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Atlas Compliance & Engineering, Inc.

FCC
Test Report

FCC CFR 47 Part 15.207, 15.209 and 15.247 COMPLIANCE

Stack Labs, Inc.
10054 Pasadena Ave.
Cupertino, CA 95014

Product:
Stack ZigBee Module
Model:
STACK002

FCC ID:	2AGFX-STACK002
Test Report Number:	1625STKmod002_fcc247
Date of Report:	June 17, 2016

Table of Contents

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Change History

1625STKmod002_fcc247

Rev.	Change Description	Reason/Application	Date	Appvd.
Draft	Report for review	Applies to STACK002	June 20, 2016	MEB
C1	Release of report	Applies to STACK002	June 21, 2016	MEB

General Information

Test Report Number:	1625STKmod002_fcc247
Date Product Tested:	June 9 – 15, 2016
Date of Report:	June 17, 2016
Applicant:	Stack Labs, Inc. 10054 Pasadena Ave. Cupertino, CA 95014
Contact Person	Mr. Kent S Whiting
Equipment Tested:	Stack ZigBee Module
Transmitter Frequency:	2405 – 2480 MHz, 16 Channels, 5 MHz spacing
Modulation:	DSSS O-QPSK
Trade Name:	Stack
Model:	STACK002
Purpose of Test:	To demonstrate the compliance of the Stack ZigBee Module, STACK002, with the requirements of FCC CFR 47 Part 15 Rules and Regulations to the limits of Subpart C 15.207, 15.209 and 15.247 using the procedure stated in ANSI C63.10.
Frequency Range Investigated:	9 KHz to 24.835 GHz
FCC ID:	2AGFX-STACK002
Test Site Locations:	Field Strength Measurement Facility: Atlas Compliance & Engineering, Inc. 726 Hidden Valley Road Royal Oaks, California 95076 Conducted Measurement Facility: Atlas Compliance & Engineering, Inc. 1792 Little Orchard Street San Jose, California 95125
Test Personnel:	Bruce Smith EMC Engineer

Test Equipment

The following list contains the test equipment that was utilized in making the measurements in this report.

Description _ Model	Serial	Manufacturer	Calibration Due
BiLog Antenna _ CBL6112B	2783	Chase Electronics Ltd.	5/8/17
Active Loop Antenna _ 6502	9108-2669	EMCO	12/28/17
Double Ridge Guide Horn Antenna _ 3115	9003-3340	EMCO	12/14/17
LISN _ 4825/2	9808-1088	EMCO	12/2/16
Pre amp 9kHz-2GHz _ CPA9231A	3259	Schaffner	10/1/16
EMI Test Receiver 9 kHz - 2500 MHz _ ESPC	DE15934 845296/0024	Rohde & Schwarz	2/19/17
EMI Test Receiver 9 kHz - 2500 MHz _ ESPC	DE14459 843820/0015	Rohde & Schwarz	2/17/17
Pre amp 1Ghz-26.5GHz _ 8449B	3008A00910	HP	2/24/17
Spectrum Analyzer 100Hz-22GHz _ 8566B	2542A13058 (IF) 2637A03426 (RF)	HP	2/23/17
Quasi-Peak Adapter _ 85650A	2521A00716	HP	2/23/17
Spectrum Analyzer 9kHz-2.4GHz _ 8594E	3543A02886	HP	2/23/17
Temperature and humidity probe _ RH-20F	200-97-082591	Omega Engineering	5/12/18
RF Cable – HPI160SCable 50 ft.	0002	Semflex	12/10/16
RF Cable 75 ft. _ BM95012.900	109	Bracke	4/27/17

Test Configuration

Customer:	Stack Labs, Inc.
Test Date:	June 9 – 15, 2016
Specification:	FCC CRF 47 Part 15.247 Limits, ANSI C63.10 Methods

General Description

The STACK002 is a fully self-contained, small form-factor, IEEE802.15.4 ZigBee module with low complexity, self-organizing, low power, low cost feature. It is based on IEEE802.15.4 standard, can be coordinated to achieve communication between the thousands of tiny sensors that require very little energy to relay the data through radio waves from one sensor to another sensor, thus with high communication efficiency.

