TEST REPORT

Report Number: 104468298MPK-003
Project Number: G104468298
December 11, 2020

Testing performed on
RFID Reader
Model: 922194627

FCC ID: 2APK7-922194627V10
IC: 23979-92219462710

to

FCC Part 15 Subpart C (15.247)
Industry Canada RSS-247 Issue 2

For

Fastenal Company

Test Performed by:	Test Authorized by:
Intertek	Fastenal Company
1365 Adams Court	8918 Beckett Rd.
Menlo Park, CA 94025 USA	West Chester, OH 45069 USA

Prepared by: _____ **Date:** December 11, 2020
Aaron Chang

Reviewed by: _____ **Date:** December 11, 2020
Krishna K Vemuri

Report No. 104468298MPK-003

Equipment Under Test:	RFID Reader
Trade Name:	Fastenal Company
Model Number:	922194627
Applicant:	Fastenal Company
Contact:	Tony McIntosh
Address:	Fastenal Company 8918 Beckett Rd. West Chester, OH 45069
Country	USA
Tel. Number:	(513) 644-0074
Email:	Mmcintos@fastenal.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) Industry Canada RSS-247 Issue 2
Date of Test:	November 5-12, 2020

We attest to the accuracy of this report:

Aaron Chang
Project Engineer

Krishna K Vemuri
EMC Manager

TABLE OF CONTENTS

1.0 Summary of Tests

Test	Reference FCC	Reference Industry Canada	Result
RF Output Power	15.247(b)(3)	RSS-247, 5.4.d)	Complies
6 dB Bandwidth	15.247(a)(2)	RSS-247, 5.2.a)	Complies
Power Density	15.247(e)	RSS-247, 5.2.b)	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

EUT receive date: November 05, 2020

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: November 5, 2020

Test completion date: November 12, 2020

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.	922194627
FCC Identifier	2APK7-922194627V10
IC Identifier	23979-92219462710
Type of transmission	Digital Transmission System (DTS)
Rated RF Output	18.21 dBm
Antenna(s) & Gain	PCB Antenna, Gain: 5.1 dBi
Frequency Range	923.3 – 927.5 MHz (Tx/Rx); 903 – 914.2 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 8918 Beckett Rd. West Chester, OH 45069 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 v05r02), and RSS-247, RSS-GEN Issue 5.

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

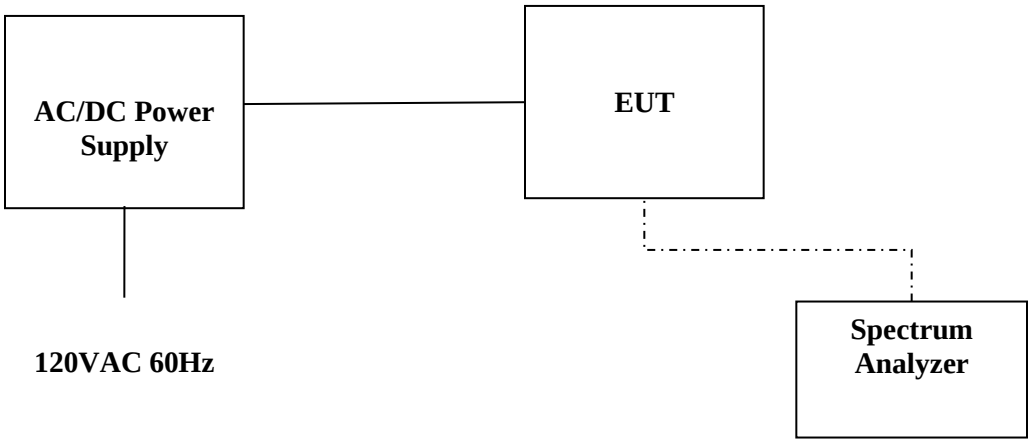
3.1 Support Equipment

No support equipment was used for testing.

3.2 Block Diagram of Test Setup

Equipment Under Test			
Description	**Manufacturer**	**Model Number**	**Serial Number**
RFID Reader	Fastenal Company	922194627	9705082
AC/DC Power Supply	CUI Inc	SDI18-5-UD	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. The EUT is attached to peripherals and they are connected and operational (as typical as possible). The EUT is wired to transmit full power. During testing, all cables are manipulated to produce worst-case emissions.

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, 5.2.a) 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 v05r02 was used to determine the DTS occupied bandwidth. Section 11.8.1 Option 1 of ANSI C63.10 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.

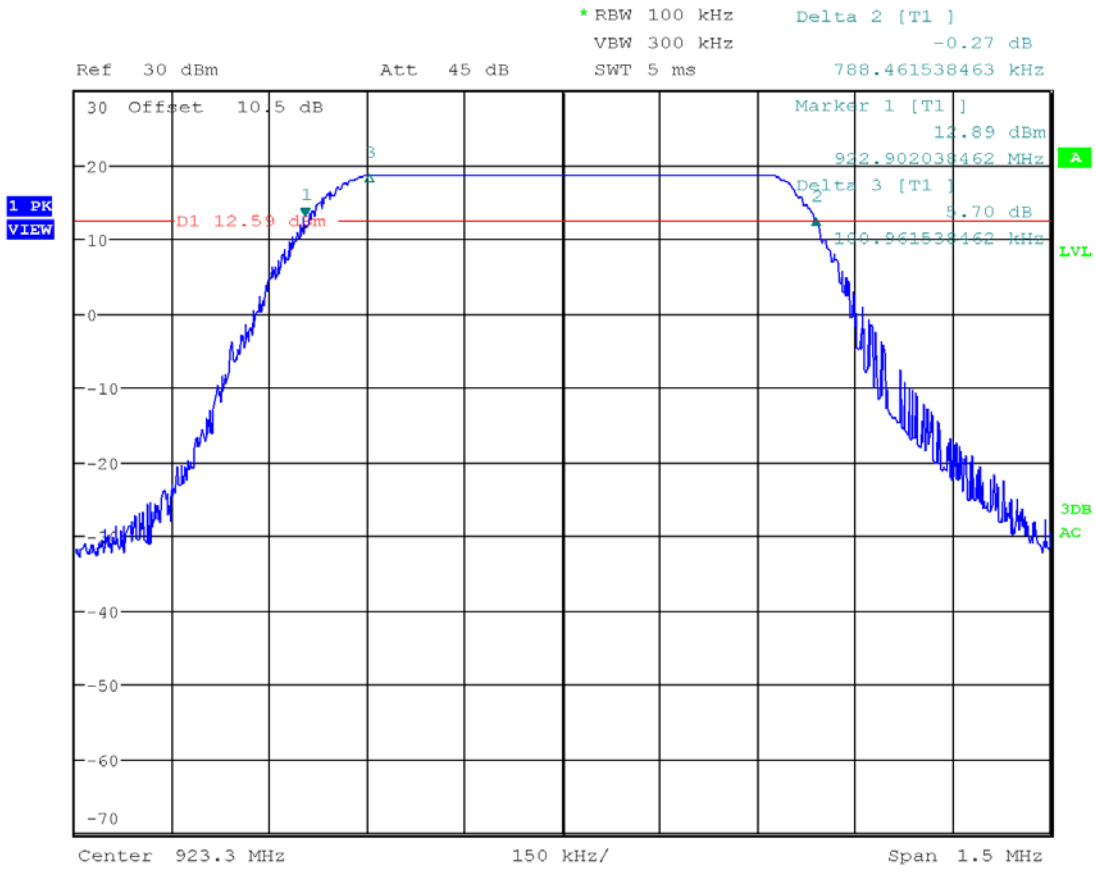
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

4.1.3 Test Result

Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN, kHz	Occupied bandwidth, RSS-GEN, kHz	Plot
923.3	788.462	--	1.1
	--	670.500	1.4
925.1	788.462	--	1.2
	--	669.000	1.5
927.5	781.250	--	1.3
	--	667.500	1.6

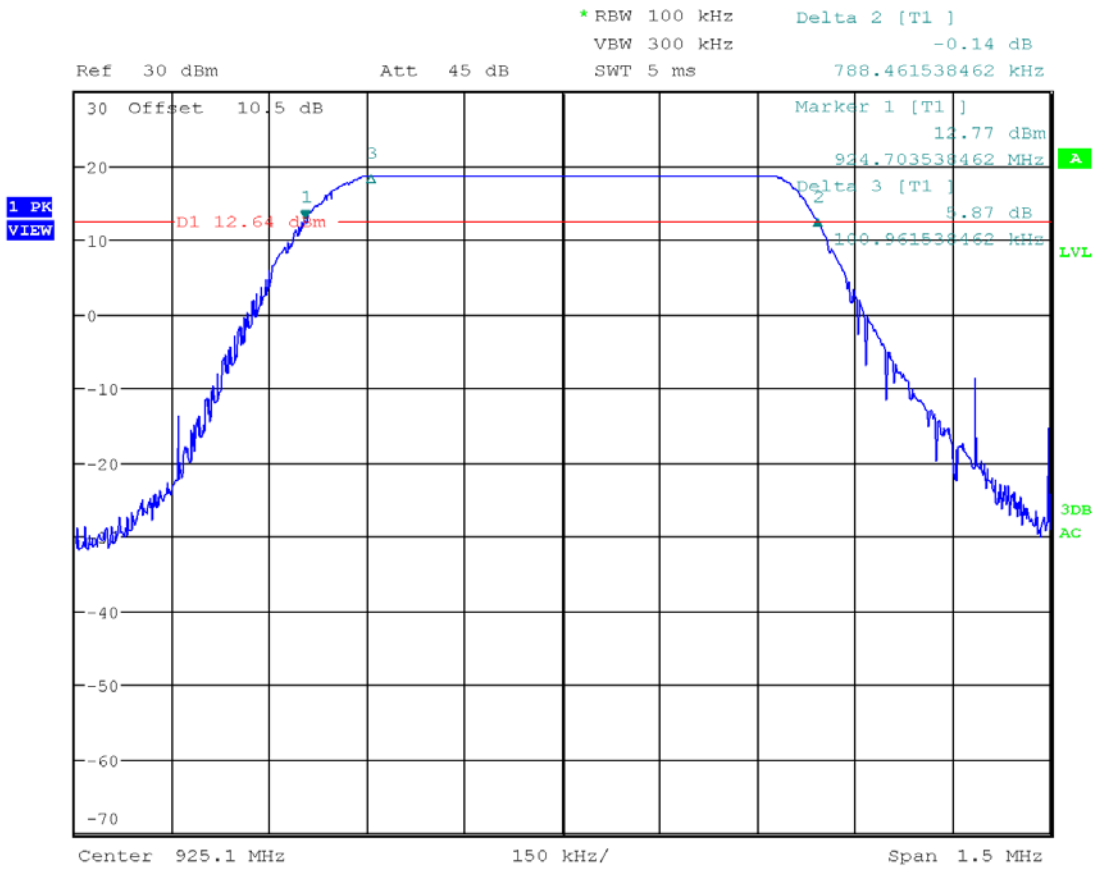
Date of Test:	November 9, 2020
Results	**Complies**

