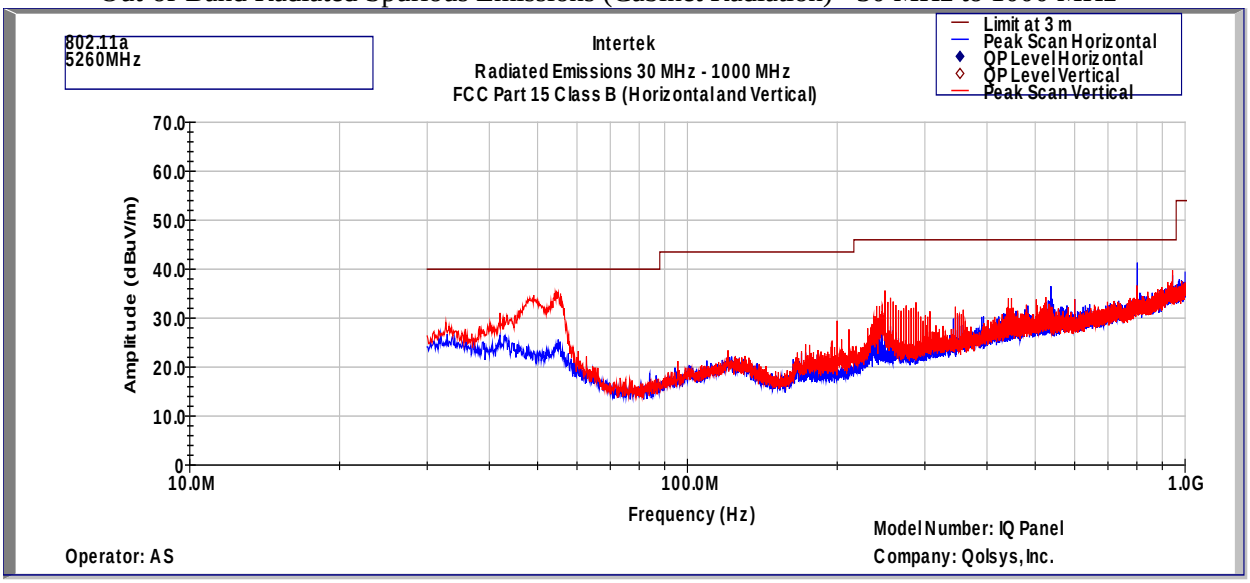
Out-of-Band Radiated Spurious Emissions (Cabinet Radiation)

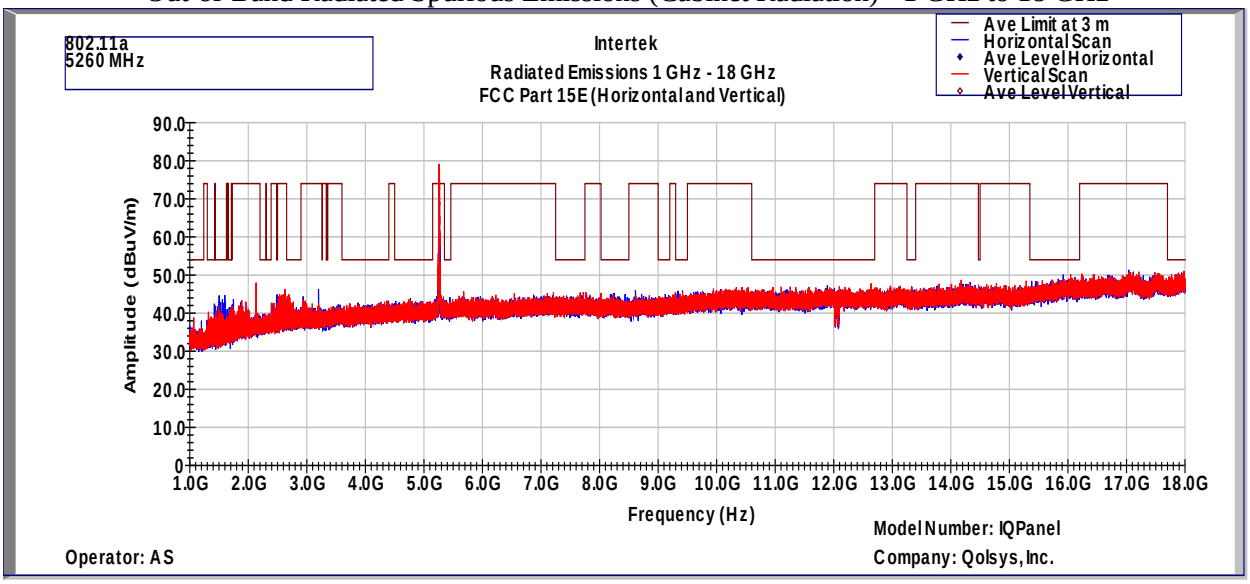
Test Date:	February 24 - 26, 2016

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11a 5180MHz

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 30 MHz to 1000 MHz



Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz



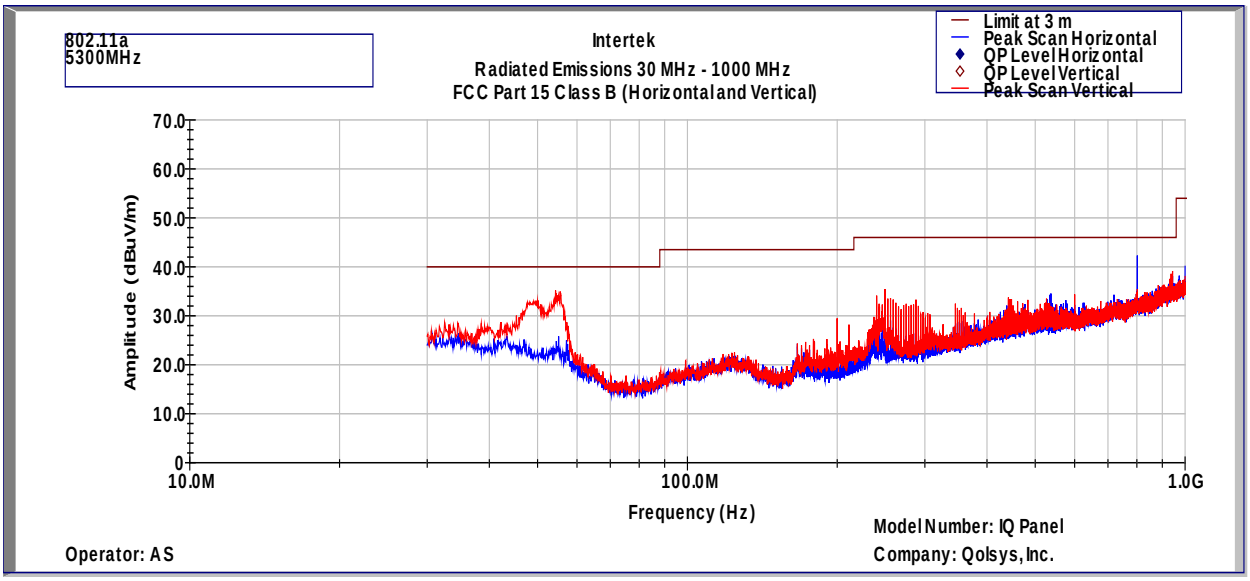
Note: Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

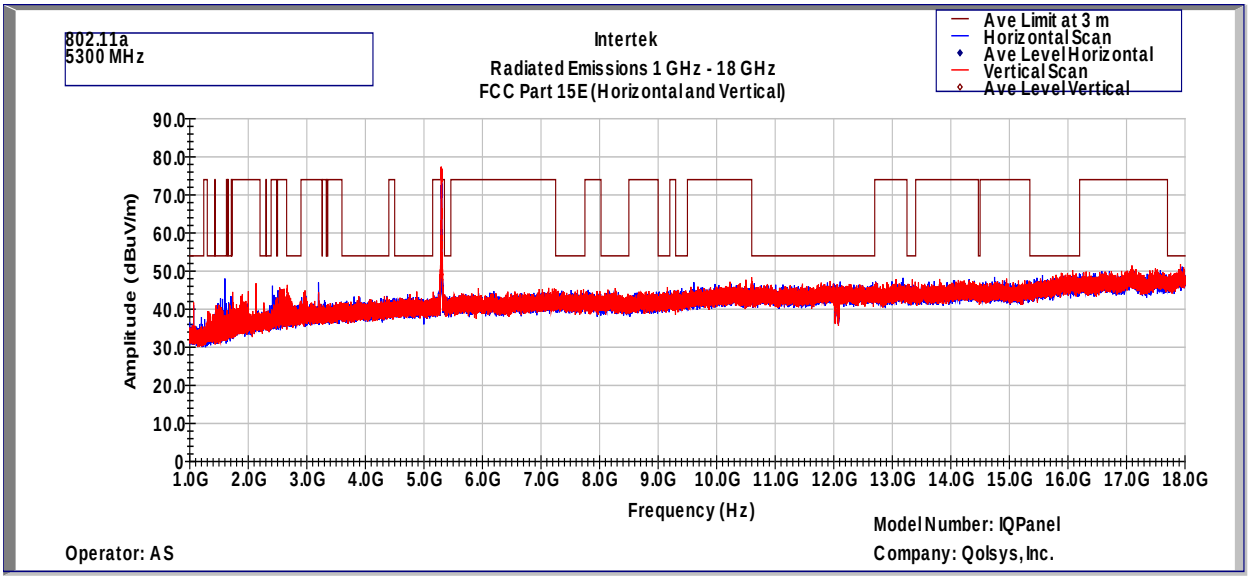
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 802.11a 5300MHz

