TEST REPORT

Report Number: 105108581MPK-006
Project Numbers: G105108581
Report Issue Date: August 17, 2022

Testing performed on
Halo ST Electronic Keypad Wi-Fi Enabled Deadbolt
&
Halo ST Electronic Touchscreen Wi-Fi Enabled Deadbolt

Models Tested: 938 & 939

FCC ID: NUL-WIFI-GIGST

to

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

For

Spectrum Brands, Inc.

Test Performed by:	**Test Authorized by:**
Intertek	Spectrum Brands, Inc.
1365 Adams Court	19701 Da Vinci
Menlo Park, CA 94025 USA	Lake Forest, CA 92610 USA

Prepared by: _____ **Date:** August 17, 2022
Amar Kacel

Reviewed by: _____ **Date:** August 17, 2022
Anderson Soungpanya

Report No. 105108581MPK-006	
Equipment Under Test:	Halo ST Electronic Keypad Wi-Fi Enabled Deadbolt Halo ST Electronic Touchscreen Wi-Fi Enabled Deadbolt
Model Numbers:	938 939
Applicant:	Spectrum Brands, Inc.
Contact:	Johanis Hashim
Address:	Spectrum Brands, Inc. 19701 Da Vinci Lake Forest, CA 92610
Country:	USA
Email:	johanis.hashim@spectrumbrands.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) ISED RSS-247 Issue 2
Date of Test:	July 25, 2022, to July 29, 2022

We attest to the accuracy of this report:

Amar Kacel
Staff Engineer

Anderson Soungpanya
EMC Team Lead

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	Not Applicable*
Antenna Requirement	15.203	RSS-GEN	Complies (Internal Antenna)

*EUT is battery powered and non-rechargeable.

EUT receive date: July 14, 2022

EUT receive condition: The production version of the EUT was received in good condition with no apparent damage.

Test start date: July 25, 2022

Test completion date: July 29, 2022

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

2.0 General Information

2.1 Product Description

Spectrum Brands, Inc. supplied the following description of the EUT:
Keypad electronic deadbolt with Bluetooth (LE) and Wi-Fi.

Model # 938 is Halo ST Electronic Keypad Wi-Fi Enabled Deadbolt and Model # 939 is Halo ST Electronic Touchscreen Wi-Fi Enabled Deadbolt
For more information, refer to the manufacturer user manual.

The following product specification, declared by the manufacturer.

Information about the 2.4 GHz BLE radio is presented below:

Applicant	Spectrum Brands, Inc.
Model No.	938 939
FCC Identifier	NUL-WIFI-GIGST
Type of transmission	Digital Transmission System (DTS)
Rated RF Output	5.09 dBm (3.23 mW)
Antenna(s) & Gain	Internal Antenna, Gain: 2.0 dBi
Frequency Range	2402 – 2480 MHz
Type of modulation/data rate	GFSK / 1Mbit/s
Number of Channel(s)	40
Test Channels	2402 MHz, 2440 MHz, 2480 MHz
Power Configuration	6Vdc – (4xAA Batteries)
Applicant Name & Address	Spectrum Brands, Inc. 19701 Da Vinci Lake Forest, CA 92610 USA

*: Antenna gain was provided by Spectrum Brands. Intertek takes no responsibility for the accuracy of the antenna gain.
*: This test report covers the BLE transmitter only. Per Spectrum Brands, the Wi-Fi module is certified.

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 Issue 2, 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

Equipment Under Test				
Description	**Manufacturer**	**Type**	**Model**	**Serial Number**
Radiated Sample	Spectrum Brands, Inc.	TOUCH	939	3767-A3EF
Radiated Sample	Spectrum Brands, Inc.	KEYPAD	938	76A0-9873
Conducted Sample	Spectrum Brands, Inc.	KEYPAD	938	14E4-B152

Equipment Under Test Power Configuration			
Rated Voltage	**Rated Current**	**Rated Frequency**	**Number of phases**
6 Vdc – internal batteries	N/A	N/A	N/A

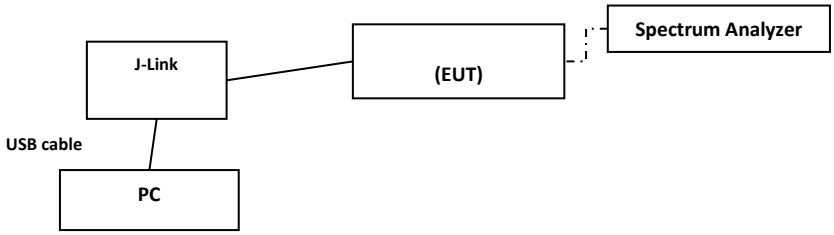
Note: New Batteries used before each test.

Support Equipment			
Description	**Manufacturer**	**Model**	**Serial Number**
PC	Intel	NSU	BOXNUC8i3BEHS
J-Link adapter	J-Link	8.08.00	50117533

3.2 Block Diagram of Test Setup

Conducted Measurements SETUP

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



Radiated Measurements SETUP

Bluetooth

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

3.3 EUT Photo

Model: 939

Model: 938

3.4 Justification

For radiated emission measurements the EUT is placed on a non-conductive table. The EUT was configured to continuously transmit. The highest clock frequency used in the EUT is 2.48 GHz.

Per Manufacturer, Model # 938 is Halo ST Electronic and Model # 939 Halo ST Electronic Touchscreen makes use of identical radio circuitry/PCB, antennas, and power source. The Differences is for the exterior portion, where Model # 938 uses a keypad instead of a touchscreen, which is used in Model # 939. Both uses a FCC and IC certified Wi-Fi module; FCC ID: c & IC: 451I-CC3220MOD.

The antenna port conducted test was made on the Halo ST Electronic Keypad Wi-Fi Enabled Deadbolt, Model: 938. Radiated Emissions measurements were made on each model.

3.5 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was provided by Spectrum Brands, Inc.

3.6 Mode of Operation during Test

Mode of operation during the tests was setup using a computer which allows controlling the radio by test software. During the transmitter tests, the transmitter was setup to transmit maximum communication and RF power levels.

EUT was placed into transmit mode at the lowest (2402MHz) middle (2440MHz), and highest (2480MHz) channels.

Channels	Freq. MHz	EUT Setting
Low	2402	hhi_ble_fcc_test_ch37_cont_mod_6dbm.s37
Mid	2440	hhi_ble_fcc_test_2440_cont_mod_6dbm.s37
High	2480	hhi_ble_fcc_test_ch39_cont_mod_6dbm.s37

3.7 Modifications Required for Compliance

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

3.8 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 KDB 558074 D01 Meas Guidance v05r02 was used to determine the DTS occupied bandwidth. Section 11.8.1 Option 1 of ANSI 63.10 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.

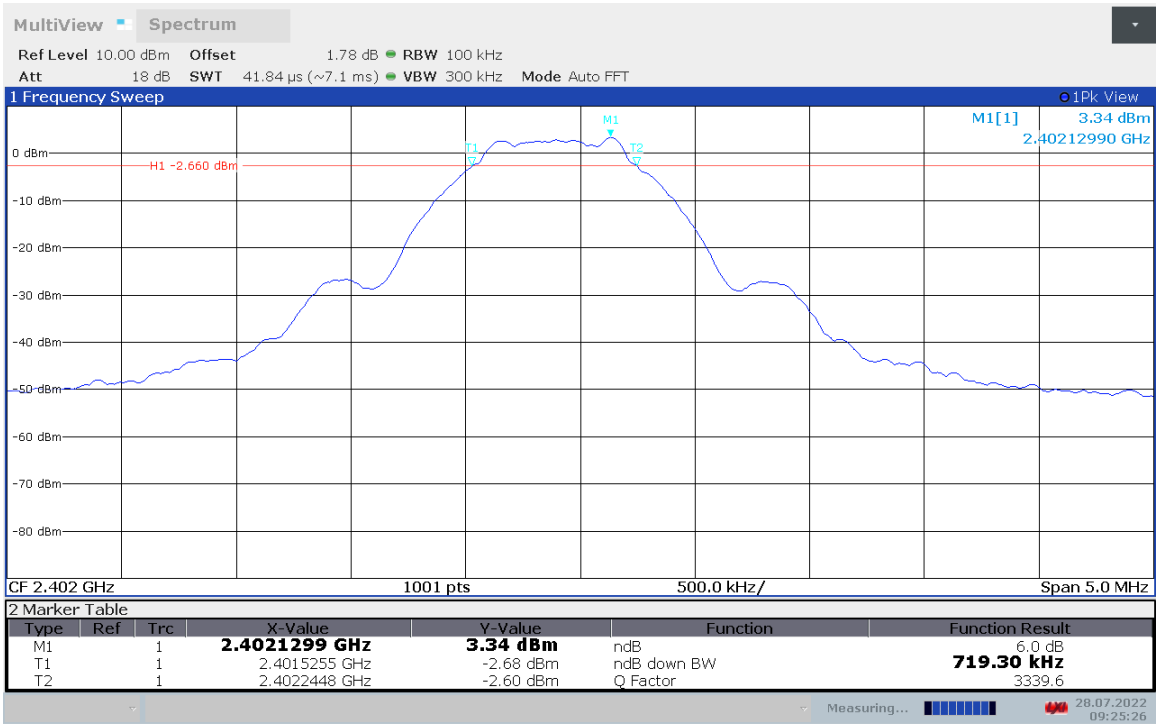
4.1.3 Test Result

Halo ST Electronic Keypad Wi-Fi Enabled Deadbolt, Model: 938

Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN, kHz	Occupied bandwidth, RSS-GEN, MHz	Plot
2402	719.3	--	1.1
	--	1.045	1.4
2440	739.3	--	1.2
	--	1.046	1.5
2480	729.3	--	1.3
	--	1.048	1.6

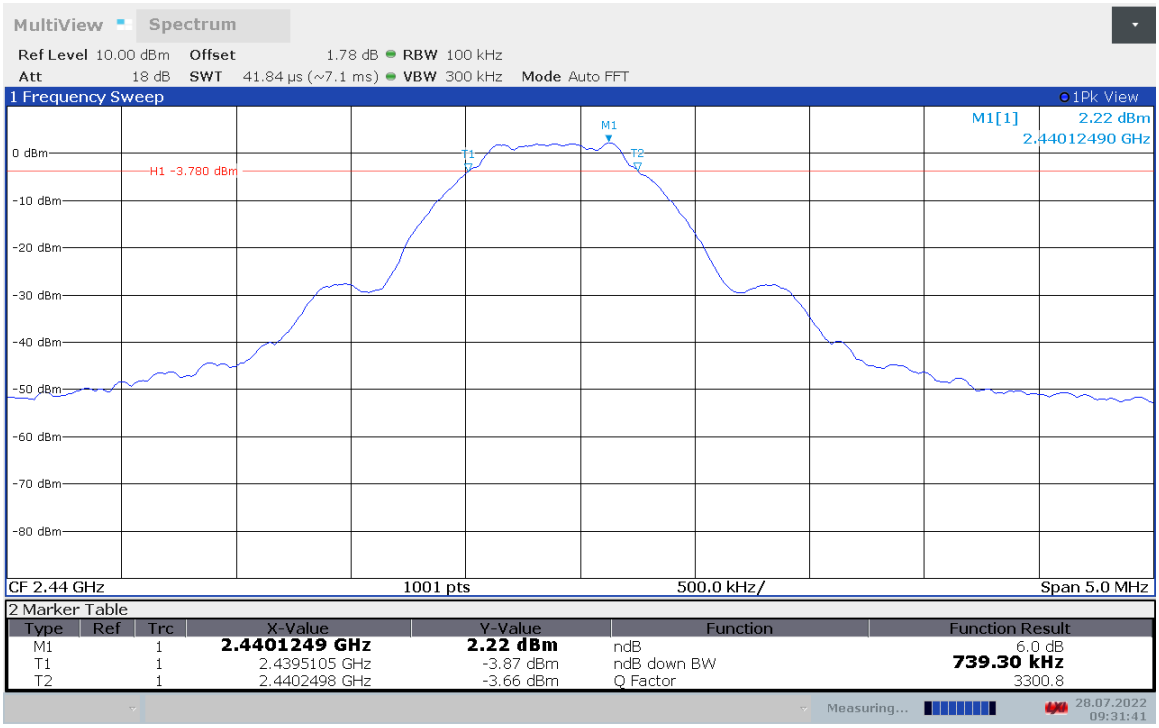
Tested By	Test Date	Results
Amar Kacel	July 28, 2022	Complies

Plot 1. 1



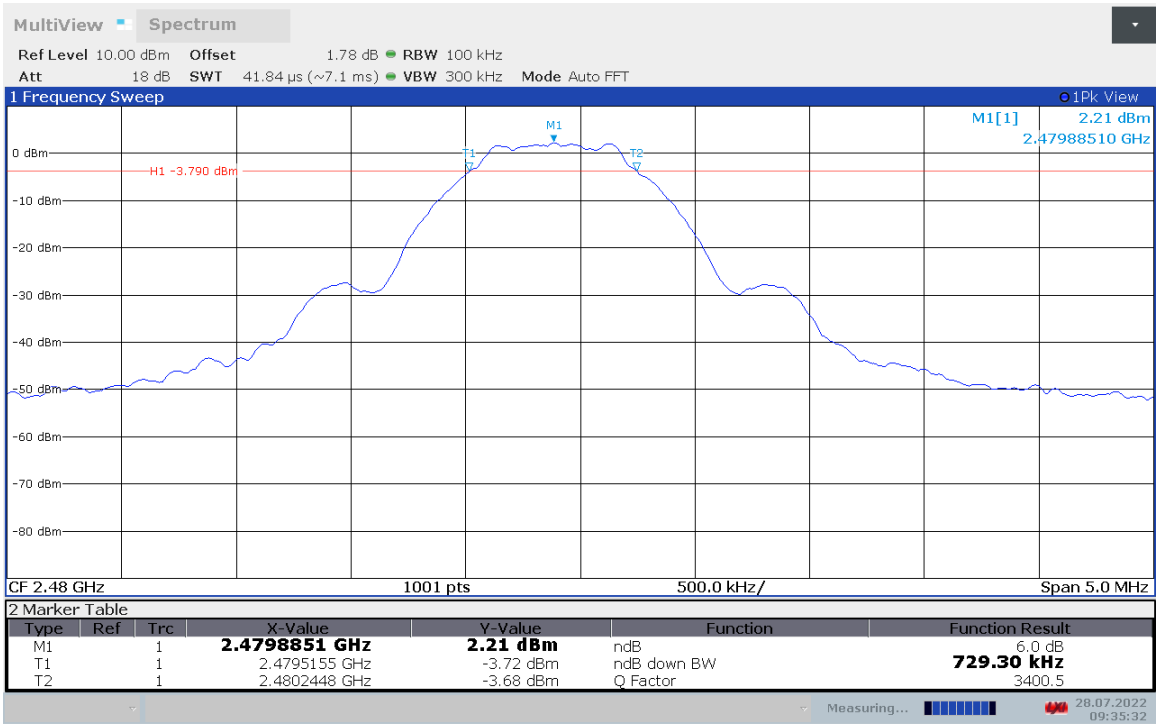
09:25:26 28.07.2022

Plot 1. 2



09:31:42 28.07.2022

Plot 1. 3



09:35:32 28.07.2022

Plot 1. 4

09:53:14 28.07.2022

Plot 1.5

09:50:49 28.07.2022

Plot 1.6

09:45:19 28.07.2022

Results	Complies

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 KDB 558074 D01 Meas Guidance v05r02 was used. Specifically, section 11.9.1.1 RBW ≥ DTS bandwidth in ANSI 63.10.

1. Set the RBW ≥ DTS Bandwidth
2. Set the VBW ≥ 3 x RBW
3. Set the span ≥ 3 x RBW
4. Detector = Peak
5. Sweep time = Auto couple
6. Trace mode = Max Hold
7. Allow trace to fully stabilize
8. Use peak marker function to determine the peak amplitude level.

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

4.2.3 Test Result

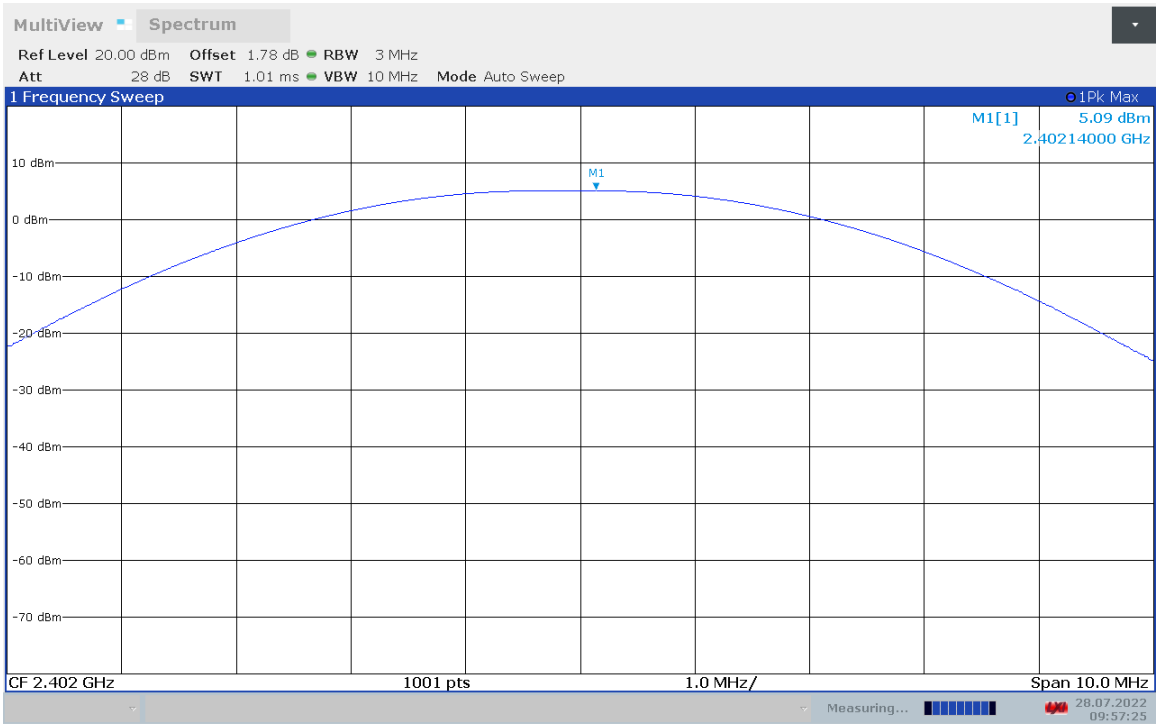
Refer to the following plots 2.1 – 2.3 for the test details.

Halo ST Electronic Keypad Wi-Fi Enabled Deadbolt, Model: 938

Frequency	Conducted Power (peak)		Plot
MHz	dBm	mW	
2402	5.09	3.228	2.1
2442	4.81	3.027	2.2
2480	4.57	2.864	2.3

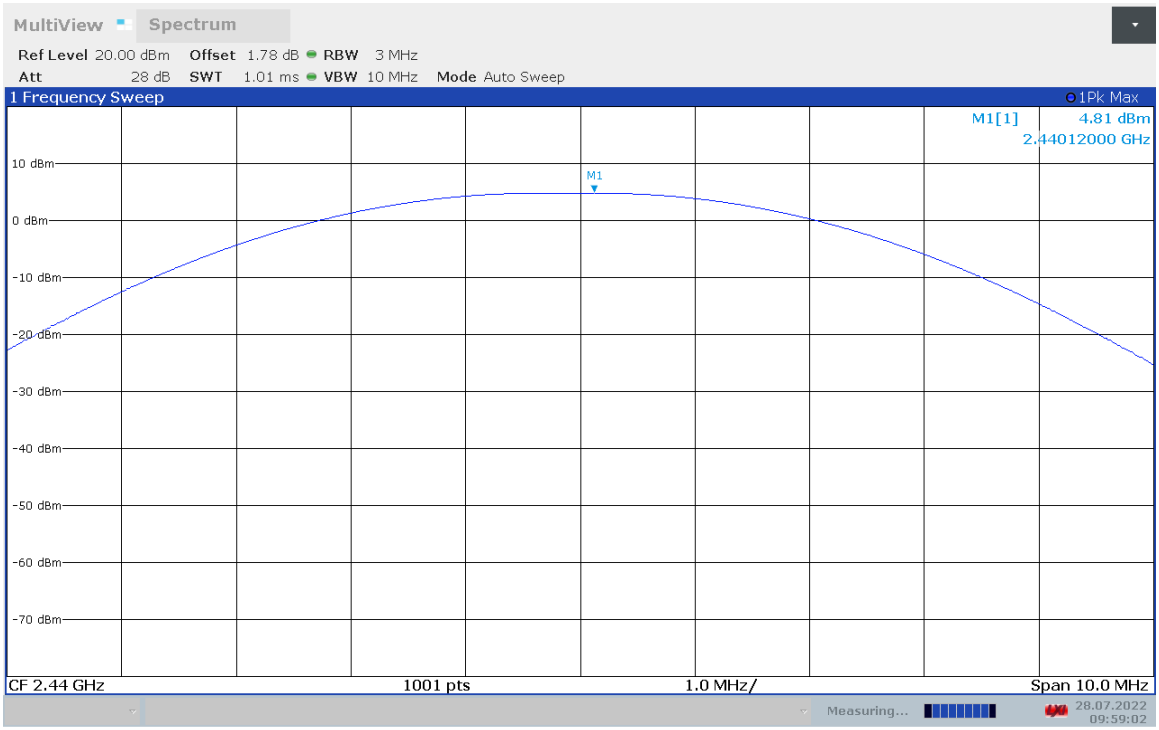
Tested By	Test Date	Results
Amar Kacel	July 28, 2022	Complies

Plot 2. 1



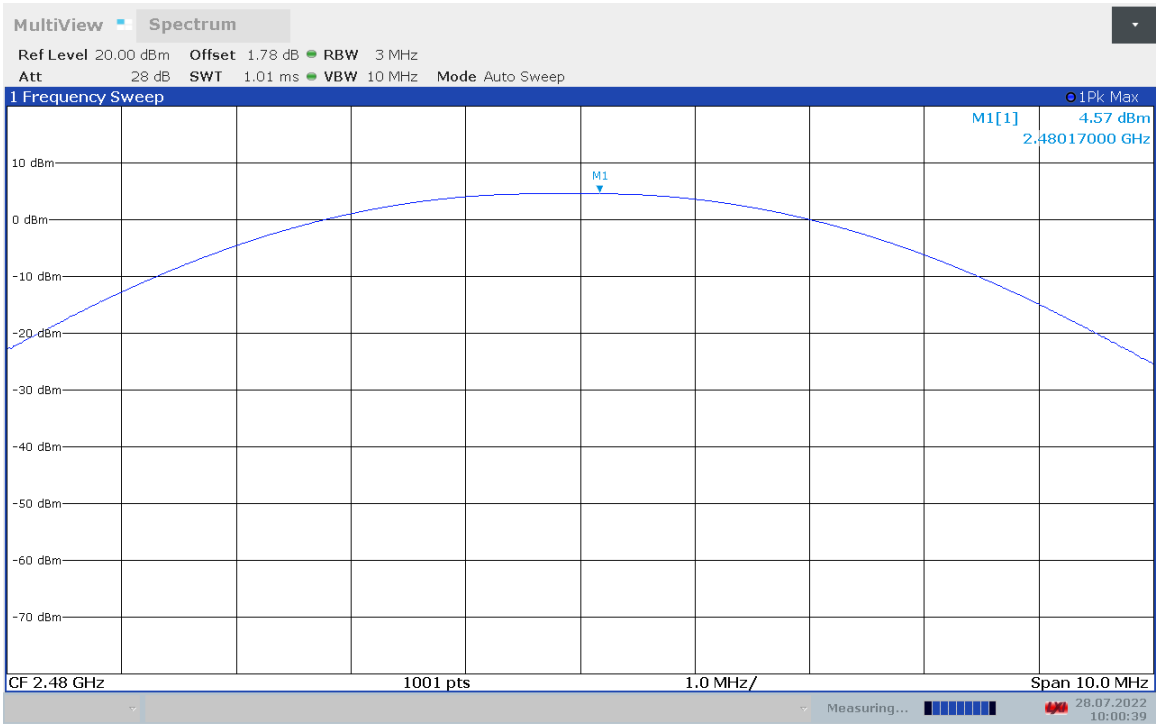
09:57:26 28.07.2022

Plot 2. 2



09:59:02 28.07.2022

Plot 2. 3



10:00:39 28.07.2022

Results	**Complies**

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 KDB 558074 D01 Meas Guidance v05r02, specifically section 11.10.2 Method PKPSD (peak PSD) of ANSI 63.10.