Plot 1. 1



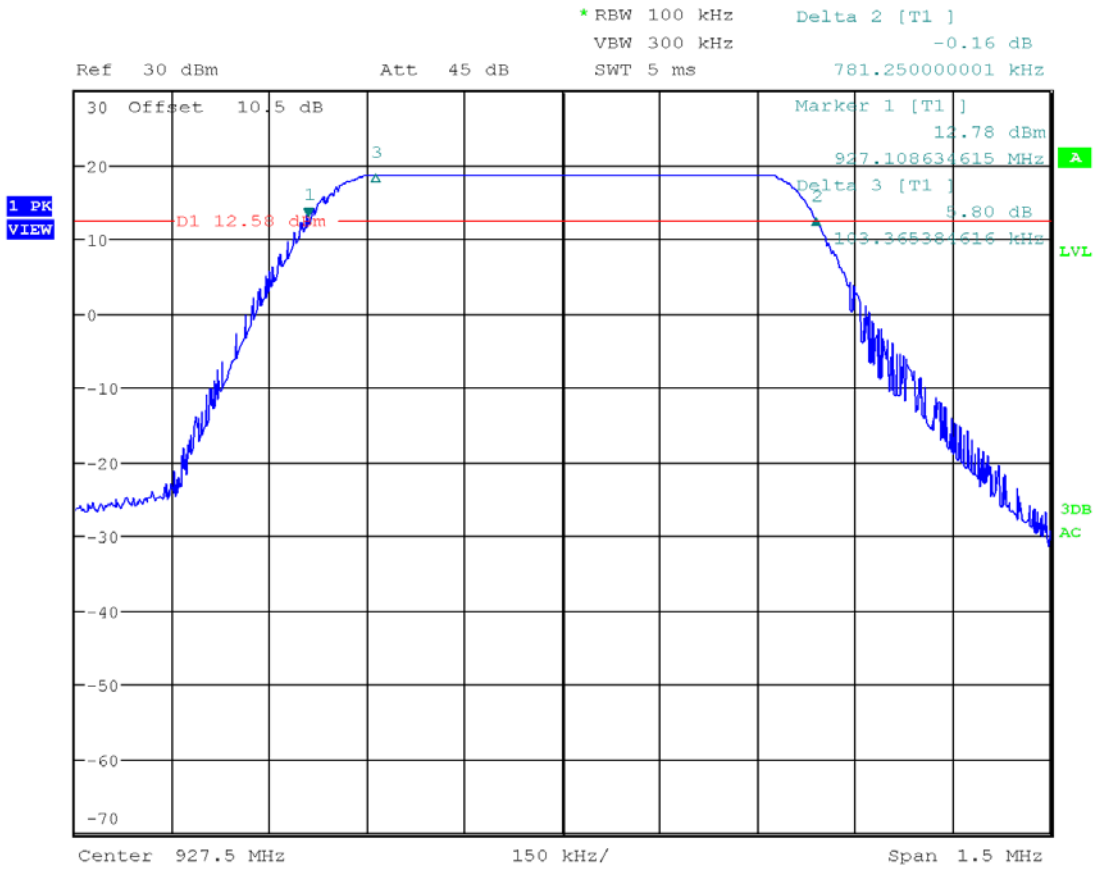
Date: 9.NOV.2020 15:41:10

Plot 1. 2

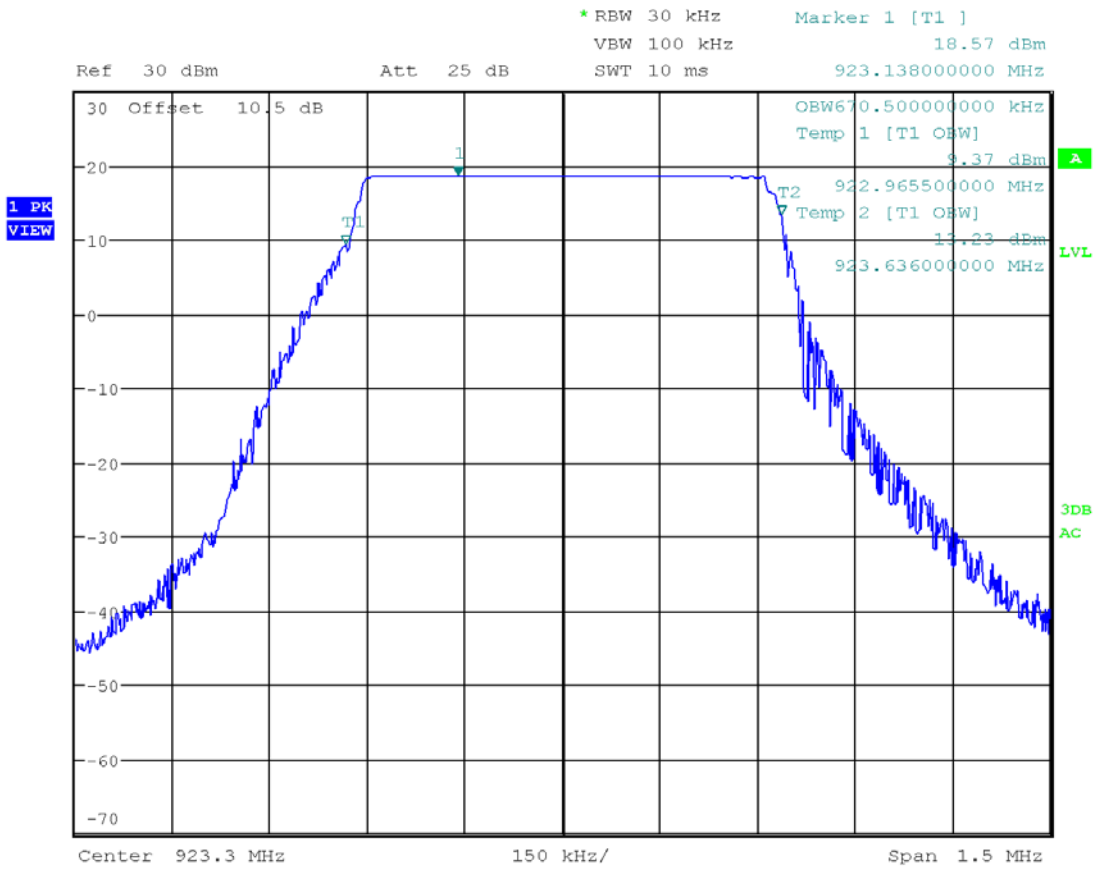


Date: 9.NOV.2020 15:17:00

Plot 1. 3

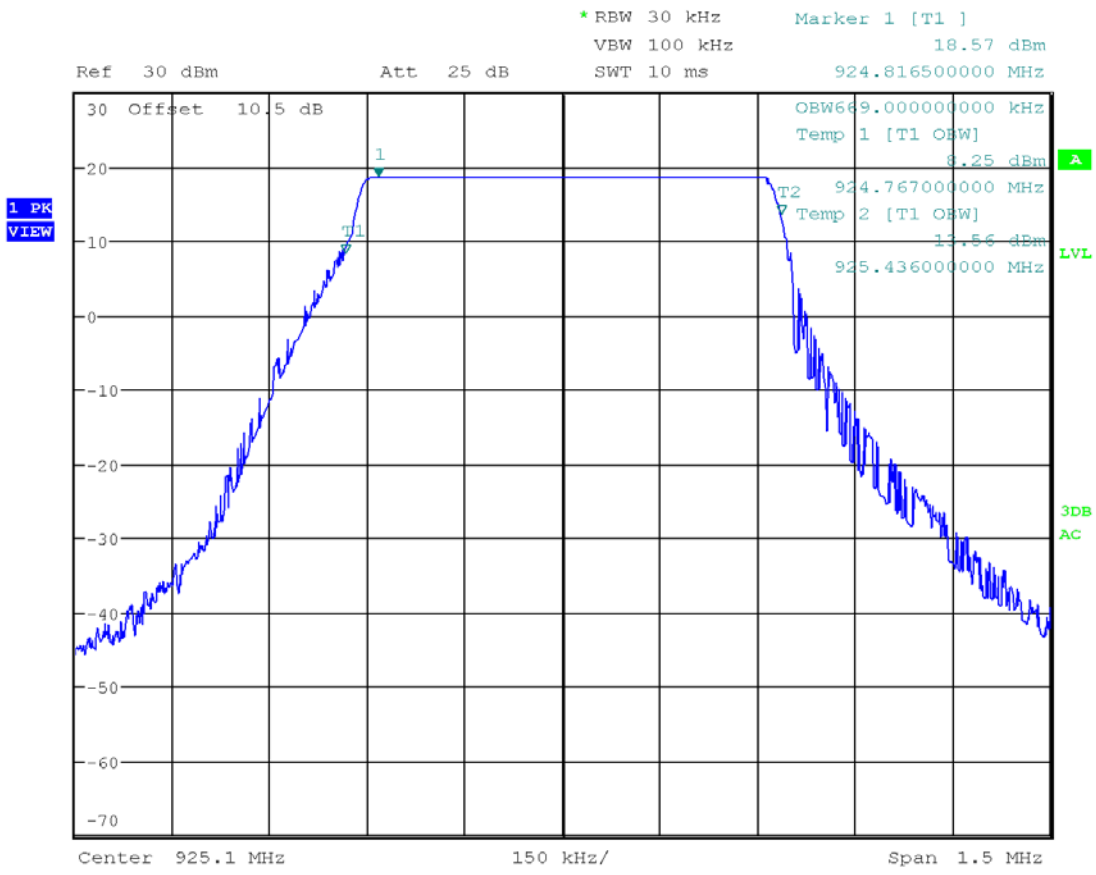

* RBW 100 kHz
VBW 300 kHz
SWT 5 ms
Delta 2 [T1]
-0.16 dB
781.250000001 kHz
Ref 30 dBm
Att 45 dB
30 Offset 10.5 dB
Marker 1 [T1]
12.78 dBm
927.108634615 MHz
Delta 3 [T1]
5.80 dB
1 PK
VIEW
D1 12.58 dBm
A
LVL
3DB
AC
Center 927.5 MHz
150 kHz/
Span 1.5 MHz
Date: 9.NOV.2020 15:35:12

Plot 1. 4



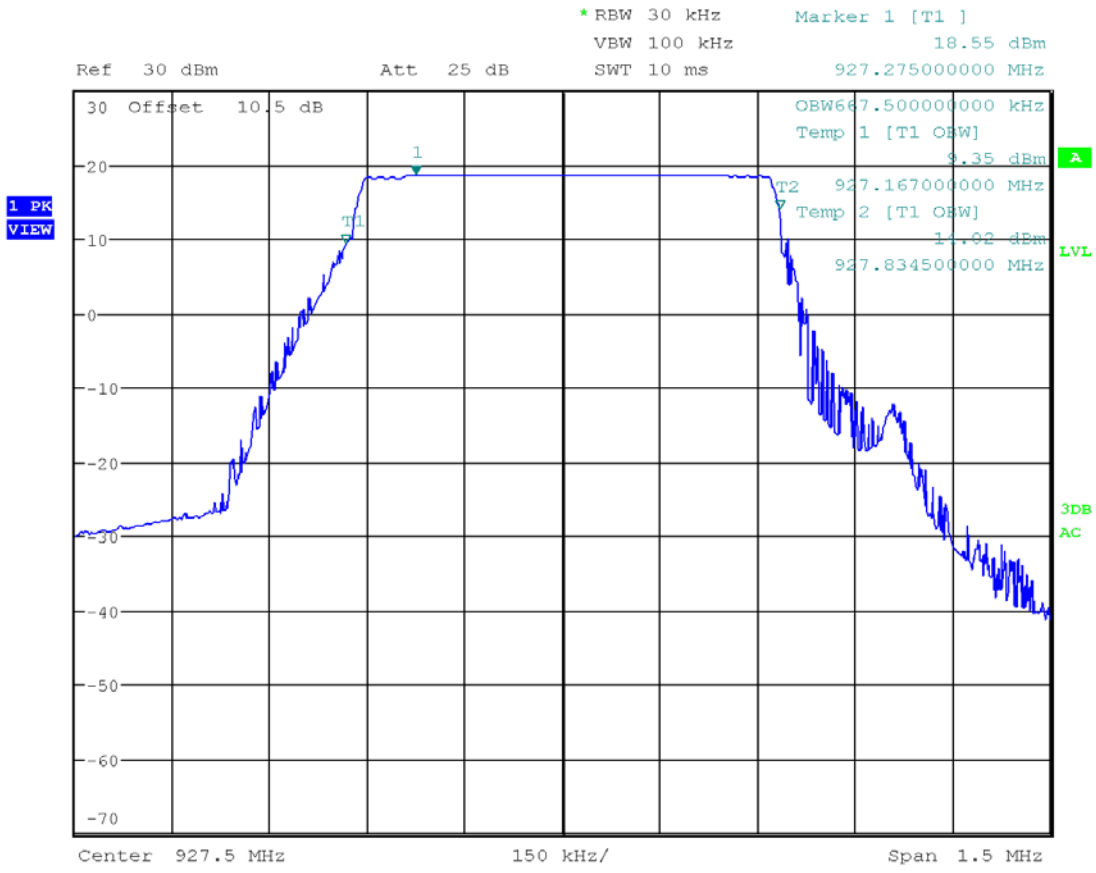
Date: 9.NOV.2020 15:46:48

Plot 1.5



Date: 9.NOV.2020 15:51:06

Plot 1.6


* RBW 30 kHz
VBW 100 kHz
SWT 10 ms
Marker 1 [T1]
18.55 dBm
927.275000000 MHz
Ref 30 dBm
Att 25 dB
30 Offset 10.5 dB
OBW667.500000000 kHz
Temp 1 [T1 OBW]
9.35 dBm
T2 927.167000000 MHz
Temp 2 [T1 OBW]
14.02 dBm
927.834500000 MHz
1 PK
VIEW
A
LVL
3DB
AC
20
10
0
-10
-20
-30
-40
-50
-60
-70
Center 927.5 MHz
150 kHz/
Span 1.5 MHz
Date: 9.NOV.2020 15:55:53

4.2 Maximum Peak Conducted Output Power at Antenna Terminals
FCC Rule: 15.247(b)(3); RSS-247, 5.4.d);

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 v05r02 was used. Specifically, section 11.9.2.2.3 Method AVGSA-1 Alternative (RMS detection with slow sweep and EUT transmitting continuously at full power) of ANSI 63.10 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.

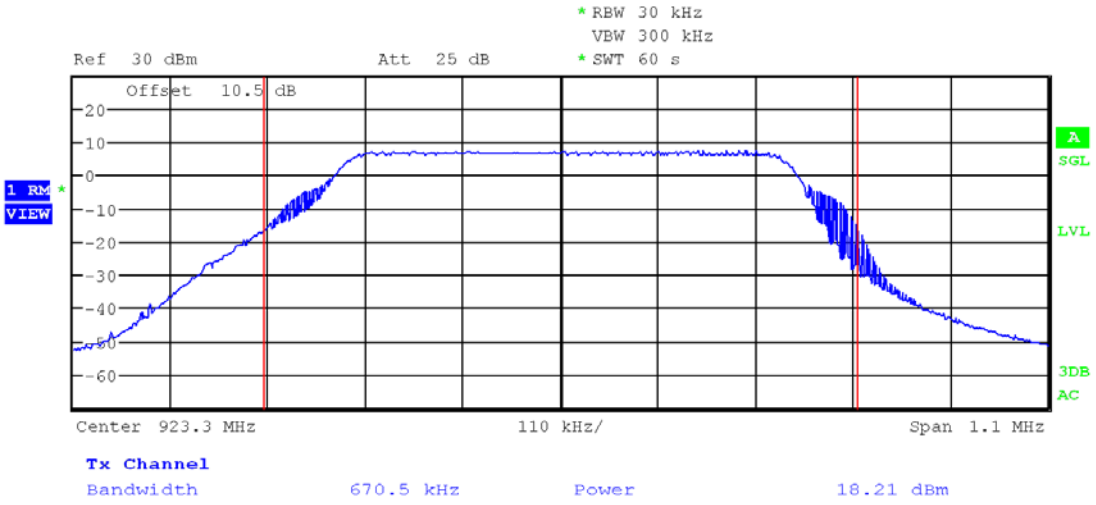
4.3.3 Test Result

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

Frequency, MHz	Conducted Power (peak), dBm	Conducted Power (peak), mW	Plot
923.3	18.21	66.22	2.1
925.1	18.17	65.61	2.2
927.5	18.20	66.07	2.3

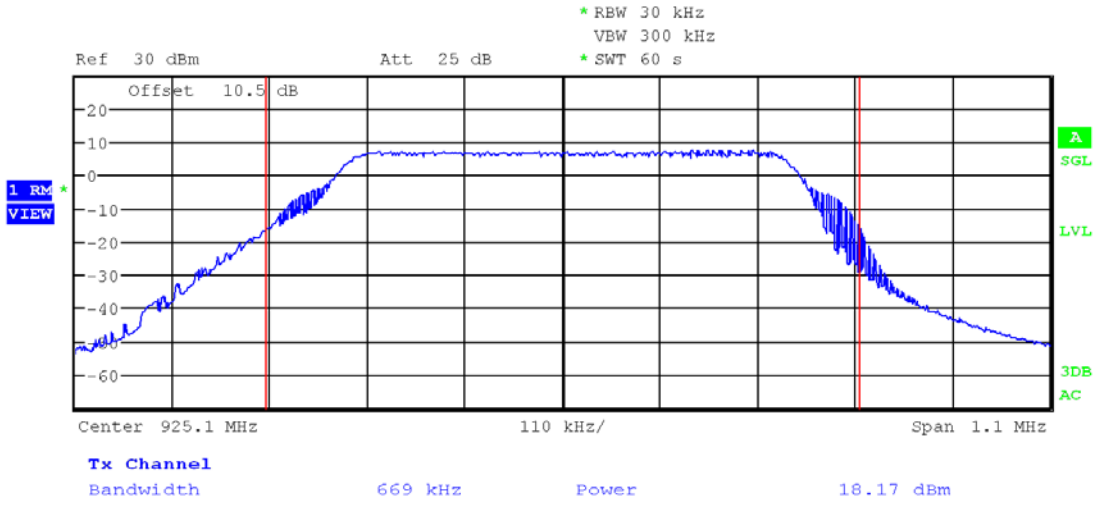
Date of Test:	November 9, 2020
Results	**Complies**

Plot 2. 1



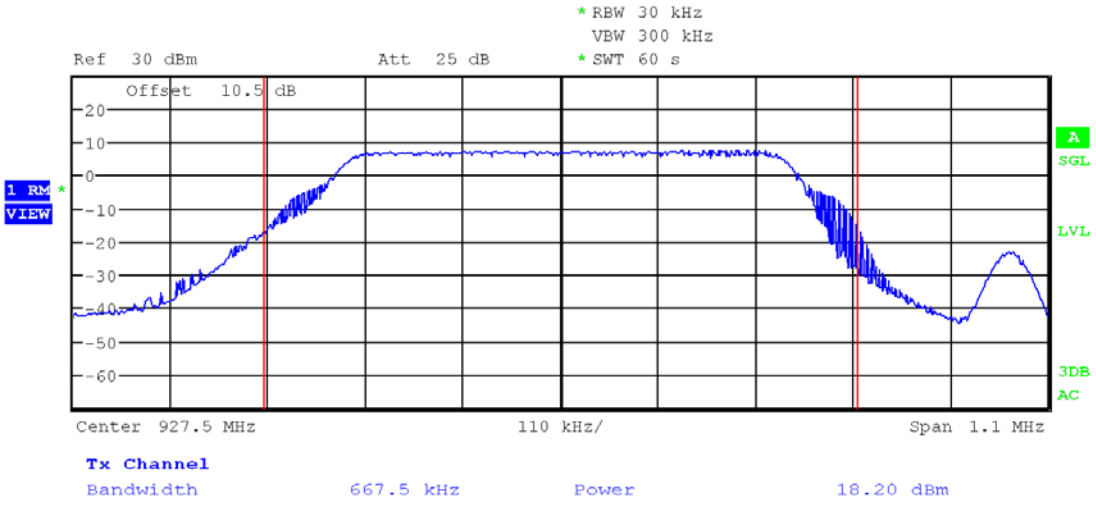
Date: 9.NOV.2020 16:04:20

Plot 2. 2



Date: 9.NOV.2020 16:08:08

Plot 2. 3



Date: 9.NOV.2020 16:01:18

4.3 Maximum Power Spectral Density
FCC: 15.247 (e); RSS-247, 5.2.b);

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 v05r02, specifically section 11.10.3 Method AVGPSD-1 (trace averaging with EUT transmitting at full power throughout each sweep) of ANSI 63.10 was utilized.

