FCC 47 CFR PART 15 SUBPART C
INDUSTRY CANADA RSS-210 ISSUE 8

CERTIFICATION TEST REPORT

FOR

2.4 GHz TRANSCEIVER

MODEL NUMBER: SD2

FCC ID: Z5ISD2

REPORT NUMBER: R10101315-RF

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Revision History

Rev.	Issue Date	Revisions	Revised By
--	2014-01-15	Initial Issue	Jeff Moser
1	2014-02-10	Revised to remove FCC Inquiry Exhibit (Sec. 7.1)	Jeff Moser

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: KCF TECHNOLOGIES
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EUT DESCRIPTION: SD2 is a 2.4 GHz transceiver that is intended for use with the SD vibration system. The SD vibration system consists of a battery operated Vibration Sensor (SD-VSN-2) and a USB powered Primary Receive Node (SD-PRN-2).

MODEL: SD2

SERIAL NUMBER: 0xFCC00001

DATE TESTED: 2013-10-28 through 2013-12-13

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Pass
INDUSTRY CANADA RSS-210 Issue 8 Annex 8	Pass
INDUSTRY CANADA RSS-GEN Issue 3	Pass

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL LLC based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released
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EMC Project Lead
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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4-2003, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 3, and RSS-210 Issue 8.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 12 Laboratory Dr., Research Triangle Park, NC 27709, USA.

UL LLC (RTP) is accredited by NVLAP, Laboratory Code 200246-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2002460.htm.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	+/- 2.5 dB
Radiated Disturbance, 30 to 1000 MHz	+/- 3.4 dB

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT (model SD2) is a 2.4 GHz DTS modular transceiver that is intended for use with the KCF Technologies SD vibration system. The SD vibration system consists of a battery operated Vibration Sensor (SD-VSN-2) and a USB powered Primary Receive Node (SD-PRN-2).

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2424-2457	Transmit	15.61	36.4

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a monopole antenna with a maximum gain as table below;

Frequency Range (MHz)	**Antenna Gain (dBi)**	**Antenna Gain (numeric)**
2424 to 2457	2.3	1.7

5.4. SOFTWARE AND FIRMWARE

The EUT was tested with the firmware installed in the device as provided by the manufacturer. Test utility software for the laptop was provided to enable the operating channel to be changed as necessary during the test.

5.5. WORST-CASE CONFIGURATION AND MODE

The fundamental of the EUT was investigated in three orthogonal orientations X,Y, and Z as shown in the set-up photographs at the end of this report. It was determined that the Z orientation was the worst-case orientation. Therefore, all final radiated testing was performed with the EUT in this orientation.

For radiated emissions above 1GHz, all three channels (low, middle, and high) were investigated. Radiated emissions below 1GHz and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as the worst-case scenario.

5.6. DESCRIPTION OF TEST SETUP

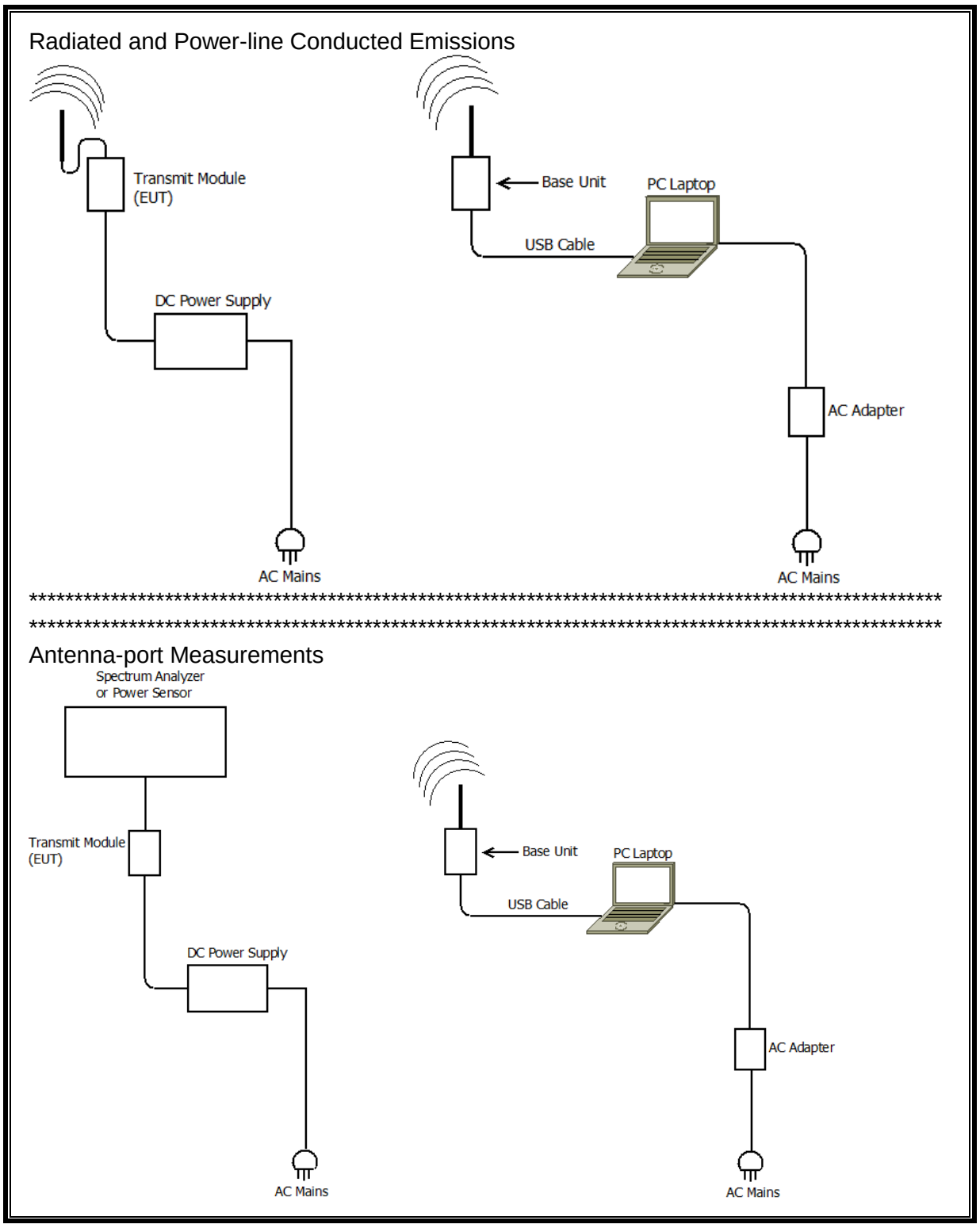
SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Laptop PC	Dell	Vostro 1720	C3ZTHJ1	N/A
Laptop PC power adapter	Dell	DA90PS2-00	-	N/A
Vibe sensor module	KCF	VSN-1 and PRN-1	0xBASE0001	N/A
DC power supply	Extech	3822202	-	N/A
DC power supply	Sorensen	HPD 60-5	51668	N/A

TEST SETUP

The EUT is set up as a stand-alone device powered by an external DC power source. Another device was located near the EUT in order for the EUT to repeatedly transmit data.

SETUP DIAGRAM FOR TESTS



6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Wireless Conducted Measurement Equipment

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
SA0016	Spectrum Analyzer	Agilent Technologies	N9030A	2013-09-04	2014-09-30
PSENSOR001	RF Power Meter Sensor Head	Rohde & Schwartz	NRP-Z81 (w/ NRP-Z3 USB adapter)	2013-09-27	2014-09-30
MM0145	Multimeter	Fluke	177	2012-08-27	2014-08-31
HI0040	Temp/Humid/Pressure Meter	Cole-Parmer	99760-00	2013-01-25	2014-01-25

Radiated Disturbance Emissions (E-field)

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AT0037	Loop Antenna (Low Range)	Electro-Metrics	EM-6871	2013-12-02	2014-12-31
AT0036	Loop Antenna (High Range)	Electro-Metrics	EM-6872	2013-12-02	2014-12-31
AT0022	Log-periodic Antenna, 200 MHz to 1000 MHz	Chase	UPA6109	2013-01-29	2014-01-31
AT0025	Biconical Antenna, 30 to 300 MHz	Schaffner-Chase EMC Ltd.	VBA6106A	2013-06-14	2014-06-30
AT0062	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2013-08-27	2014-08-31
AT0063	Horn Antenna, 18-26.5GHz	ARA	MWH-1826/B	2013-11-12	2014-11-30
SAC_C (Biconical 3m location)	Gain-Loss string for biconical antenna at 3m	Various	Various	2013-09-06	2014-09-30
SAC_D (Log-Periodic 3m location)	Gain-Loss string for log-periodic antenna at 3m	Various	Various	2013-09-06	2014-09-30
SAC_E_LR (Loop)	Gain-Loss string for loop/rod antenna at 3m	Various	Various	2013-09-06	2014-09-30
SAR003	Spectrum Analyzer / Receiver	Rohde & Schwarz	ESIB40 (1088.7490.40)	2013-09-03	2014-09-30
SA0015	Spectrum Analyzer / Receiver	Rohde & Schwarz	ESCI7	2013-09-04	2014-09-30
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
AMP011	RF Amp, 1-20GHz	Miteq	AMF-6D-01002000-22-10P	2013-09-04	2014-09-30

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AMP013	RF Amp, 18-40GHz	Miteq	JS44-18004000-33-8P	2013-09-04	2014-09-30
HI0040	Temp/Humid/Pressure Meter	Cole-Parmer	99760-00	2013-01-25	2014-01-25
BRF003	2,4GHz band reject filter	Microtronics	BRM50702	2013-09-04	2014-09-30
MM0145	Multimeter	Fluke	177	2012-08-27	2014-08-31

Conducted Disturbance Emissions - Voltage

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
SA0015	EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESCI 7	2013-09-04	2014-09-30
ATA016	Coaxial cable, 20 ft., BNC -male to BNC-male	UL	RG-223	2013-09-05	2014-09-30
HI0040	Temp/Humid/Pressure Meter	Cole-Parmer	99760-00	2013-01-25	2014-01-25
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
ATA508	Transient Limiter, 0.009 to 100 MHz	Electro-Metrics	EM 7600	2013-09-06	2014-09-30
LISN003	LISN, 50-ohm/50-uH, 2-conductor, 25A	Fischer Custom Com.	FCC-LISN-50-25-2-01-550V	2013-09-03	2014-09-30
MM0145	Multimeter	Fluke	177	2012-08-27	2014-08-31

7. ANTENNA PORT TEST RESULTS

7.1. DUTY CYCLE

RATIONALE AND FCC ALLOWANCE TO USE DUTY CYCLE PER FCC §15.35 (c)

Given the very limited transmit time of this device, an inquiry was sent to the FCC's OET requesting that the duty-cycle correction method outlined in FCC §15.35 (c) be used for such devices. Due to technical limitations the device was designed for very limited-transmit times and, as such, was unable to transmit continuously as desired by KDB 558074. Therefore, a KDB inquiry was sought for this device. The inquiry and response has been uploaded with this application for device certification.

LIMITS

FCC §15.35 (c)
The measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer or radiated field strength. The RBW is set to 8 MHz and the VBW is set to 50 MHz. The sweep time is coupled and the span is set to 0 Hz. The pulse width and worst-case inter-packet period is recorded and used to calculate the expected worst-case duty-cycle.

