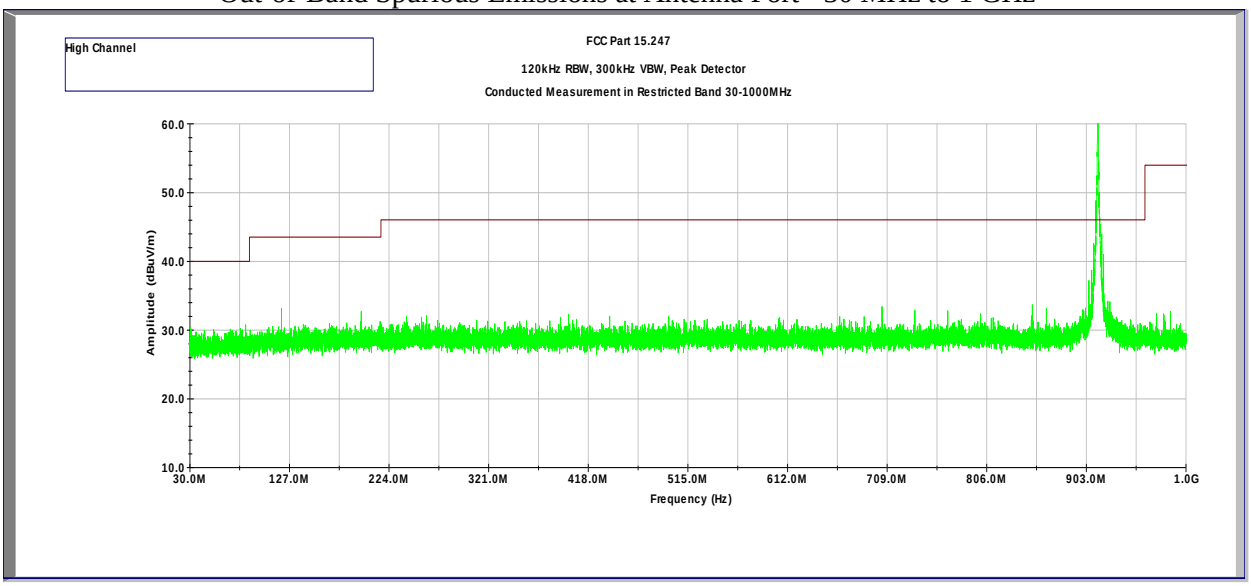


Frequency	Corrected Amplitude	Avg Limit	Margin	Detector	Results
GHz	dBµV/m	dBµV/m	dB		
2.724	45.5	54	-8.5	Peak	Pass

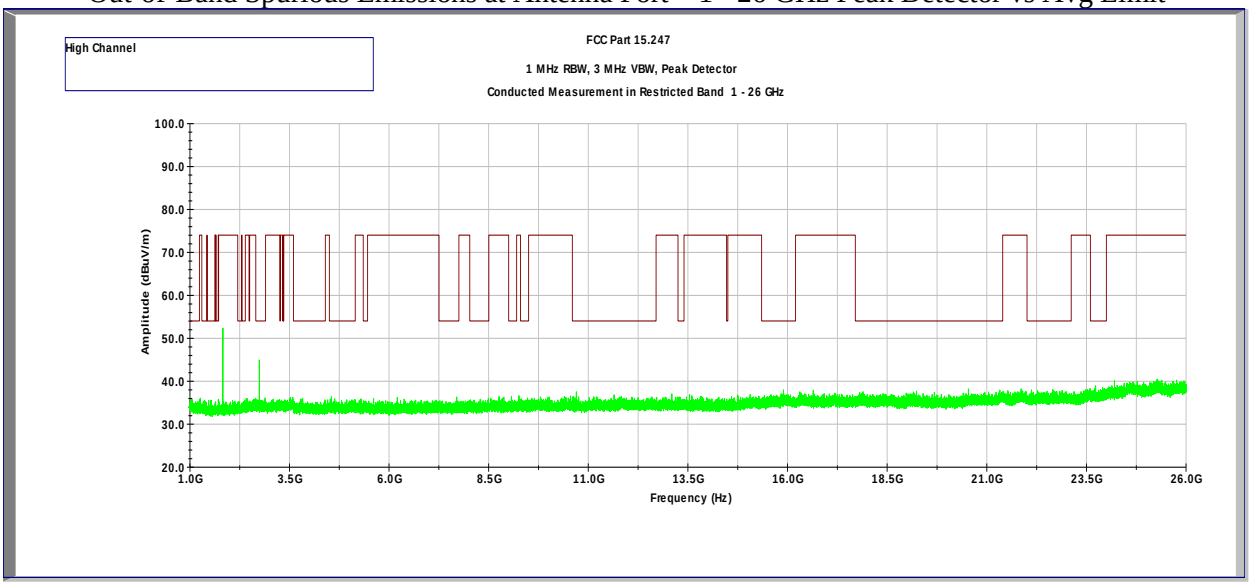
Out-of-Band Conducted Spurious Emissions (at Antenna Port)

Tx @ 914.2 MHz

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz



Out-of-Band Spurious Emissions at Antenna Port – 1 - 26 GHz Peak Detector vs Avg Limit

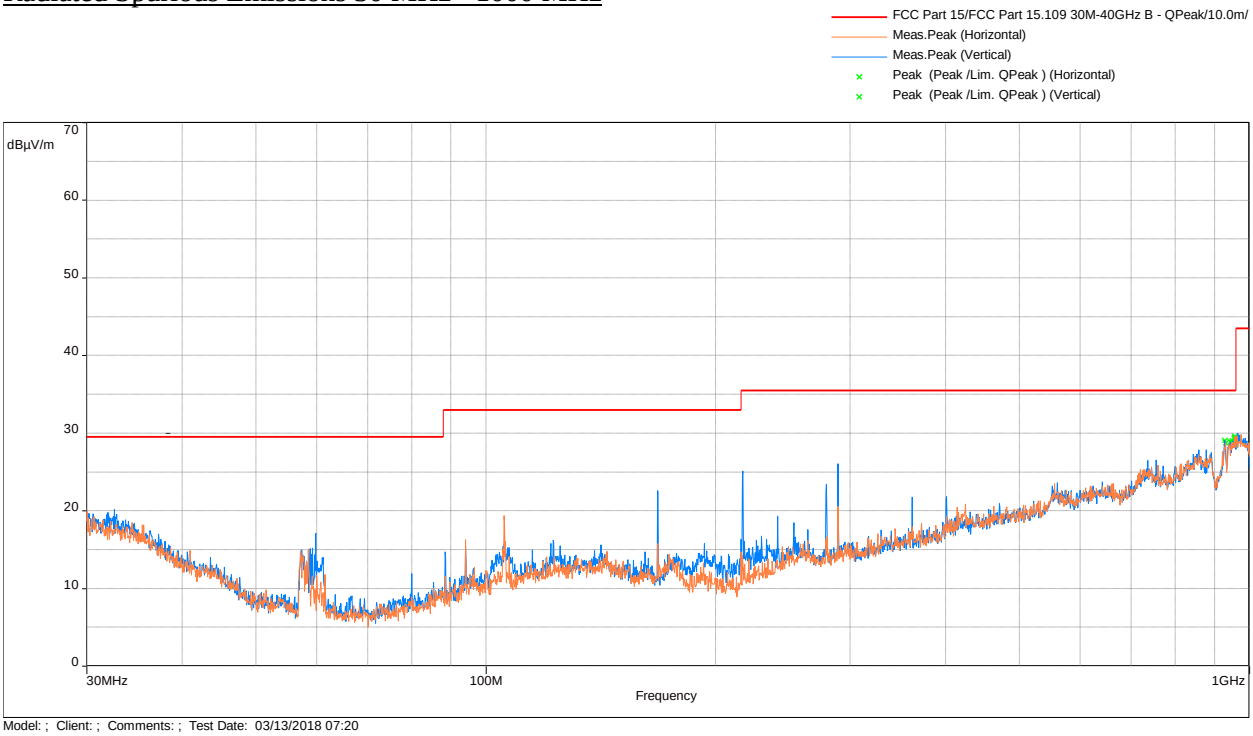


Frequency	Corrected Amplitude	Avg Limit	Margin	Detector	Results
GHz	dBµV/m	dBµV/m	dB		
2.742	44.9	54	-9.1	Peak	Pass

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation)