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).

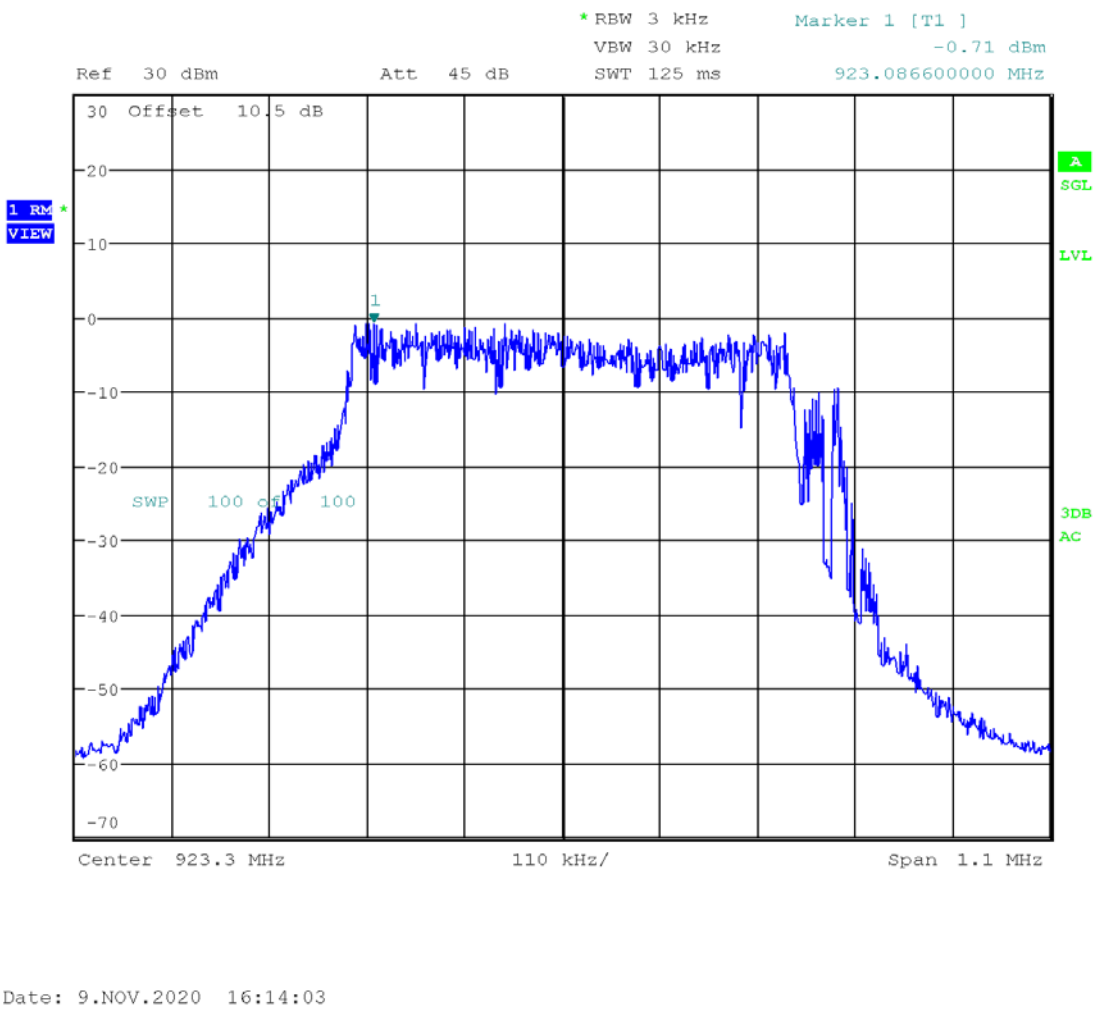
4.3.3 Test Result

Refer to the following plots for the test result

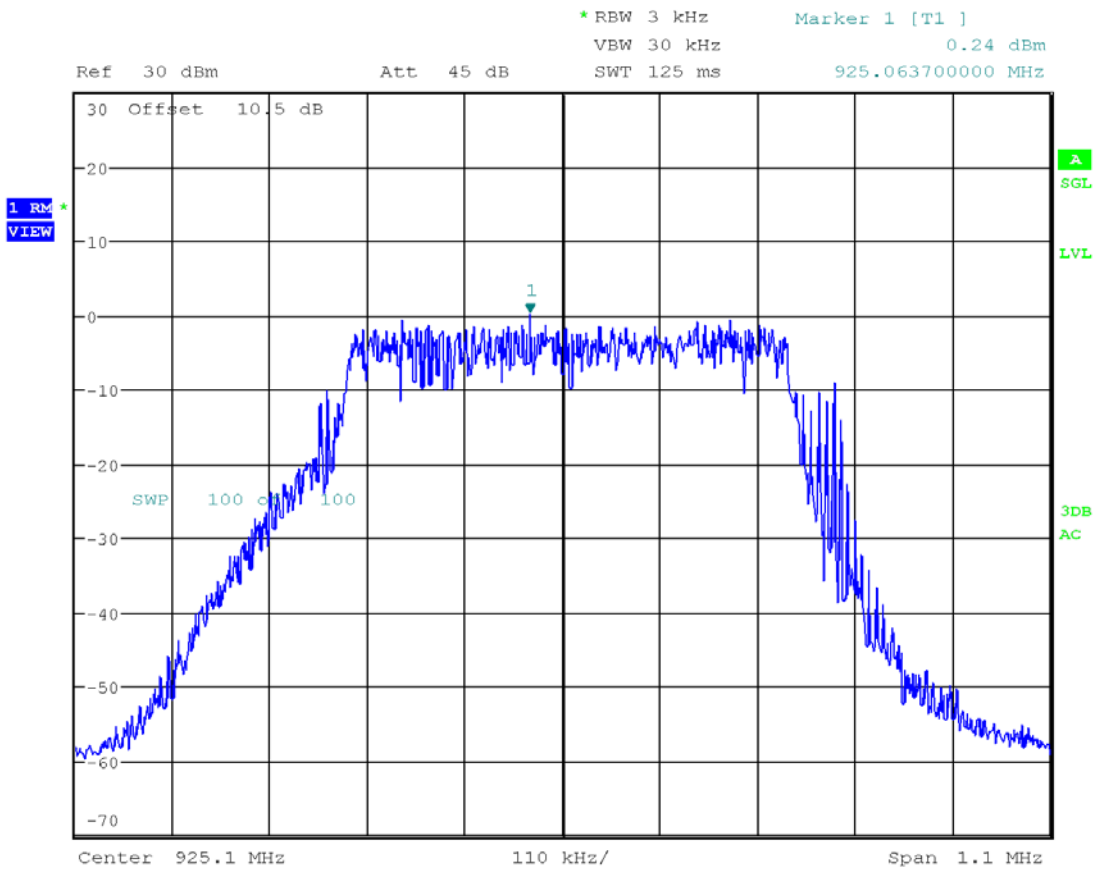
Frequency, MHz	Maximum Power Spectral Density, dBm	Maximum Power Spectral Density Limit, dBm	Margin, dB	Plot
923.3	-0.71	8.0	-8.71	3.1
925.1	0.24	8.0	-7.76	3.2
927.5	-0.13	8.0	-8.13	3.3

Date of Test:	November 9, 2020
Results	**Complies**

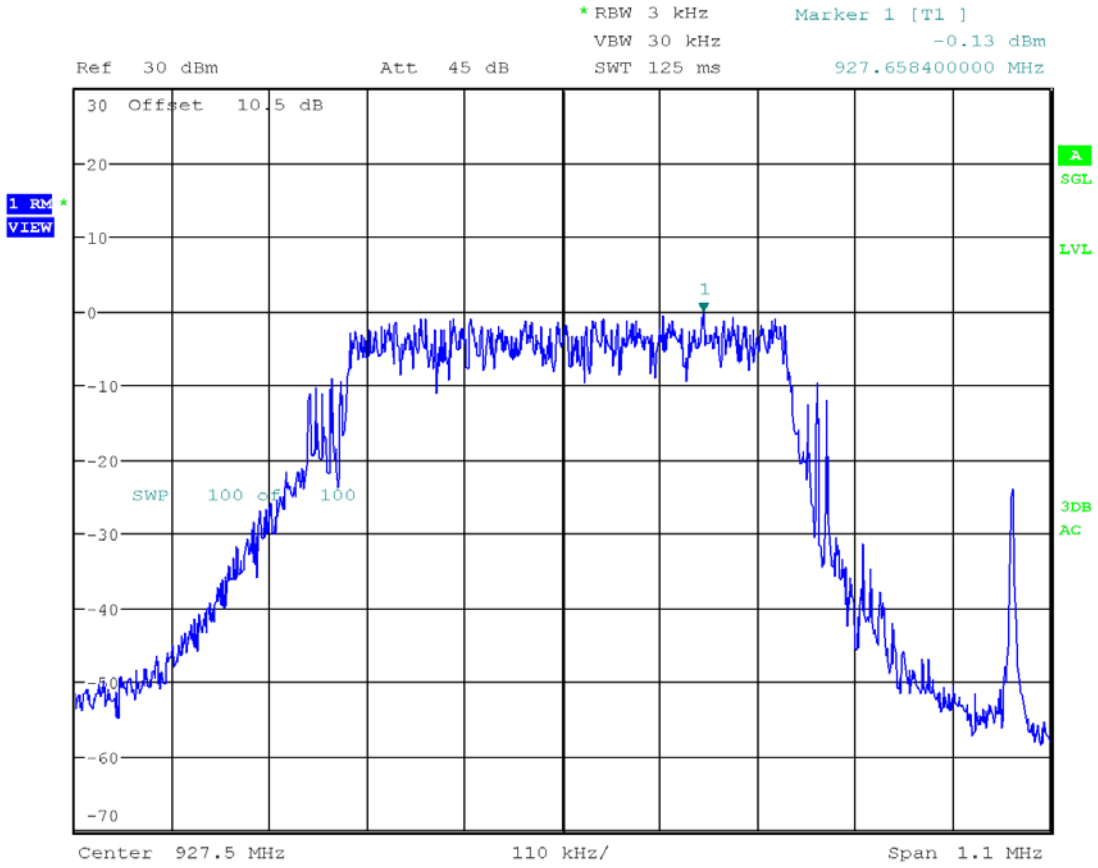
Plot 3. 1


* RBW 3 kHz
VBW 30 kHz
SWT 125 ms
Marker 1 [T1]
-0.71 dBm
923.086600000 MHz
Ref 30 dBm
Att 45 dB
30 Offset 10.5 dB
1 RM
VIEW
A
SGL
LVL
3DB
AC
SWP 100 sec 100
Center 923.3 MHz
110 kHz/
Span 1.1 MHz
Date: 9.NOV.2020 16:14:03

Plot 3. 2


* RBW 3 kHz
VBW 30 kHz
SWT 125 ms
Marker 1 [T1]
0.24 dBm
925.063700000 MHz
Ref 30 dBm
Att 45 dB
30 Offset 10.5 dB
1 RM
VIEW
A
SGL
LVL
3DB
AC
SWP 100 of 100
Center 925.1 MHz
110 kHz/
Span 1.1 MHz
Date: 9.NOV.2020 16:10:55

Plot 3. 3


* RBW 3 kHz
VBW 30 kHz
SWT 125 ms
Marker 1 [T1]
-0.13 dBm
927.658400000 MHz
Ref 30 dBm
Att 45 dB
30 Offset 10.5 dB
1 RM
VIEW
A
SGL
LVL
3DB
AC
SWP 100 of 100
Center 927.5 MHz
110 kHz/
Span 1.1 MHz
Date: 9.NOV.2020 16:13:04

4.4 Unwanted Conducted Emissions
FCC: 15.247(d); RSS-247, 5.5;

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 v05r02, specifically section 11.11 Emissions in non-restricted frequency bands of ANSI 63.10 was utilized.

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.