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the *DTS bandwidth*.
3. Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

4.3.3 Test Result

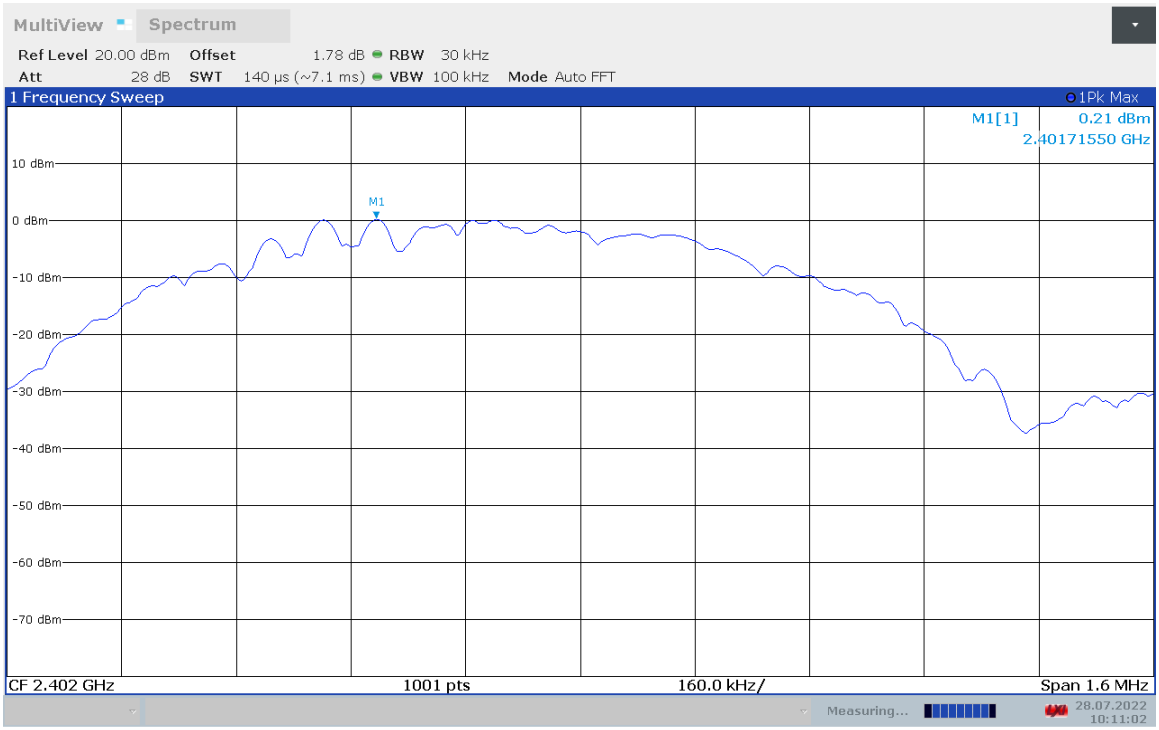
Refer to the following plots for the test result

Halo ST Electronic Keypad Wi-Fi Enabled Deadbolt, Model: 938

Frequency, MHz	Maximum Power Spectral Density, dBm	Maximum Power Spectral Density Limit, dBm	Margin, dB	Plot
2402	0.21	8.0	7.79	3.1
2440	-0.04	8.0	8.04	3.2
2480	-0.22	8.0	8.22	3.3

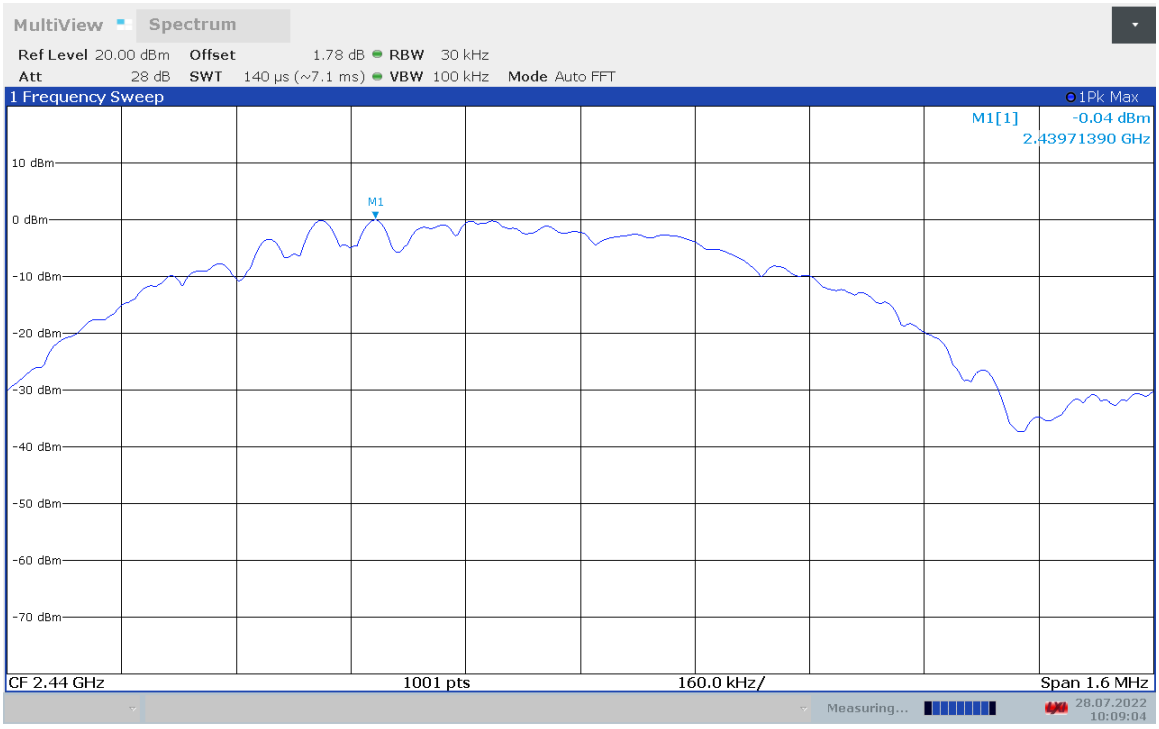
Tested By	Test Date	Results
Amar Kacel	July 29, 2022	Complies

Plot 3. 1



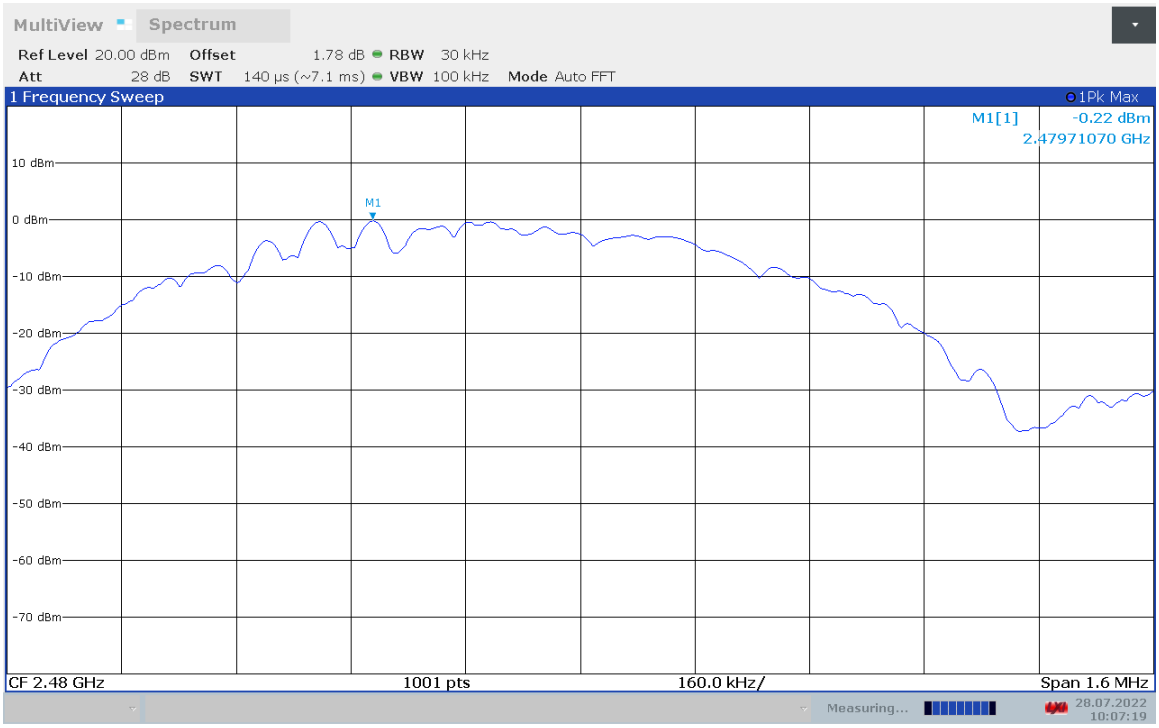
10:11:02 28.07.2022

Plot 3. 2



10:09:05 28.07.2022

Plot 3. 3



10:07:20 28.07.2022

Results	**Complies**

4.4 Out of Band Antenna Conducted Emission
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 KDB 558074 D01 Meas Guidance v05r02, specifically section 11.11 DTS Emissions in non-restricted frequency bands of ANSI 63.10.

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

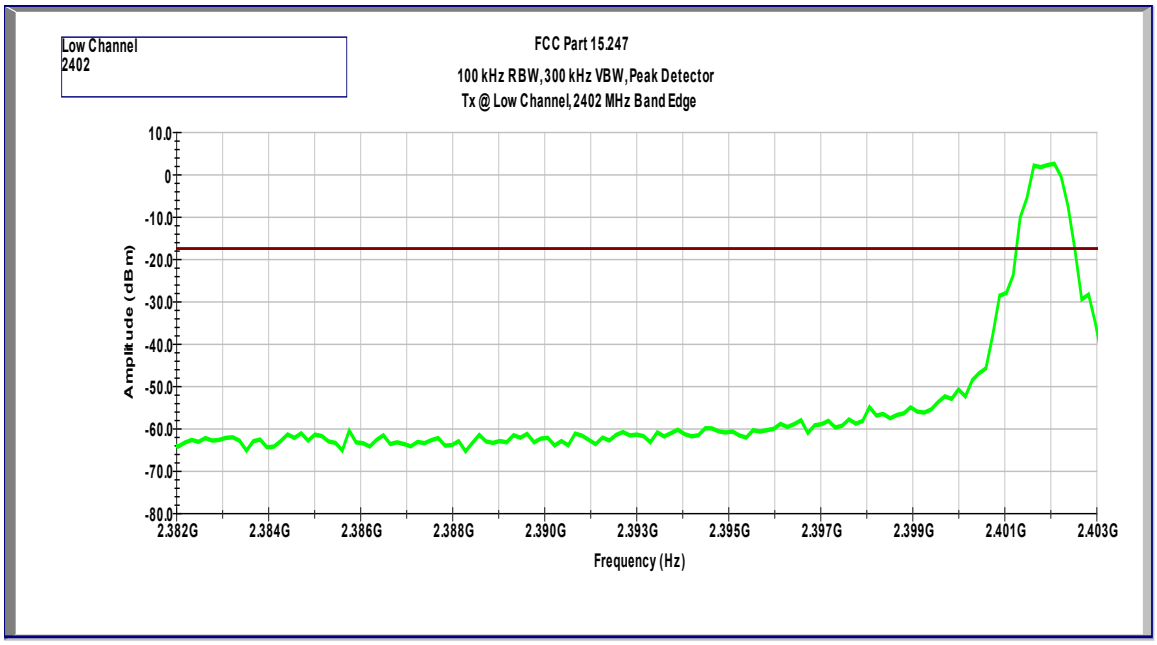
Refer to the following plots 4.3 – 4.5 and plots 4.2.3 – 4.2.5 for unwanted conducted emissions. The plot shows -20dB attenuation limit line.

Halo ST Electronic Keypad Wi-Fi Enabled Deadbolt, Model: 938

Tested By	Test Date	Results
Amar Kacel	July 29, 2022	Complies

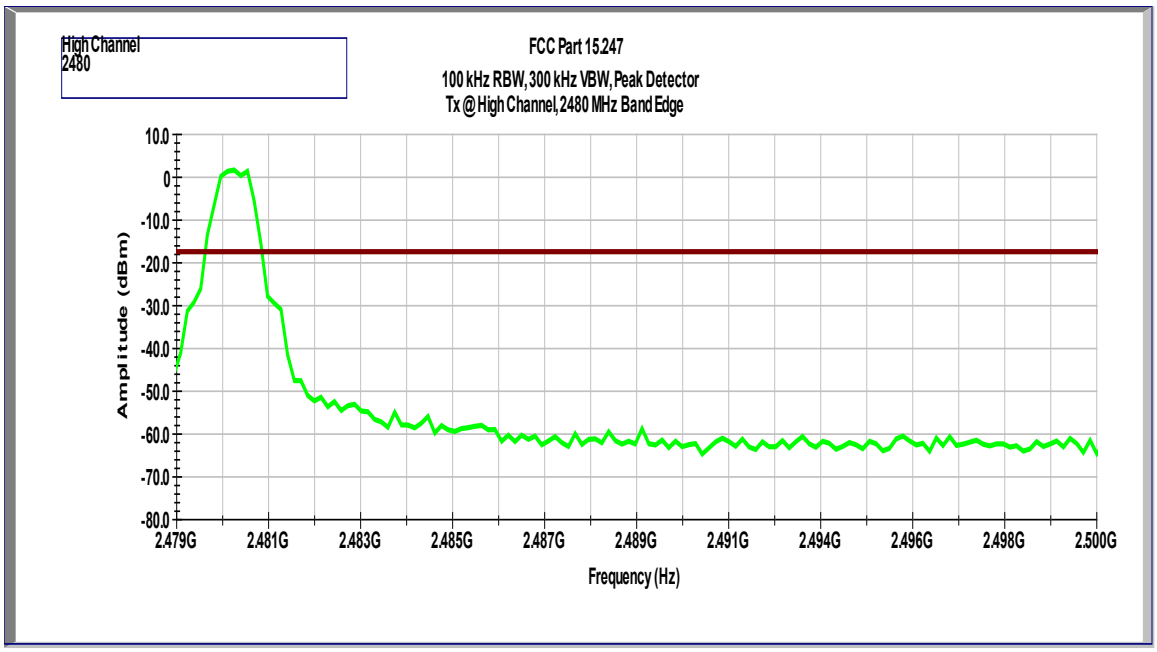
Tx @ Low Channel, 2402 MHz Band Edge

Plot 4.1

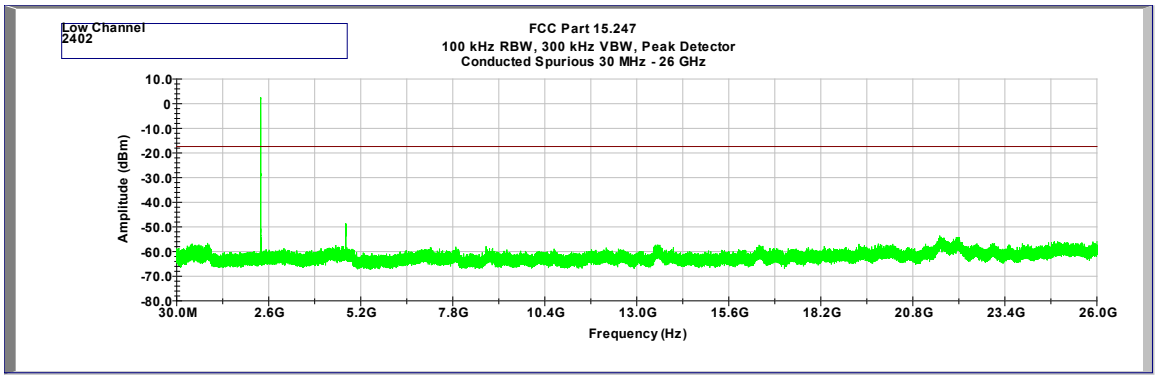


Tx @ High Channel, 2480 MHz Band Edge

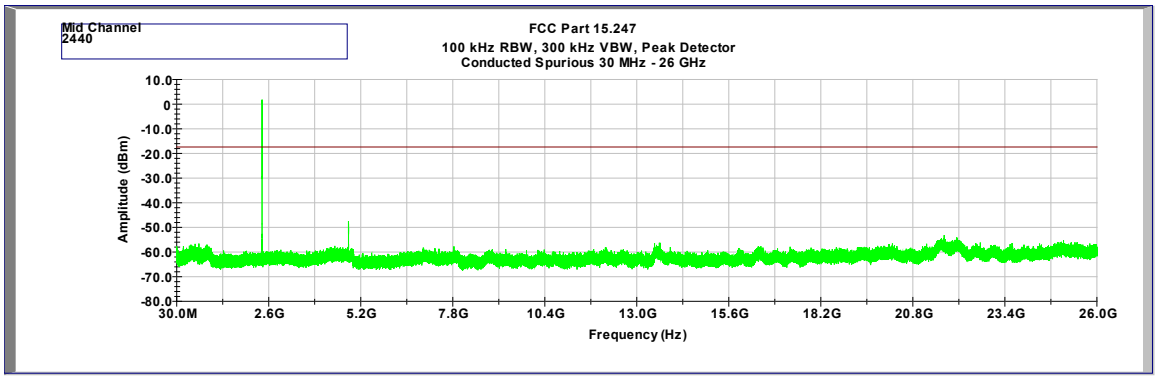
Plot 4.2



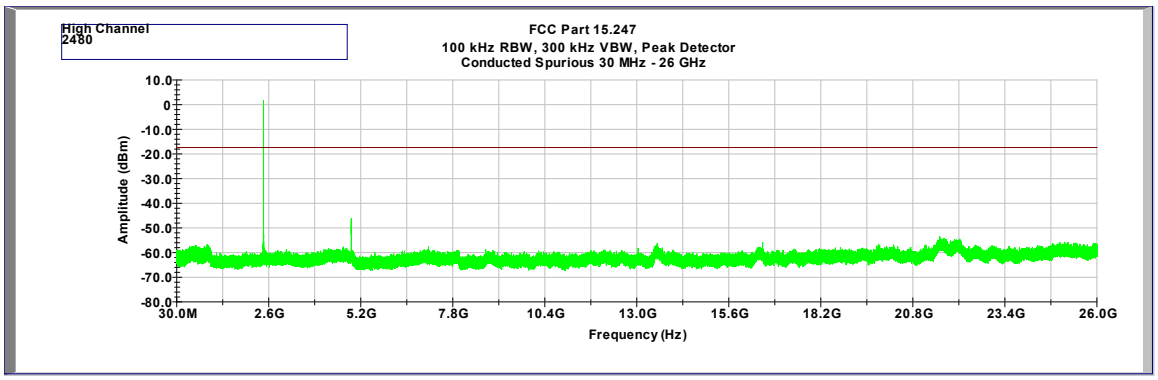
Tx @ Low Channel, 2402 MHz
30MHz -26GHz Conducted Spurious
Plot 4.3



Tx @ Mid Channel, 2440 MHz
30MHz -26GHz Conducted Spurious
Plot 4.4



Tx @ High Channel, 2480 MHz
30MHz -26GHz Conducted Spurious
Plot 4.5



Results	**Complies**

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 26.5 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.

Measurements made from 1 GHz to 18GHz had a 2.4-2.5GHz notch filter in place. A preamp was used from 9kHz to 26.5GHz.

All measurements were made with a Peak Detector and compared to QP limits for 30MHz – 1GHz and Average limits for 1GHz – 26.5GHz.

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.

Data is presented with 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 Test Results

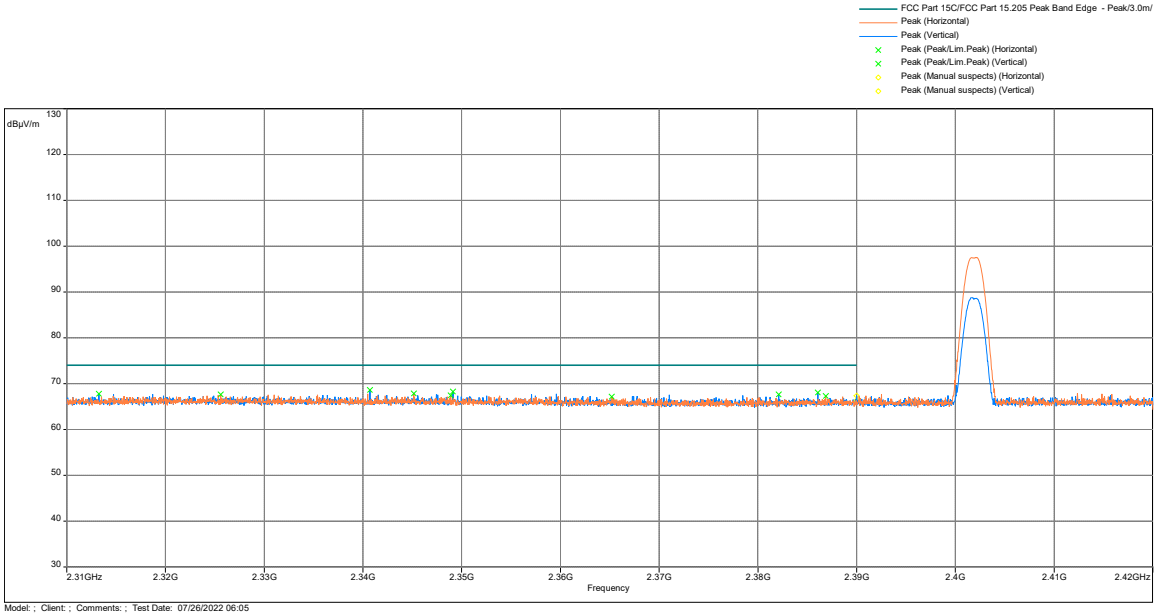
All testing in this section were performed by radiated measurements.

