1809 10th St. # 400
Plano TX 75074

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TEST REPORT

Report Number: **101877795DAL-001**
Project Number: **G101877795**

Report Issue Date: **July 14, 2015**

Product Name: **IPPAN**

Standards: **FCC Part 15 Subpart C (15.247)**
Industry Canada RSS-247 Issue 1

Tested by:
Intertek Testing Services NA, Inc.
1809 10th ST #400
Plano, TX 75074

Client:
Amatis Controls, Inc.
400 W. Main St
Aspen CO 81661

Report prepared by

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EMC Engineer

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1 Introduction and Conclusion

The tests indicated in section 2 were performed on the product constructed as described in section 3. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test method, a list of the actual test equipment used, documentation photos, results and raw data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested complied with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested.

The INTERTEK-Dallas is located at 1809 10th St. # 400, Plano TX 75074. The radiated emission test site is a 3-meter semi-anechoic chamber. The chamber meets the characteristics of CISPR 16-1 and ANSI C63.4. For measurements, a remotely controlled flush-mount metal-top turntable is used to rotate the EUT a full 360 degrees. A remote controlled non-conductive antenna mast is used to scan the antenna height from one to four meters. The test site is listed with the FCC under registration number 485103. The test site is listed with Industry Canada under site number IC 6018A-1.

2 Test Summary

Page	Test full name	FCC Reference	IC Reference	Result
7	Peak Conducted Power	§ 15.247(b)(3)(4)	RSS-247, 5.4.4	Pass
9	Occupied Bandwidth	§ 15.247(a)(2)	RSS-247, 5.2.1	Pass
16	Power Spectral Density and Conducted Spurious Emissions	§ 15.247(e)	RSS-247, 5.2.2	Pass
24	Radiated Spurious Emissions (Transmitter) 15.205 in restricted bands, all others <-20dBc	§ 15.247(c)/15.209	RSS-247, 5.5	Pass
49	Radiated Spurious Emissions (Receiver) see note 1	§ 15.109	RSS-Gen (6.1)	Pass
53	AC Power Line Conducted Emissions	§ 15.107, § 15.207	RSS-Gen (7.2.4)	Pass

Note 1: Peak Pout is sufficiently below the 30dBm limit that Duty cycle Determination is not necessary.

Description of Equipment under Test

Equipment Under Test	
Manufacturer	Amatis Controls Inc.
Model Number	IPPAN
Serial Number	Not Labeled
Receive Date	June 5, 2015
Test Start Date	June 8, 2015
Test End Date	July 9, 2015
Device Received Condition	Good
Test Sample Type	Pre-production Prototype
Frequency Band	2415-2470MHz
Mode(s) of Operation	Transmit
Modulation Type	DTS
Maximum Output Power	-2.94dBm
Test Channels	2415 , 2440, 2470
Antenna Type (15.203)	Amatis, Monopole (whip) antenna 5.19 dBi Johanson Technology, SMD Chip Antenna 2.2 dBi
Operating Voltage	9VDC Battery

Description of Equipment Under Test
IPPAN embeds wireless IPv6-based communication into each Amatis or host device, and uses wireless mesh networking technology to connect to the internet. Each IPPAN module has a unique IPv6 address and smart functionality which enables wireless data gathering, communication, and control of the host device. The module is designed to be a self-contained wireless interface to be employed in conjunction with a variety of daughter boards that provides a diverse set of I/O options which include serial interface or general purpose I/O. IPPAN is comprised of a microcontroller, transceiver, amplifier, and two antennas. One antenna is a client manufactured half dipole whip; the second antenna is a Johanson Technologies ceramic antenna.

Operating modes of the EUT:

No.	**Descriptions of EUT Exercising**
1	For Peak Power and Radiated Emissions testing EUT was operating in a constant transmit, modulated mode.
2	For all other testing EUT was operated in modulated mode as dictated by the FCC 15.247/RSS247
3	The EUT continuously transmitted at manufacturer's production power level pre-set.
4	The EUT was tuned to a low, middle, and high channel to perform power, occupied bandwidth, and spurious/harmonic tests.

Note: The Amatis Controls, Inc. IPPAN was tested to and found to be in compliance with FCC 15.247 and IC RSS-247 Issue 1

System setup including cable interconnection details, support equipment and simplified block diagram

2.1 EUT Block Diagram:

3M chamber

2.2 Cables:

Cables					
Description	Length	Shielding	Ferrites	Connection	
				From	To
none					

2.3 Support Equipment:

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
none			

3 Peak Conducted Power

3.1 Test Limits

§ 15.247(b)(3): For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

§ 15.247(b)(4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.2 Test Procedure

ANSI C63.10-2013 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247). The peak output power was measured using the spectrum analyzer.

This testing was performed at Intertek Plano, located at 1809 10th St. Suite #400, Plano TX 75074.

3.3 Test Equipment Used:

Description	Manufacturer	Model	Serial Number	Cal Date	Cal Due
EMI Receiver rated: 20Hz-26.5GHz	R & S	ESR-26	102665	6/25/2015	6/25/2016

3.4 Results:

Project #	Date	Rule	Distance	Antenna	RBW	VBW	Detector
G101877795	07/06/2014	15.247	N/A	Direct	3MHz	10MHz	Peak

Conducted-Transmitting

Frequency (MHz)	Recorded Level (dBm)	Cable Loss (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
2415	-5.61	0.10	-5.51	30	-33.34
2440	-2.94	0.10	-2.84	30	-32.84
2470	-3.44	0.10	-3.34	30	-35.51

Results: Pass

4 Occupied Bandwidth

4.1 Test Limits

§ 15.247(a)(2): Occupied bandwidth measurements were performed on the EUT to determine compliance with FCC 15.247(a)(2) and RSS-247.For digital modulation systems, the minimum 6dB bandwidth shall be at least 500kHz.

4.2 Test Procedure

ANSI C63.10:2013 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247).
The occupied bandwidth was measured with a spectrum analyzer directly connected to the EUT while the EUT was operating in continuous transmit mode at the appropriate center frequency. The analyzer center frequency was set to the EUT carrier frequency. Display line and marker delta functions were used to measure the occupied bandwidth of the EUT. Measurements were made at three frequencies.

The 20dB bandwidth must be measured and reported for the FCC and for IC.

This testing was performed at Intertek Plano, located at 1809 10th St. Suite #400, Plano TX 75074.

4.3 Test Equipment Used:

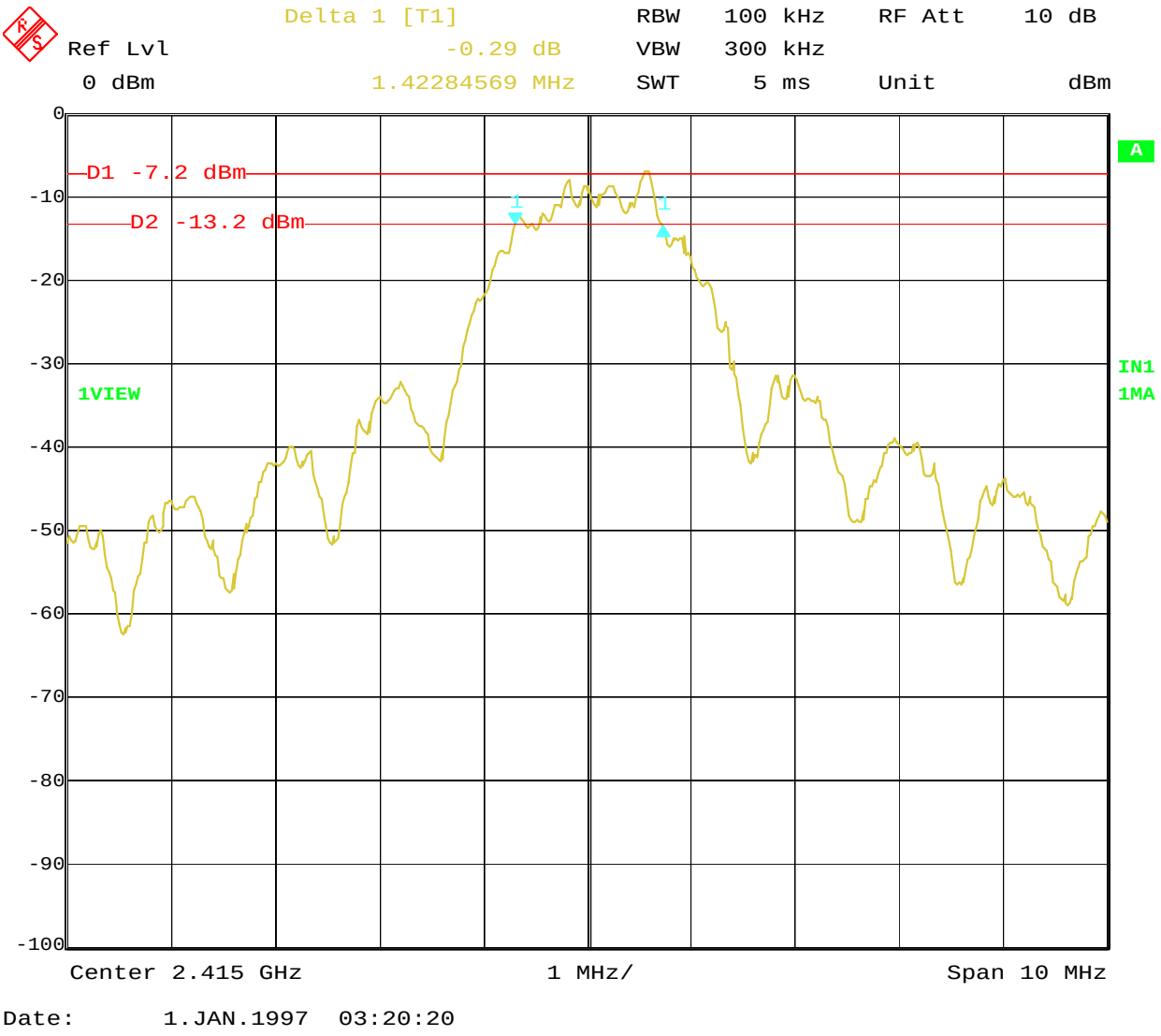
Description	Manufacturer	Model	Serial Number	Cal. Date	Cal. Due
EMI Receiver rated: 20Hz-26.5GHz	R & S	ESR-26	102665	6/25/2015	6/25/2016

4.4 Results:

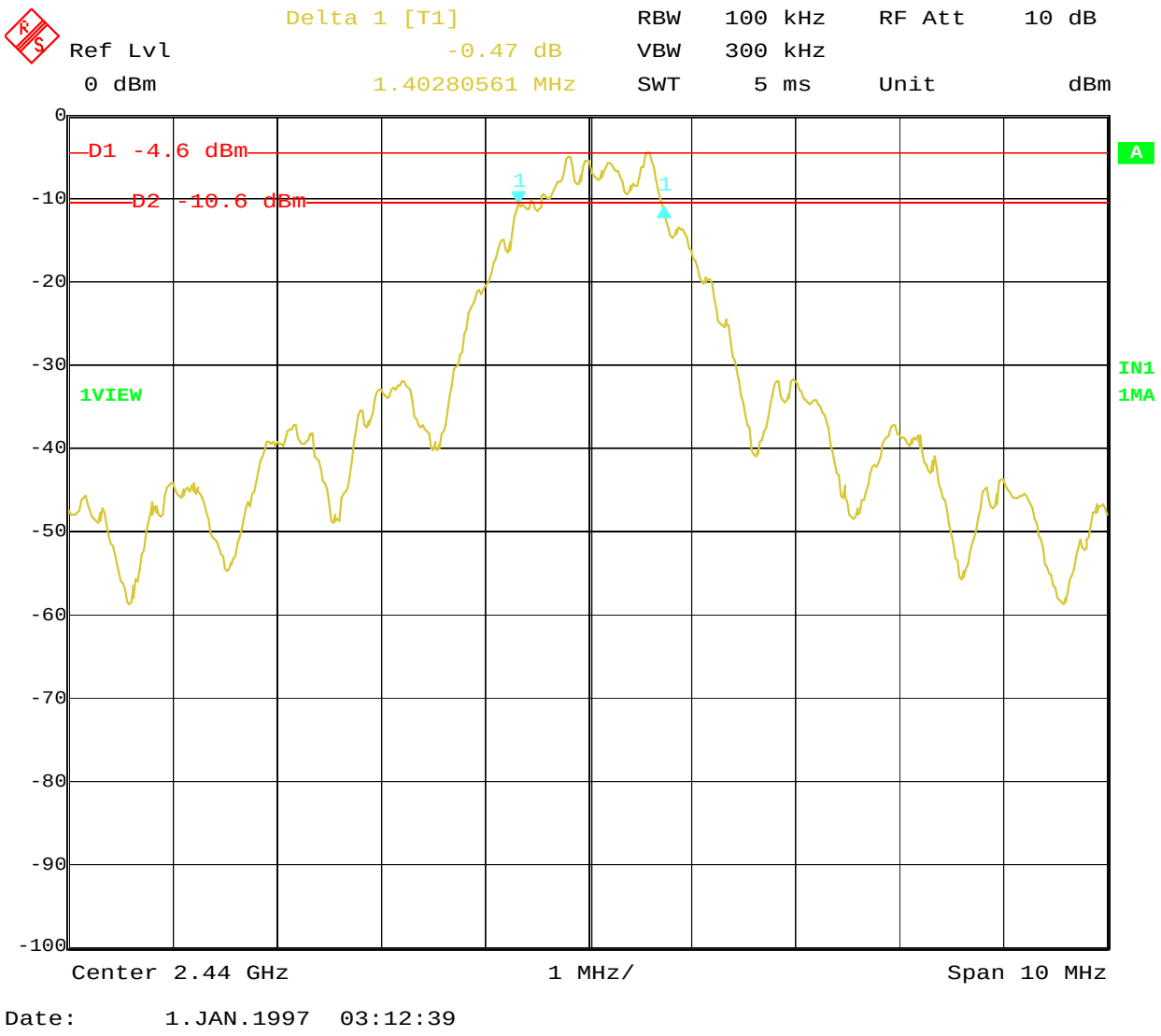
Mode	Channel Number	Frequency (MHz)	Bandwidth (KHz)	Result
6 dB BW	Low	2415	1422	Pass
6 dB BW	Mid	2440	1403	Pass
6 dB BW	High	2470	1463	Pass
20 dB BW	Low	2415	2565	Pass
20 dB BW	Mid	2440	2525	Pass
20 dB BW	High	2470	2605	Pass

Results: Pass

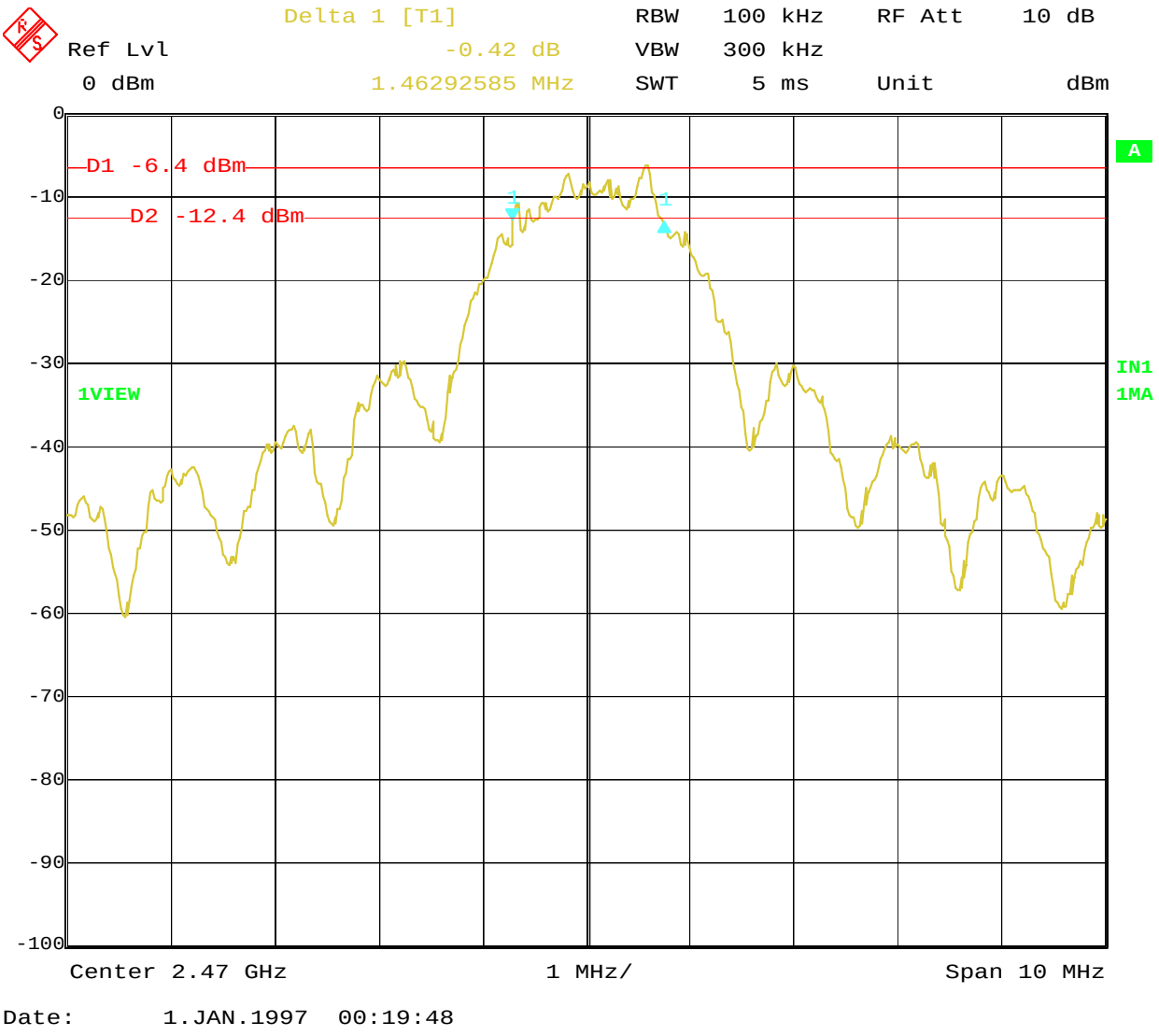
6dB Bandwidth Plot (Low Channel)



