25800 Commercentre Drive
Lake Forest, CA 92630 USA

Telephone: (949) 448-4100
Facsimile: (949) 448-4111
www.intertek-etlsemko.com

TEST REPORT

Report Number:	**101289472LAX-001a**
Project Number:	**G101289472**
Report Issue Date:	**10/29/2013**
Product Name:	**Compact Console Unit**
Model Number:	**Remote Control Receiver SCP680135**
FCCID:	**VGESCP135R**
ICID:	**7228A-SCP135R**
Standards:	**FCC Part 15 Subpart C (15.247)** **FCC Part 15, Subpart B** **Industry Canada RSS-210 Issue 8** **Industry Canada ICES-003**
Radios Under Test:	**Low Energy Bluetooth (BT4.0)**

Tested by:
Intertek Testing Services NA, Inc.
25800 Commercentre Drive
Lake Forest, CA 92630 USA

Client:
Abbott Medical Optics, Inc.
1700 East Saint Andrew Place
Santa Ana, CA 92705 USA

Report prepared by

Mosin Dean
EMC Project Engineer

Report reviewed by

Krishna K Vemuri
EMC Senior Staff Engineer

TABLE OF CONTENTS

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- Lake Forest is located at 25800 Commercentre Drive, Lake Forest CA. 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.

2 Test Summary

Page	Test full name	FCC Reference	IC Reference	Result
6	Peak Conducted Power	§ 15.247(b)(3)(4)	RSS-210 (A8.4)	Pass
9	Occupied Bandwidth	§ 15.247(a)(2)	RSS-210 (A8.2), RSS-GEN (4.6.1)	Pass
16	Conducted Spurious Emissions	§ 15.247(d)	RSS-210 (A8.5)	Pass
21	Power Spectral Density	§ 15.247(e)	RSS-210 (A8.2b)	Pass
24	Radiated Spurious Emissions (Transmitter)	§ 15.247(d), § 15.209, and § 15.205	RSS-210 (2.2) (A8.5)	Pass
32	Radiated Emission from Digital Parts and Receiver	§ 15.109	RSS-Gen (6.1)	Pass
39	AC Power line Conducted Emissions	§ 15.107, § 15.207	RSS-Gen (7.2.4)	Pass
45	Antenna Requirement per FCC Part 15.203	§ 15.203	RSS-Gen (7.1.2)	Pass
46	RF Exposure Evaluation	15.247(i)	RSS-102	Pass

3 Description of Equipment Under Test

Equipment Under Test	
Manufacturer	Abbott Medical Optics
Model Number	Remote Control Receiver SCP680135
Serial Number	130322040
FCC Identifier	VGESCP135R
IC Identifier	7228A-SCP135R
Receive Date	08/16/2013
Test Start Date	08/16/2013
Test End Date	08/30/2013
Device Received Condition	Good
Test Sample Type	Production
Frequency Band	2402MHz – 2480MHz
Mode(s) of Operation	BT4.0
Modulation Type	GFSK
Transmission Control	Test Commands
Test Channels	0, 19, 39 (2402, 2440, 2480 MHz)
Antenna Type (15.203)	Internal, Chip Antenna, Maximum Antenna Gain= 2.5 dBi
Power Supply	5 VDC USB connection

Description of Equipment Under Test
The Compact Console Unit is a Bluetooth Low Energy receiver unit, with transceiver capabilities, operated in conjunction within with the Compact Intuitiv Ophthalmic Surgery System.

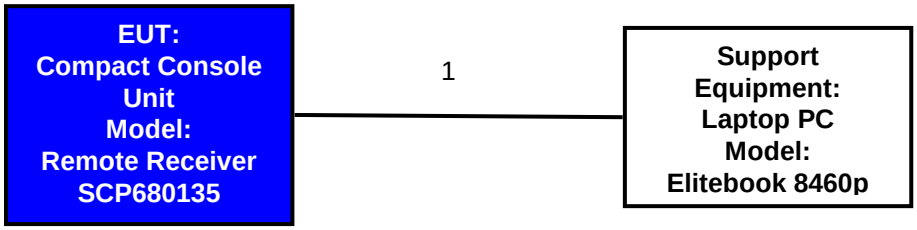
Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Transmitting BT4.0 Signal on low mid or high channels
2	Receive / idle mode

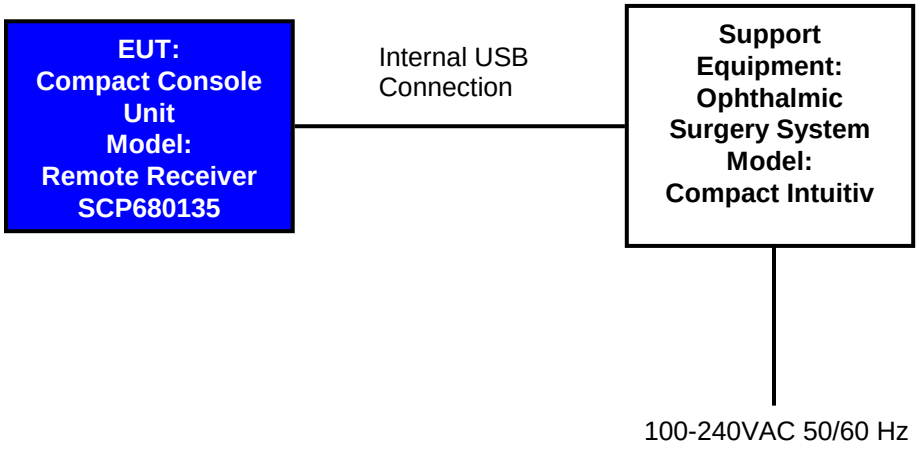
3.1 System setup including cable interconnection details, support equipment and simplified block diagram

3.2 EUT Block Diagram:

Transmitter Test Setup:



Receiver/Digital Parts Test Setup:



3.3 Cables:

Cables				
No.	Description	Length	Shielding	Ferrites
1	USB Cable	3 m	Yes	No

3.4 Support Equipment:

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Laptop PC	HP	Elitebook 8460p	CNU2202CWV
Ophthalmic Surgery System	Abbott Medical Optics	Compact Intuitiv	P023

4 Peak Conducted Power

4.1 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.

4.2 Test Procedure:

ANSI C63.10: 2009 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247). The peak output power was measured using the channel power function of the spectrum analyzer.

4.3 Test Equipment Used:

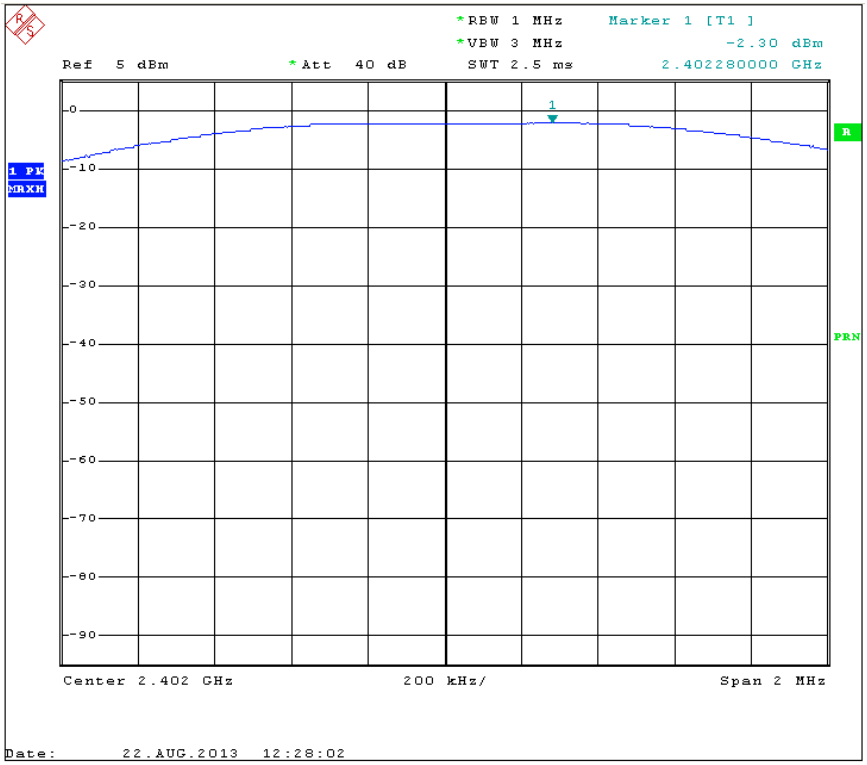
Description	Serial Number	Manufacturer	Model	IID	Cal. Date	Cal. Due
Spectrum Analyzer	1093-4495-40	Rohde&Schwarz	FSP	690	04/11/2013	04/11/2014

4.4 Results:

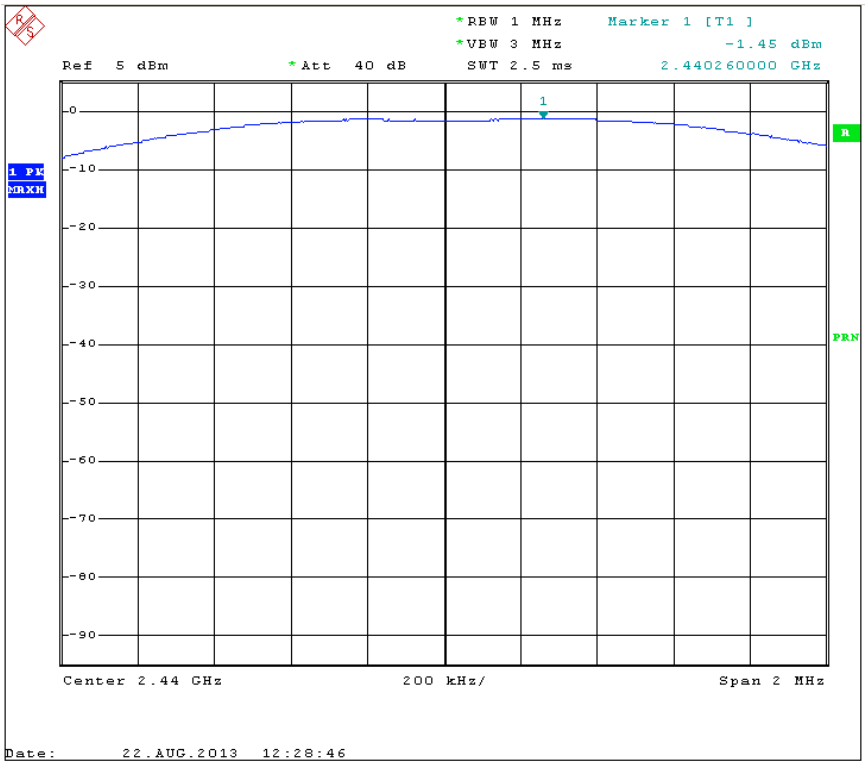
The peak output power measurements were all below the 30dBm limit.

Mode	Channel Number	Frequency (MHz)	Peak Output Power (dBm)	Limit (dBm)	Result
BT4.0	0	2402	-2.30	30	Pass
BT4.0	19	2440	-1.45	30	Pass
BT4.0	39	2480	-0.76	30	Pass

4.5 Test Plots:

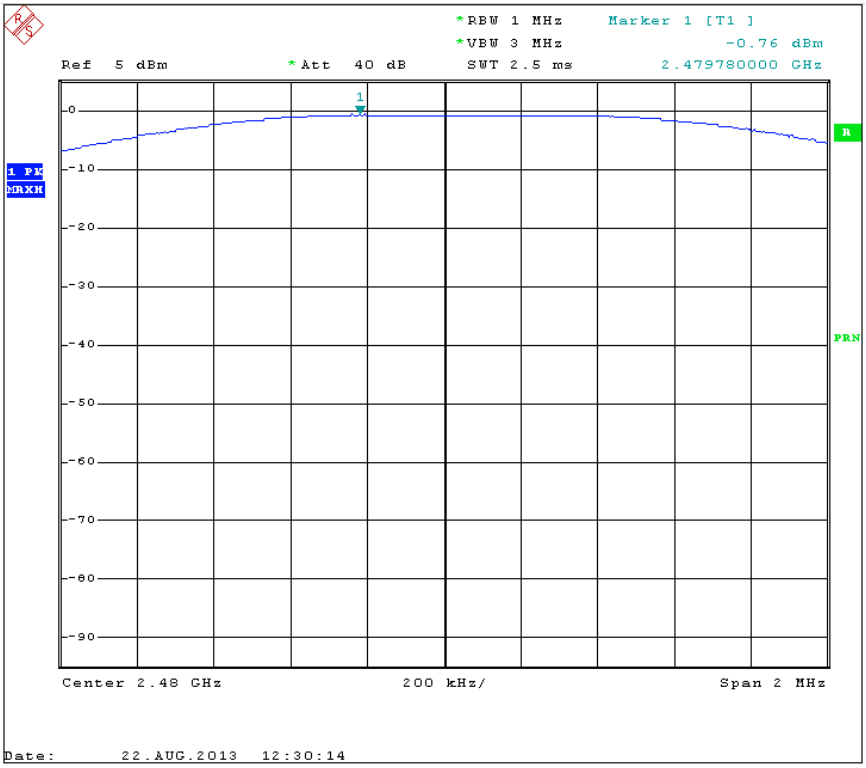


Peak Output Power, Low Channel



Peak Output Power, Mid Channel

4.6 Test Plots:



Peak Output Power, High Channel

5 Occupied Bandwidth

5.1 Test Limits

§ 15.247(a)(2): For digital modulation systems, the minimum 6dB bandwidth shall be at least 500kHz.

5.2 Test Procedure:

ANSI C63.10: 2009 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

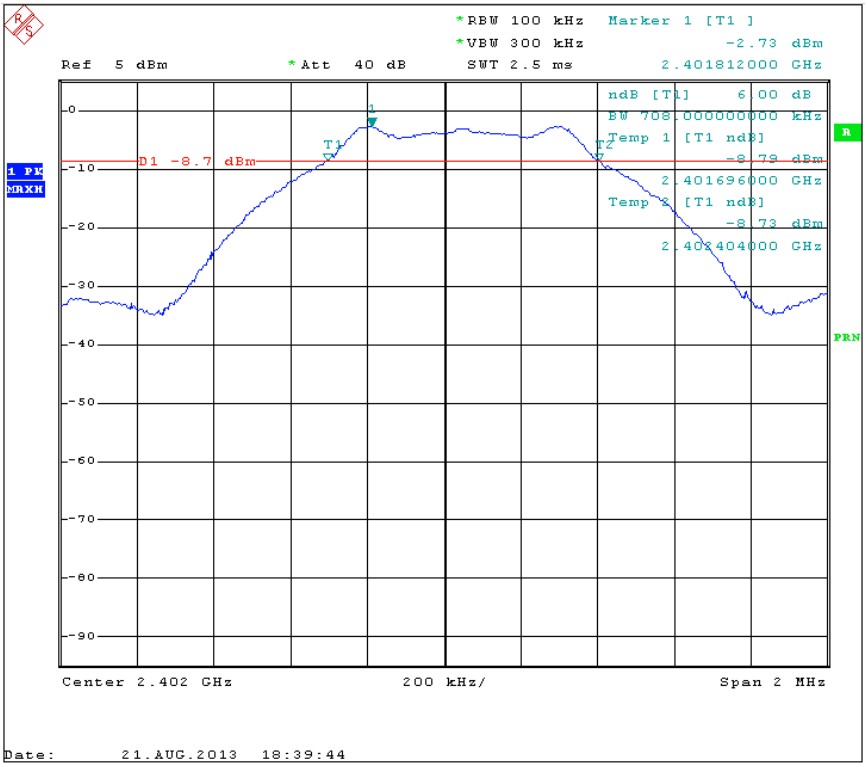
5.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	IID	Cal. Date	Cal. Due
Spectrum Analyzer	1093-4495-40	Rohde&Schwarz	FSP	690	04/11/2013	04/11/2014