CALCULATION

Given the variable inter-pack delay, a worst-case duty-cycle was arrived at using the longest on time and shortest period between pulses as follows:

Shortest inter-pulse period: 2.2 ms
Longest on time: 198us

Average Reading = Peak Reading (dBuV/m) + 20log (Duty Cycle), Where Duty Cycle is
(# of long pulses * long pulse width) + (# of short pulses * short pulse width) / 100 or T

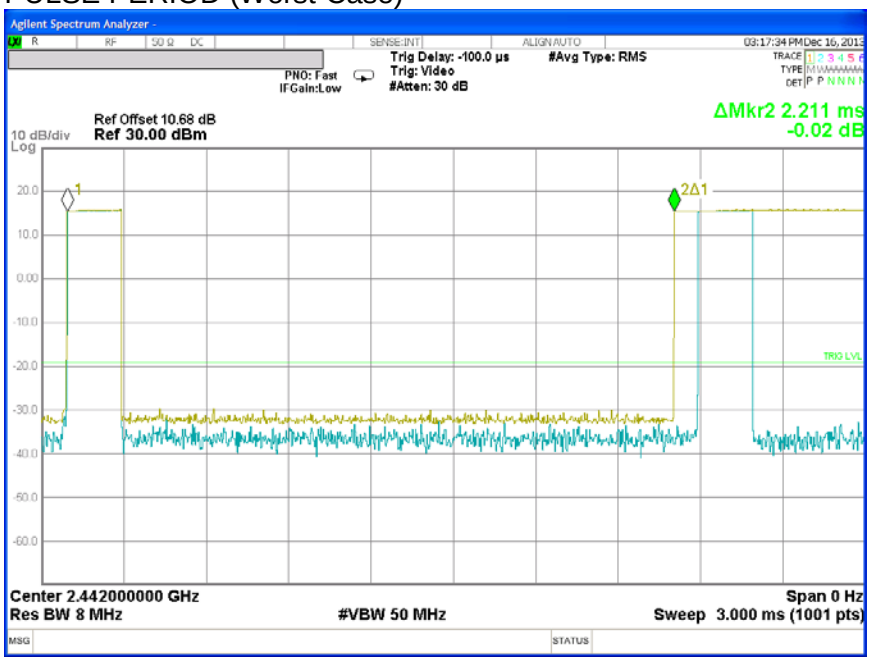
RESULTS

No non-compliance noted:

One Period (ms)	Pulse Width (ms)	# of Pulses	Duty Cycle	20*Log Duty (dB)
2.2	0.198	1	0.090	-20.9

ON TIME (Worst-Case)

PULSE PERIOD (Worst-Case)



The above plot consists of two traces as follows:

Channel 1: Max-hold trace that captures the worst-case pulse period.

Channel 2: Real-time trace showing an intermediate pulse period.

7.2. TRANSMIT MODE IN THE 2.4 GHz BAND

7.2.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

IC RSS-210 A8.2 (a)

The minimum 6 dB bandwidth shall be at least 500 kHz.

TEST PROCEDURE

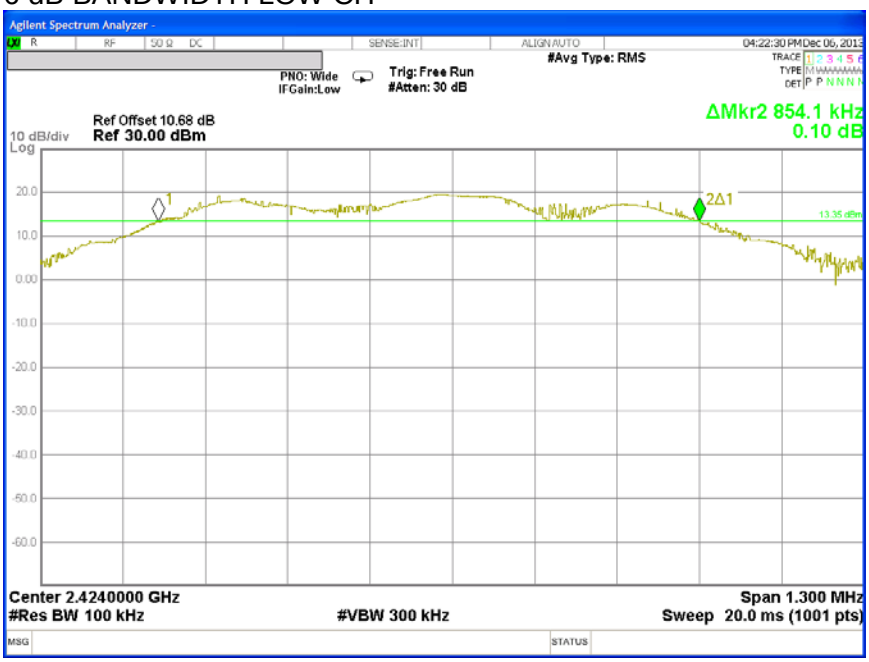
The transmitter output is connected to a spectrum analyzer. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

RESULTS

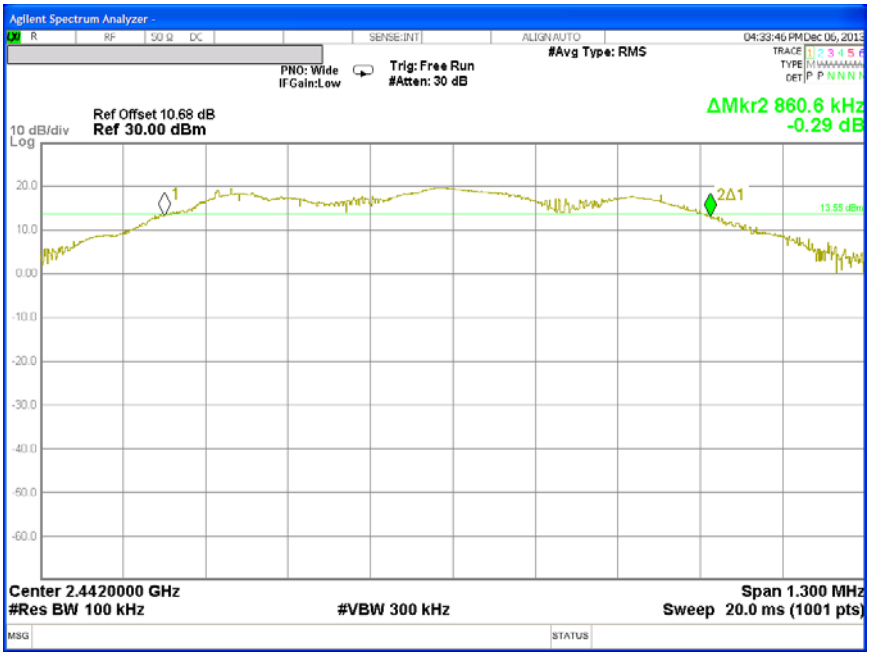
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2424	0.854	0.5
Middle	2442	0.861	0.5
High	2457	0.850	0.5

6 dB BANDWIDTH

6 dB BANDWIDTH LOW CH



6 dB BANDWIDTH MID CH



6 dB BANDWIDTH HIGH CH

7.2.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

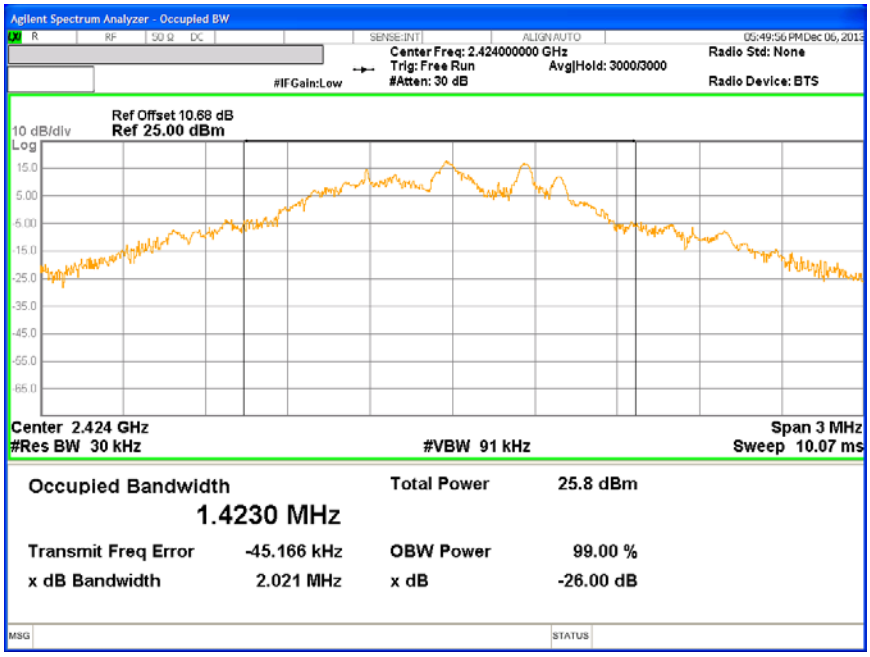
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2424	1.423
Middle	2442	1.425
High	2457	1.381