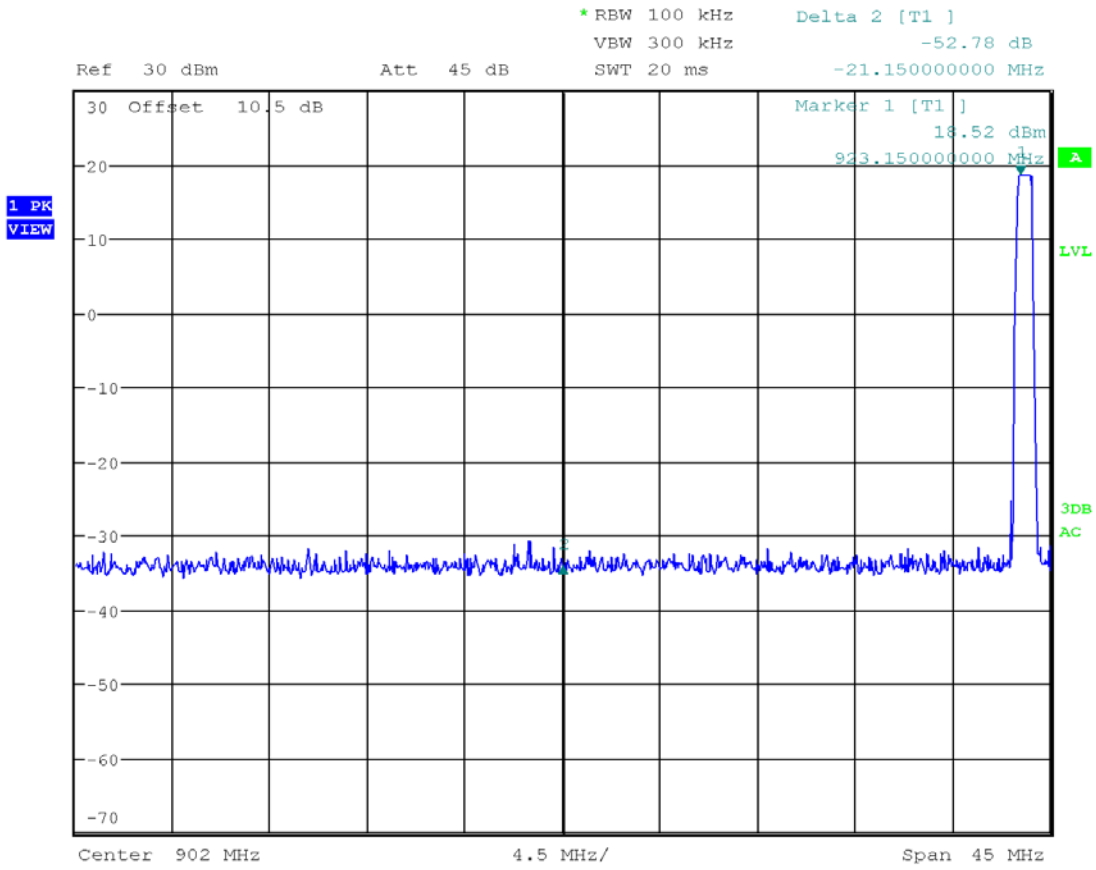
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

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.

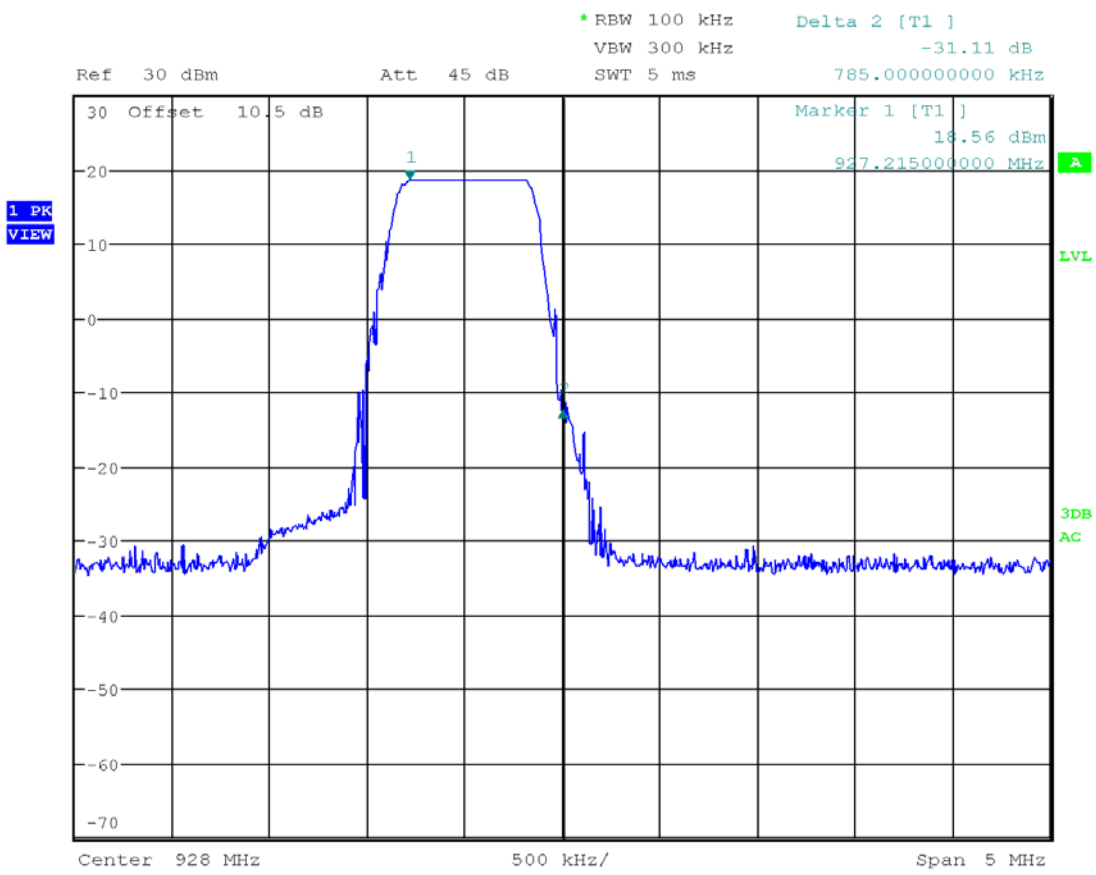
Date of Test:	November 9, 2020
Results	**Complies**

Tx @ Low Channel, 902 MHz Band Edge
Plot 4.1



Date: 9.NOV.2020 16:18:12

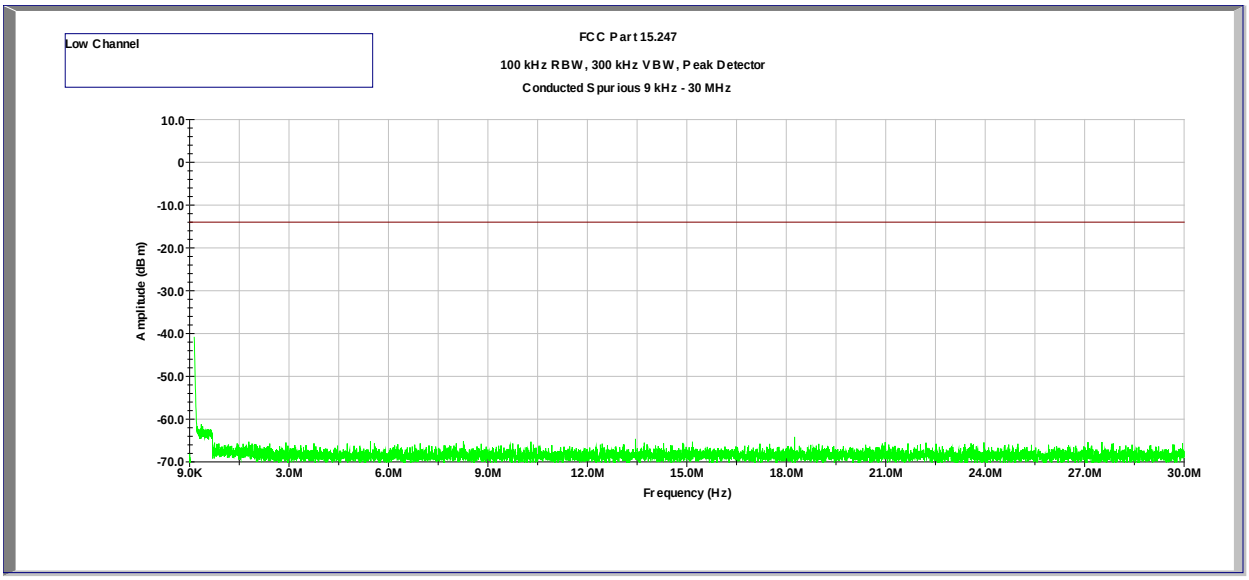
Tx @ High Channel, 928 MHz Band Edge
Plot 4.2