Tested By	Test Date	Results
Amar Kacel	July 26, 2022, to July 29, 2022	Complies

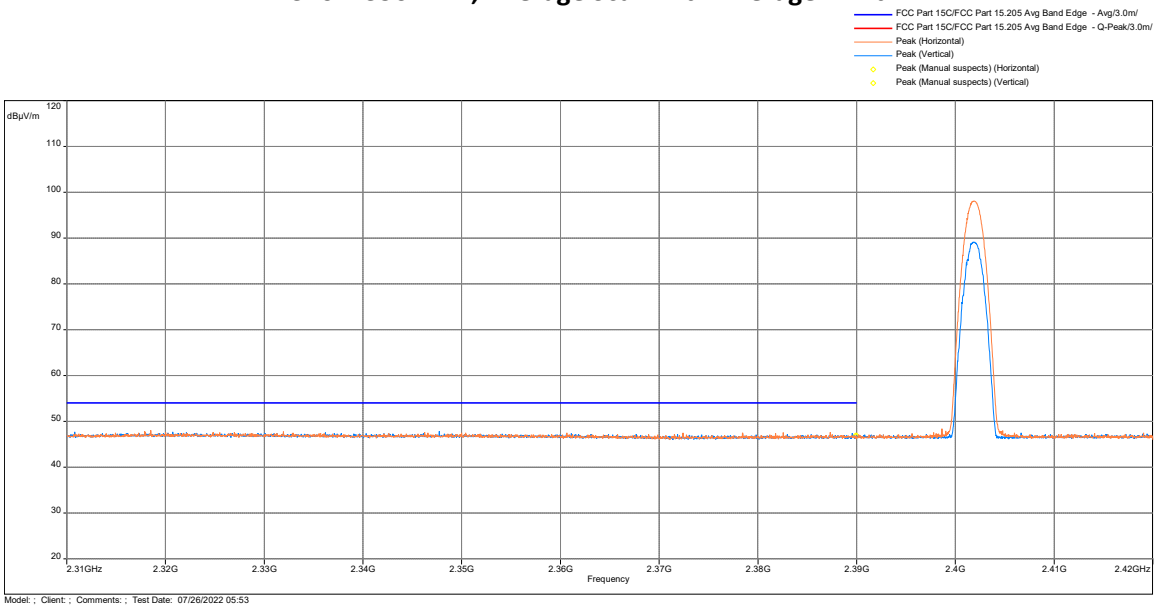
Test Results: 15.209/15.205 Radiated Restricted Band Emissions

TOUCHSCREEN Model: 939

Out-of-Band Radiated spurious emissions at the Band-edge @3m distance
2310–2390 MHz, Peak Scan with Peak Limit

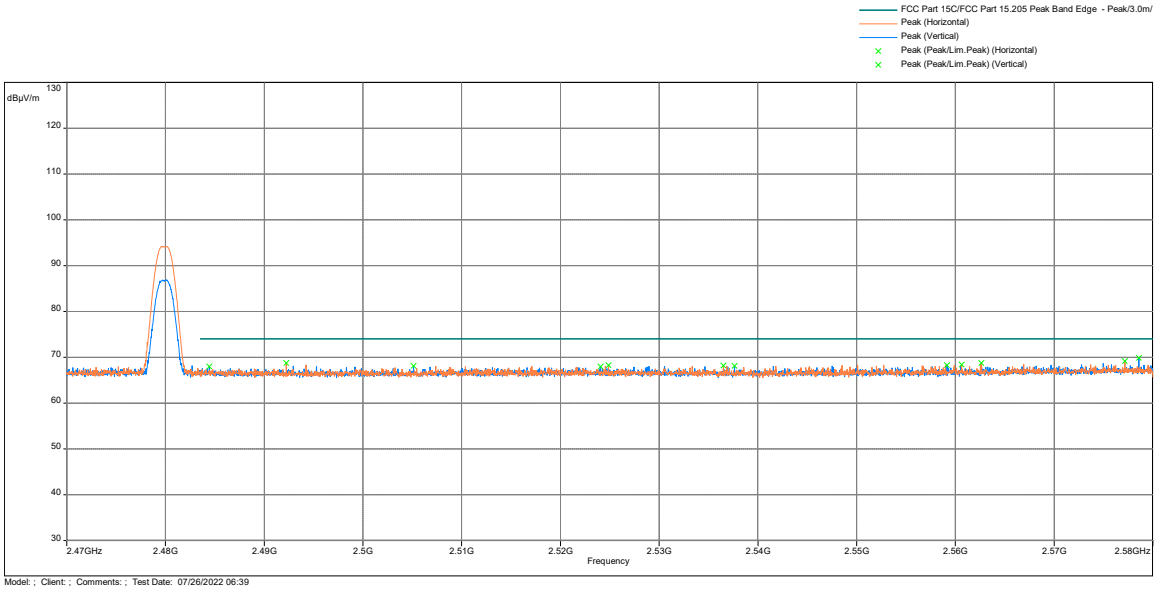


2310–2390 MHz, Average Scan with Average Limit

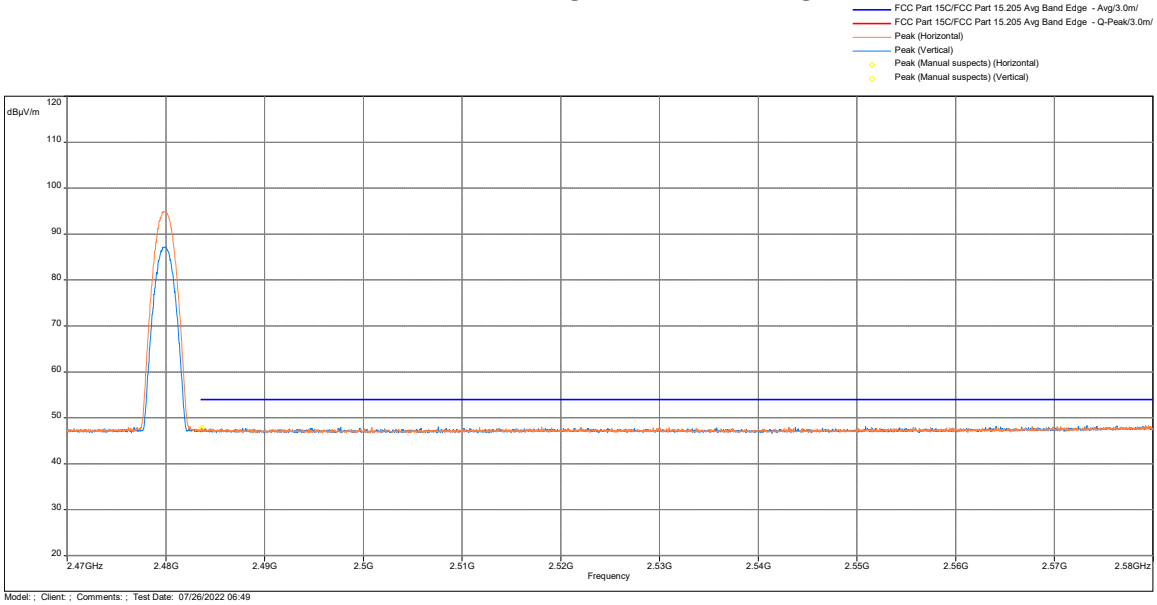


Freq. MHz	Peak@3m dB(uV/m)	Avg Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2390.000	46.88	54	-7.12	2.01	0	Vertical	31.27

Out-of-Band Radiated spurious emissions at the Band-edge @3m distance
2483.5–2500 MHz, Peak Scan with Peak Limit



2483.5–2500 MHz, Average Scan with Average Limit

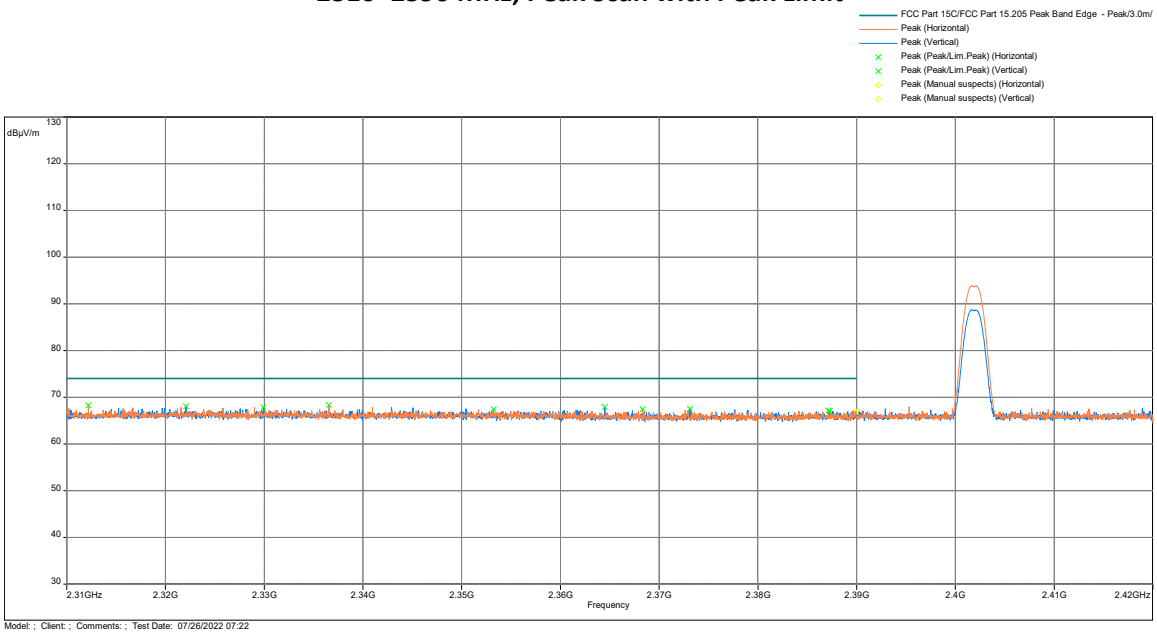


Freq. MHz	Peak@3m dB(uV/m)	Avg Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2483.500	47.78	54	-6.22	2.01	311.75	Vertical	31.58

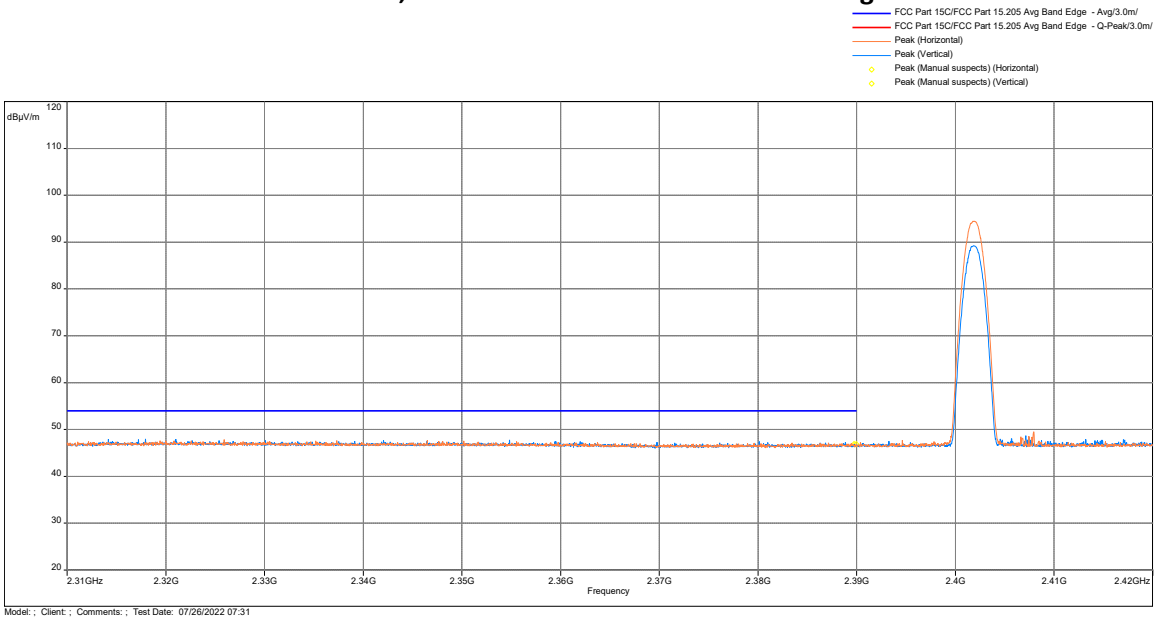
Results	Complies

KEYPAD Model: 938

Out-of-Band Radiated spurious emissions at the Band-edge @3m distance
2310–2390 MHz, Peak Scan with Peak Limit

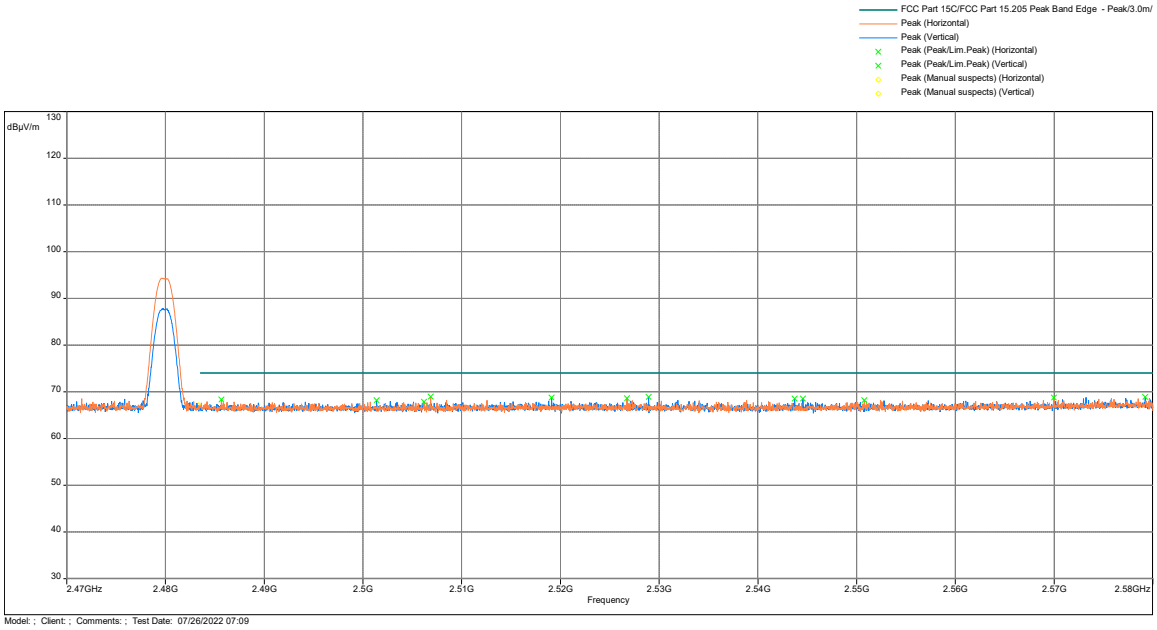


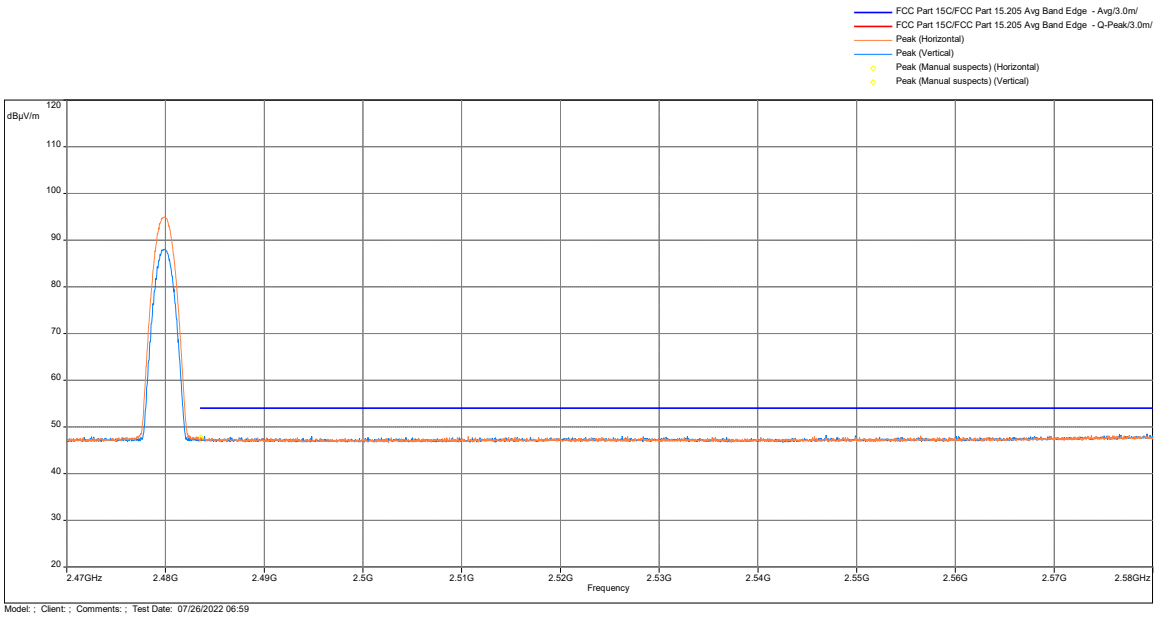
2310–2390 MHz, Peak Scan with Peak Limit and Average Limit



Freq. MHz	Peak@3m dB(uV/m)	Avg Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2390.000	46.88	54	-7.12	2.51	35.25	Horizontal	31.27

Out-of-Band Radiated spurious emissions at the Band-edge @3m distance
2483.5–2500 MHz, Peak Scan with Peak Limit





Freq. MHz	Peak@3m dB(uV/m)	Avg Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2483.500	47.68	54	-6.32	2.99	325.5	Vertical	31.58

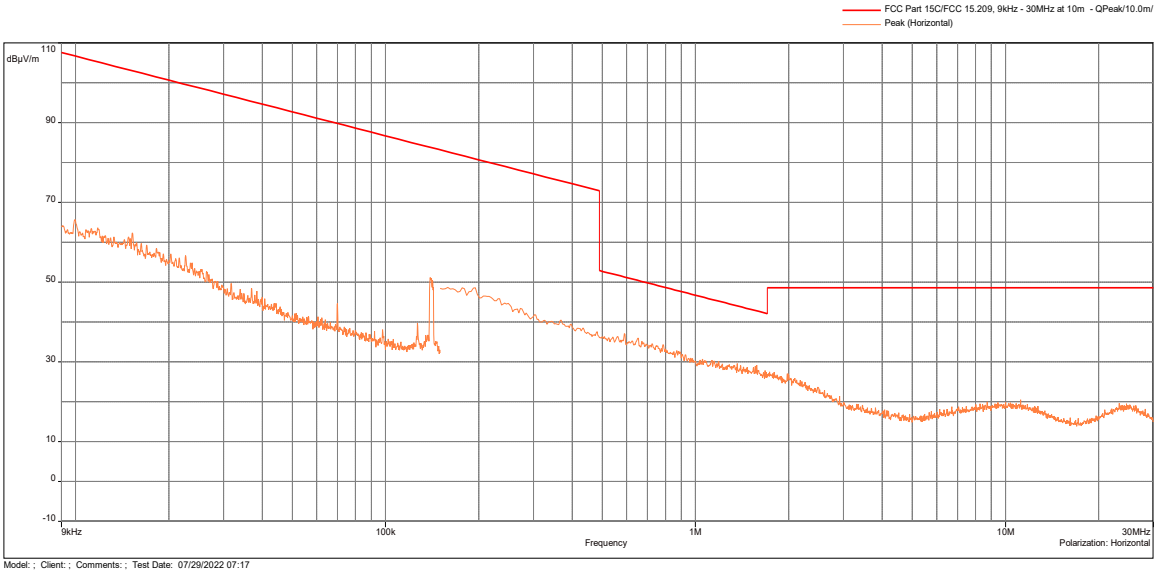
Results	Complies

TOUCHSCREEN Model: 939

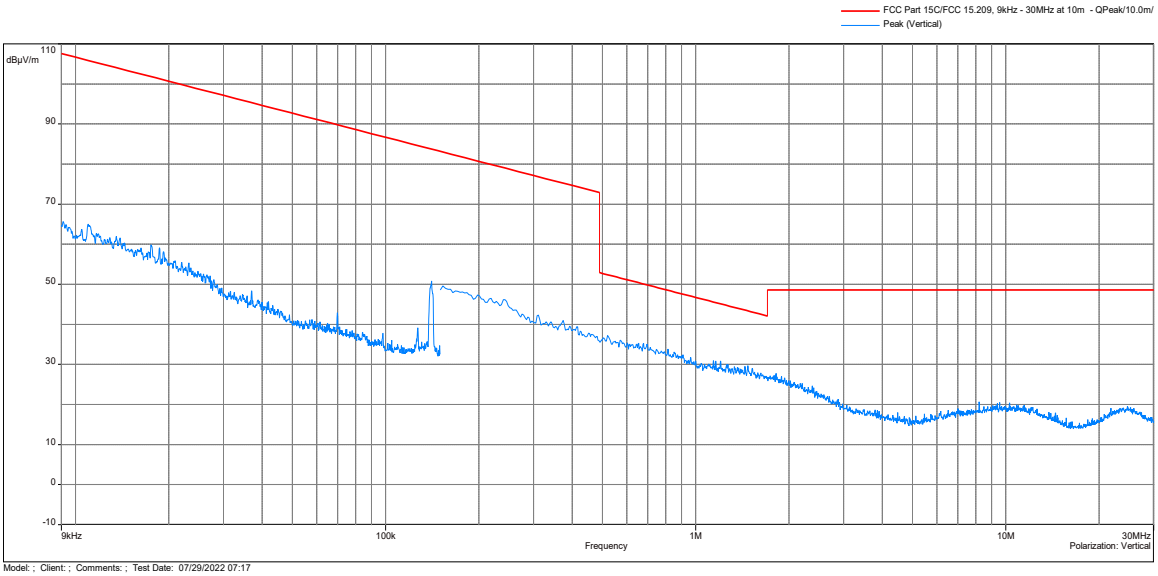
Out-of-Band Radiated Spurious Emissions

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

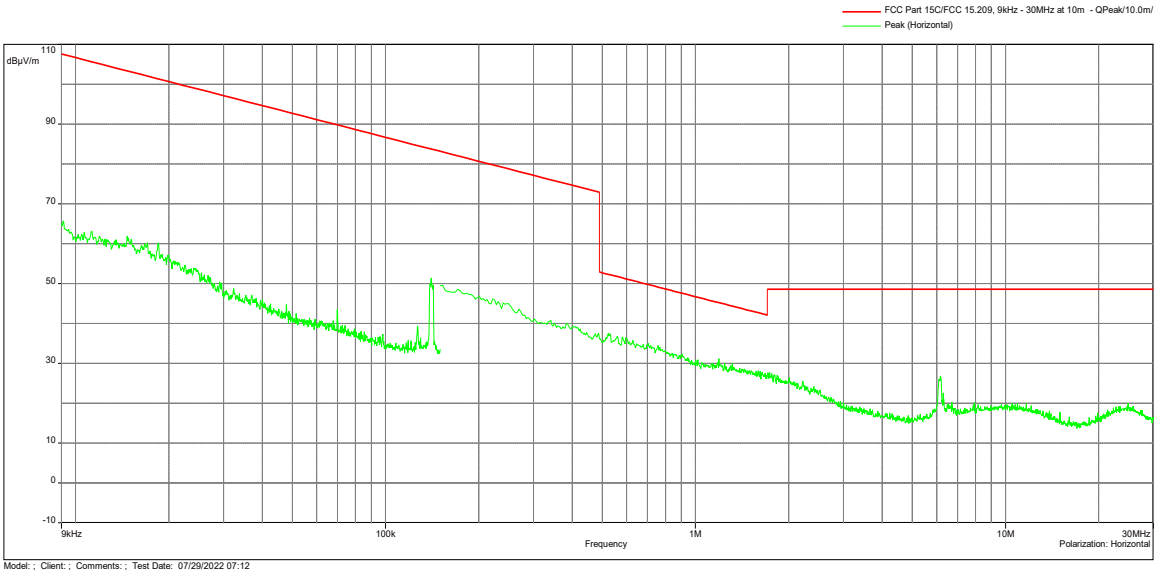
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