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 30 MHz to 1000 MHz



Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz



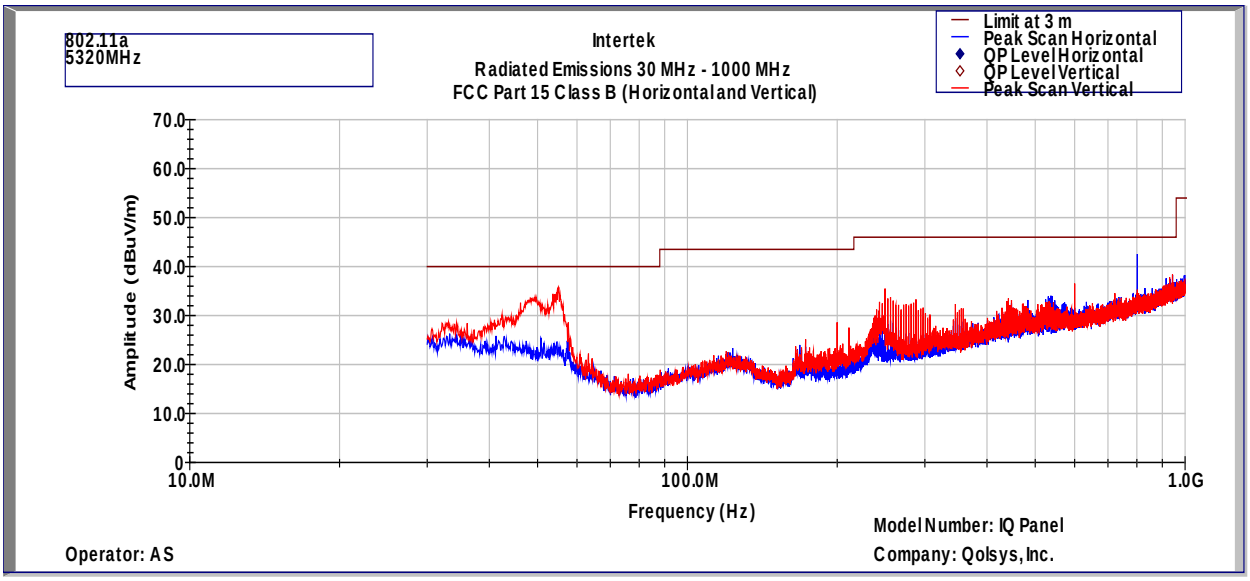
Note: Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

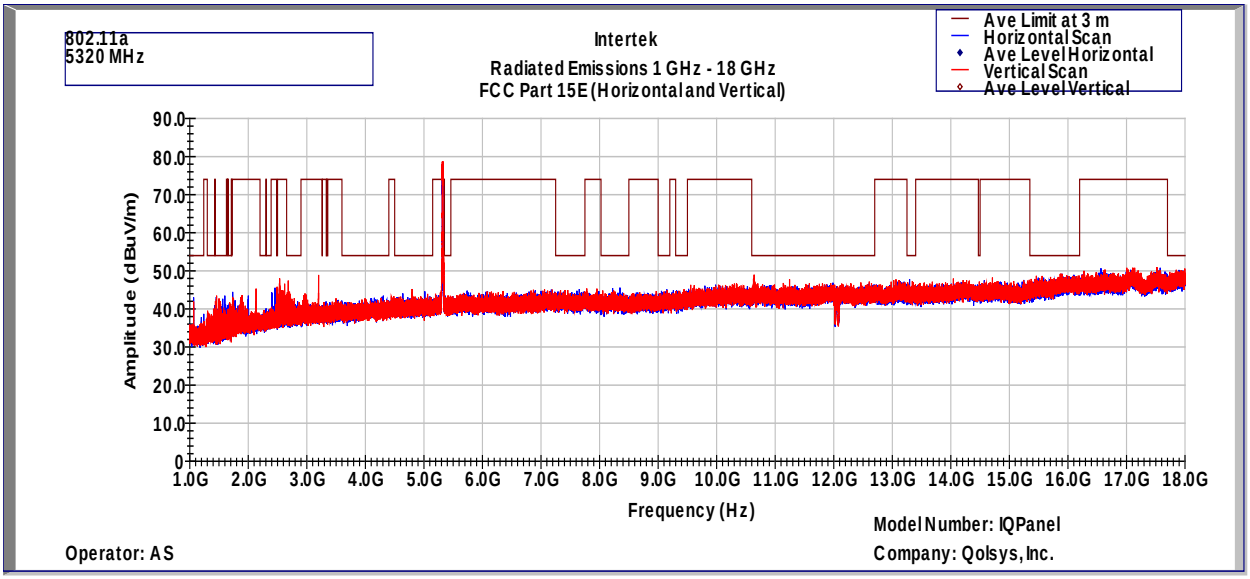
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 802.11a 5320MHz

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 30 MHz to 1000 MHz



Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz



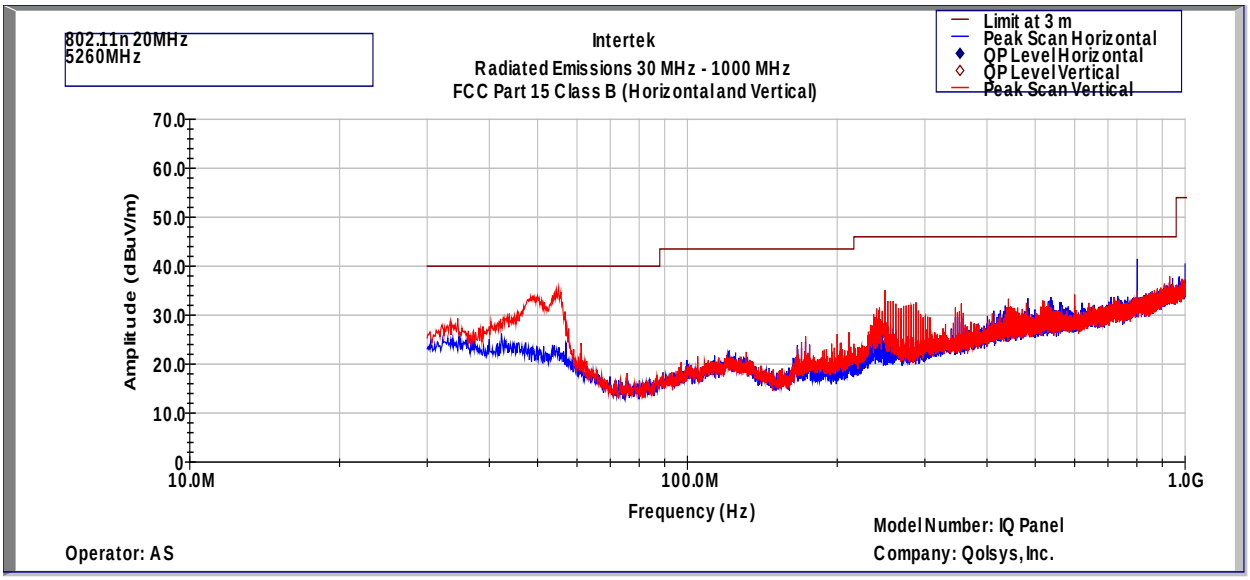
Note: Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

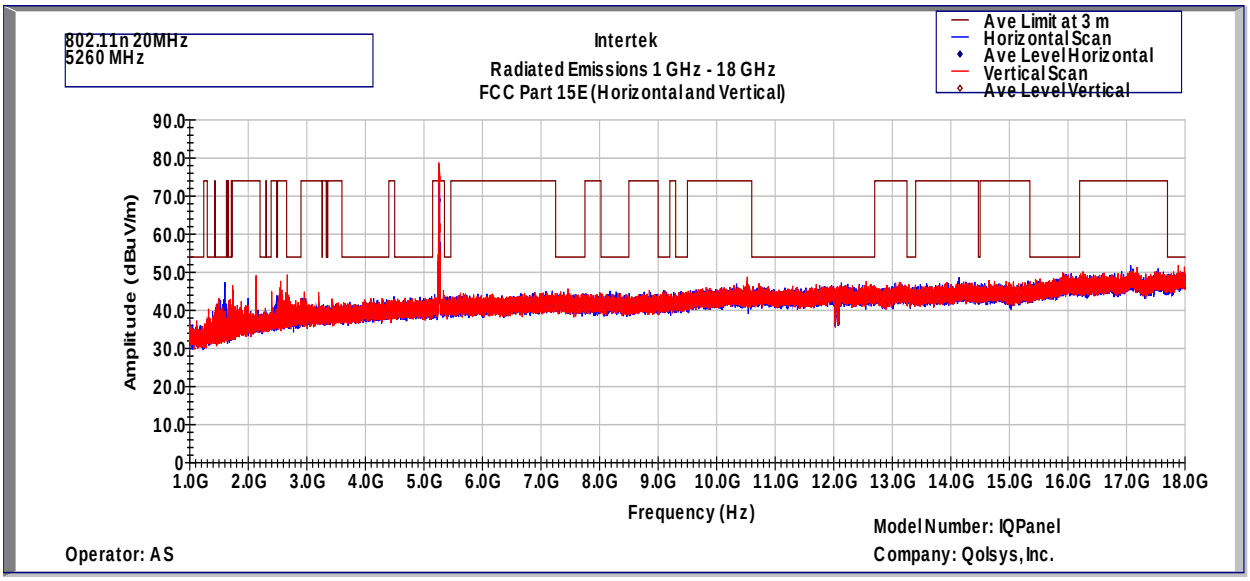
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz 5260MHz