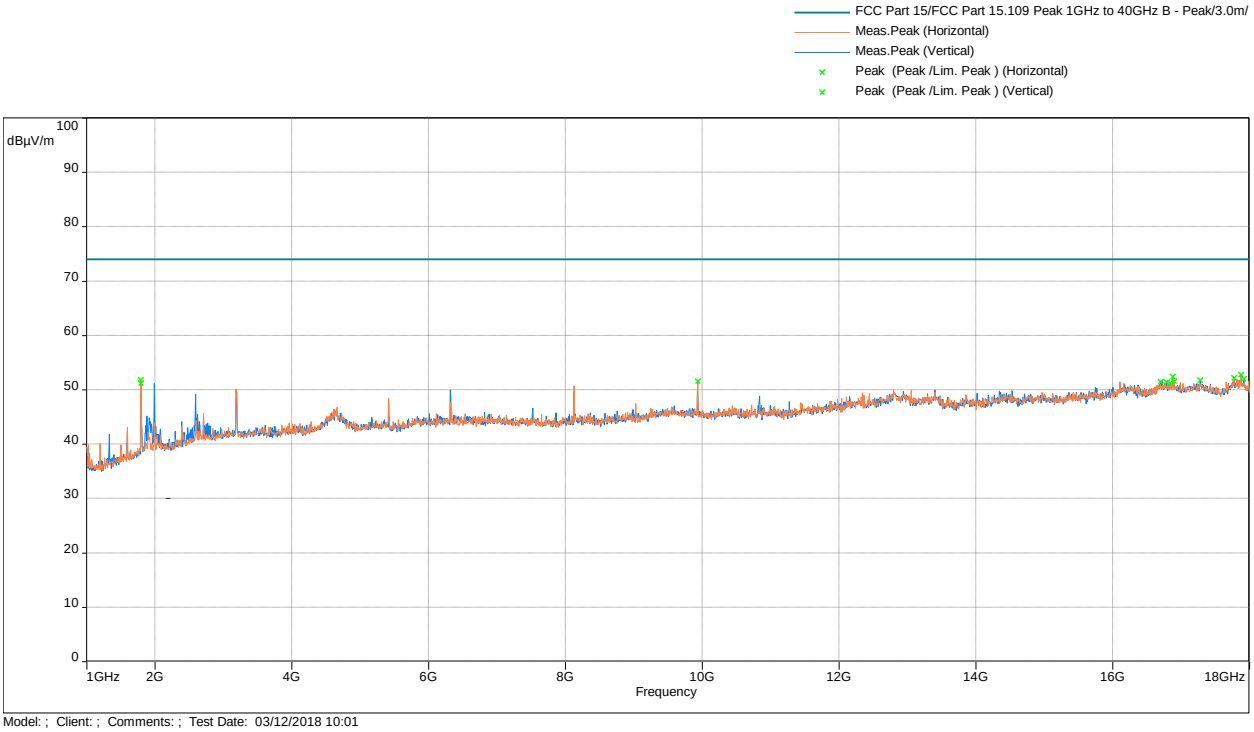
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 903 MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



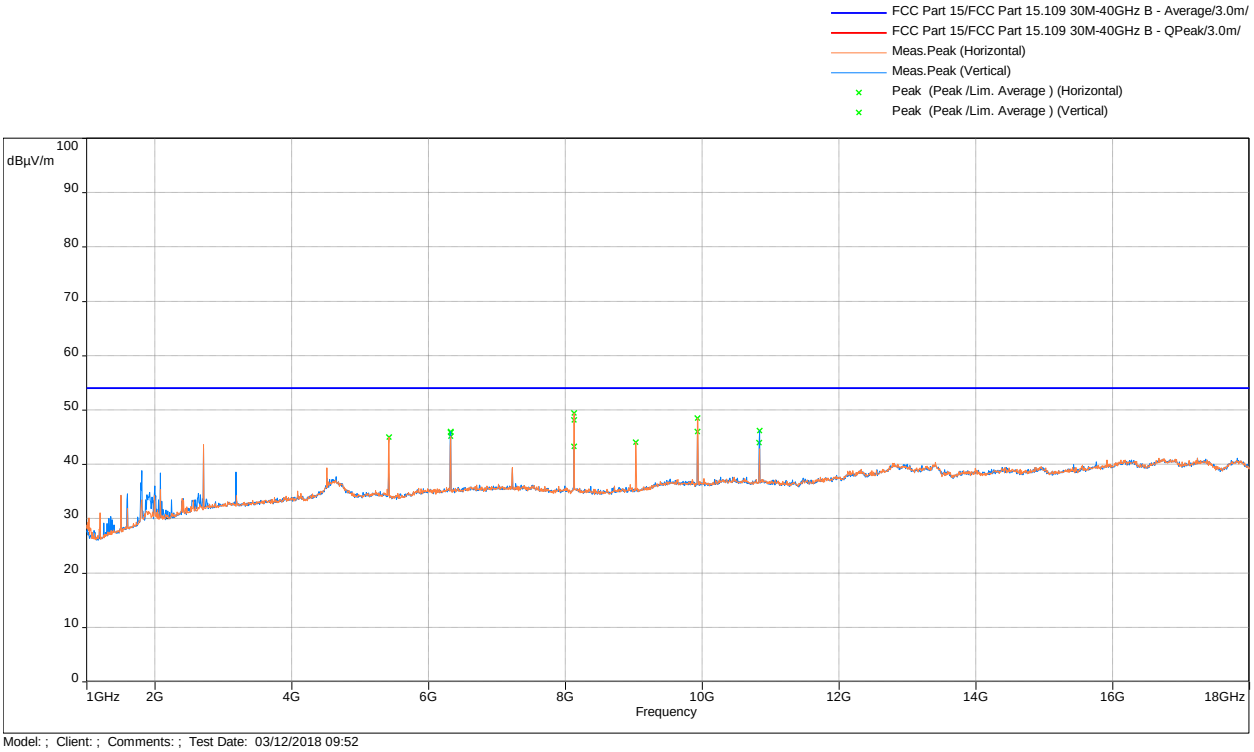
Model: ; Client: ; Comments: ; Test Date: 03/13/2018 07:20

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



Model: ; Client: ; Comments: ; Test Date: 03/12/2018 10:01

Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/12/2018 09:52

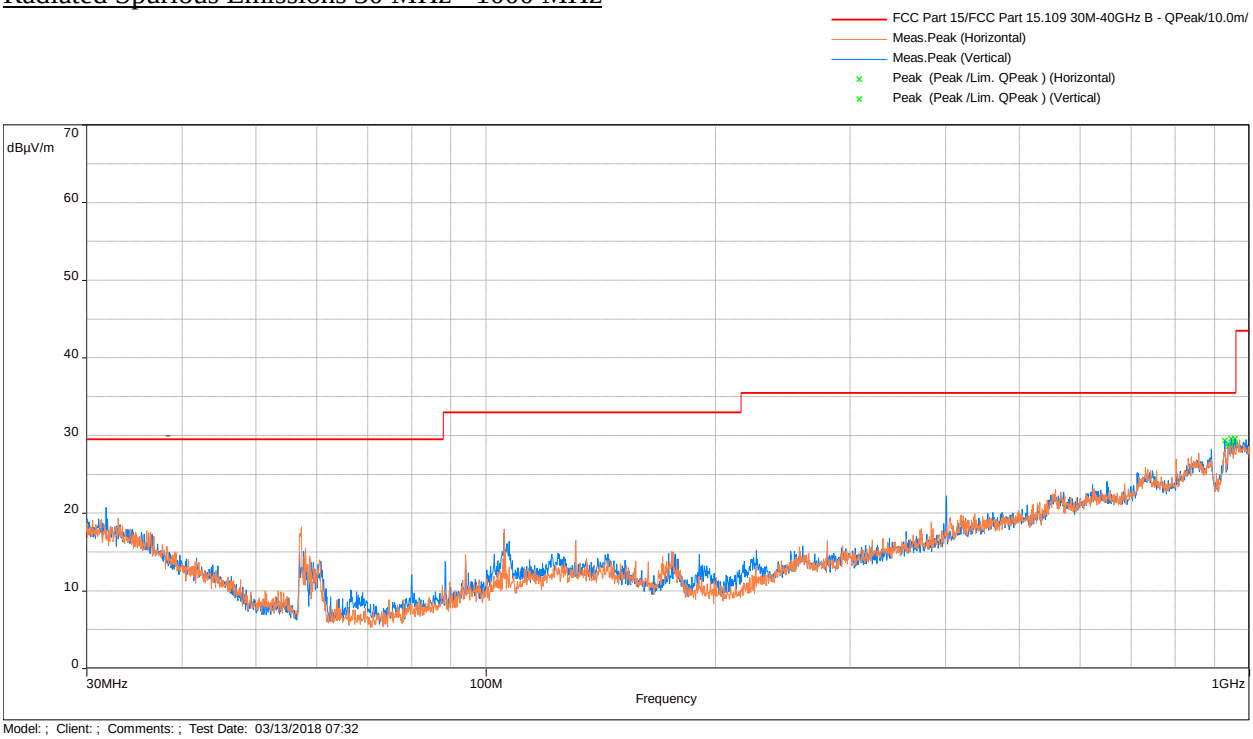
Frequency	FS@3m	Avg Limit	Margin	Detector	Results
MHz	dBµV/m	dBµV/m	dB		
8128.667	49.4	54	-4.6	Avg	Pass