The STACK002 employs the world's lowest power consumption embedded architecture. It has been optimized for all kinds of ZigBee applications in the home automation, smart grid, smart lighting, handheld device, personal medical application and industrial control that have lower data rates, and transmit or receive data on an infrequent basis.

The STACK002 integrates all IEEE802.15.4 ZigBee functionality into a low-profile, 15.6x12.2x2.0mmSMT module package that can be easily mounted on main PCB with application specific circuits.

Device Features

- Size: 15.6x12.2x2.0mm Smallest size module;
- High RX sensitivity: ≤-101dBm;
- Excellent link budget: > 110dB;
- Max output power: 9dBM +/- 1.5dBm;
- Extend Operation Temperatures: -40℃ to 110℃ for smart lighting application;
- Low power consumption:
    - Operating Current: < 150mA
    - Deep Sleep Current: <10uA

- 512KB Internal Flash, 160KB SRAM resource for customized application;
- Full ZigBee ZHA/ZLL profile supported;
- Various peripherals interface:
  - 15 x GPIO ports
  - 3 x 16-bit ADC input channel
  - 2 x UART with hardware flow control
  - 1 x SPI interface
  - 1 x I2C interface
  - SWD debug interface
- Power Supply Range from 2V to 3.6V, support battery supply application;

STACK002 Pulsed Operation:

RSS-Gen 6.10 Pulsed Operation

When the field strength (or envelope power) is not constant or it is in pulses, and an average detector is specified to be used, the value of field strength or power shall be determined by averaging over one complete pulse train, including blanking intervals within the pulse train, as long as the pulse train does not exceed 0.1 second. In cases where the pulse train exceeds 0.1 second, the average value of field strength or output power shall be determined during a 0.1 second interval during which the field strength or power is at its maximum value.

The exact method of calculating the average field strength shall be submitted with the application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

FCC CFR 47 § 15.35(c)

Unless otherwise specified, e.g. §15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, 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.

One of the main features of the ZigBee protocol is that it is designed for low power consumption so that battery operated devices can utilize it for communication without quickly draining their resources. With that in mind ZigBee transmitters are operated as pulsed transmitters only putting power out into the air when it is required for them to do so. This pulsed operation is thus used for getting a realistic average value of the signal being put out.

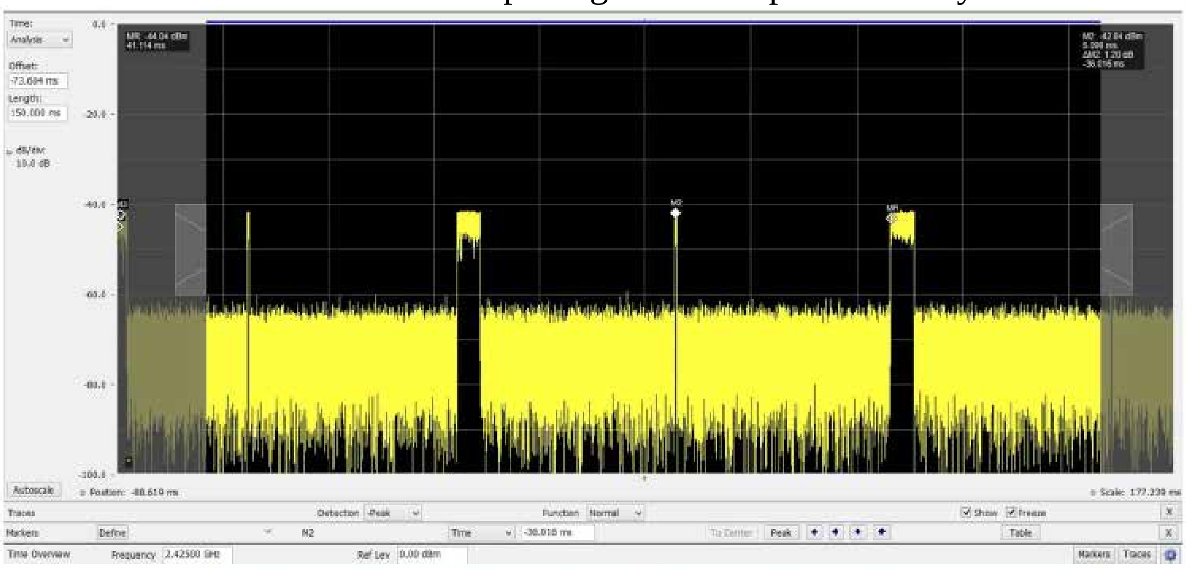
Our Worst case operation will be during our Over The Air (OTA) update procedure, where we utilize our biggest packets and continually transmit the data needed to update the software on the device. During this procedure we transmit one large packet (120 Bytes) followed by a smaller packet (50 Bytes) and then repeat this until all the data is sent. At the 250 KB/s data rate we operate at, each byte means 32us of transmission air time. Between sends it takes our processor an average of 32ms to process and queue up the next data to be sent.