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 30 MHz to 1000 MHz



Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz



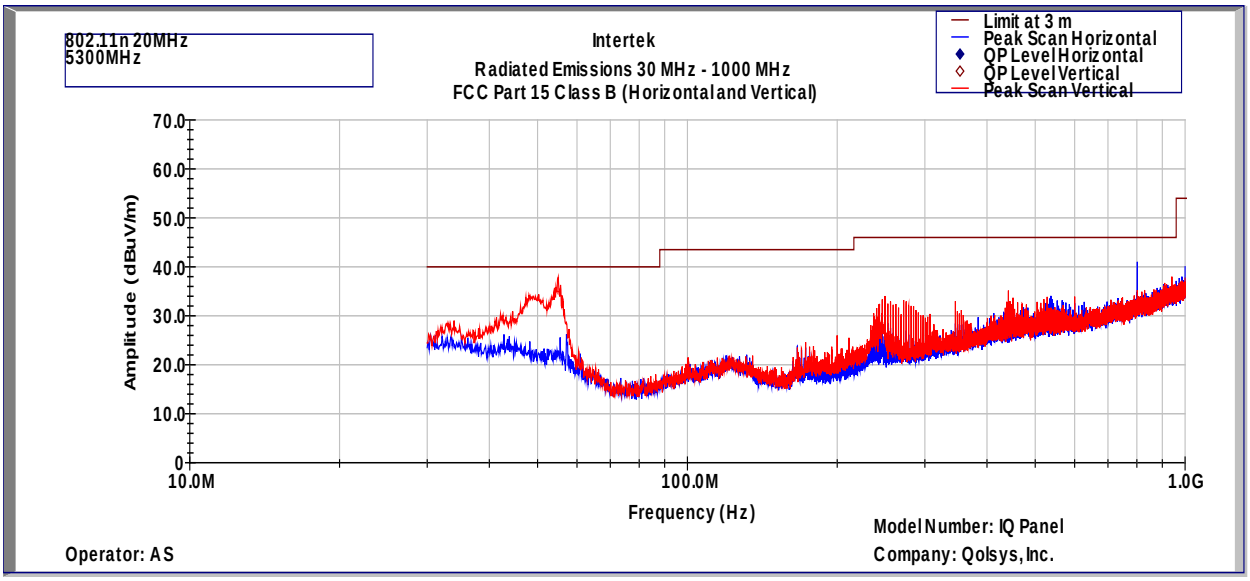
Note: Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

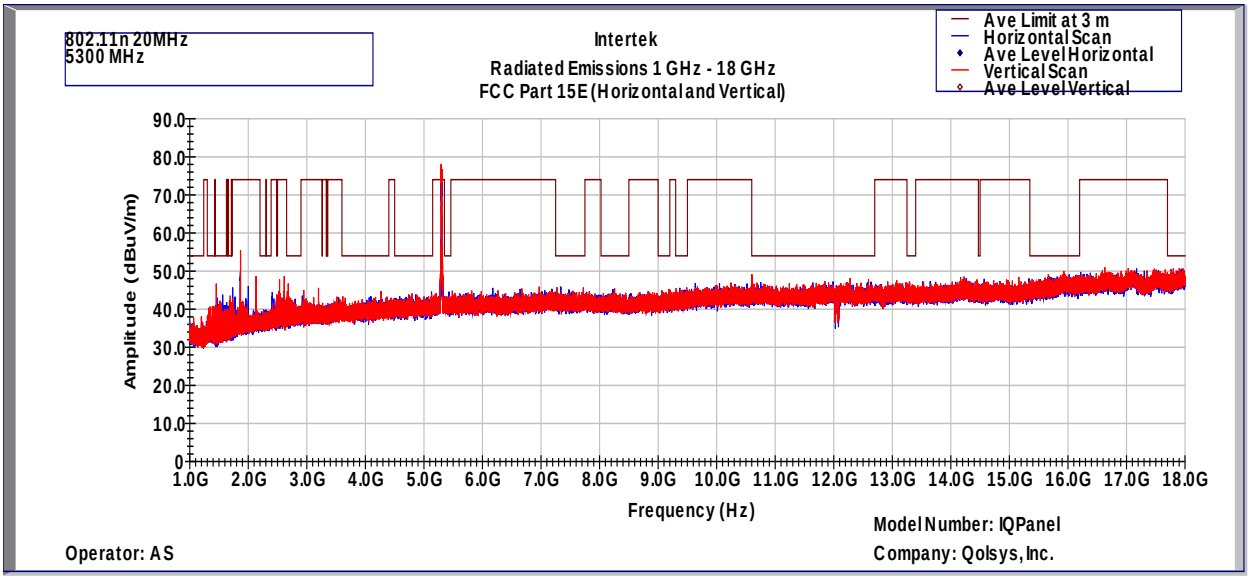
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 802.11n 20MHz 5300MHz

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 30 MHz to 1000 MHz



Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz



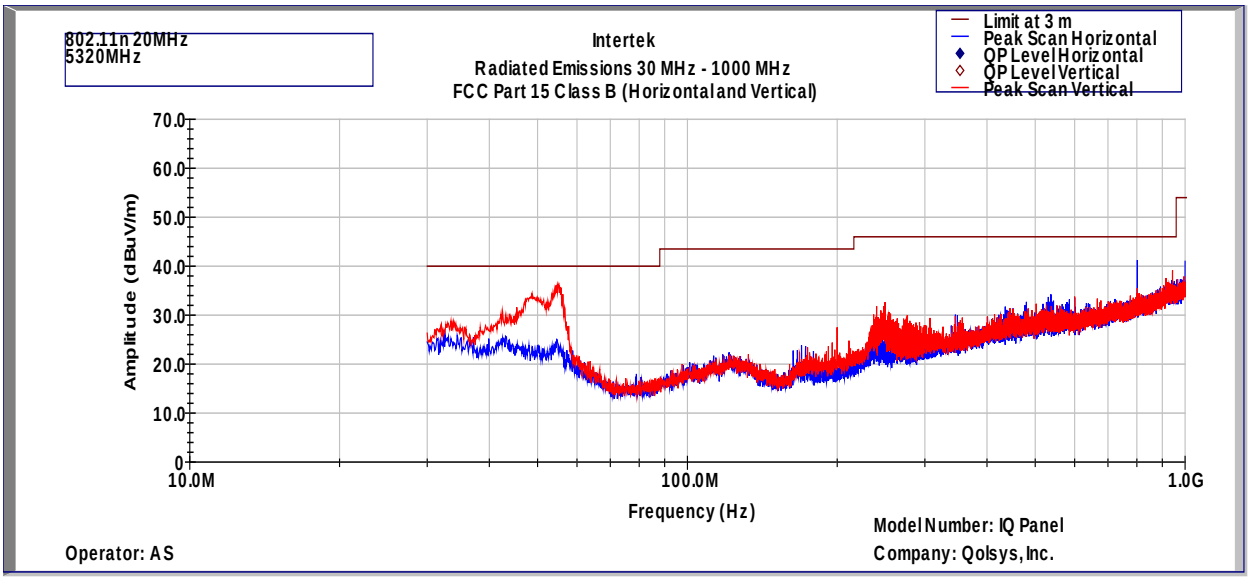
Note: Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

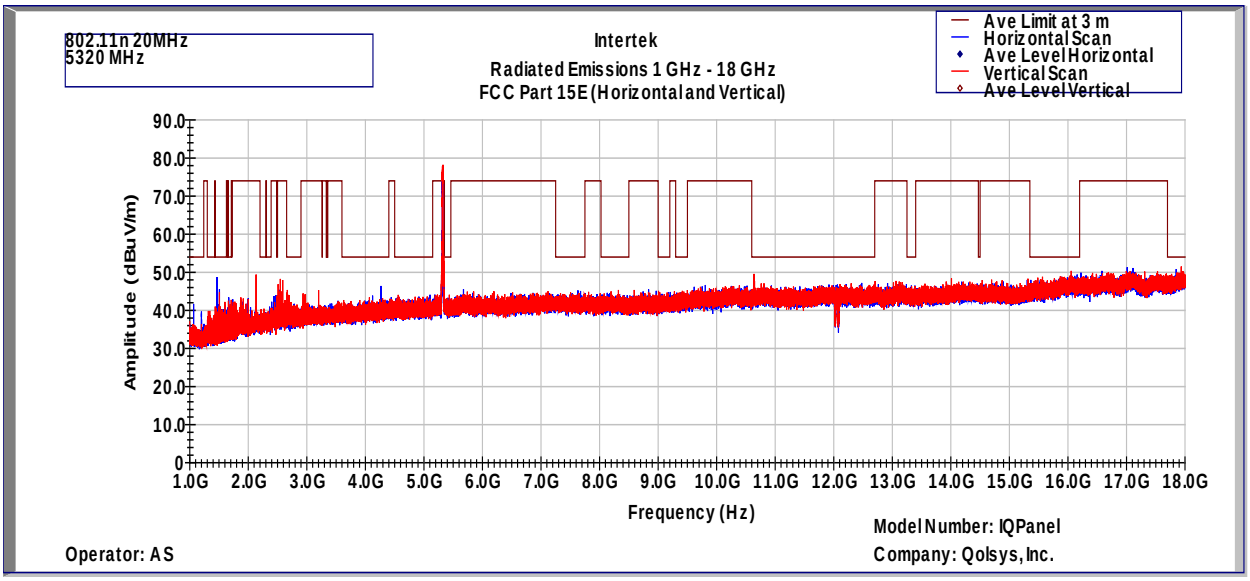
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 802.11n 20MHz 5320MHz