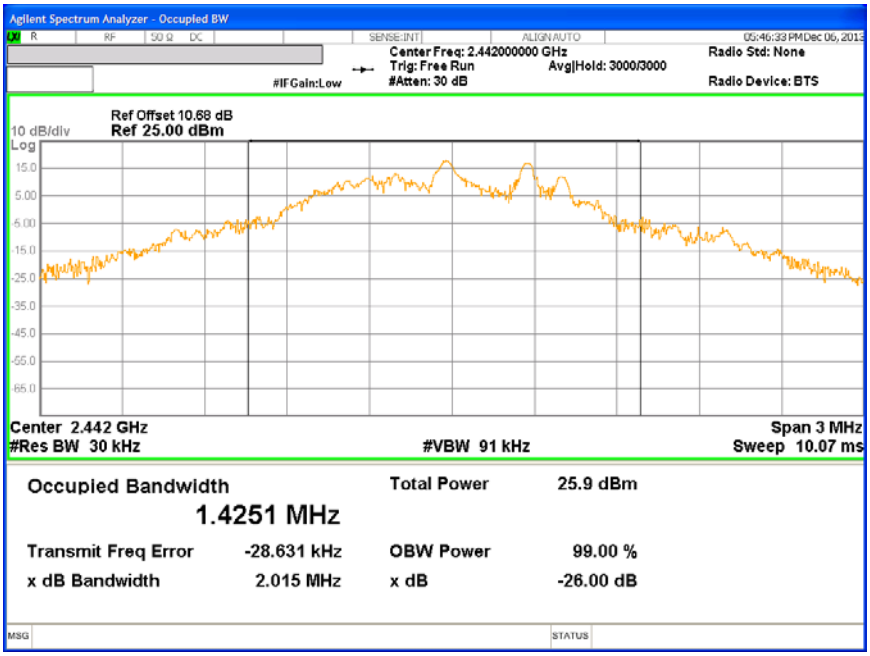
99% BANDWIDTH

99% BANDWIDTH LOW CH



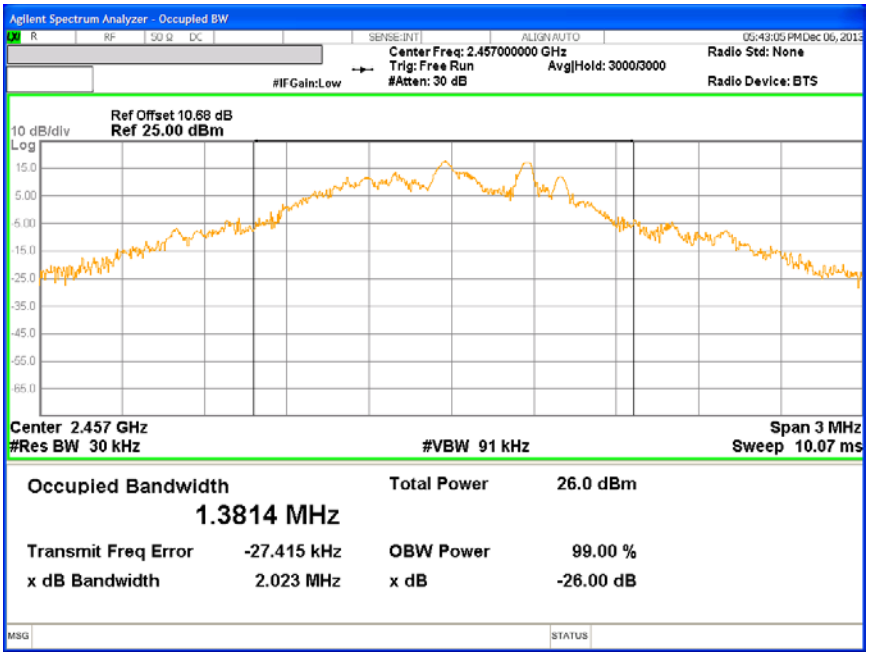
Detector type: Sample

99% BANDWIDTH MID CH



Detector type: Sample

99% BANDWIDTH HIGH CH



Detector type: Sample

7.2.3. OUTPUT POWER

LIMITS

FCC §15.247 (b)

IC RSS-210 A8.4

The maximum antenna gain is less than or equal to 6 dBi, therefore the limit is 30 dBm.

TEST PROCEDURE

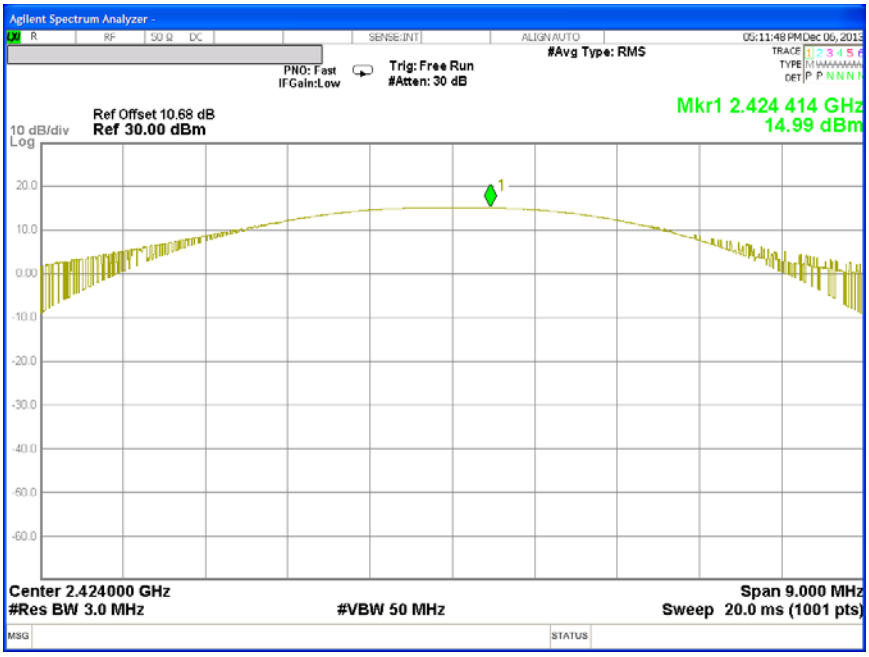
The transmitter output is connected to a spectrum analyzer the analyzer bandwidth is set to a value greater than the 99% bandwidth of the EUT.

RESULTS

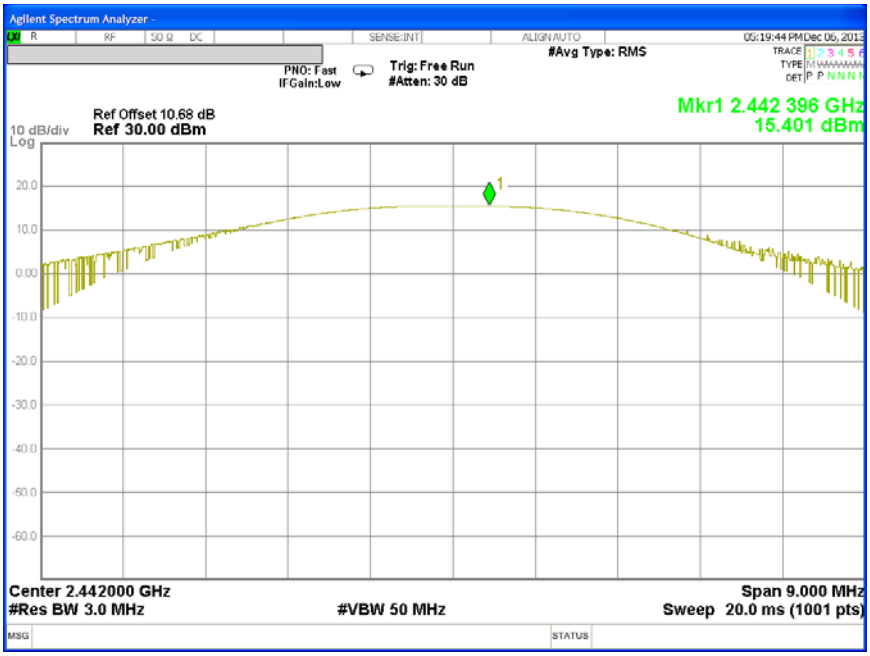
Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2424	14.99	30	-15.01
Middle	2442	15.40	30	-14.60
High	2457	15.61	30	-14.39

OUTPUT POWER

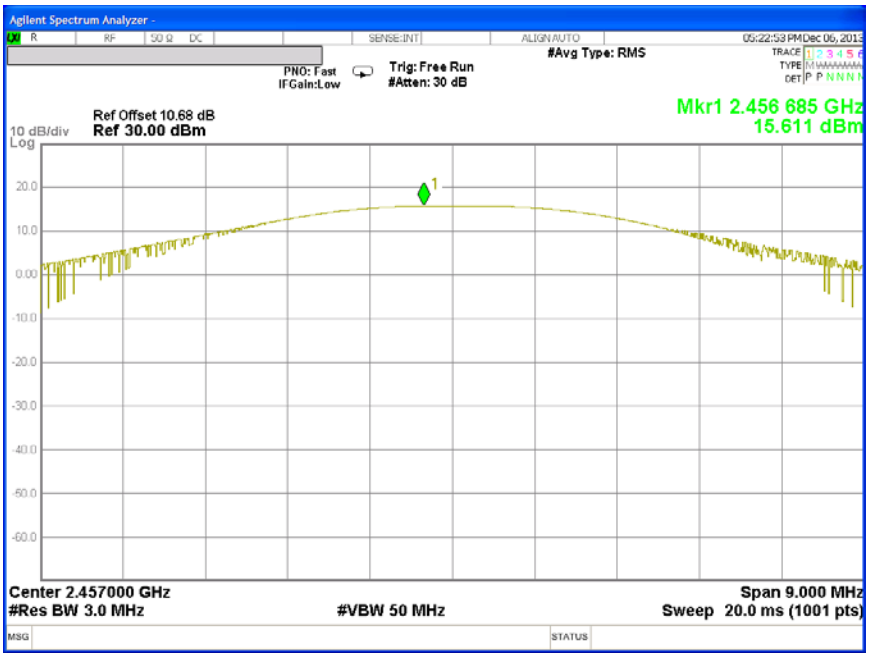
OUTPUT POWER LOW CH



OUTPUT POWER MID CH



OUTPUT POWER HIGH CH



7.2.4. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

The cable assembly insertion loss of 10.68 dB (including 10 dB pad and0.68 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (MHz)	Power (dBm)
Low	2424	14.88
Middle	2442	15.38
High	2457	15.51

Note: The above measurements were gated average measurements.

7.2.5. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

IC RSS-210 A8.2 (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

TEST PROCEDURE

Output power was measured based on the use of a peak measurement, therefore the power spectral density was measured using PSD Option 1 in accordance with FCC document "Measurement of Digital Transmission Systems Operating under Section 15.247", March 23, 2005.

RESULTS

Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dB)
Low	2424	5.4	8	-2.6
Middle	2442	5.7	8	-2.3
High	2457	6.2	8	-1.8

POWER SPECTRAL DENSITY

PSD LOW CH

PSD MID CH

PSD HIGH CH

7.2.6. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

IC RSS-210 A8.5

Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

TEST PROCEDURE

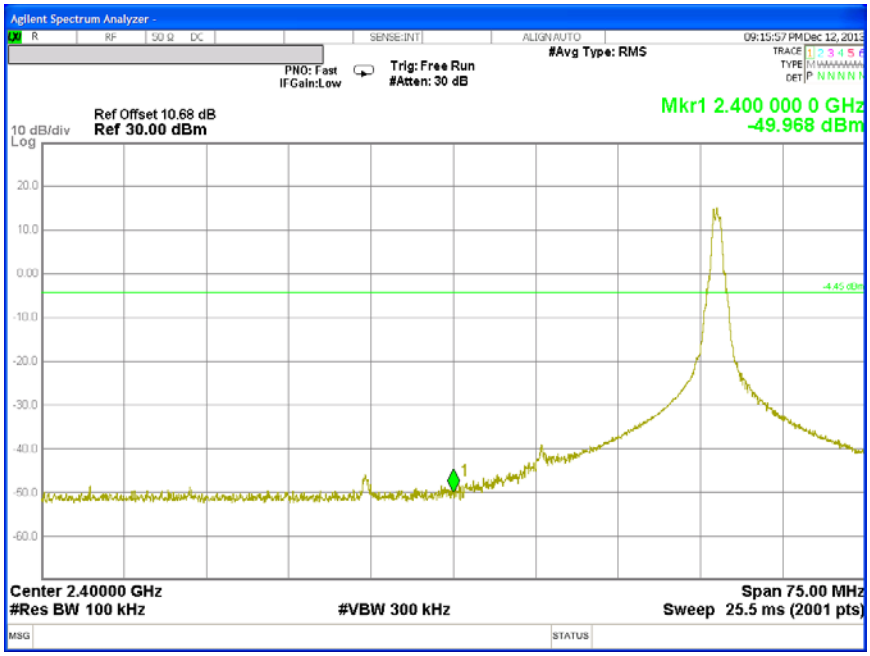
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

RESULTS

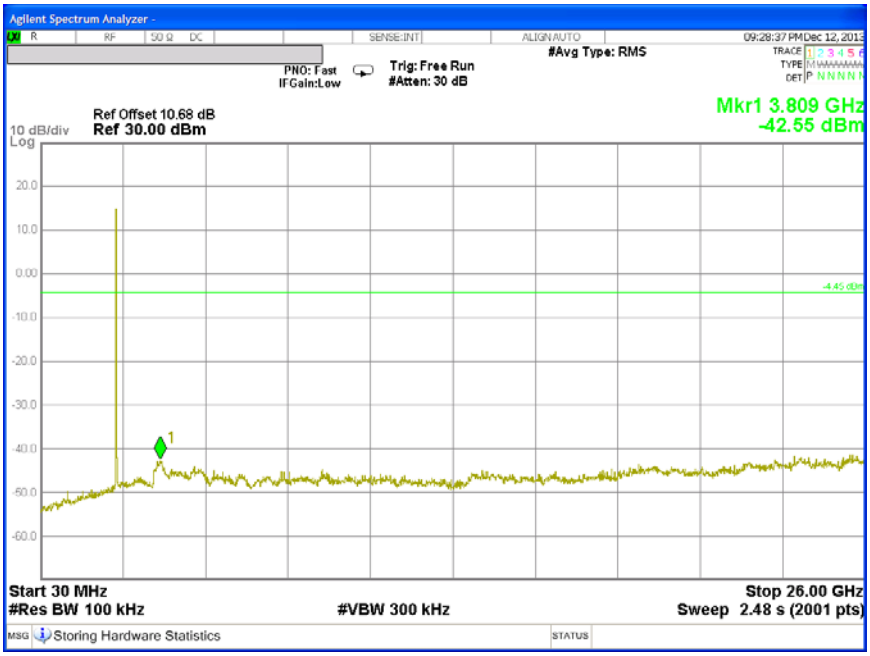
SPURIOUS EMISSIONS, LOW CHANNEL

LOW CH BANDEDGE



Note: The high channel had the highest peak power. Therefore, the high channel was used as the reference.