Note: FS@3m = RA + AF + CF - Preamp

Results	Complies

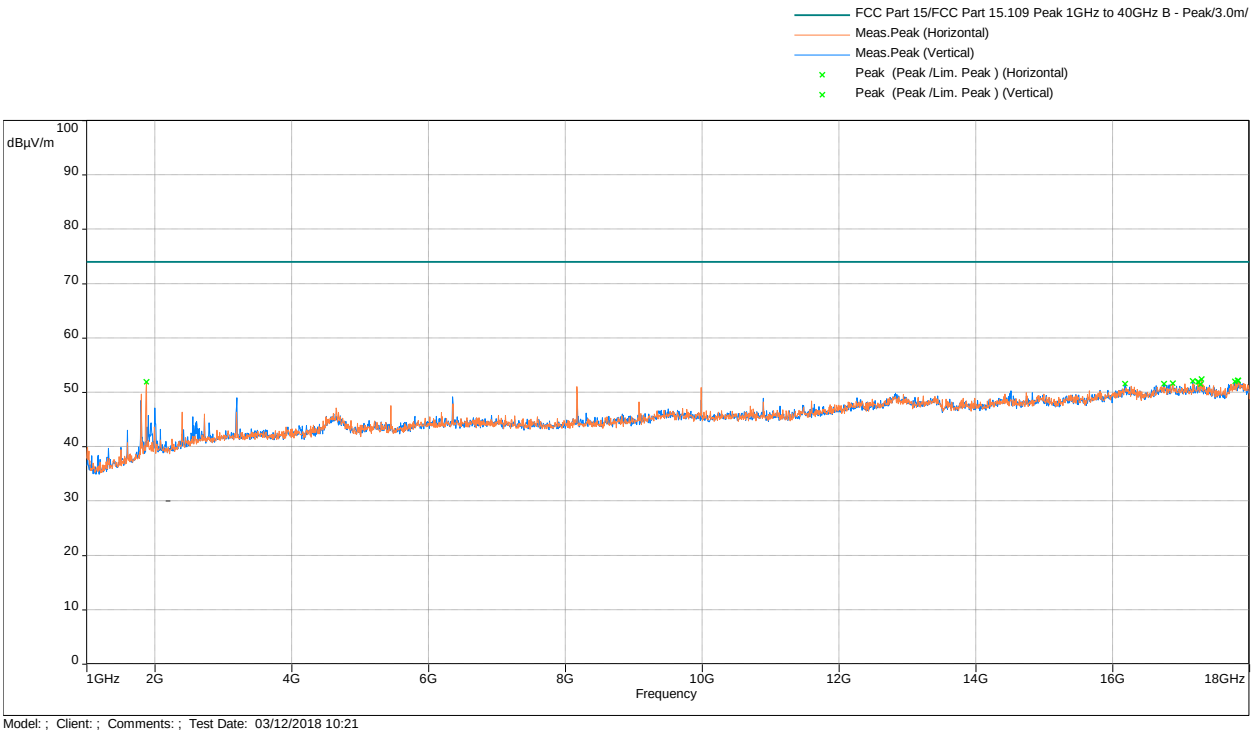
Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 907.8 MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



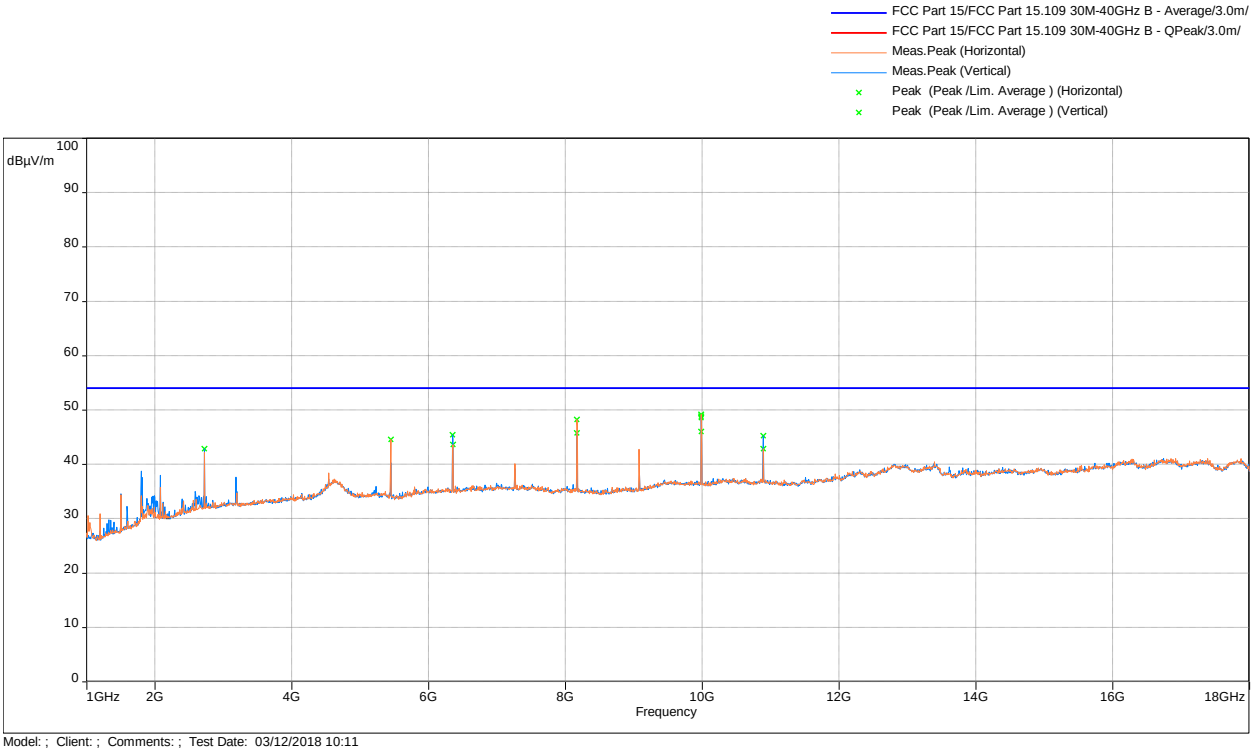
Model: ; Client: ; Comments: ; Test Date: 03/13/2018 07:32