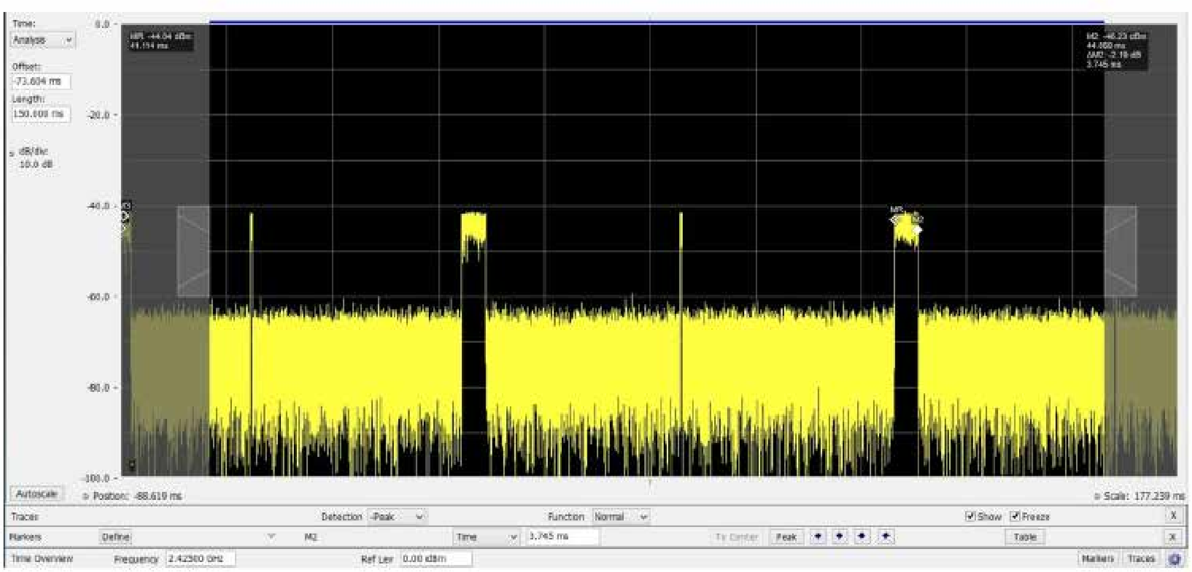
To do this on a 100ms timescale the sequence of events as requested in 15.35(c) would look like this:

120 Bytes(3.84ms) 32ms ---- Processing 50 ---- Bytes (1.6ms) 32ms ---- Processing120 ---- Bytes(3.84ms) ----

$$DutyCycle = \frac{Ton}{Ton+Toff} = \frac{3.84ms+1.6ms+3.84ms}{100ms} = 9.28\%$$