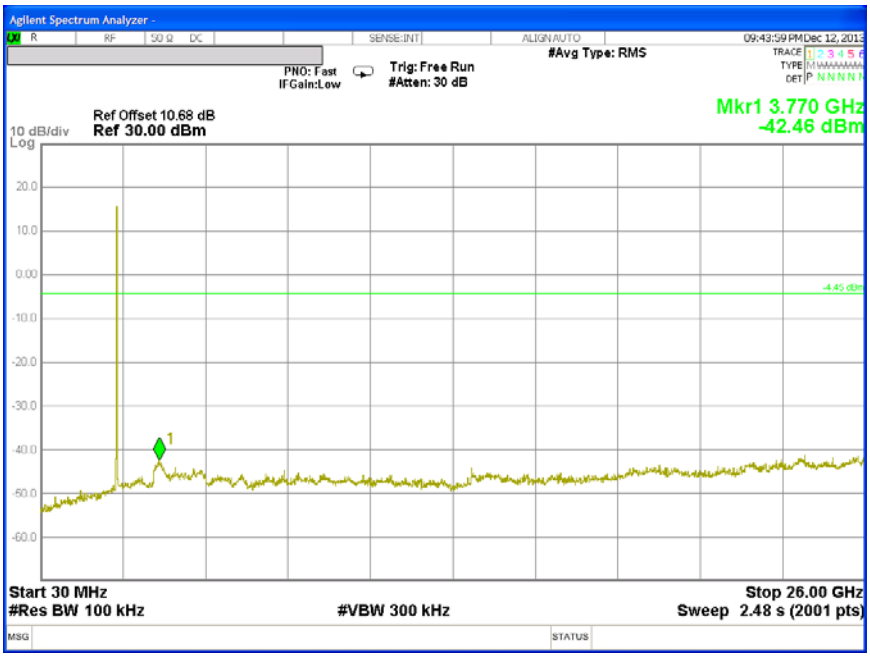
LOW CH SPURIOUS



Note: The high channel had the highest peak power. Therefore, the high channel was used as the reference.

SPURIOUS EMISSIONS, MID CHANNEL

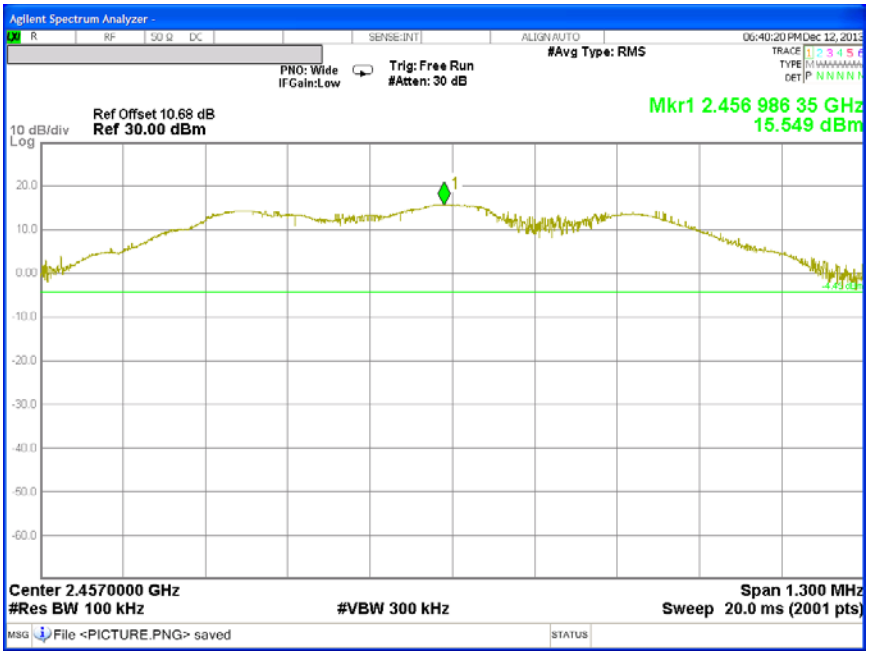
MID CH SPURIOUS



Note: The high channel had the highest peak power. Therefore, the high channel was used as the reference.

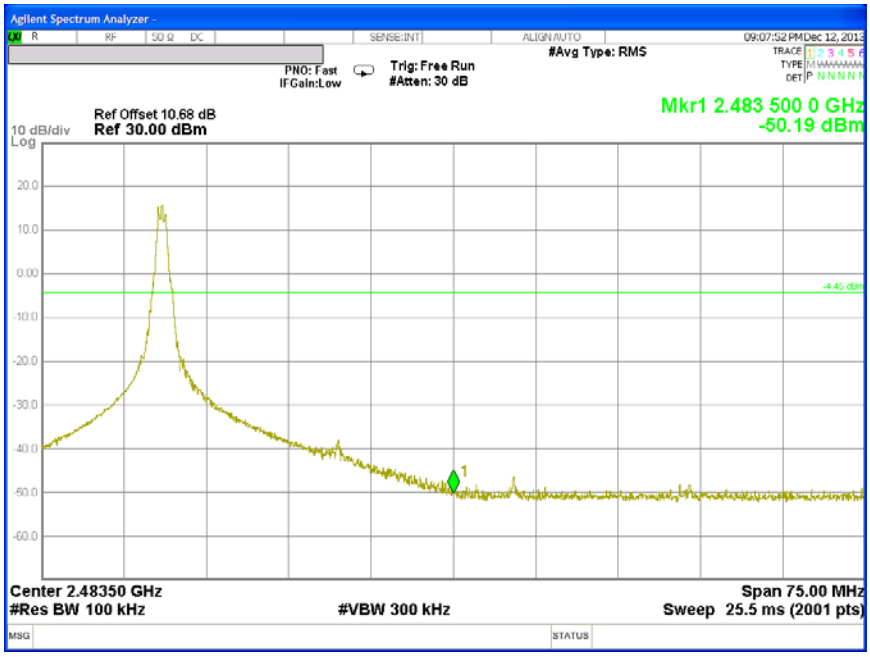
SPURIOUS EMISSIONS, HIGH CHANNEL

HIGH CH REFERENCE



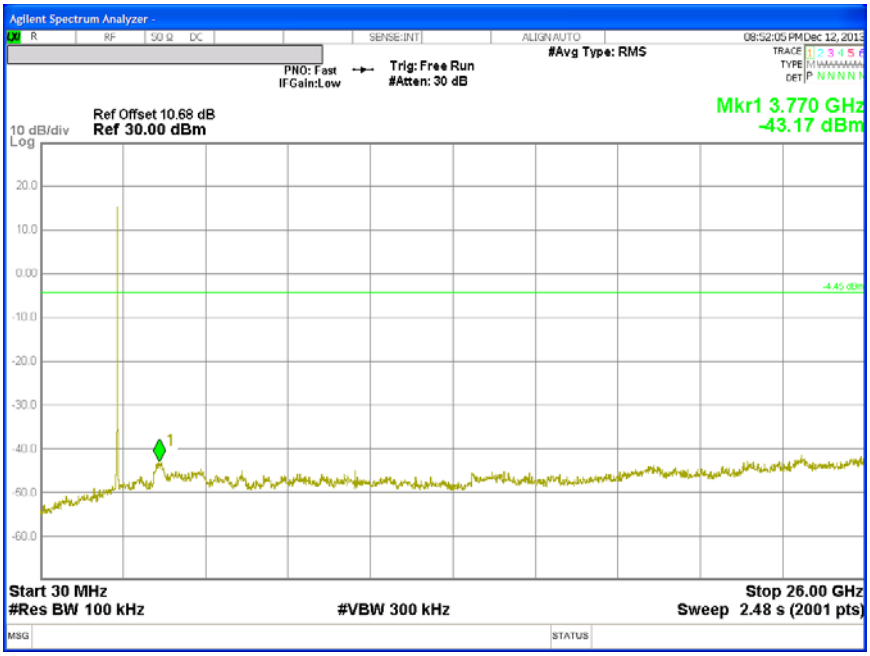
Note: The high channel had the highest peak power. Therefore, the high channel was used as the reference.

HIGH CH BANDEDGE



Note: The high channel had the highest peak power. Therefore, the high channel was used as the reference.

HIGH CH SPURIOUS



Note: The high channel had the highest peak power. Therefore, the high channel was used as the reference.

8. RADIATED TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

IC RSS-210 Clause 2.6 (Transmitter)

IC RSS-GEN Clause 6 (Receiver)

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.4. The EUT is set to transmit in a continuous mode.

For measurements between 30 MHz and 1 GHz the resolution bandwidth is set to 120 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 1 MHz for peak measurements and as applicable for average measurements.