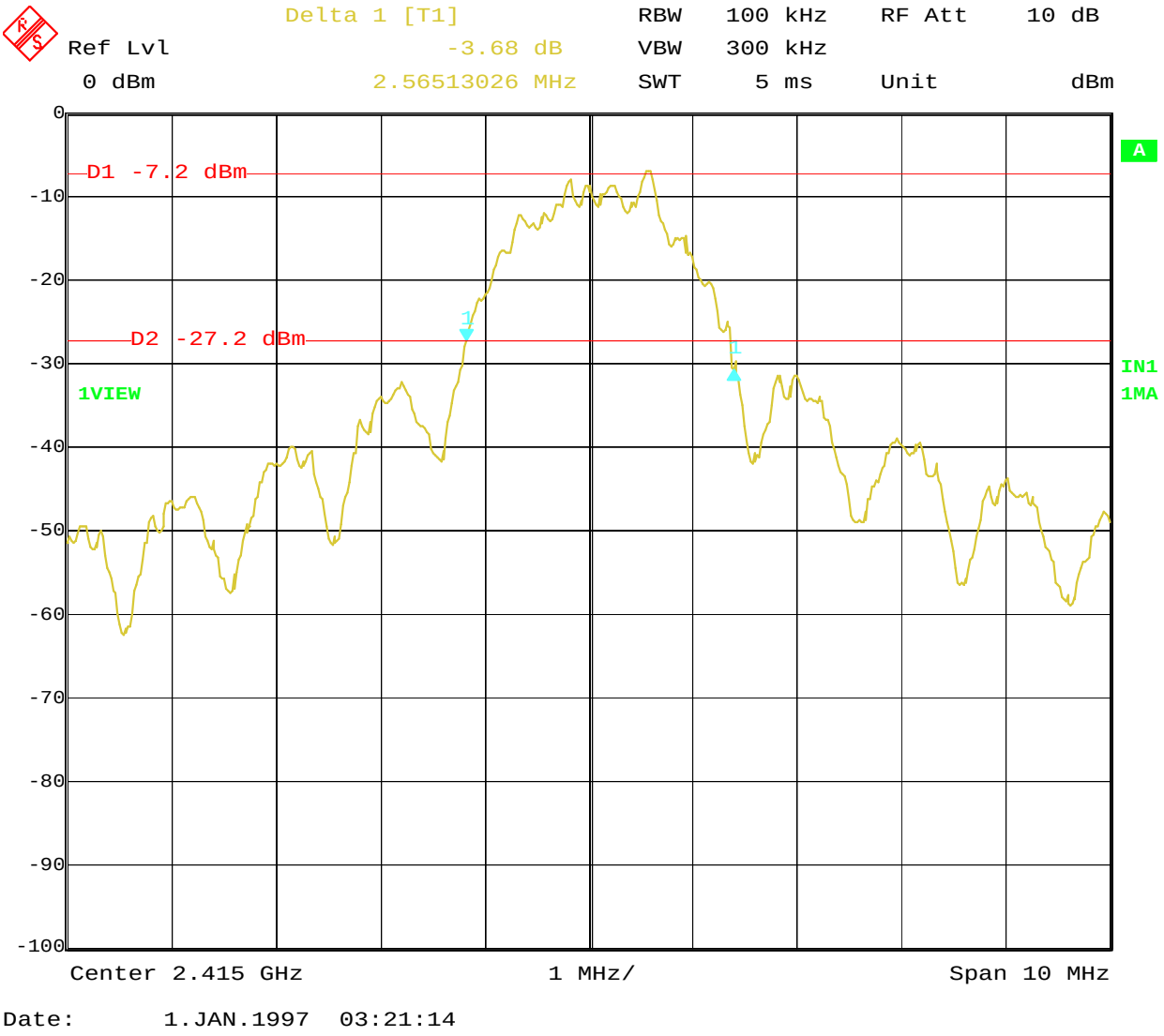
6dB Bandwidth Plot (Mid Channel)



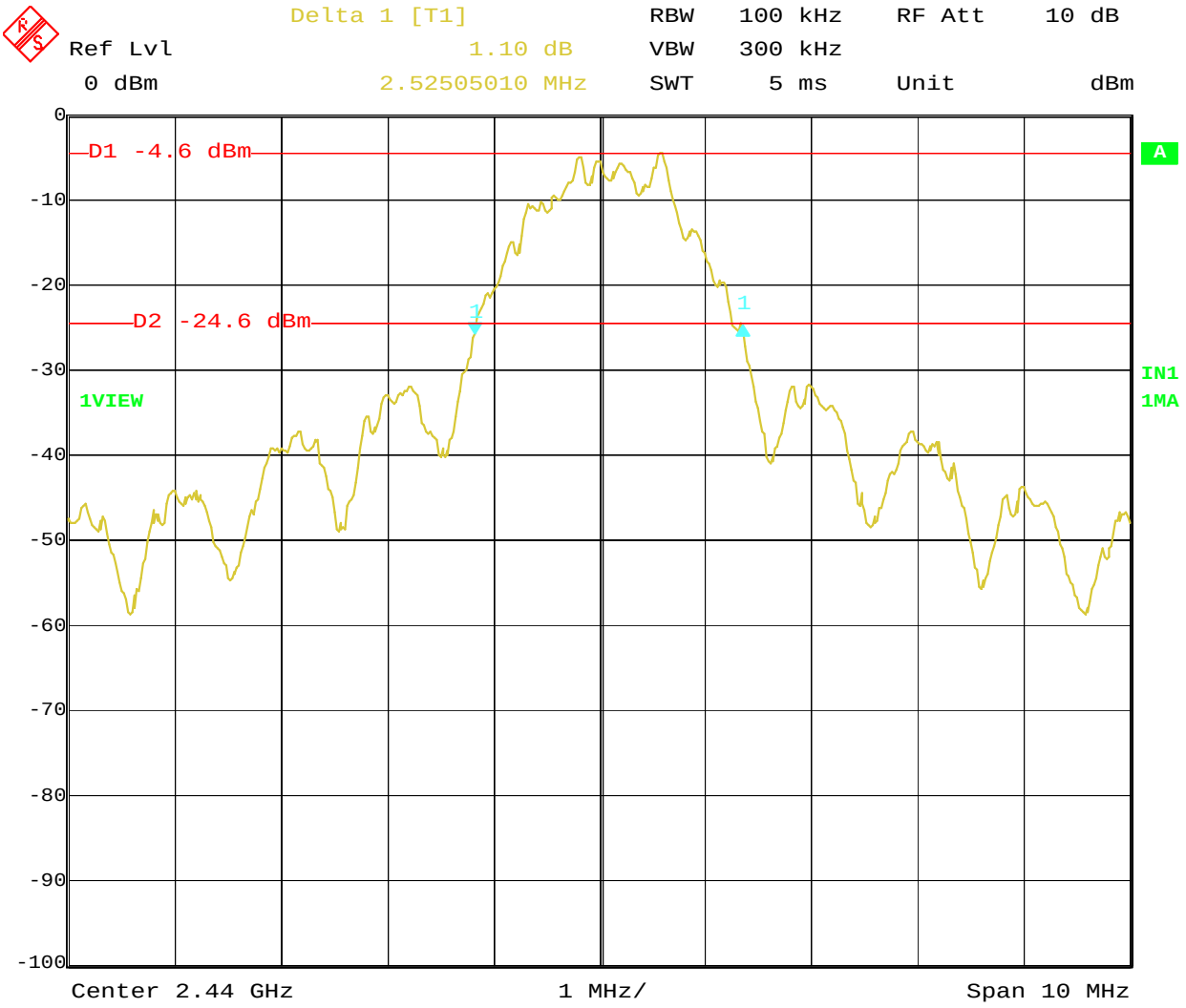
6dB Bandwidth Plot (High Channel)



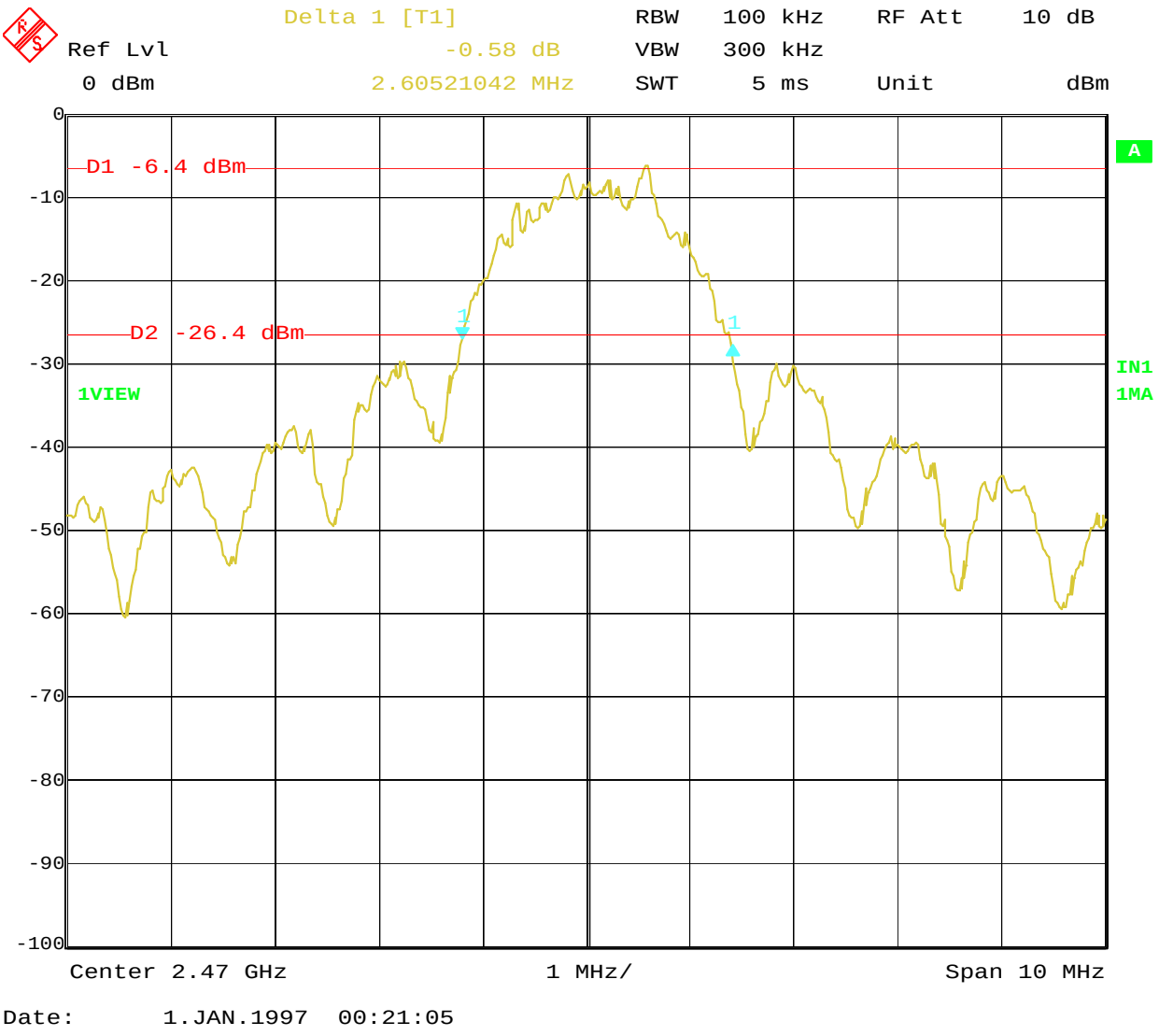
20dB Bandwidth Plot (Low Channel)



20dB Bandwidth Plot (Mid Channel)



20dB Bandwidth Plot (High Channel)



5 Power Spectral Density/Conducted Spurious Emissions

5.1 Test Limits

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

5.2 Test Procedure Conducted Spurious Emissions

ANSI C63.10:2013 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)
Peak spurious measurements were made in the frequency range of 30 MHz to a minimum of the 10th harmonic range while the EUT was tuned to the low middle and highest channels. The EUT was directly connected to a spectrum analyzer with a calibrated measurement cable.

From 30 MHz to 26.5GHz the RBW/VBW of the Spectrum Analyzer was 100KHz/300Khz.

This testing was performed at Intertek Plano, located at 1809 10th St. Suite #400, Plano TX 75074.

5.3 Test Equipment Used:

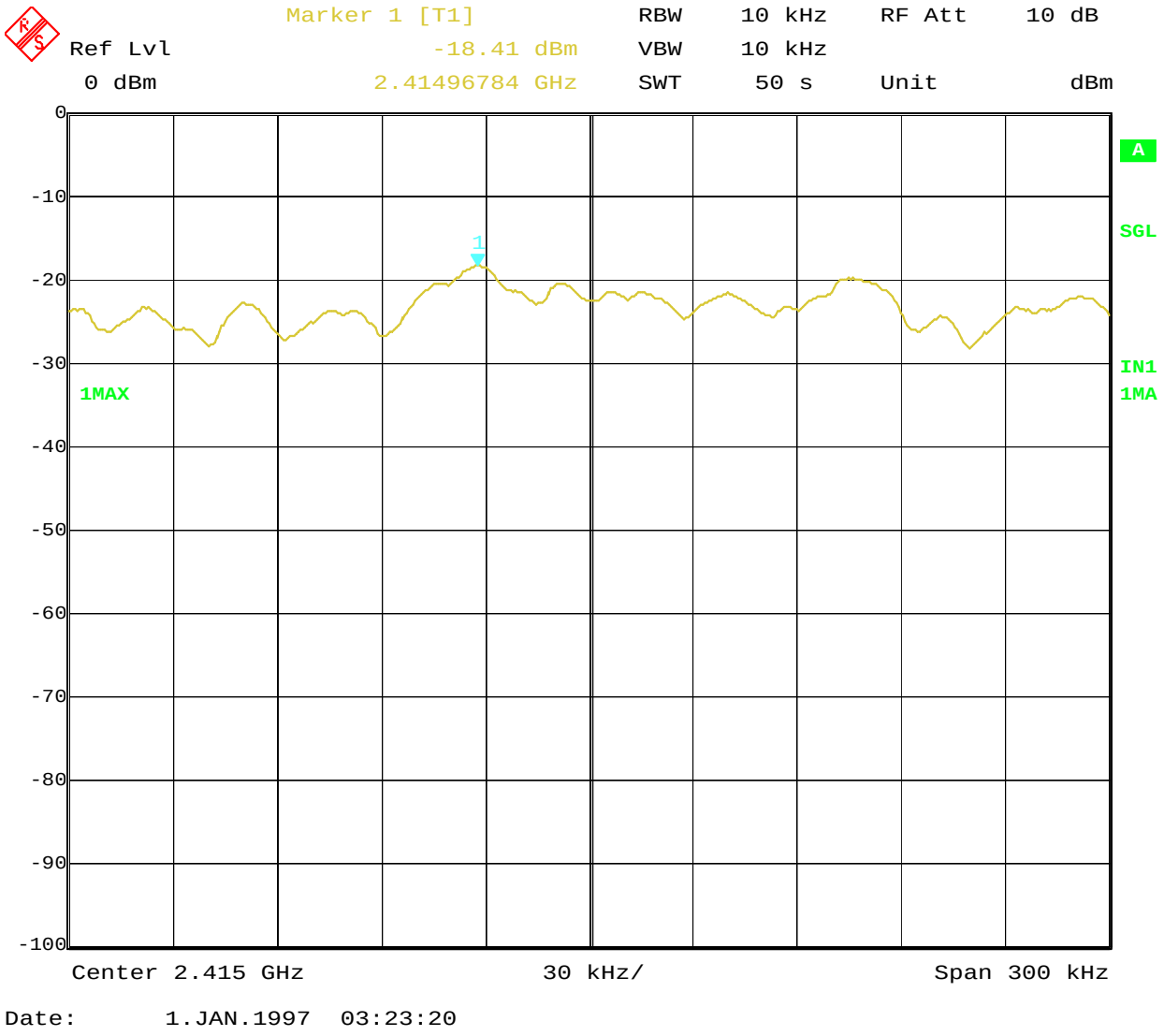
Description	Manufacturer	Model	Serial Number	Cal. Date	Cal. Due
EMI Receiver rated: 20Hz-26.5GHz	R & S	ESR-26	102665	6/25/2015	6/25/2016
Conducted Spur TILE profile	Intertek	1130-008	Ver. 10	VBU	VBU

5.4 Results:

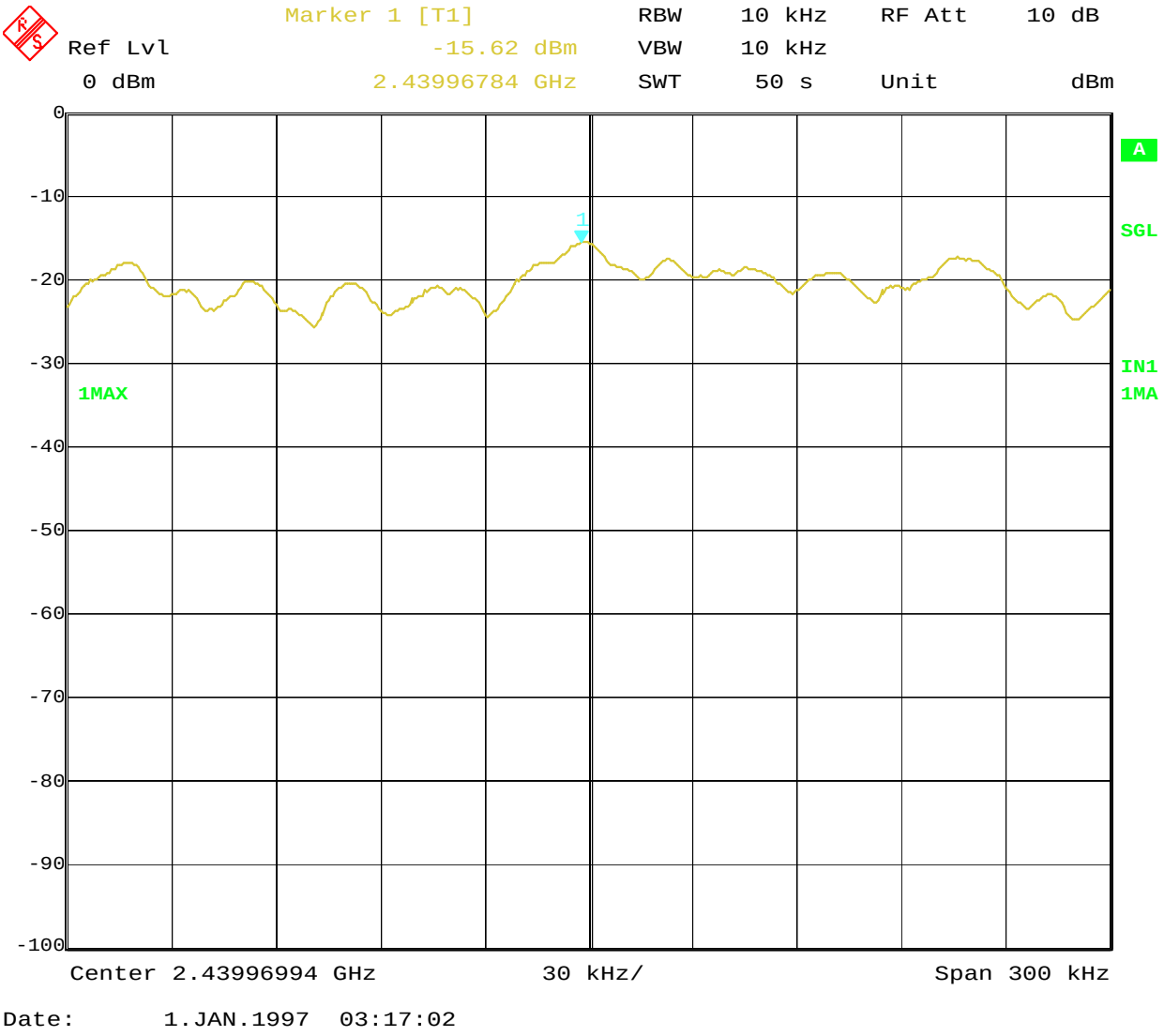
The following plots show that there are no conducted spurious emissions exceeding the 20dB down criteria.