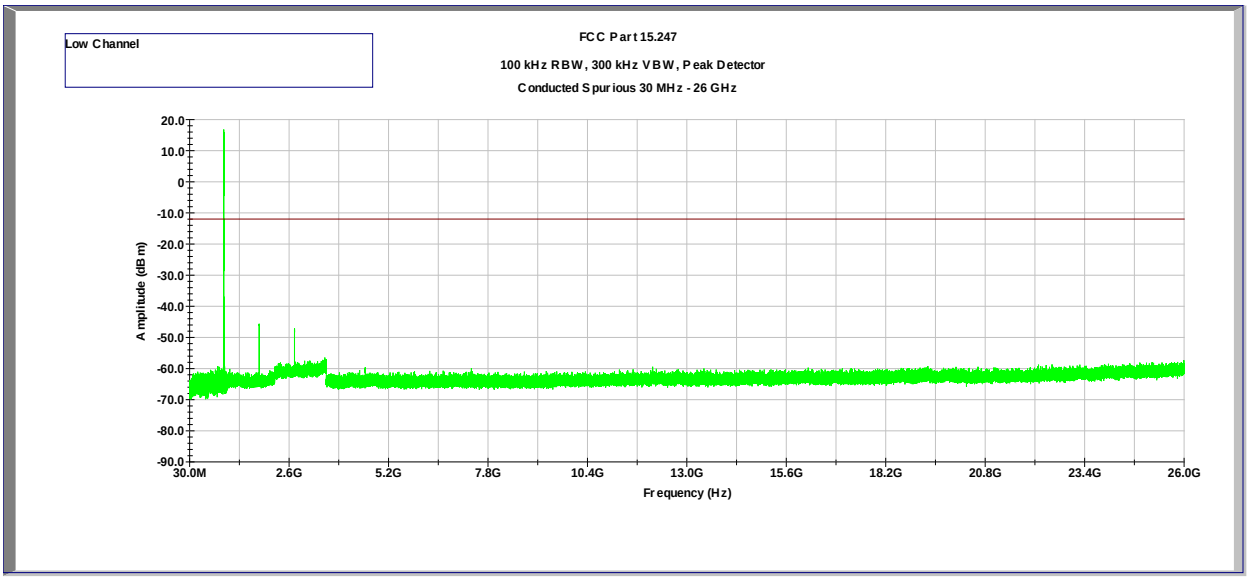


Date: 9.NOV.2020 16:20:55

Tx @ Low Channel, 923.3 MHz

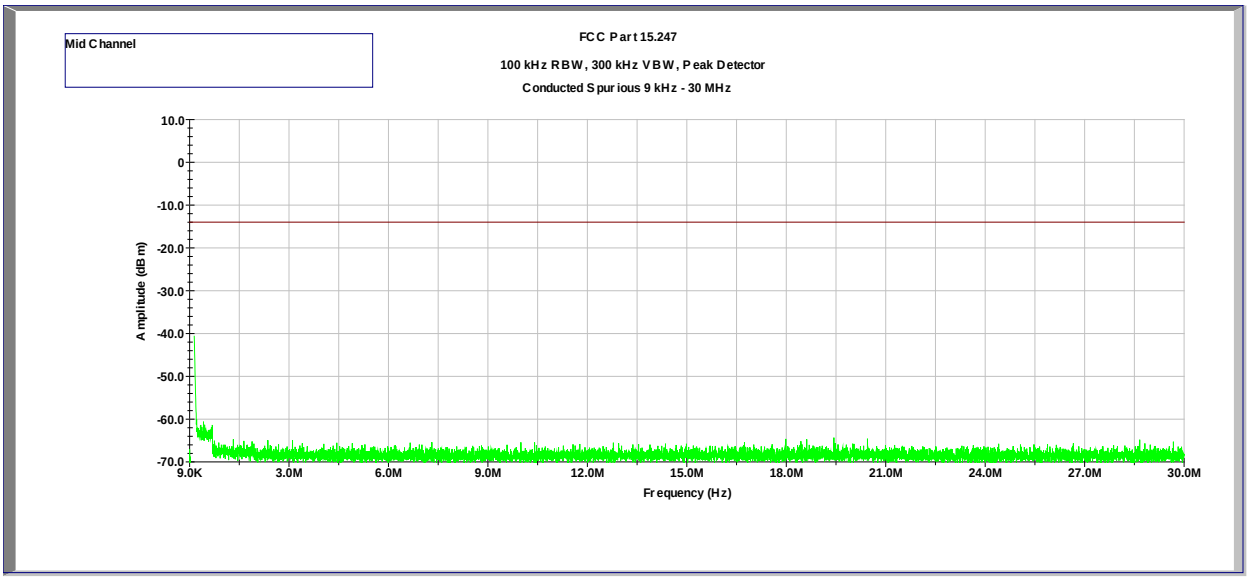
9kHz -26GHz Conducted Spurious
Plot 4.3

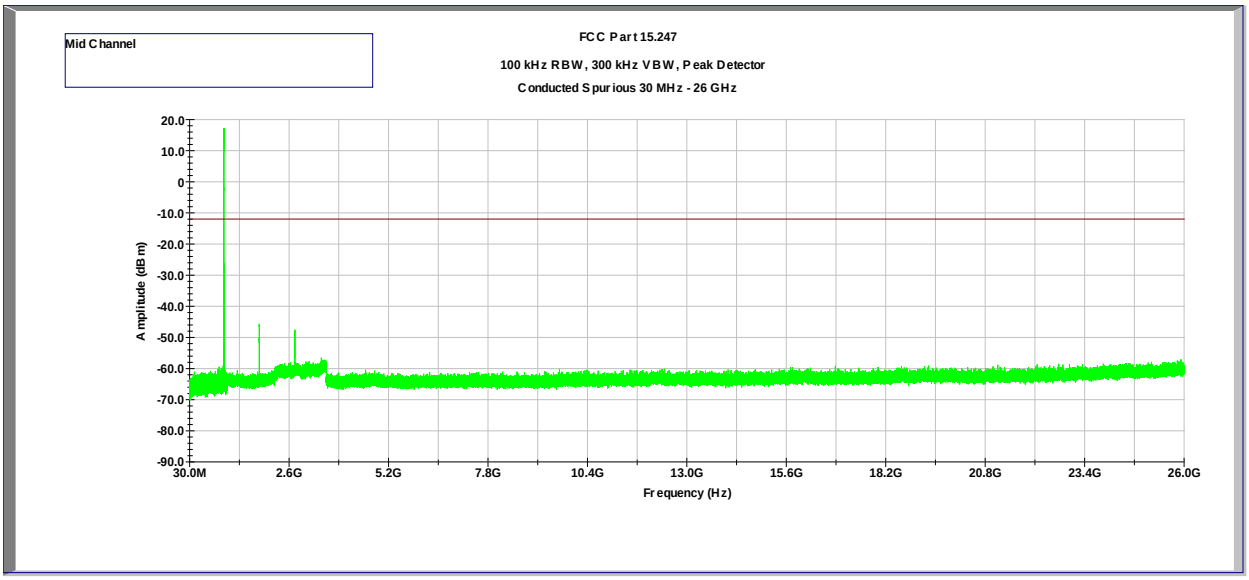




Tx @ Mid Channel, 925.1 MHz

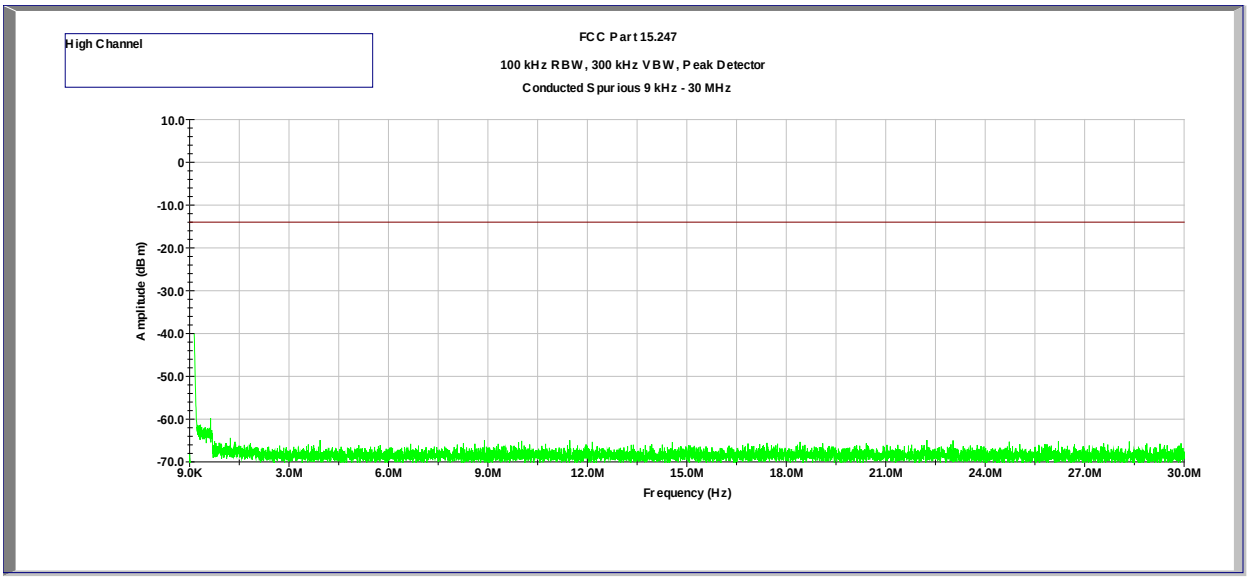
9kHz -26GHz Conducted Spurious
Plot 4.4

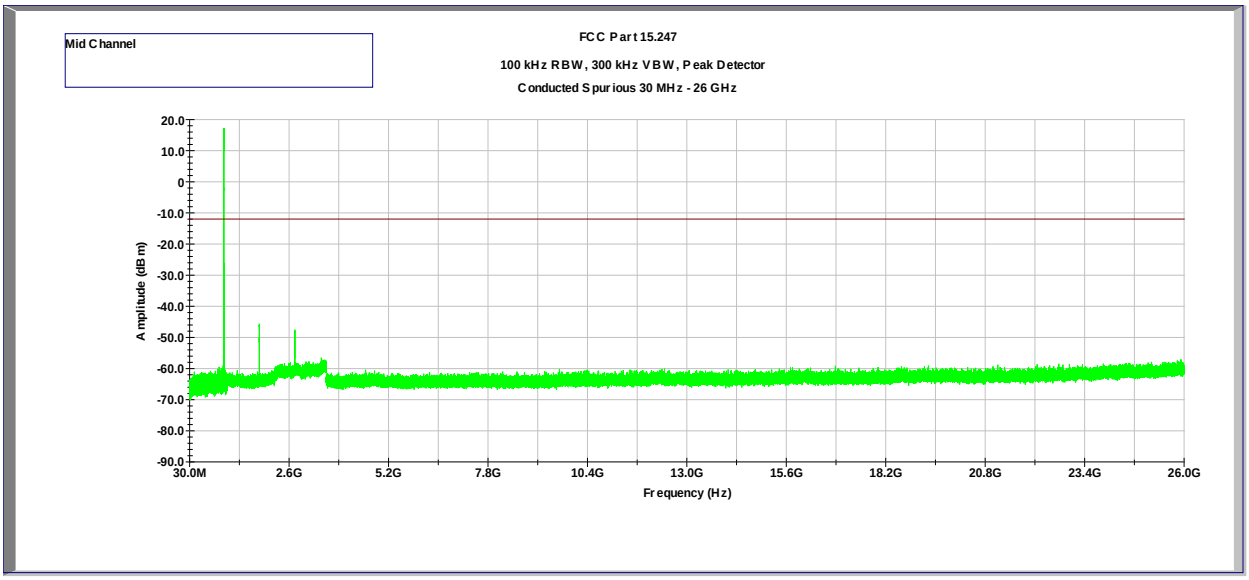




Tx @ High Channel, 927.5 MHz

30MHz -26GHz Conducted Spurious
Plot 4.5





4.5 Transmitter Radiated Emissions
FCC Rules: 15.247(d), 15.209, 15.205; RSS-247, 5.5;

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 9 kHz to 25 GHz according to the procedure described in ANSI C63.10: 2013. Spectrum Analyzer Resolution Bandwidth is 200Hz or greater for frequencies 9kHz to 30MHz, 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).

Correlation measurements were performed below 30MHz between 10m ALSE and Open Field site according to FCC KDB 414788 D01 Radiated Test Site v01r01 section 2. All readings were within the acceptable tolerance.

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.

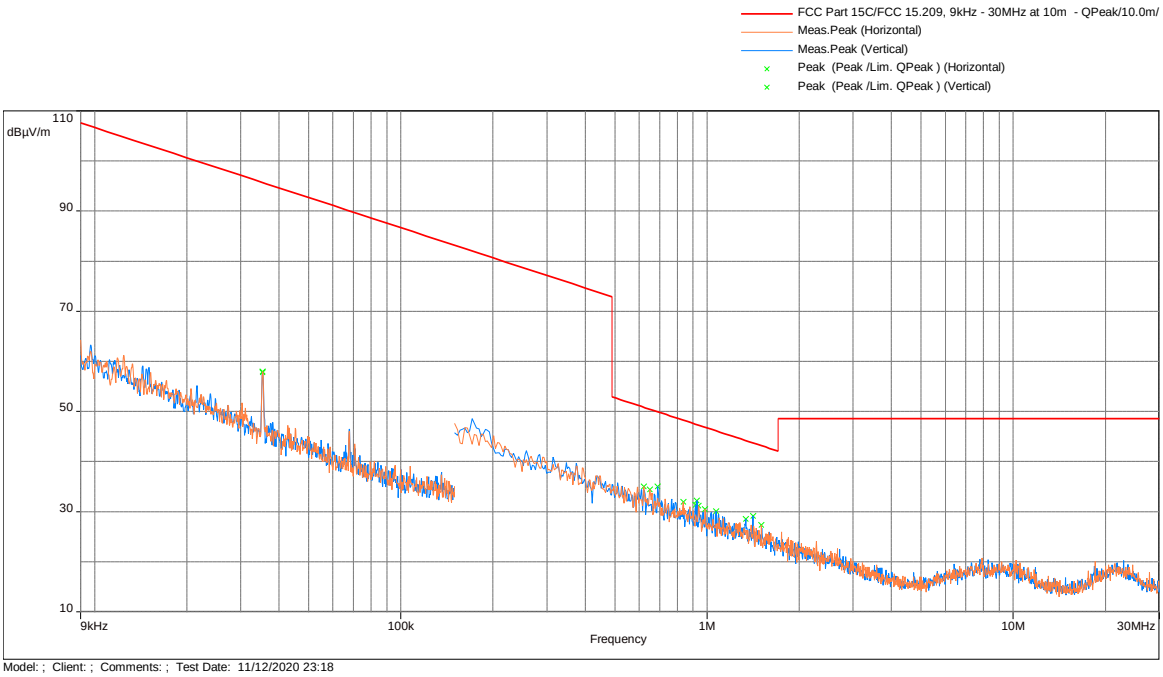
All radiated measurements were conducted with the AC adapter. The worst-case data was reported.

Date of Test:	November 5 - 12, 2020
Results	**Complies**

Out-of-Band Radiated Spurious Emissions

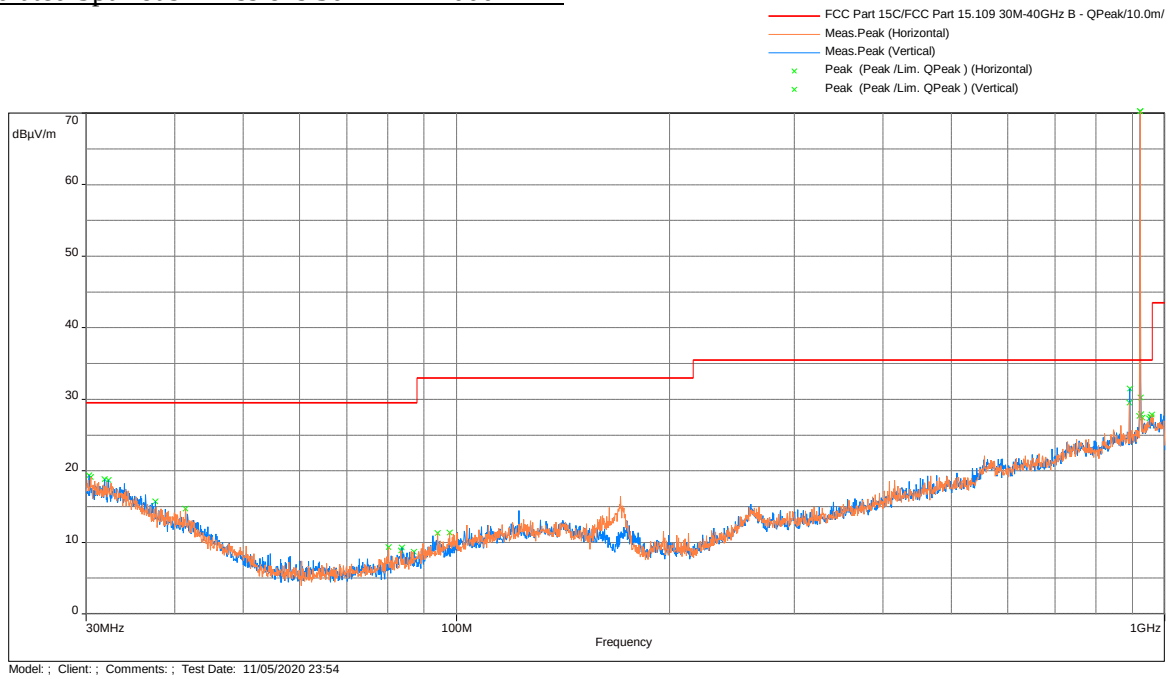
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 923.3 MHz

Radiated Spurious Emissions 9 kHz - 30 MHz



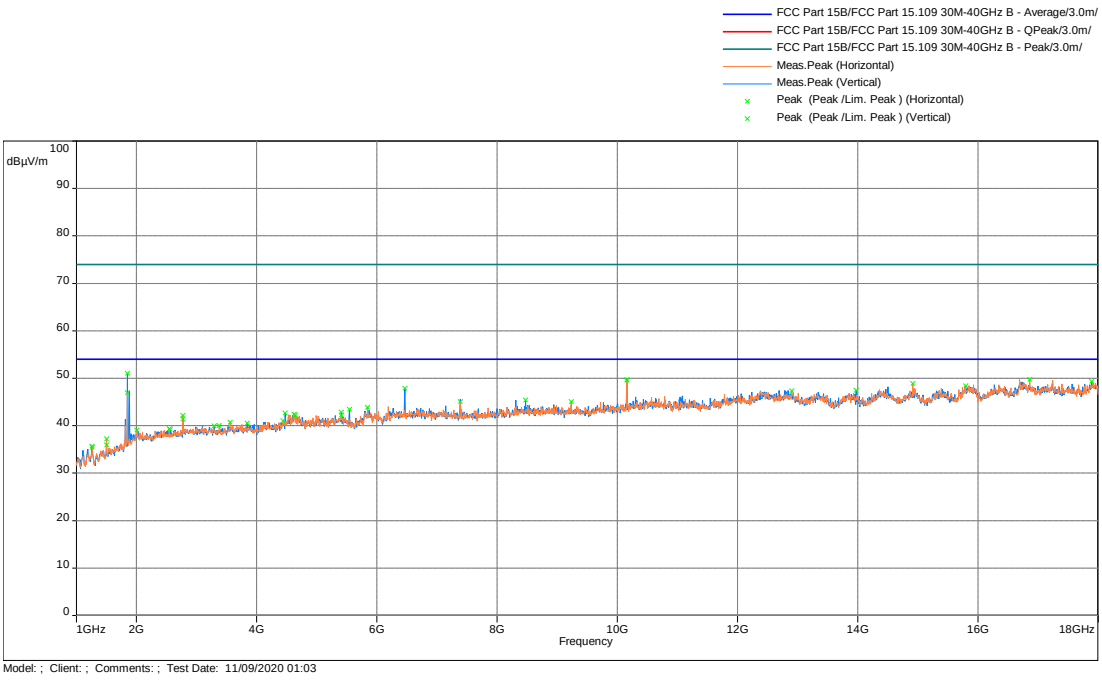
Model: ; Client: ; Comments: ; Test Date: 11/12/2020 23:18