The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

For measurements below 30 MHz loop antennas were used per FCC requirements, and measurement equipment settings test method were consistent with ANSI C63.4.
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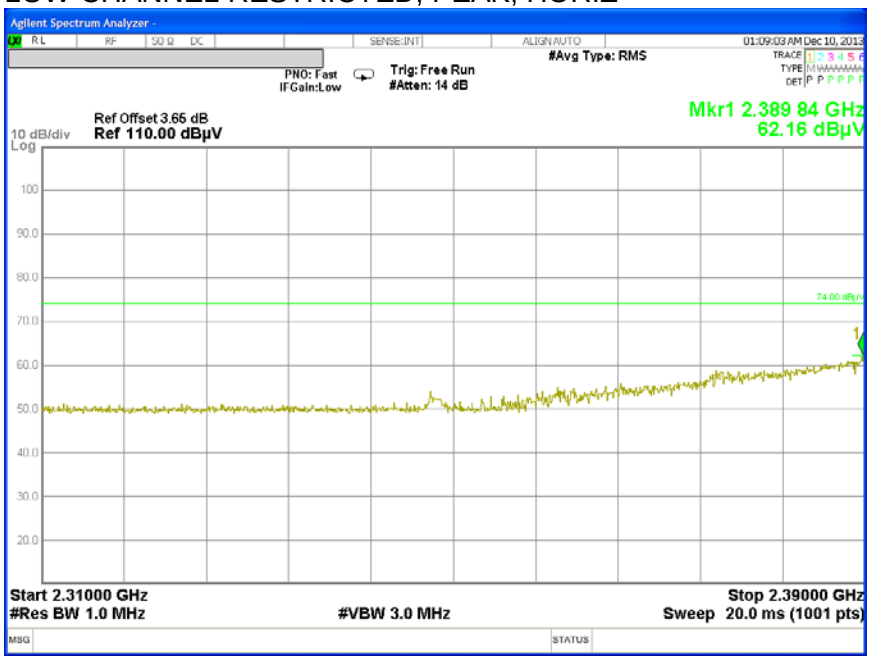
8.2. TRANSMITTER ABOVE 1 GHz

8.2.1. TX ABOVE 1 GHz FOR TRANSMIT MODE IN THE 2.4 GHz BAND

RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)

LOW CHANNEL RESTRICTED, PEAK, HORIZ



Channel frequency: 2424MHz

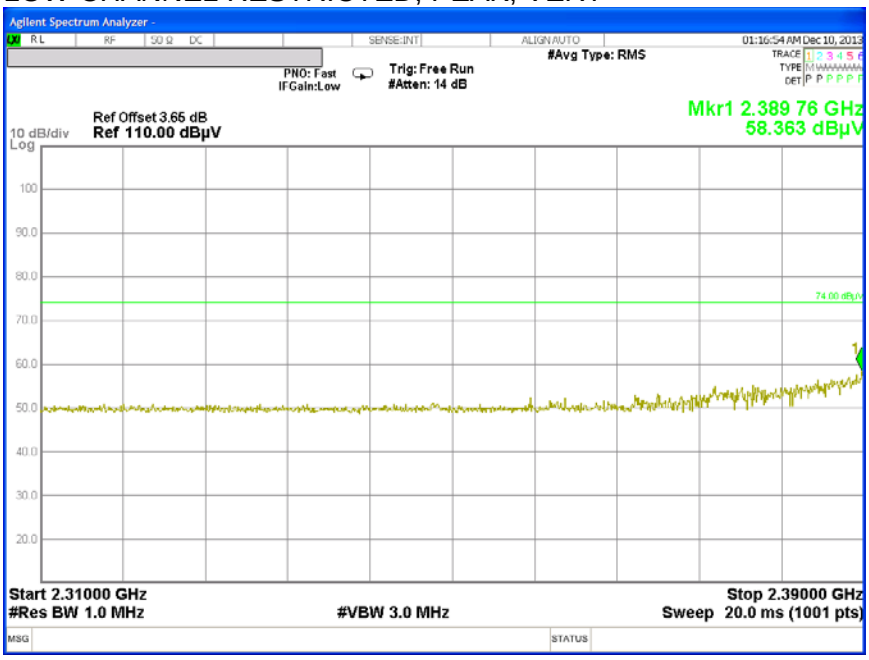
LOW CHANNEL RESTRICTED, AVG, HORIZ

Worst-case average	= Max-peak – DCF.
Worst-case average	= 62.16dBuV/m – 20.9dB.
Worst-case average	= 41.3dBuV/m.
Average Limit	= 54 dBuV/m
Margin	= -12.7 dB

Channel frequency: 2424MHz

RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)

LOW CHANNEL RESTRICTED, PEAK, VERT



Channel frequency: 2424MHz

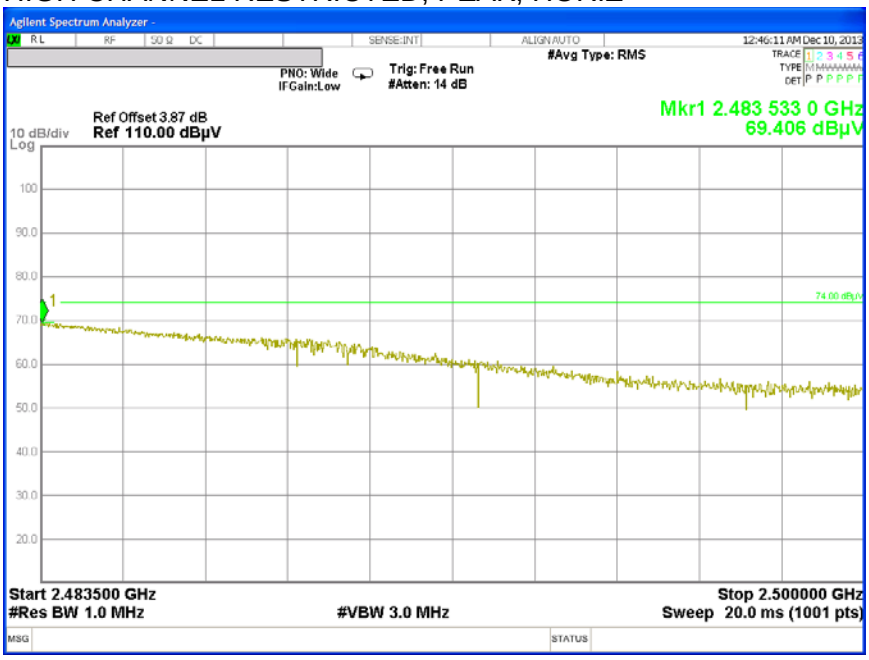
LOW CHANNEL RESTRICTED, AVG, VERT

Worst-case average	= Max-peak – DCF.
Worst-case average	= 58.363dBuV/m – 20.9dB.
Worst-case average	= 37.5dBuV/m.
Average Limit	= 54 dBuV/m
Margin	= -16.5 dB

Channel frequency: 2424MHz

RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)

HIGH CHANNEL RESTRICTED, PEAK, HORIZ



Channel frequency: 2457MHz

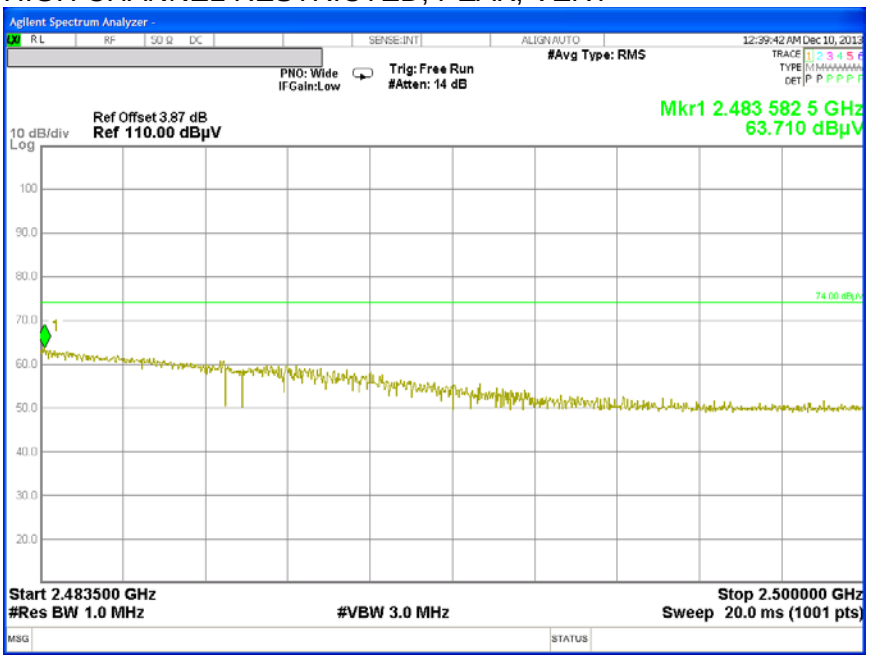
HIGH CHANNEL RESTRICTED, AVG, HORIZ

Worst-case average	= Max-peak – DCF.
Worst-case average	= 69.406dBuV/m – 20.9dB.
Worst-case average	= 48.5dBuV/m.
Average Limit	= 54 dBuV/m
Margin	= -5.5 dB

Channel frequency: 2457MHz

RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)

HIGH CHANNEL RESTRICTED, PEAK, VERT



Channel frequency: 2457MHz

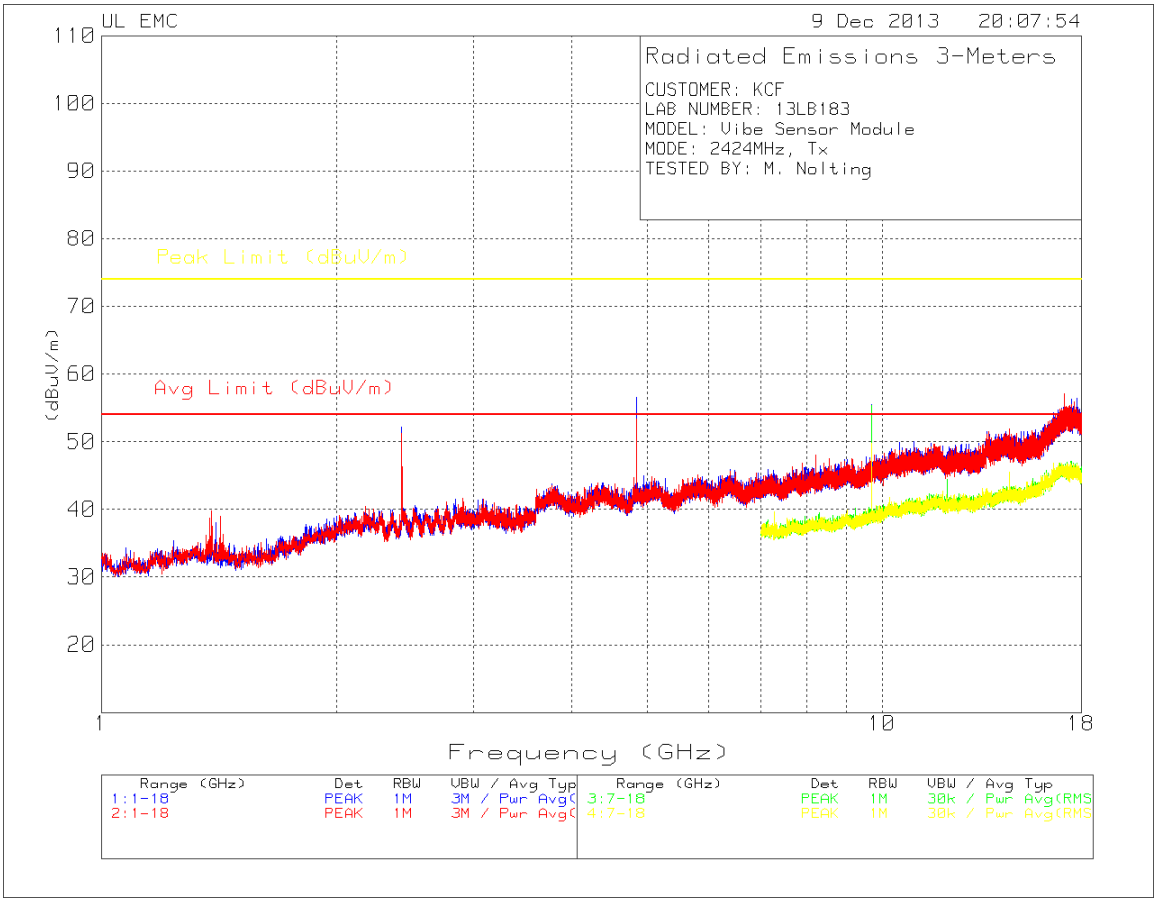
HIGH CHANNEL RESTRICTED, AVG, VERT

Worst-case average	= Max-peak – DCF.
Worst-case average	= 63.71dBuV/m – 20.9dB.
Worst-case average	= 42.8dBuV/m.
Average Limit	= 54 dBuV/m
Margin	= -11.2 dB