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



Model: ; Client: ; Comments: ; Test Date: 03/12/2018 10:21

Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/12/2018 10:11

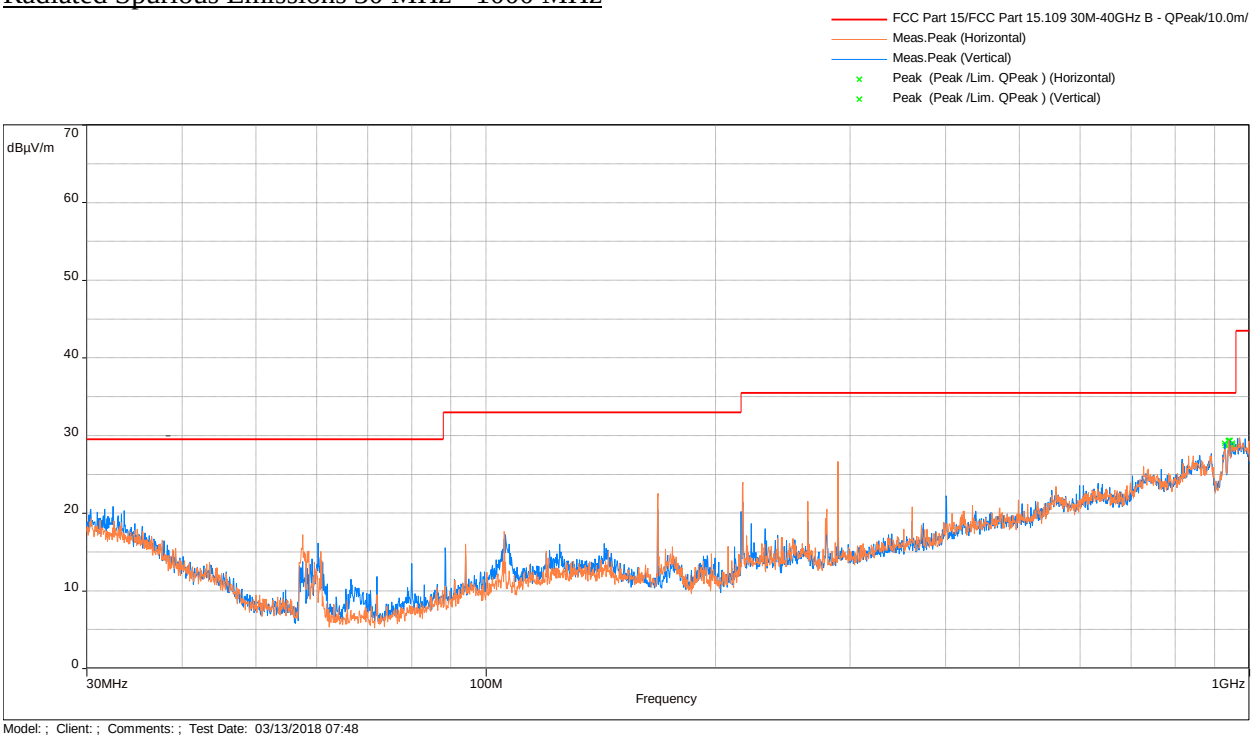
Frequency	FS@3m	Avg Limit	Margin	Detector	Results
MHz	dBµV/m	dBµV/m	dB		
9987.9	49.2	54	-4.8	Avg	Pass

Note: FS@3m = RA + AF + CF - Preamp

Results	Complies

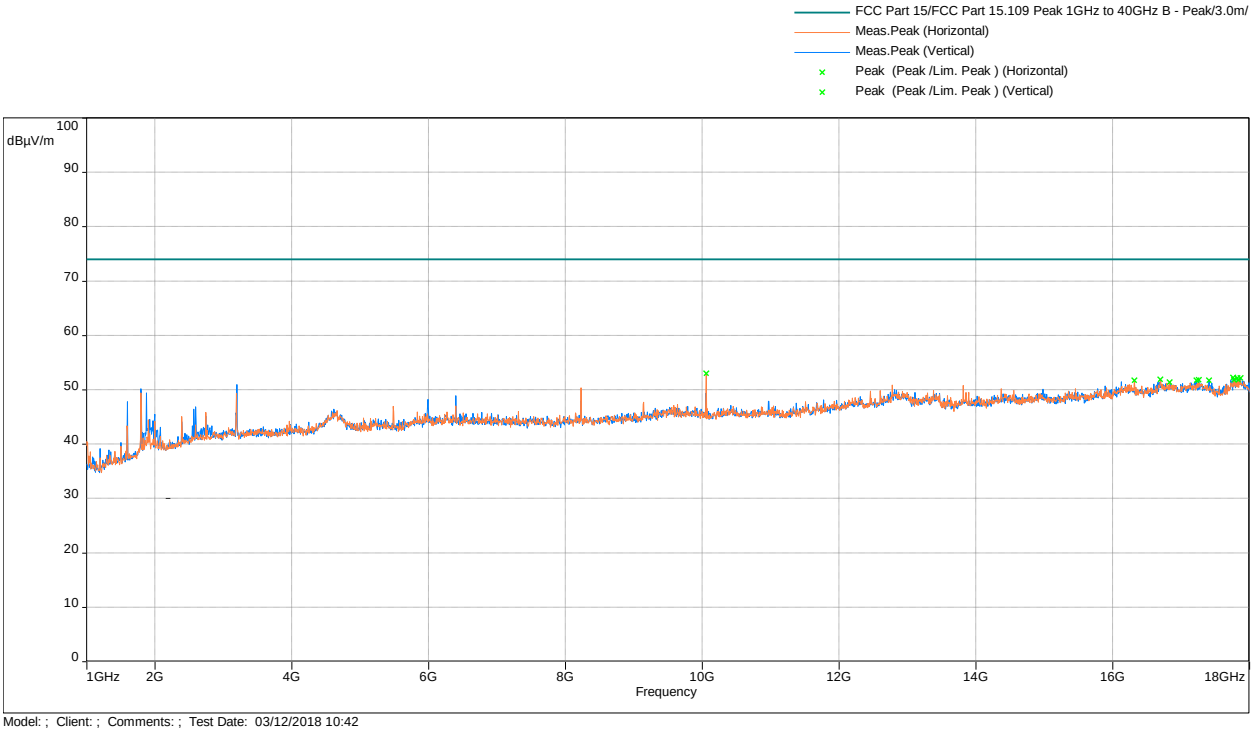
Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 914.2 MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



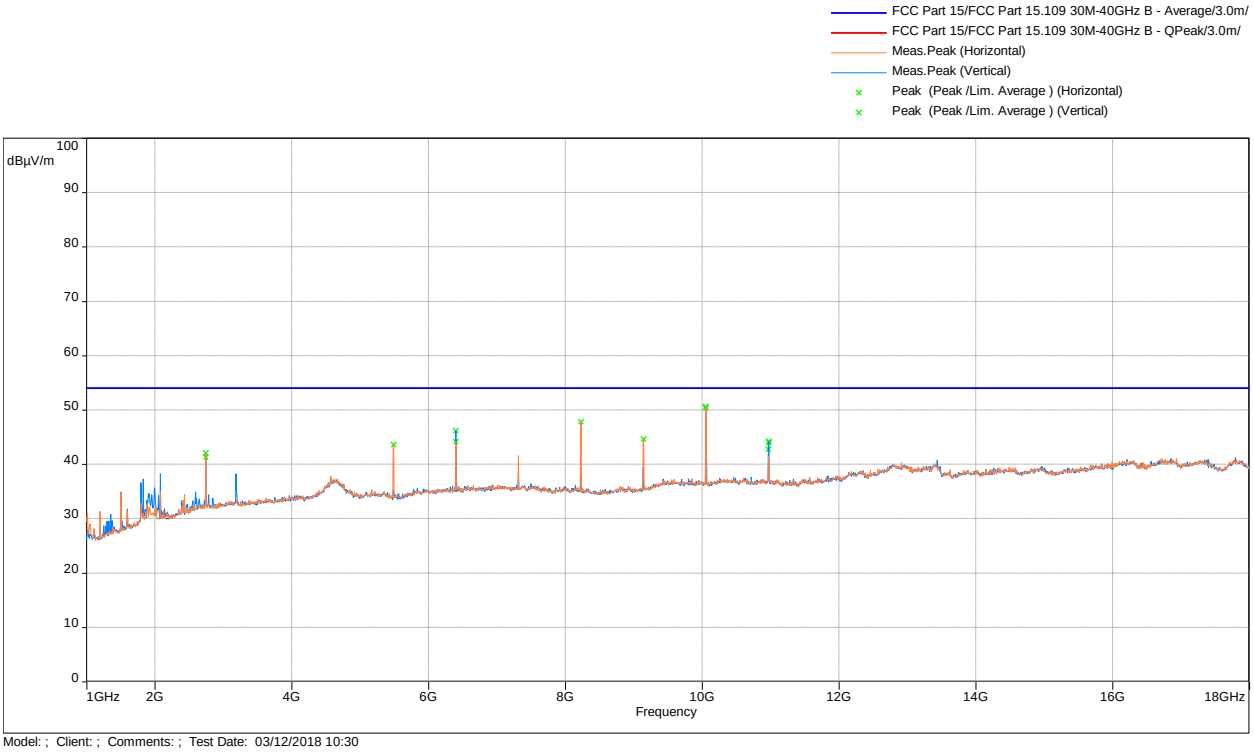
Model: ; Client: ; Comments: ; Test Date: 03/13/2018 07:48