Results: Pass

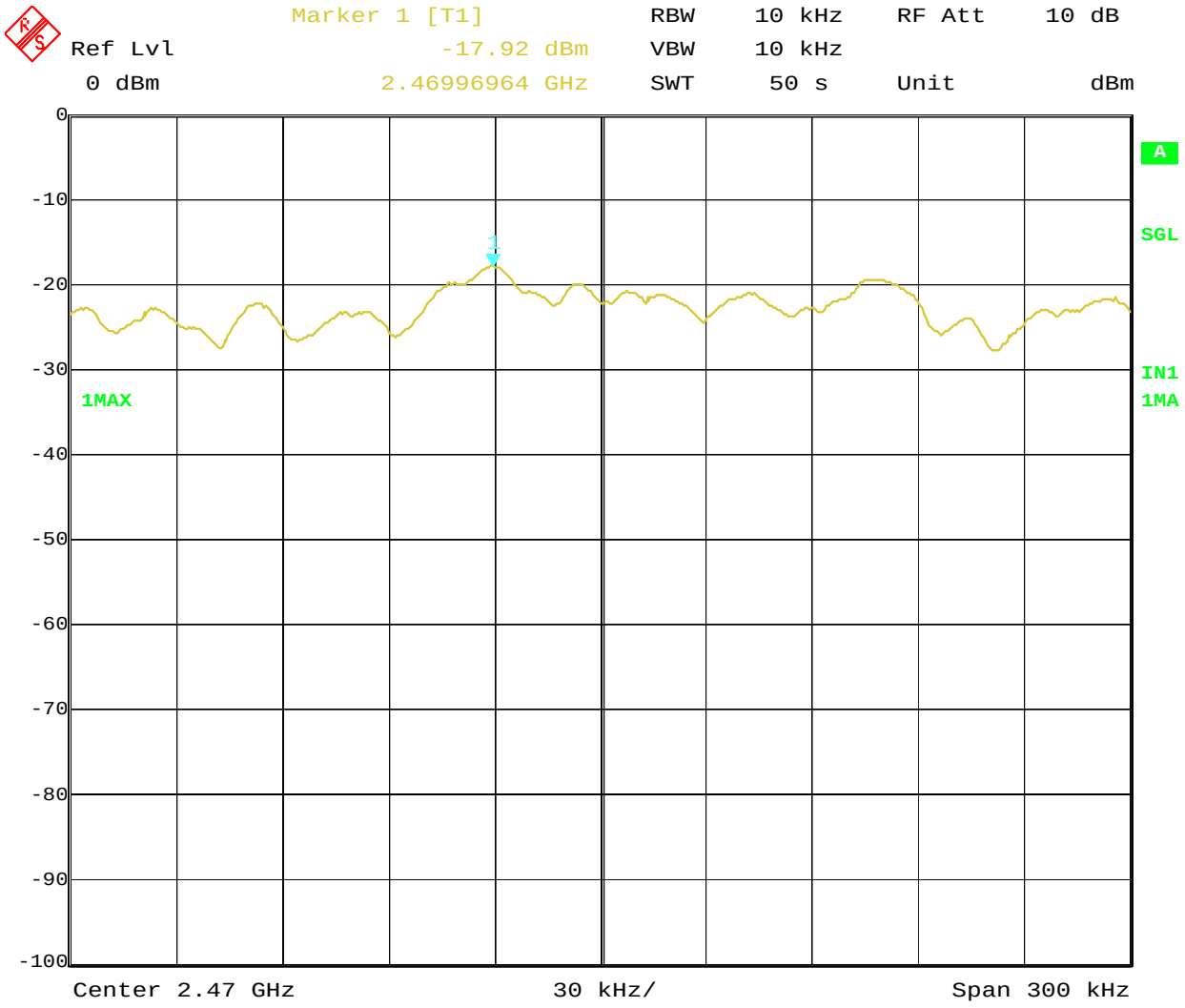
Spectral Density Lo Channel.



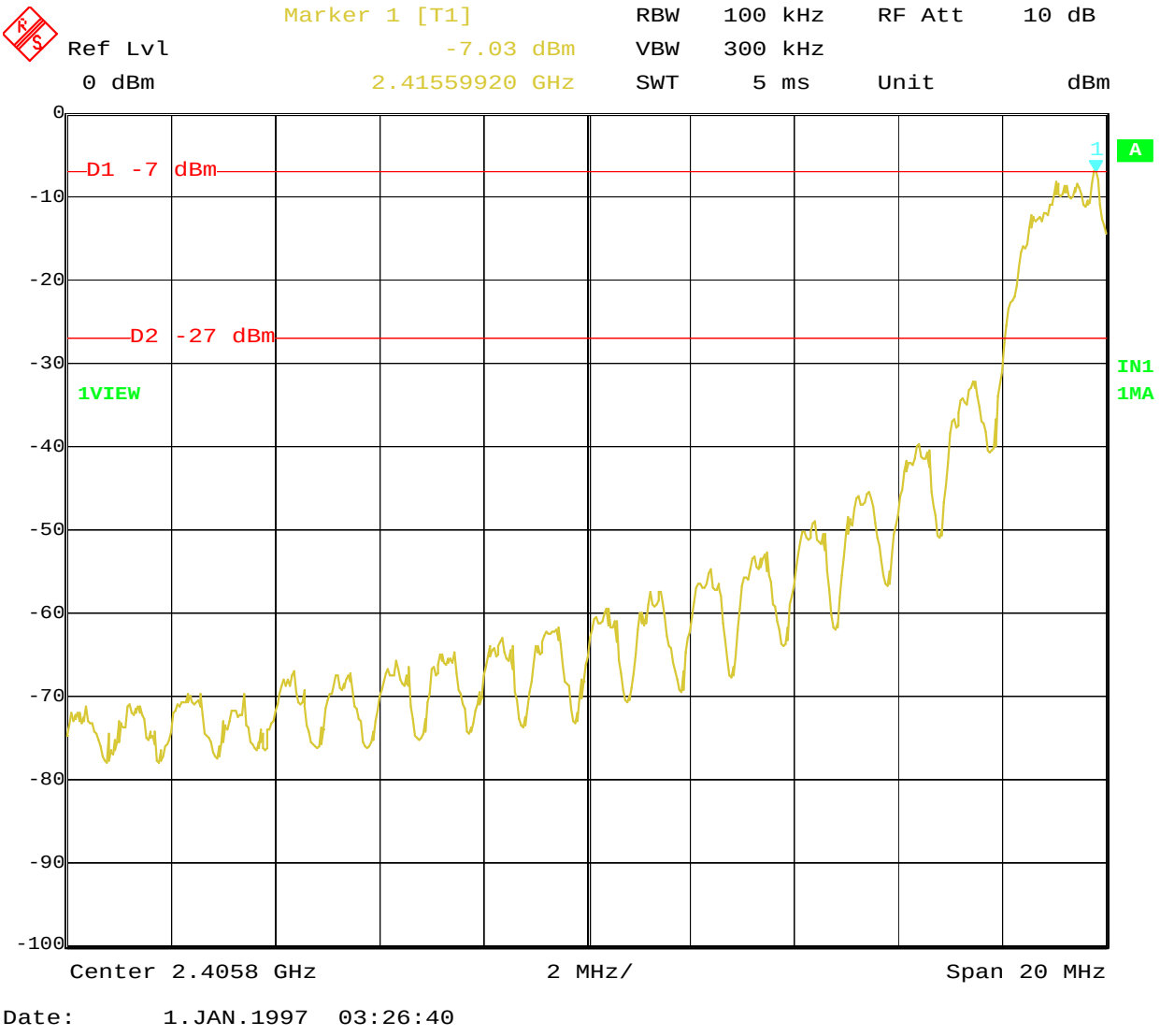
Spectral Density Mid Channel.



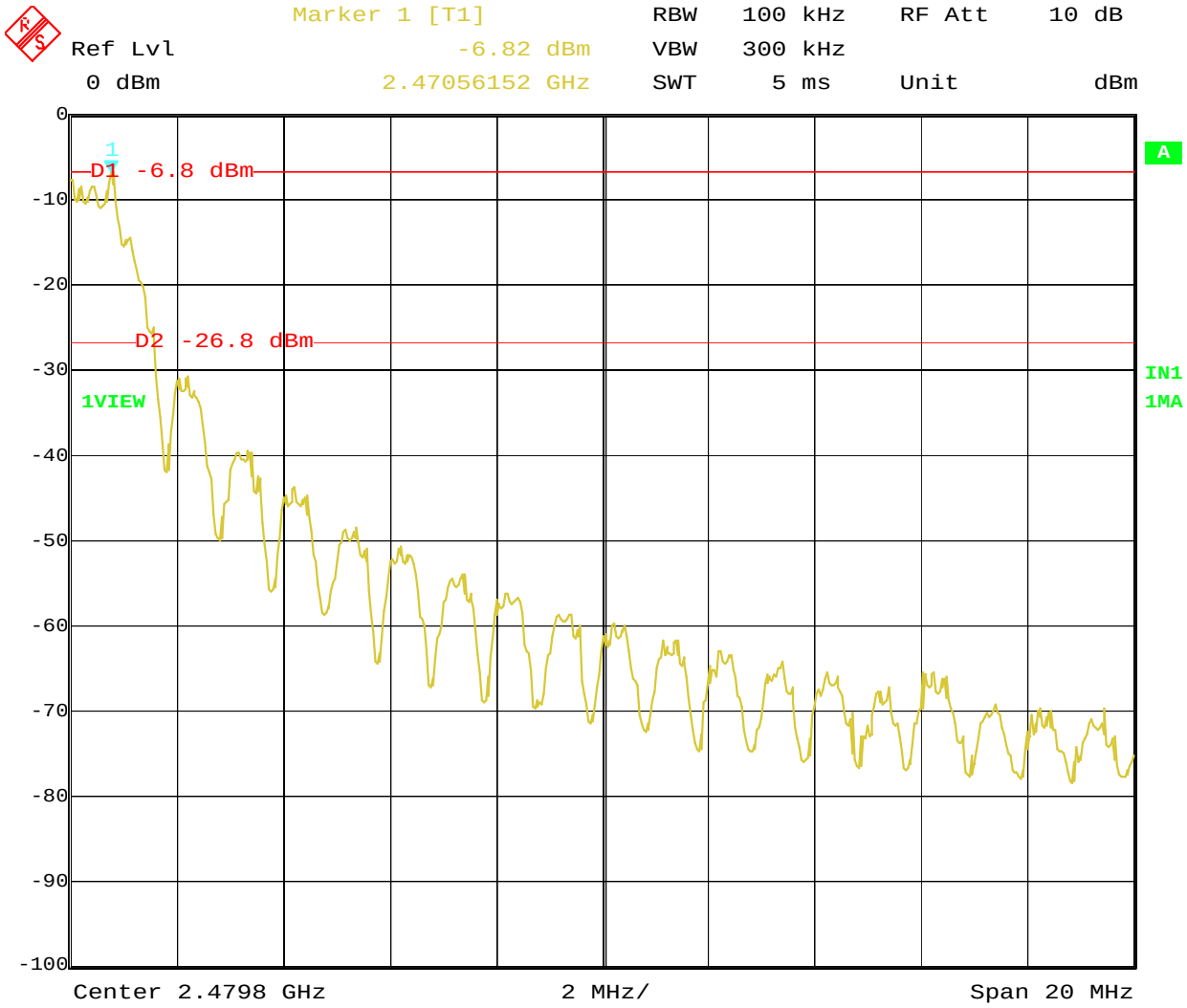
Spectral Density High Channel.

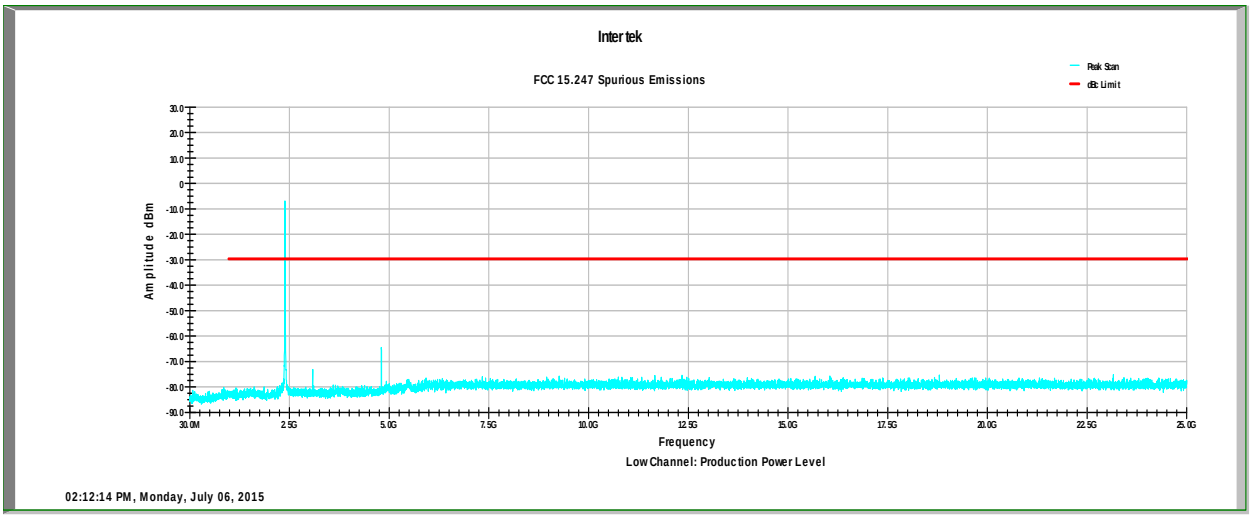


Band Edge Low Channel

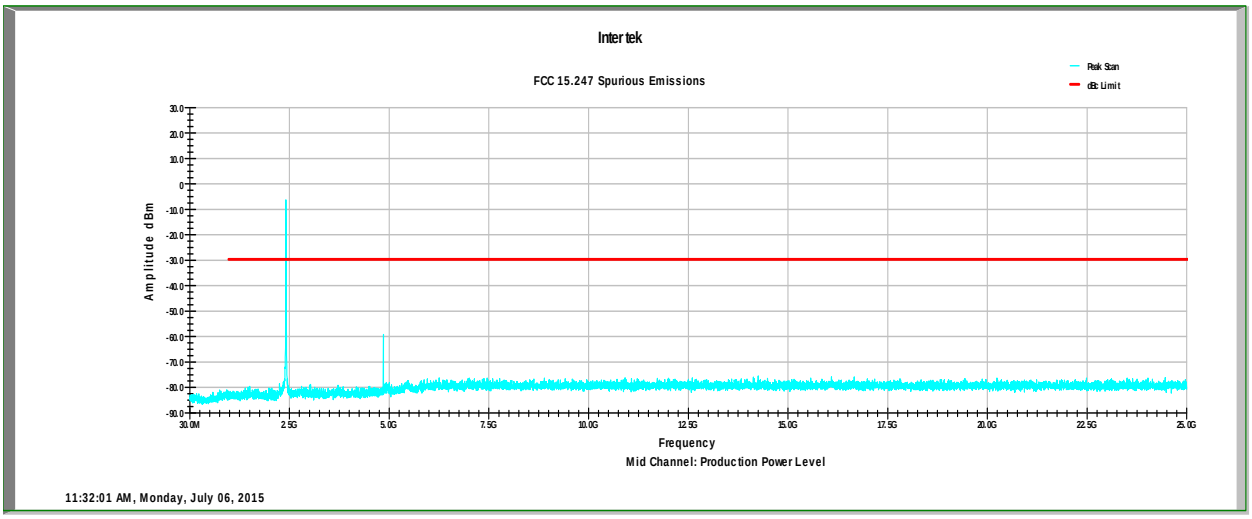


Band Edge Hi Channel

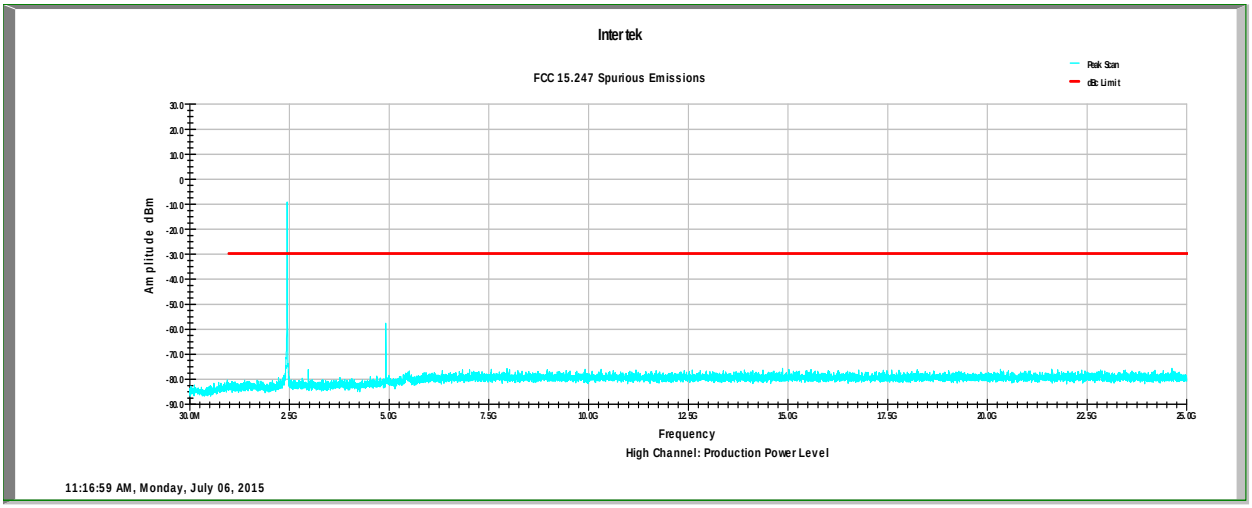




Conducted Spurious Emissions Low Channel



Conducted Spurious Emissions Mid Channel



Conducted Spurious Emissions High Channel

6 Radiated Spurious Emissions (Transmitter)

6.1 Test Limits

§ 15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Part 15.205(a): Restricted Bands of Operations

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	[2]
13.36–13.41.			

[1] Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.
[2] Above 38.6

Part 15.209(a): Field Strength Limits for Restricted Bands of Operation

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

6.2 Test Procedure

ANSI C63.10:2013 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247).

This testing was performed at Intertek Plano, located at 1809 10th St. Suite #400, Plano TX 75074.