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 30 MHz to 1000 MHz



Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz



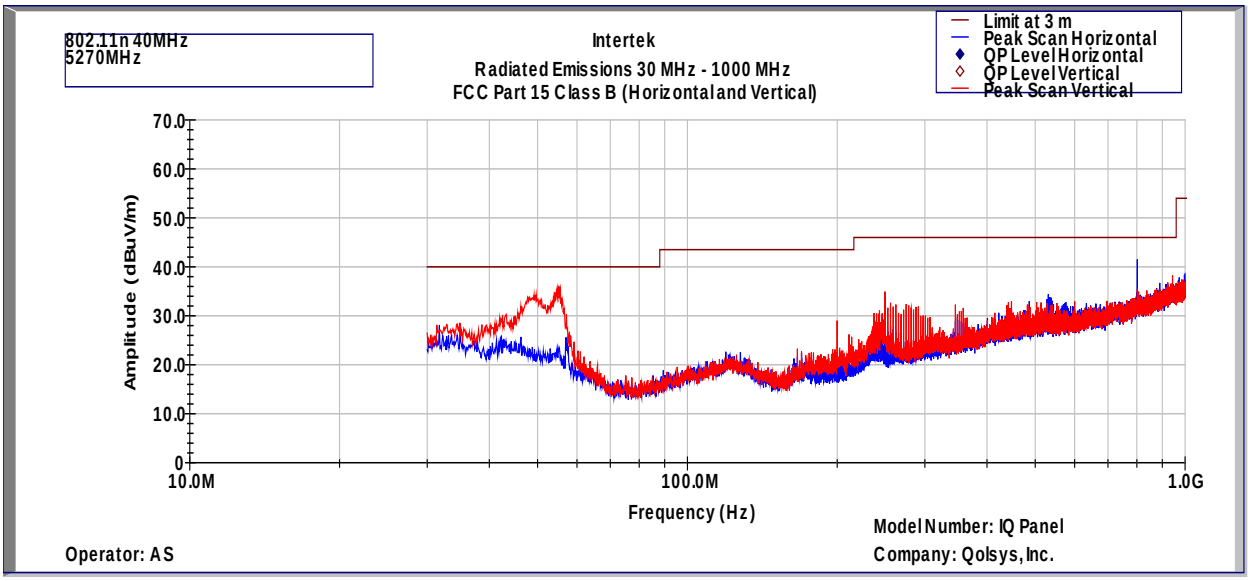
Note: Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

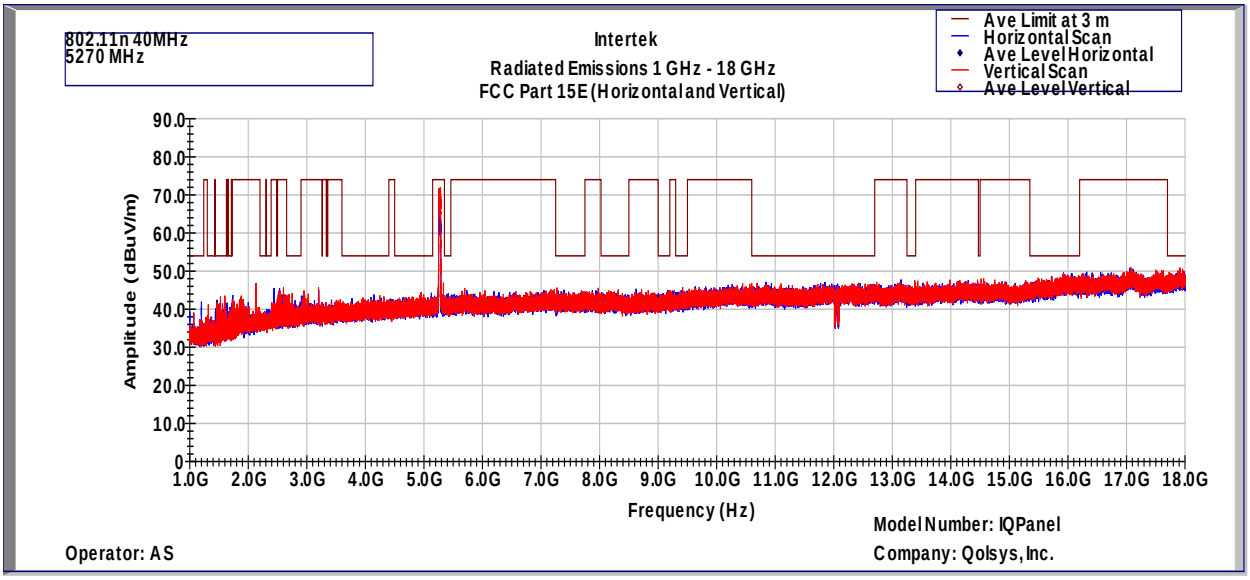
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 40MHz 5270MHz

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 30 MHz to 1000 MHz



Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz



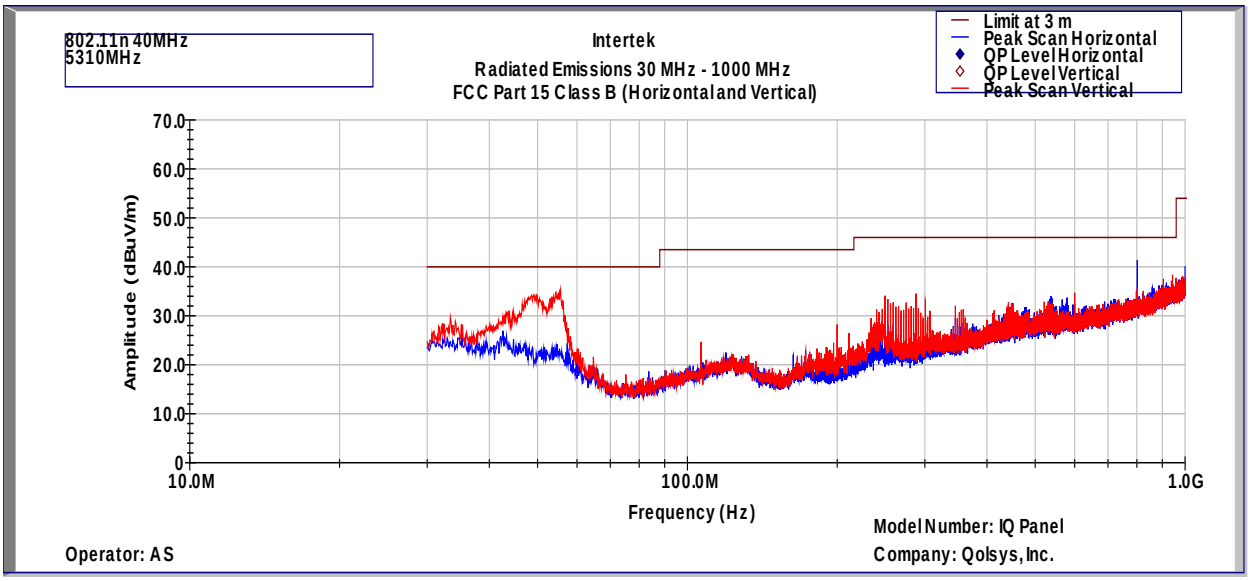
Note: Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

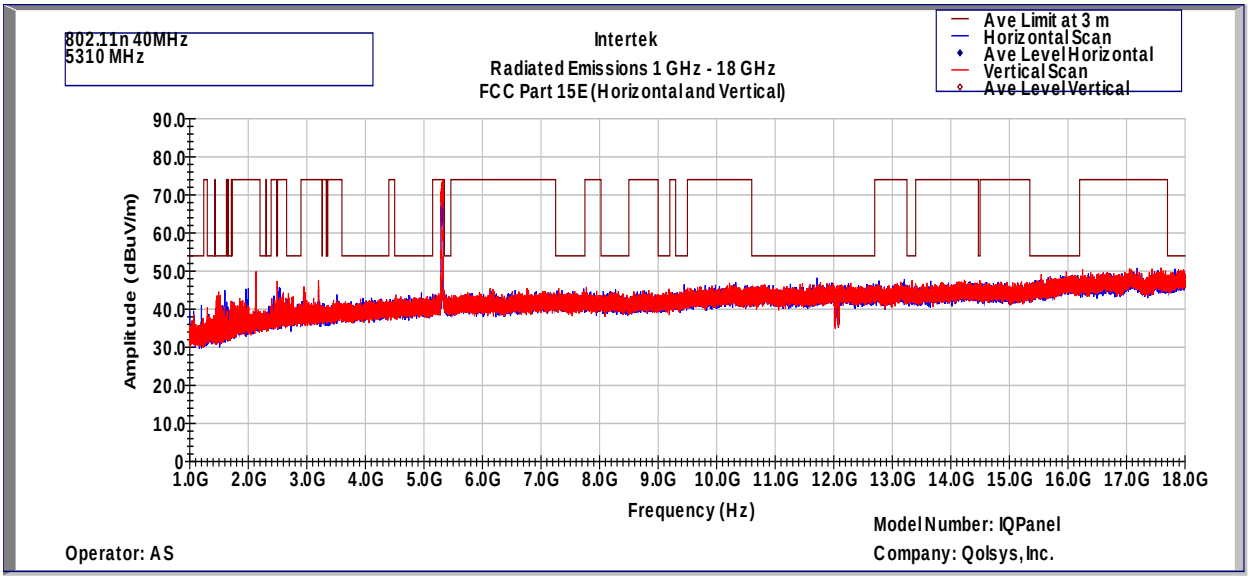
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 802.11n 40MHz 5310MHz