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



Model: ; Client: ; Comments: ; Test Date: 03/12/2018 10:42

Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



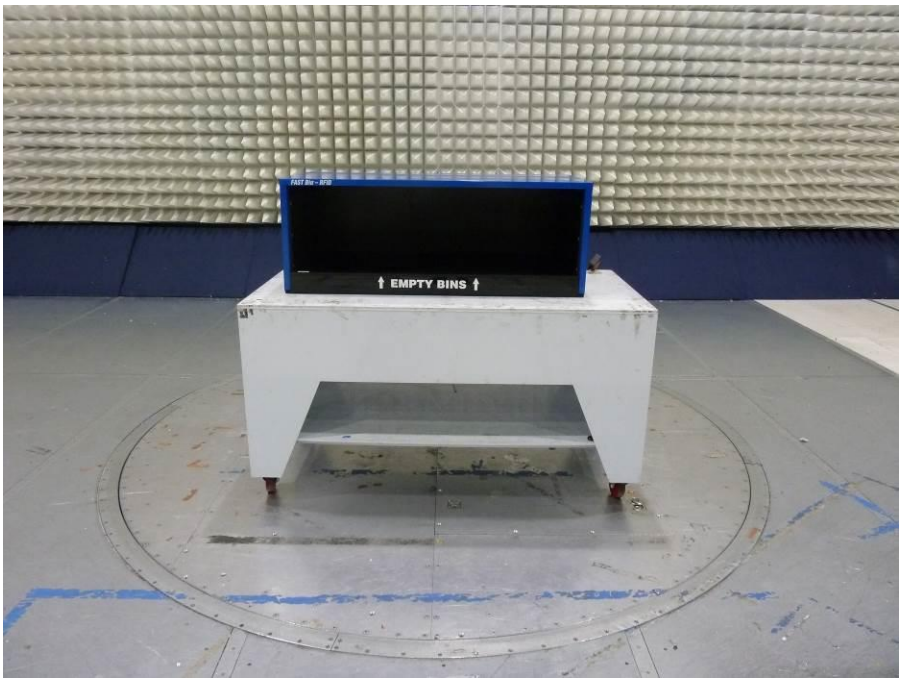
Frequency	FS@3m	Avg Limit	Margin	Detector	Results
MHz	dBµV/m	dBµV/m	dB		
10054.77	50.6	54	-3.4	Avg	Pass

Note: FS@3m = RA + AF + CF - Preamp

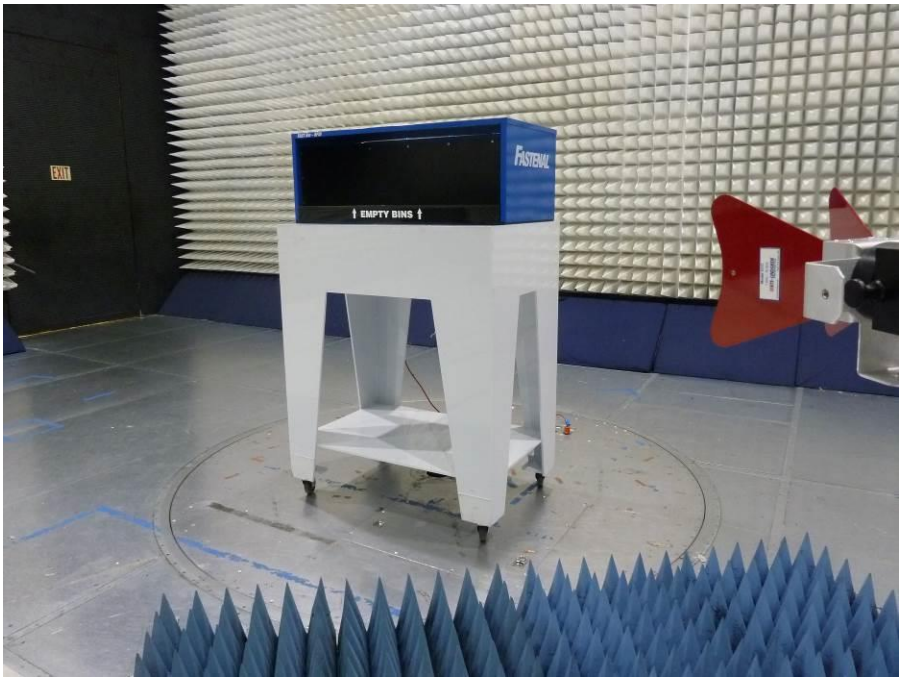
Results	Complies

4.5.8 Test setup photographs

The following photographs show the testing configurations used.



4.5.8 Test Setup Photographs (Continued)



4.6 Radiated Emissions

FCC Ref: 15.109, ICES 003

4.6.1 Requirement

Limits for Electromagnetic Radiated Emissions FCC Section 15.109(b), ICES 003*, RSS GEN

Frequency (MHz)	**Class A at 10m dB(µV/m)**	**Class B at 3m dB(µV/m)**
30-88	39	40.0
88-216	43.5	43.5
216-960	46.4	46.0
Above 960	49.5	54.0

* According to FCC Part 15.109(g) an alternative to the radiated emission limits shown above, digital devices may be shown to comply with the limit of CISPR Pub. 22

4.6.2 Procedures

Measurements are conducted with a quasi-peak detector instrument in the frequency range of 30 MHz to 1000 MHz and with the average detector instrument in the frequency range above 1000 MHz. The measuring receiver meets the requirements of Section One of CISPR 16 and the measuring antenna correlates to a balanced dipole.

Measurements of the radiated field are made with the antenna located at a distance of 10 meters from the EUT. If the field-strength measurements at 10m cannot be made because of high ambient noise level or for other reasons, measurements of Class B equipment may be made at a closer distance, for example 3m. An inverse proportionality factor of 20 dB per decade should be used to normalize the measured data to the specified distance for determining compliance.

The antenna is adjusted between 1m and 4m in height above the ground plane for maximum meter reading at each test frequency.

The antenna-to-EUT azimuth is varied during the measurement to find the maximum field-strength readings.

The antenna-to-EUT polarization (horizontal and vertical) is varied during the measurements to find the maximum field-strength readings.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for a larger EUT.

Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material.

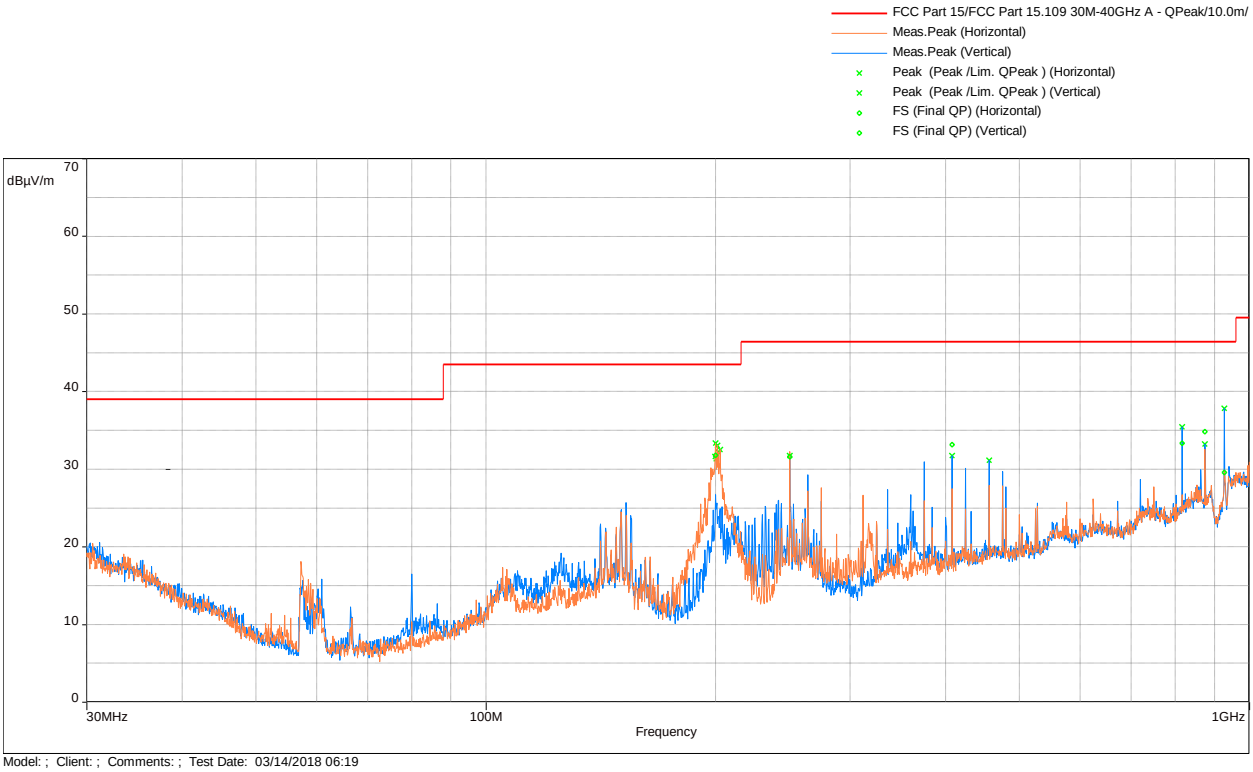
Equipment setup for radiated disturbance tests followed the guidelines of ANSI C63.4-2014.