6.3 Example of Field Strength Calculation Method:

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculations are listed below:

Formula:
FS = RA + AF + CF

FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB
CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

RA = 19.48 dBµV
AF = 18.52 dB
CF = 0.78 dB

FS = 19.48 + 18.52 + 0.78 = 38.78 dBµV/m
Level in µV/m = Common Antilogarithm [(38.78 dBµV/m)/20] = 86.89 µV/m

6.4 Test Equipment Used:

Description	Manufacturer	Model	Serial Number	Cal Date	Cal Due
DC to 18GHz Coaxial RF Cable 3M Em Chamber	MegaPhase	F520NKNK315	11111301002	10/13/2014	10/13/2015
7 Meter RF Cable 26.5GHz EMC lab (cable 1)	Maury Microwave	UC-SMA-MM-276	15.16.109	05/26/2015	05/26/2016
SMA RF CABLE	Insulated Wire Inc.	SPS-2303-720-SPS	804	08/08/2014	08/08/2015
Preamplifier 1-1000 MHz 33dB typical gain	Com Power	PAM-103	441031	06/25/2015	06/25/2016
Antenna - 20 MHz to 6 GHz	Sunol Sciences	JB6	A101612	03/04/2014	03/04/2015
700 MHz to 18 GHz Horn Antenna	A H Systems	SAS-571	1497	03/20/2015	03/20/2016
DC to 18GHz Coaxial RF Cable 3M Em Chamber	MegaPhase	F520NKNK315	11111301002	10/13/2014	10/13/2015
1 Meter RF Cable 18GHz EMC lab	Maury Microwave	UC-N-MM-36	14.04.114	05/14/2015	05/14/2016
LNA 500 MHz to 18 GHz	Miteq Inc.	AMF-5D-00501800-28-1	1469795	07/18/2014	07/18/2015
18 to 26GHz Pre-amplifier	Miteq Inc.	AMF-6F18002650-20-10	1467280	12/18/2014	12/18/2015
EMI Receiver rated: 20Hz-26.5GHz	R & S	ESR-26	102665	06/25/2015	06/25/2016
Radiated Emissions TILE profile	Intertek	1130-002	Ver 10	VBU	VBU

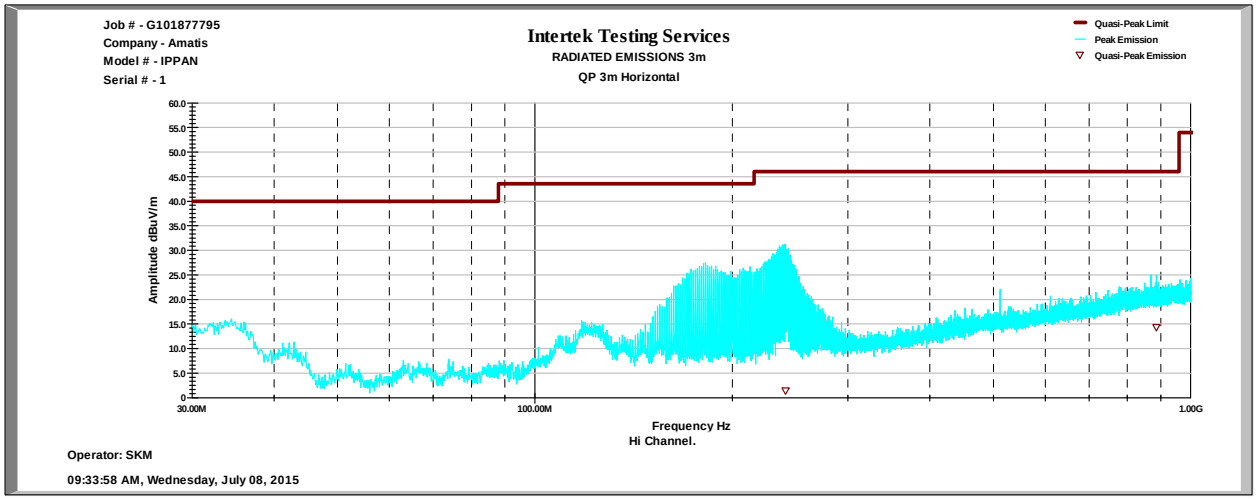
6.5 Results:

All spurious emissions were attenuated by at least 20dB below the level of the fundamental as required by Part 15.247(d). Additionally, all emissions falling within restricted bands of operation and at the band edges were found to be below the limit specified in Part 15.209(a) and 15.205(a). The spurious emissions listed in the following tables are the worst case emissions.

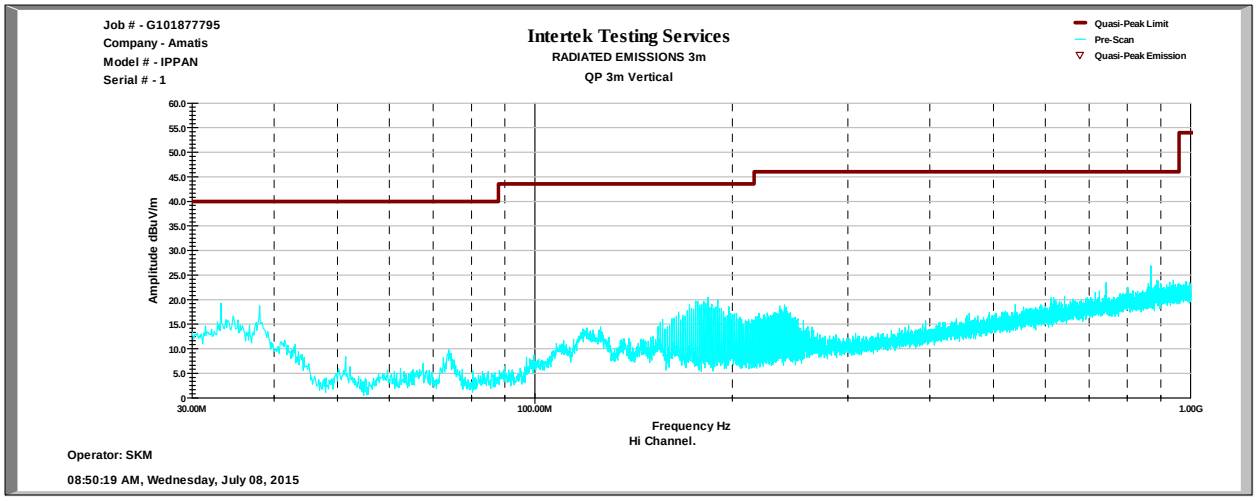
Worst Case Spurious Measurements

*Emissions were investigated through 3 orthogonal axis to determine the worst case.

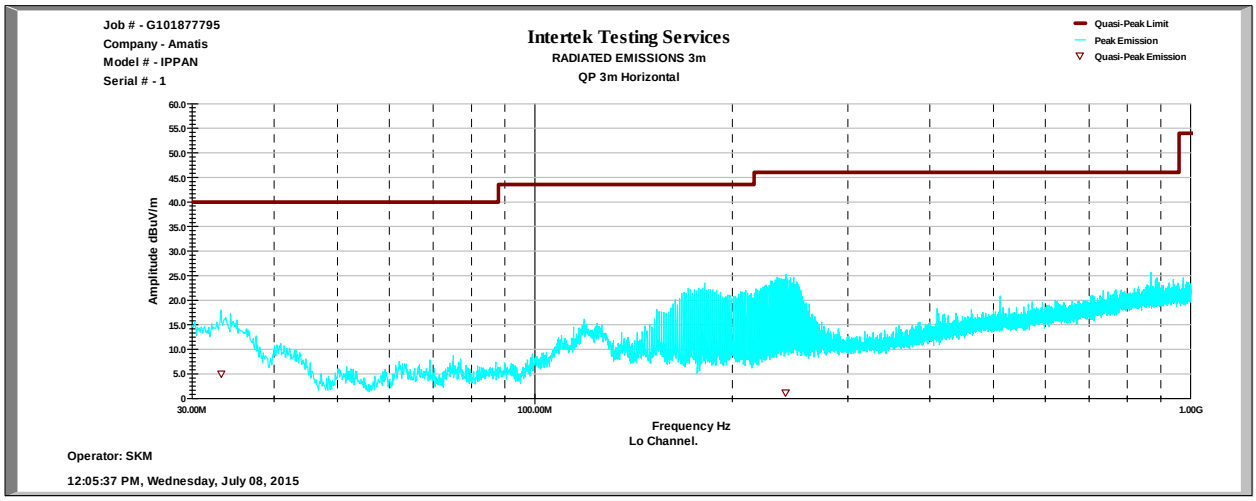
6.6 30-1000MHz Plots/Data:



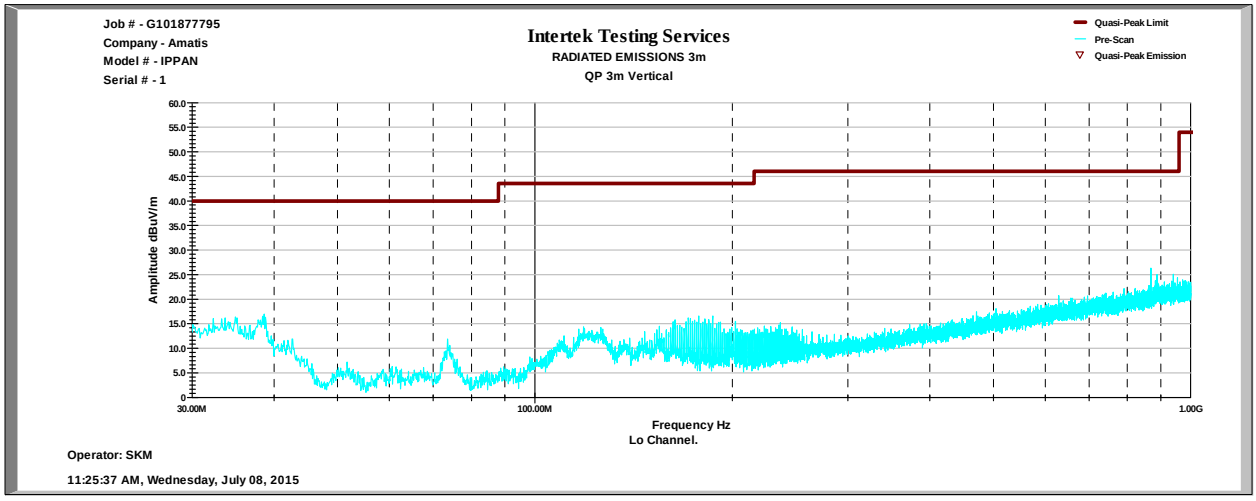
30 to 1000 Radiated Emi Ceramic Antenna Hi Ch 3m Horiz.



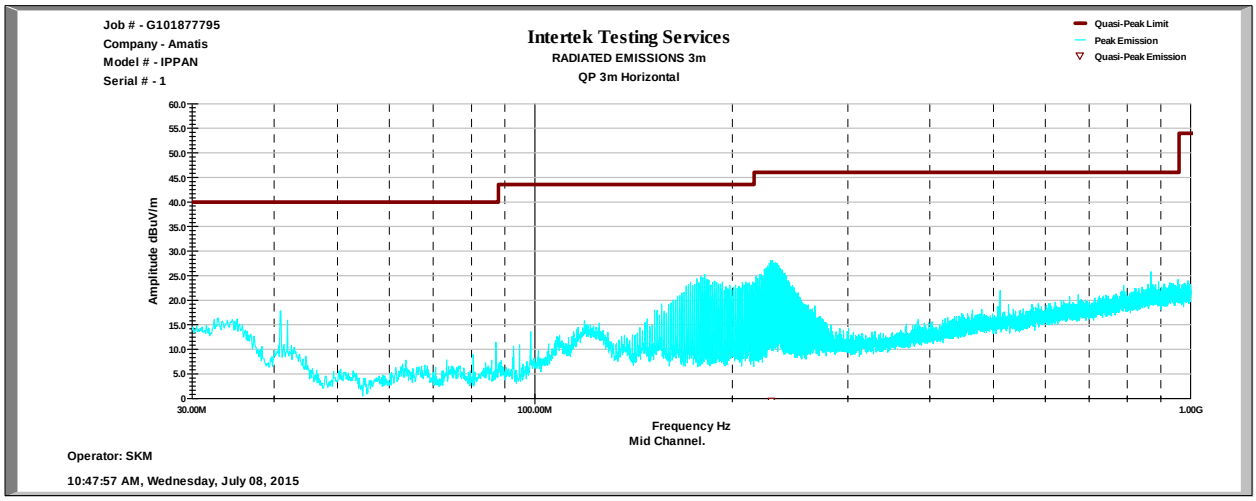
30 to 1000 Radiated Emi Ceramic Antenna Hi Ch 3m Vert.



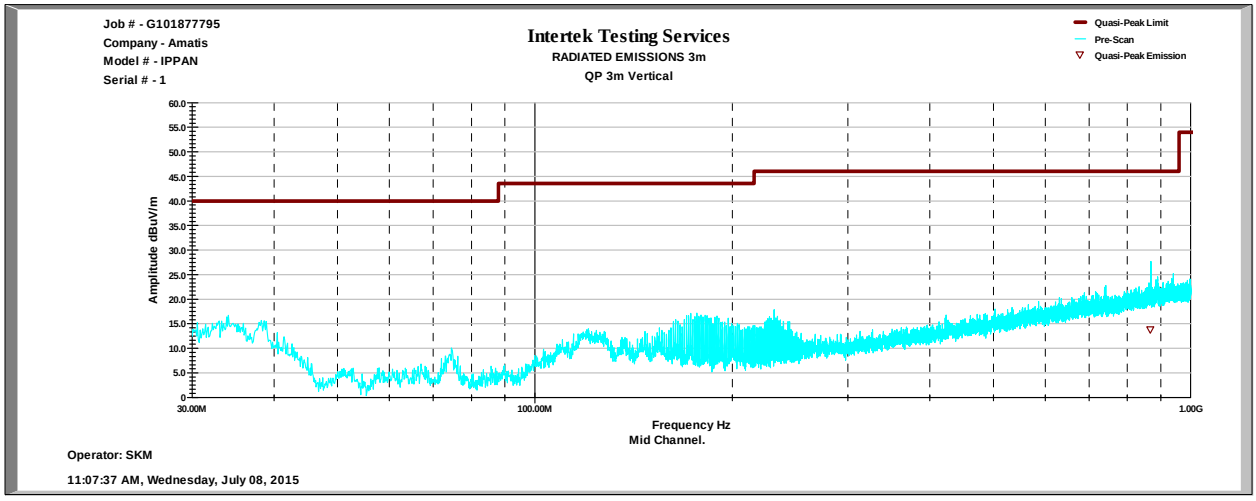
30 to 1000 Radiated Emi Ceramic Antenna Lo Ch 3m Horizontal



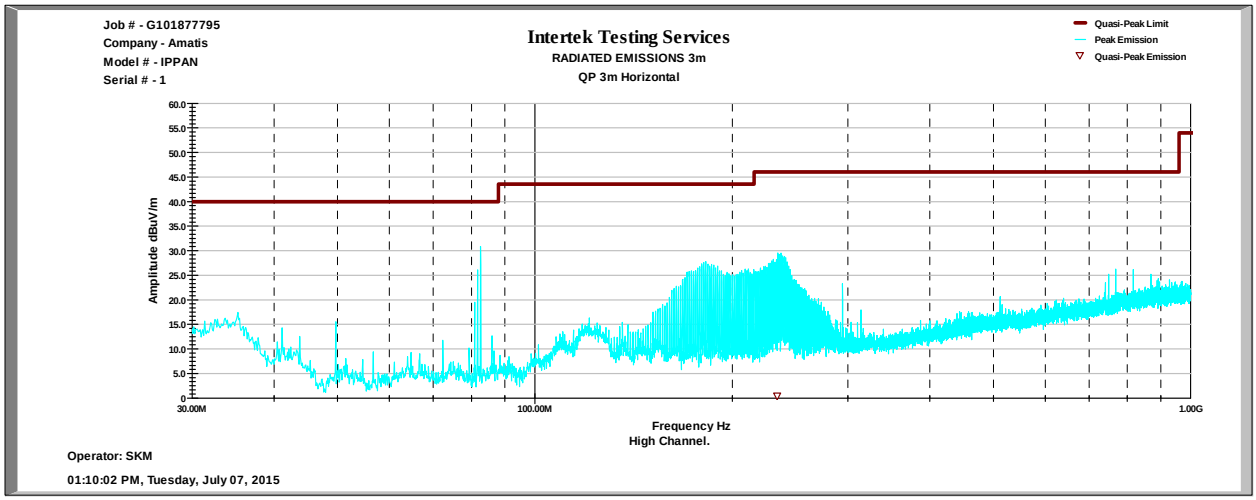
30 to 1000 Radiated Emi Ceramic Antenna Lo Ch QP 3m Vertical



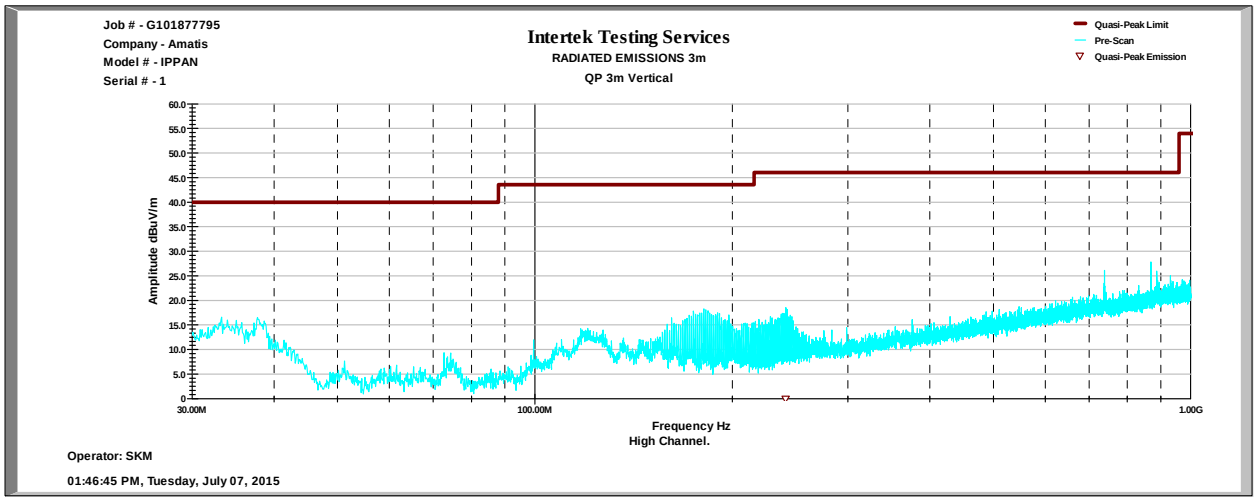
30 to 1000 Radiated Emi Ceramic Antenna Mid Ch QP 3m Horizontal



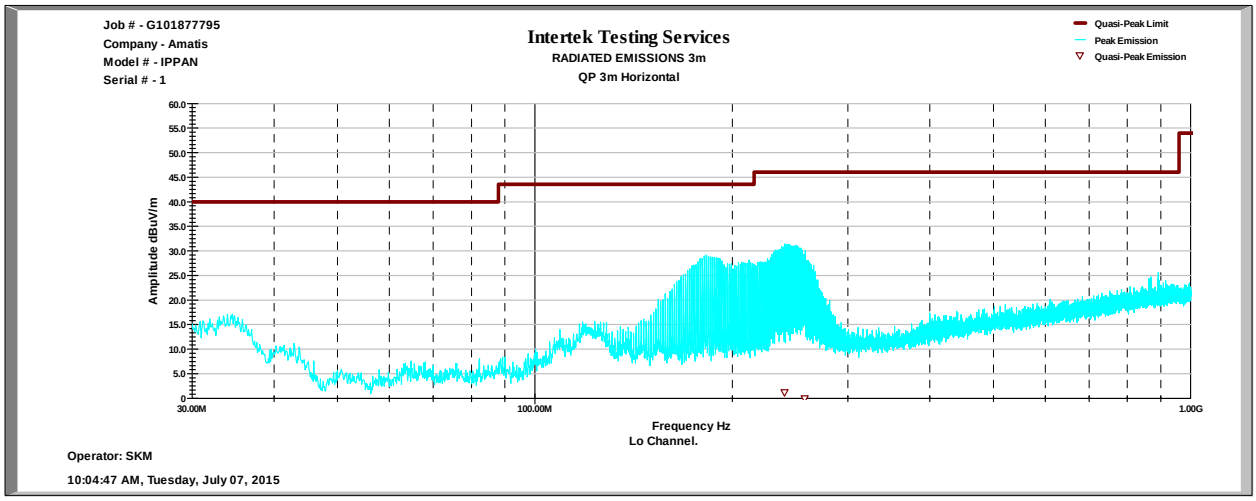
30 to 1000 Radiated Emi Ceramic Antenna Mid Ch. 3m Vert



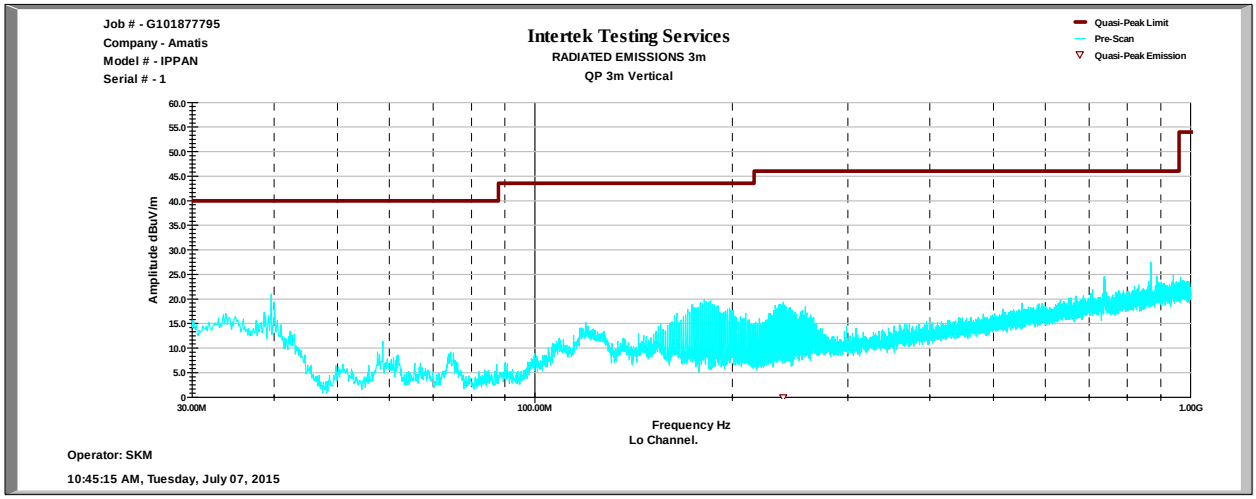
30 to 1000 Radiated Emi Whip Antenna Hi Ch. 3m Horiz.