Radiated Spurious Emissions 30 MHz - 1000 MHz



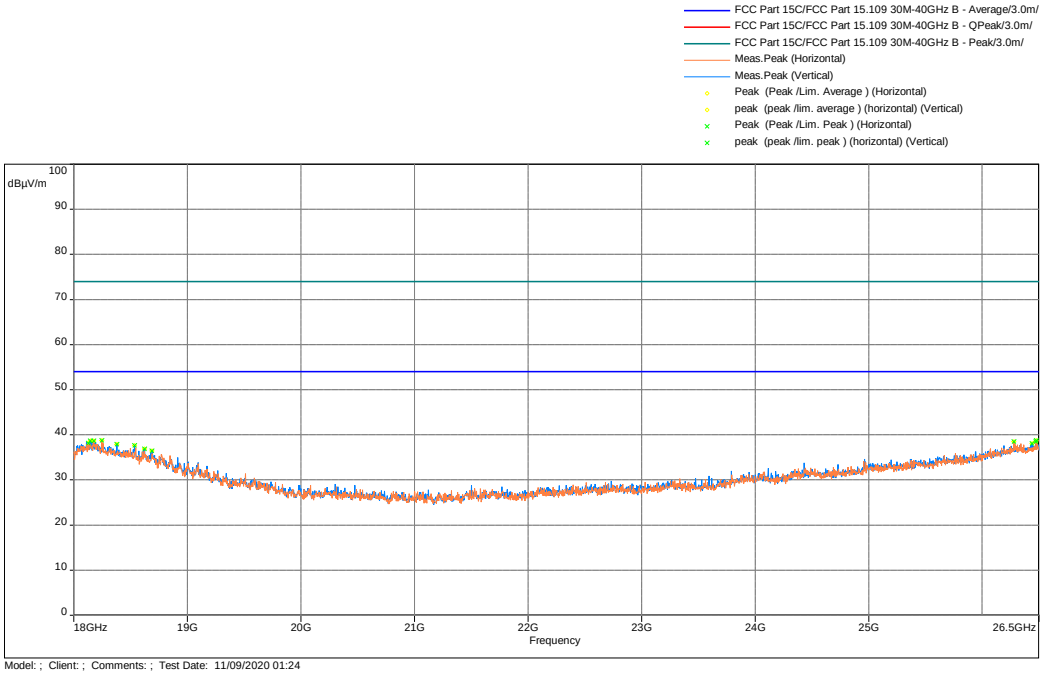
Model: ; Client: ; Comments: ; Test Date: 11/05/2020 23:54

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



Model: ; Client: ; Comments: ; Test Date: 11/09/2020 01:03

Radiated Spurious Emissions 18000 - 26500 MHz, Peak Scan vs Peak & Avg Limit



Model: ; Client: ; Comments: ; Test Date: 11/09/2020 01:24

Frequency (MHz)	QPeak@ 10m (dBµV/m)	Lim. QPeak @10m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
892.33	31.48	35.5	-4.02	3.98	55.75	Vertical	-1.65

Frequency (MHz)	Peak @3m (dBµV/m)	Lim. Peak @3m dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
1846.600	51.04	74	-22.96	2.48	275	Vertical	-15.75
10158.470	49.64	74	-24.36	3.99	274.75	Horizontal	-1.96
10155.630	49.62	74	-24.38	3.98	15	Vertical	-1.95

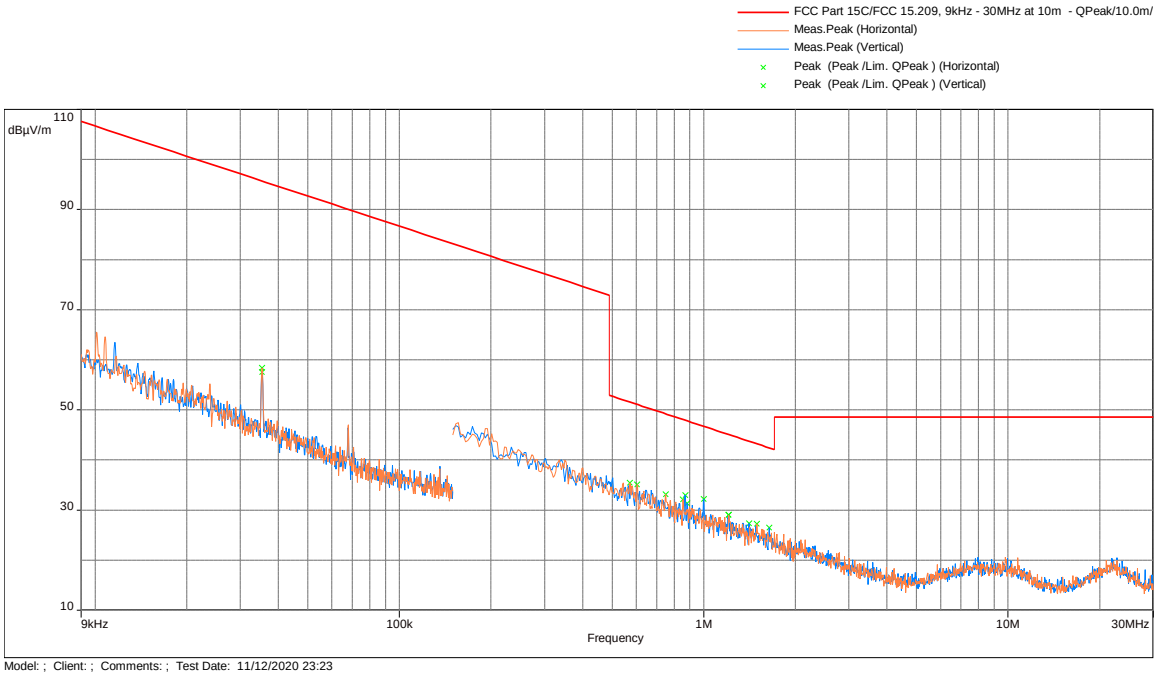
Frequency (MHz)	Average @3m (dBµV/m)	Lim. Average @3m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
1846.600	50.21	54	-3.79	2.48	254.5	Vertical	-15.76
10155.630	48.91	54	-5.09	3.98	237.5	Vertical	-1.95
10158.470	47.45	54	-6.55	1.02	275.5	Horizontal	-1.96

Note: Correction = AF + CF - Preamp

Results	Complies

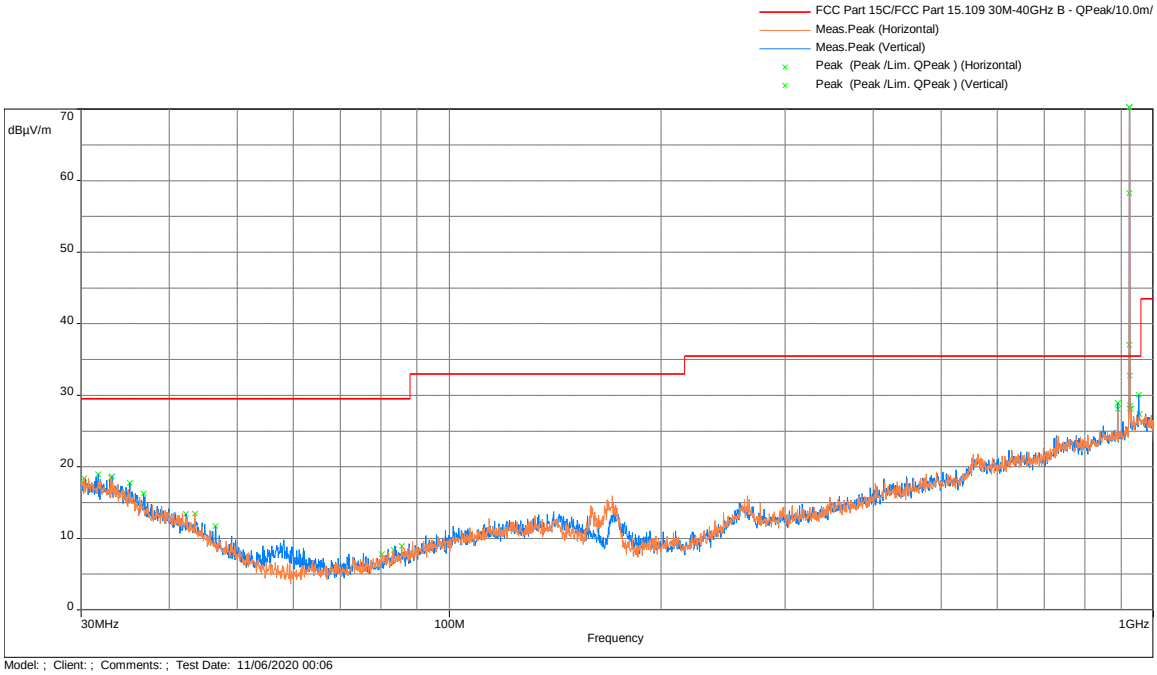
Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 925.1 MHz

Radiated Spurious Emissions 9 kHz - 30 MHz



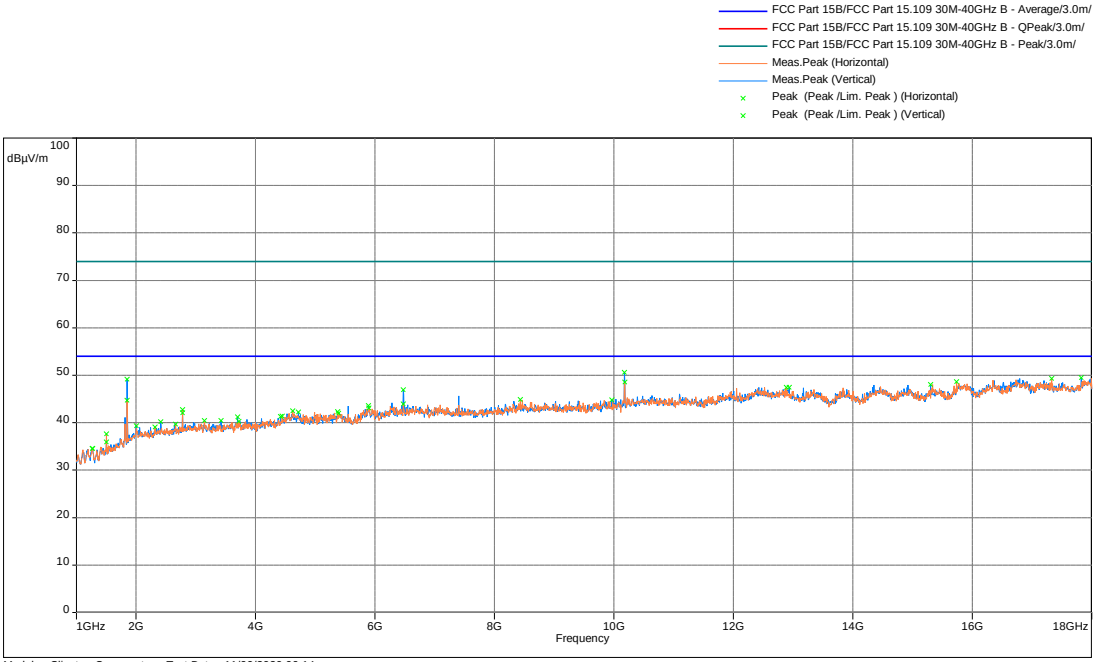
Model: ; Client: ; Comments: ; Test Date: 11/12/2020 23:23

Radiated Spurious Emissions 30 MHz - 1000 MHz



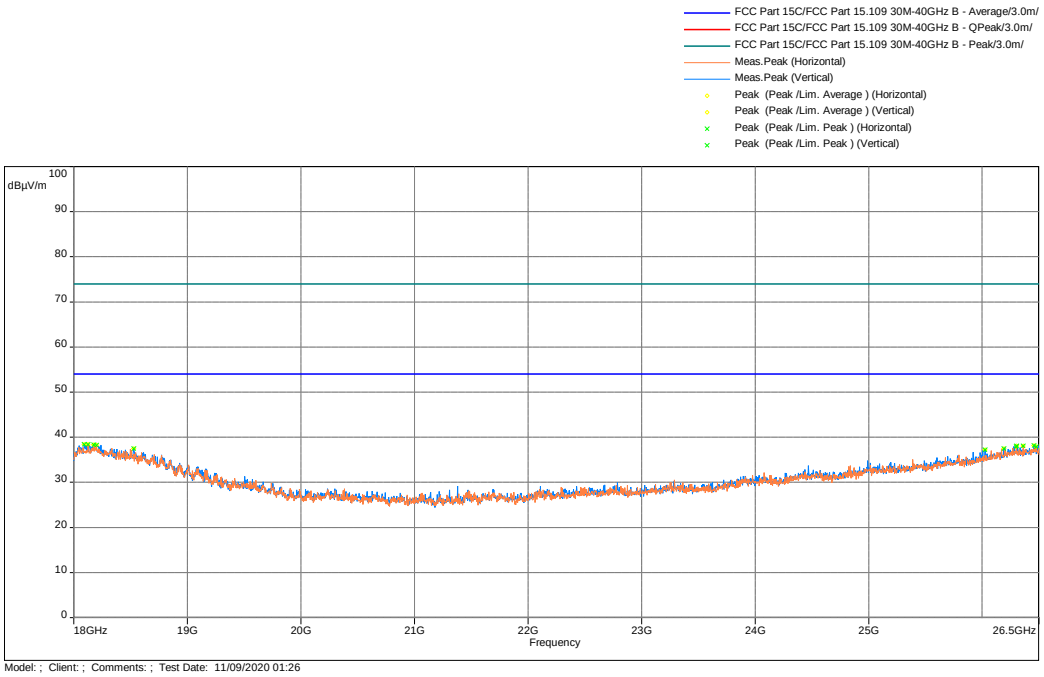
Model: ; Client: ; Comments: ; Test Date: 11/06/2020 00:06

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



Model: ; Client: ; Comments: ; Test Date: 11/09/2020 00:14

Radiated Spurious Emissions 18000 - 26500 MHz, Peak Scan vs Peak & Avg Limit



Model: ; Client: ; Comments: ; Test Date: 11/09/2020 01:26

Frequency (MHz)	QPeak@ 10m (dBµV/m)	Lim. QPeak @10m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
890.067	28.93	35.5	-6.57	3.98	44.75	Vertical	-1.76

Frequency (MHz)	Peak @3m (dBµV/m)	Lim. Peak @3m dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
1850.00	49.13	74	-24.87	2.48	274.75	Vertical	-15.72
10176.030	50.62	74	-23.38	3.98	6	Vertical	-1.99
10176.600	48.57	74	-25.43	3.99	275	Horizontal	-2