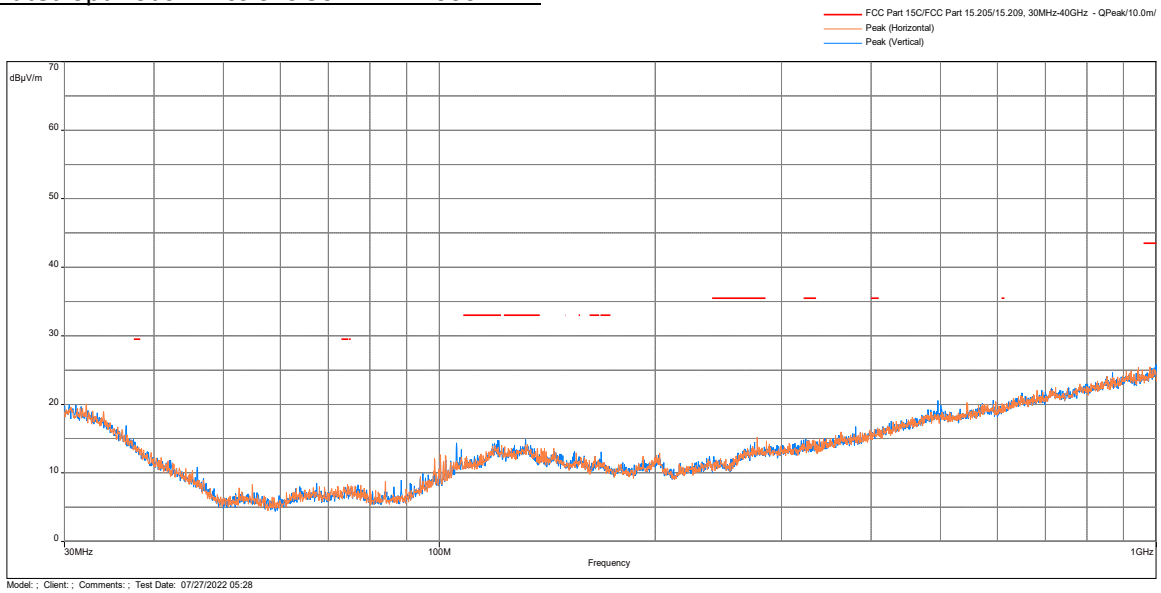
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



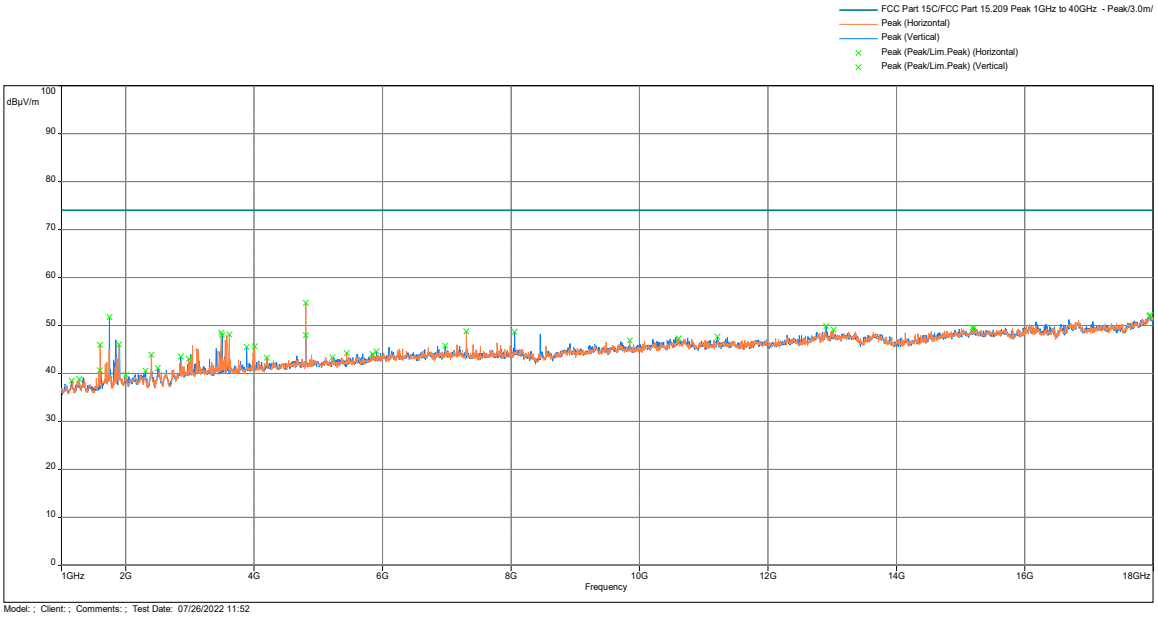
Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization



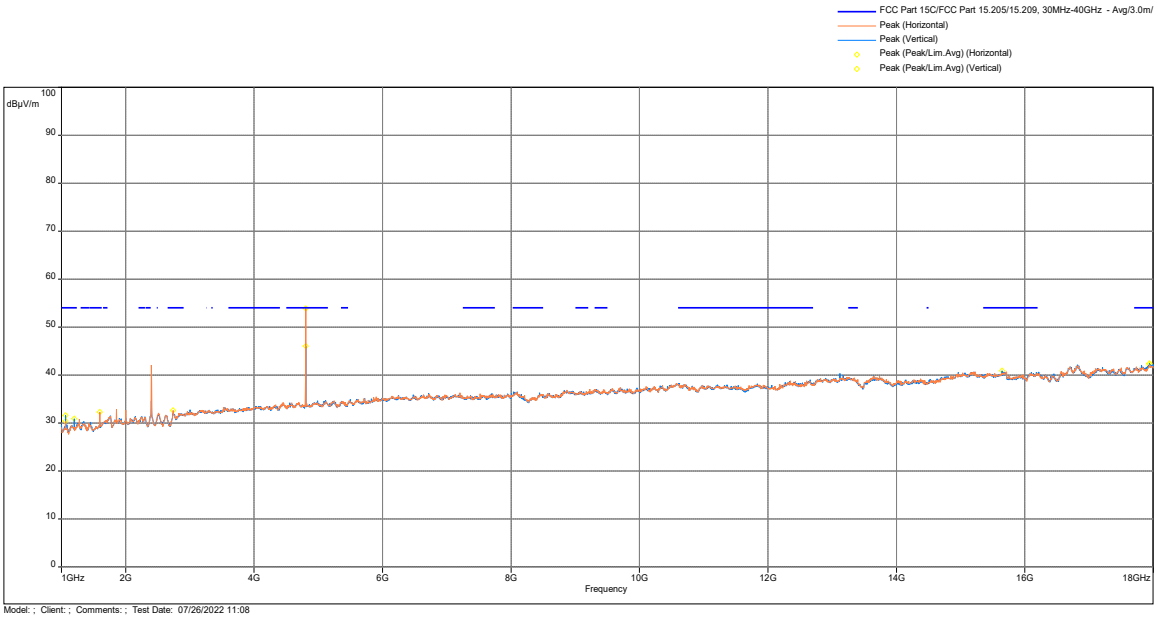
Radiated Spurious Emissions 30 MHz - 1000 MHz



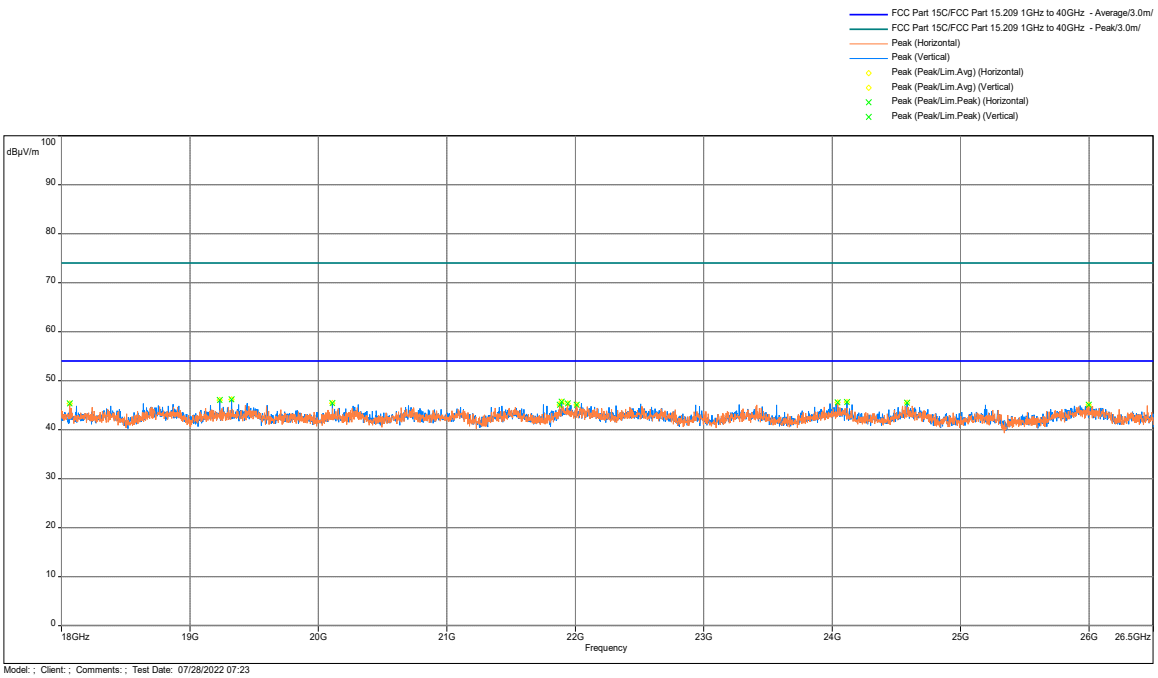
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



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



Radiated Spurious Emissions 18 – 26.5 GHz, Peak Scan vs Peak and Average Limit



Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Frequency (MHz)	QPeak@ 10m (dBµV/m)	Lim. QPeak @10m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
999.224	25.8	43.5	-17.7	0.99	140.5	Vertical	1.72
979.242	25.49	43.5	-18.01	4	320.25	Horizontal	0.99
131.8823	14.87	33	-18.13	2.99	196.5	Vertical	-12.55
981.4407	25.35	43.5	-18.15	1.98	196.75	Vertical	1.07
121.0507	14.76	33	-18.24	2.99	65.25	Vertical	-12.65
132.6907	14.14	33	-18.86	2	329	Horizontal	-12.63

Note: Correction = AF + CF - Preamp

Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4803.47	53.87	54	-0.13	1.01	113	Horizontal	-6.64
4803.47	46.04	54	-7.96	3.99	114.5	Vertical	-6.64
17938.23	42.46	54	-11.54	3.99	270.25	Vertical	8.9
17943.33	42.14	54	-11.86	2.01	191.5	Horizontal	8.95
15646.07	40.9	54	-13.1	1.01	304	Vertical	2.59

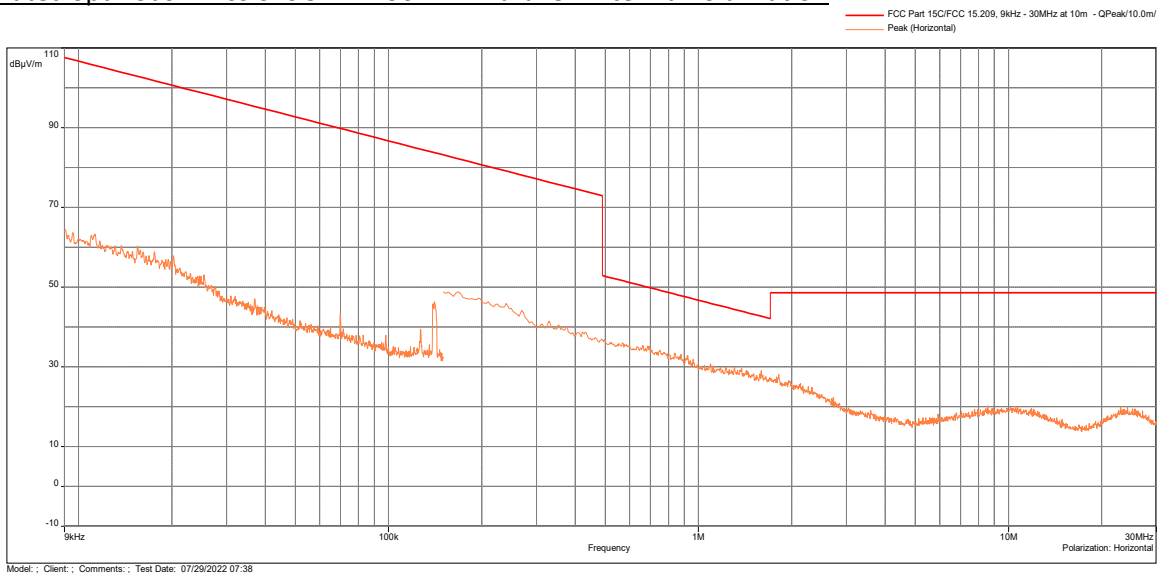
Note: Correction = AF + CF - Preamp

Results	**Complies** by 0.13 dB

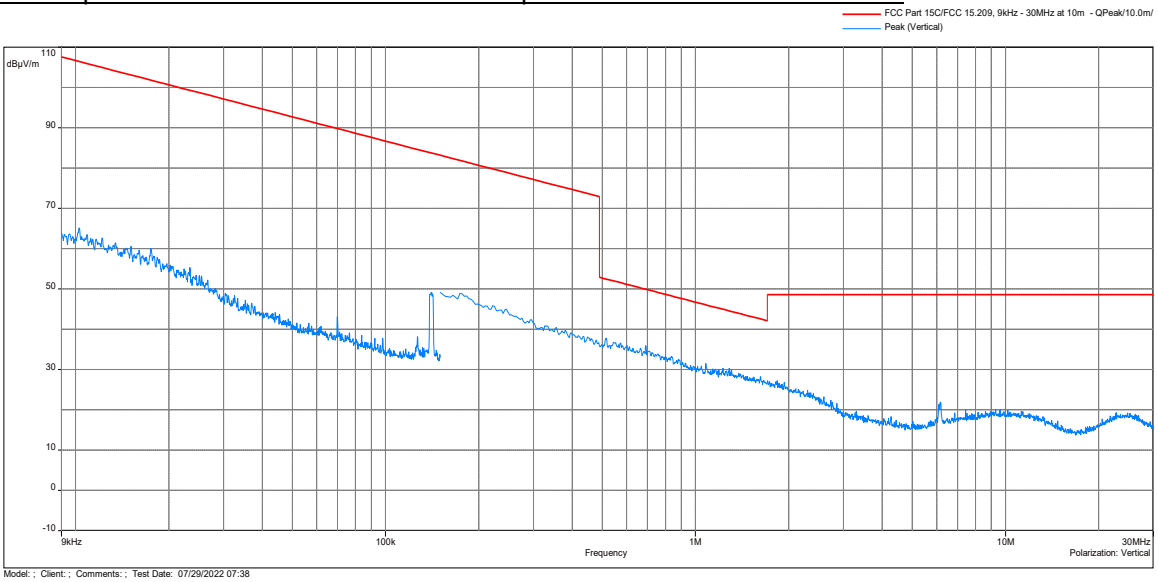
*Note: Measured result is below the specification limit by a margin less than the measurement uncertainty; it is not therefore possible to determine compliance at confidence level of 95%. However, the measured result indicates a higher probability that the product tested complies with the specification limit.

Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2440 MHz

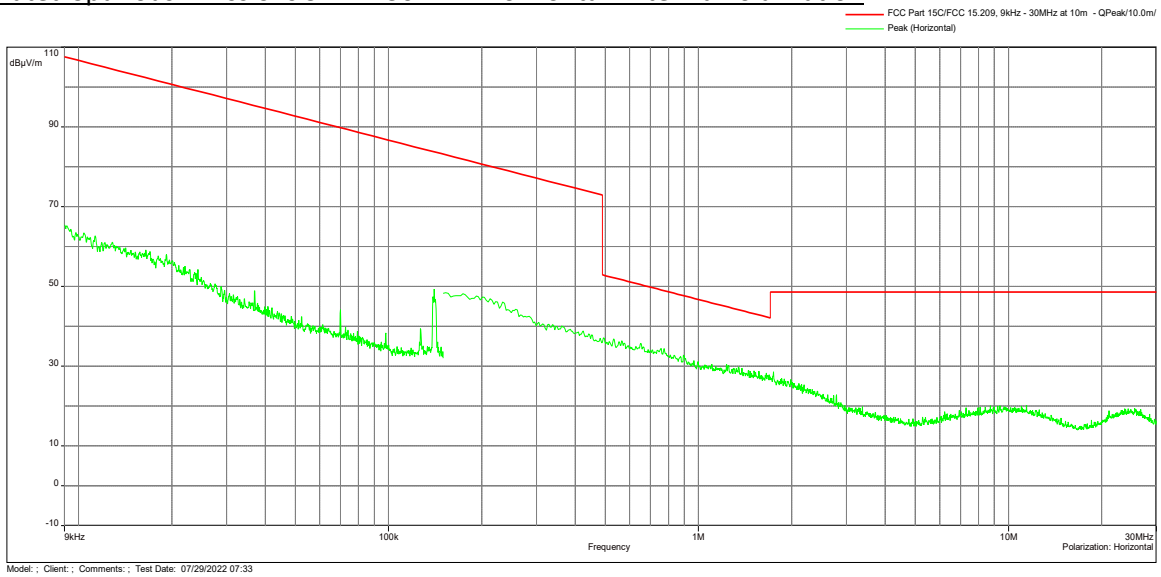
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



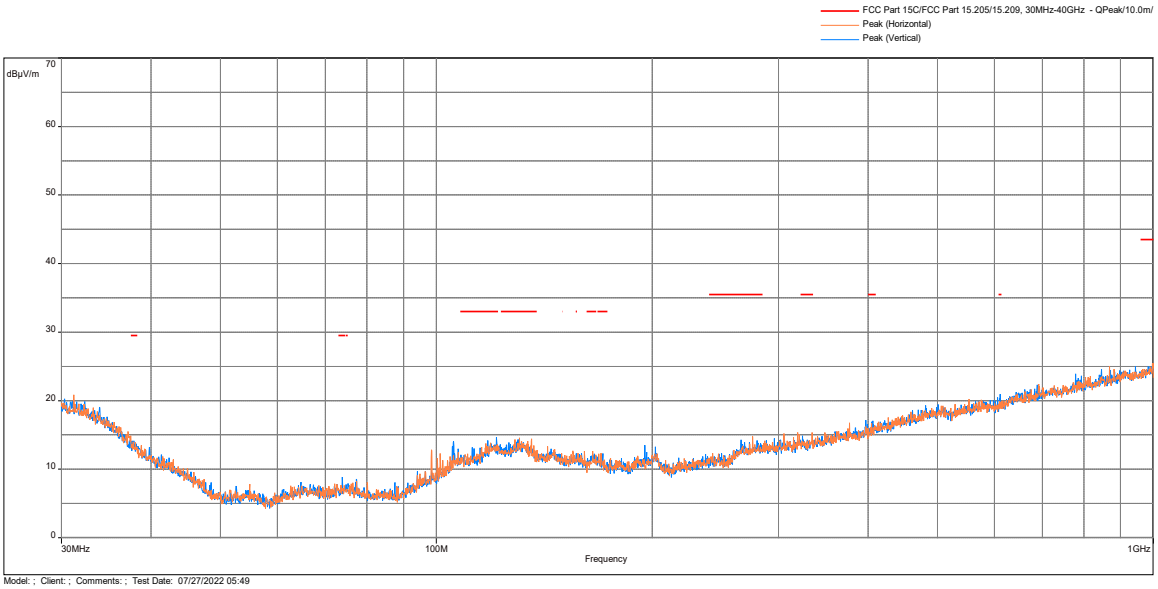
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



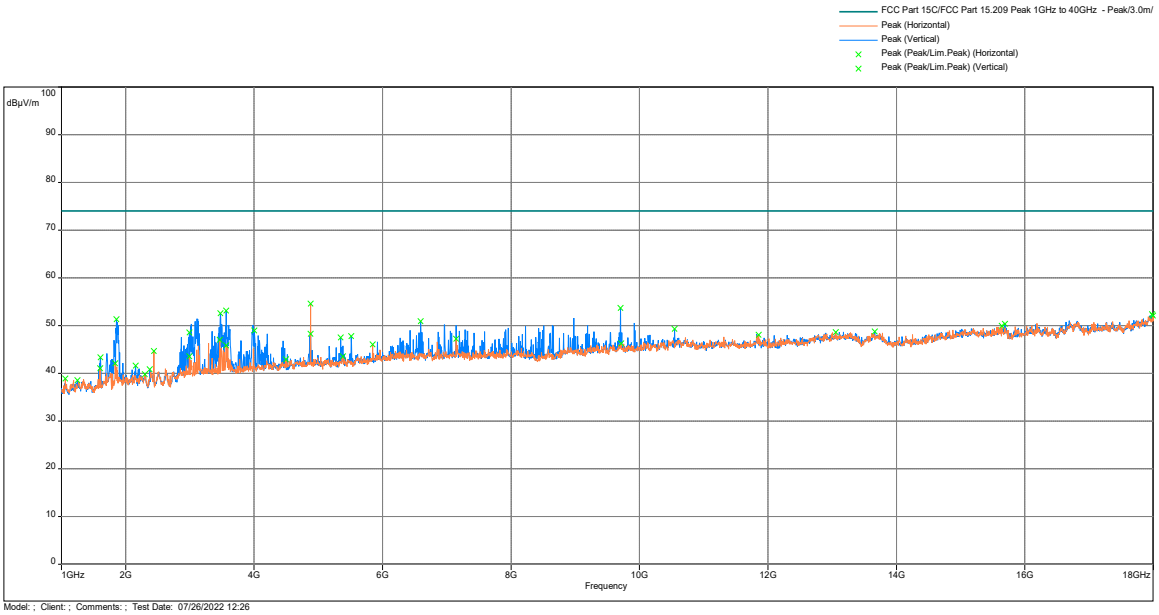
Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization



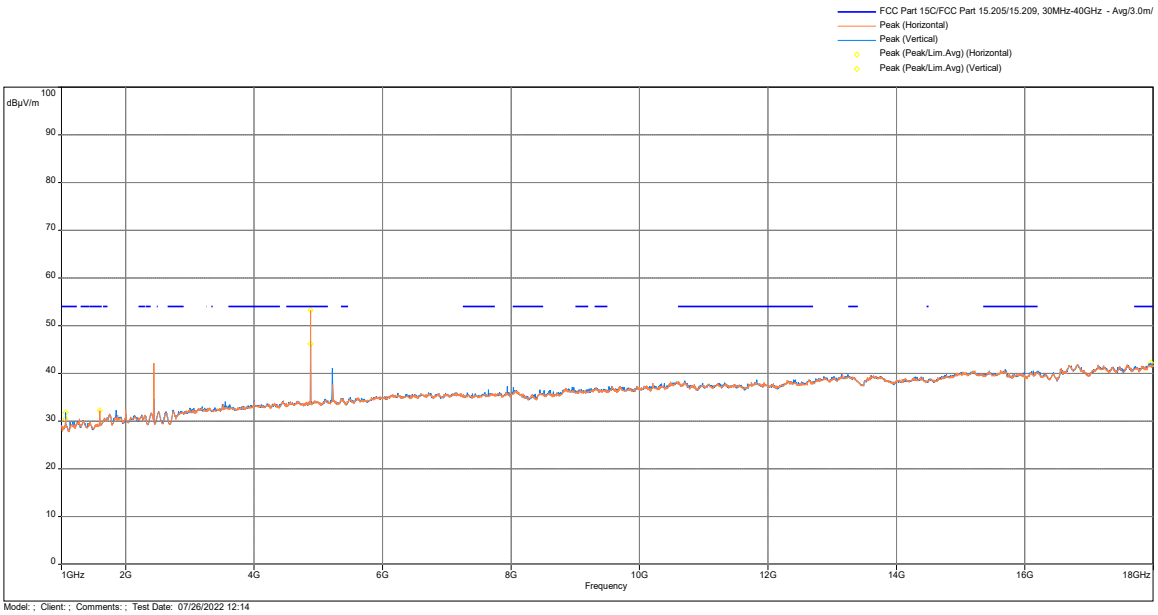
Radiated Spurious Emissions 30 MHz - 1000 MHz



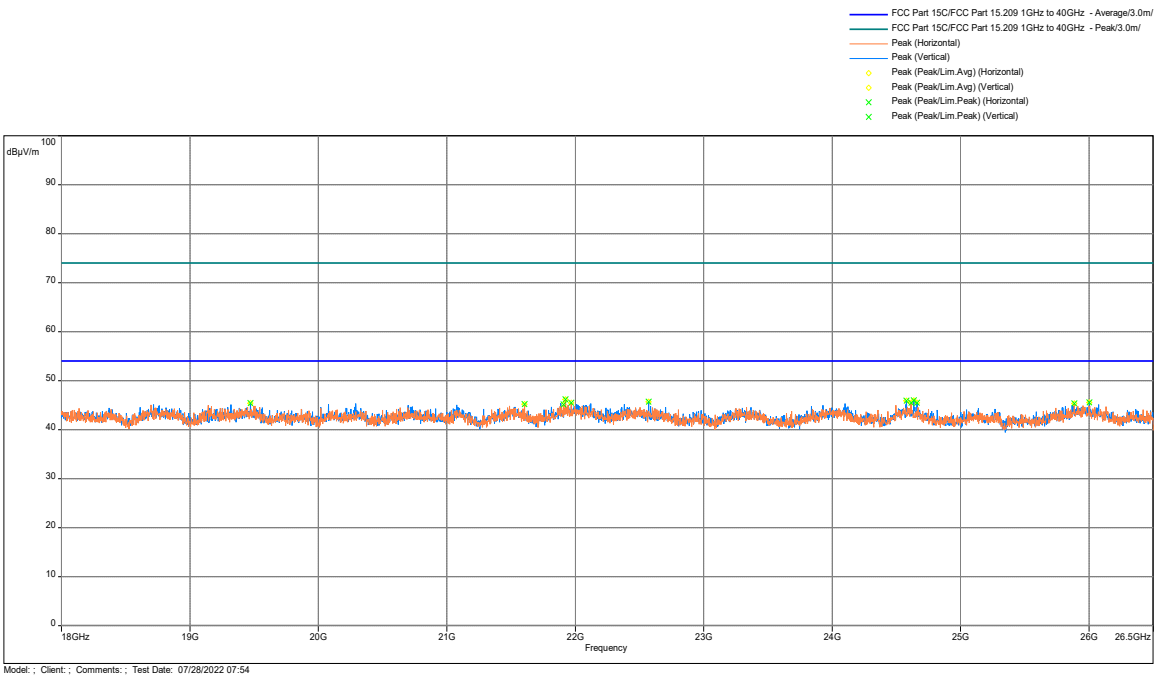
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



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



Radiated Spurious Emissions 18 – 26.5 GHz, Peak Scan vs Peak and Average Limit



Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2440 MHz

Frequency (MHz)	QPeak@ 10m (dBµV/m)	Lim. QPeak @10m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
611.224	20.94	35.5	-14.56	4	87.5	Vertical	-5.78
998.9007	25.49	43.5	-18.01	4	198	Horizontal	1.69
999.806	25.22	43.5	-18.28	4	208.25	Vertical	1.79
121.3417	14.63	33	-18.37	3	311.5	Vertical	-12.61
130.5567	14.57	33	-18.43	2	262.5	Horizontal	-12.42
406.3277	17.07	35.5	-18.43	2	1.5	Vertical	-9.51

Note: Correction = AF + CF – Preamp

Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4879.97	53.28	54	-0.72	1.01	113.5	Horizontal	-6.59
4879.40	46.17	54	-7.83	1.99	170.5	Vertical	-6.59
17961.47	42.24	54	-11.76	1.01	276.25	Vertical	9.12
1600.10	32.23	54	-21.77	2.01	7.5	Horizontal	-15.76
1065.17	31.79	54	-22.21	3.99	56.75	Vertical	-17.49

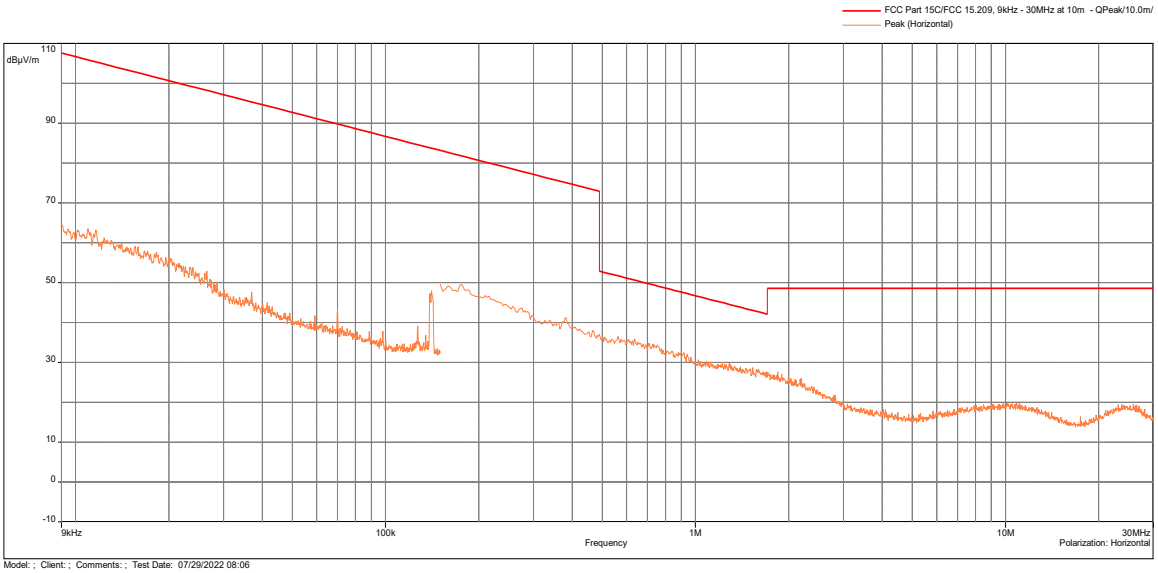
Note: Correction = AF + CF - Preamp

Results **Complies** by 0.72 dB

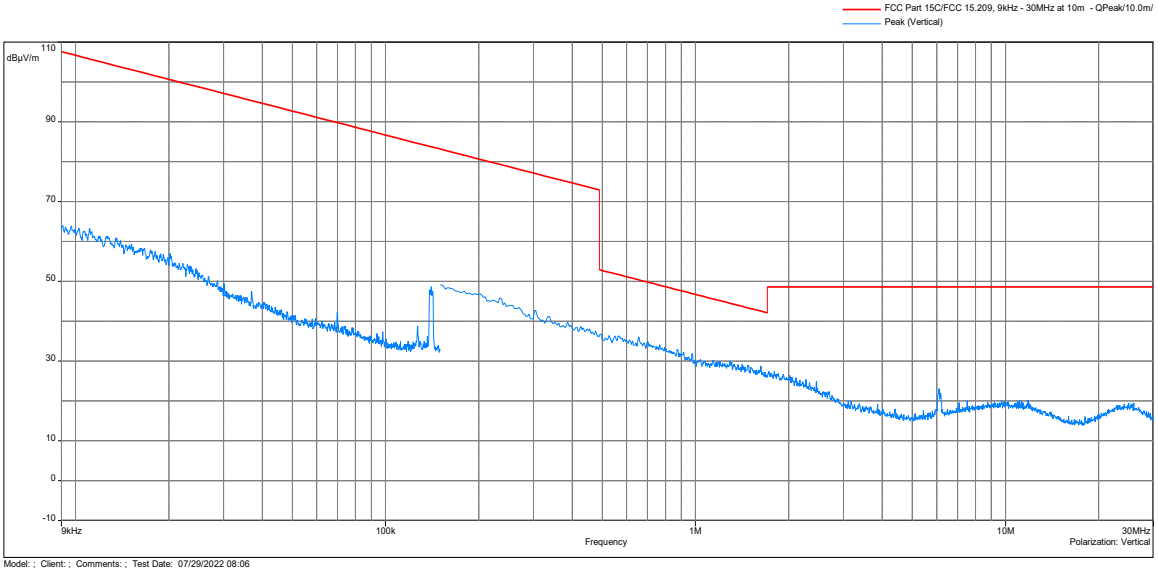
*Note: Measured result is below the specification limit by a margin less than the measurement uncertainty; it is not therefore possible to determine compliance at confidence level of 95%. However, the measured result indicates a higher probability that the product tested complies with the specification limit.

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz

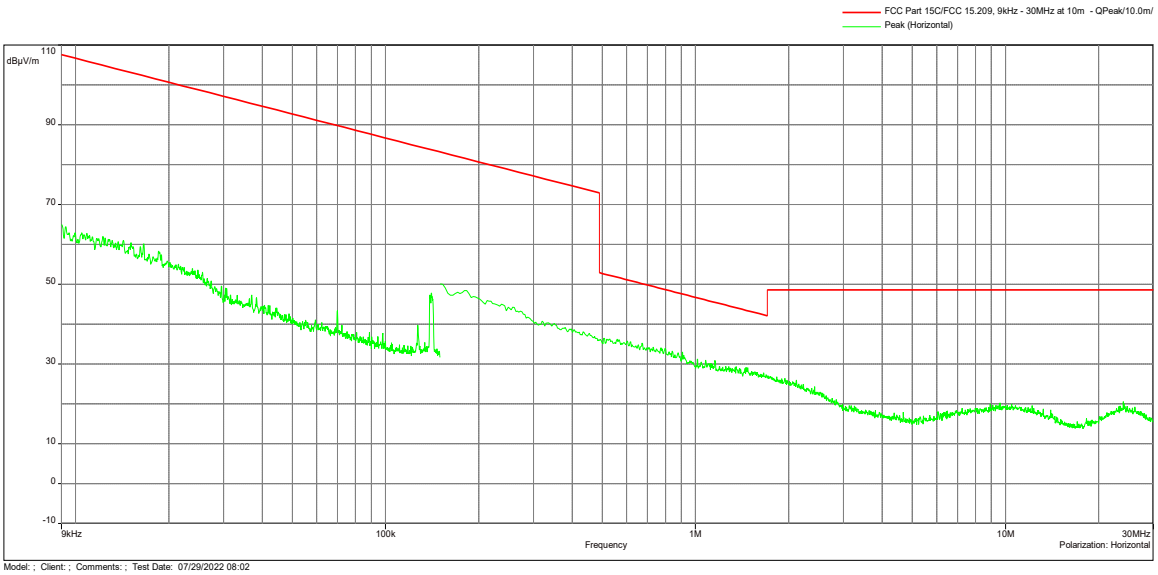
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



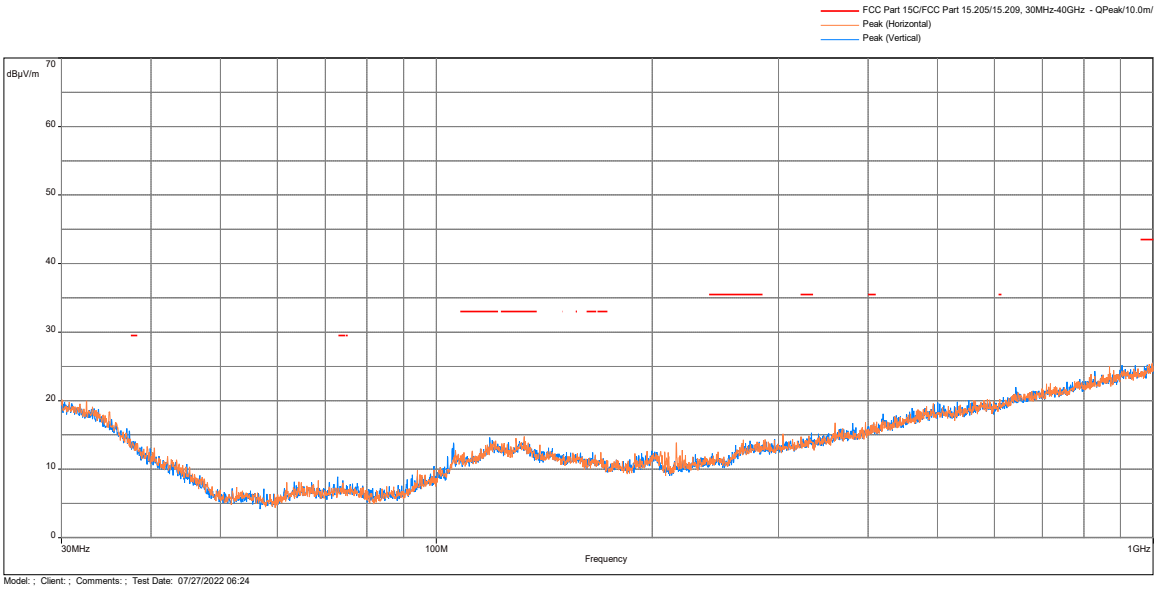
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



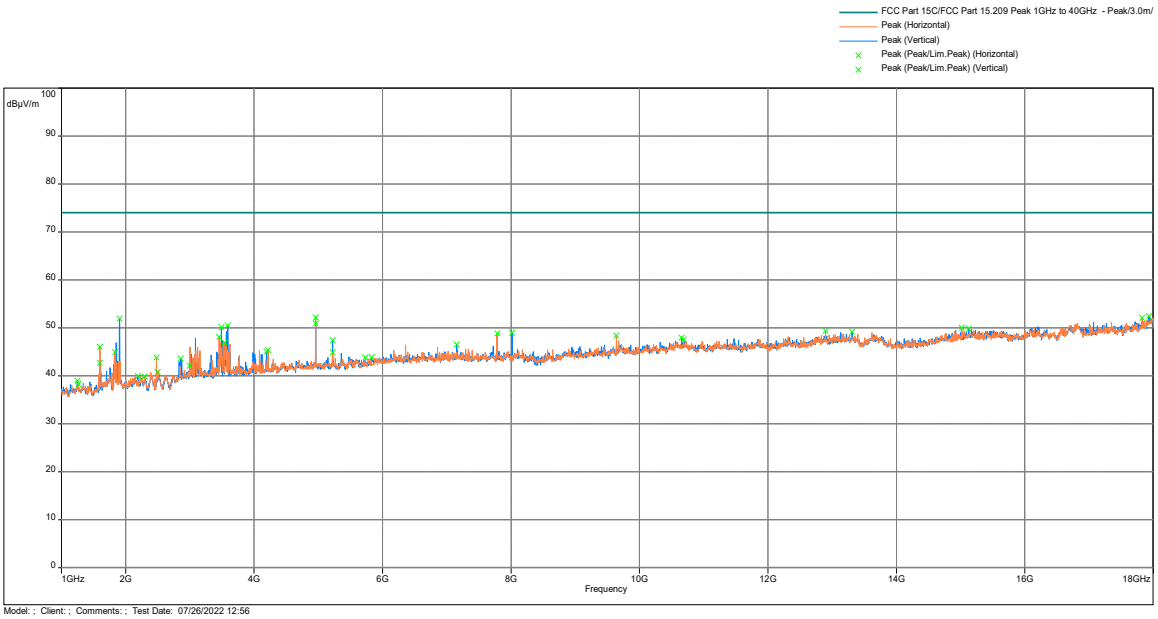
Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization



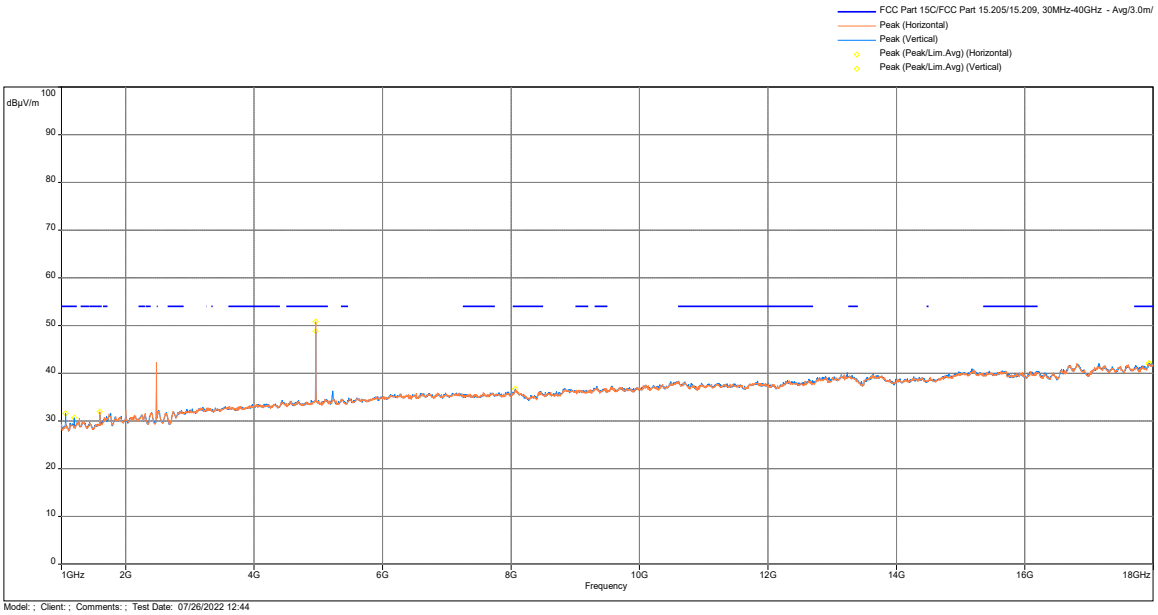
Radiated Spurious Emissions 30 MHz - 1000 MHz



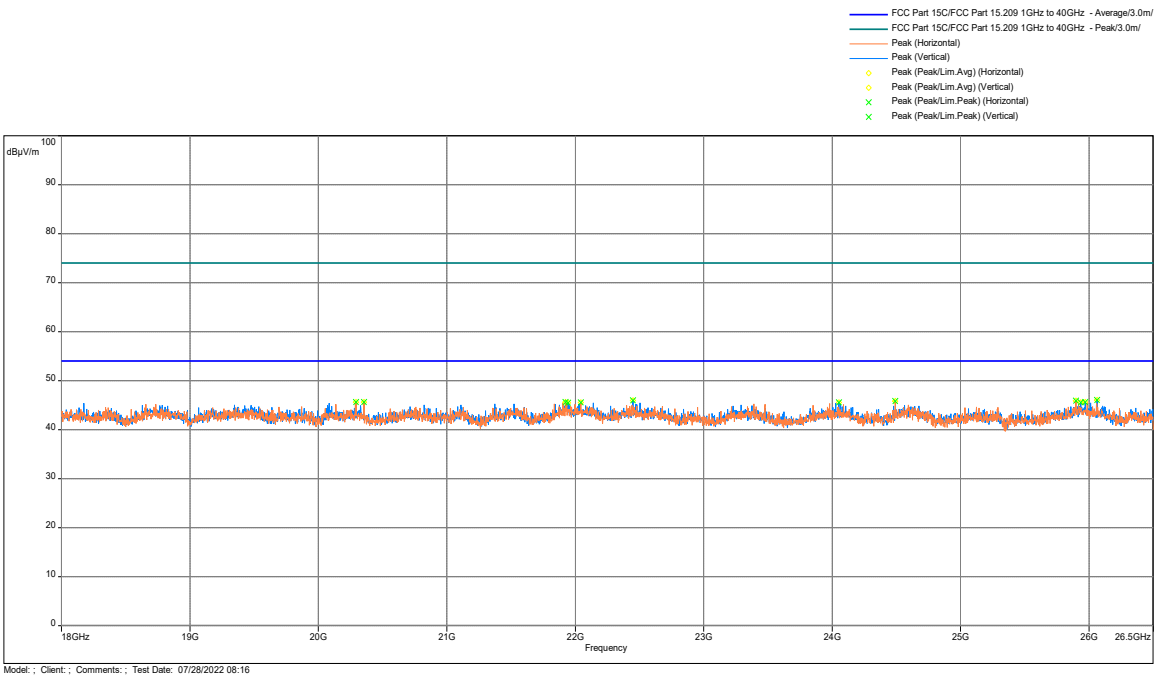
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



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



Radiated Spurious Emissions 18 – 26.5 GHz, Peak Scan vs Peak and Average Limit



Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz

Frequency (MHz)	QPeak@ 10m (dBµV/m)	Lim. QPeak @10m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
996.67	25.55	43.5	-17.95	0.98	79.25	Horizontal	1.66
997.41	25.51	43.5	-17.99	2	13.75	Vertical	1.67
132.59	14.77	33	-18.23	4	306	Horizontal	-12.62
118.76	14.63	33	-18.37	2	49	Vertical	-12.79
971.22	25.02	43.5	-18.48	3	63	Vertical	0.66
333.64	15.31	35.5	-20.19	0.99	2	Vertical	-11.38

Note: Correction = AF + CF – Preamp

Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4959.87	50.81	54	-3.19	1.01	127.25	Horizontal	-6.57
4959.87	48.85	54	-5.15	1.99	170.5	Vertical	-6.57
17933.13	42.13	54	-11.87	3.99	71	Vertical	8.84
17933.13	41.97	54	-12.03	1.01	355.25	Horizontal	8.84
8068.60	36.76	54	-17.24	1.99	227.5	Vertical	-3.32

Note: Correction = AF + CF - Preamp

Results	**Complies** by 3.19 dB

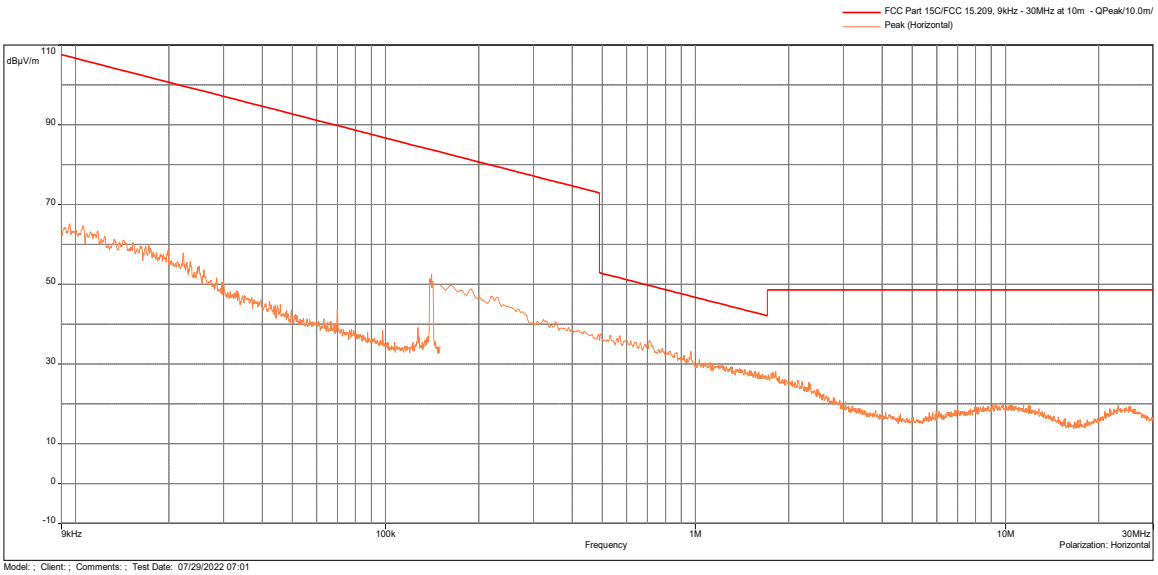
*Note: Measured result is below the specification limit by a margin less than the measurement uncertainty; it is not therefore possible to determine compliance at confidence level of 95%. However, the measured result indicates a higher probability that the product tested complies with the specification limit.