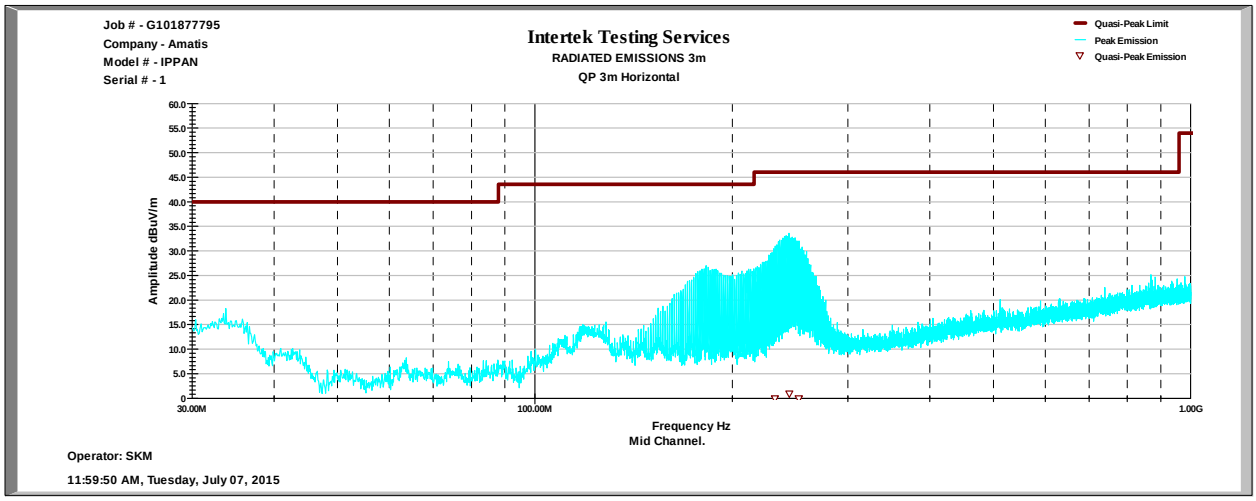
30 to 1000 Radiated Emi Whip Antenna Hi Ch. Vertical



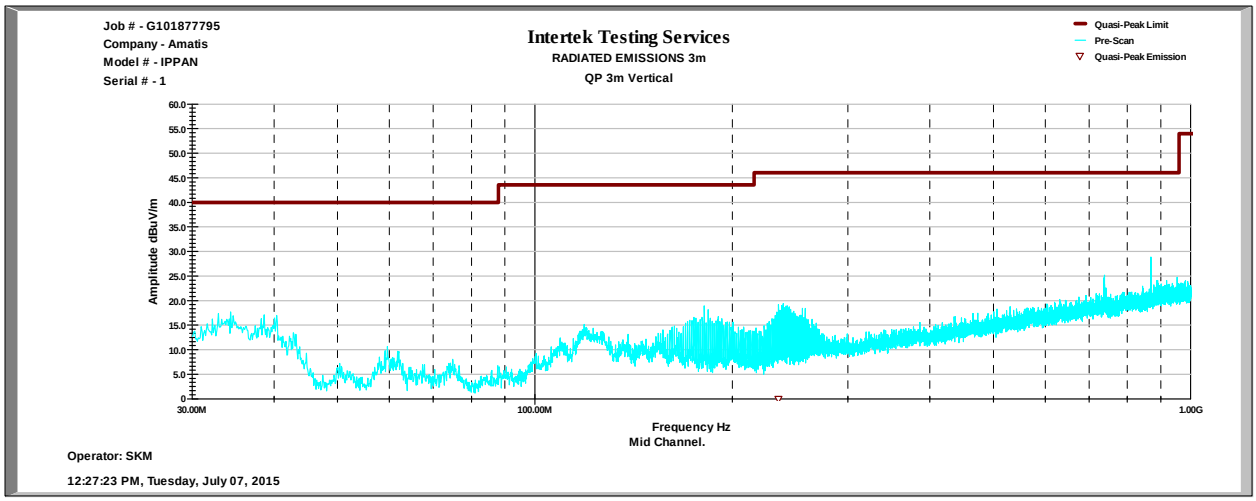
30 to 1000 Radiated Emi Whip Antenna Lo Ch. 3m Horizontal



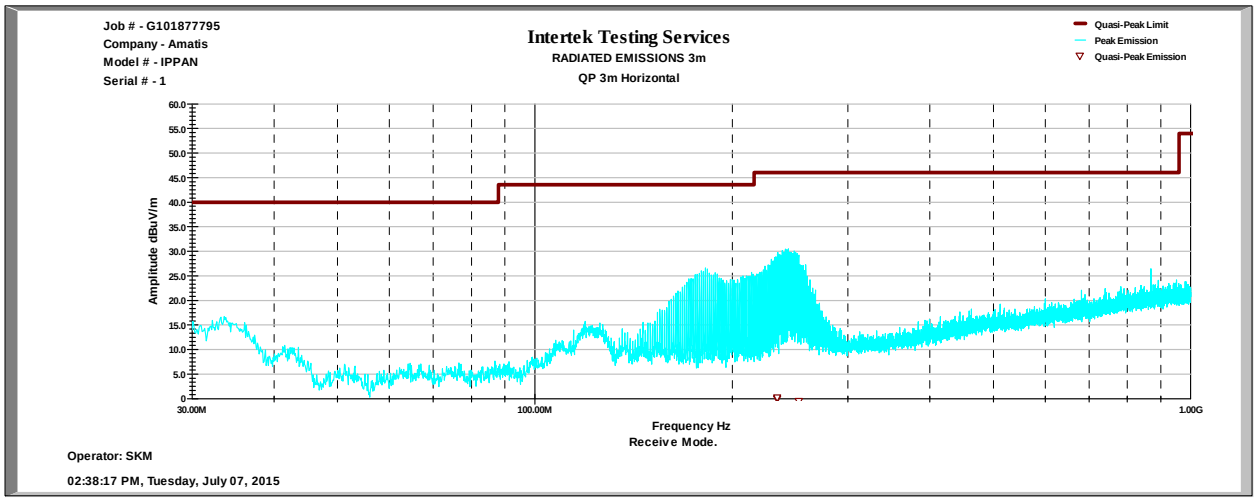
30 to 1000 Radiated Emi Whip Antenna Lo Ch. 3m Vert



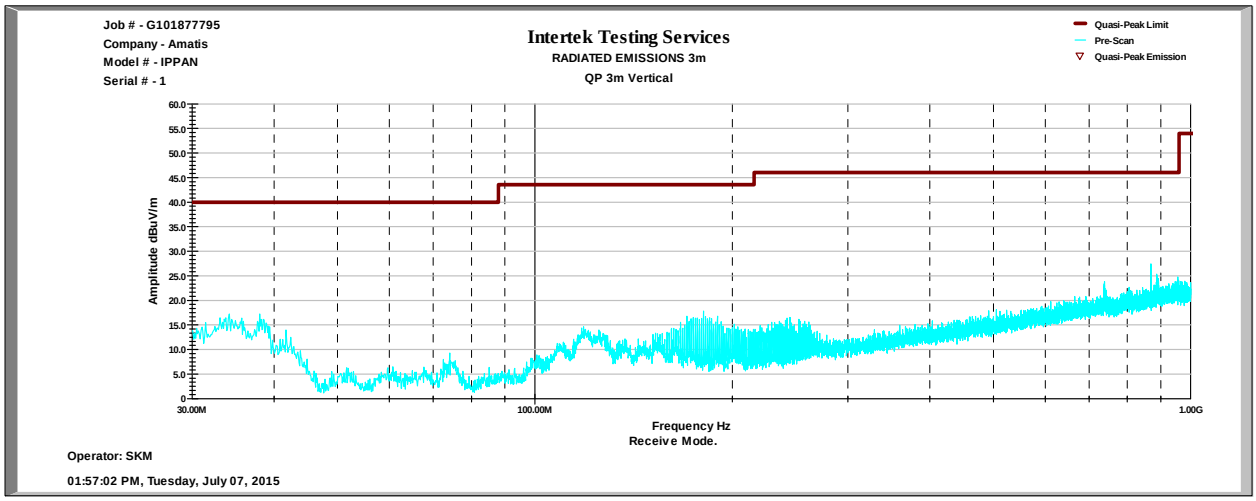
30 to 1000 Radiated Emi Whip Antenna Mid Ch. 3m Horiz



30 to 1000 Radiated Emi Whip Antenna Mid Ch. 3m Vert



30 to 1000 Radiated Emi RCVR Mode QP 3m Horizontal



30 to 1000 Radiated Emi RCVR Mode QP 3m Vertical

6.7 Data Sheet: 30 to 1000MHz Radiated Scans

30 to 1000 Radi Emi Ceramic Hi Ch Quasi-Peak Measurements 3m Horizontal

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
182.05	142.0	214.0	34.9	11.6	35.6	1.7	12.6	43.5	-30.9
241.02	134.0	194.0	32.1	12.9	35.5	1.9	11.3	46.0	-34.7
886.30	153.0	257.0	21.6	22.4	33.7	3.9	14.2	46.0	-31.8

30 to 1000 Radi Emi Ceramic Hi Ch Quasi-Peak Measurements 3m Vertical

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
33.20	115.0	25.0	15.7	18.8	35.0	0.7	-0.2	40.0	-40.2
183.50	121.0	151.0	15.4	11.6	35.6	1.7	6.9	43.5	-36.6
869.40	111.0	145.0	-7.8	22.3	33.8	3.8	7.6	46.0	-38.4

30 to 1000 Radi Emi Ceramic Lo Ch Quasi-Peak Measurements 3m Horizontal

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
33.19	162.0	79.0	19.6	19.8	35.0	0.7	5.1	40.0	-34.9
181.57	149.0	214.0	20.1	11.6	35.6	1.7	-2.2	43.5	-45.7
241.59	141.0	213.0	21.9	12.8	35.5	1.9	1.1	46.0	-44.9

30 to 1000 Radi Emi Ceramic Lo Ch Quasi-Peak Measurements 3m Vertical

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
38.60	105.0	66.0	19.6	14.8	35.1	0.7	0.0	40.0	-40.0
118.60	145.0	156.0	25.2	13.6	35.6	1.3	4.5	43.5	-39.0
186.70	115.0	166.0	26.6	11.5	35.6	1.7	4.2	43.5	-39.3
869.40	134.0	204.0	14.5	22.3	33.8	3.8	6.8	46.0	-39.2

30 to 1000 Radi Emi Ceramic Mid Ch Quasi-Peak Measurements 3m Horizontal

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
181.48	142.0	169.0	20.4	11.7	35.6	1.7	-1.9	43.5	-45.4
229.07	134.0	213.0	21.1	11.9	35.6	1.9	-0.6	46.0	-46.6

30 to 1000 Radi Emi Ceramic Mid Ch Quasi-Peak Measurements 3m Vertical

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
172.84	152.0	123.0	20.1	12.3	35.6	1.6	-1.6	43.5	-45.1
869.50	158.0	123.0	21.4	22.3	33.8	3.8	13.8	46.0	-32.2

30 to 1000 Radi Emi Whip Hi Chan Quasi-Peak Measurements 3m Horizontal

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
81.81	141.0	262.0	19.5	8.3	35.6	1.1	-6.7	40.0	-46.7
82.65	153.0	99.0	19.9	8.3	35.6	1.1	-6.2	40.0	-46.2
182.16	140.0	54.0	20.4	11.6	35.6	1.7	-1.9	43.5	-45.4
234.66	132.0	54.0	21.5	12.5	35.6	1.9	0.4	46.0	-45.7

30 to 1000 Radi Emi Whip Hi Chan Quasi-Peak Measurements 3m Vertical

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
183.37	153.0	32.0	21.0	11.6	35.6	1.7	-1.3	43.5	-44.8
241.35	160.0	39.0	21.5	12.1	35.5	1.9	-0.1	46.0	-46.1

30 to 1000 Radi Emi Whip Lo Chan Quasi-Peak Measurements 3m Horizontal

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
178.16	142.0	261.0	20.0	11.8	35.6	1.7	-2.1	43.5	-45.6
212.15	134.0	54.0	21.6	11.1	35.6	1.8	-1.1	43.5	-44.6
240.29	135.0	169.0	22.0	12.9	35.5	1.9	1.3	46.0	-44.8
258.36	133.0	12.0	20.7	12.8	35.5	2.0	0.0	46.0	-46.0

30 to 1000 Radi Emi Whip Lo Chan Quasi-Peak Measurements 3m Vertical

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
185.11	152.0	283.0	20.4	11.6	35.6	1.7	-1.9	43.5	-45.4
239.14	202.0	299.0	21.5	12.0	35.5	1.9	-0.2	46.0	-46.2

30 to 1000 Radi Emi Whip Mid Chan Quasi-Peak Measurements 3m Horizontal

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
182.30	142.0	218.0	20.7	11.6	35.6	1.7	-1.6	43.5	-45.1
232.40	134.0	198.0	21.3	12.2	35.6	1.9	-0.1	46.0	-46.1
244.00	134.0	13.0	21.8	12.7	35.5	1.9	0.9	46.0	-45.1
253.07	134.0	9.0	20.9	12.5	35.5	2.0	-0.2	46.0	-46.2

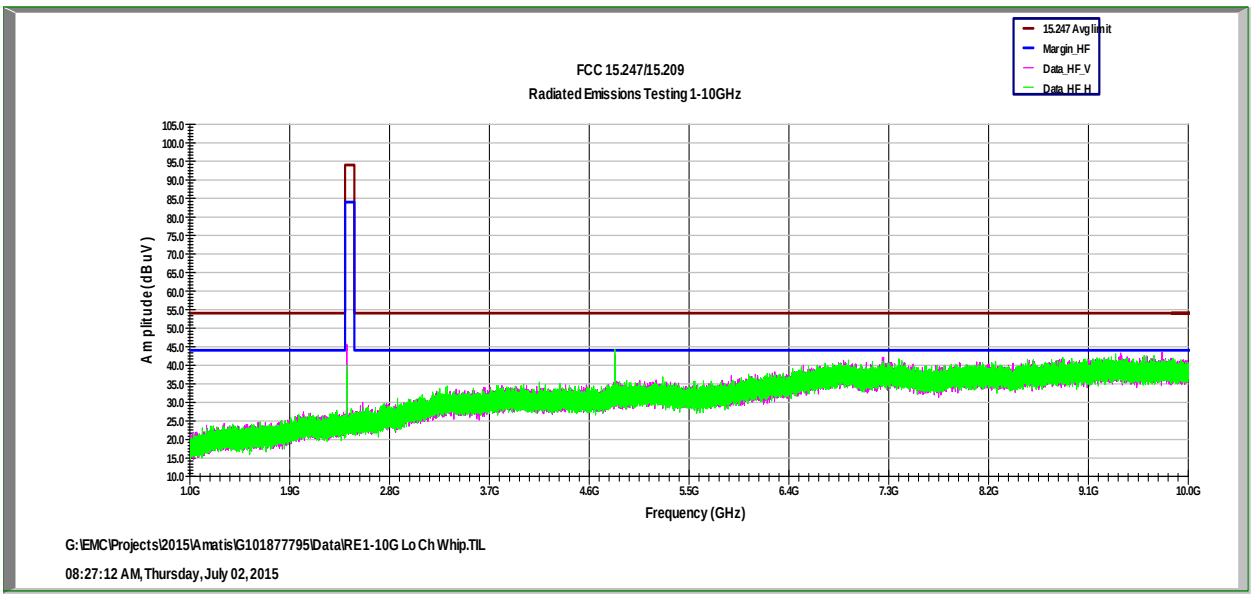
30 to 1000 Radi Emi Whip Mid Chan Quasi-Peak Measurements 3m Vertical

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
181.21	151.0	320.0	20.0	11.8	35.6	1.7	-2.1	43.5	-45.6
235.05	202.0	306.0	21.8	11.8	35.5	1.9	-0.1	46.0	-46.1

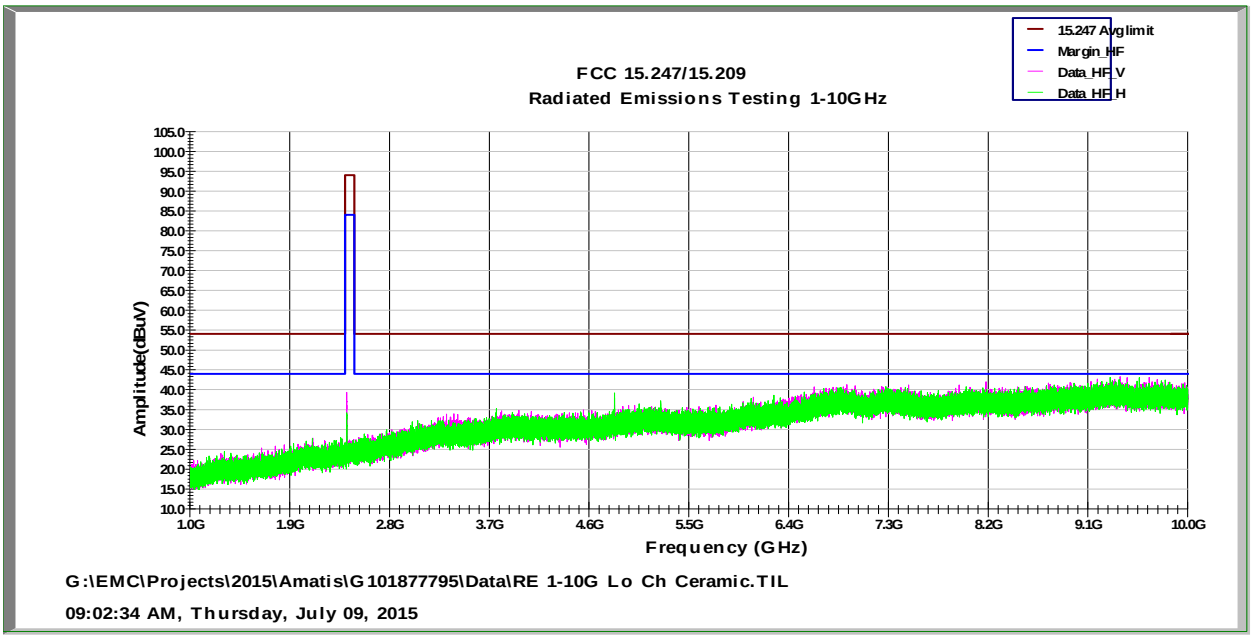
Results: Pass

Note: From 1 to 10 GHz testing was completed at 3 transmit frequencies to determine compliance. EUT was measured at 3m distance.