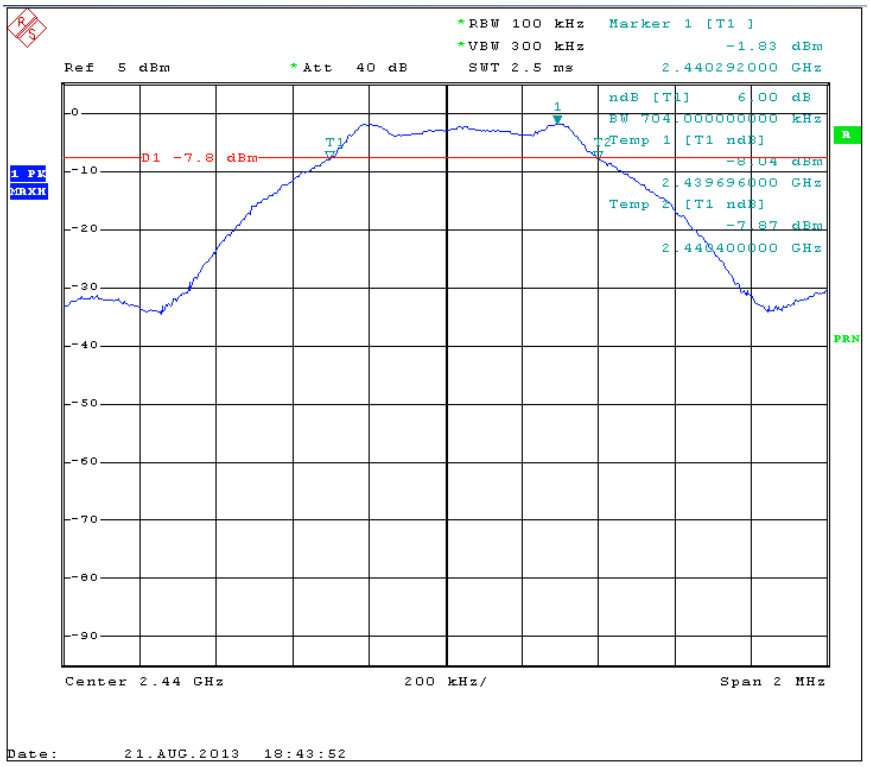
5.4 Results:

Mode	Channel Number	Frequency (MHz)	6dB Bandwidth	6dB Bandwidth at 10 kHz	99% Power Bandwidth	99% Power Bandwidth at 10 kHz	Pass
BT4.0	0	2402	708 kHz	636 kHz	1.076 MHz	1.060 MHz	Pass
BT4.0	19	2440	704 kHz	612 kHz	1.080 MHz	1.060 MHz	Pass
BT4.0	39	2480	712 kHz	616 kHz	1.080 MHz	1.052 MHz	Pass