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 30 MHz to 1000 MHz



Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz



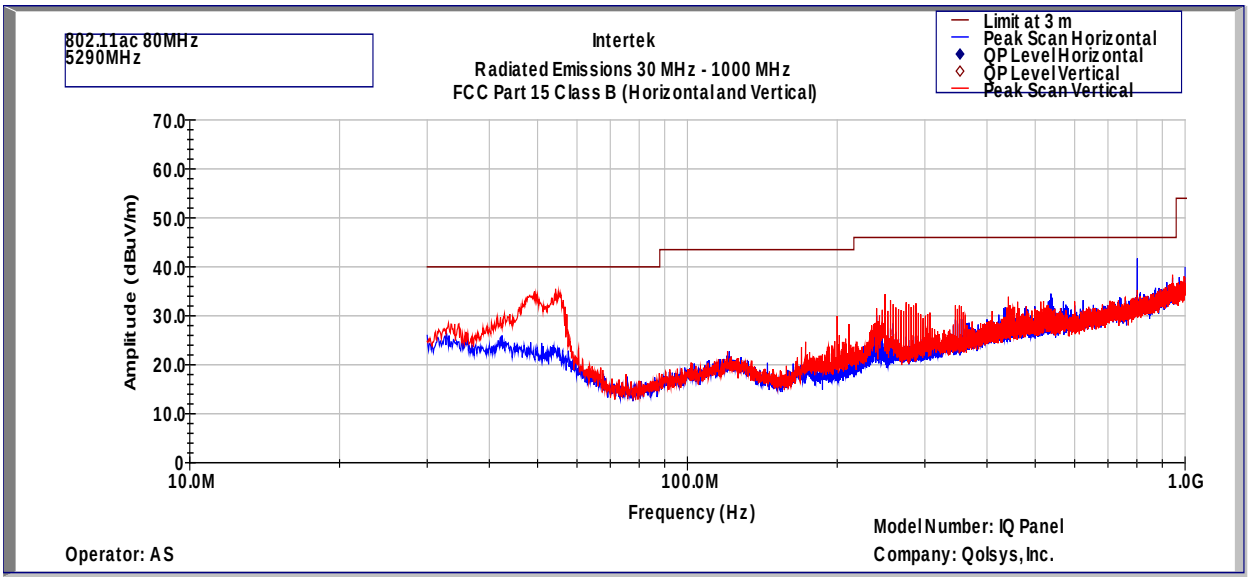
Note: Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

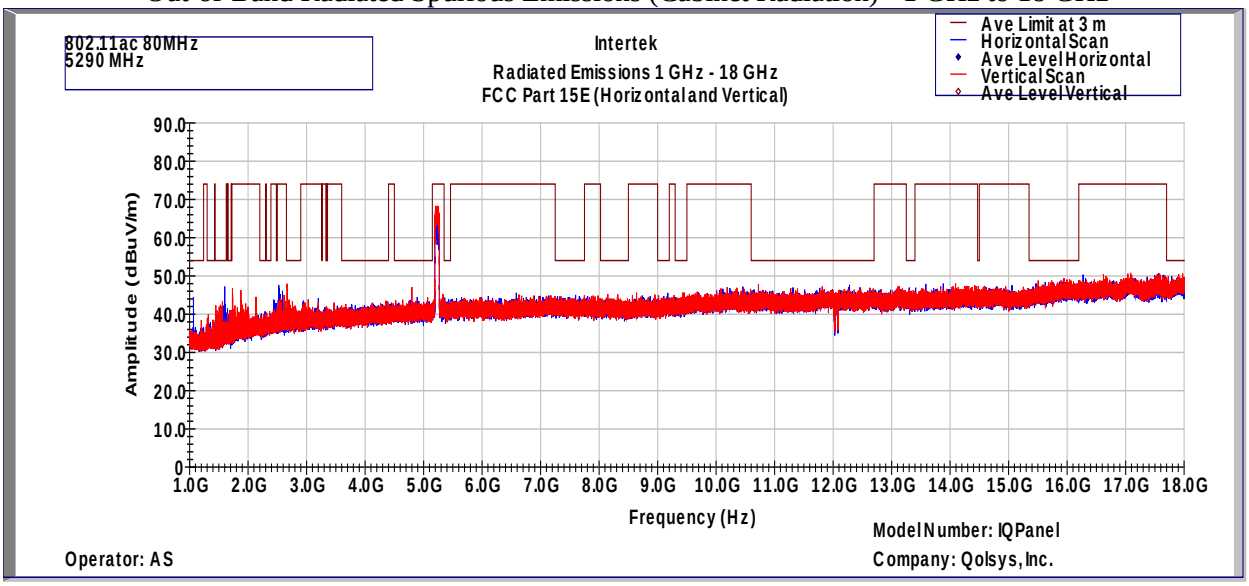
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions, Tx at 802.11ac 80MHz 5290MHz

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 30 MHz to 1000 MHz



Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz

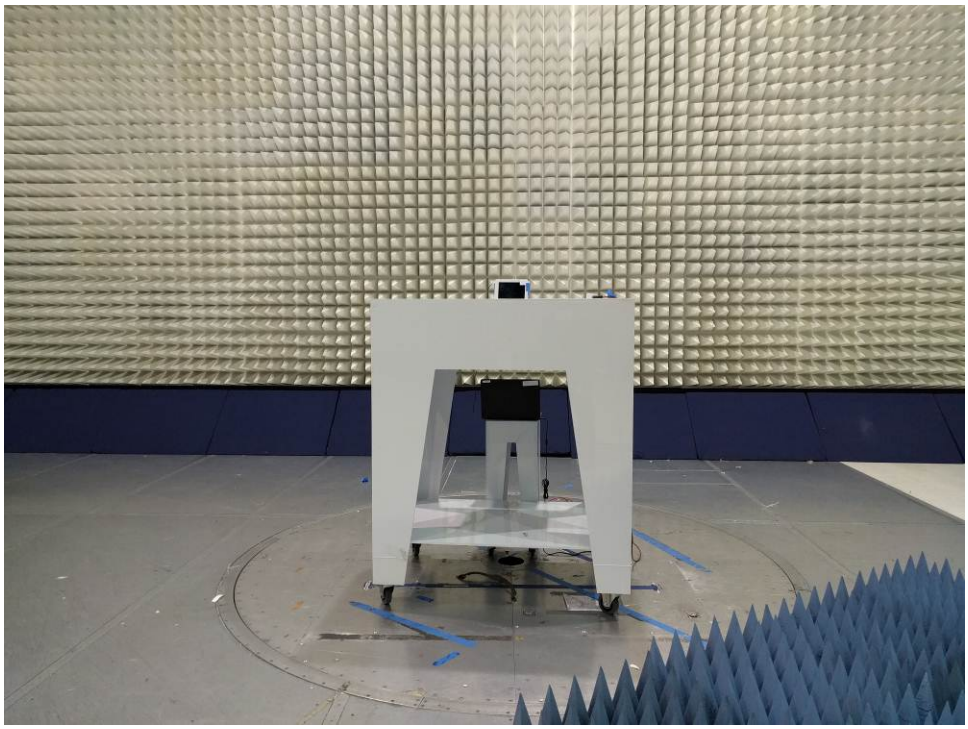


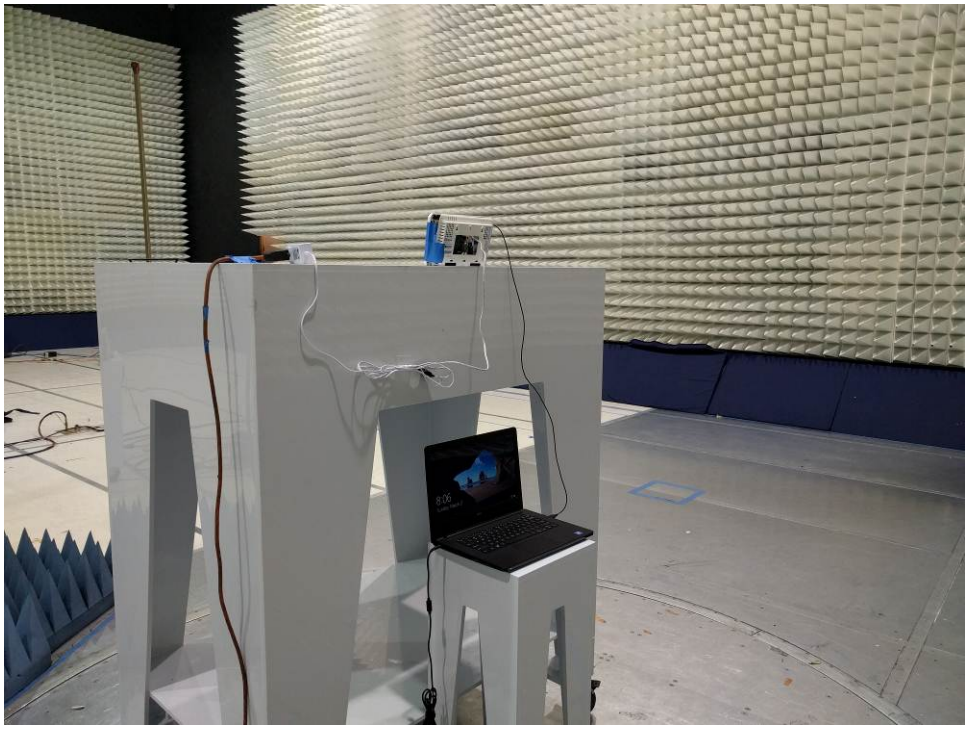
Note: Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz
Note: FS@3m = RA + AF + CF - Preamp, (Peak)
Corrected Peak Scans are under the Average Limit of 54.

4.5.8 Test setup photographs

The following photographs show the testing configurations used.