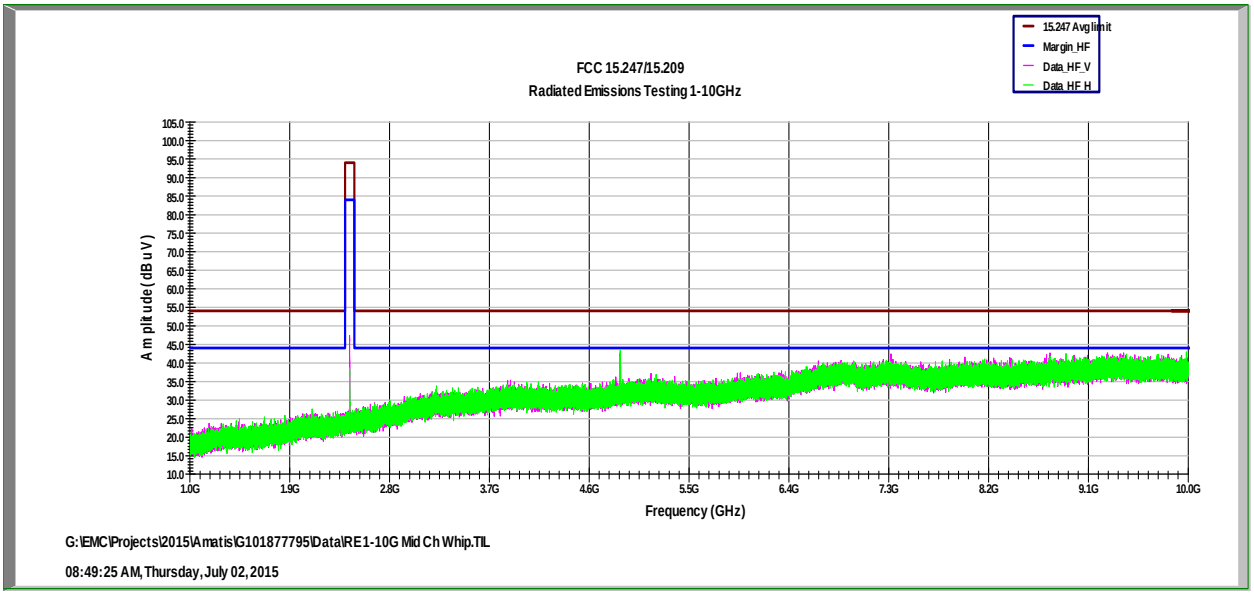
6.8 1 to 10GHz plots:



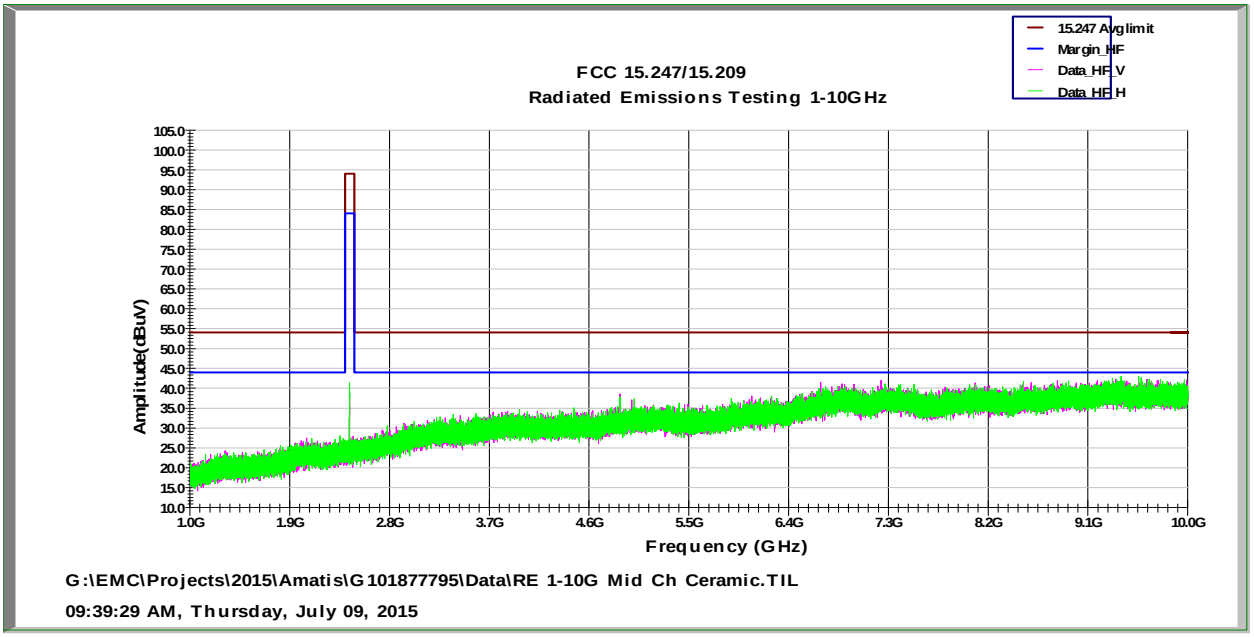
Low Channel, 1 to 10GHz Whip Antenna Scan Plot



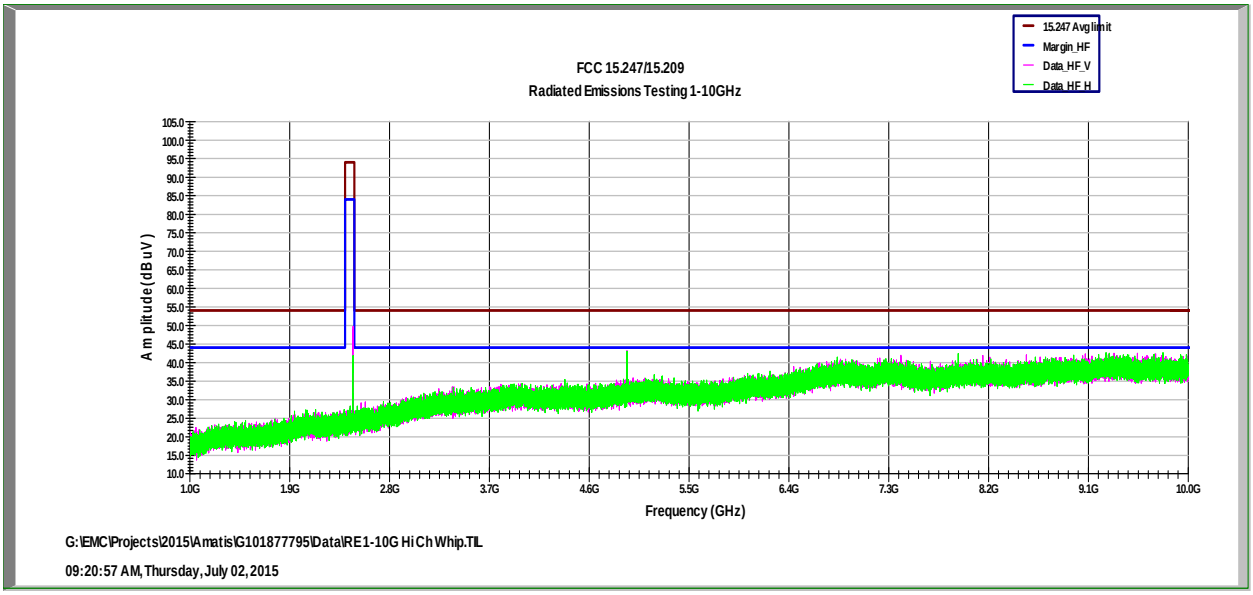
Low Channel, 1 to 10GHz Ceramic Antenna Scan Plot



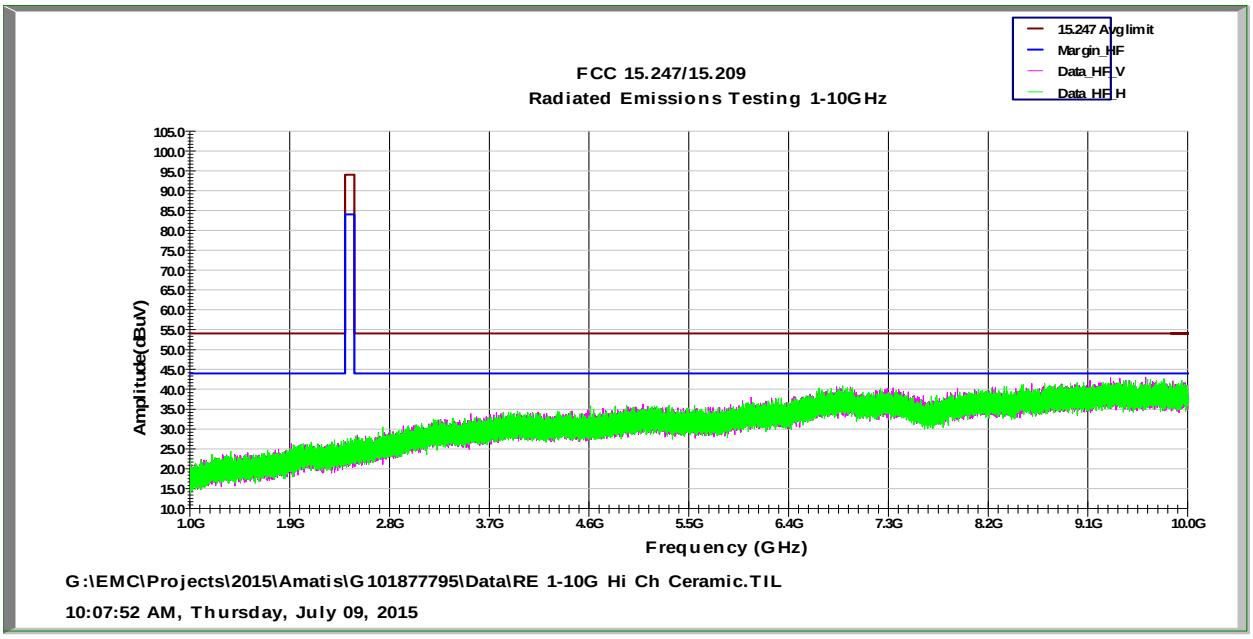
Mid Channel, 1 to 10GHz Whip Antenna Scan Plot



Mid Channel, 1 to 10GHz Ceramic Antenna Scan Plot

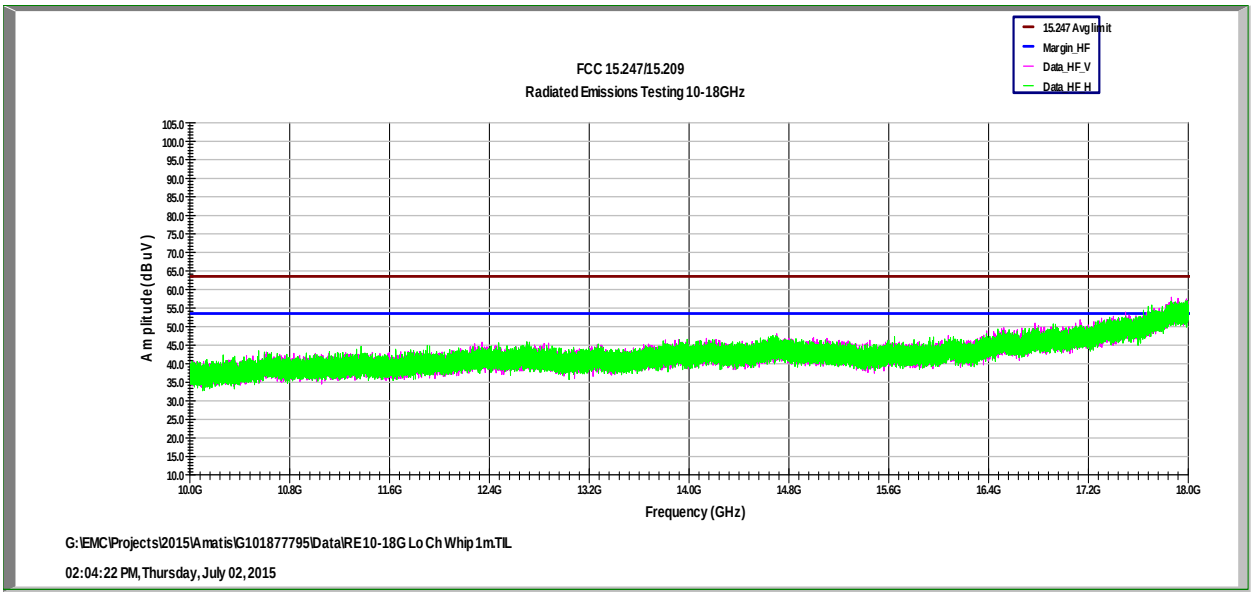


High Channel, 1 to 10GHz Whip Antenna Scan Plot

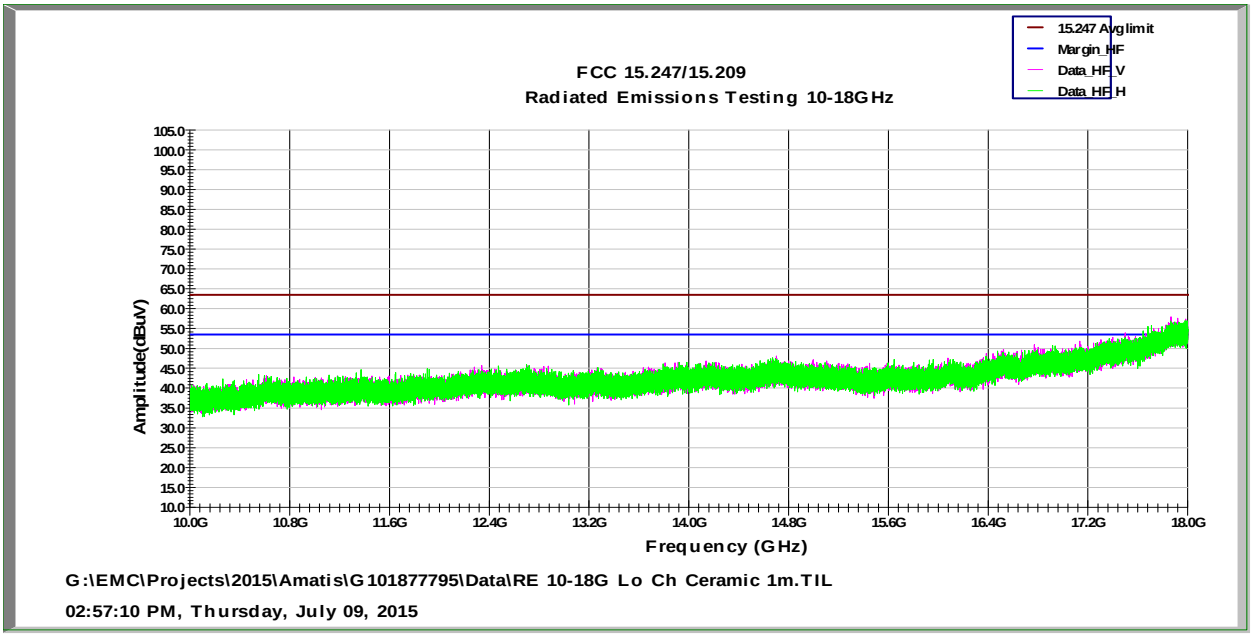


High Channel, 1 to 10GHz Ceramic Antenna Scan Plot

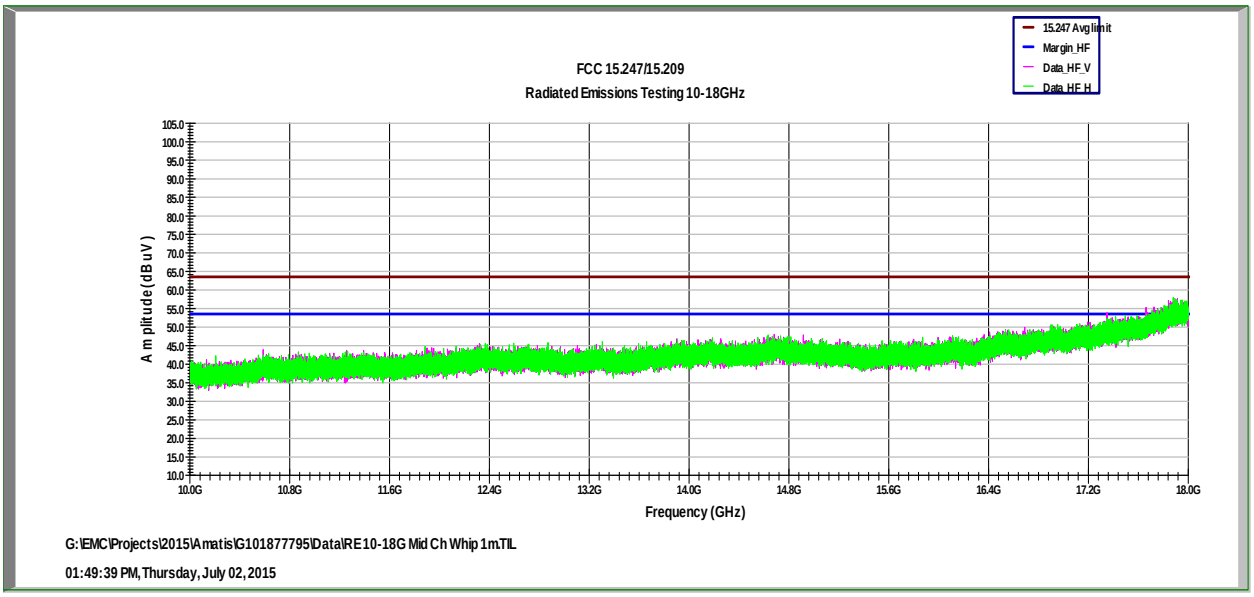
Note: From 10 to 26.5 GHz testing was completed at 3 transmit frequencies to determine compliance. EUT was measured at 1m distance.