Tested By:	Aaron Chang
Test Date:	March 14, 2018

4.6.3 Test Results

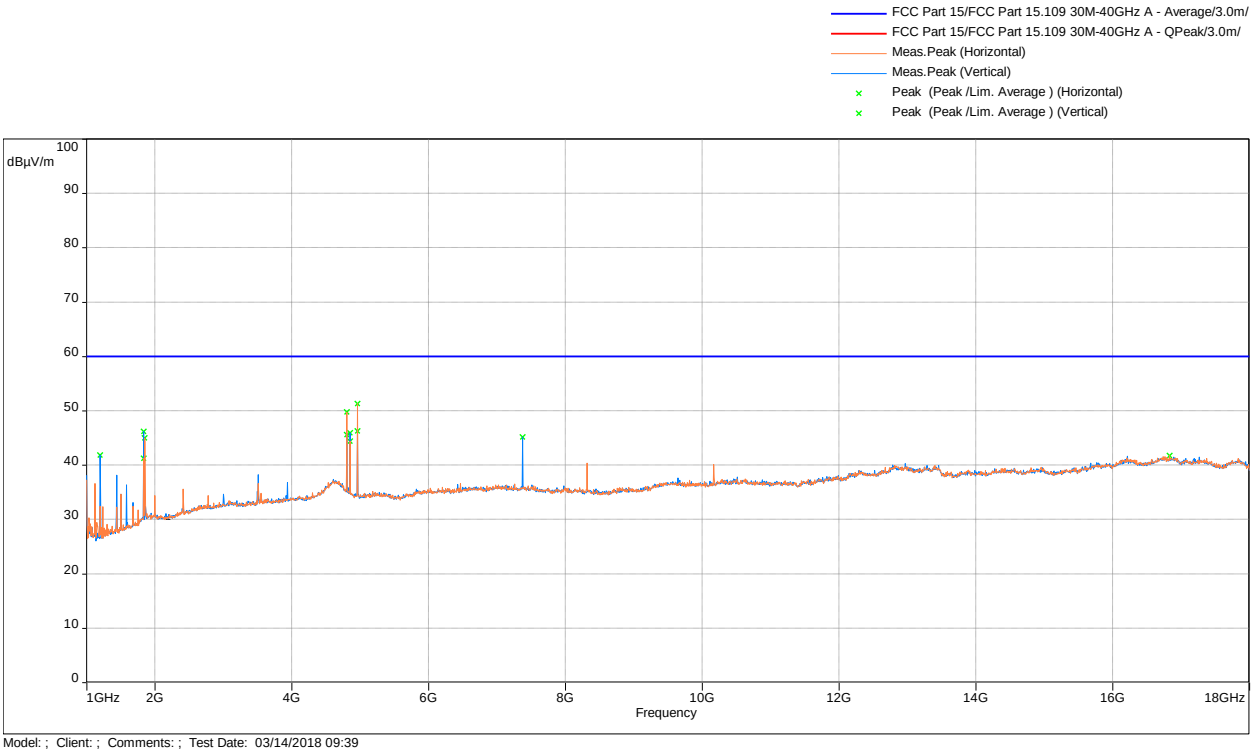
The EUT met the radiated disturbance requirements of FCC & ICES 003 for a Class A device.

FCC & ICES 003 Radiated Disturbance
30MHz to 1GHz
120V 60Hz



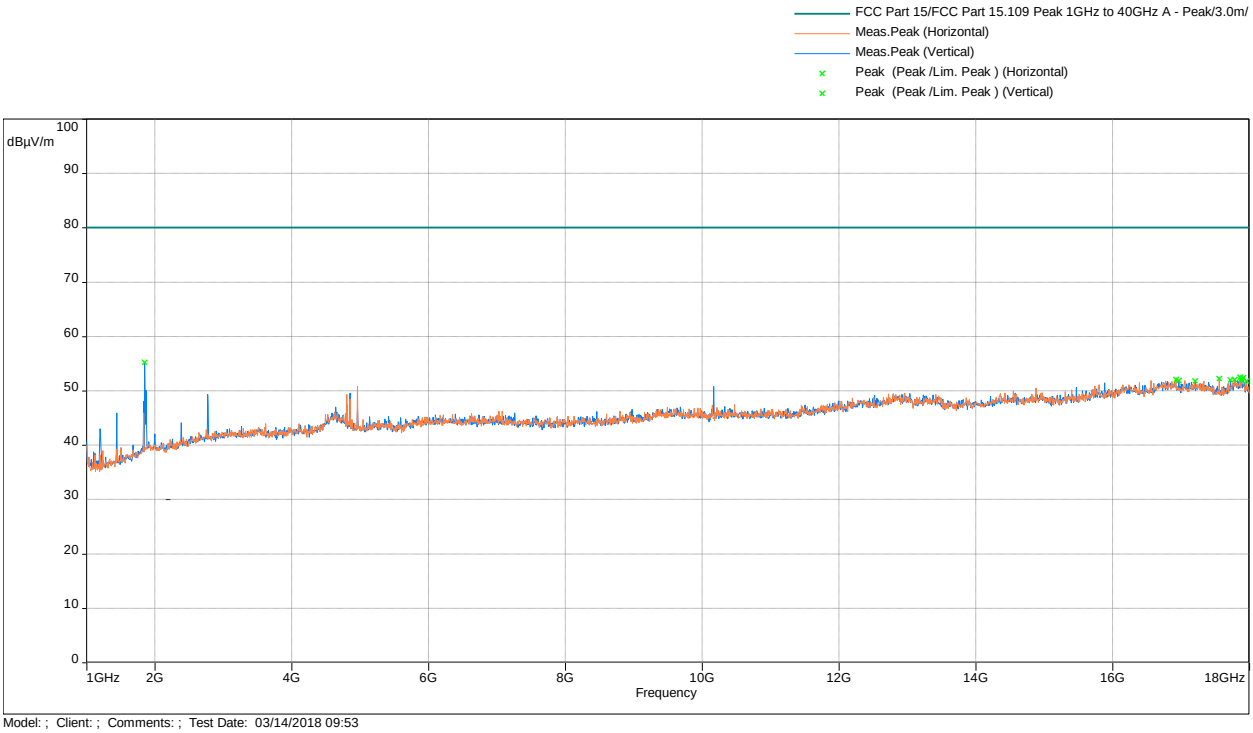
Frequency	FS	Limit	Margin	Azimuth	Height	Polarity	RA	Correction
MHz	dBµV/m	dBuV/m	dB	deg	m		dBuV	dB
199.999	31.77	43.5	-11.73	113.75	3.28	Horizontal	48.73	-16.96
249.998	31.62	46.4	-14.78	340.75	1.12	Vertical	45.03	-13.41
408.022	33.16	46.4	-13.24	160.5	3.63	Vertical	42.12	-8.96
816.043	33.35	46.4	-13.05	135.75	2.1	Vertical	35.01	-1.65
874.988	34.8	46.4	-11.6	48.75	2.1	Vertical	35.32	-0.52
927.428	29.59	46.4	-16.81	229.25	2.19	Vertical	28.61	0.98