5.5 Test Plots:

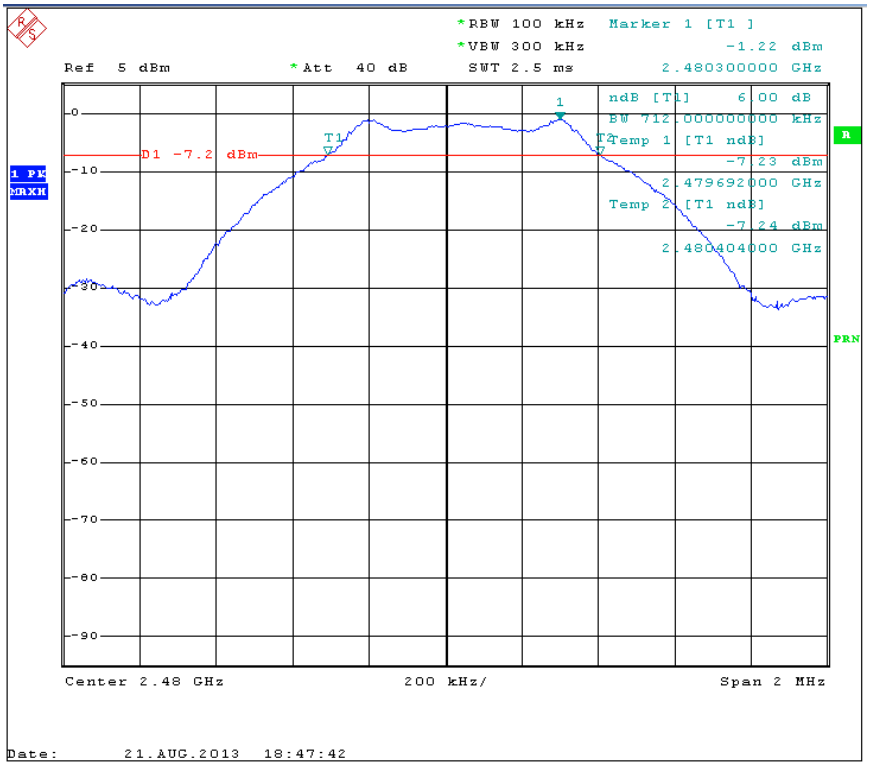


6dB Bandwidth, Low Channel

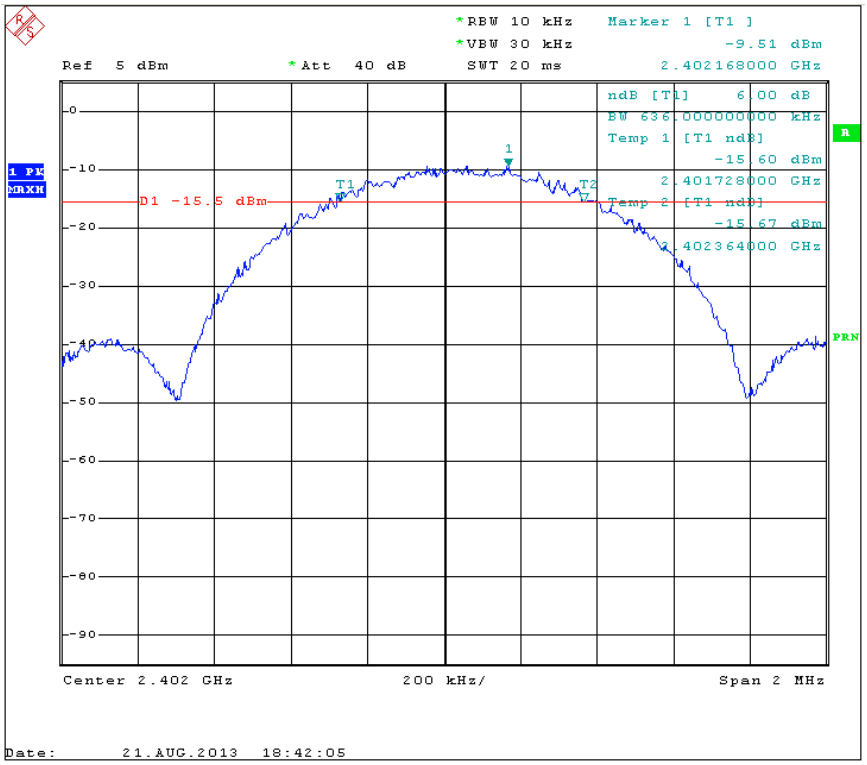


6dB Bandwidth, Middle Channel

5.6 Test Plots:

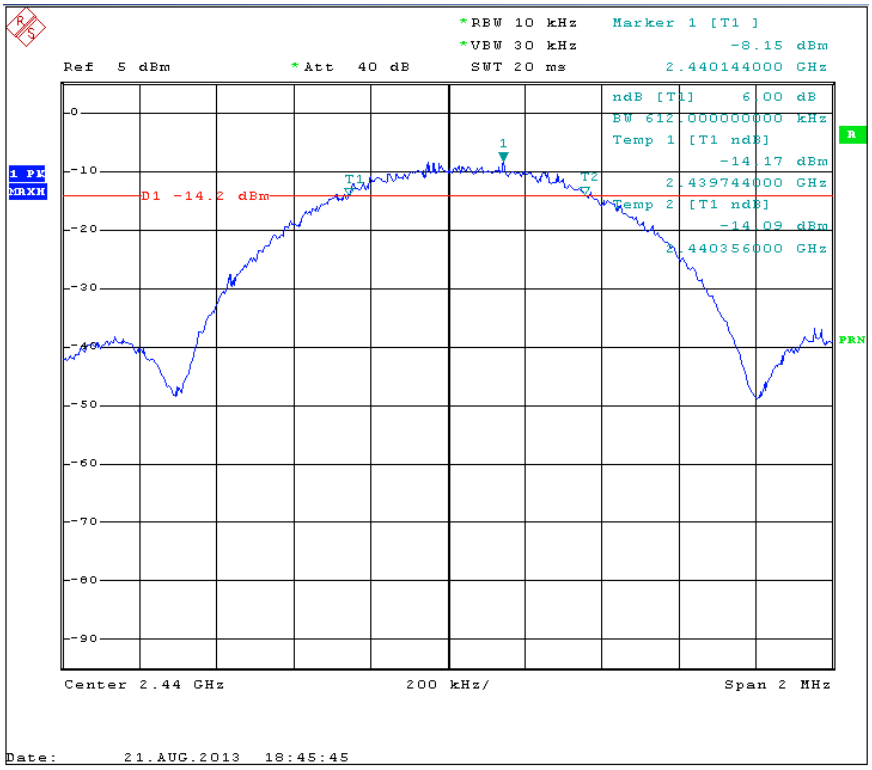


6dB Bandwidth, High Channel

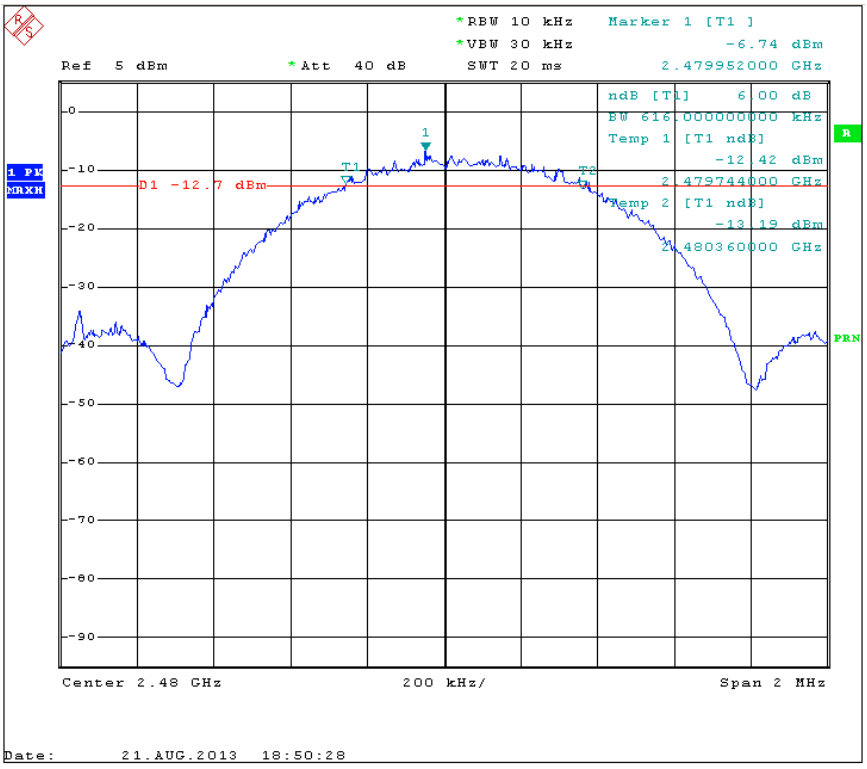


6dB Bandwidth at 10 kHz, Low Channel

5.7 Test Plots:

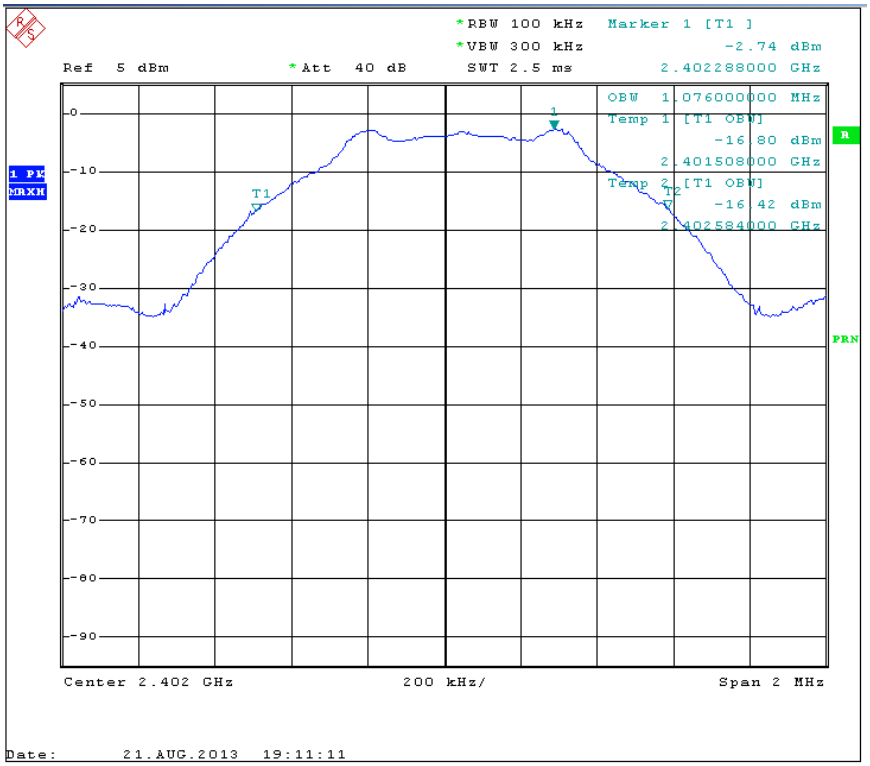


6dB Bandwidth at 10 kHz, Middle Channel

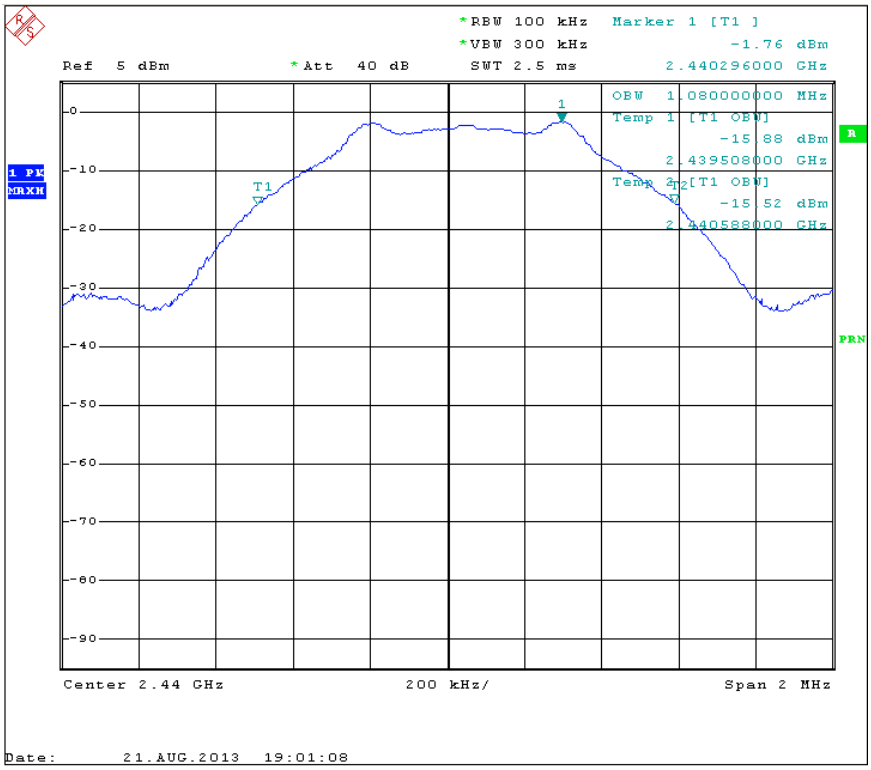


6dB Bandwidth at 10 kHz, High Channel

5.8 Test Plots:

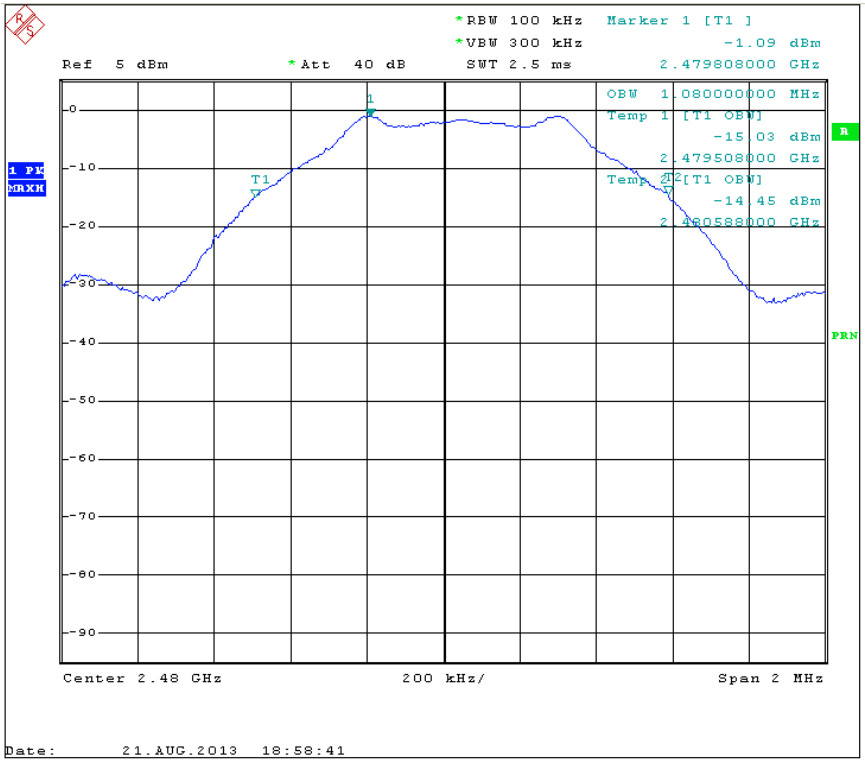


99% Bandwidth, Low Channel

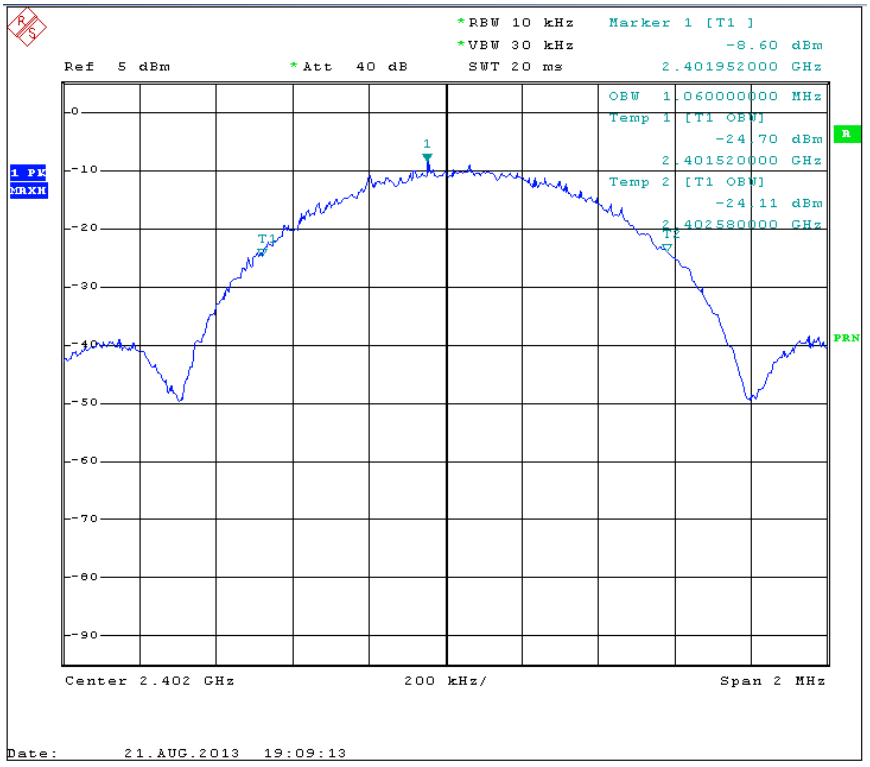


99% Bandwidth, Middle Channel

5.9 Test Plots:

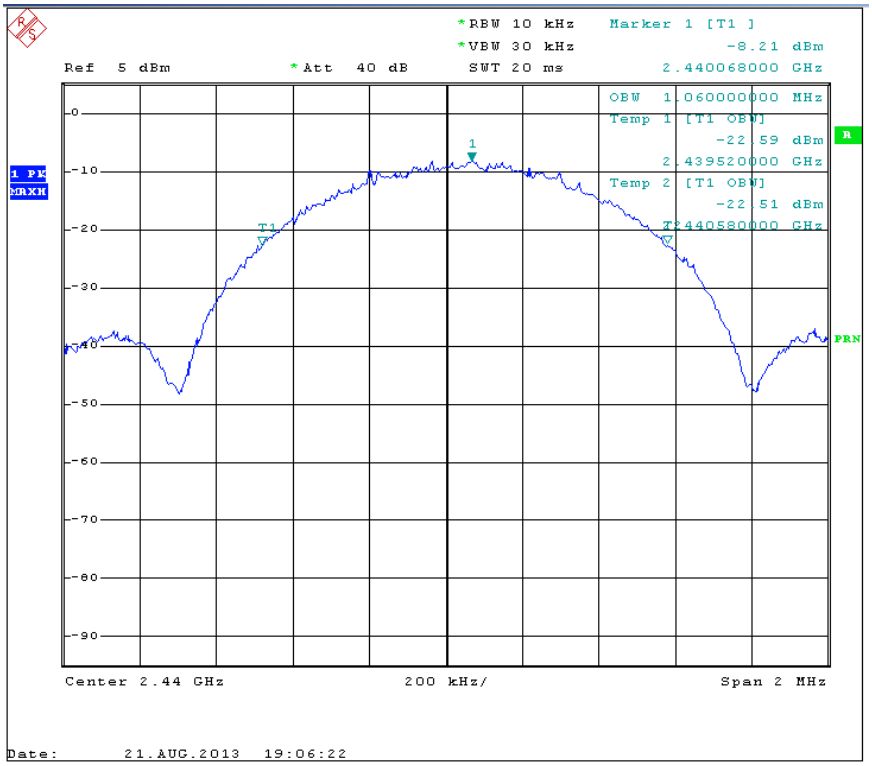


99% Bandwidth, High Channel

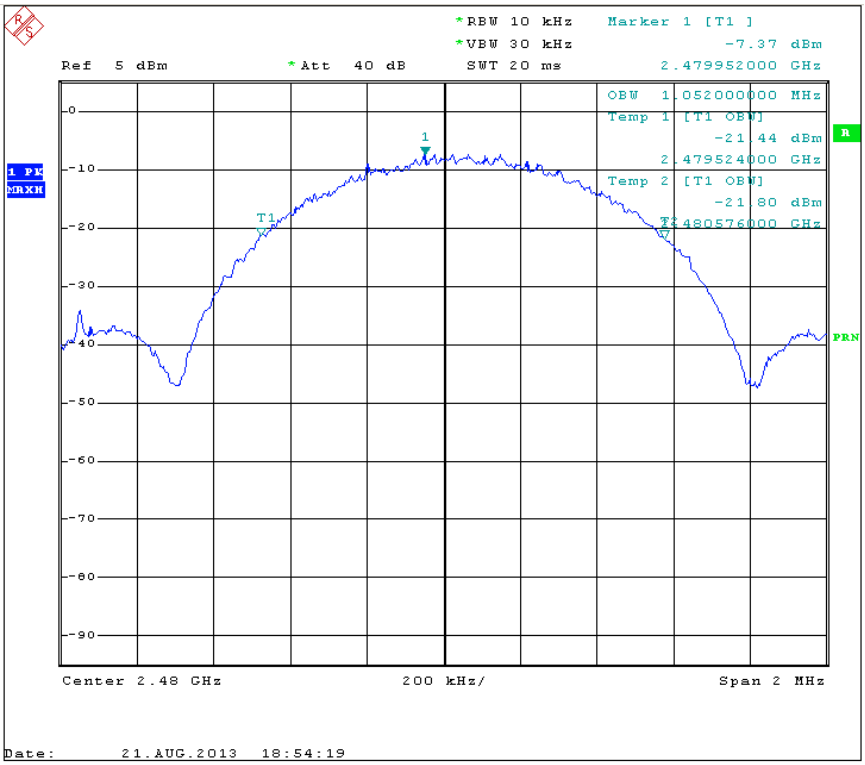


99% Bandwidth 10 kHz, Low Channel

5.10 Test Plots:



99% Bandwidth 10 kHz, Middle Channel



99% Bandwidth 10 kHz, High Channel

6 Conducted Spurious Emissions

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.

6.2 Test Procedure:

ANSI C63.10: 2009 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

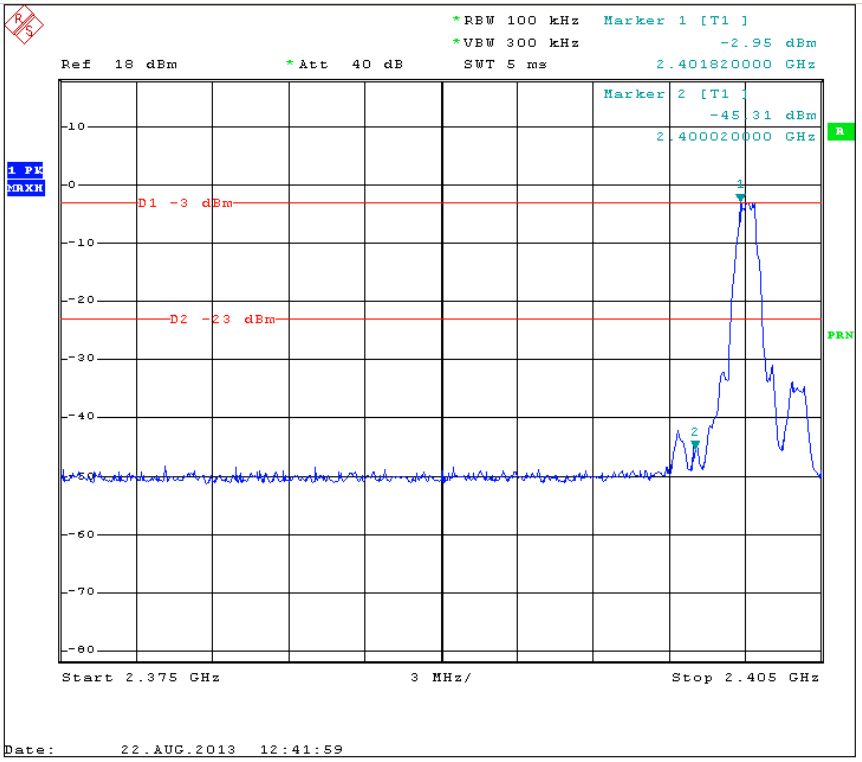
6.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	IID	Cal. Date	Cal. Due
Spectrum Analyzer	1093-4495-40	Rohde&Schwarz	FSP	690	04/11/2013	04/11/2014

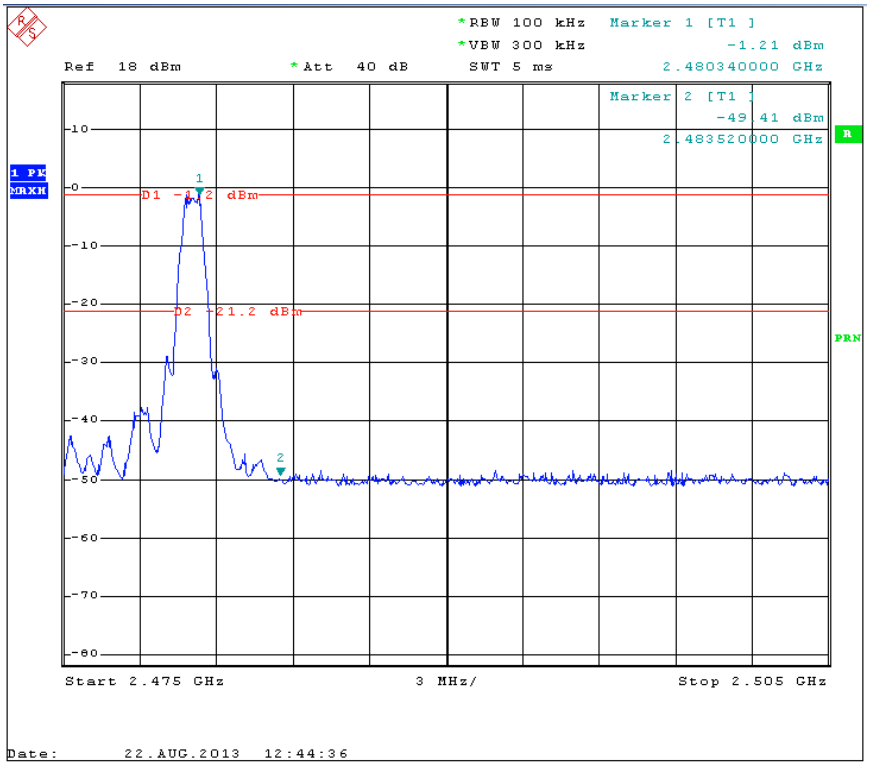
6.4 Results:

Refer to the Conducted Spurious Emissions plots 6.5 to 6.8, the attenuation of emissions outside the EUT pass-band is more than 20dB.