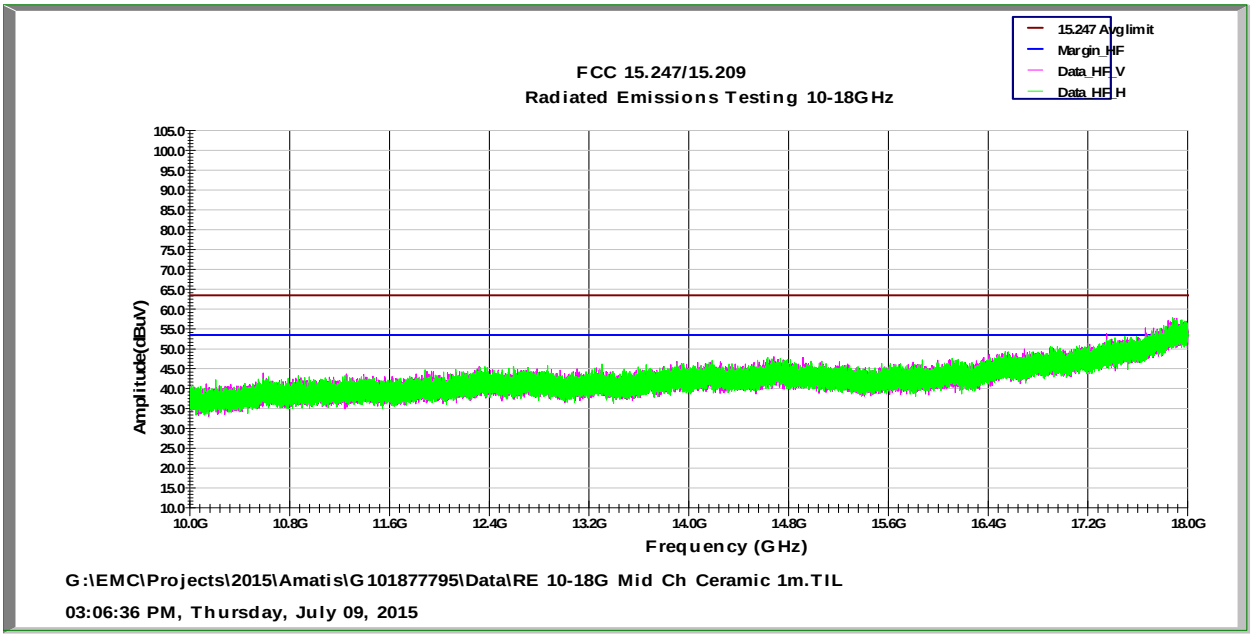
Low Channel, 10 to 18GHz Whip Antenna Scan Plot



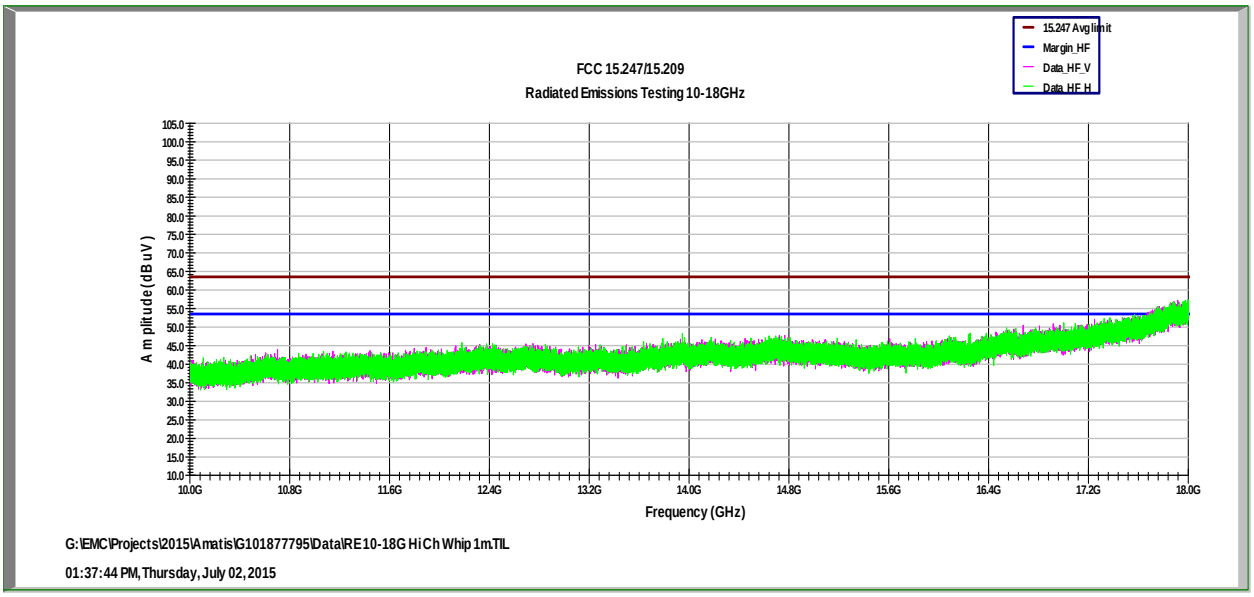
Low Channel, 10 to 18GHz Ceramic Antenna Scan Plot



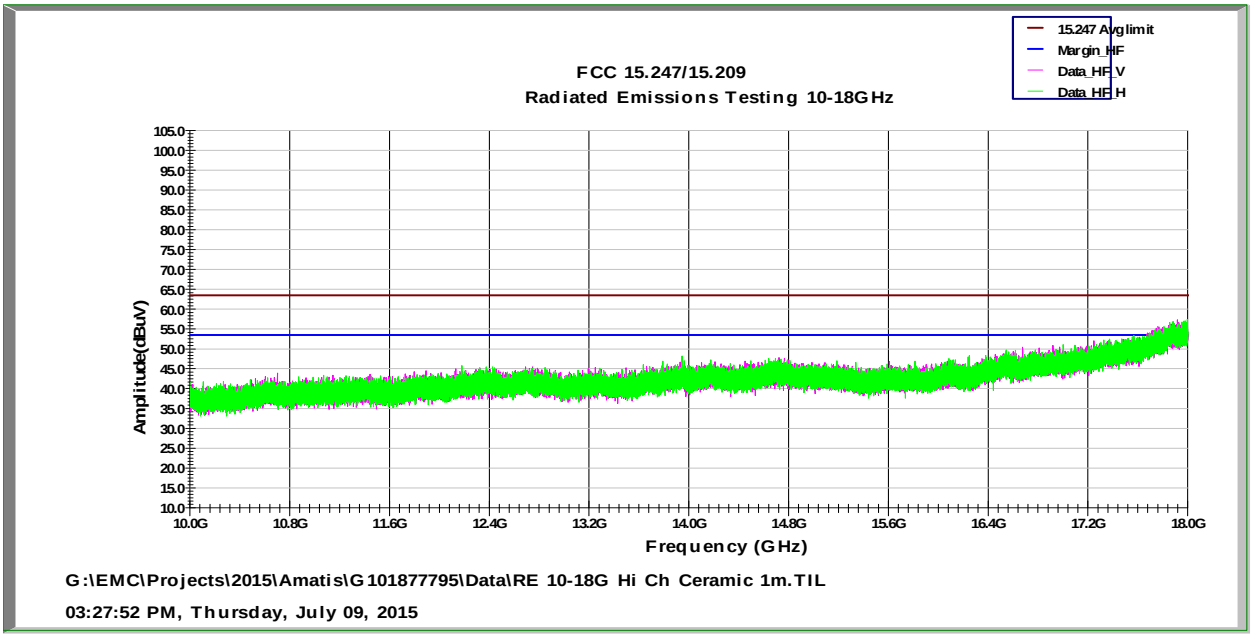
Mid Channel, 10 to 18GHz Whip Antenna Scan Plot



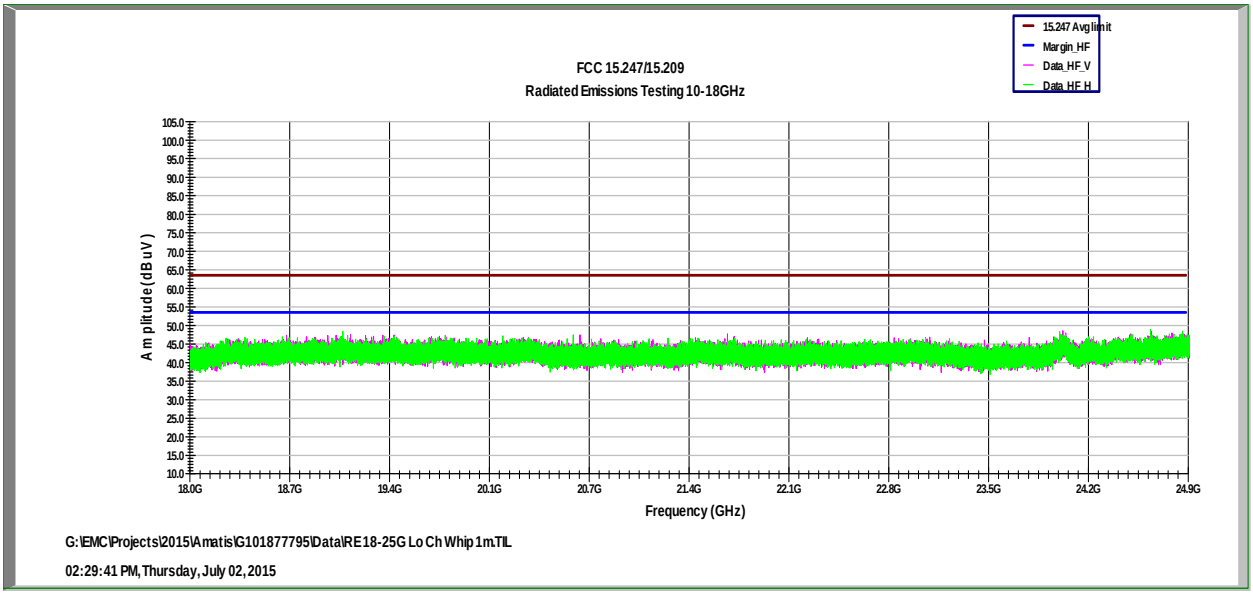
Mid Channel, 10 to 18GHz Ceramic Antenna Scan Plot



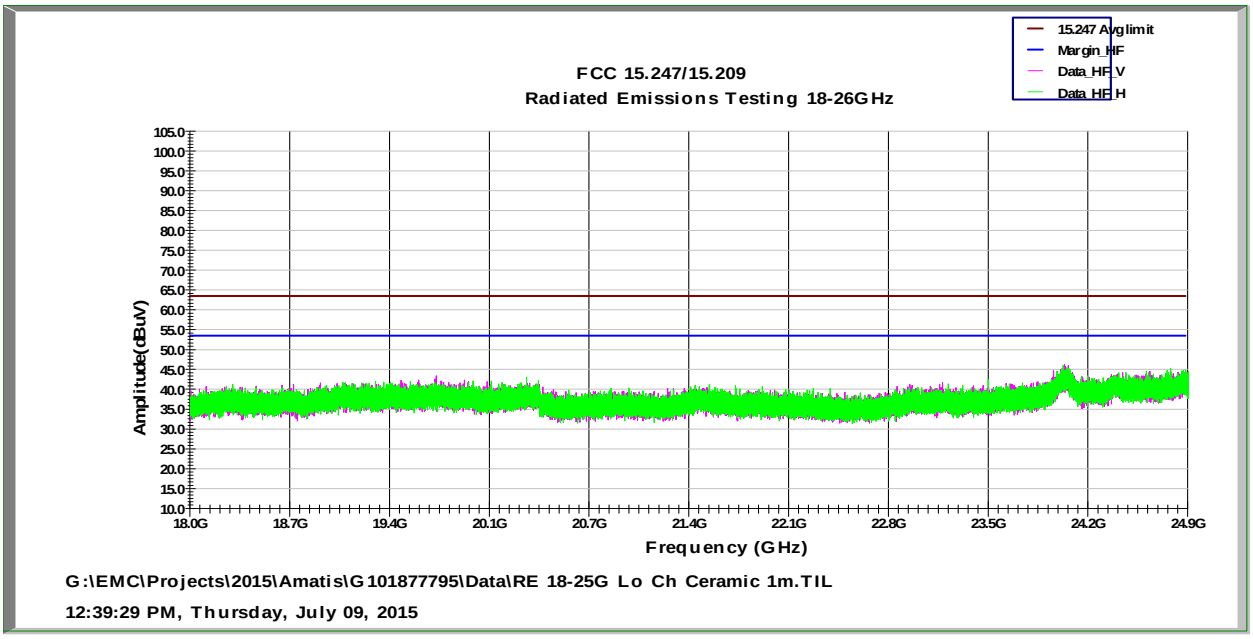
High Channel, 10 to 18GHz Whip Antenna Scan Plot



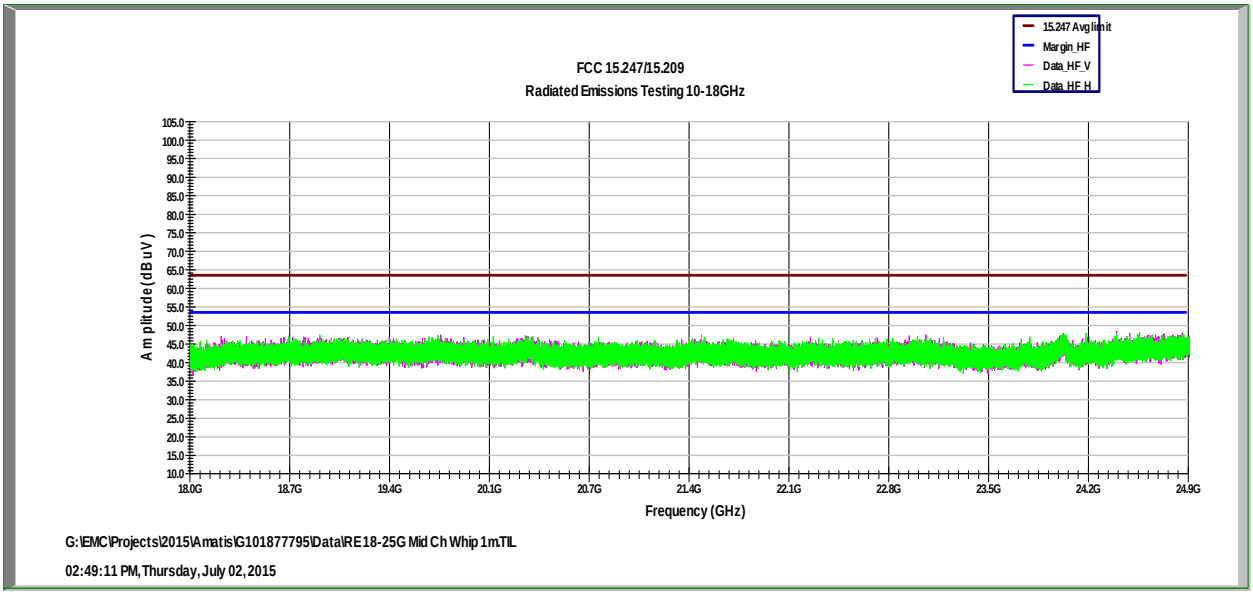
High Channel, 10 to 18GHz Ceramic Antenna Scan Plot



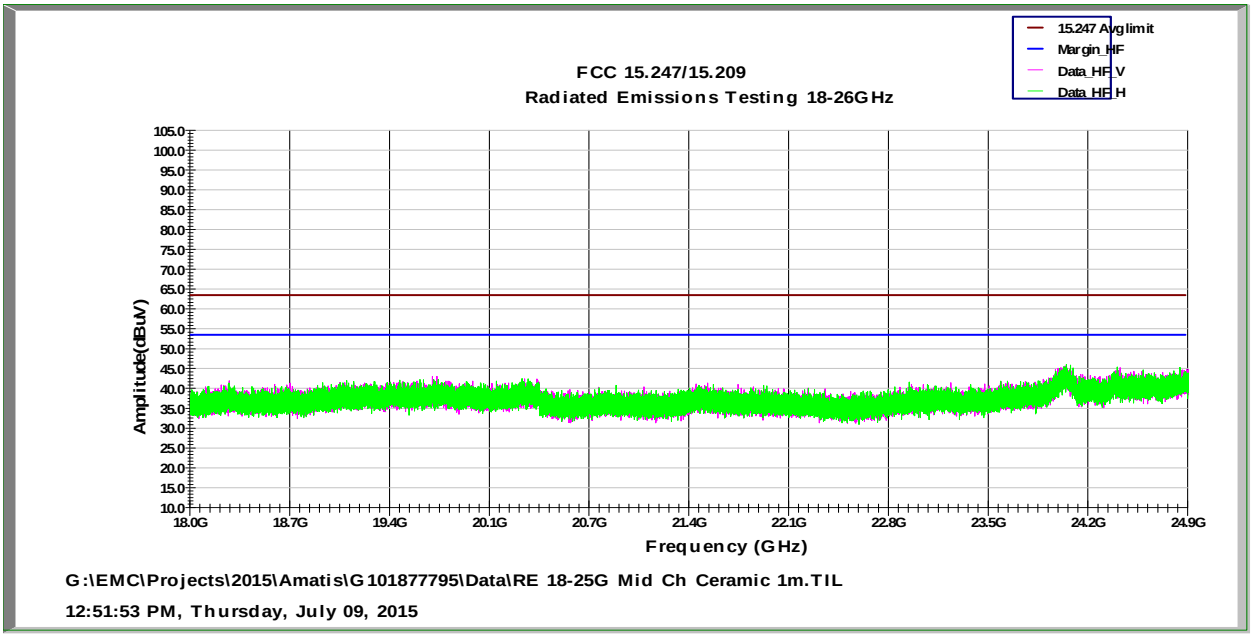
Low Channel, 18 to 26.5GHz Whip Antenna Scan Plot



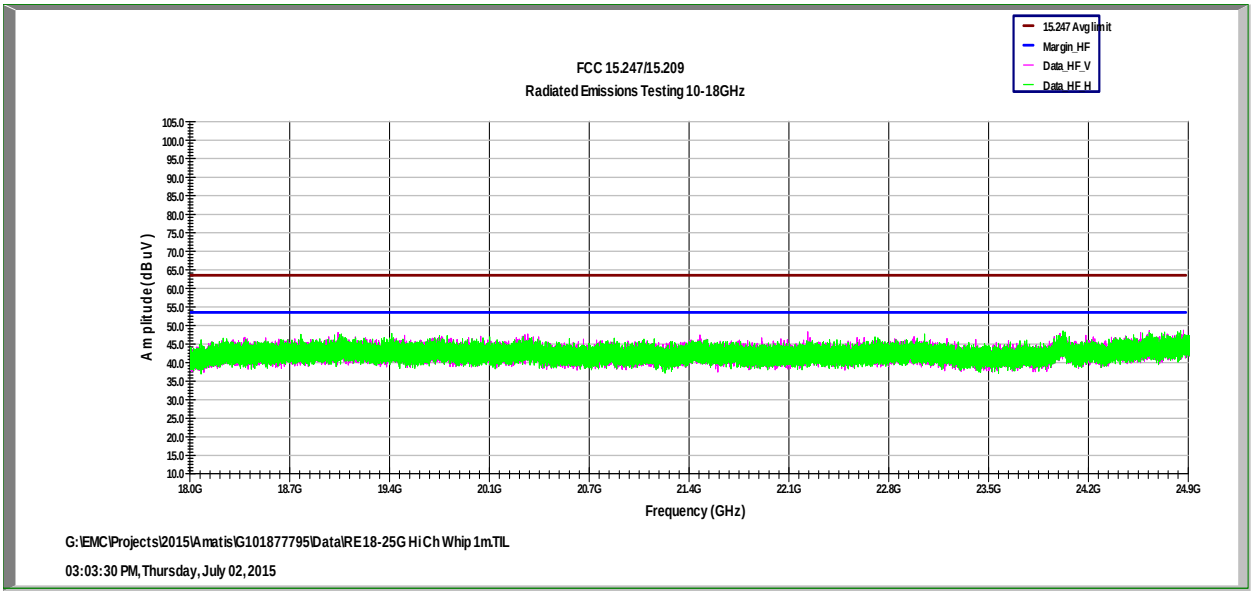
Low Channel, 18 to 26.5GHz Ceramic Antenna Scan Plot