KEYPAD Model: 938

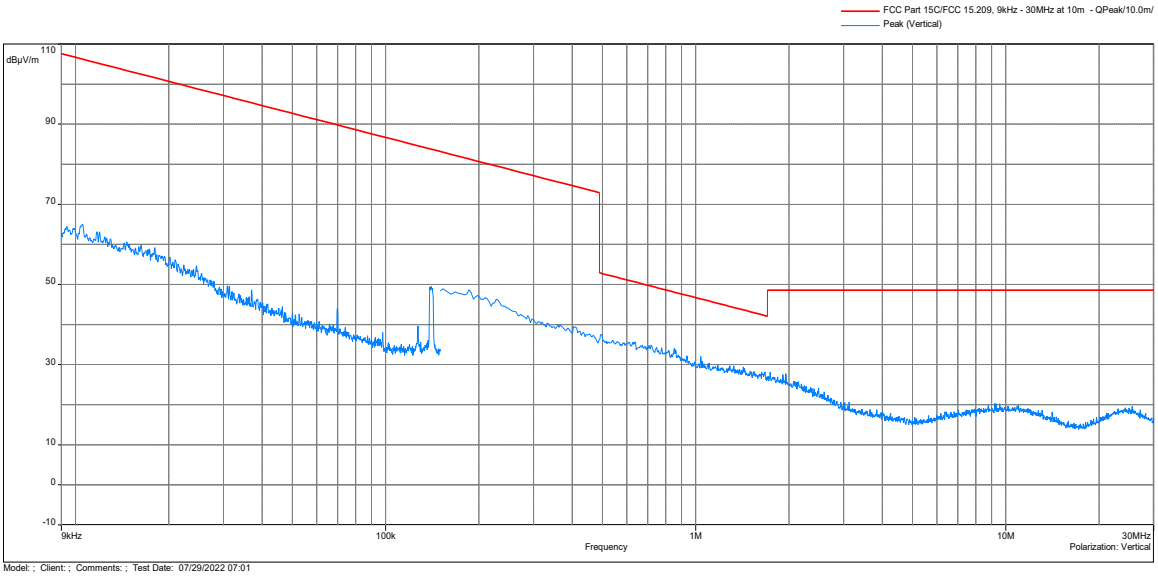
Out-of-Band Radiated Spurious Emissions

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

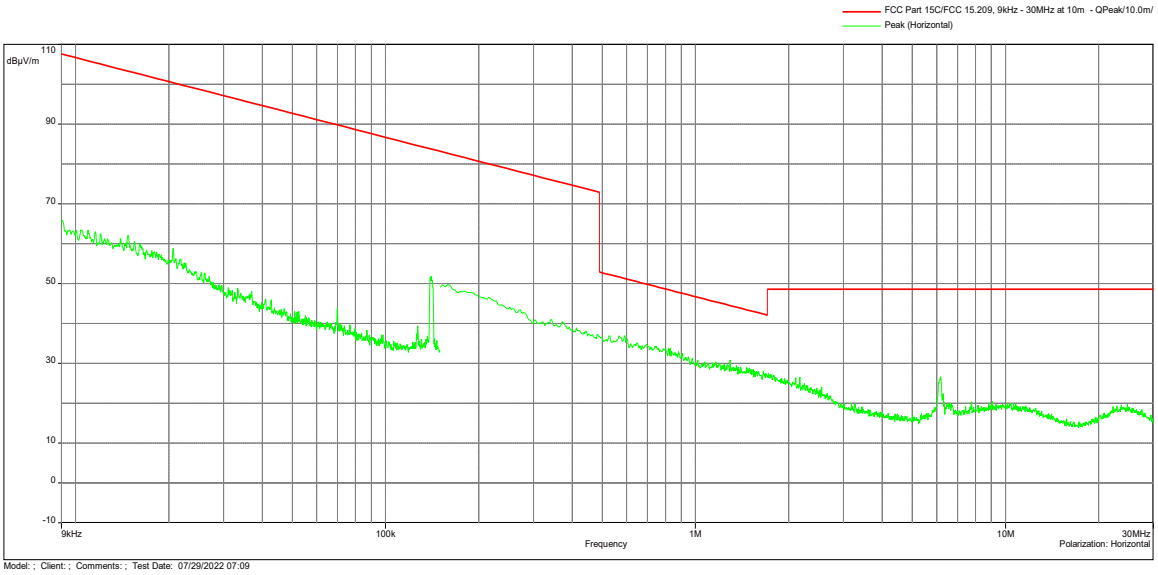
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



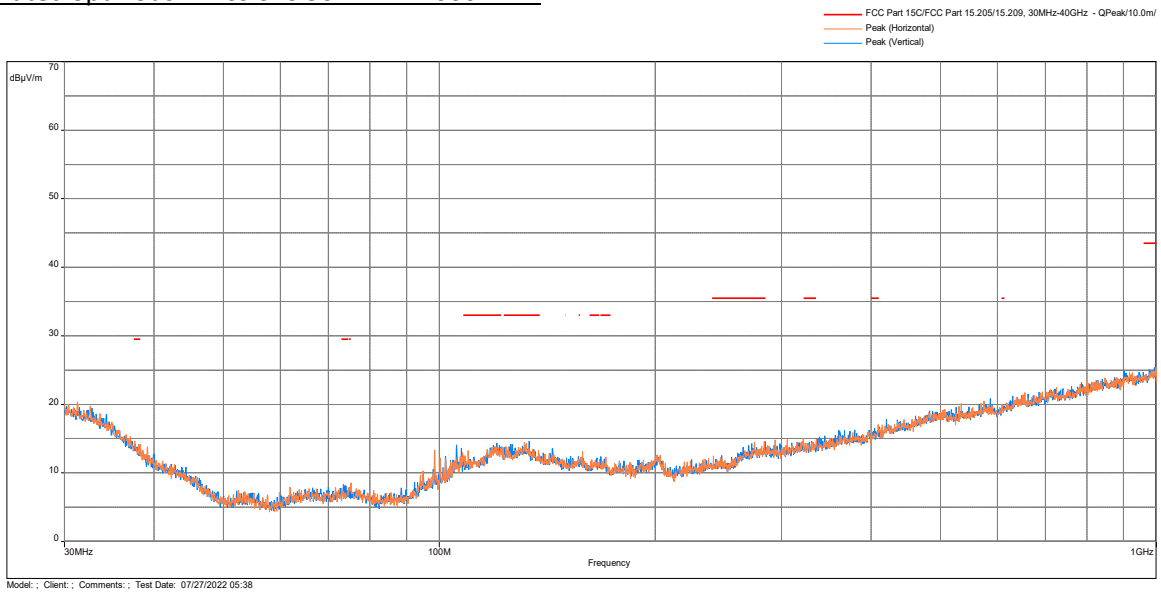
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



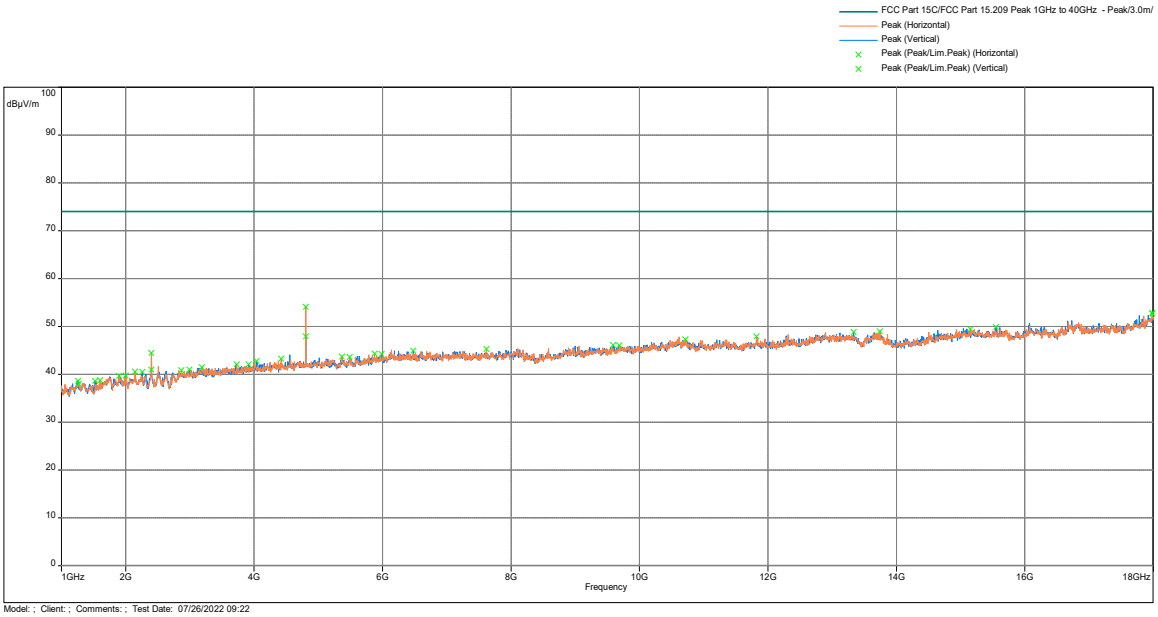
Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization



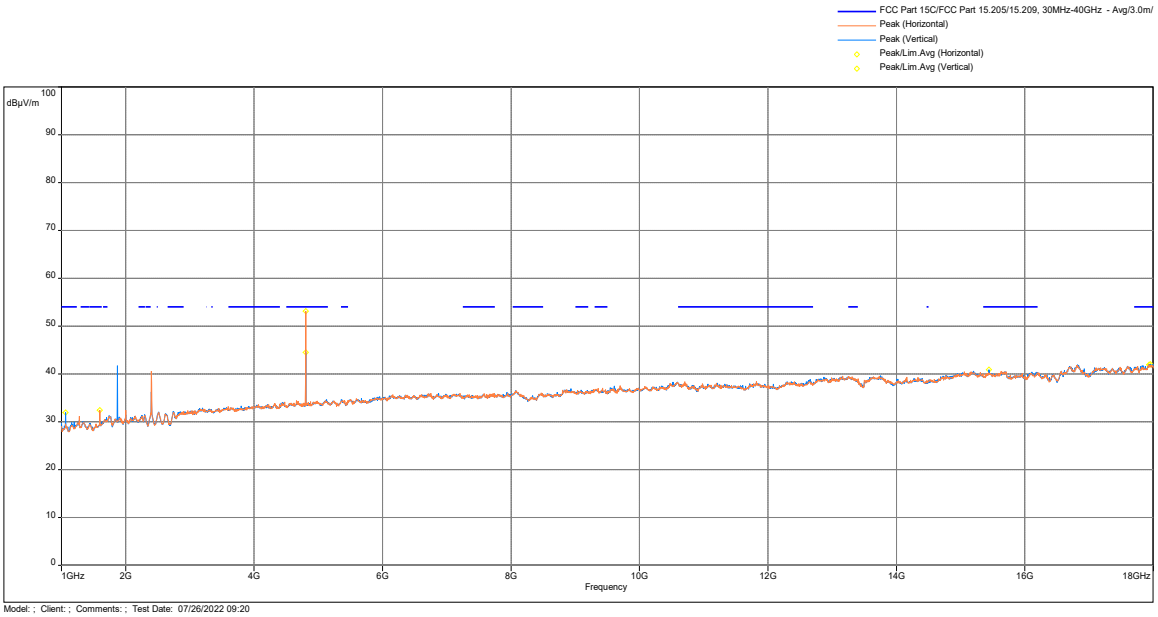
Radiated Spurious Emissions 30 MHz - 1000 MHz



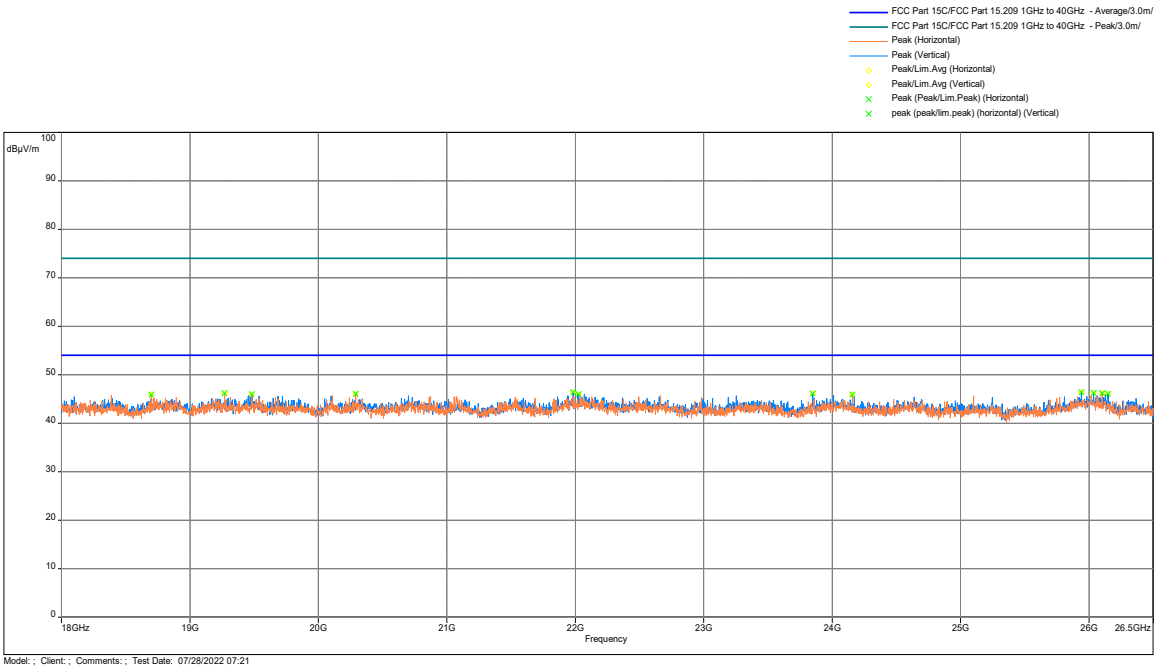
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



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



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



Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Frequency (MHz)	QPeak@ 10m (dBµV/m)	Lim. QPeak @10m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
999.06	25.45	43.5	-18.05	1	97.75	Horizontal	1.7
993.76	25.38	43.5	-18.12	2.99	217	Vertical	1.58
133.47	14.63	33	-18.37	1.98	34.75	Vertical	-12.7
409.24	17.08	35.5	-18.42	4	146.5	Horizontal	-9.4
131.37	14.49	33	-18.51	1	50.25	Horizontal	-12.5
109.70	13.29	33	-19.71	2	158.5	Horizontal	-14.18

Note: Correction = AF + CF - Preamp.

Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4804.03	53.11	54	-0.89	1.01	156.5	Horizontal	-6.64
4804.03	44.53	54	-9.47	1.99	213.25	Vertical	-6.64
17952.97	42.03	54	-11.97	3.99	127.25	Vertical	9.05
17933.70	41.92	54	-12.08	3.01	141.75	Horizontal	8.84
15442.63	40.91	54	-13.09	3.99	42.5	Vertical	2.19

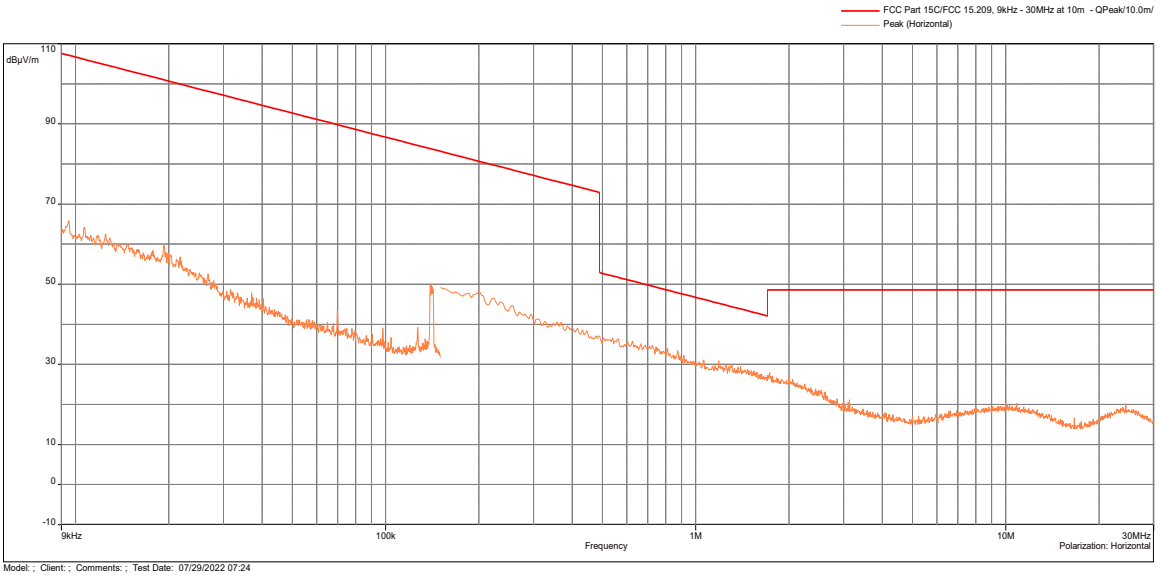
Note: Correction = AF + CF - Preamp

Results	**Complies** by 0.89 dB

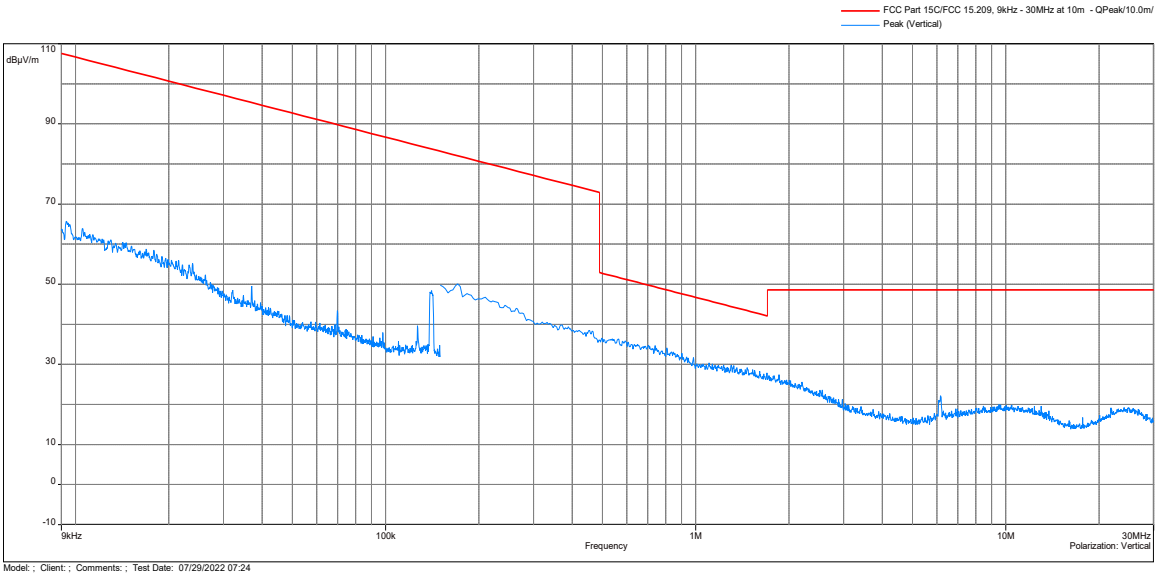
*Note: Measured result is below the specification limit by a margin less than the measurement uncertainty; it is not therefore possible to determine compliance at confidence level of 95%. However, the measured result indicates a higher probability that the product tested complies with the specification limit.

Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2440 MHz

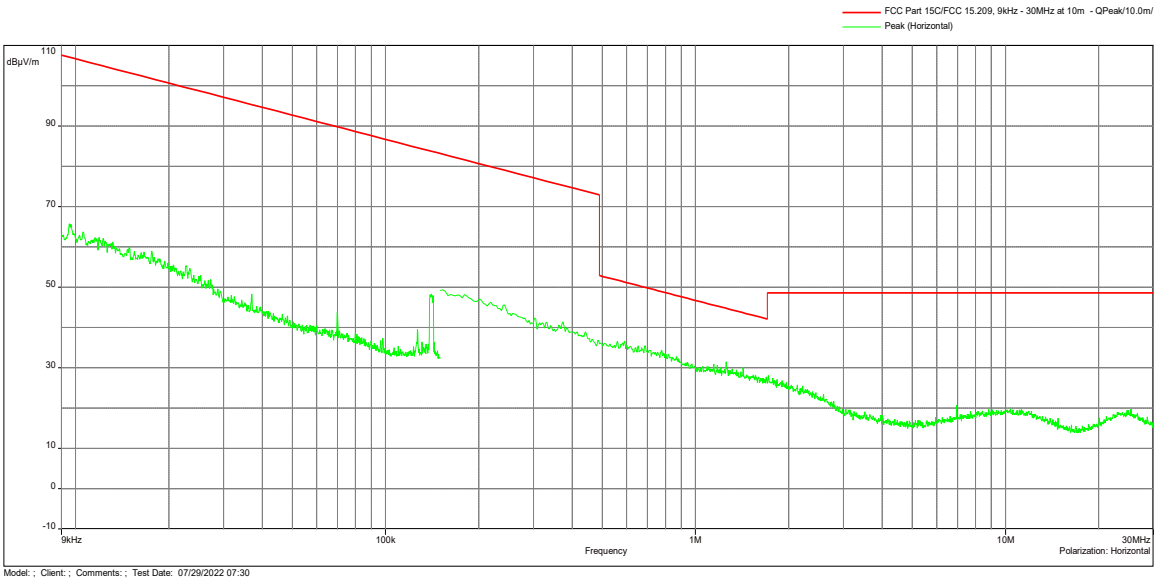
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



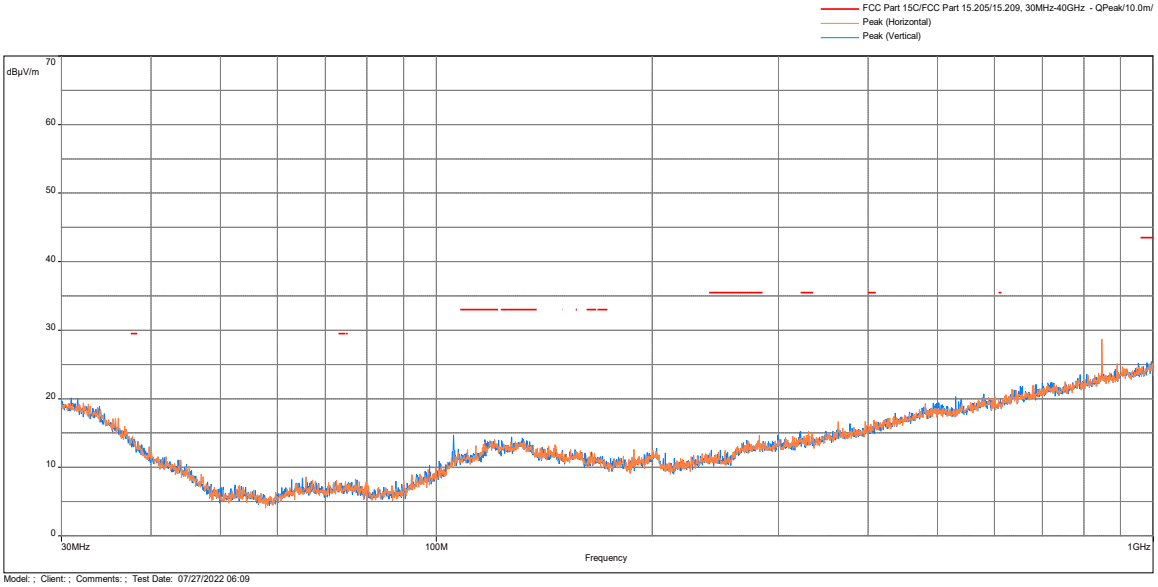
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



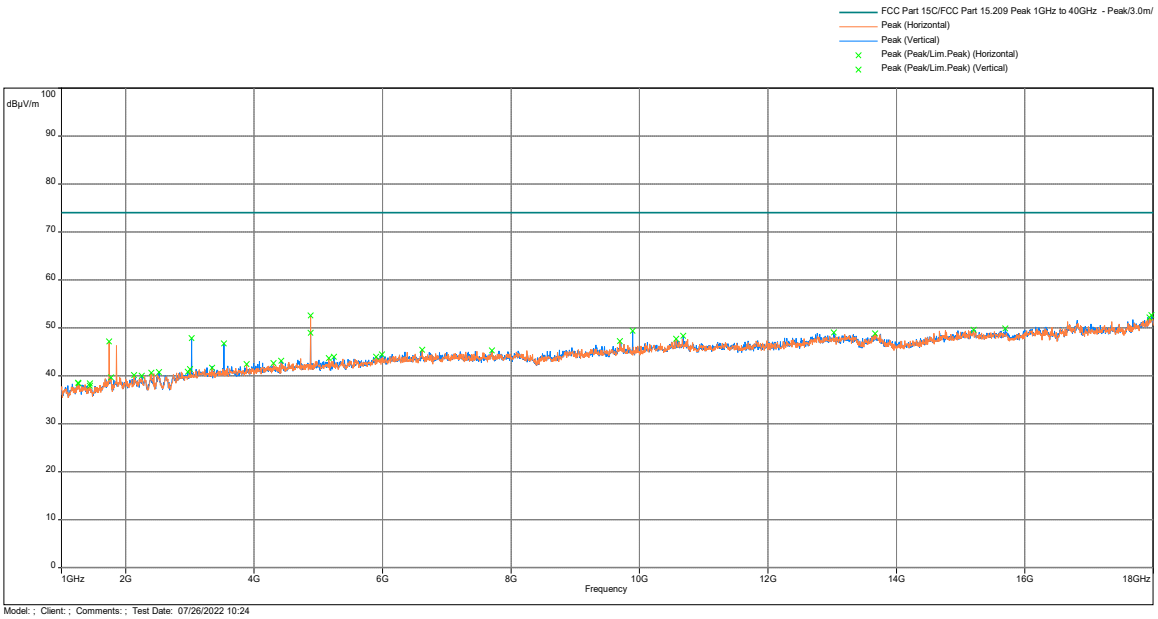
Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization



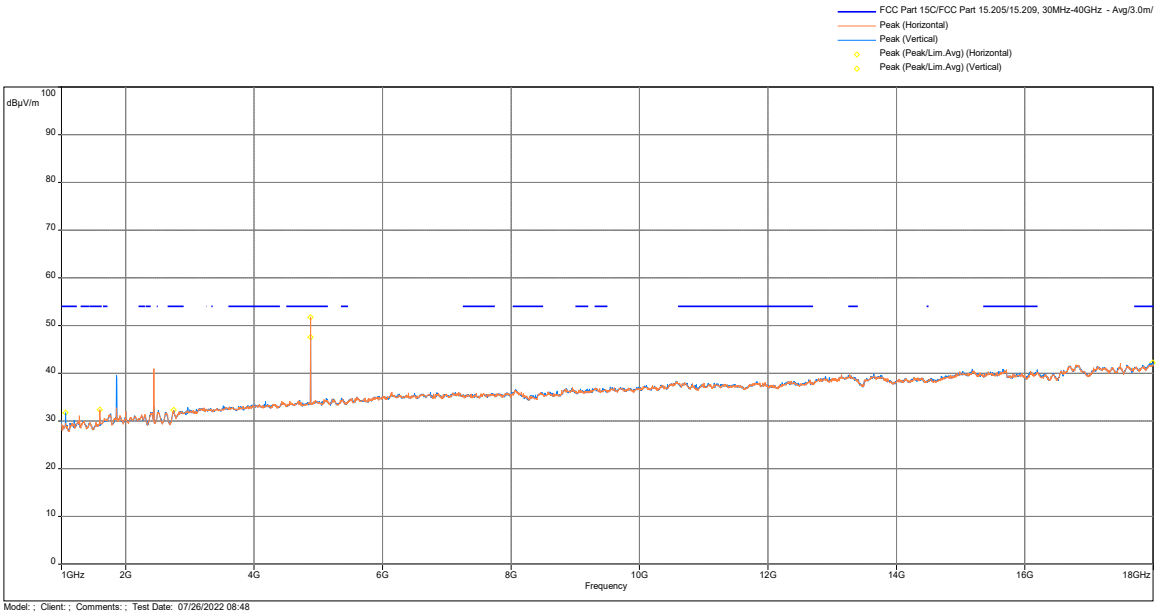
Radiated Spurious Emissions 30 MHz - 1000 MHz



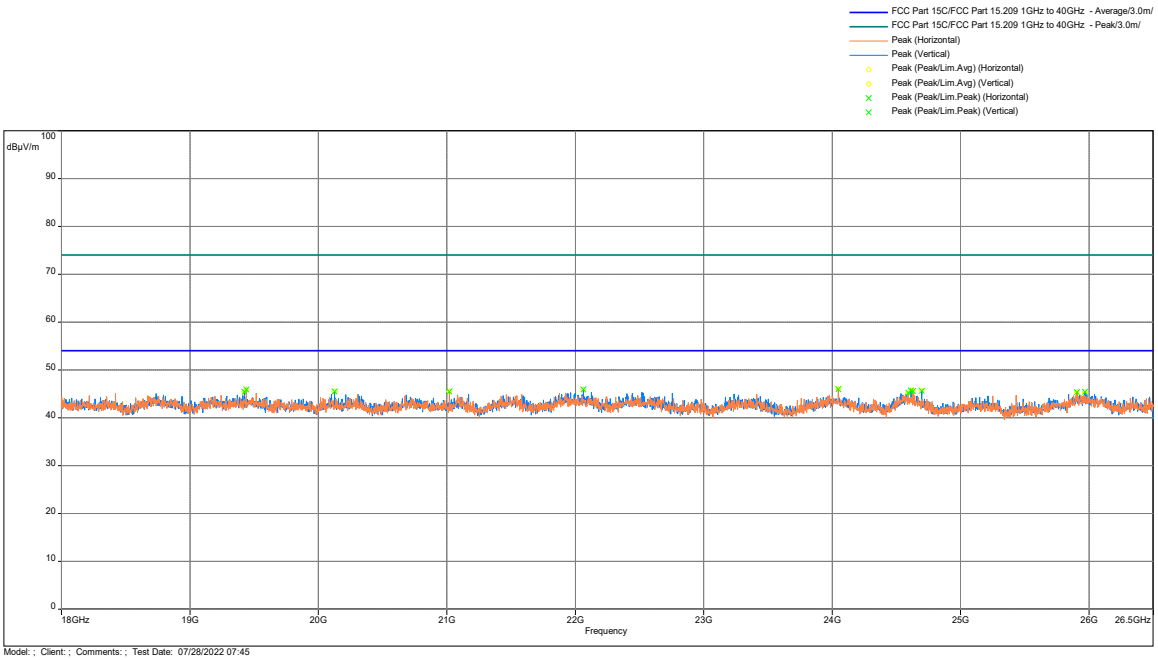
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



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



Radiated Spurious Emissions 18 – 26.5 GHz, Peak Scan vs Peak and Average Limit



Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2440 MHz

Frequency (MHz)	QPeak@ 10m (dBµV/m)	Lim. QPeak @10m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
994.12	25.4	43.5	-18.1	1.97	106.75	Vertical	1.61
979.50	25.27	43.5	-18.23	2.99	345.25	Vertical	0.99
997.38	25.17	43.5	-18.33	4	0.25	Horizontal	1.67
127.32	14.45	33	-18.55	1.97	125.25	Vertical	-12.39
407.85	16.91	35.5	-18.59	4	347.75	Horizontal	-9.43
120.57	14.04	33	-18.96	2	145.5	Horizontal	-12.65

Note: Correction = AF + CF – Preamp

Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4879.97	51.77	54	-2.23	1.01	114	Horizontal	-6.59
4879.40	47.56	54	-6.44	1.99	170.5	Vertical	-6.59
17990.37	42.2	54	-11.8	3.99	269.75	Vertical	9.45
1599.53	32.38	54	-21.62	2.01	190.75	Horizontal	-15.76
2746.47	32.29	54	-21.71	3.99	35	Horizontal	-11.16

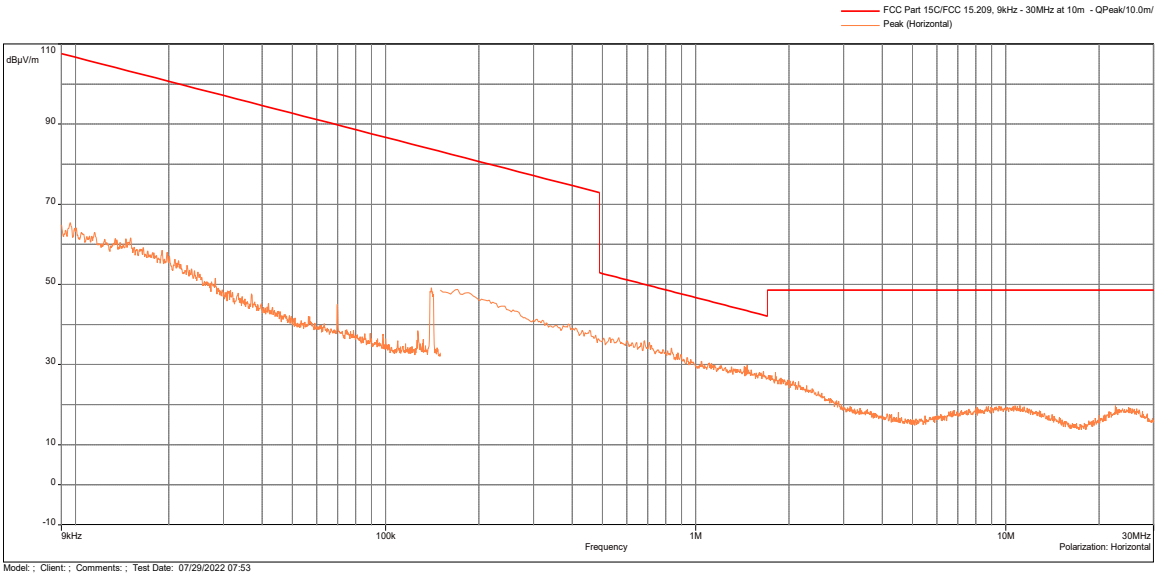
Note: Correction = AF + CF - Preamp

Results	**Complies** by 2.23 dB

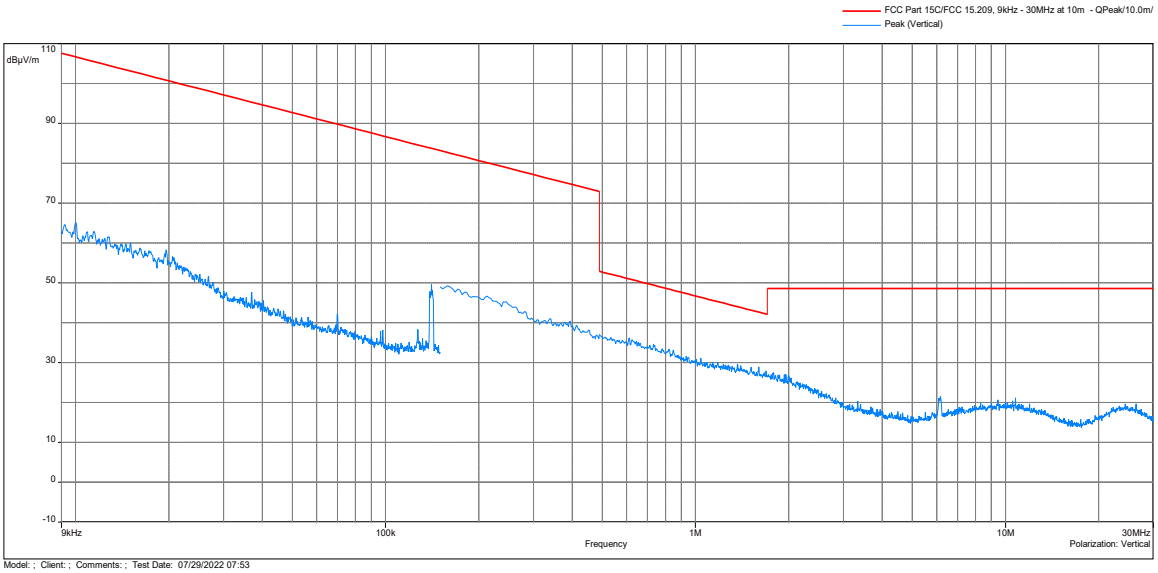
*Note: Measured result is below the specification limit by a margin less than the measurement uncertainty; it is not therefore possible to determine compliance at confidence level of 95%. However, the measured result indicates a higher probability that the product tested complies with the specification limit.

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz

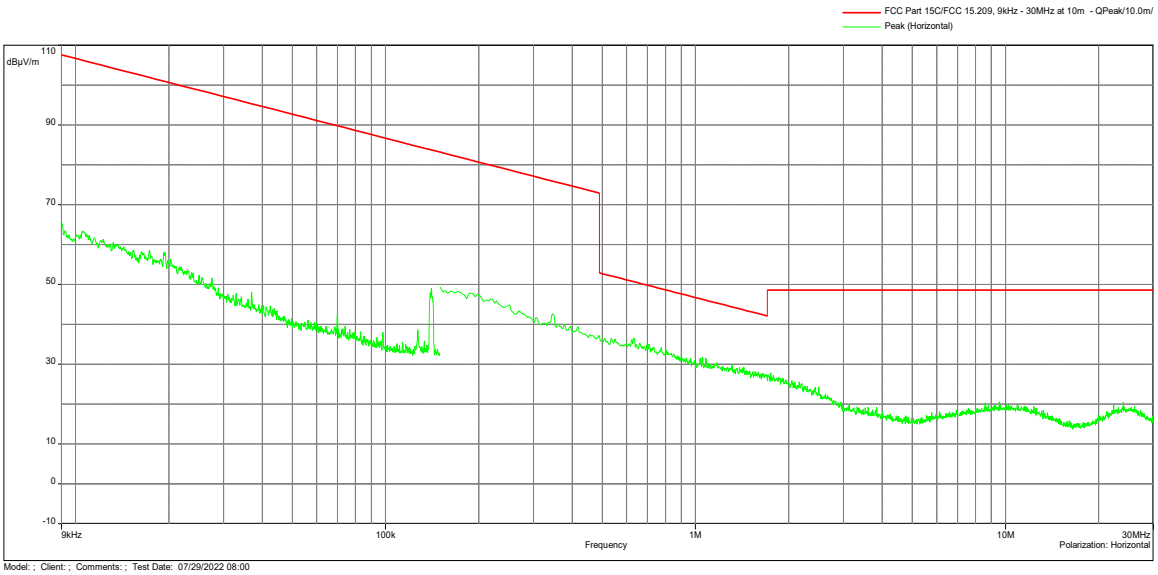
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



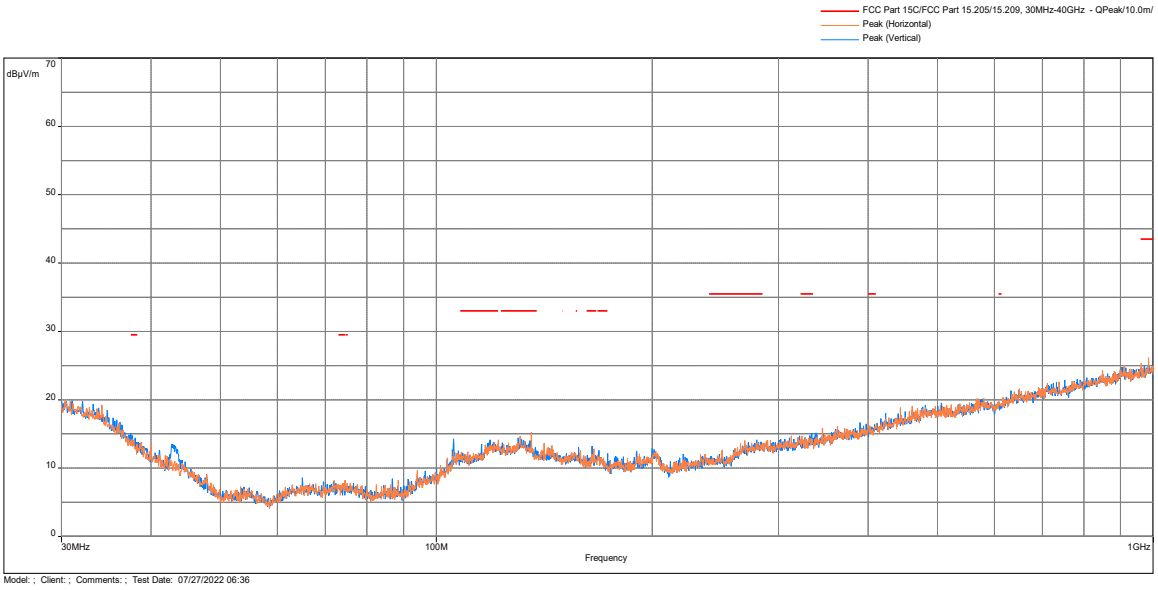
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



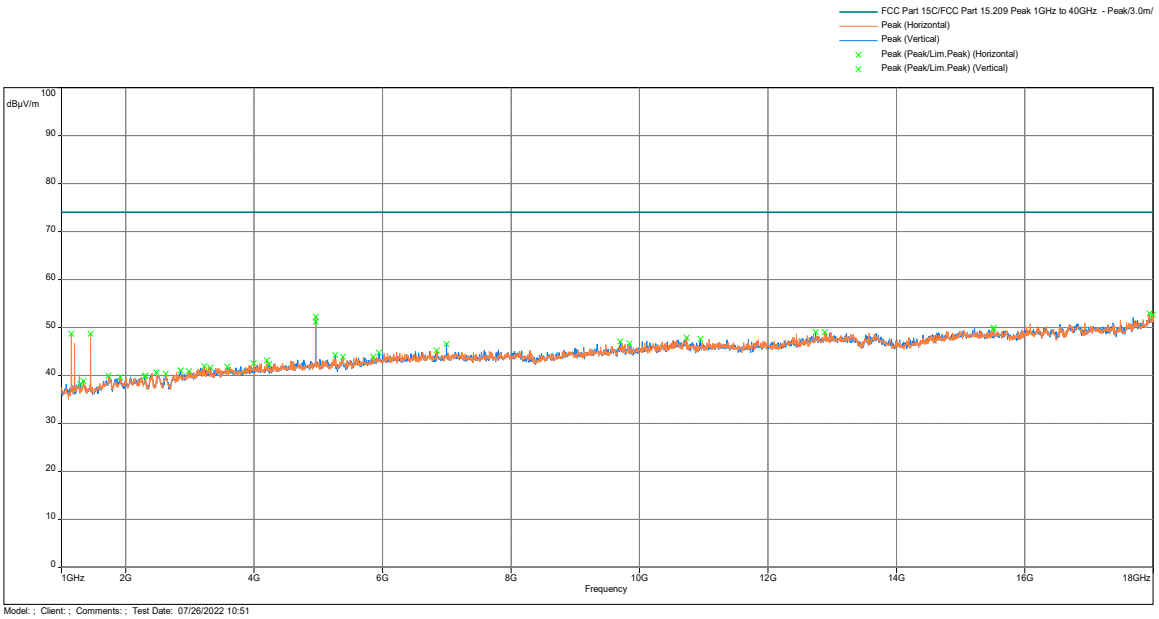
Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization



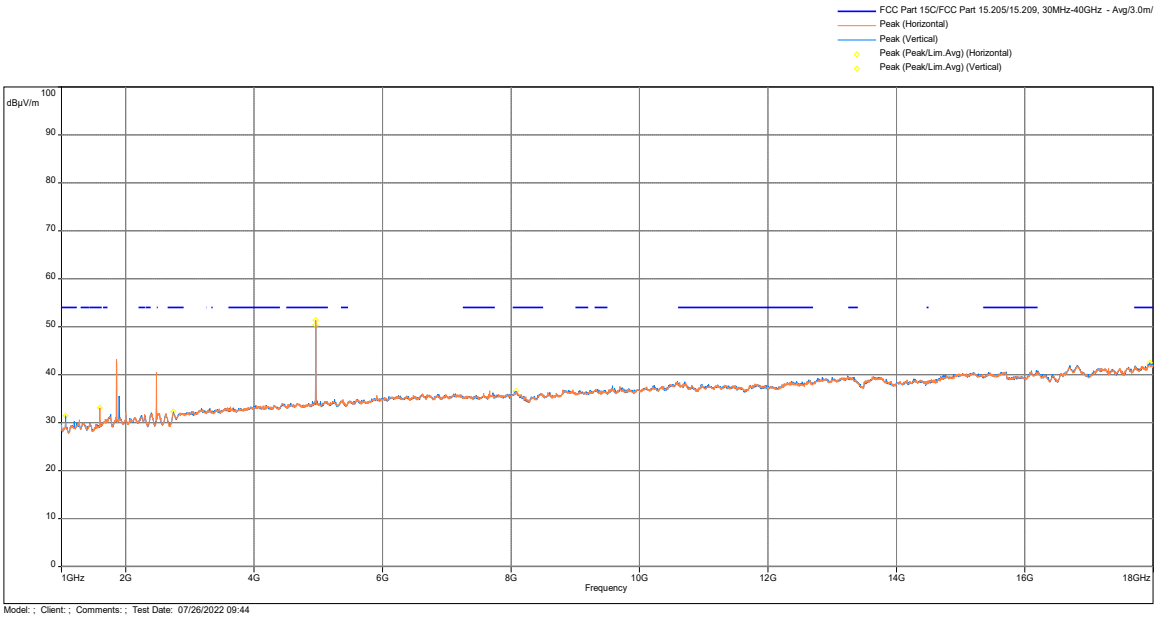
Radiated Spurious Emissions 30 MHz - 1000 MHz



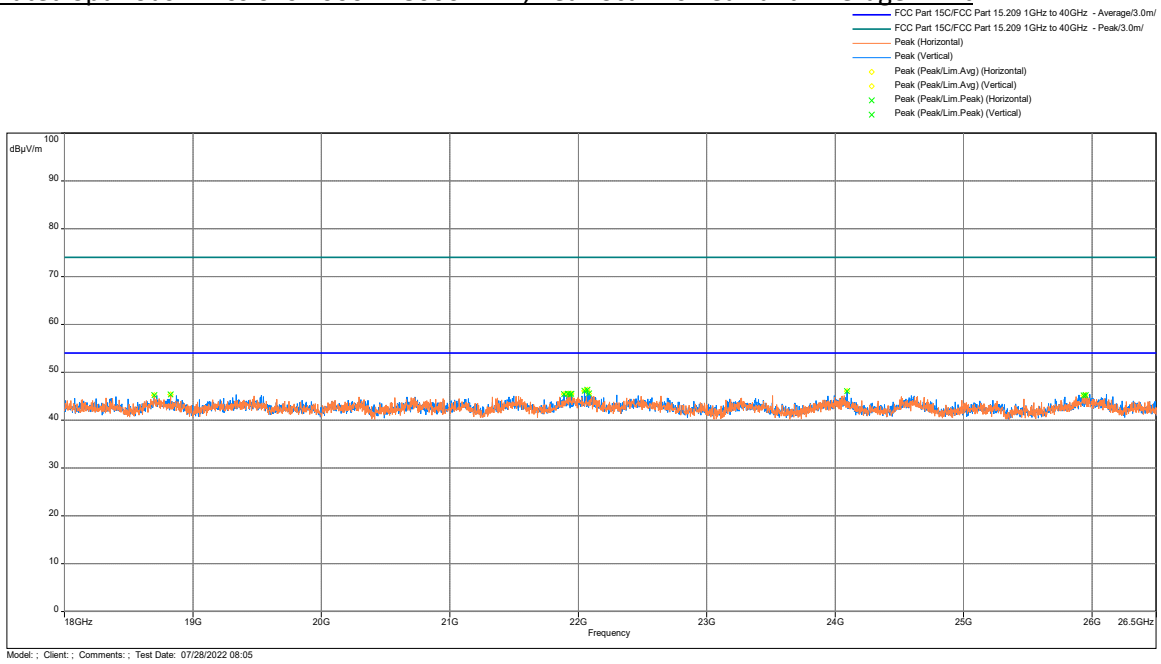
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



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



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



Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz

Frequency (MHz)	QPeak@ 10m (dBµV/m)	Lim. QPeak @10m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
984.64	26.15	43.5	-17.35	4	92.75	Horizontal	1.24
135.63	15.22	33	-17.78	2.98	93.25	Horizontal	-12.81
962.23	25.32	43.5	-18.18	0.98	282	Horizontal	0.53
130.88	14.67	33	-18.33	4	137.5	Horizontal	-12.45
400.35	17.04	35.5	-18.46	1.98	314.5	Horizontal	-9.82
998.45	25.03	43.5	-18.47	3	117.25	Vertical	1.69

Note: Correction = AF + CF – Preamp

Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4959.30	51.37	54	-2.63	1.01	114	Horizontal	-6.57
4959.87	50.42	54	-3.58	1.99	171	Vertical	-6.57
17946.73	42.51	54	-11.49	2.99	34.75	Vertical	8.99
17946.73	42.03	54	-11.97	3.99	35	Horizontal	8.99
8075.97	36.61	54	-17.39	2.99	204.5	Vertical	-3.33
1600.10	33.17	54	-20.83	2.01	332.25	Horizontal	-15.76

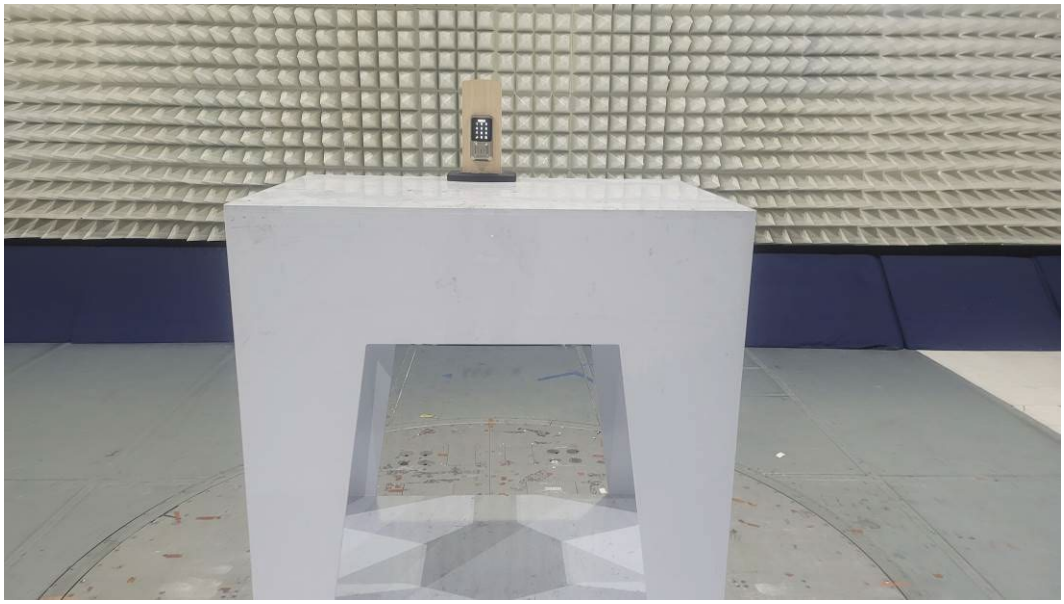
Note: Correction = AF + CF - Preamp

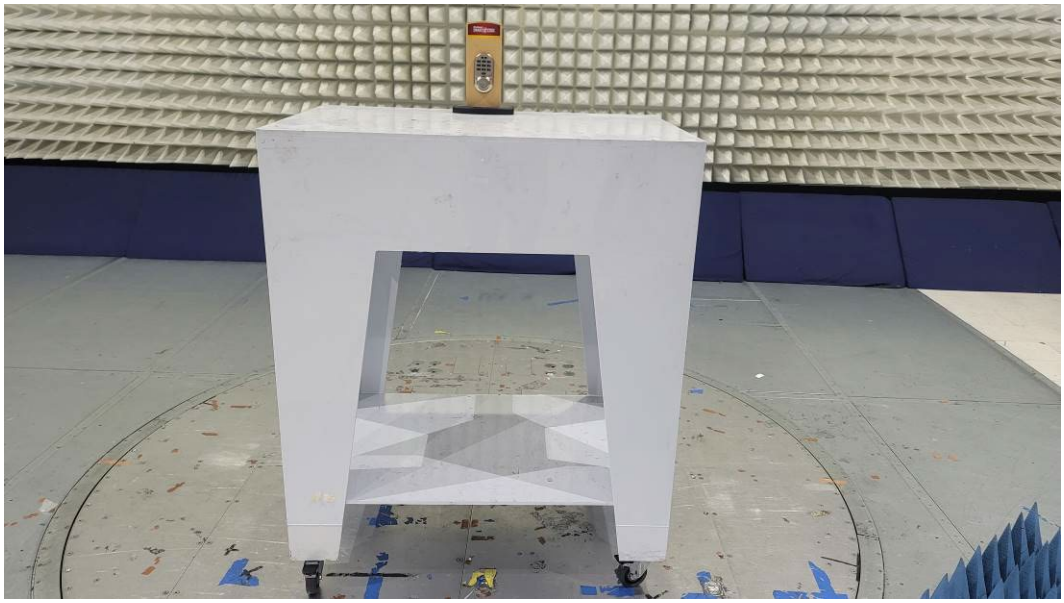
Results	**Complies** by 2.63

*Note: Measured result is below the specification limit by a margin less than the measurement uncertainty; it is not therefore possible to determine compliance at confidence level of 95%. However, the measured result indicates a higher probability that the product tested complies with the specification limit.

4.5.5 Test Setup Configuration

The following photographs show the testing configurations used.

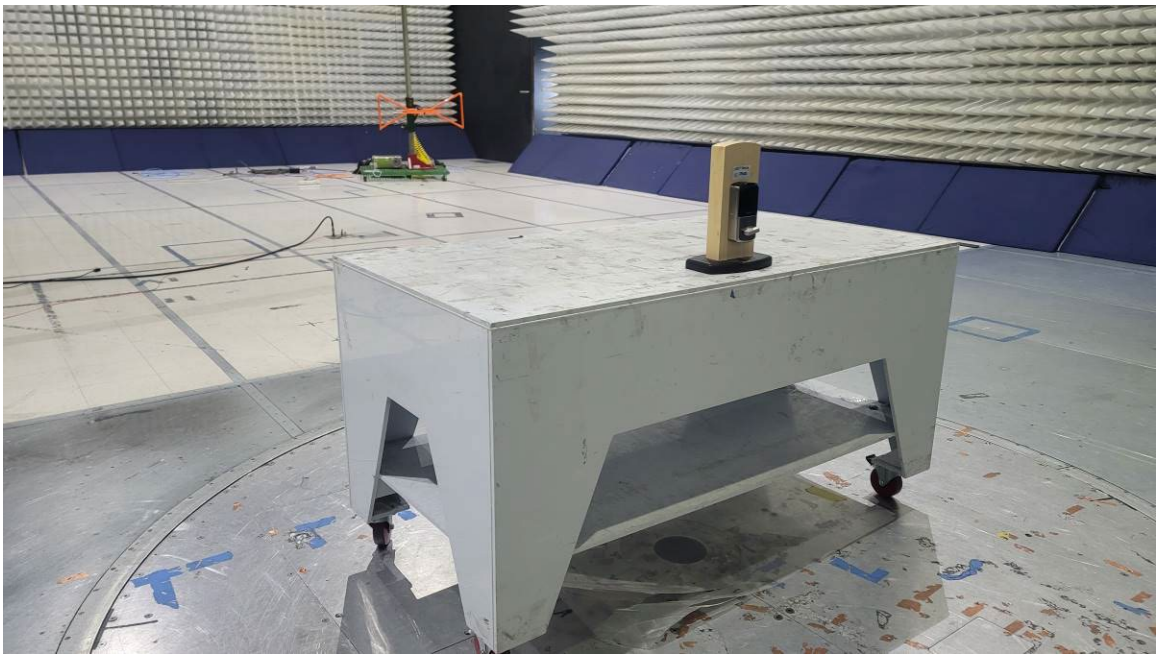


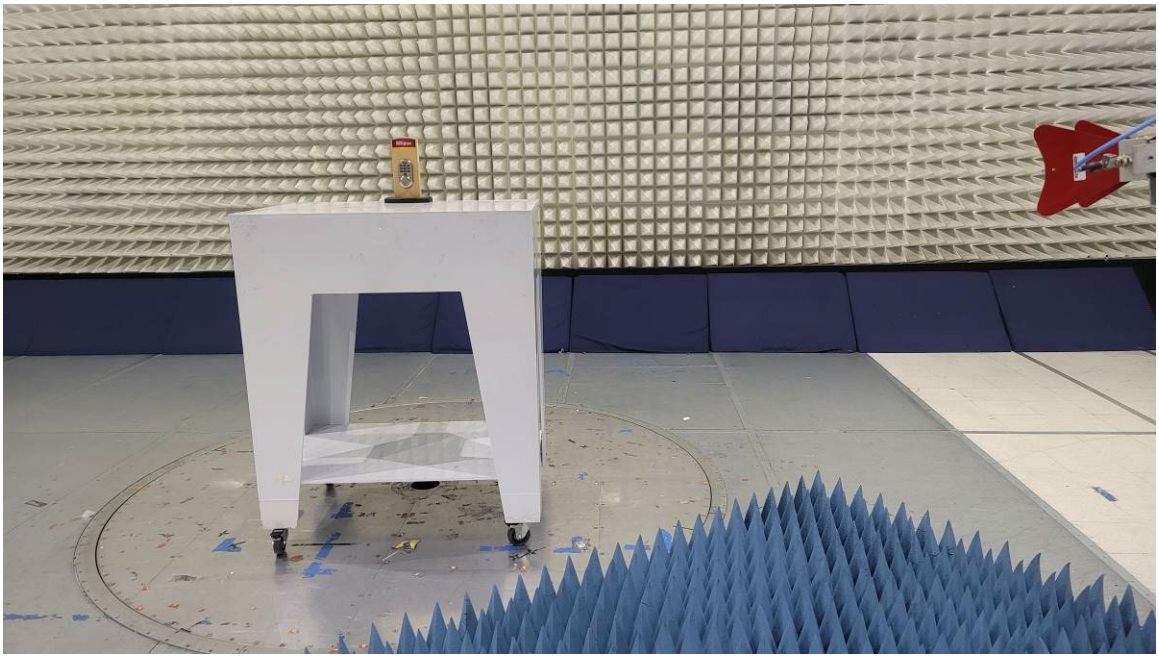


4.5.5 Test Setup Configuration (Continued)

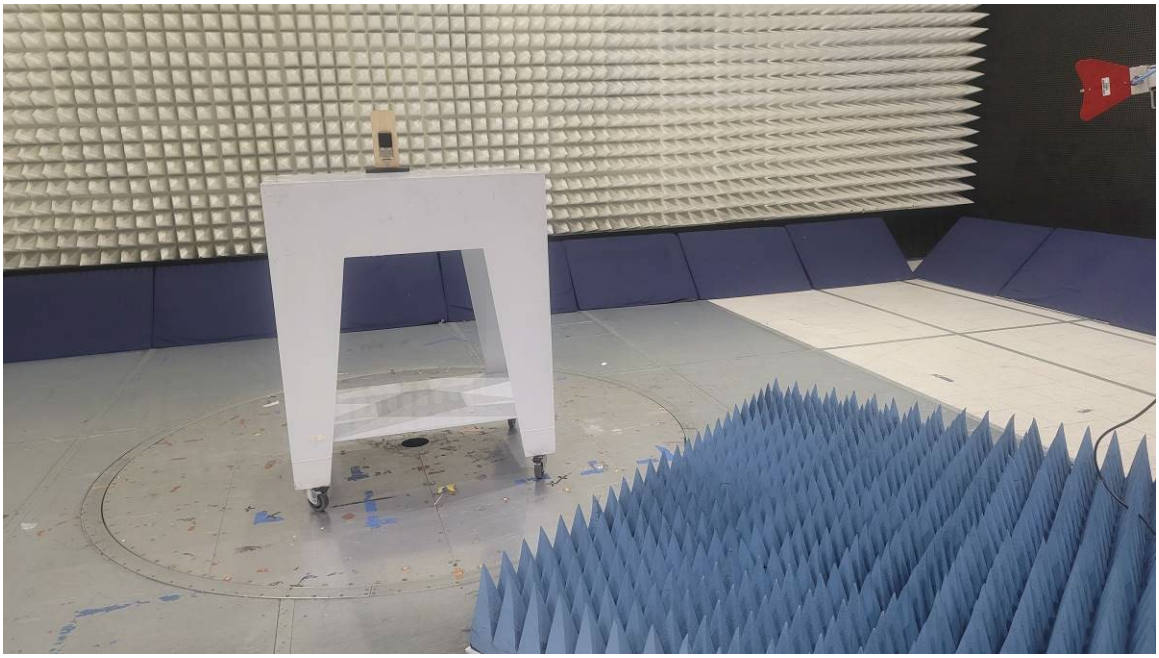
4.5.5 Test Setup Configuration (Continued)

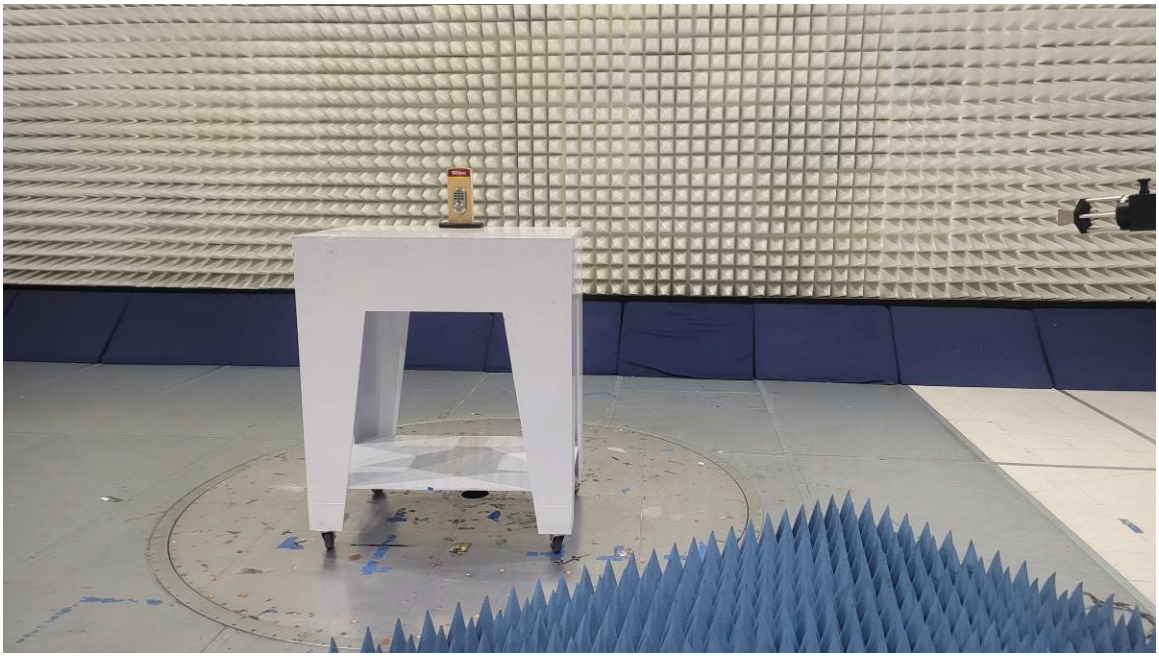
4.5.5 Test Setup Configuration (Continued)





4.5.5 Test Setup Configuration (Continued)





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

4.6.1 Requirement

Frequency Band MHz	Class B Limit dB(μV)		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 a 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 EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

AC mains conducted emissions measurements were performed according to the procedures in ANSI C63.10: 2013. EUT was placed in transmission mode then tested for conducted emissions per 15.207 to ensure the device complies with 15.207.

4.6.3 Test Result

Not applicable. The EUT is battery powered only.

5.0 List of Test Equipment

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

Equipment	Manufacturer	Model/Type	Asset #	Cal Int	Cal Due
EMI Test Receiver	Rohde & Schwarz	FSW43	ITS 01818	12	07/19/2023
EMI Test Receiver	Rohde & Schwarz	ESR7	ITS 01607	12	11/19/2022
9kHz-30MHz Loop Antenna (Passive)	ETS Lindgren	6512	ITS 01573	12	11/09/2022
30MHz-2GHz Bi-Log Antenna	SunAR RF Motion	JB1	ITS 01577	12	02/10/2023
1-18GHz Horn Antenna	ETS Lindgren	3117-PA	ITS 01325	12	10/26/2022
18 - 26.5GHz Horn Antenna	EMCO	3160-09	ITS 00571	12	#
18-40GHz Preamp	uComp Nordic	MCNS-50-18004000335P	ITS 01799	12	03/24/2023
NOTCH FILTER	MICRO-TRONICS	BRC50702	ITS 01166	12	06/24/2023
10kHz - 1GHz 15 meter RF Cable	TRU Corp.	TRU Core 300	01470	12	09/14/2022
10kHz - 1GHz 2 meter RF Cable	TRU Corp.	TRU Core 300	01467	12	09/14/2022
10kHz - 1GHz 3 meter RF Cable	TRU Corp.	TRU Core 300	01465	12	09/14/2022
10kHz-1GHz 6 meter RF Cable	TRU Corp.	TRU Core 300	01333	12	05/16/2023
1-40GHz RF Cable (SMA type)	MEGAPHASE	EMC1-K1K1-20	01889	12	03/11/2023
1-40GHz RF Cable (Type SMA)	MEGA PHASE	EMC1-K1K1-236	01849	12	10/25/2022
10kHz-40GHz RF Cable	Mega PHASE	EMC1-K1K1-236	01781	12	02/25/2023
10kHz - 1GHz 2 meter RF Cable	TRU Corp.	TRU Core 300	01466	12	09/14/2022
10m Semi-Anechoic Chamber	Panashield	10m Chamber	ITS 00984	36	07/29/2023

No Calibration required

Software used for emission compliance testing utilized the following:

Name	Manufacturer	Version	Template/Profile
BAT-EMC	Nexio	3.20.0.23	10m Template
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 / G105108581	AK	AS	August 17, 2022	Original document

END OF REPORT