As can also be seen when capturing data on a spectrum analyzer:





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Testing:

In order to create this OTA scenario though another device must be present for communication. As the second device's output would corrupt the test results, we instead loop a data transmission at 10% duty cycle to replicate the same resulting average value. The setup specifics are 76 Byte Payload with a 22ms wait interval between packets.

$$DutyCycle = \frac{2.432ms}{2.432ms+22ms} = 9.95\%$$

ANSI C63.10 section 7.5 Procedure for determining the average value of pulsed emissions
Unless otherwise specified, when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, 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 s (100 ms). In cases where the pulse train exceeds 0.1 s, the measured field strength shall be determined during a 0.1 s interval. The following procedure is an example of how the average value may be determined. The average field strength may be found by measuring the peak pulse amplitude (in log equivalent units) and determining the duty cycle correction factor (in dB) associated with the pulse modulation as shown in Equation (10):

$$\delta(dB) = 20\log(\Delta) \qquad (10)$$

where
δ is the duty cycle correction factor (dB)
Δ is the duty cycle (dimensionless)

Duty cycle correction factor therefore is 20log(9.95) = 19.95dB

EUT Description / Note:

The EUT, STACK002, a Stack ZigBee Module was powered up and in a continuous transmitting mode at full power for fundamental emissions measurements. The EUT interface was through the host circuits to send commands to place it in the different operating modes. The EUT was running at a 10% duty cycle for all other emission measurements to simulate a normal condition of operation. The power for the EUT was supplied by new batteries. The antennas used for testing are a ¼ wavelength j-bend wire and a ¼ wavelength coax wire. Details of these antennas are provided in separate Stack Lighting documents.

EUT Support Program

The EUT was tested at lowest channel, 2405 MHz, mid channel, 2440 MHz, and highest channel, 2480 MHz in a continuous transmit mode. The transmitter was at full power and 100% modulation. The EUT was then operated in 10% duty cycle to find worst case levels of unwanted emissions. Preliminary radiated tests were performed to identify which operating mode produced the worst case (maximum) transmit level. Using this mode the module was tested to find maximum transmit level. Tests were performed with the module attached to a host PCB that included interface communications from a host computer to place the module in the different transmit channels and the two different antennas. Tests were performed with the measurement antenna in both horizontal and vertical orientations and the EUT in all three orthogonal orientations.

EUT Modifications for Compliance

There were no modifications performed on the EUT. The test results state the emission levels of the EUT in the condition as it was received.

Measurement Uncertainty

Measurement uncertainty is caused by random effects and imperfect correction of systematic effects. The measurement uncertainties stated were calculated with a confidence level of approximately 95%, using a coverage factor of k = 2.

Expanded Measurement Uncertainty at 95% confidence probability;

Radiated emissions = ±2.77dB
Conducted emissions = ±1.16dB

EUT Support Devices

Table 1 – Support Equipment Used For Test

Model:	Description:	S/N	FCC ID#
Inspiron 5720	Dell Laptop computer	DZ53DT1	NA
OSEPP FTD-01	FTDI Breakout Board USB-to-serial	NA	NA

I/O Ports and Cables

Table 2 – EUT Port Termination's

I/O Port	Cable Type	Length	Connector	Termination
NA				

Table 3 – Host Port Termination's

I/O Port	Cable Type	Length	Connector	Termination
USB	Shielded	1 M	USB	USB-to-serial