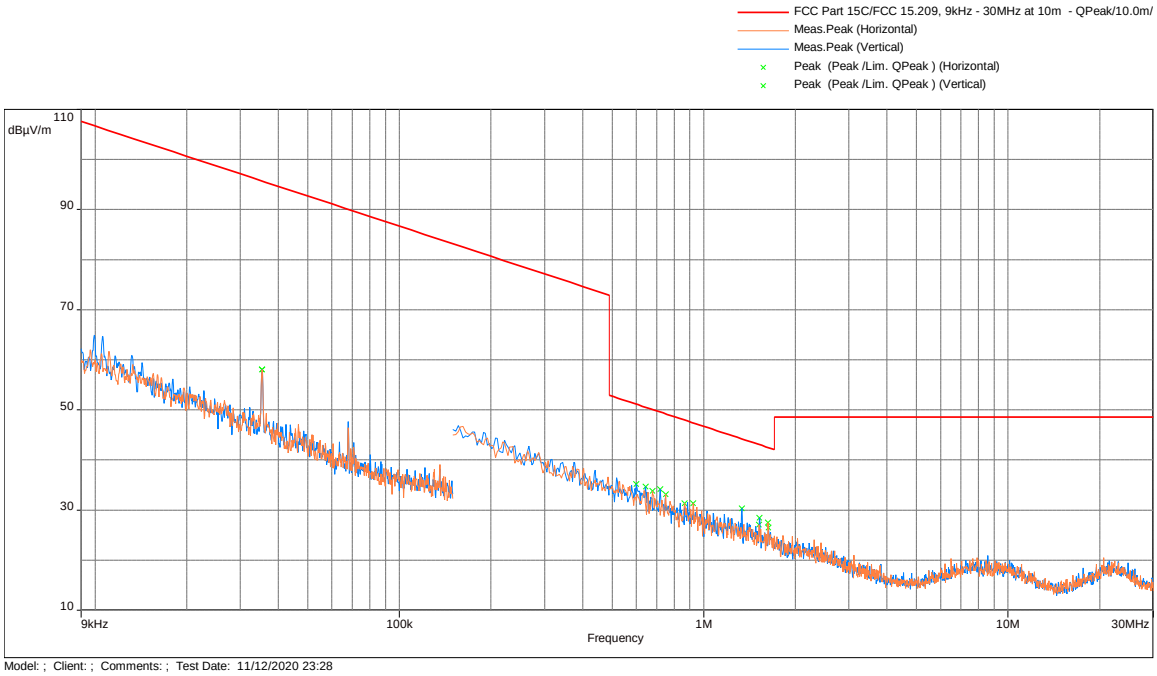
Frequency (MHz)	Average @3m (dBµV/m)	Lim. Average @3m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
1850.00	48.28	54	-5.72	2.48	255.75	Vertical	-15.72
10176.030	47.84	54	-6.16	3.98	148.75	Vertical	-1.99
10176.600	47.45	54	-6.55	3.99	256.75	Horizontal	-1.99

Note: Correction = AF + CF - Preamp

Results	Complies

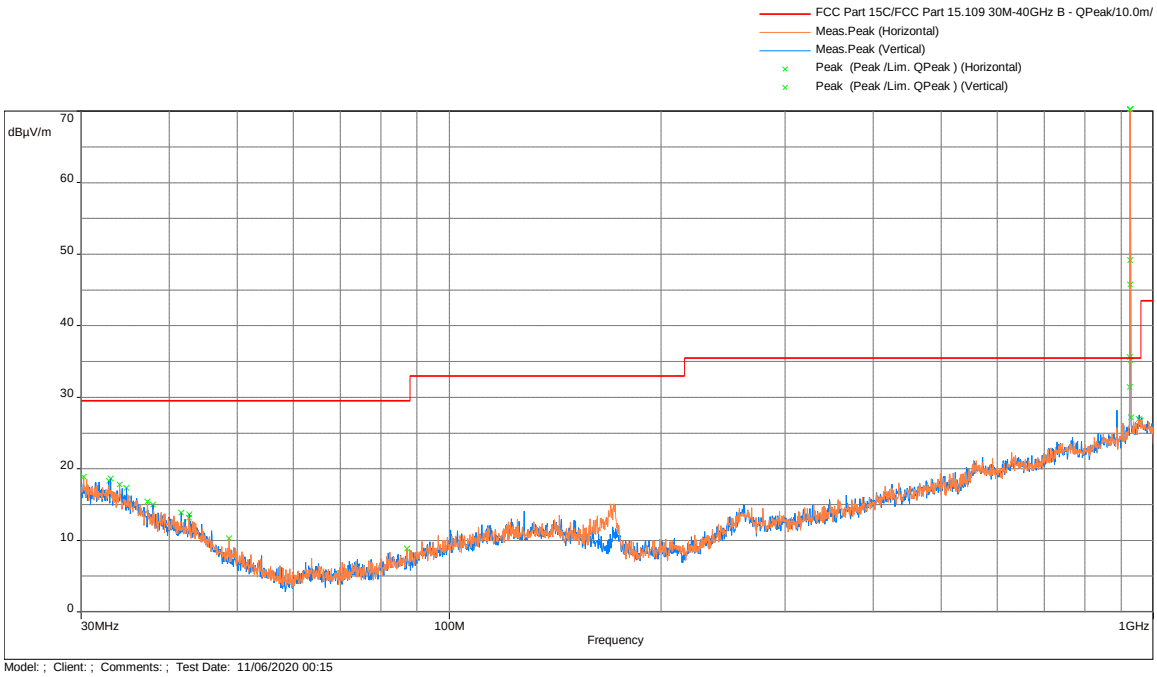
Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 927.5 MHz

Radiated Spurious Emissions 9 kHz - 30 MHz



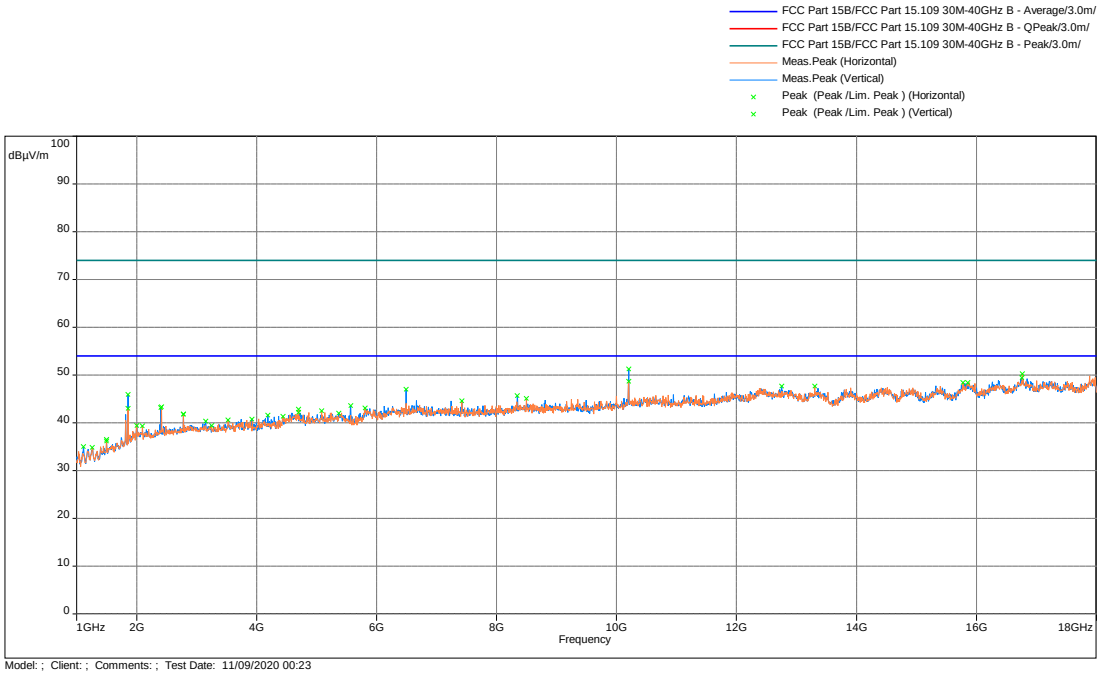
Model: ; Client: ; Comments: ; Test Date: 11/12/2020 23:28

Radiated Spurious Emissions 30 MHz - 1000 MHz



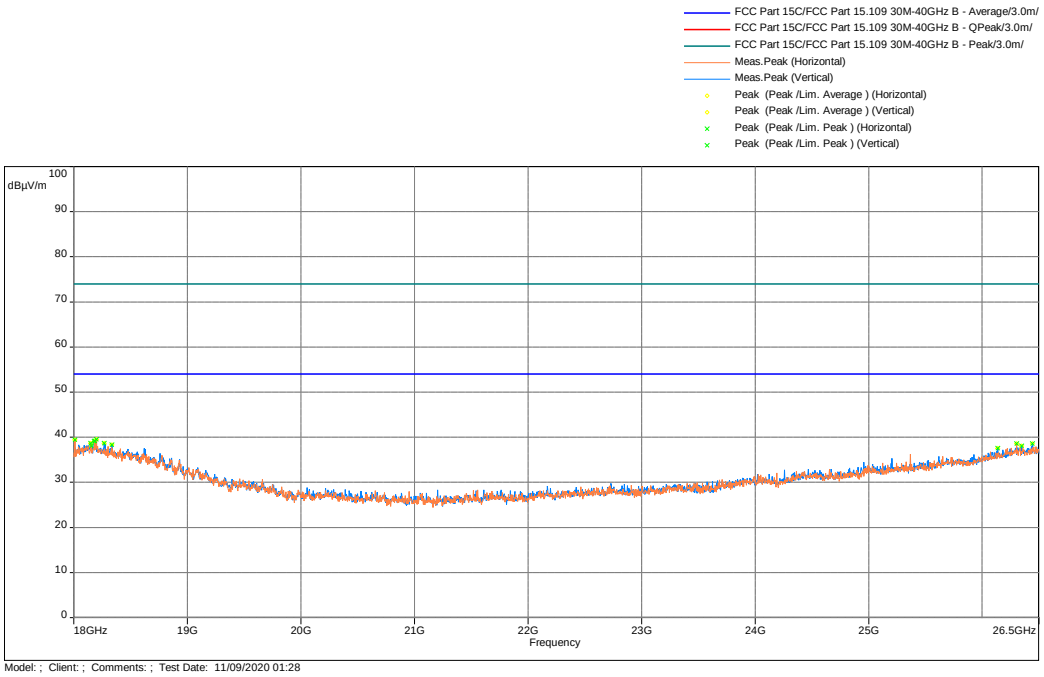
Model: ; Client: ; Comments: ; Test Date: 11/06/2020 00:15

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



Model: ; Client: ; Comments: ; Test Date: 11/09/2020 00:23

Radiated Spurious Emissions 18000 - 26500 MHz, Peak Scan vs Peak & Avg Limit



Model: ; Client: ; Comments: ; Test Date: 11/09/2020 01:28

Frequency (MHz)	QPeak@ 10m (dBµV/m)	Lim. QPeak @10m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
953.537	26.97	35.5	-8.53	2.52	148	Horizontal	0.97

Frequency (MHz)	Peak @3m (dBµV/m)	Lim. Peak @3m dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
10202.500	51.23	74	-22.77	3.98	5.25	Vertical	-2.05
10202.500	48.69	74	-25.31	3.99	292.5	Horizontal	-2.05

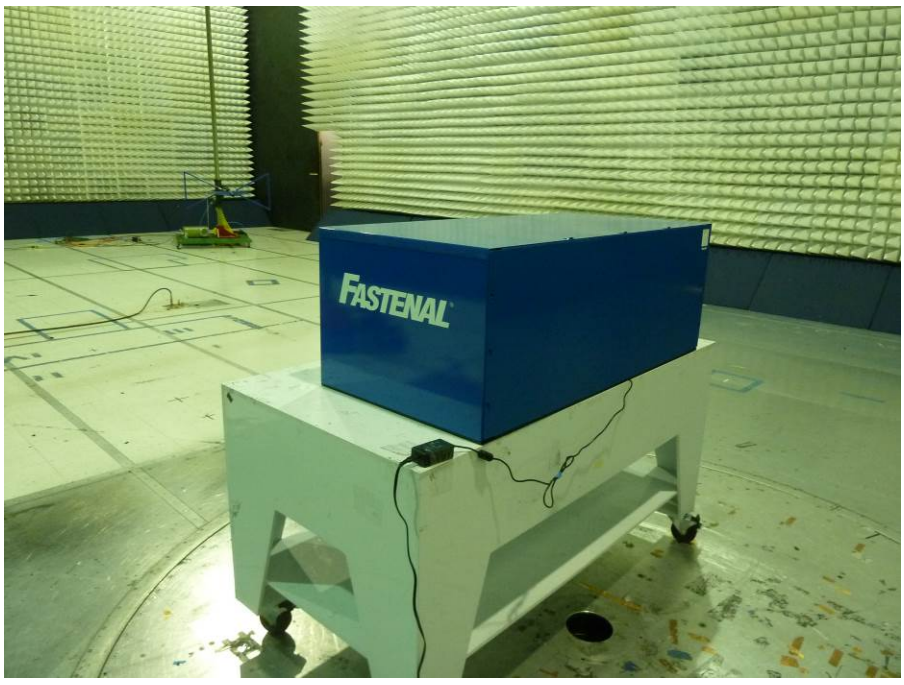
Frequency (MHz)	Average @3m (dBµV/m)	Lim. Average @3m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
10202.500	47.78	54	-6.22	3.98	16.25	Vertical	-2.05
10202.500	45.41	54	-8.59	3.99	256.25	Horizontal	-2.05

Note: Correction = AF + CF - Preamp

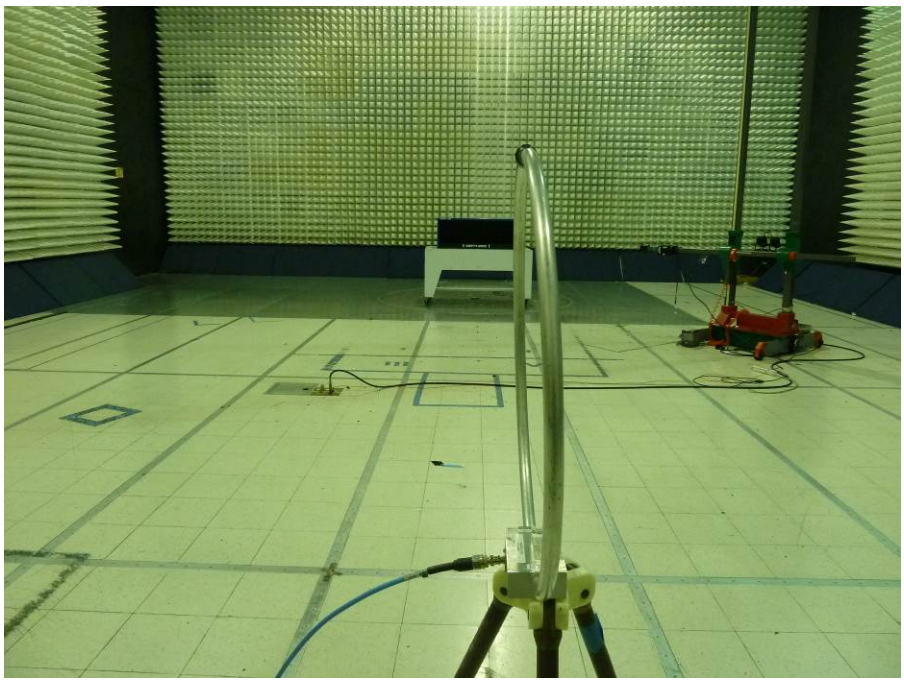
Results	Complies

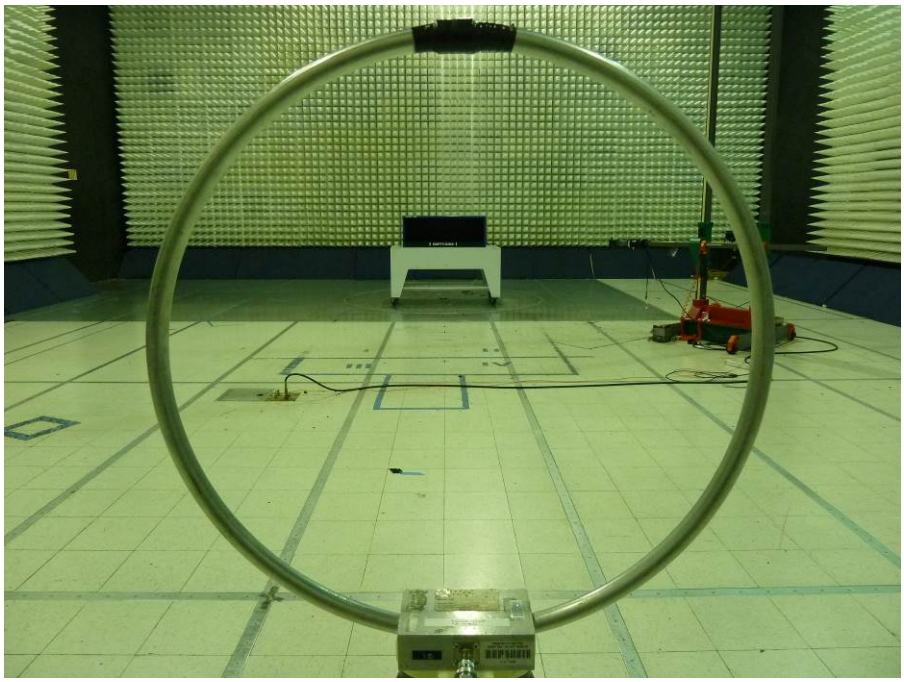
4.5.8 Test setup photographs

The following photographs show the testing configurations used.