4.5.8 Test Setup Photographs





4.6 Dynamic Frequency Selection (DFS)

4.6.1 Requirement

Applicability of DFS Requirements Prior to Use of a Channel

Requirement	Operational Mode		
	Master	**Client Without Radar Detection**	**Client With Radar Detection**
Non-Occupancy Period	Yes	Not Required	Yes
DFS Detection Threshold	Yes	Not Required	Yes
Channel Availability Check Time	Yes	Not Required	Not Required
U-NII Detection Bandwidth	Yes	Not Required	Yes

Applicability of DFS requirements during normal operation

Requirement	Operational Mode	
	Master Device or Client with Radar Detection	**Client With Radar Detection**
DFS Detection Threshold	Yes	Not Required
Channel Closing Transmission Time	Yes	Yes
Channel Move Time	Yes	Yes
U-NII Detection Bandwidth	Yes	Not Required

Additional requirements for devices with multiple bandwidth modes	**Master Device or Client with Radar Detection**	**Client Without Radar Detection**
U-NII Detection Bandwidth and Statistical Performance Check	All BW modes must be tested	Not required
Channel Move Time and Channel Closing Transmission Time	Test using widest BW mode available	Test using the widest BW mode available for the link
All other tests	Any single BW mode	Not required
Note: Frequencies selected for statistical performance check should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in each of the bonded 20 MHz channels and the channel center frequency.		

4.6.1.1 DFS Detection Thresholds for Master or Client Devices with DFS Detection

Maximum Transmit Power	Values (See Notes 1, 2, and 3)
EIRP ≥ 200 milliwatt	-64 dBm
EIRP < 200 milliwatt and power spectral density < 10 dBm/MHz	-62 dBm
EIRP < 200 milliwatt that do not meet the power spectral density requirement	-64 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna. **Note 2:** Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response. **Note3:** EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01	

Parameter	Value
Non-Occupancy Period	Minimum 30 minutes
Channel Availability Check Time	60 Seconds
Channel Move Time	10 seconds (see note 1)
Channel Closing Transmission Time	200 ms + an aggregate of 60 ms over remaining 10 Second period. (see note 1 and 2)
U-NII Detection Bandwidth	Minimum 100% of the U-NII 99% transmission power bandwidth. (see note 3)
Note 1: *Channel Move Time* and the *Channel Closing Transmission Time* should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst. **Note 2:** The *Channel Closing Transmission Time* is comprised of 200 milliseconds starting at the beginning of the *Channel Move Time* plus any additional intermittent control signals required to facilitate a *Channel* move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions. **Note 3:** During the *U-NII Detection Bandwidth* detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.	

4.6.1.2 Test Waveform

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	See Note 1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a	$\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^6}{\text{PRI}_{\mu\text{sec}}}\right)\right\}$	60.00%	30
		Test B: 15 unique PRI values randomly selected within the range of 518-3066 µsec, with a minimum increment of 1 µsec, excluding PRI values selected in Test A			
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120
Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.					

Radar Type	Pulse Width (µsec)	Chrip Width (MHz)	PRI (µsec)	Number of Pulses per Burst	Number of Burst	Minimum Percentage of Successful Detection	Minimum Number of Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

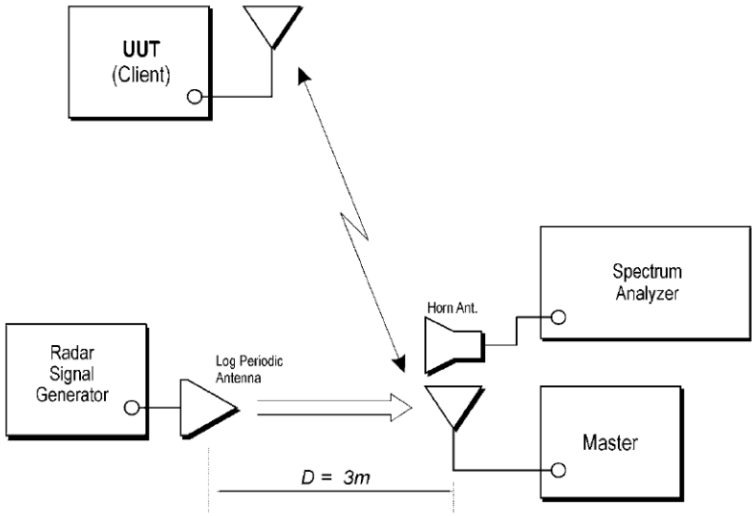
Radar Type	Pulse Width (µsec)	PRI (µsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

4.6.2 Procedure

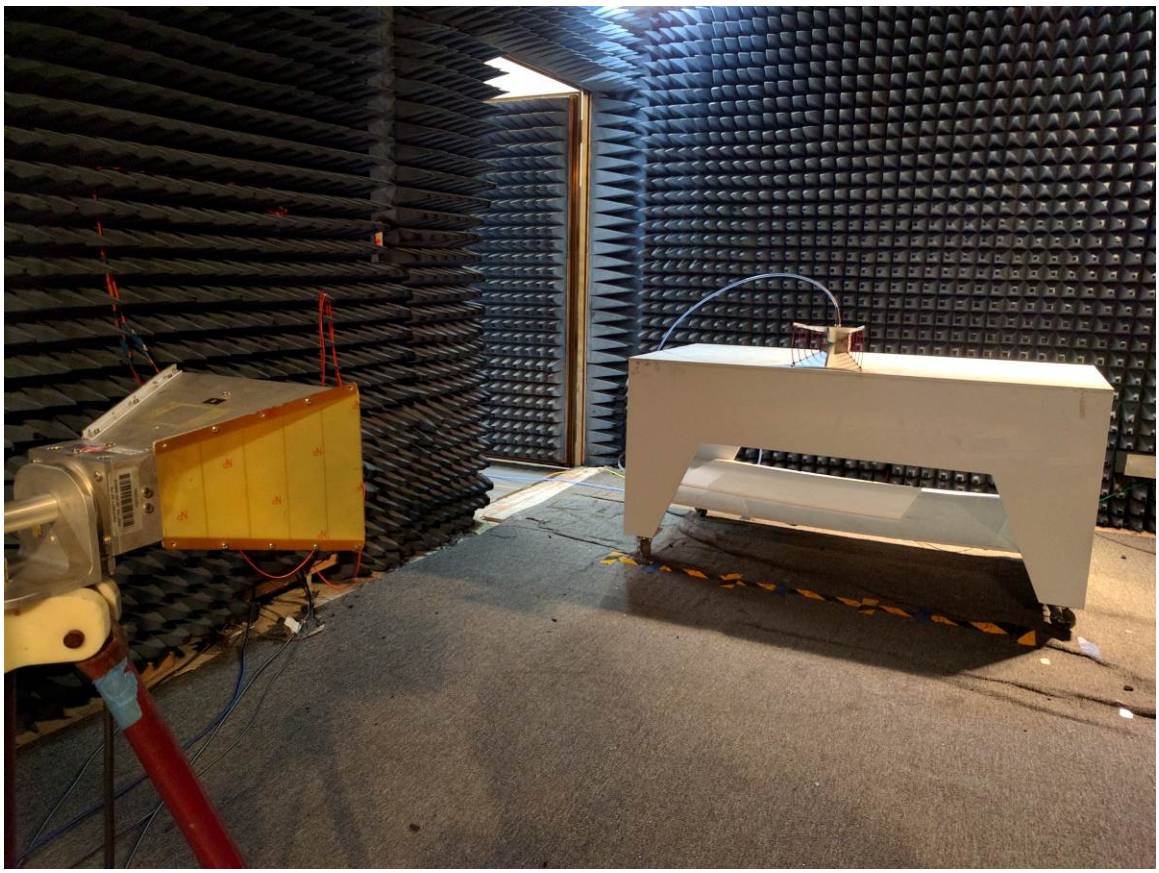
DFS Waveform Calibration

Calibration Procedure

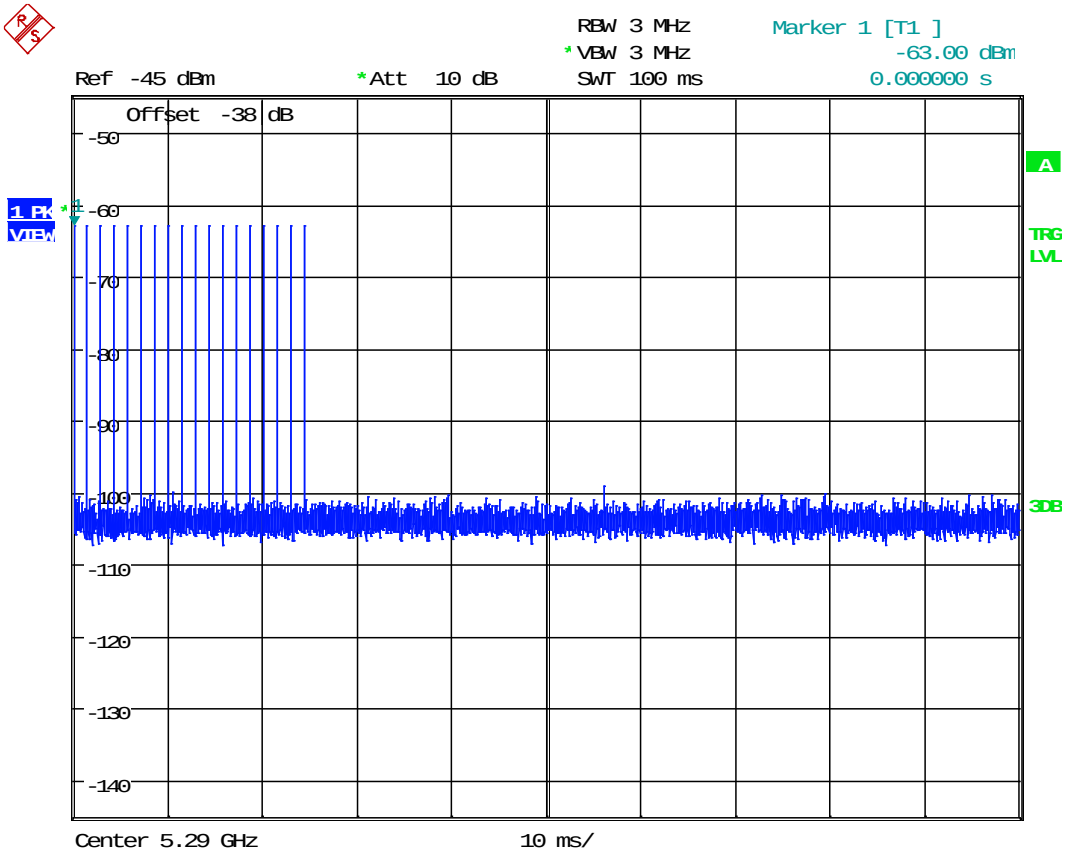
For the DFS signal, horn antenna was attached to a signal generator (RS SMU700A). On the Receive side another horn antenna was attached to a spectrum analyzer with a preamp inline. The spectrum analyzer's resolution bandwidth was set to 3 MHz and the video bandwidth was set to 3 MHz with peak detection. The field was corrected to account for cable loss, antenna gain and preamp. The DFS signal was calibrated to a field strength of -63 dBm. Test wave form 0 was utilized. The calibration setup is diagrammed below along with a setup picture.