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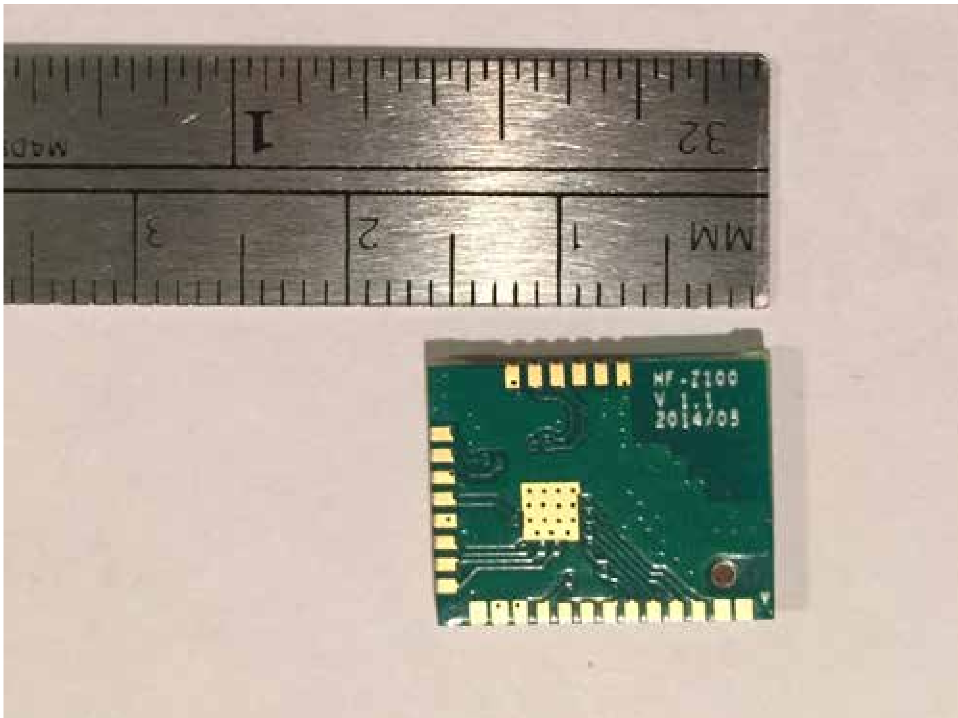
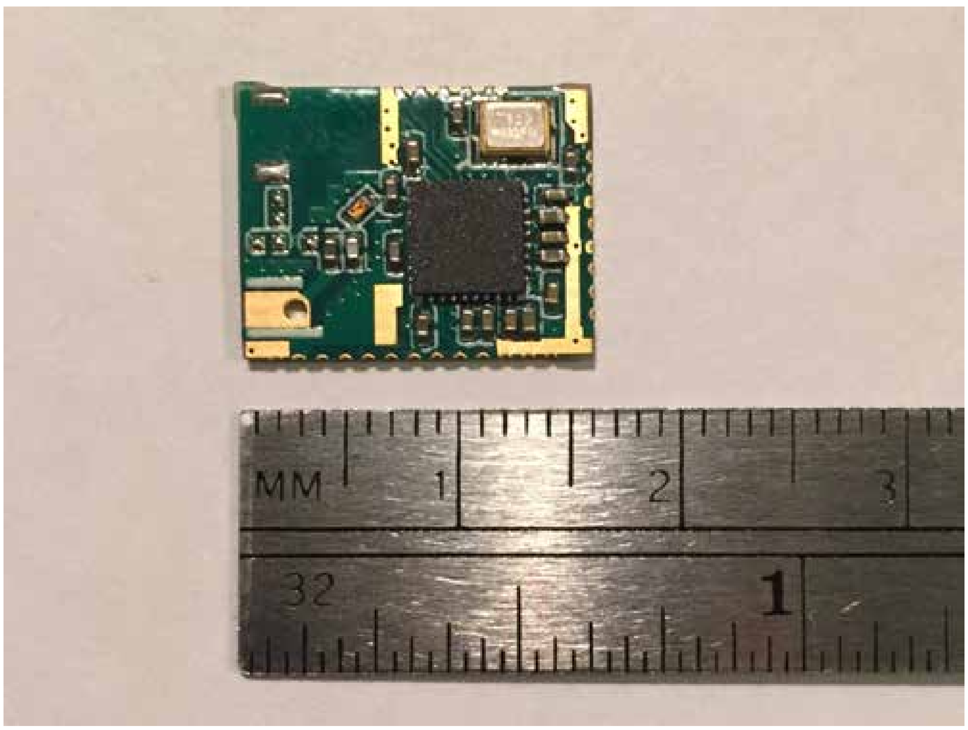
Equipment Under Test