Channel frequency: 2457MHz

HARMONICS AND SPURIOUS EMISSIONS

Low Channel: Horizontal/Vertical Plot



Low Channel: Tabular Data

CUSTOMER: KCF
LAB NUMBER: 13LB183
MODEL: Vibe Sensor Module
MODE: 2424MHz, Tx
TESTED BY: M. Nolting

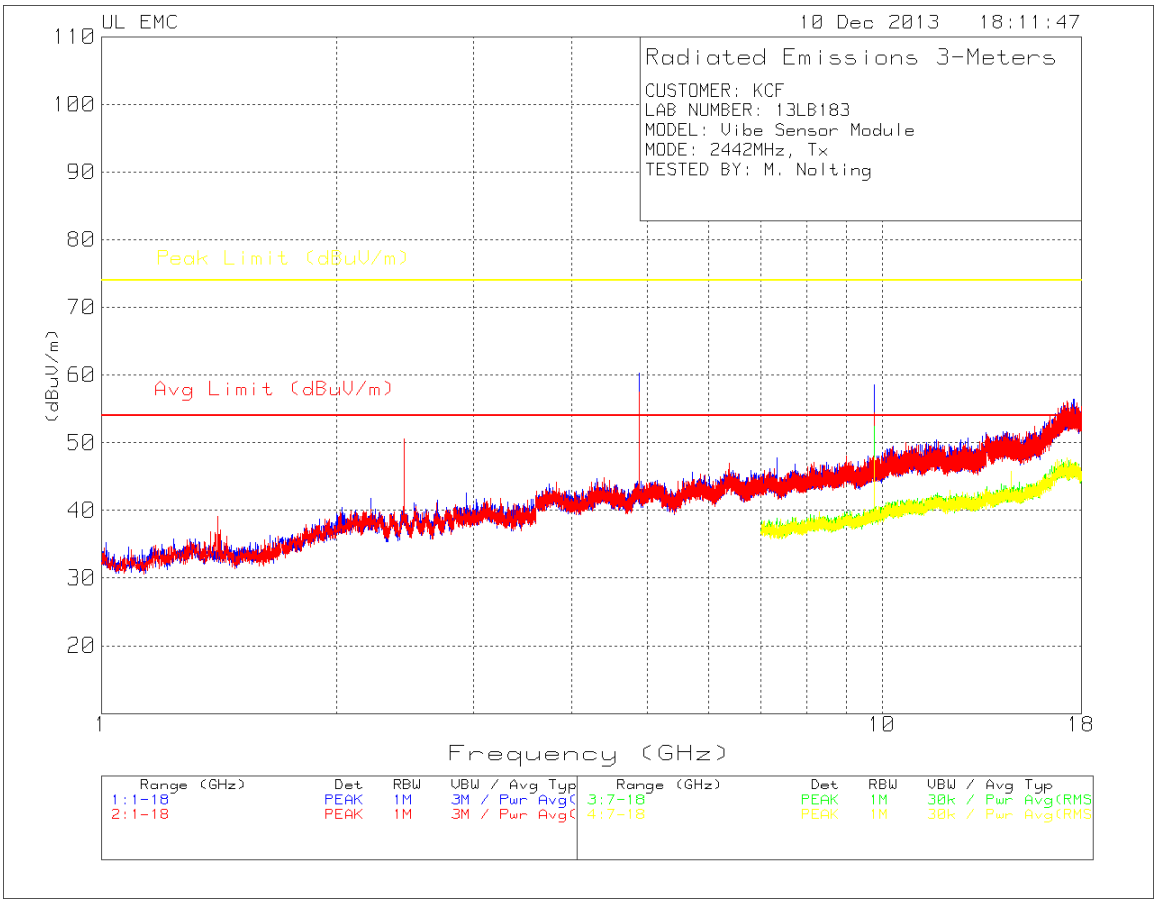
Freq (GHz)	Meter Reading [dBuV]	Detector	Antenna Factor [dB/m]	Gain/Loss [dB]	Peak Field Strength [dBuV/m]	15.209 Peak Limit [dBuV/m]	Margin [dB]	DCF (dB)	Average Field Strength [dBuV/m]	FCC 15.209 Average Limit [dBuV/m]	Margin [dB]	Antenna Polarity	In Restricted Band?
1.402	49.80	PK	28.20	-40.00	38.0	74.0	-36.0	-	-	54.0	-16.0	H	Y
4.849	60.54	PK	34.10	-36.30	58.3	74.0	-15.6	-20.9	37.4	54.0	-16.5	H	Y
7.271	49.01	PK	35.60	-32.70	51.9	74.0	-22.1	-20.9	31.0	54.0	-23.0	H	Y
12.121	42.84	PK	39.20	-31.40	50.6	74.0	-23.3	-20.9	29.7	54.0	-24.2	H	Y
9.696	53.14	PK	37.10	-31.90	58.3	-	-	-	-	-	-	H	N
14.546	40.07	PK	39.40	-29.60	49.9	-	-	-	-	-	-	H	N
1.384	51.66	PK	28.20	-40.10	39.8	74.0	-34.2	-	-	54.0	-14.2	V	Y
4.848	63.94	PK	34.10	-36.30	61.7	74.0	-12.2	-20.9	40.8	54.0	-13.1	V	Y
7.271	50.33	PK	35.60	-32.70	53.2	74.0	-20.7	-20.9	32.3	54.0	-21.6	V	Y
12.120	46.10	PK	39.20	-31.40	53.9	74.0	-20.1	-20.9	33.0	54.0	-21.0	V	Y
9.696	55.57	PK	37.10	-31.90	60.8	-	-	-	-	-	-	V	N
14.542	43.81	PK	39.40	-29.60	53.6	-	-	-	-	-	-	V	N

PK - Peak detector

Average Field Strength computed as follows for the harmonics of the transmit frequency: PK + DCF, where DCF = -20.9dB

18-26GHz frequency range: No EUT-related noise observed in this range.

Middle Channel: Horizontal/Vertical Plot



Middle Channel: Tabular Data

CUSTOMER: KCF
LAB NUMBER: 13LB183
MODEL: Vibe Sensor Module
MODE: 2442MHz, Tx
TESTED BY: M. Nolting

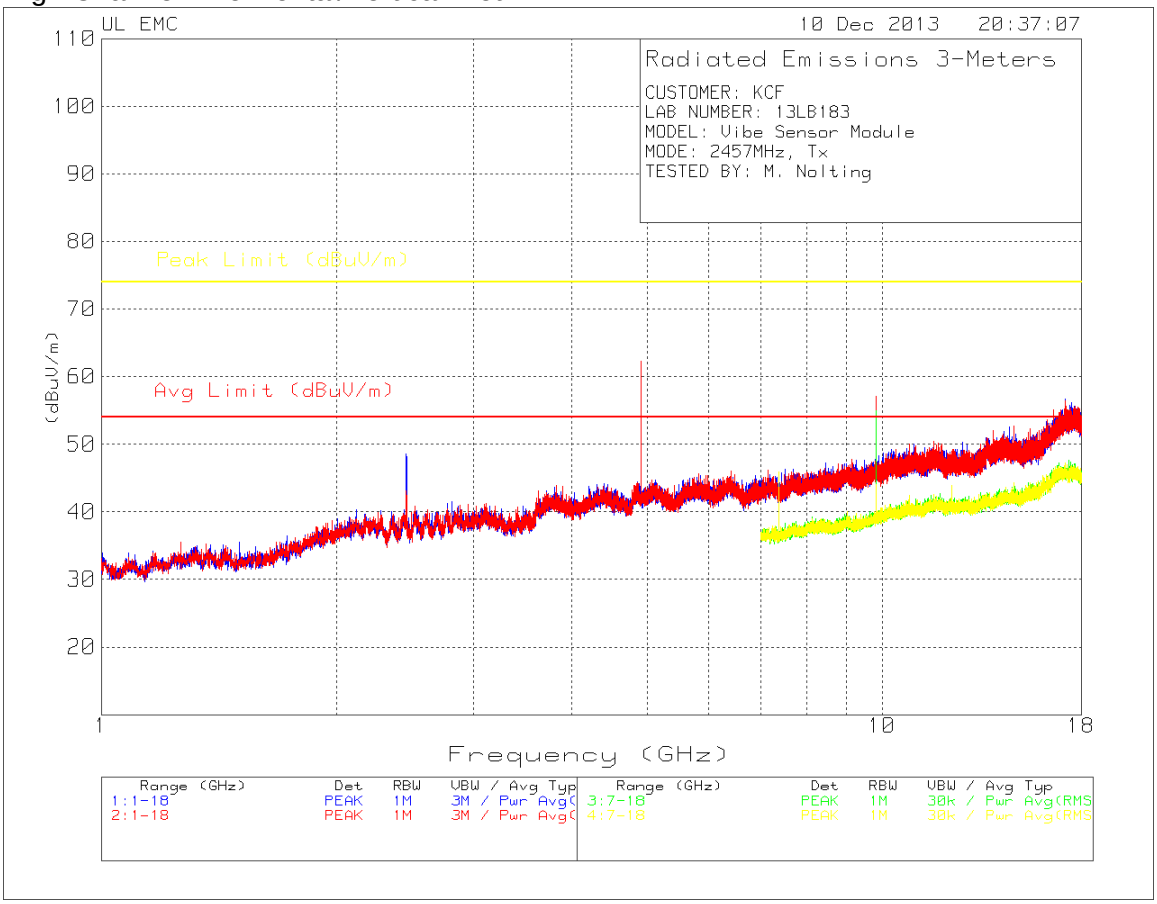
Freq (GHz)	Meter Reading [dBuV]	Detector	Antenna Factor [dB/m]	Gain/Loss [dB]	Peak Field Strength [dBuV/m]	15.209 Peak Limit [dBuV/m]	Margin [dB]	DCF (dB)	Average Field Strength [dBuV/m]	FCC 15.209 Average Limit [dBuV/m]	Margin [dB]	Antenna Polarity	In Restricted Band?
4.883	62.68	PK	34.00	-36.20	60.5	74.0	-13.5	-20.9	39.6	54.0	-14.4	H	Y
7.362	41.46	PK	35.60	-32.70	44.4	74.0	-29.6	-20.9	23.5	54.0	-30.5	H	Y
12.210	44.62	PK	39.40	-31.40	52.6	74.0	-21.4	-20.9	31.7	54.0	-22.3	H	Y
9.768	54.05	PK	37.20	-31.80	59.5	-	-	-	-	-	-	H	N
14.651	40.45	PK	39.60	-29.70	50.4	-	-	-	-	-	-	H	N
17.094	36.42	PK	42.40	-27.70	51.1	-	-	-	-	-	-	H	N
1.408	50.96	PK	28.20	-40.00	39.2	74.0	-34.8	-	-	54.0	-14.8	V	Y
4.884	67.01	PK	34.00	-36.20	64.8	74.0	-9.2	-20.9	43.9	54.0	-10.1	V	Y
7.326	51.60	PK	35.60	-32.60	54.6	74.0	-19.4	-20.9	33.7	54.0	-20.3	V	Y
9.767	53.41	PK	37.20	-31.80	58.8	-	-	-	-	-	-	V	N
12.209	45.41	PK	39.40	-31.40	53.4	74.0	-20.6	-20.9	32.5	54.0	-21.5	V	Y
14.654	40.92	PK	39.60	-29.70	50.8	-	-	-	-	-	-	V	N
17.096	37.13	PK	42.40	-27.70	51.8	-	-	-	-	-	-	V	N

PK - Peak detector

Average Field Strength computed as follows for the harmonics of the transmit frequency: PK + DCF, where DCF = -20.9dB

18-26GHz frequency range: No EUT-related noise observed in this range.