6.5 Test Plots

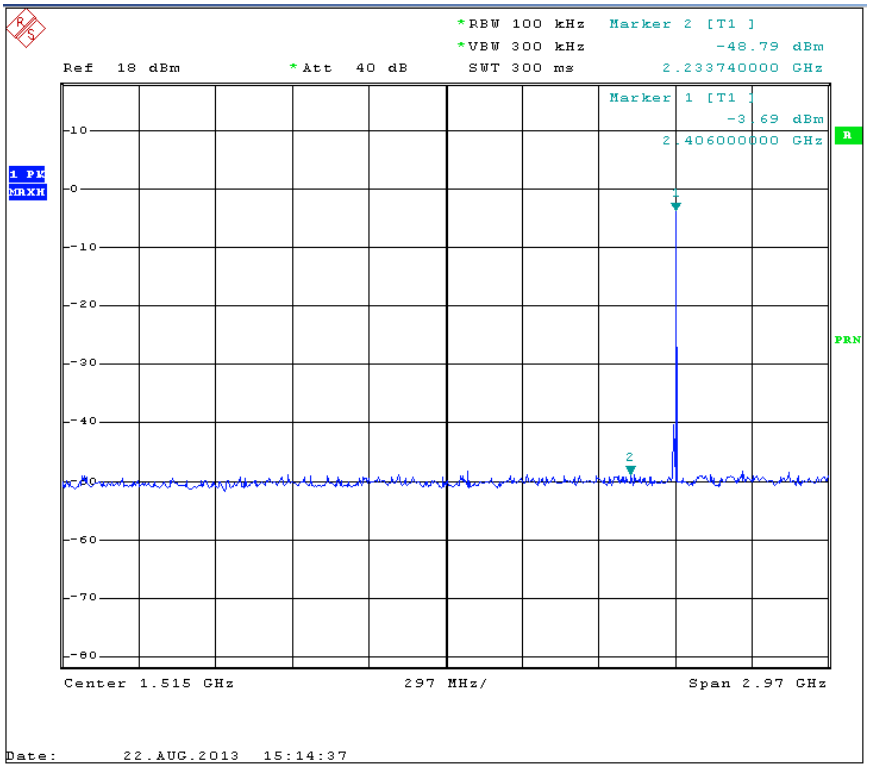


Low Band Edge Plot, Low Channel

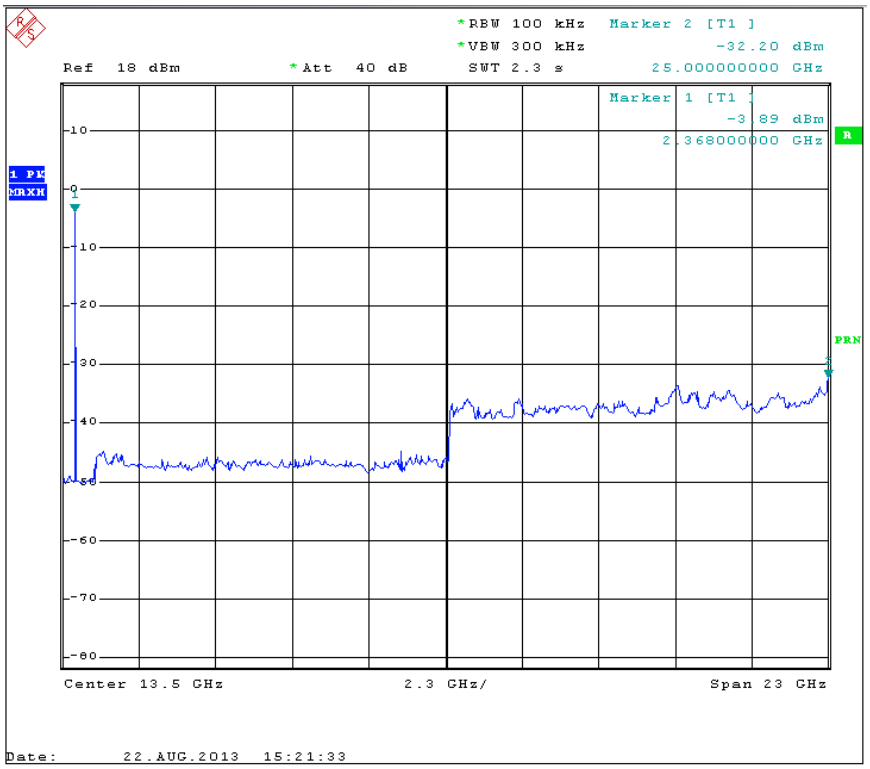


High Band Edge Plot, High Channel

6.6 Test Plots

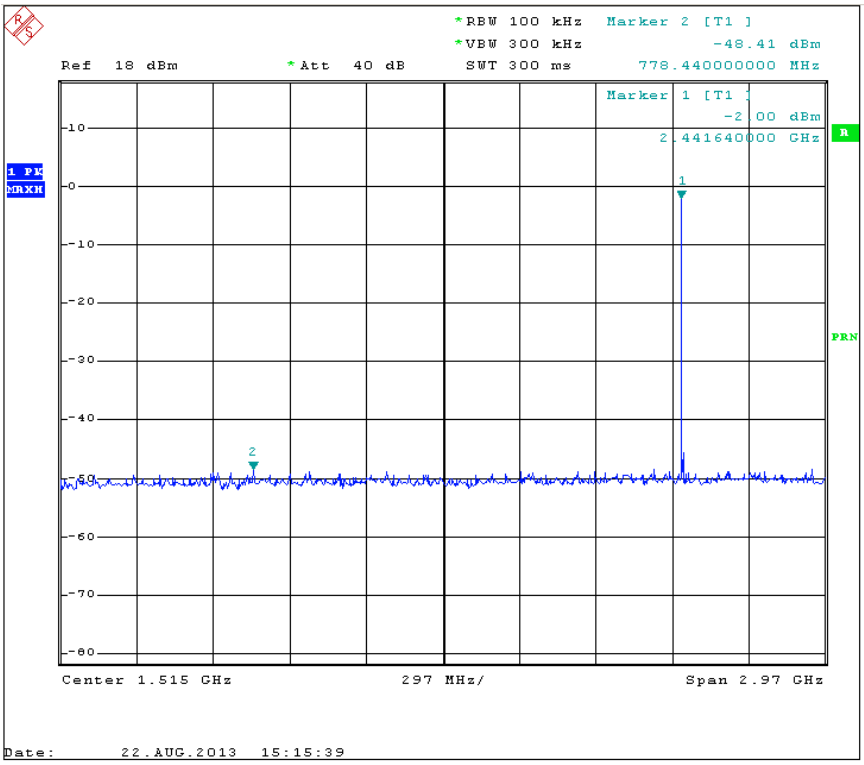


Conducted Spurious Emissions, Low Channel

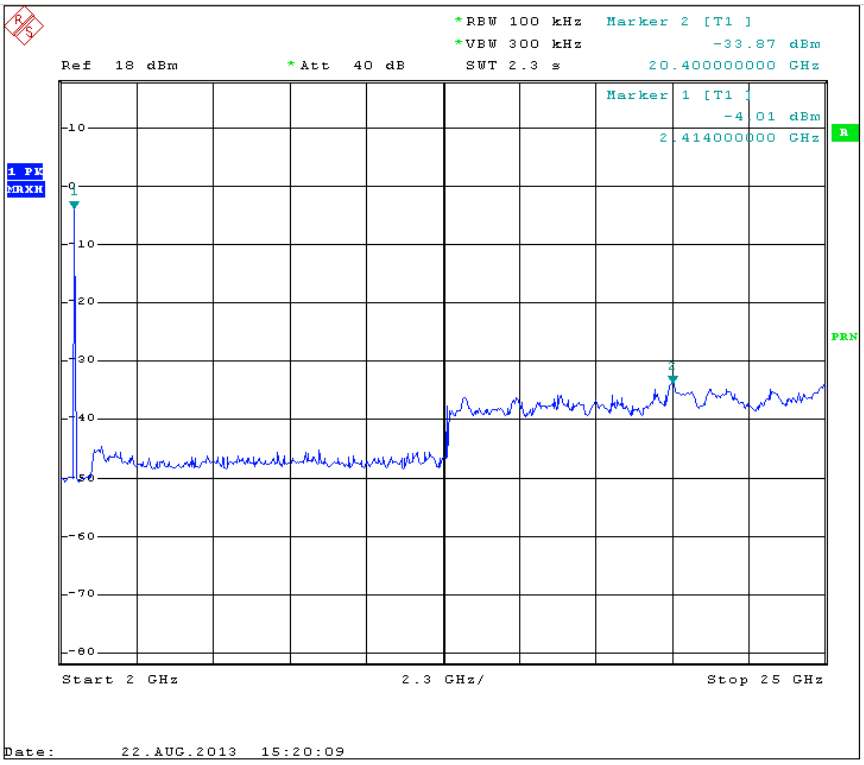


Conducted Spurious Emissions, Low Channel

6.7 Test Plots

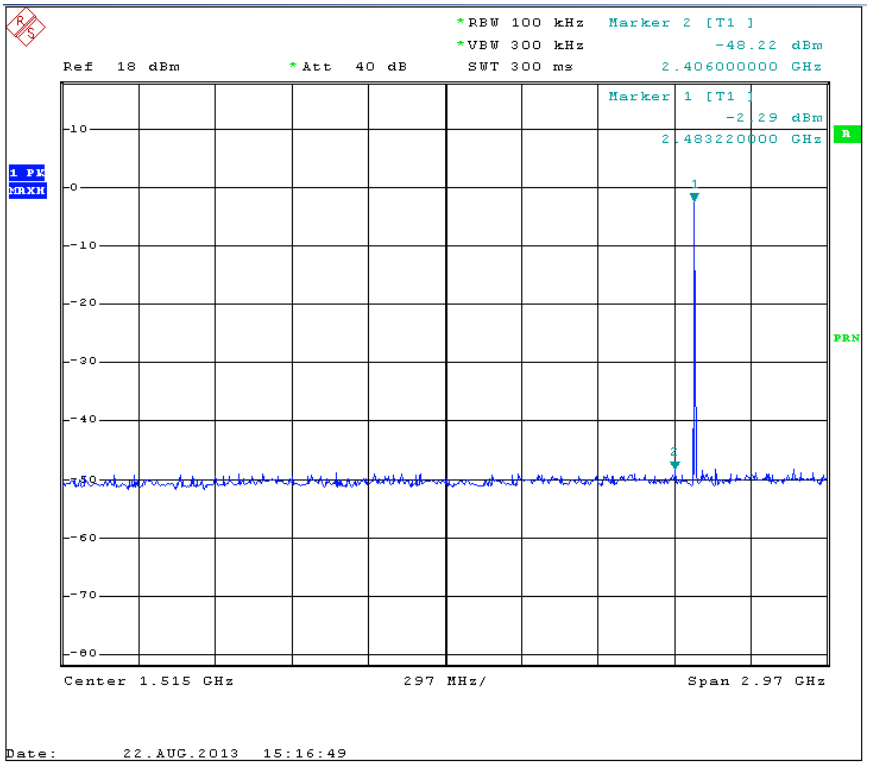


Conducted Spurious Emissions, Middle Channel

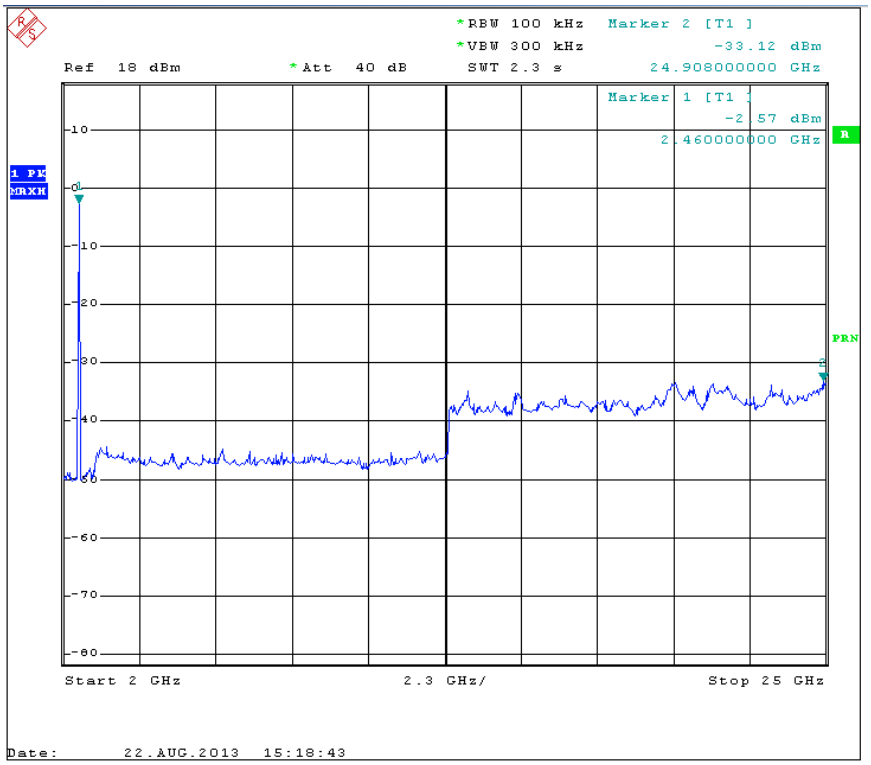


Conducted Spurious Emissions, Middle Channel

6.8 Test Plots



Conducted Spurious Emissions, High Channel



Conducted Spurious Emissions, High Channel

7 Power Spectral Density

7.1 Test Limits

§ 15.247(e): 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.

7.2 Test Procedure

ANSI C63.10: 2009 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

7.3 Test Equipment Used:

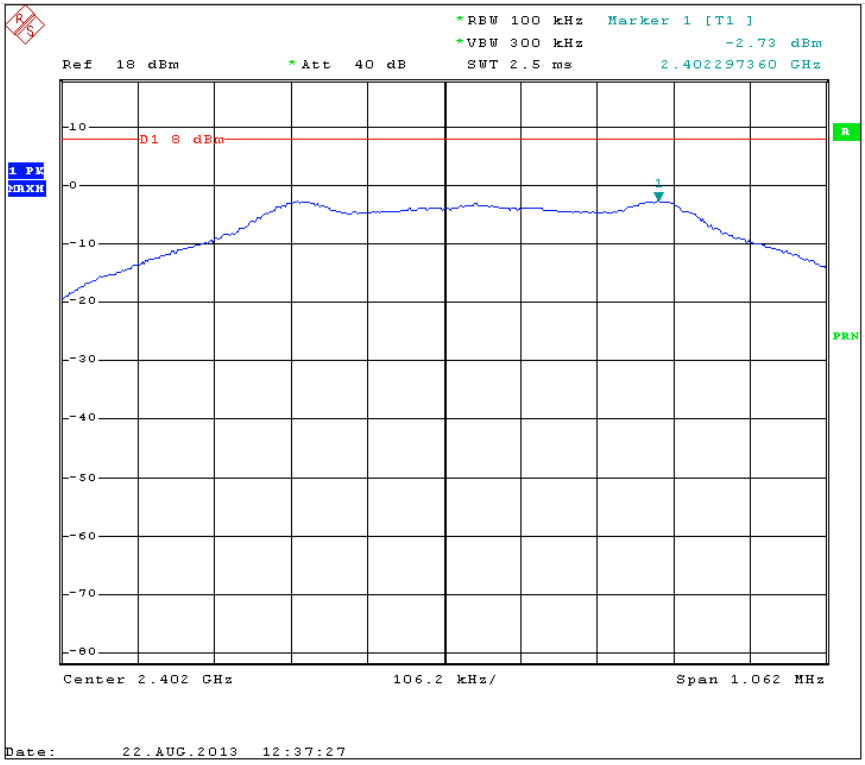
Description	Serial Number	Manufacturer	Model	IID	Cal. Date	Cal. Due
Spectrum Analyzer	1093-4495-40	Rohde&Schwarz	FSP	690	04/11/2013	04/11/2014

7.4 Results:

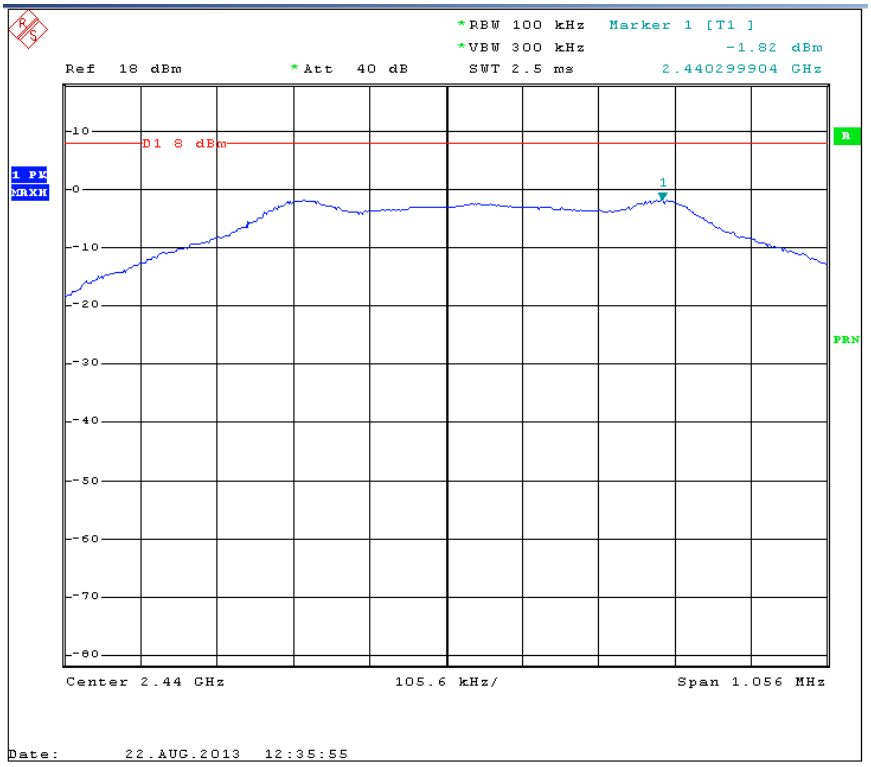
*PSD Option 1 Method

Mode	Channel Number	Frequency (MHz)	PSD in 3kHz BW (dBm)	Limit (dBm)	Result
BT4.0	0	2402	-2.73	8.0	Pass
BT4.0	19	2440	-1.82	8.0	Pass
BT4.0	39	2480	-1.16	8.0	Pass

7.5 Test Plots:

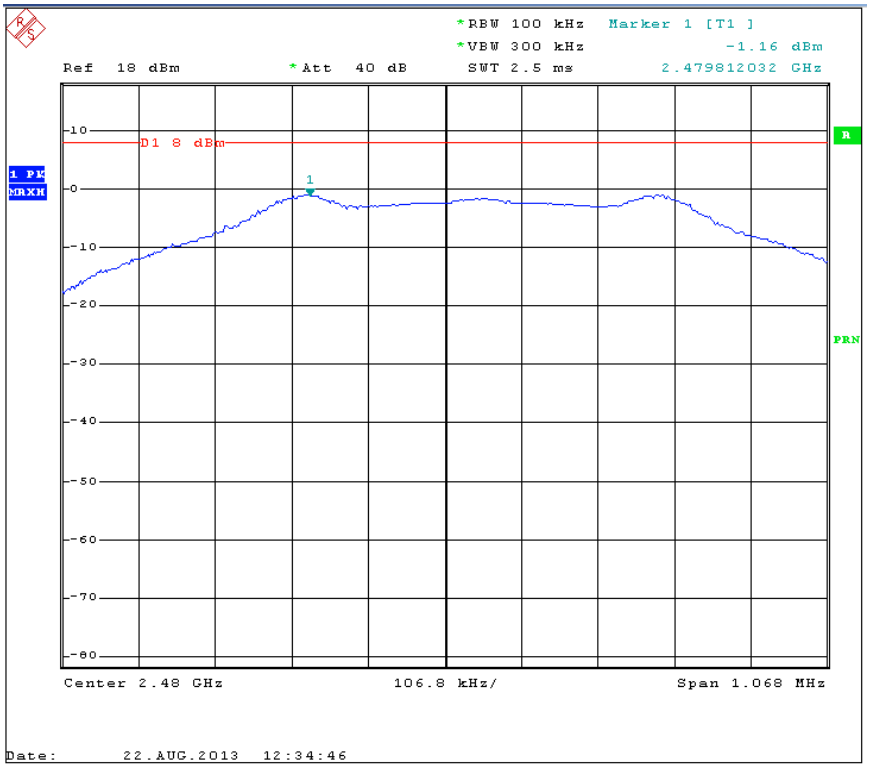


PSD Low Channel



PSD Middle Channel

7.6 Test Plots:



PSD High Channel

8 Radiated Spurious Emissions (Transmitter)

8.1 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

8.2 Test Procedure

ANSI C63.10: 2009 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

8.3 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+AG+DCF+DF

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)
AG = Amplifier Gain
DCF = Duty Cycle Factor
DF = Distance Factor