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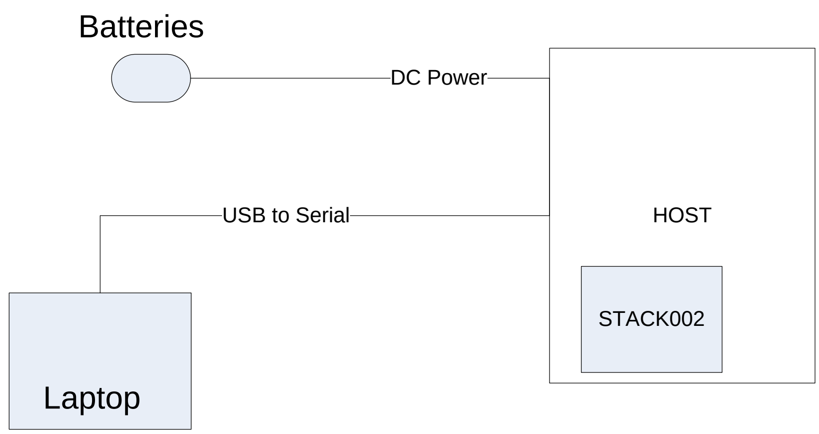
Equipment Block Diagram

Following is the block diagram of the test setup. Refer to TEST CONFIGURATION pages for port connections and information.

Figure 1 – Test Setup Diagram



EUT:
STACK002

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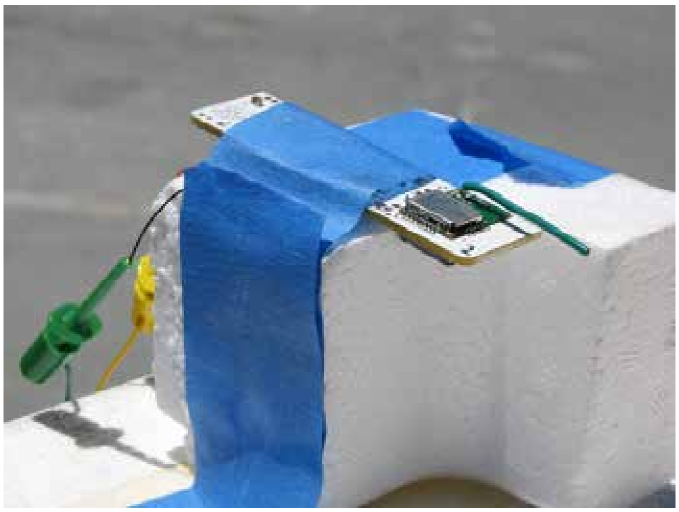
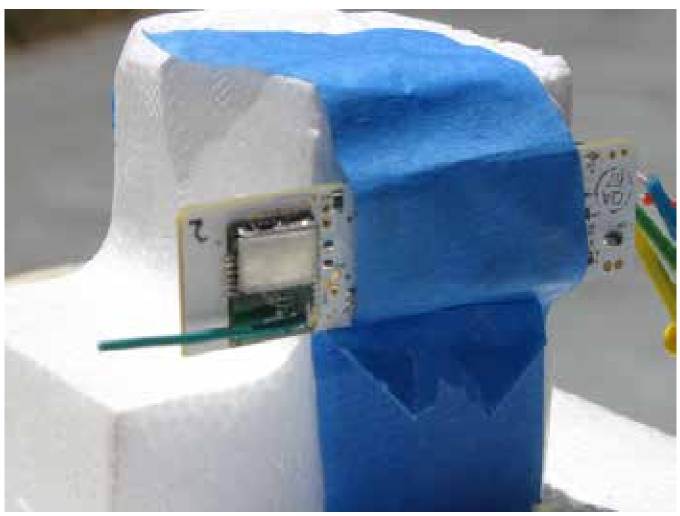
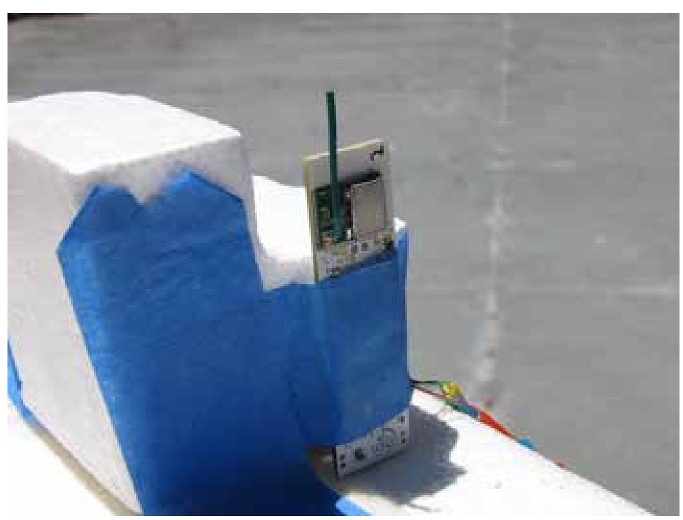
Test Setup (Radiated Emissions)