Tested By:	Anderson Soungpanya
Test Date:	March 07, 2016



Radar Type 0 Calibration 5290MHz



The Spectrum Analyzer Reference Level Offset is System Gain + Antenna Gain

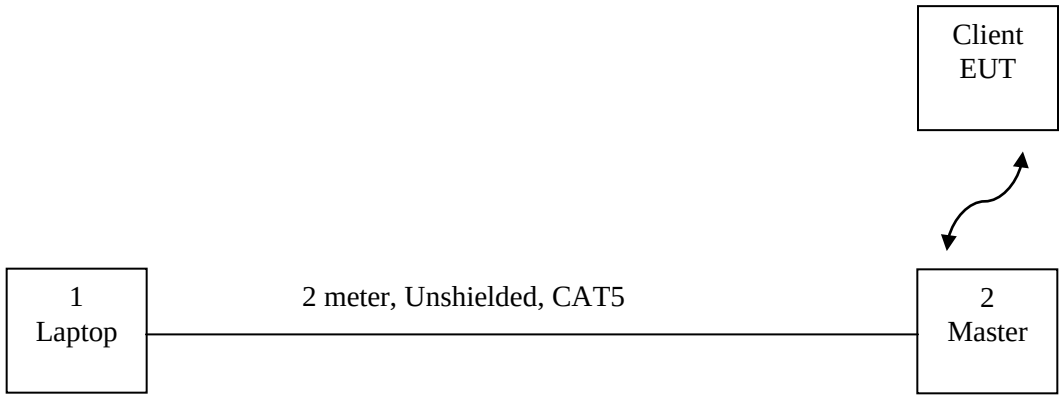
Frequency	Antenna Gain	System Gain (Preamp & Cable Loss)	Reference Offset
MHz	dBi	dB	dB
5290	10.5	27.5	-38.0

DFS Setup & Procedure

Test Procedure

A radiated test method was used and the test setup was made as depicted in the diagram below. DFS testing was setup as a client with injection into the master.

The diagram below depicts the setup of the EUT along with associated support equipment.



Item	Description	Model	Serial
1	HP Laptop	EliteBook 8460p	CNU14429SL
2	Ruckus Wireless, Inc.	R710 Access Point FCC ID: S9GR710	421503700725

Test Procedure Continued

The Master and Client (EUT) were placed in a semi-anechoic chamber. The simulated radar waveform was transmitted from a horn antenna towards the Master. The signal level of the simulated radar waveform was set 10 dB higher than calibrated level to -53 dBm and was applied to the Master. The horn antenna was connected to the spectrum analyzer and positioned towards the client with the level >10 dB higher than emissions from the Master.

A Rhode & Schwarz Vector Signal Generator with Pulse Sequencer Software was used to generate the DFS radar signals. A Rhode & Schwarz Spectrum Analyzer was used to monitor the transmissions of the Client. The trigger of the spectrum analyzer was aligned with the end of the radar waveform burst from the signal generator.

Channel closing transmission time and channel move time were measured by applying a radar signal to the Master device. The EUT transmissions were observed while Type 0 Radar waveforms were applied. The time between the end of the applied radar waveform and the final transmission on the channel is the channel move time. The channel closing transmission time comprises only those fragments of the channel move time during which the EUT transmits.

The EUT (client without DFS detection) was configured to communicate with a Master wirelessly. The test file/data was streamed from the Master to the Client. The channel load is recorded and presented in test results below.

4.6.3 Test Results

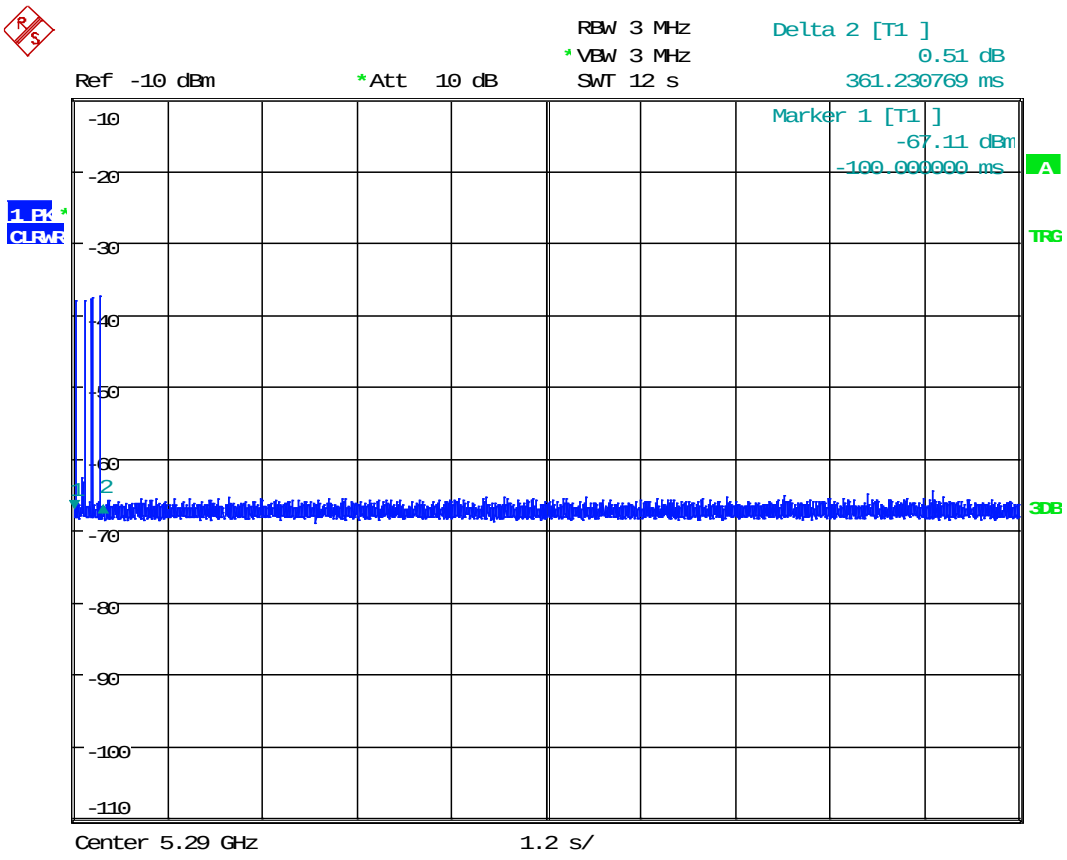
Channel Move Time Test Summary						
Description	**Plot #**	**Radar Type**	**Frequency MHz**	**Measured Value**	**Limit Requirements**	**Results**
Channel Move Time	1	0	5290	361.23ms	10s	Pass

Channel Closing Transmission Time Test Summary						
Description	**Plot #**	**Radar Type**	**Frequency MHz**	**Aggregate Measured Value**	**Limit Requirements**	**Results**
Channel Closing Transmission Time	2	0	5290	< 260ms	260ms	Pass

Unoccupancy Time Test Summary							
Description	**Plot #**	**Radar Type**	**Frequency MHz**	**Number of Beacons Observed**	**Measured Value**	**Minimum Requirement**	**Results**
Channel Move Time	3	0	5290	0	> 30 min	30 min	Pass