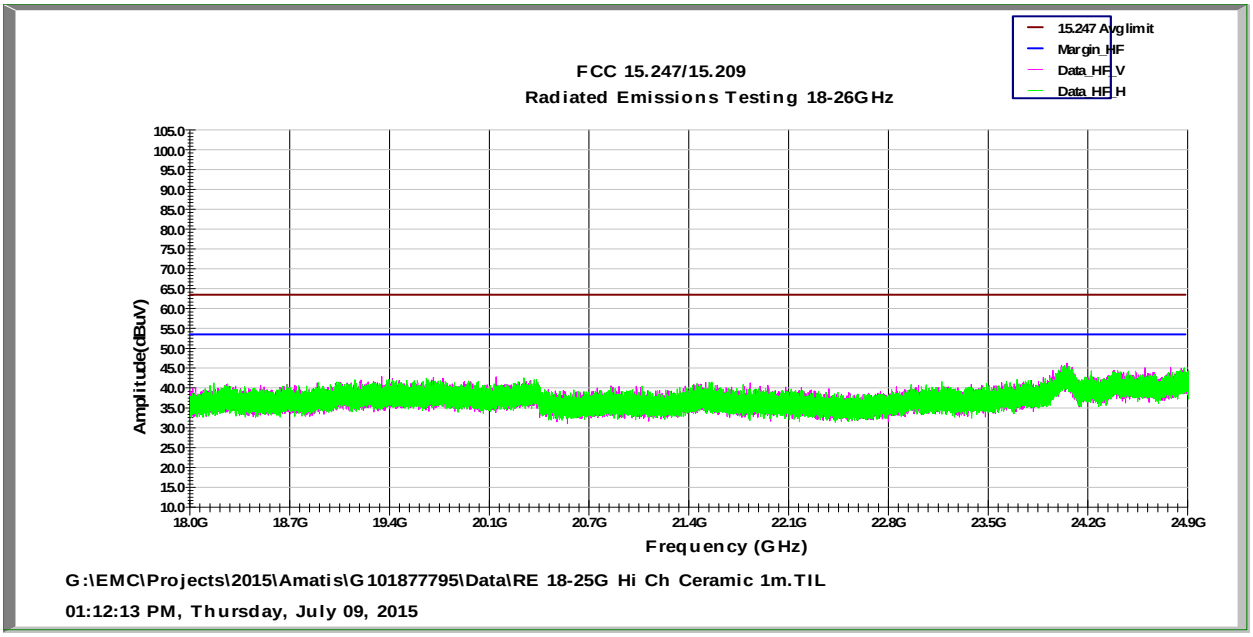
Mid Channel, 18 to 26.5GHz Whip Antenna Scan Plot



Mid Channel, 18 to 26.5GHz Ceramic Antenna Scan Plot



High Channel, 18 to 26.5GHz Whip Antenna Scan Plot



High Channel, 18 to 26.5GHz Ceramic Antenna Scan Plot

6.9 Data Sheet: 1 to 26.5GHz Radiated/Restricted Band Scans

Whip Antenna

A	B	C	D	E	F	G	H	I	J	K
Antenna Polarity (H/V)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Duty Cycle Factor dB	Net dB(uV/m)	3m Limit dB(uv/m)	Margin dB	Detector
Hi Channel										
H	4939.000	40.5	33.3	7.1	38.7	0.0	42.3	74.0	-31.7	Pk
H	4939.000	34.2	33.3	7.1	38.7	0.0	36.0	54.0	-18.0	Av
V	4939.000	41.2	33.3	7.1	38.7	0.0	43.0	74.0	-31.0	Pk
V	4939.000	34.6	33.3	7.1	38.7	0.0	36.4	54.0	-17.6	Av
H	7414.000	30.4	37.1	8.9	37.0	0.0	39.4	74.0	-34.6	Pk
H	7414.000	25.2	37.1	8.9	37.0	0.0	34.2	54.0	-19.8	Av
V	7414.000	33.0	37.1	8.9	37.0	0.0	42.0	74.0	-32.0	Pk
V	7414.000	27.5	37.1	8.9	37.0	0.0	36.5	54.0	-17.5	Av
Mid Channel										
H	4879	43.5	33.3	7.1	38.7	0.0	45.3	74.0	-28.7	Pk
H	4879	36.4	33.3	7.1	38.7	0.0	38.2	54.0	-15.8	Av
V	4879	43.2	33.3	7.1	38.7	0.0	45.0	74.0	-29.0	Pk
V	4879	36.2	33.3	7.1	38.7	0.0	38.0	54.0	-16.0	Av
H	7321	26.8	37.1	8.9	37.0	0.0	35.8	74.0	-38.2	Pk
H	7321	22.5	37.1	8.9	37.0	0.0	31.5	54.0	-22.5	Av
V	7321	34.2	37.1	8.9	37.0	0.0	43.2	74.0	-30.8	Pk
V	7321	26.2	37.1	8.9	37.0	0.0	35.2	54.0	-18.8	Av
H	9812	28.8	38.5	10.4	37.6	0.0	40.1	74.0	-33.9	Pk
H	9812	21.5	38.5	10.4	37.6	0.0	32.8	54.0	-21.2	Av
V	9812	29	38.5	10.4	37.6	0.0	40.3	74.0	-33.7	Pk
V	9812	23.2	38.5	10.4	37.6	0.0	34.5	54.0	-19.5	Av
Low Channel										
H	4829.000	43.1	33.3	7.1	38.7	0.0	44.9	74.0	-29.1	Pk
H	4829.000	36.2	33.3	7.1	38.7	0.0	38.0	54.0	-16.0	Av
V	4829.000	43.3	33.3	7.1	38.7	0.0	45.1	74.0	-28.9	Pk
V	4829.000	36.3	33.3	7.1	38.7	0.0	38.1	54.0	-15.9	Av
H	9661.000	31.5	38.3	10.3	37.5	0.0	42.6	74.0	-31.4	Pk
H	9661.000	30.8	38.3	10.3	37.5	0.0	41.9	54.0	-12.1	Av
V	9661.000	32.2	38.3	10.3	37.5	0.0	43.3	74.0	-30.7	Pk
V	9661.000	31.1	38.3	10.3	37.5	0.0	42.2	54.0	-11.8	Av
Calculations		G=C+D+E+F		I = G - H						

Results: Pass

Ceramic Antenna

A	B	C	D	E	F	G	H	I	J	K
Antenna Polarity (H/V)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Duty Cycle Factor dB	Net dB(uV/m)	3m Limit dB(uv/m)	Margin dB	Detector
Hi Channel										
H	4939.000	29.9	33.3	7.1	38.7	0.0	28.8	74.0	-39.8	Pk
H	4939.000	23.2	33.3	7.1	38.7	0.0	21.5	54.0	-26.6	Av
V	4939.000	28.3	33.3	7.1	38.7	0.0	26.6	74.0	-34.8	Pk
V	4939.000	22.7	33.3	7.1	38.7	0.0	21.0	54.0	-25.3	Av
H	7414.000	43.2	37.1	8.9	37.0	0.0	34.2	74.0	-34.9	Pk
H	7414.000	37.5	37.1	8.9	37.0	0.0	28.5	54.0	-21.8	Av
Mid Channel										
H	4879	44	33.3	7.1	38.7	0.0	42.3	74.0	-31.7	Pk
H	4879	37.9	33.3	7.1	38.7	0.0	36.2	54.0	-17.8	Av
V	4879	41.2	33.3	7.1	38.7	0.0	39.5	74.0	-34.5	Pk
V	4879	35.1	33.3	7.1	38.7	0.0	33.4	54.0	-20.6	Av
H	7321	47.4	37.1	8.9	37.0	0.0	40.2	74.0	-33.8	Pk
H	7321	44.4	37.1	8.9	37.0	0.0	35.4	54.0	-18.6	Av
V	7321	45.2	37.1	8.9	37.0	0.0	38.2	74.0	-35.8	Pk
V	7321	42.4	37.1	8.9	37.0	0.0	33.4	54.0	-20.6	Av
Low Channel										
H	4939.000	35.9	33.3	7.1	38.7	0.0	34.2	74.0	-39.8	Pk
H	4939.000	29.1	33.3	7.1	38.7	0.0	27.4	54.0	-26.6	Av
V	4939.000	40.9	33.3	7.1	38.7	0.0	39.2	74.0	-34.8	Pk
V	4939.000	30.4	33.3	7.1	38.7	0.0	28.7	54.0	-25.3	Av
H	7414.000	30.1	37.1	8.9	37.0	0.0	39.1	74.0	-34.9	Pk
H	7414.000	23.2	37.1	8.9	37.0	0.0	32.2	54.0	-21.8	Av
Calculations		G=C+D+E+F		I = G - H						

Results: Pass

7 Radiated Spurious Emissions (Receiver)

7.1 Test Limits

§ 15.109: Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency of emission (MHz)	Field strength (microvolts/meter)	Field strength (dBuV/m)
30–88	100	40
88–216	150	43.5
216–960	200	46
Above 960	500	54

These limits are identical to those in RSS-GEN

This testing was performed at Intertek Plano, located at 1809 10th St. Suite #400, Plano TX 75074.

7.2 Test Procedure

ANSI C63.4: 2003

7.3 Example of Field Strength Calculation Method:

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculations are listed below:

Formula:
FS = RA + AF + CF

FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB
CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

RA = 19.48 dBµV
AF = 18.52 dB
CF = 0.78 dB

FS = 19.48 + 18.52 + 0.78 = 38.78 dBµV/m
Level in µV/m = Common Antilogarithm [(38.78 dBµV/m)/20] = 86.89 µV/m

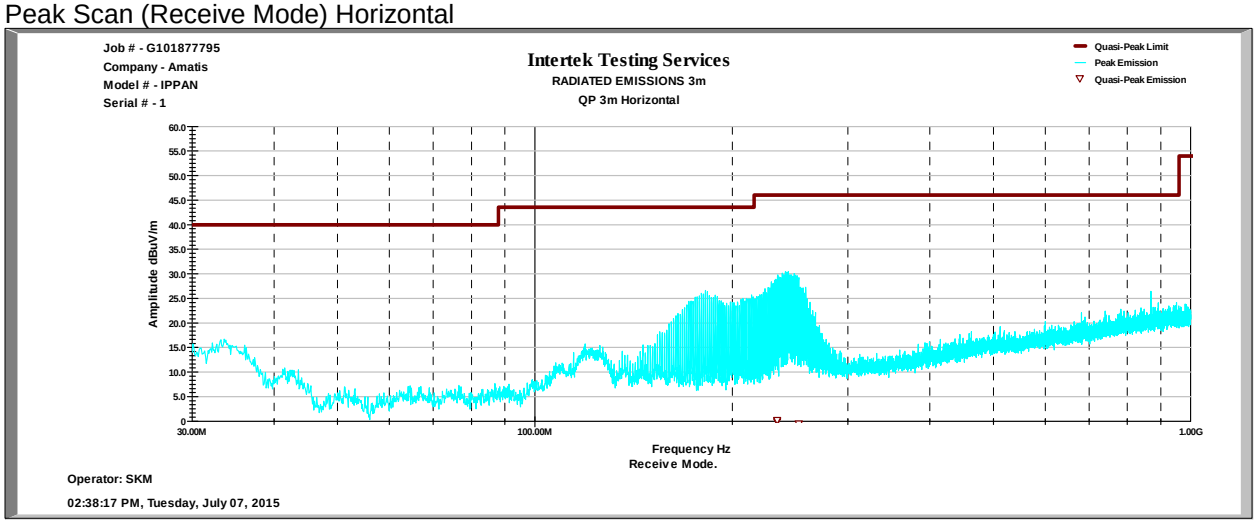
7.4 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Receiver rated: 10KHz-7GHz	Agilent	E7405A	A4205062388	08/24/2013	08/24/2014
DC to 18GHz Coaxial RF Cable 3M Em Chamber	MegaPhase	F520NKNK315	11111301002	10/13/2014	10/13/2015
SMA RF CABLE	Insulated Wire Inc.	SPS-2303-720-SPS	804	08/08/2014	08/08/2015
Preamplifier 1-1000 MHz 33dB typical gain	Com Power	PAM-103	441031	06/25/2015	06/25/2016
Antenna - 20 MHz to 6 GHz	Sunol Sciences	JB6	A101612	03/04/2014	03/04/2015
Rental	EMI Receiver rated: 20Hz-26.5GHz	R & S	ESR-26	102665	6/25/2015
Radiated Emissions TILE profile	Intertek	1130-002	Ver 10	VBU	VBU

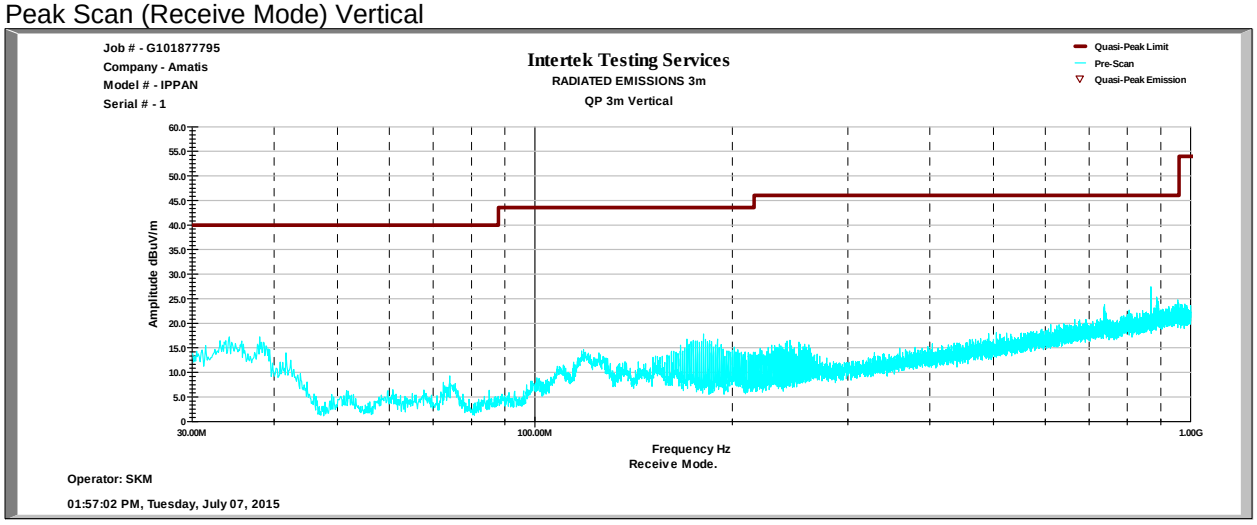
7.5 Results:

All spurious emissions with the test sample in receive mode were below the limits specified in Part 15.109 for a class B digital device and RSS-GEN Section 6.1. All peak detected emissions were at least 15dB below the limit.

Peak Scan (Receive Mode) Horizontal



Peak Scan (Receive Mode) Vertical



30 to 1000 Radi Emi RCVR Mode Quasi-Peak Measurements 3m Horizontal

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
179.38	141.0	34.0	20.0	11.8	35.6	1.7	-2.2	43.5	-45.7
234.41	133.0	12.0	21.2	12.4	35.6	1.9	-0.0	46.0	-46.1
234.41	133.0	14.0	21.4	12.4	35.6	1.9	0.2	46.0	-45.8
252.78	133.0	9.0	20.6	12.5	35.5	2.0	-0.4	46.0	-46.5

30 to 1000 Radi Emi RCVR Mode Quasi-Peak Measurements 3m Vertical

Freq. MHz	Antenna Height cm	Azimuth degrees	Receiver Reading dBuV/m	Antenna Factor dB	PreAmp Factor dB	Cable Factor dB	Final QP Reading dBuV/m	Limit QP dBuV/m	Margin QP dB
118.60	123	26.0	21.6	13.6	35.6	1.3	-0.1	43.5	-43.6
180.70	56	32.0	23.5	11.8	35.6	1.7	1.4	43.5	-42.1
869.50	133	9.0	15.4	22.3	33.8	3.8	7.7	46.0	-38.3

Test Personnel:	Shawn McGuinness	Test Date:	July 10, 2015
Product Standard:	FCC 47CFR 15B	Limit Applied:	B
Input Voltage:	Battery	Ambient Temperature:	23.8 ºC
		Relative Humidity:	52.8 %
Pretest Verification w/ Ambient Signals or BB Source:	yes	Atmospheric Pressure:	996.00 mbars

Deviations, Additions, or Exclusions: None

8 AC Power Line Conducted Emissions

Not Applicable: EUT is Battery-powered

9 Antenna Requirement

9.1 Method

The test methods used comply with ANSI C63.10. Unless otherwise stated no deviations were made from FCC CFR47 15.203.

This testing was performed at Intertek Plano, located at 1809 10th St. Suite #400, Plano TX 75074.

9.2 Test Requirement/Specification

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

- FCC 15.203

9.3 Results:

The product utilizes an integral antenna – not user accessible; therefore, the sample tested was found to comply.

10 RF Exposure Evaluation

MPE Evaluation
The EUT is a wireless device used in a mobile application, at least 20 cm from any body part of the user or nearby persons.

The maximum Peak EIRP calculated is 2.35 dBm or 1.72 mW; therefore, to comply with RF Exposure Requirement, the MPE is calculated.

The Power Density can be calculated using the formula

$$S = EIRP/ 4\pi D_2$$

Where: S is Power Density in W/m_2
D is the distance from the antenna.

It is considered that 20 cm is the minimum distance that user can go closest to the EUT.
At 20 cm, S = S = 0.00342 W/m2, which is below the MPE Limit of 10 W/m2

11 RF Exposure Requirements

11.1 Method

The test methods used comply with ANSI C63.10. Unless otherwise stated no deviations were made from FCC OET 65 & IC RSS-102.

This testing was performed at Intertek Plano, located at 1809 10th St. Suite #400, Plano TX 75074.

11.2 Test Requirement/Specification

- FCC OET Bulletin 65/ KDB 447498
- RSS-102

11.3 Results:

The sample tested was found to comply.

12 Measurement Uncertainty

The measured value related to the corresponding limit will be used to decide whether the equipment meets the requirements.

The measurement uncertainty figures were calculated and correspond to a coverage factor of k = 2, providing a confidence level of respectively 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian).

Measurement uncertainty Table

Parameter	Uncertainty	Notes
Radiated emissions, 30 to 1000 MHz	±3.9dB	
Radiated emissions, 1 to 18 GHz	±4.2dB	
Radiated emissions, 18 to 40 GHz	±4.3dB	
Power Port Conducted emissions, 150kHz to 30 MHz	±2.8dB	

13 Revision History

Revision Level	Date	Report Number	Notes
0	July 14 1, 2014	101877795DAL-001	Original Issue