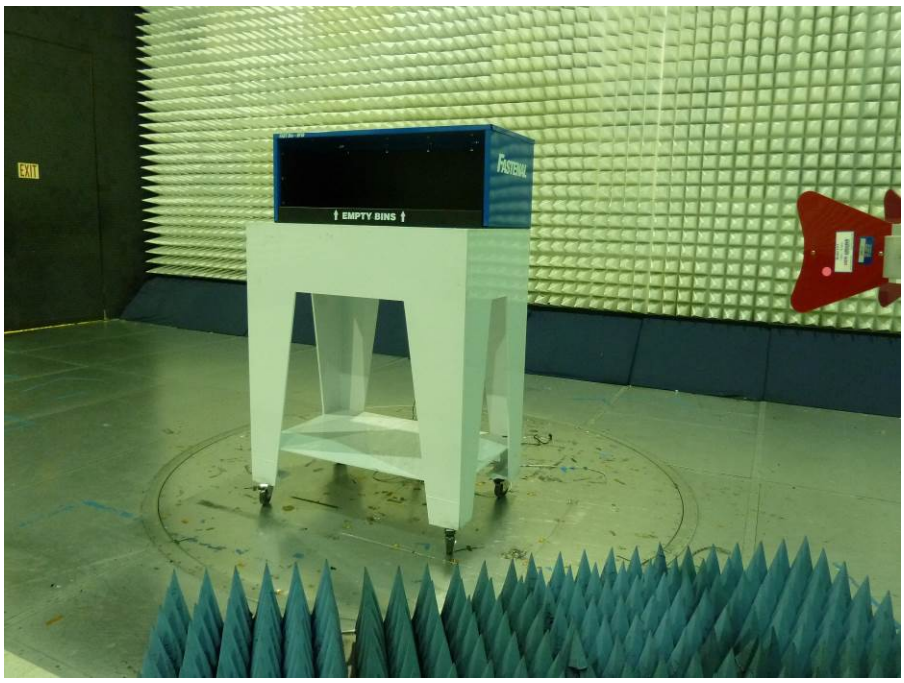


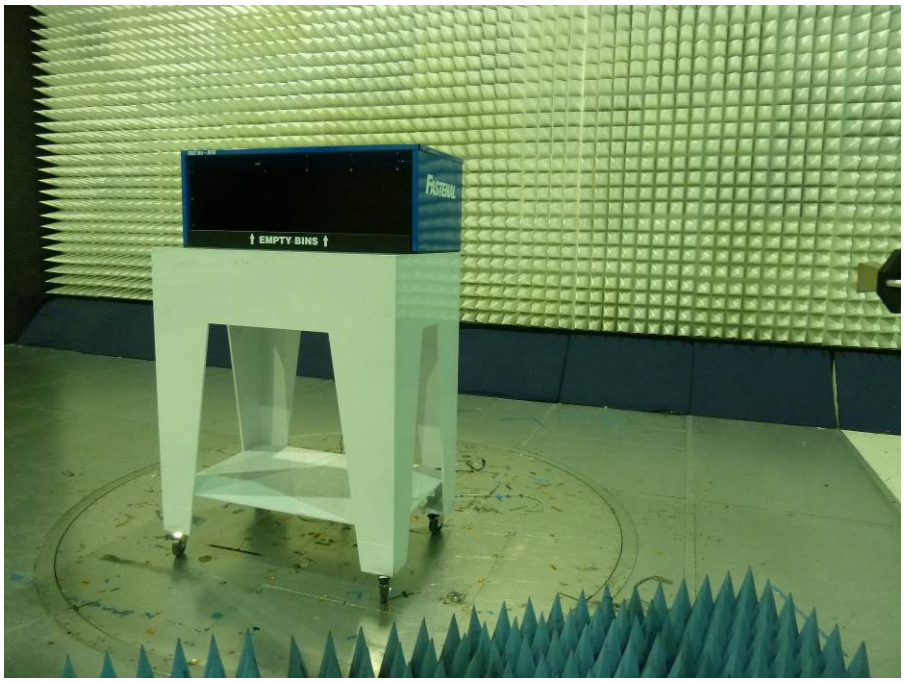
4.5.8 Test Setup Photographs (Continued)





4.5.8 Test Setup Photographs (Continued)





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

4.6.1 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.*

4.6.2 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.

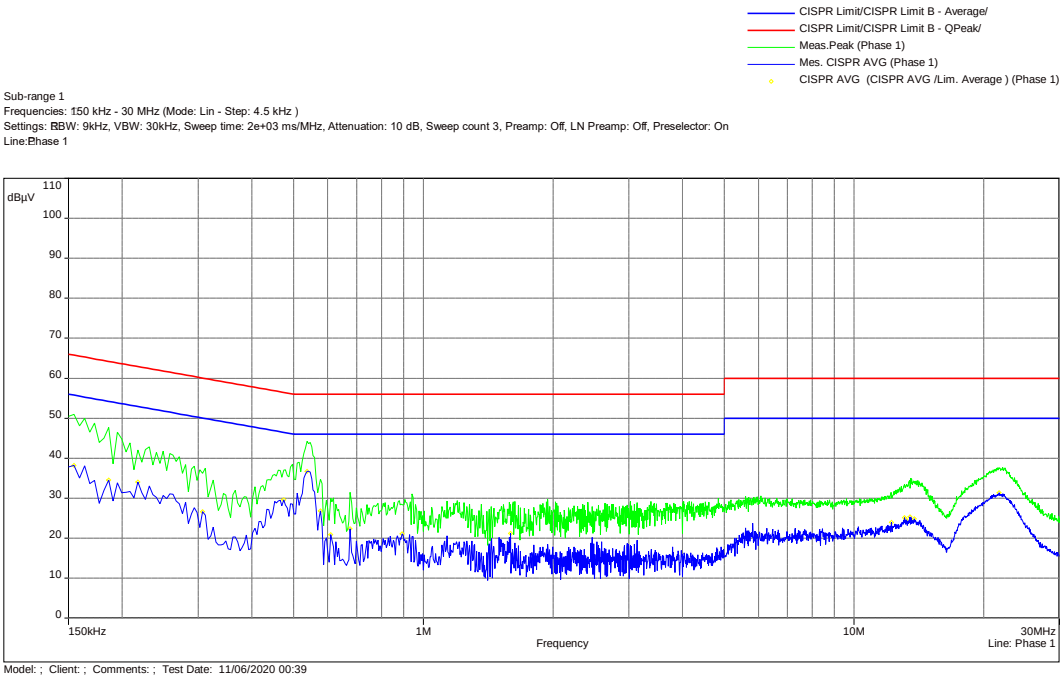
Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.10: 2013.

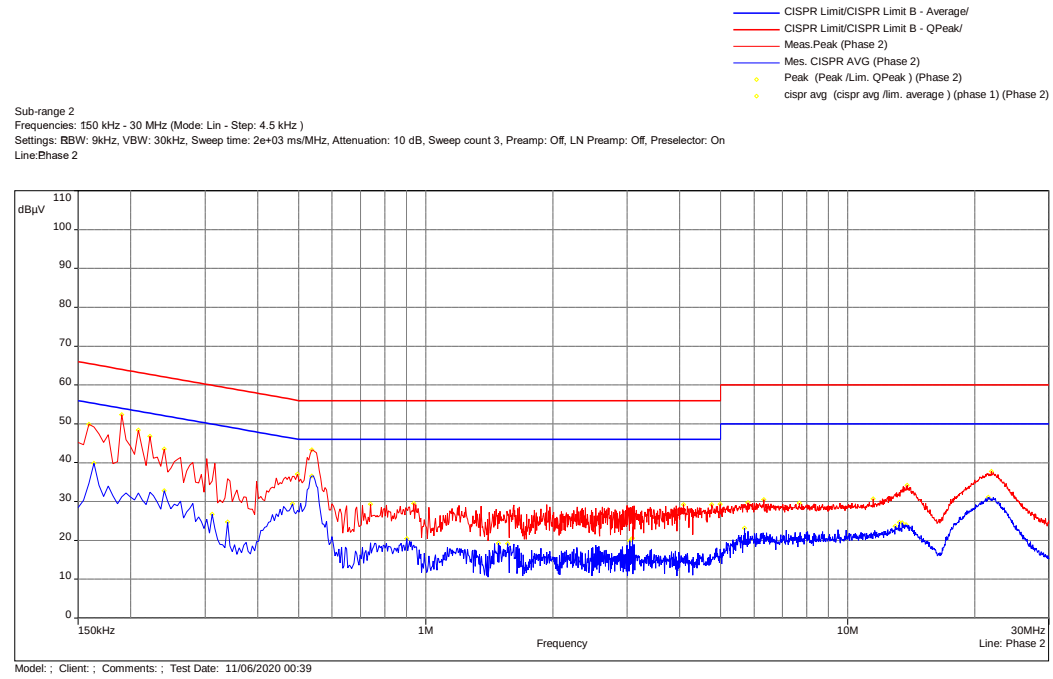
Tested By:	Aaron Chang
Test Date:	November 6, 2020

4.6.3 Test Result

15.207 FCC & ICES 003 Conducted Disturbance at AC Mains

120V 60Hz



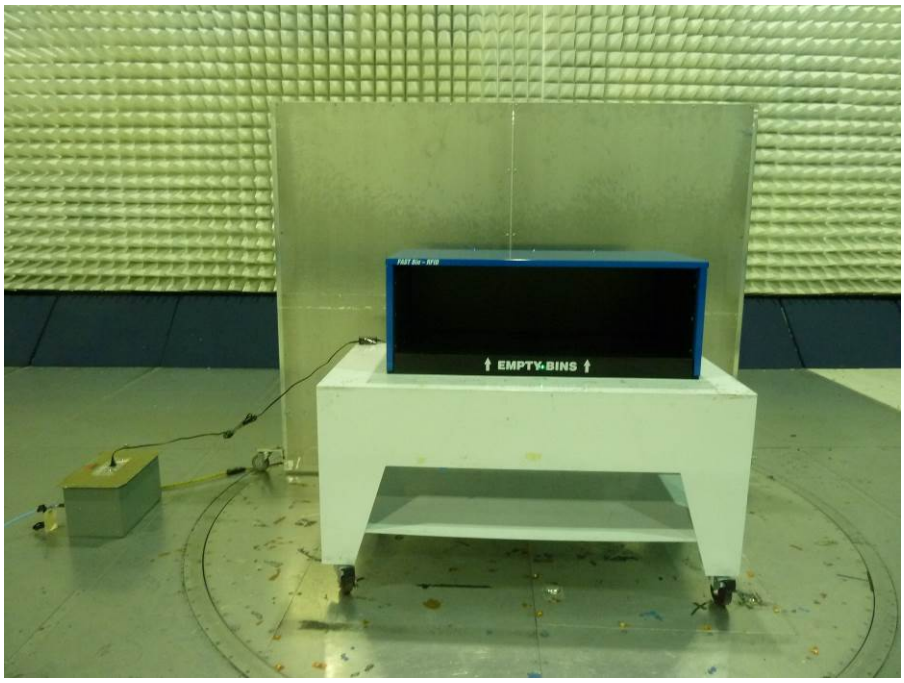


Freq.	Ave Level	QP Level	Ave Limit	QP Limit	Ave Margin	QP Margin	Line	Correction
MHz	dBµV	dBµV	dBµV	dBµV	dB	dB		dB
0.155	38.23	50.92	55.75	65.75	-17.53	-14.83	Phase 1	10.97
0.160	34.14	46.43	55.52	65.52	-21.37	-19.08	Phase 2	10.98
0.240	32.82	43.57	52.1	62.1	-19.27	-18.52	Phase 2	10.97
0.537	36.74	44.19	46	56	-9.26	-11.81	Phase 1	10.99
0.537	36.6	43.34	46	56	-9.4	-12.66	Phase 2	10.99
0.677	22.33	31.42	46	56	-23.67	-24.58	Phase 1	11.03

Result: **Complies by** 9.26 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
EMI Receiver	Rohde and Schwarz	ESU	ITS 00961	12	04/02/21
Active Horn Antenna	ETS-Lindgren	3117-PA	ITS 01636	12	02/24/21
BI-Log Antenna	Teseq	CBL 6111D	ITS 01058	12	11/12/21
Pre-Amplifier	Sonoma Instrument	310	ITS 00942	12	04/14/21
Pyramidal Horn Antenna	EMCO	3160-09	ITS 00571	#	#
Pre-Amplifier (18-40GHz)	Miteq	TTA1840-35-S-M	ITS 01393	12	03/02/21
RF Cable	TRU Corporation	TRU CORE 300	ITS 01462	12	09/01/21
RF Cable	TRU Corporation	TRU CORE 300	ITS 01465	12	09/01/21
RF Cable	TRU Corporation	TRU CORE 300	ITS 01470	12	09/01/21
Attenuator	Narda	FSCM99899	ITS 01583	12	10/20/21
High Pass Filter	Micro-Tronics	HPM50114-02	ITS 01722	12	11/12/21
RF Cable	Megaphase	EMC1-K1K1-236	ITS 01538	12	06/12/21
LISN	FCC	FCC-LISN-50-50-M-H	ITS 00551	12	11/16/21

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 10-26-2020.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 / G104468298	AC	KV	December 11, 2020	Original document