High Channel: Horizontal/Vertical Plot



High Channel: Tabular Data

CUSTOMER: KCF
LAB NUMBER: 13LB183
MODEL: Vibe Sensor Module
MODE: 2457MHz, Tx
TESTED BY: M. Nolting

Freq (GHz)	Meter Reading [dBuV]	Detector	Antenna Factor [dB/m]	Gain/Loss [dB]	Peak Field Strength [dBuV/m]	15.209 Peak Limit [dBuV/m]	Margin [dB]	DCF (dB)	Average Field Strength [dBuV/m]	FCC 15.209 Average Limit [dBuV/m]	Margin [dB]	Antenna Polarity	In Restricted Band?
3.809	47.23	PK	33.50	-37.10	43.6	74.0	-30.3	-	-	54.0	-10.3	H	Y
4.914	63.64	PK	34.00	-36.20	61.4	74.0	-12.5	-20.9	40.5	54.0	-13.4	H	Y
7.370	51.49	PK	35.50	-32.60	54.4	74.0	-19.6	-20.9	33.5	54.0	-20.5	H	Y
12.284	49.70	PK	39.20	-31.30	57.6	74.0	-16.4	-20.9	36.7	54.0	-17.3	H	Y
9.827	52.60	PK	37.30	-31.90	58.0	-	-	-	-	-	-	H	N
14.740	39.05	PK	39.60	-29.90	48.8	-	-	-	-	-	-	H	N
17.200	35.48	PK	42.10	-27.50	50.1	-	-	-	-	-	-	H	N
4.914	66.86	PK	34.00	-36.20	64.7	74.0	-9.3	-20.9	43.8	54.0	-10.2	V	Y
7.370	52.53	PK	35.50	-32.60	55.4	74.0	-18.5	-20.9	34.5	54.0	-19.4	V	Y
12.284	48.52	PK	39.20	-31.30	56.4	74.0	-17.6	-20.9	35.5	54.0	-18.5	V	Y
9.827	55.89	PK	37.30	-31.80	61.4	-	-	-	-	-	-	V	N
14.740	42.38	PK	39.60	-29.90	52.1	-	-	-	-	-	-	V	N
17.198	36.26	PK	42.10	-27.50	50.9	-	-	-	-	-	-	V	N

PK - Peak detector

Average Field Strength computed as follows for the harmonics of the transmit frequency: PK + DCF, where DCF = -20.9dB

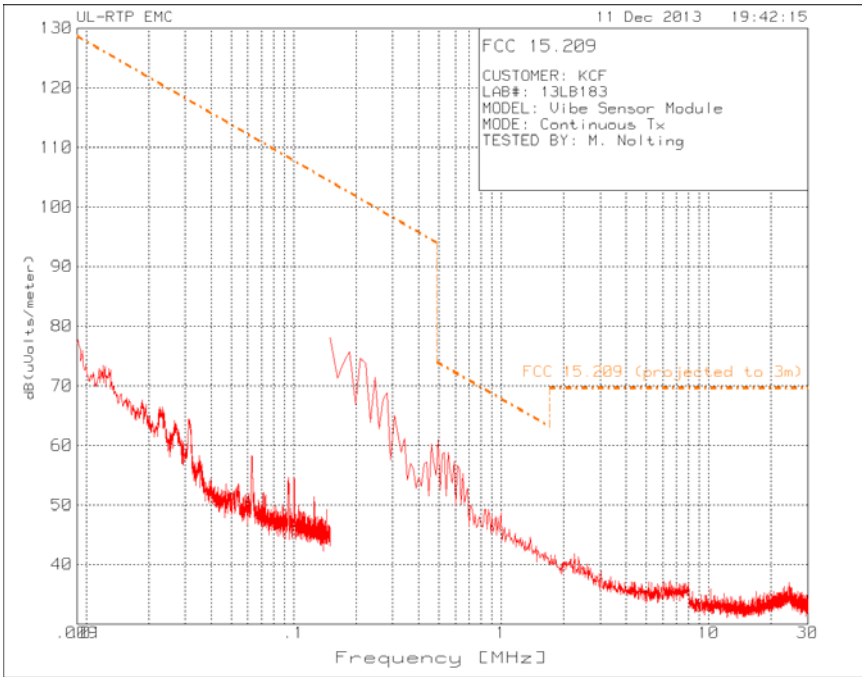
18-26GHz frequency range: No EUT-related noise observed in this range.

8.3. WORST-CASE BELOW 1 GHz

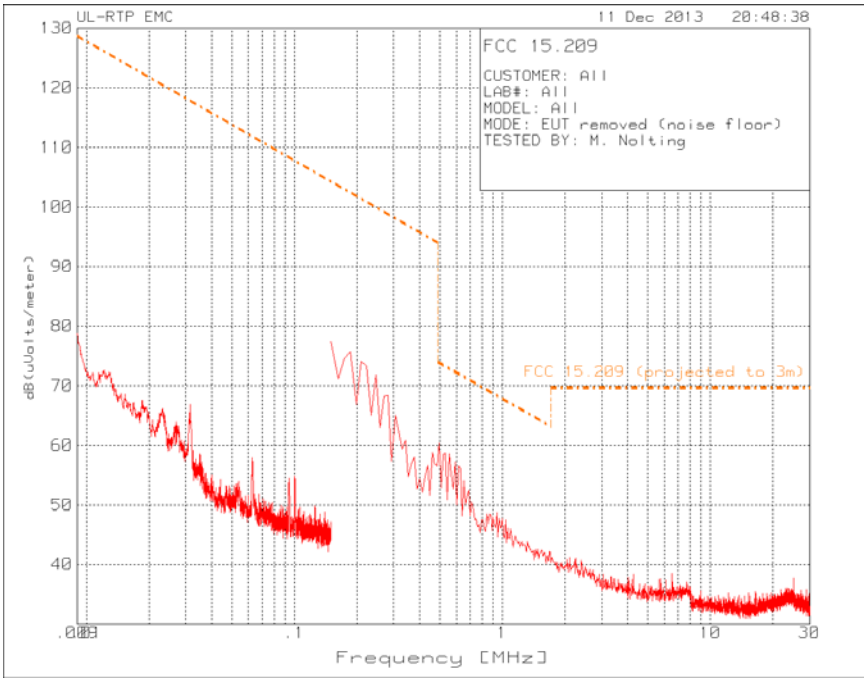
SPURIOUS EMISSIONS BELOW 30 MHz (WORST-CASE CONFIGURATION)

Note: All measurements were made at a test distance of 3 m. The limits in the plots and tabular data are the FCC/IC limits extrapolated from the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz – 30 MHz) to the measurement distance to clearly show the relative levels of fundamental and spurious emissions and demonstrate compliance with the requirement that the level of any spurious emissions be below the level of the intentionally transmitted signal. The extrapolation factor for the limits were 40*Log (specification distance / test distance).

EUT PLOT



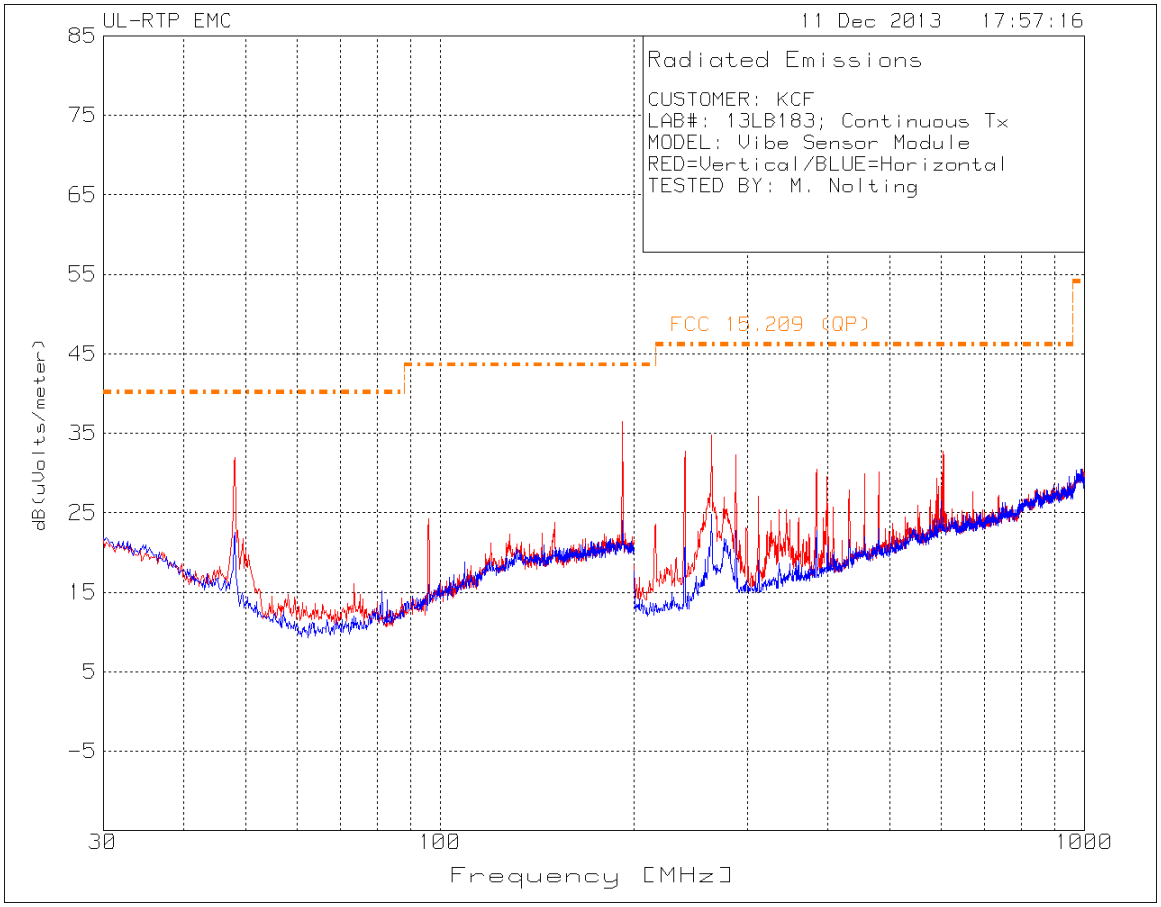
NOISE-FLOOR PLOT



The above plots demonstrate there were no EUT-related emissions of interest relative to the FCC 15.209 limit below 30MHz.