Example Calculation:

RA = 54.01 dBµV
AF = 40.13 dB
CF = 3.76 dB
AG = -43.66
DCF = -6.78
DF = 0

FS = 54.01+40.13+3.76– 43.66 – 6.78 + 0 = 47.46 dBµV/m

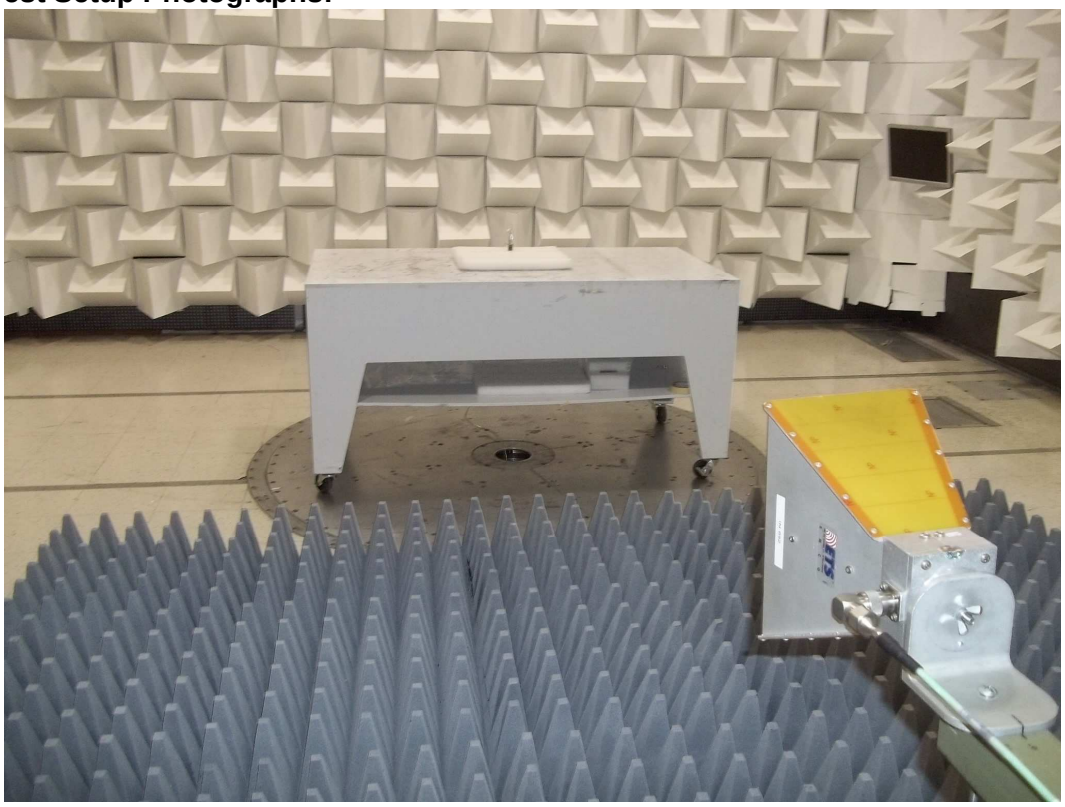
8.4 Test Equipment Used:

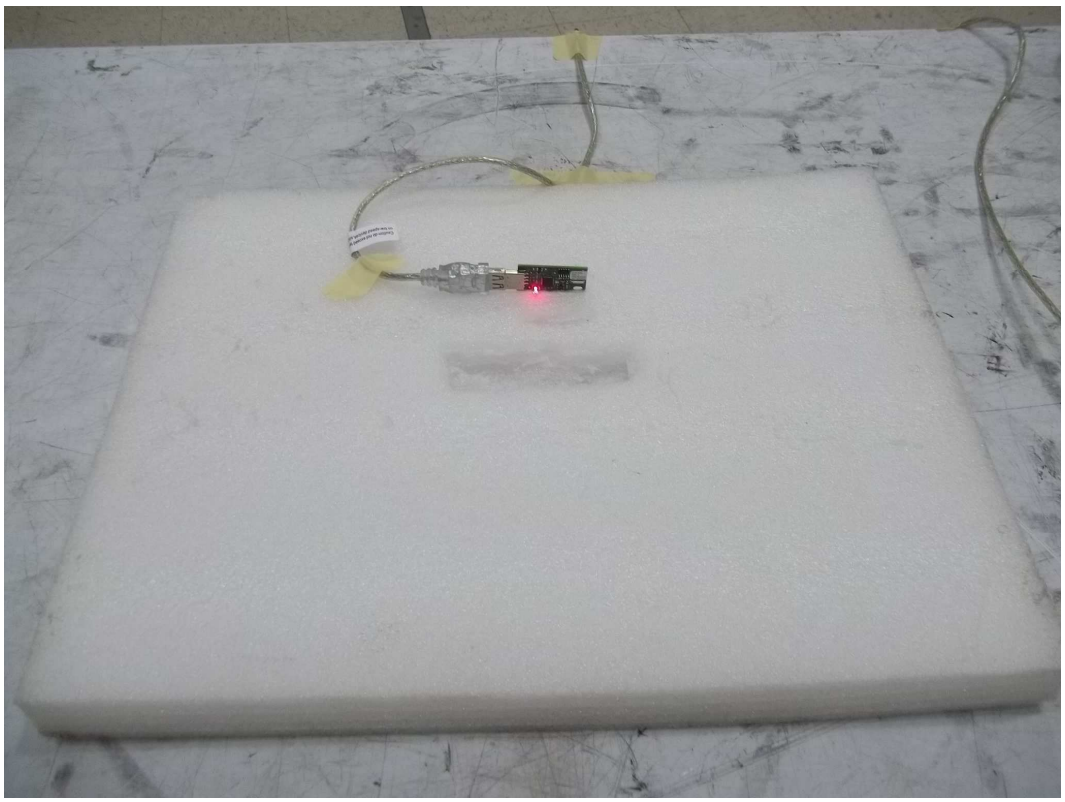
Description	Serial Number	Manufacturer	Model	IID	Cal. Date	Cal. Due
Spectrum Analyzer	1093-4495-40	Rohde&Schwarz	FSP	690	04/11/2013	04/11/2014
Preamplifier	1685147	Miteq	AMF-6D-0050180 0-24-10P	1135	01/04/2013	01/04/2014
1-18 GHz Horn Antenna	1513	A.H. Systems	SAS-571	1093	11/19/2012	11/19/2013
18-26 GHz Horn Antenna	9307-1012	EMCO	3160-09	571	Calibration Not Required, Category III Equipment	Calibration Not Required, Category III Equipment

8.5 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). The spurious emissions listed in the following tables are the worst case emissions. Emissions not reported were at or below the measurement noise floor. The test sample was evaluated on three orthogonal axes since it was a hand held device and could be used in any orientation.

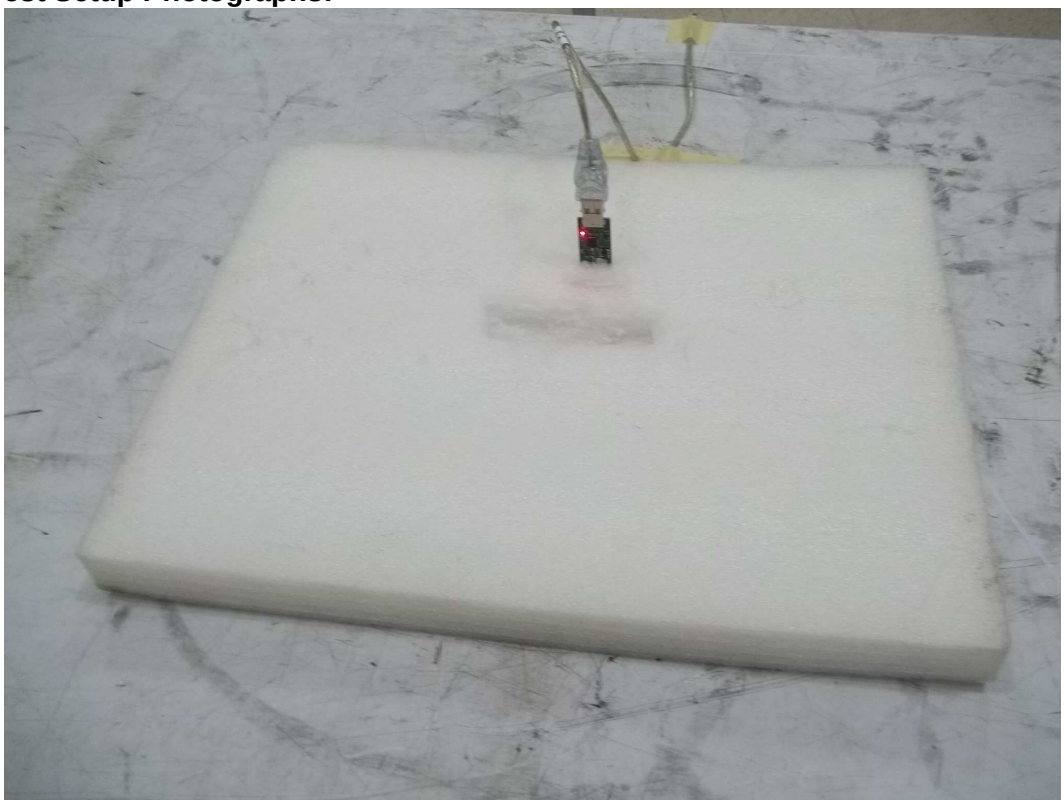
8.6 Test Setup Photographs:



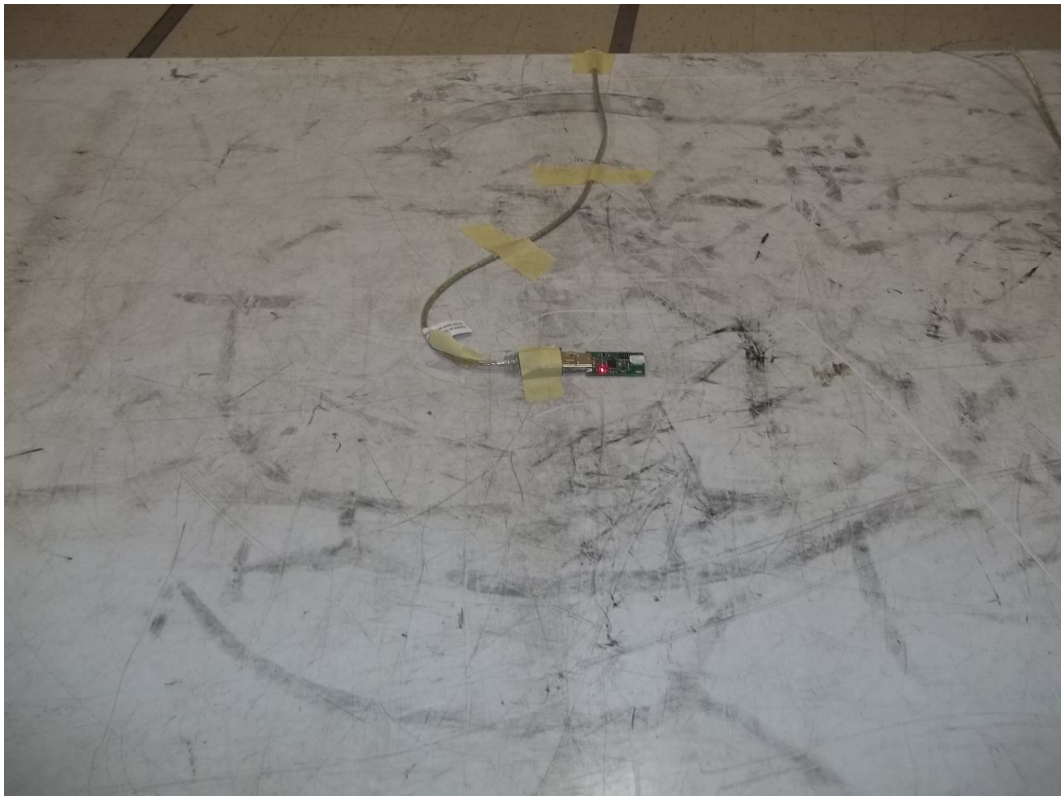


X Orthogonal Position

8.7 Test Setup Photographs:



Y Orthogonal Positions



Z Orthogonal Position

8.8 Test Data:

Frequency	FS	Limit@3m	Margin	RA	AG	AF	CF	DCF	DF	Detector
MHz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB(1/m)	dB	dB	dB	Pk/Av
4804	63.68	74	-10.32	70.58	-43.66	33	3.76	0	0	Pk
4804	46.45	54	-7.55	70.58	-43.66	33	3.76	-17.23	0	Av
12010	39.38	74	-34.62	48.4	-45.68	40.13	6.07	0	-9.54	Pk
12010	22.15	54	-31.85	48.4	-45.68	40.13	6.07	-17.23	-9.54	Av
19216	55.49	74	-18.51	52.61	-35.76	40.3	7.88	0	-9.54	Pk
19216	38.26	54	-15.74	52.61	-35.76	40.3	7.88	-17.23	-9.54	Av

* Measurement was taken at 1 meter.

Worst Case Spurious Emissions (BT4.0, Low Channel Horizontal Antenna Polarity)

Frequency	FS	Limit@3m	Margin	RA	AG	AF	CF	DCF	DF	Detector
MHz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB(1/m)	dB	dB	dB	Pk/Av
4880	54.52	74	-19.48	61.07	-43.68	33.35	3.78	0	0	Pk
4880	37.29	54	-16.71	61.07	-43.68	33.35	3.78	-17.23	0	Av
7320	62.65	74	-11.35	63.49	-42.67	37.13	4.7	0	0	Pk
7320	45.42	54	-8.58	63.49	-42.67	37.13	4.7	-17.23	0	Av
12200	39.05	74	-34.95	47.75	-45.86	40.58	6.12	0	-9.54	Pk
12200	21.82	54	-32.18	47.75	-45.86	40.58	6.12	-17.23	-9.54	Av
19520	55.46	74	-18.54	53.03	-36.26	40.3	7.93	0	-9.54	Pk
19520	38.23	54	-15.77	53.03	-36.26	40.3	7.93	-17.23	-9.54	Av

* Measurement was taken at 1 meter.

Worst Case Spurious Emissions (BT4.0, Middle Channel Horizontal Antenna Polarity)

Frequency	FS	Limit@3m	Margin	RA	AG	AF	CF	DCF	DF	Detector
MHz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB(1/m)	dB	dB	dB	Pk/Av
4960	67.4	74	-6.6	67.4	-43.62	33.35	3.81	0	0	Pk
4960	50.17	54	-3.83	50.17	-43.62	33.35	3.81	-17.23	0	Av
7440	62.42	74	-11.58	63.38	-42.5	37.12	4.42	0	0	Pk
7440	45.19	54	-8.81	63.38	-42.5	37.12	4.42	-17.23	0	Av
12400	39.33	74	-34.67	47.98	-45.65	40.31	6.23	0	-9.54	Pk
12400	22.1	54	-31.9	47.98	-45.65	40.31	6.23	-17.23	-9.54	Av
19840	54.2	74	-19.8	53.92	-38.47	40.3	7.99	0	-9.54	Pk
19840	36.97	54	-17.03	53.92	-38.47	40.3	7.99	-17.23	-9.54	Av
22320	57.18	74	-16.82	53.66	-35.88	40.3	8.64	0	-9.54	Pk
22320	39.95	54	-14.05	53.66	-35.88	40.3	8.64	-17.23	-9.54	Av

* Measurement was taken at 1 meter.

Worst Case Spurious Emissions (BT4.0, High Channel Horizontal Antenna Polarity)

8.9 Test Data:

Frequency	FS	Limit@3m	Margin	RA	AG	AF	CF	DCF	DF	Detector
MHz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB(1/m)	dB	dB	dB	Pk/Av
4804	56.53	74	-17.47	63.43	-43.66	33	3.76	0	0	Pk
4804	39.3	54	-14.7	63.43	-43.66	33	3.76	-17.23	0	Av
12010	39.25	74	-34.75	48.27	-45.68	40.13	6.07	0	-9.54	Pk
12010	22.02	54	-31.98	48.27	-45.68	40.13	6.07	-17.23	-9.54	Av
19216	55.43	74	-18.57	52.55	-35.76	40.3	7.88	0	-9.54	Pk
19216	38.2	54	-15.8	52.55	-35.76	40.3	7.88	-17.23	-9.54	Av

* Measurement was taken at 1 meter.