FCC & ICES 003 Radiated Disturbance
1GHz to 18GHz, Average
120V 60Hz



Model: ; Client: ; Comments: ; Test Date: 03/14/2018 09:39

FCC & ICES 003 Radiated Disturbance
1GHz to 18GHz, Peak
120V 60Hz

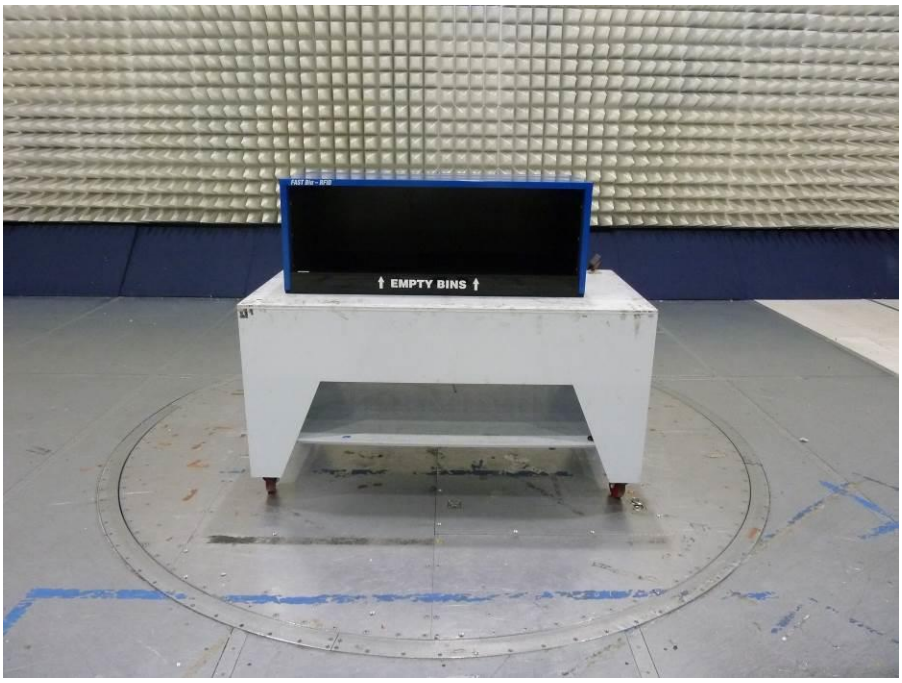


Model: ; Client: ; Comments: ; Test Date: 03/14/2018 09:53

Result:	**Complies by** 11.6 dB

4.6.4 Test Configuration Photographs

The following photographs show the testing configurations used.



Electromagnetic Radiated Disturbance Setup Photograph

4.7 AC Line Conducted Emission
FCC: 15.207, 15.107; RSS-GEN;

4.7.1 Requirement

Frequency Band MHz	FCC 15.207 Limit dB(μV)		FCC 15.107 Class A Limit dB(μV)	
	Quasi-Peak	Average	Quasi-Peak	Average
0.15-0.50	66 to 56 *	56 to 46 *	79	66
0.50-5.00	56	46	73	60
5.00-30.00	60	50	73	60

*Note: *Decreases linearly with the logarithm of the frequency. At the transition frequency the lower limit applies.*

4.7.2 Procedure

Measurements are carried out using quasi-peak and average detector receivers in accordance with CISPR 16. An AMN is required to provide defined impedance at high frequencies across the power feed at the point of measurement of terminal voltage and also to provide isolation of the circuit under test from the ambient noise on the power lines. An AMN as defined in CISPR 16 shall be used.

The EUT is located so that the distance between the boundary of the EUT and the closest surface of the AMN is 0.8m.

Where a flexible mains cord is provided by the manufacturer, this shall be 1m long or if in excess of 1m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4m in length.

The EUT is arranged and connected with cables terminated in accordance with the product specification.

Conducted disturbance is measured between the phase lead and the reference ground, and between the neutral lead and the reference ground. Both measured values are reported.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground plane not being part of the EUT. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for larger EUT.

Floor standing EUTs are placed on a horizontal metal ground plane and isolated from the ground plane by an insulating material up to 12mm thick. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.10: 2013 & ANSI C63.4-2014.

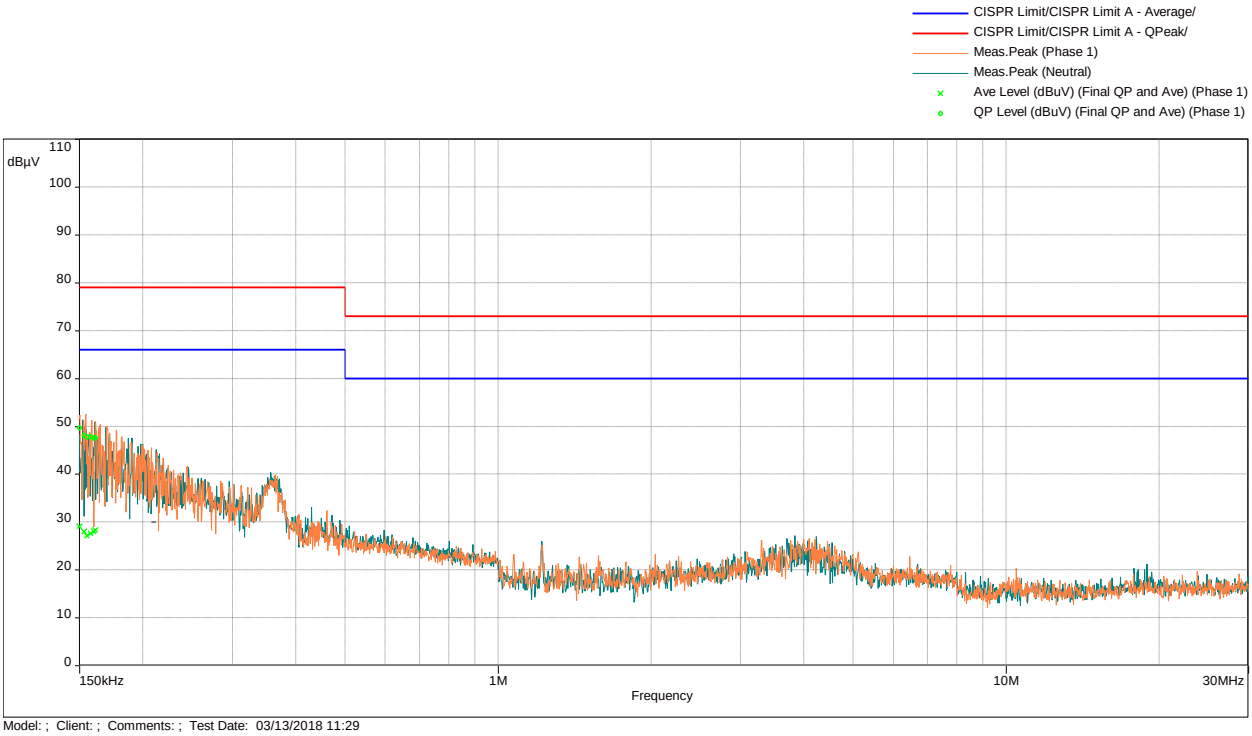
Tested By:	Aaron Chang
Test Date:	March 13, 2018

4.7.3 Test Result

The EUT met the conducted disturbance requirement of FCC & ICES 003 for a Class A device.