Plot 1

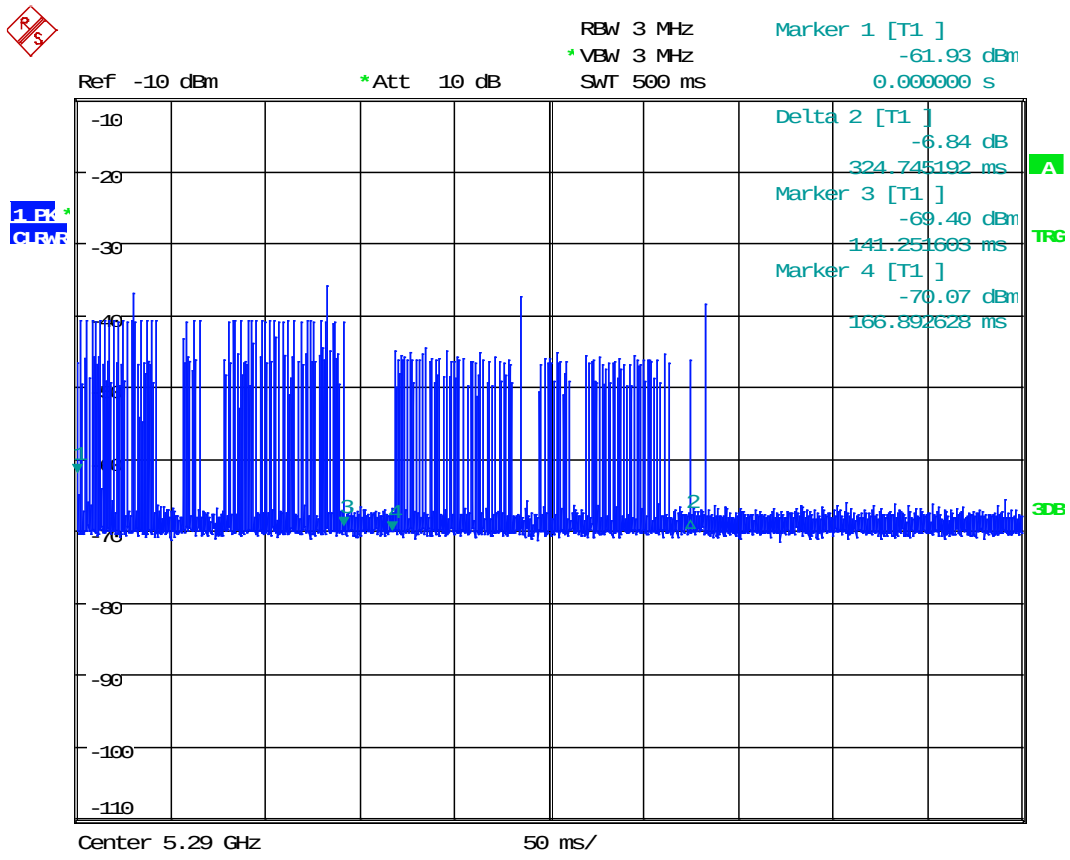
Channel Move Time (CMT), Radar Type 1 @ 5290 MHz



Date: 7.MAR.2016 10:11:40

Plot 2

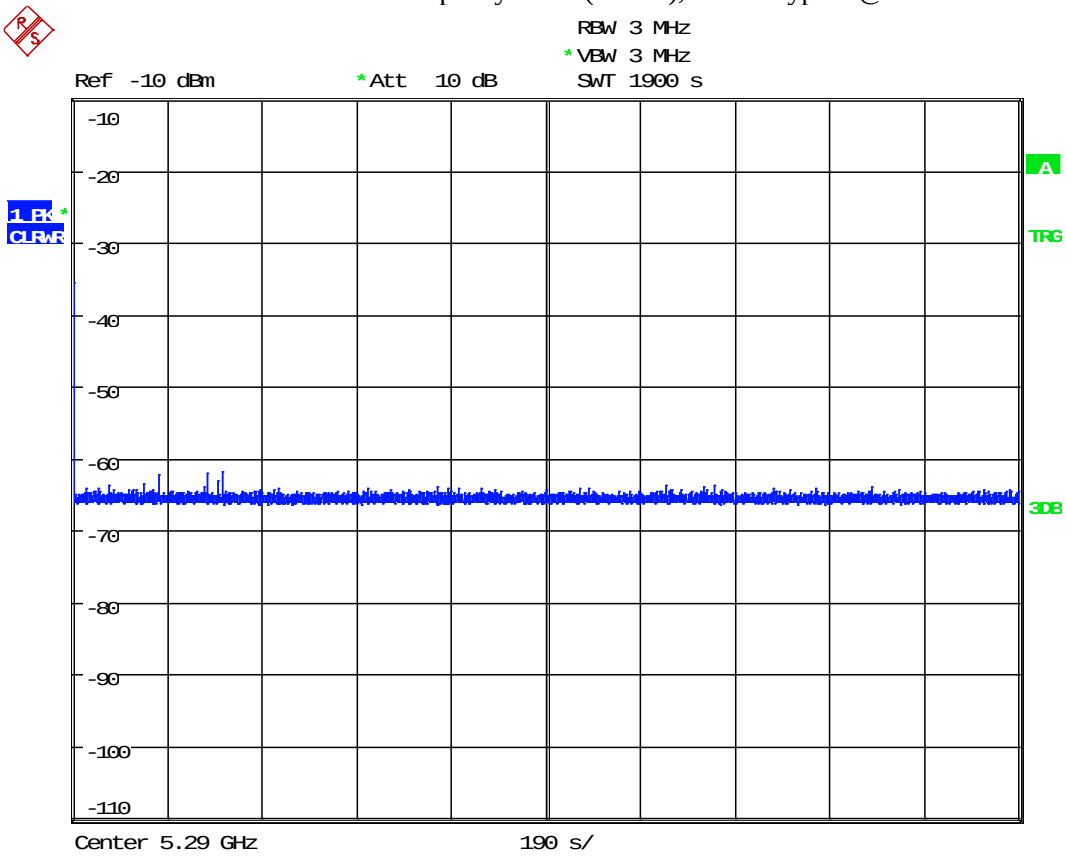
Channel Closing Transmission Time (CCTT), Radar Type 1 @ 5290 MHz



Date: 7.MAR.2016 10:32:13

Plot 3

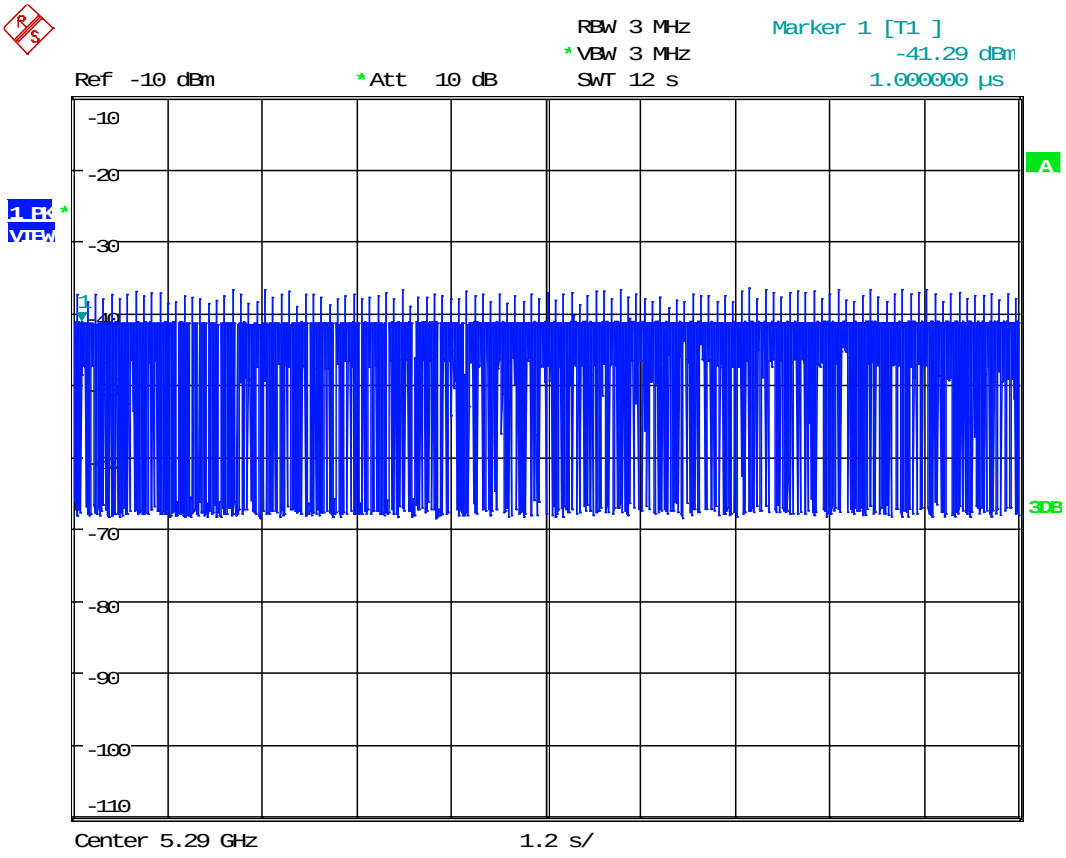
Channel Un-occupancy Time (CCTT), Radar Type 1 @ 5290 MHz



Date: 7.MAR.2016 11:09:12

Plot 4

Channel Loading 5290MHz



Date: 7.MAR.2016 10:09:57

4.6.4 Test Setup Picture

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	06/02/16
Spectrum Analyzer	Rohde and Schwarz	FSU	ITS 00913	12	01/05/17
BI-Log Antenna	Antenna Research	LPB-2513	ITS 00355	12	08/11/16
Pyramidal Horn Antenna	EMCO	3160-09	ITS 00571	#	#
Pyramidal Horn Antenna	EMCO	3160-10	ITS 00572	#	#
Pre-Amplifier	Sonoma Instrument	310	ITS 00942	12	01/07/17
Pre-Amplifier (1-18GHz)	Miteq	AMF-4D-001180-24-10P	ITS 00526	12	10/06/16
Pre-Amplifier (18-40GHz)	Miteq	JSD44-18004000-305P	ITS 00921	12	06/18/16
Horn Antenna	EMCO	3115	ITS 01595	12	02/08/17
Horn Antenna	ETS Lindgren	3117-PA	ITS 01365	12	10/15/16
Horn Antenna	ETS Lindgren	3115	ITS 00982	12	12/16/16

No Calibration required

6.0 Document History

Revision/ Job Number	Writer Initials	Reviewer Initials	Date	Change
1.0 / G102374971	AS	KV	March 29, 2016	Original document