Worst Case Spurious Emissions (BT4.0, Low Channel Vertical Antenna Polarity)

Frequency	FS	Limit@3m	Margin	RA	AG	AF	CF	DCF	DF	Detector
MHz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB(1/m)	dB	dB	dB	Pk/Av
4880	56.11	74	-17.89	62.66	-43.68	33.35	3.78	0	0	Pk
4880	38.88	54	-15.12	62.66	-43.68	33.35	3.78	-17.23	0	Av
7320	51.03	74	-22.97	51.87	-42.67	37.13	4.7	0	0	Pk
7320	33.8	54	-20.2	51.87	-42.67	37.13	4.7	-17.23	0	Av
12200	39.43	74	-34.57	48.13	-45.86	40.58	6.12	0	-9.54	Pk
12200	22.2	54	-31.8	48.13	-45.86	40.58	6.12	-17.23	-9.54	Av
19520	55.54	74	-18.46	53.11	-36.26	40.3	7.93	0	-9.54	Pk
19520	38.31	54	-15.69	53.11	-36.26	40.3	7.93	-17.23	-9.54	Av

* Measurement was taken at 1 meter.

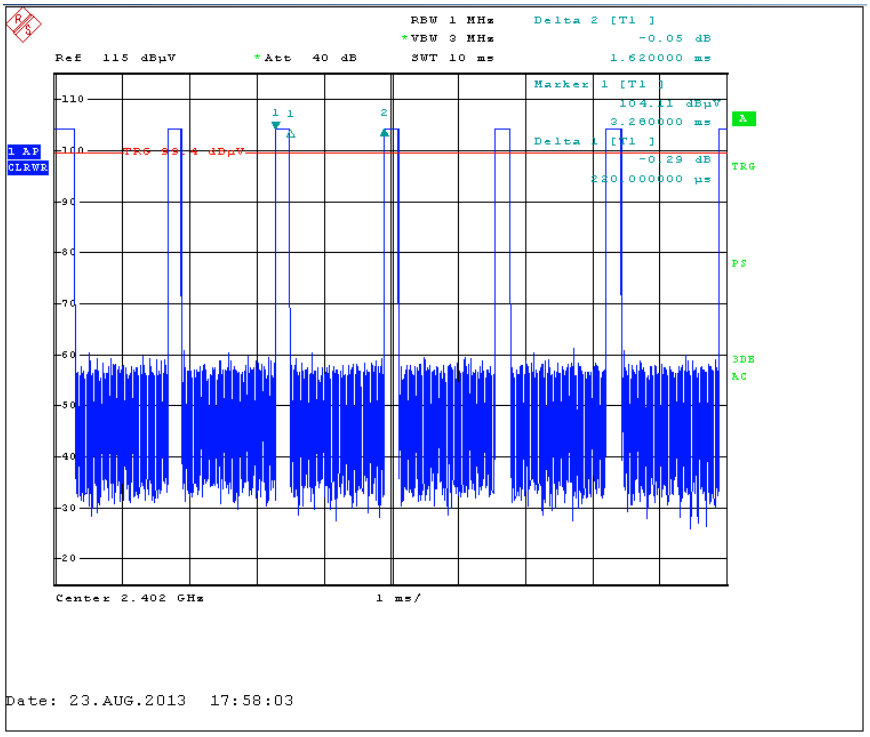
Worst Case Spurious Emissions (BT4.0, Middle Channel Vertical Antenna Polarity)

Frequency	FS	Limit@3m	Margin	RA	AG	AF	CF	DCF	DF	Detector
MHz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB(1/m)	dB	dB	dB	Pk/Av
4960	59.17	74	-14.83	65.63	-43.62	33.35	3.81	0	0	Pk
4960	41.94	54	-12.06	65.63	-43.62	33.35	3.81	-17.23	0	Av
7440	52.48	74	-21.52	53.44	-42.5	37.12	4.42	0	0	Pk
7440	35.25	54	-18.75	53.44	-42.5	37.12	4.42	-17.23	0	Av
12400	39.96	74	-34.04	48.61	-45.65	40.31	6.23	0	-9.54	Pk
12400	22.73	54	-31.27	48.61	-45.65	40.31	6.23	-17.23	-9.54	Av
19840	54.15	74	-19.85	53.87	-38.47	40.3	7.99	0	-9.54	Pk
19840	36.92	54	-17.08	53.87	-38.47	40.3	7.99	-17.23	-9.54	Av
22320	57.32	74	-16.68	53.8	-35.88	40.3	8.64	0	-9.54	Pk
22320	40.09	54	-13.91	53.8	-35.88	40.3	8.64	-17.23	-9.54	Av

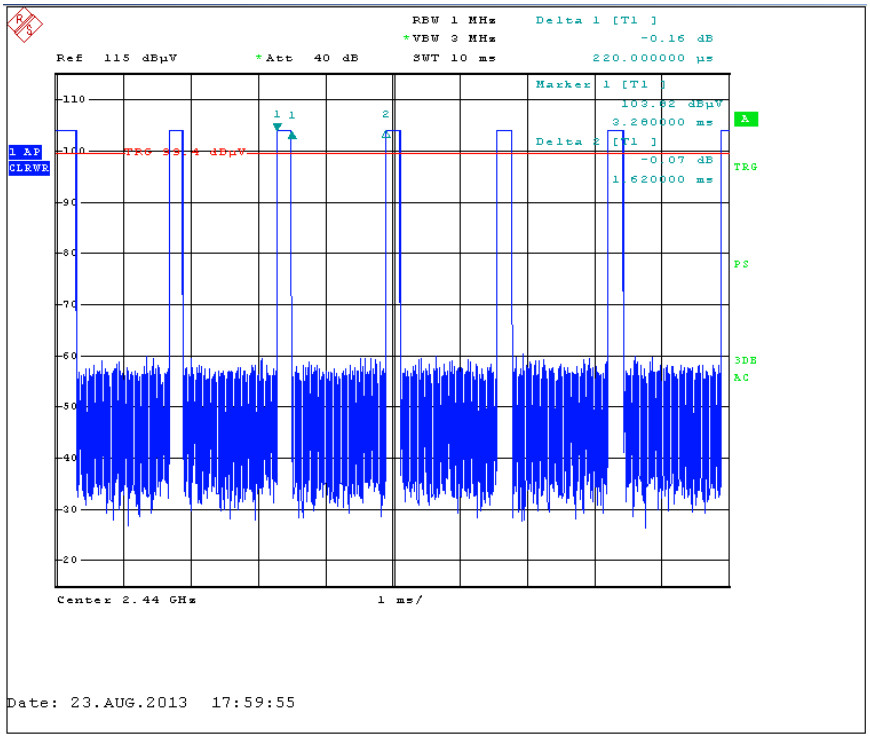
* Measurement was taken at 1 meter.

Worst Case Spurious Emissions (BT4.0, High Channel Vertical Antenna Polarity)

8.10 Duty Cycle Factor Measurement:

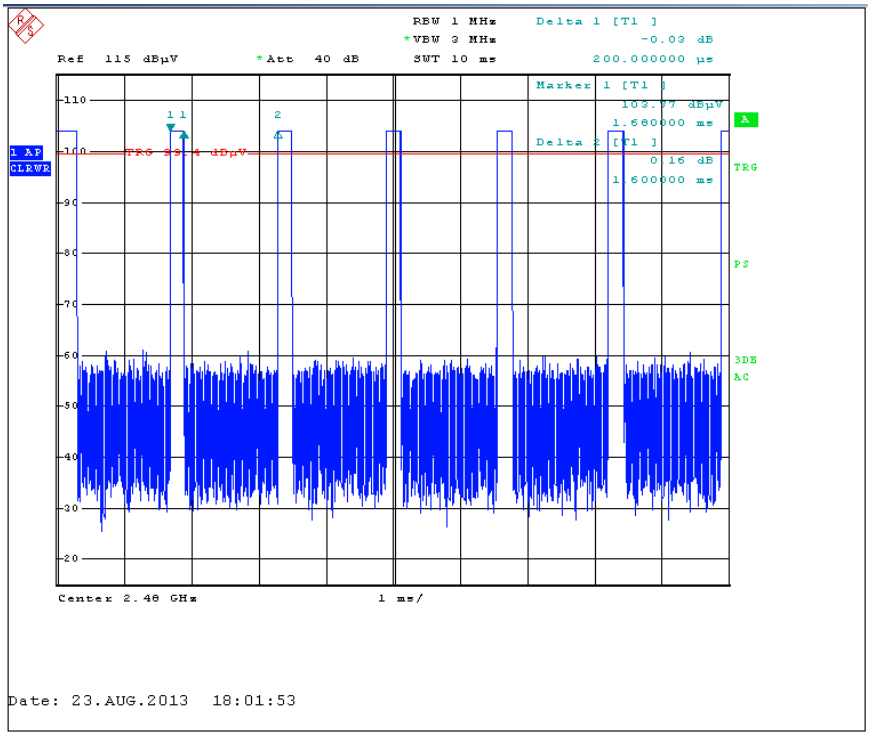


Duty Cycle Low Channel



Duty Cycle Middle Channel

8.11 Duty Cycle Factor Measurement:



Duty Cycle High Channel

Duty Cycle Factor (DCF) Calculation:

DCF = 20log(t/T)

t = 220 µs
T = 1.6 ms

DCF = 20log(220µs/1.6ms) = -17.23 dB

Note 1: Per manufacturer declaration the duty cycle of the Compact Console Unit is too small to measure on a Spectrum Analyzer. At manufacturer's request, the Duty Cycle Factor from the Compact Wireless Remote will be used instead as a worst case DCF. Calculation of the DCF from the Compact Wireless Remote, along with test plots can be found above, and in report number: 101289472LAX-001. A letter of attestation has provided by the manufacturer declaring the Duty Cycle for the Compact Console Unit.

9 Radiated Emission from Digital Parts and Receiver

9.1 Test Limits

§ 15.109(a): 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

§ 15.109(b): The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the following:

Frequency of emission (MHz)	Field strength (microvolts/meter)	Field strength (dBuV/m)
30–88	90	39.1
88–216	150	43.5
216–960	210	46.4
Above 960	300	49.5

9.2 Test Procedure

ANSI C63.4: 2009

9.3 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+AG+DCF+DF

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)
AG = Amplifier Gain
DCF = Duty Cycle Factor
DF = Distance Factor

Example Calculation:

RA = 54.01 dBµV
AF = 40.13 dB
CF = 3.76 dB
AG = -43.66
DCF = -6.78
DF = -10.5

FS = 54.01 + 40.13 + 3.76 – 43.66 – 6.78 – 10.5 = 36.96 dBµV/m

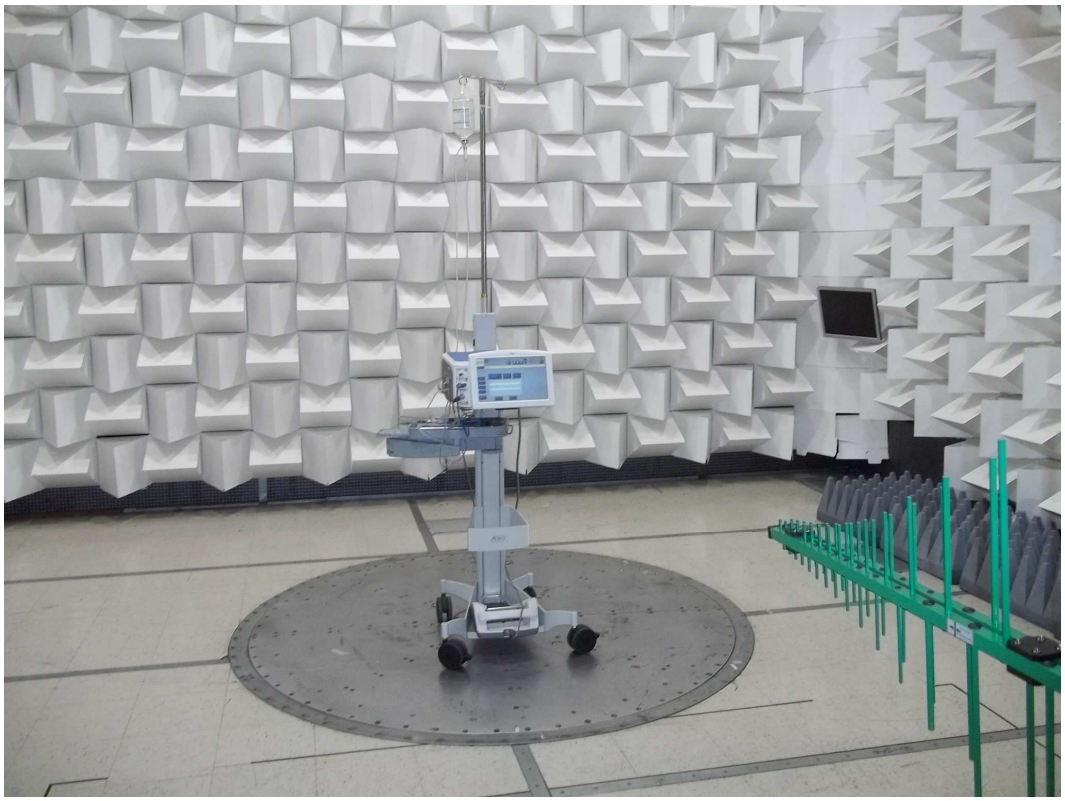
9.4 Test Equipment Used:

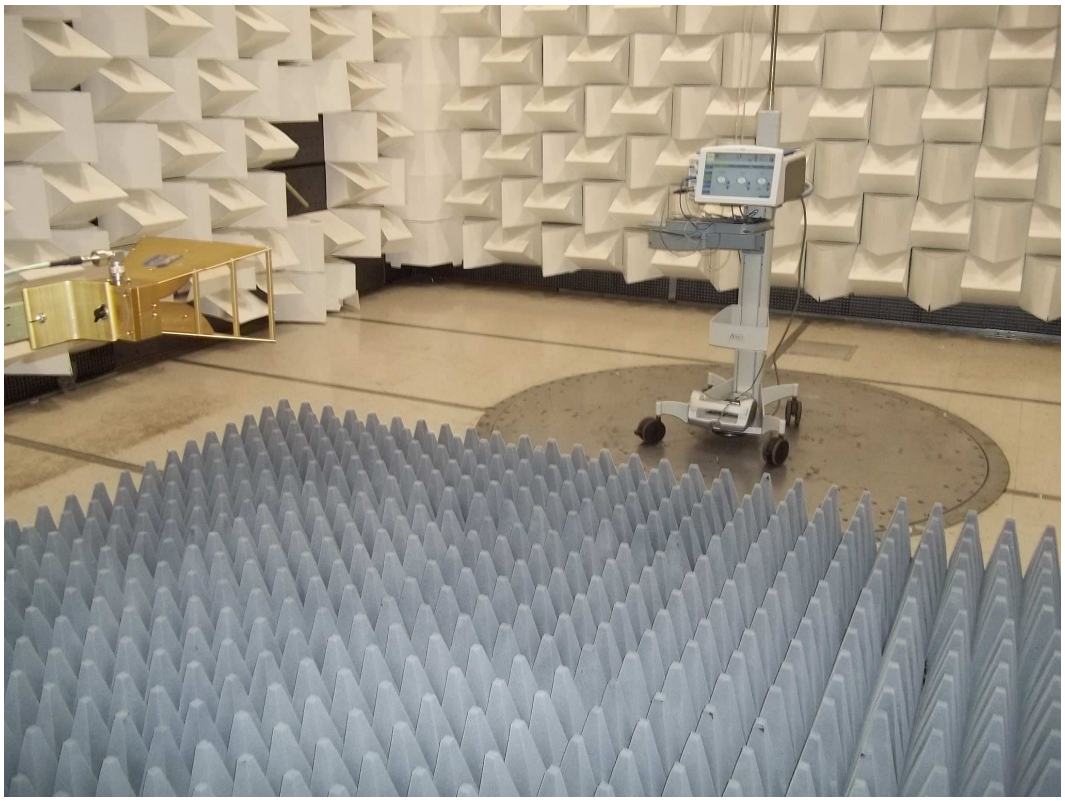
Description	Serial Number	Manufacturer	Model	IID	Cal. Date	Cal. Due
Spectrum Analyzer	1093-4495-40	Rohde&Schwarz	FSP	690	04/11/2013	04/11/2014
Preamplifier	1685147	Miteq	AMF-6D-00501800-24-10P	1135	01/04/2013	01/04/2014
1-18 GHz Horn Antenna	1513	A.H. Systems	SAS-571	1093	11/19/2012	11/19/2013
Bilog Antenna	32852	TESEQ	CBL6112D	1147	02/01/2013	02/01/2014

9.5 Results:

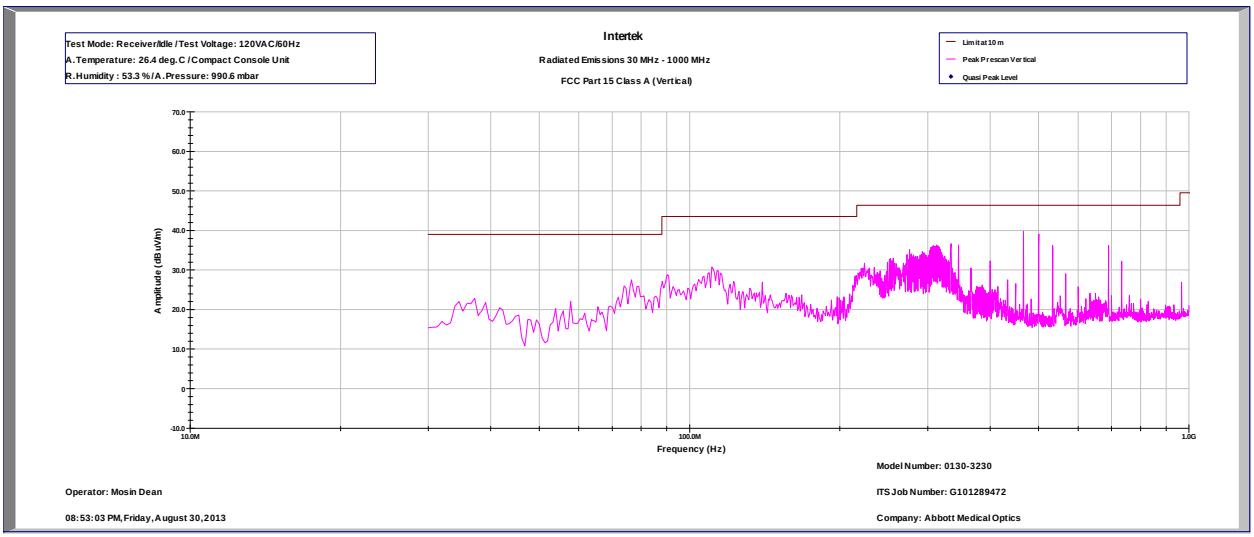
All spurious emissions with the test sample in receive mode were below the limits specified in Part 15.109 for a class A digital device and RSS-GEN Section 6.1.