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION)

VERTICAL/HORIZONTAL PLOT



TABULAR DATA

CUSTOMER: KCF
LAB NUMBER: 13LB183
MODEL: Vibe Sensor Module
MODE: Continuous Tx
TESTED BY: M. Nolting

Freq (MHz)	Meter Reading [dBuV]	Detector	Antenna Factor [dB/m]	Gain/Loss [dB]	Field Strength [dBuV/m]	15.209 QP Limit [dBuV/m]	Margin [dB]	Antenna Polarity	In Restricted Band?
48.04	36.59	PK	10.10	-24.10	22.6	40.0	-17.4	H	N
264.04	40.49	PK	12.40	-28.10	24.8	46.0	-21.2	H	Y
288.06	37.79	PK	13.00	-28.00	22.8	46.0	-23.2	H	N
384.12	34.69	PK	15.10	-27.00	22.8	46.0	-23.2	H	N
48.04	45.92	PK	10.10	-24.10	31.9	40.0	-8.1	V	N
96.03	37.85	PK	10.30	-23.90	24.3	43.5	-19.3	V	N
192.17	44.13	PK	15.20	-22.90	36.4	43.5	-7.1	V	N
240.03	49.76	PK	11.30	-28.30	32.8	46.0	-13.2	V	Y
264.04	50.43	PK	12.40	-28.10	34.7	46.0	-11.3	V	Y
288.06	47.33	PK	13.00	-28.00	32.3	46.0	-13.7	V	N
384.12	42.32	PK	15.10	-27.00	30.4	46.0	-15.6	V	N
603.47	39.47	PK	19.70	-26.40	32.8	46.0	-13.2	V	N

PK - Peak detector
QP - Quasi-peak detector

9. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 7.2.2

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	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.

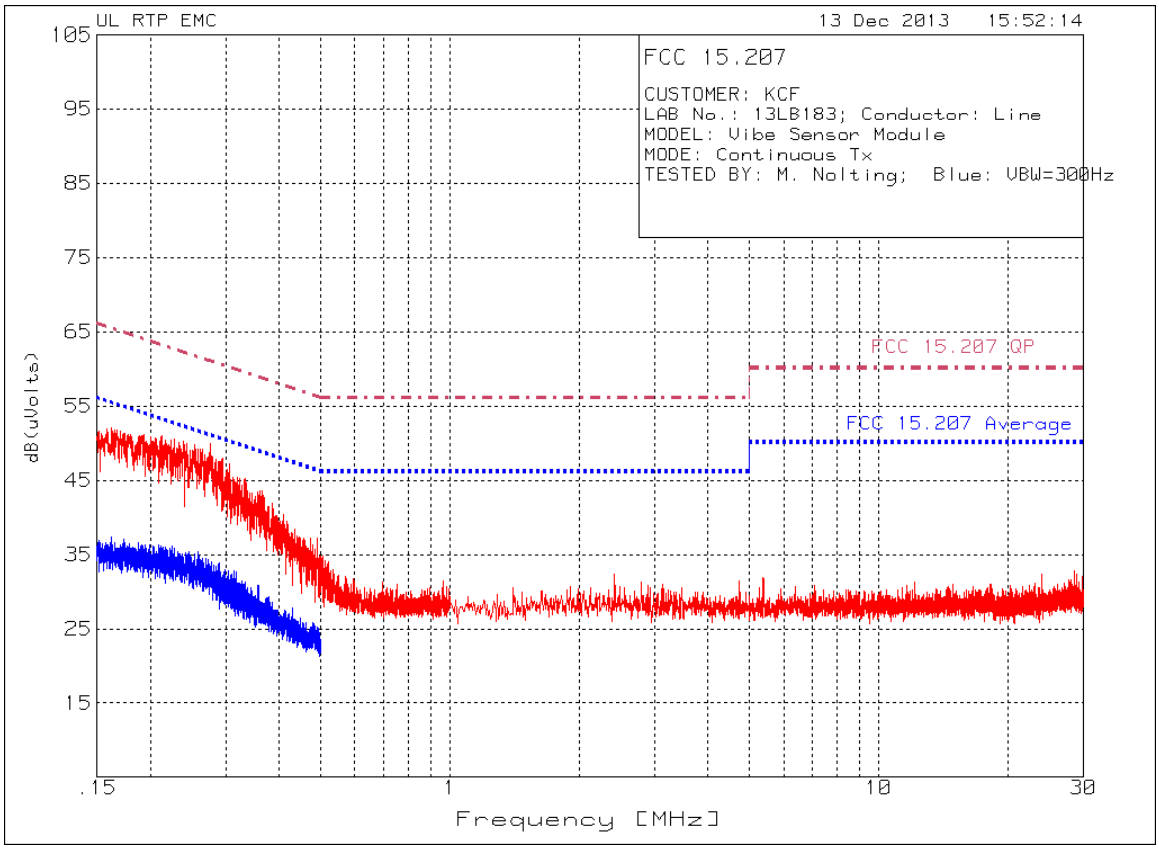
TEST PROCEDURE

ANSI C63.4

RESULTS

LINE 1 RESULTS

LINE 1 AC LINE PLOT



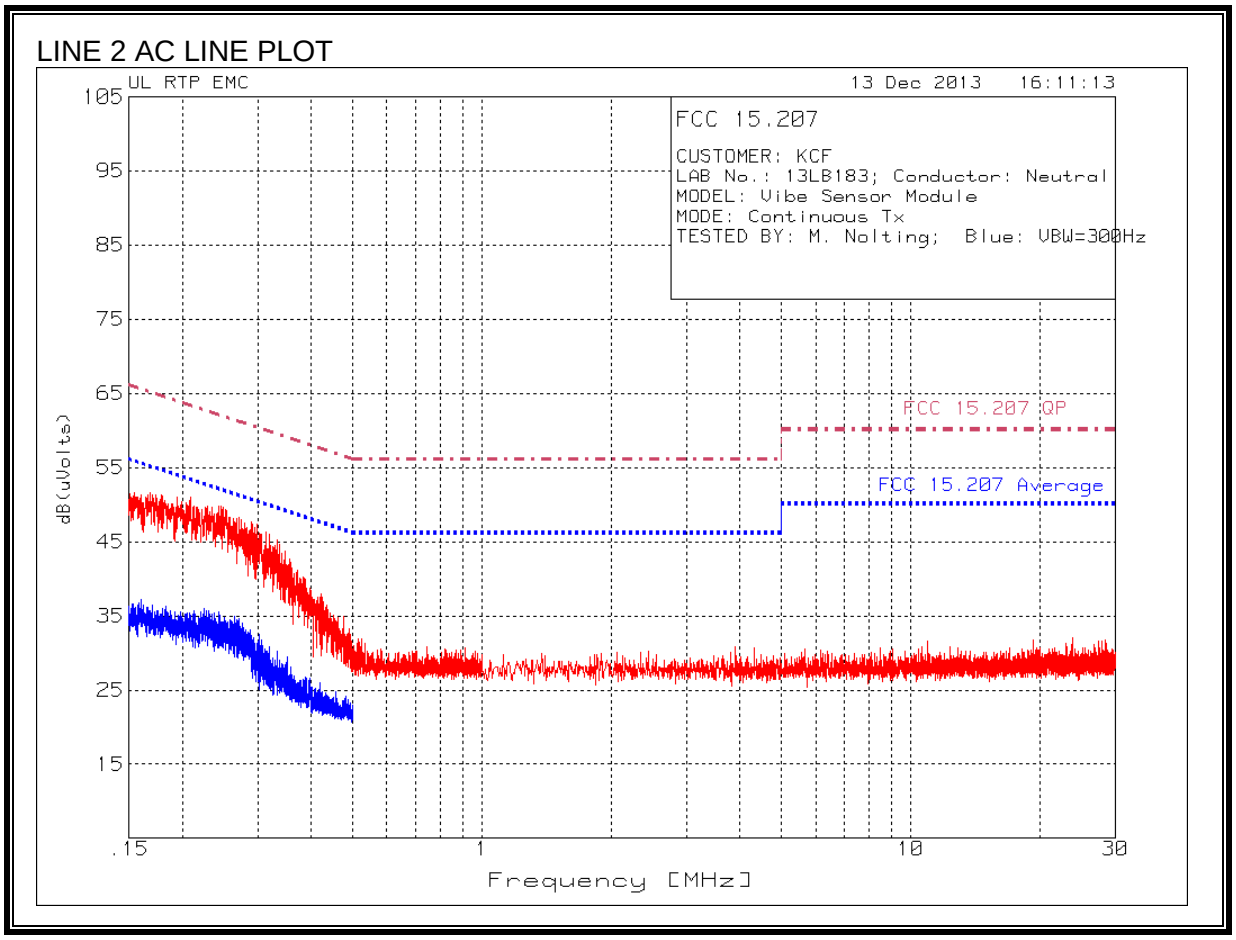
LINE 1 AC TABULAR DATA

CUSTOMER: KCF
LAB No.: 13LB183; Conductor: Line
MODEL: Vibe Sensor Module
MODE: Continuous Tx
TESTED BY: M. Nolting; Blue: VBW=300Hz

Test Frequency [MHz]	Meter Reading [dBuV]	Detector*	LISN [dB]	Cable Loss [dB]	RF Line Voltage [dBuV]	FCC 15.207 (QP) [dBuV]	Margin [dB]	FCC 15.207 (AV) [dBuV]	Margin [dB]
0.162	32.53	QP	0.40	9.30	42.23	65.3	-23.1	55.3	-13.1
0.276	28.62	QP	0.10	9.30	38.02	60.9	-22.9	50.9	-12.9
0.294	27.74	QP	0.10	9.30	37.14	60.4	-23.3	50.4	-13.3
0.363	22.62	QP	0.10	9.30	32.02	58.7	-26.7	48.7	-16.7
2.420	22.97	PK	0.00	9.40	32.37	56.0	-23.6	46.0	-13.6
4.732	22.07	PK	0.00	9.40	31.47	56.0	-24.5	46.0	-14.5

*PK = Peak, QP = Quasi-Peak, CAV = CISPR-compliant average

LINE 2 RESULTS



LINE 2 AC TABULAR DATA

CUSTOMER: KCF
LAB No.: 13LB183; Conductor: Neutral
MODEL: Vibe Sensor Module
MODE: Continuous Tx
TESTED BY: M. Nolting; Blue: VBW=300Hz

Test Frequency [MHz]	Meter Reading [dBuV]	Detector*	LISN [dB]	Cable Loss [dB]	RF Line Voltage [dBuV]	FCC 15.207 (QP) [dBuV]	Margin [dB]	FCC 15.207 (AV) [dBuV]	Margin [dB]
0.155	32.52	QP	0.40	9.30	42.22	65.7	-23.5	55.7	-13.5
0.209	31.11	QP	0.20	9.30	40.61	63.3	-22.7	53.3	-12.7
0.249	29.33	QP	0.20	9.30	38.83	61.8	-23.0	51.8	-13.0
0.298	25.27	QP	0.10	9.30	34.67	60.3	-25.6	50.3	-15.6
3.892	21.49	PK	0.00	9.40	30.89	56.0	-25.1	46.0	-15.1
4.309	21.30	PK	0.00	9.40	30.70	56.0	-25.3	46.0	-15.3

*PK = Peak, QP = Quasi-Peak, CAV = CISPR-compliant average