15.107 FCC & ICES 003 Conducted Disturbance at AC Mains

120V 60Hz

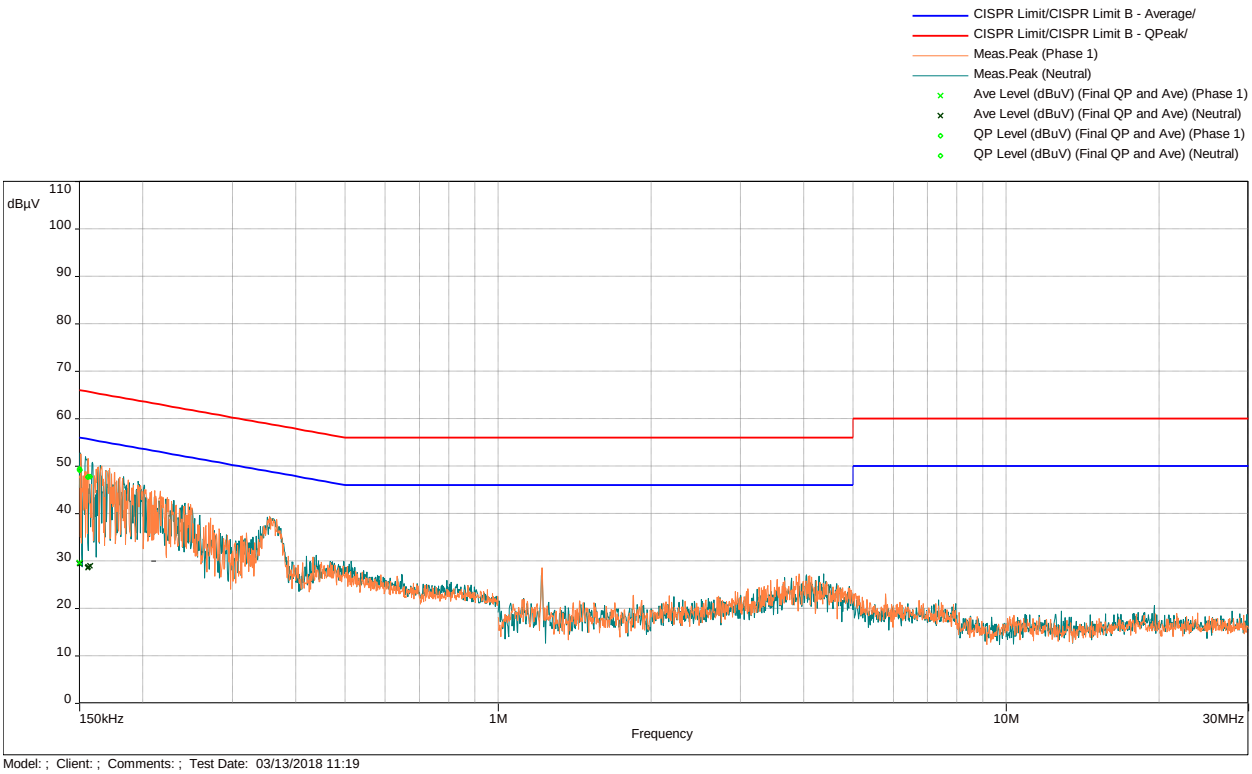


Freq.	Ave Level	QP Level	Ave Limit	QP Limit	Ave Margin	QP Margin	Line	Correction
MHz	dBµV	dBµV	dBµV	dBµV	dB	dB		dB
0.150	29.11	49.62	66	79	-36.89	-29.38	Phase 1	11.01
0.153	28.01	48.15	66	79	-37.99	-30.85	Phase 1	11.02
0.155	27.15	47.69	66	79	-38.85	-31.31	Phase 1	11.02
0.158	27.6	47.82	66	79	-38.4	-31.18	Phase 1	11.02
0.160	27.94	47.51	66	79	-38.06	-31.49	Phase 1	11.02
0.161	28.3	47.61	66	79	-37.7	-31.39	Phase 1	11.02

Result: **Complies by** 29.38 dB

15.207 FCC & ICES 003 Conducted Disturbance at AC Mains

120V 60Hz



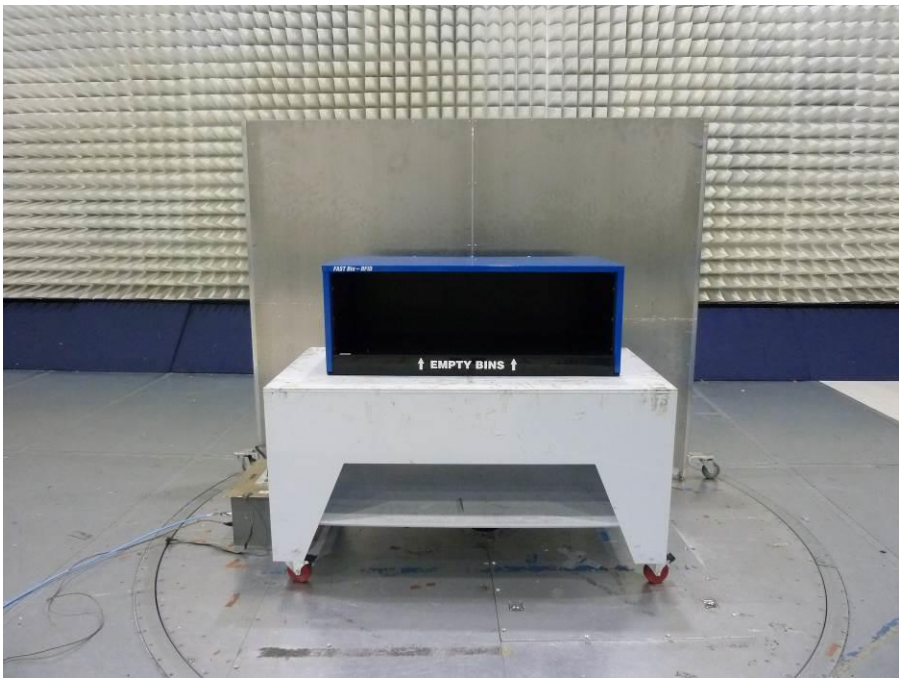
Model: ; Client: ; Comments: ; Test Date: 03/13/2018 11:19

Freq.	Ave Level	QP Level	Ave Limit	QP Limit	Ave Margin	QP Margin	Line	Correction
MHz	dBµV	dBµV	dBµV	dBµV	dB	dB		dB
0.150	29.57	49.42	56	66	-26.43	-16.58	Phase 1	11.01
0.150	29.45	49.14	56	66	-26.55	-16.86	Neutral	11.01
0.151	29.41	49.17	55.99	65.99	-26.58	-16.82	Neutral	11.01
0.156	28.54	47.68	55.68	65.68	-27.14	-17.99	Neutral	11.02
0.156	28.76	47.72	55.66	65.66	-26.9	-17.95	Neutral	11.02
0.158	28.95	47.77	55.59	65.59	-26.64	-17.82	Neutral	11.02

Result: **Complies by** 16.58 dB

4.7.4 Test Configuration Photographs

The following photographs show the testing configurations used.



AC Mains Line-Conducted Disturbance Setup Photograph

5.0 List of Test Equipment

Measurement equipment used for emission compliance testing utilized the equipment on the following list:

Equipment	Manufacturer	Model/Type	Asset #	Cal Int	Cal Due
Spectrum Analyzer	Rohde and Schwarz	FSU	ITS 00913	12	01/24/19
Spectrum Analyzer	Rohde and Schwarz	ESR	ITS 01607	12	10/09/18
Active Horn Antenna	ETS-Lindgren	3117-PA	ITS 01636	12	01/11/19
EMI Receiver	Rohde and Schwarz	ESU	ITS 00961	12	07/10/18
BI-Log Antenna	Teseq	CBL 6111D	ITS 01058	12	08/11/18
Pre-Amplifier	Sonoma Instrument	310	ITS 00942	12	01/26/19
RF Cable	TRU Corporation	TRU CORE 300	ITS 01462	12	08/19/18
RF Cable	TRU Corporation	TRU CORE 300	ITS 01465	12	08/19/18
RF Cable	TRU Corporation	TRU CORE 300	ITS 01470	12	08/19/18
Attenuator	Narda	FSCM99899	ITS 01583	12	08/31/18
RF Cable	Megaphase	EMC1-K1K1-236	ITS 01538	12	06/13/18
LISN	FCC	FCC-LISN-50-50-M-H	ITS 00552	12	11/14/18
LISN	FCC	FCC-LISN-50-50-M-H	ITS 00551	12	09/15/18
LISN	COM-POWER	LIN-120A	ITS 01612	12	02/05/19

No Calibration required

Software used for emission compliance testing utilized the following:

Name	Manufacturer	Version	Template/Profile
Tile	Quantum Change	3.4.K.22	Conducted Restricted Band Edge_Avg Conducted Restricted Band Edge_Peak Conducted Restricted Band_1-26GHz Conducted Restricted Band_30M-1GHz Conducted Spurious_30M-26GHz
BAT-EMC	Nexio	3.16.0.64	Fastenal G103406457 3-12-2018.bpp
RS Commander	Rohde Schwarz	1.6.4	Not Applicable (Screen grabber)

6.0 Document History

Revision/ Job Number	Writer Initials	Reviewers Initials	Date	Change
1.0 / G103436674	AC	KV	April 05, 2018	Original document