9.6 Test Setup Photographs:

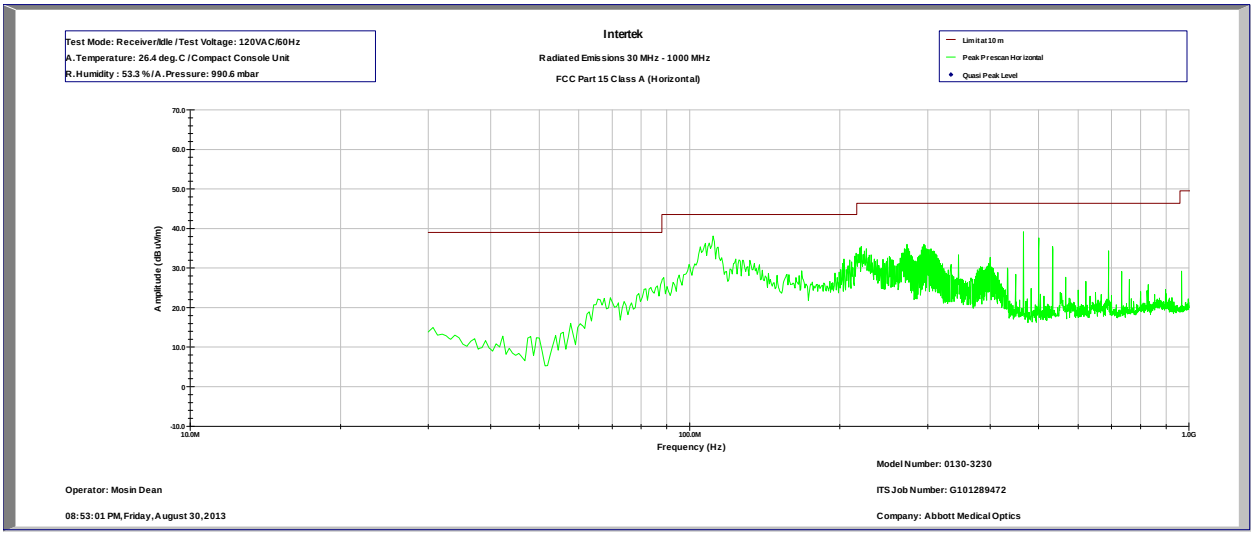




9.7 Test Plots:



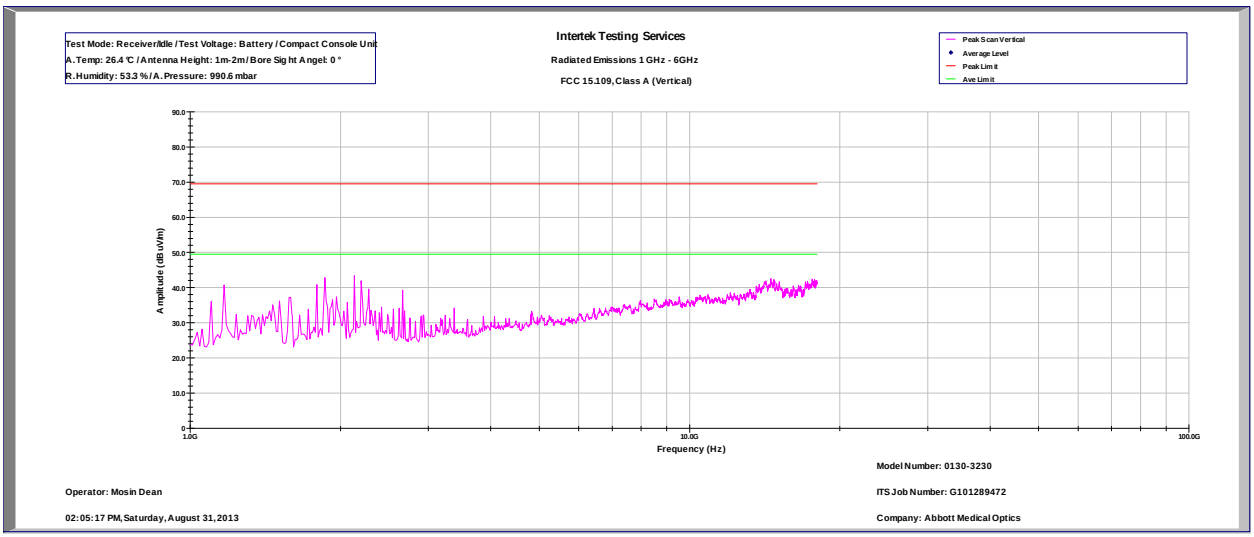
Radiated Emissions Peak Scan Vertical Polarization 30-1000 MHz at 120VAC/60Hz for Compact Console Unit



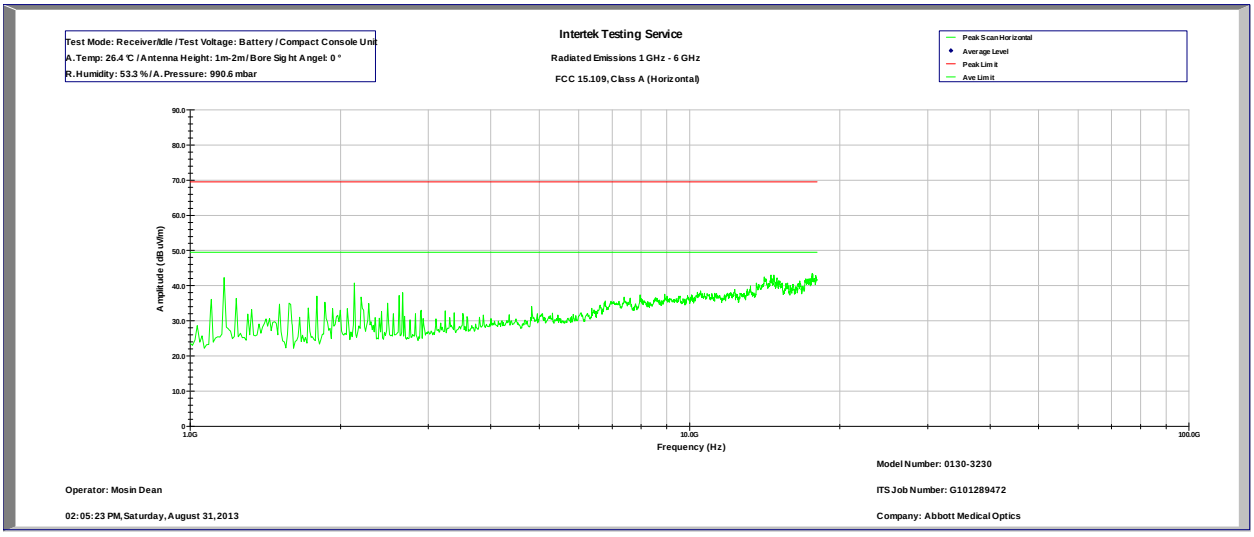
Radiated Emissions Peak Scan Horizontal Polarization 30-1000 MHz at 120VAC/60Hz for Compact Console Unit

Note 1: Measurements were taken at 3 meters and extrapolated back to a 10 meter distance.

9.8 Test Plots:



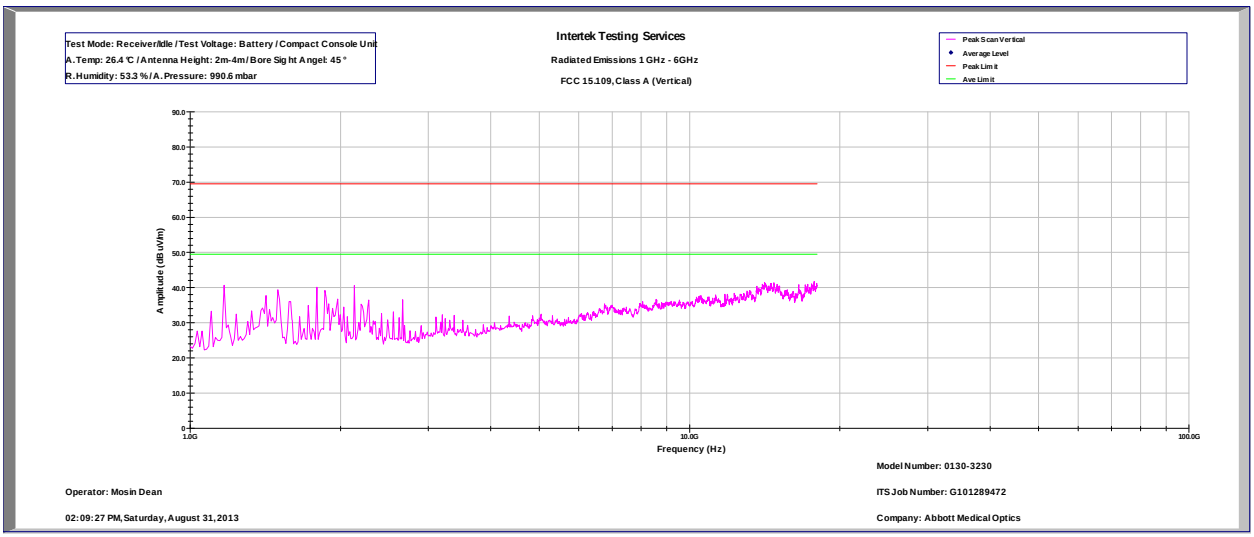
Radiated Emissions Peak Scan Vertical Polarization / Bore Sight: 0°/ Antenna Height: 1m-2m / Frequency Range: 1-18 GHz, at 120VAC/60Hz for Compact Wireless Remote



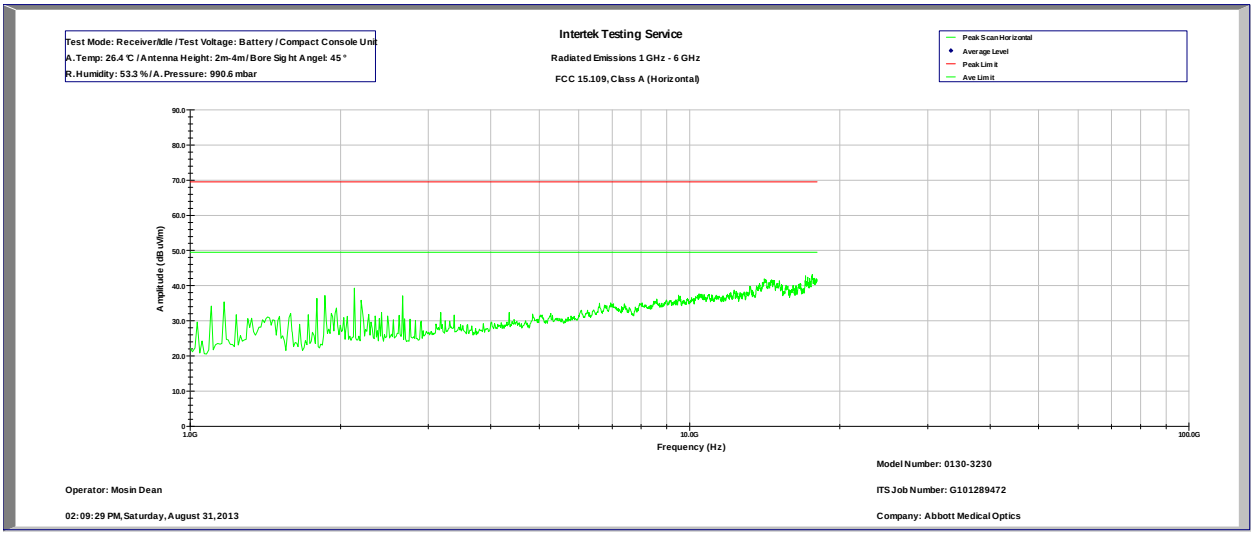
Radiated Emissions Peak Scan Horizontal Polarization / Bore Sight: 0°/ Antenna Height: 1m-2m / Frequency Range:1-18 GHz at 120VAC/60Hz for Compact Wireless Remote

Note 1: All Peak emissions from 1-18 GHz are below the average limits specified in 15.109, final field strength emissions not taken due to low emissions.

9.9 Test Plots:



Radiated Emissions Peak Scan Vertical Polarization / Bore Sight: 45°/ Antenna Height: 2m-4m / Frequency Range: 1-18 GHz at 120VAC/60Hz for Compact Wireless Remote



Radiated Emissions Peak Scan Horizontal Polarization / Bore Sight: 45°/ Antenna Height: 2m-4m / Frequency Range: 1-18 GHz at 120VAC/60Hz for Compact Wireless Remote

Note 2: All Peak emissions from 1-18 GHz are below the average limits specified in 15.109, final field strength emissions not taken due to low emissions.

9.10 Test Data:

Test: Radiated Emissions
Frequency Range: 30 MHz to 1000 MHz
Limits: Class A
Measurement Distance: 3 meters
EUT: Compact Console Unit

Measurement Uncertainty: 4.2 dB
Temperature: 26.4 ˚C
Relative Humidity: 53.3 %
Power Input: 120VAC/60 Hz

FCC 15.109, Class A (QP-Vertical)								
Frequency MHz	Quasi Pk FS dB(uV/m)	Limit@10m dB(uV/m)	Margin dB	RA dB(uV)	AG dB	AF dB(1/m)	CF dB	DF dB
333.33	19.7	47	-27.3	14.6	0	14.2	1.4	10.5
345.57	23.4	47	-23.6	17.5	0	14.9	1.5	10.5
466.5	23	47	-24	14.5	0	17.3	1.7	10.5
500.12	24.3	47	-22.7	15.3	0	17.7	1.8	10.5
533.1	24.4	47	-22.6	14.6	0	18.4	1.8	10.5
690.24	27	47	-20	16.1	0	19.3	2.1	10.5
Detectors/Bandwithds (Det/RBW/VBW)= 120/300kHz								

FCC 15.109, Class A (QP-Horizontal)								
Frequency MHz	Quasi Pk FS dB(uV/m)	Limit@10m dB(uV/m)	Margin dB	RA dB(uV)	AG dB	AF dB(1/m)	CF dB	DF dB
(*) 220.76	33.3	40	-6.7	32.1	0	10.5	1.2	10.5
272.5	30.6	47	-16.4	26.2	0	13.5	1.3	10.5
466.5	38.1	47	-8.9	29.5	0	17.4	1.7	10.5
500.12	26.6	47	-20.4	17.4	0	17.9	1.8	10.5
533.1	30.7	47	-16.3	21.1	0	18.2	1.8	10.5
690.24	34.3	47	-12.7	22.8	0	19.9	2.1	10.5
Detectors/Bandwithds (Det/RBW/VBW)= 120/300kHz								

Quasi FS – (Final) Quasi Peak Field Strength
RA – Receiver (quasi peak) Amplitude
AG – Preamp Gain
AF – Antenna Factor
CF – Cable Factor
DF – Distance Factor
Calculation: FS=RA+AF+CF-AG-DCF

Test Result: (*)The EUT PASSED Radiated Emissions test in the frequency range of 30-1000 MHz with -6.7 dB margin at 220.76 MHz.

Deviations, Additions, or Exclusions: None

10 AC Power line Conducted Emissions

10.1 Test Limits

§ 15.107(b): For a Class A digital device that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms LISN. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Class A Limits		
Frequency of emission (MHz)	**Conducted limit (dBµV)**	
	Quasi-peak	**Average**
0.15-0.5	79	66
0.5-30	73	60

§ 15.207(a): Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Class B Limits		
Frequency of emission (MHz)	**Conducted limit (dBµV)**	
	Quasi-peak	**Average**
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

10.2 Test Procedure

ANSI C63.4: 2003

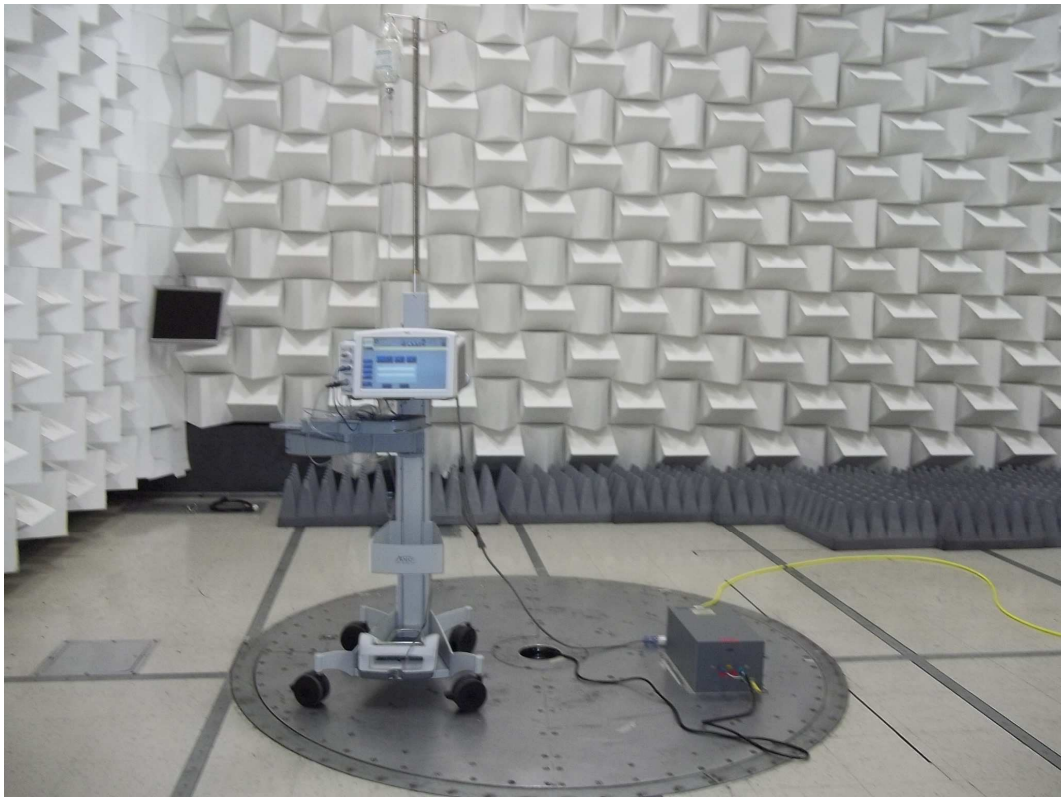
10.3 Test Equipment Used:

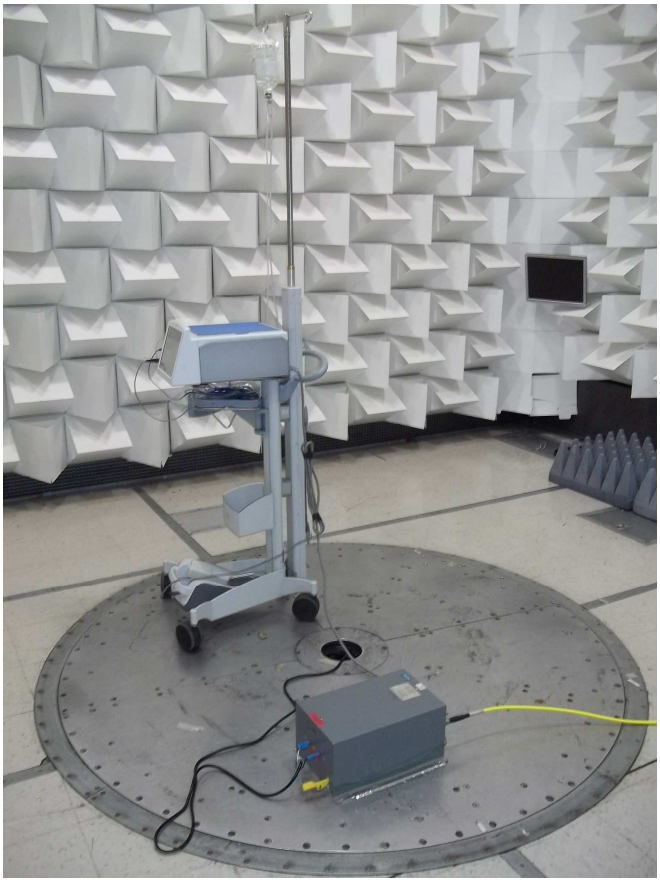
Description	Serial Number	Manufacturer	Model	IID	Cal. Date	Cal. Due
EMI Test Receiver	100825	Rohde & Schwarz	ESCI7	1140	02/19/2014	04/11/2014
LISN	9866	Fischer Custom Com.	FCC-LISN-50-25-2-01	602	04/17/2013	04/17/2014

10.4 Results:

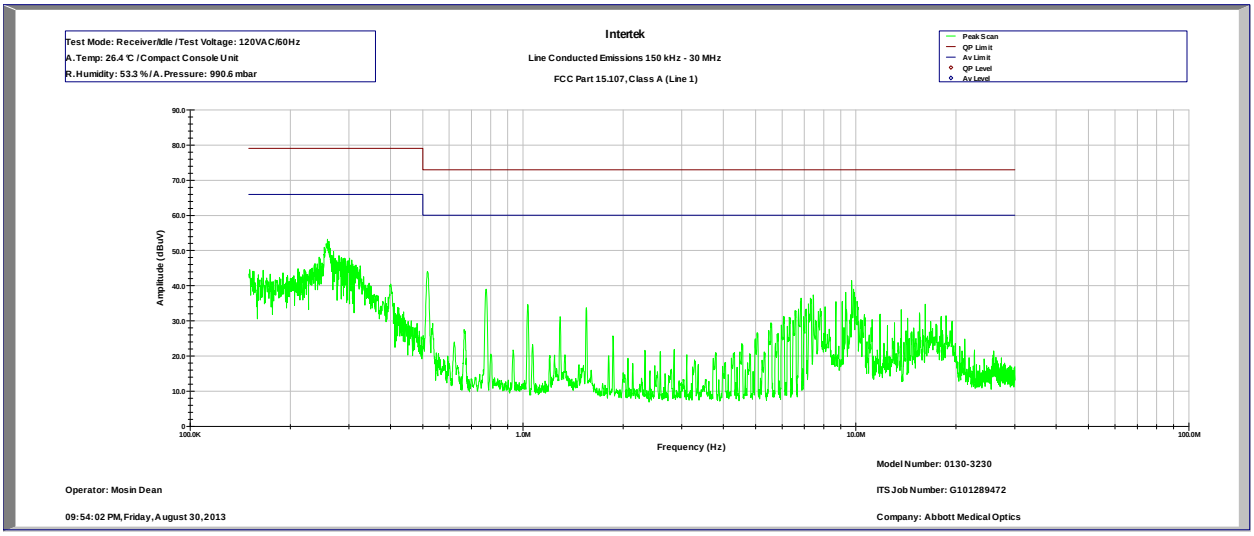
The sample tested was found to comply.

10.5 Test Setup Photographs:

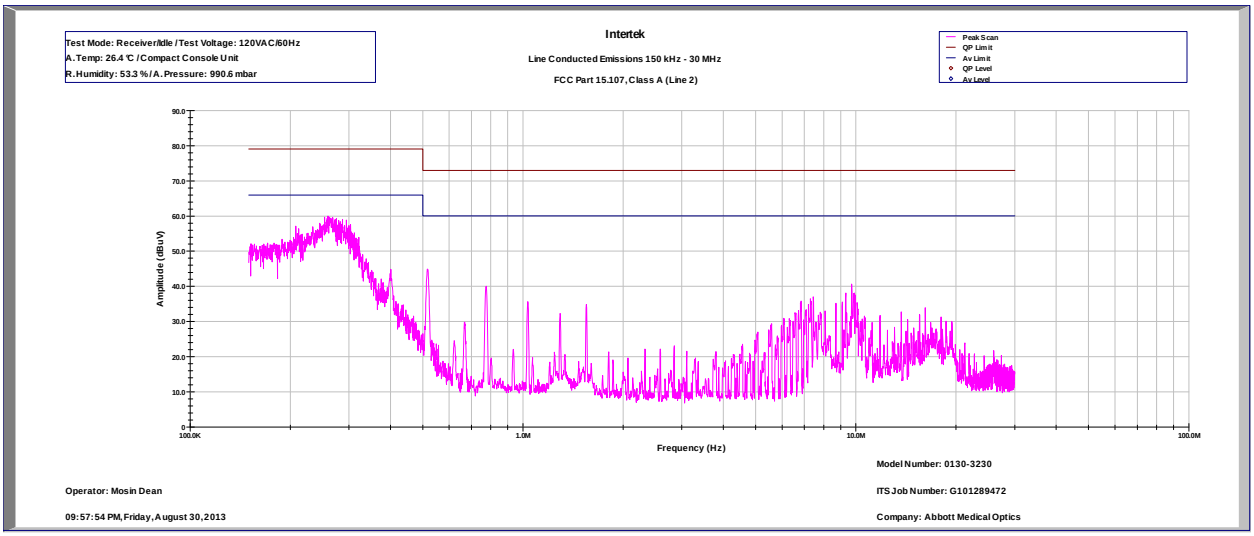




10.6 Test Plots:



Conducted Emissions Peak Scan – Line 1 at 120VAC/60Hz for Compact Console Unit



Conducted Emissions Peak Scan – Line 2 at 120VAC/60Hz for Compact Console Unit

10.7 Test Data:

Test: Conducted Emissions
Frequency Range: 150 kHz to 30 MHz
Limits: Class A
EUT: Compact Console Unit

Measurement Uncertainty: 2.6 dB
Temperature: 26.4 ˚C
Relative Humidity: 53.3 %
Power Input: 120VAC/60Hz

FCC 15.107, Class A (Line 1)						
Frequency MHz	Av Level (dBuV)	QP Level (dBuV)	Av Limit (dBuV)	QP Limit (dBuV)	Av Margin (dB)	QP Margin (dB)
(*) 0.258	47	47.6	66	79	-19	-31.4
0.400	45	45	66	79	-21	-34
0.515	39.6	39.4	60	73	-20.4	-33.6
0.775	29.1	28.8	60	73	-30.9	-44.2
6.83	13.2	17	60	73	-46.8	-56
9.71	24	36.6	60	73	-36	-36.4
Detectors/Bandwidths (Det/RBW/VBW)= 9/30kHz						

FCC 15.107, Class A (Line 2)						
Frequency MHz	Av Level (dBuV)	QP Level (dBuV)	Av Limit (dBuV)	QP Limit (dBuV)	Av Margin (dB)	QP Margin (dB)
0.260	23.7	49.1	66	79	-42.3	-29.9
0.400	24.7	45.5	66	79	-41.3	-33.5
0.516	44.2	43.9	60	73	-15.8	-29.1
0.775	39.7	39.4	60	73	-20.3	-33.6
1.03	35.3	35	60	73	-24.7	-38
9.71	36.4	38.3	60	73	-23.6	-34.7
Detectors/Bandwidths (Det/RBW/VBW)= 9/30kHz						

Test Result: (*) The EUT PASSED Conducted Emission test with 19.0 dB margin at 0.258 MHz.

Deviations, Additions, or Exclusions: None

10.8 Test Data:

Test: Conducted Emissions
Frequency Range: 150 kHz to 30 MHz
Limits: Class A
EUT: Compact Console Unit

Measurement Uncertainty: 2.6 dB
Temperature: 26.4 ˚C
Relative Humidity: 53.3 %
Power Input: 120VAC/60Hz

FCC 15.207, Class B (Line 1)						
Frequency MHz	Av Level (dBuV)	QP Level (dBuV)	Av Limit (dBuV)	QP Limit (dBuV)	Av Margin (dB)	QP Margin (dB)
0.258	47	47.6	52.9	62.9	-5.9	-15.3
0.400	45	45	48.9	58.9	-3.9	-13.9
0.515	39.6	39.4	46.0	56.0	-6.4	-16.6
0.775	29.1	28.8	46.0	56.0	-16.9	-27.2
6.83	13.2	17	50.0	60.0	-36.8	-43.0
9.71	24	36.6	50.0	60.0	-26.0	-23.4
Detectors/Bandwidths (Det/RBW/VBW)= 9/30kHz						

FCC 15.207, Class B (Line 2)						
Frequency MHz	Av Level (dBuV)	QP Level (dBuV)	Av Limit (dBuV)	QP Limit (dBuV)	Av Margin (dB)	QP Margin (dB)
0.260	23.7	49.1	52.9	62.9	-29.2	-13.8
0.400	24.7	45.5	48.9	58.9	-24.2	-13.4
(*) 0.516	44.2	43.9	46.0	56.0	-1.8	-12.1
0.775	39.7	39.4	46.0	56.0	-6.3	-16.6
1.03	35.3	35.0	46.0	56.0	-10.7	-21.0
9.71	36.4	38.3	50.0	60.0	-13.6	-21.7
Detectors/Bandwidths (Det/RBW/VBW)= 9/30kHz						

Test Result: (*) The EUT PASSED Conducted Emission test with 1.8 dB margin at 0.516 MHz.

Deviations, Additions, or Exclusions: None

11 Antenna Requirement per FCC Part 15.203

11.1 Test Limits

§ 15.203: 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. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

11.2 Results:

The sample tested met the antenna requirement. The antenna is internally mounted within an enclosure of an IC.

12 RF Exposure Evaluation

The EUT is a Wireless Module used in a mobile application. It will be located at least 20 cm from any body part of the user or nearby persons. For mobile wireless devices the RF Exposure Limit is Maximum Permissible Exposure (MPE).

The maximum conducted output power is -0.76 dBm (0.839 mW); maximum antenna gain is 2.5 dBi.

Therefore, to comply with RF Exposure Requirement, the MPE is calculated.
The maximum Peak EIRP calculated with the following equation,

$EIRP(dBm) = P_T - L_C + G_a$

P_T = Power of transmitter
L_C = Cable loss
G_a = Antenna gain of transmitter

EIRP = 1.56 dBm = 0.0014 W

The Power Density can be calculated using the formula

$S = EIRP/ 4\pi D^2$

Where: S is Power Density in W/m2
D is the distance from the antenna in meters.

It is considered that 20 cm is the minimum distance that any persons will be next to the EUT.
At 0.2 m, S = 0.0028 W/m2, which is below the FCC MPE Limit of 10 W/m2 for uncontrolled environment

13 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	±4.2dB	
Radiated emissions, 1 to 18 GHz	±4.2dB	
Radiated emissions, 18 to 40 GHz	±4.2dB	
Power Port Conducted emissions, 150kHz to 30 MHz	±2.6dB	

14 Revision History

Revision Number	Revision Contents	Date	Prepared By	Reviewed By
2013116LAX	**Pg.1,4 and 5:** Corrected model name **Pg.1 and 3:** Corrected ITS address **Pg.1:** Removed footer	10/03/2013	Mosin Dean	Martin Liu
2013123LAX	**Pg.3:** Added RF Exposure Evaluation section to test summary **Pg.26, 27, 34, and 40:** Added test setup photos **Pg.44:** Added RF Exposure Evaluation **Pg.4** removed 40 hopping channels from table 3.	10/29/2013	Mosin Dean	Krishna Vemuri