The photographs below show the test setup for radiated emission testing.







Test Setup (Radiated Emissions)

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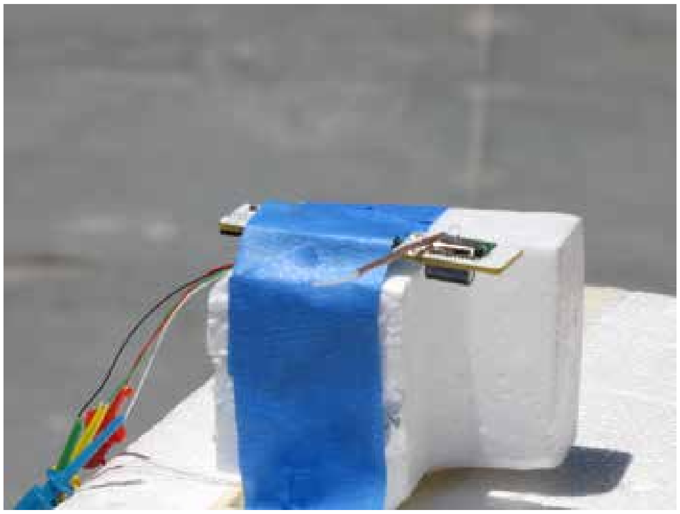

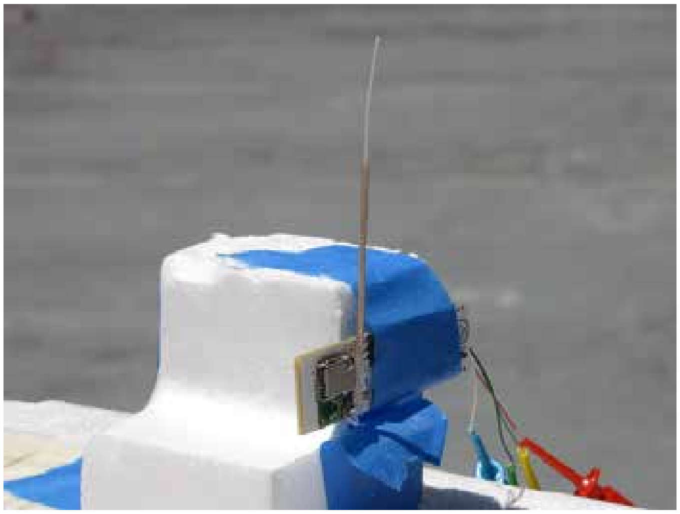

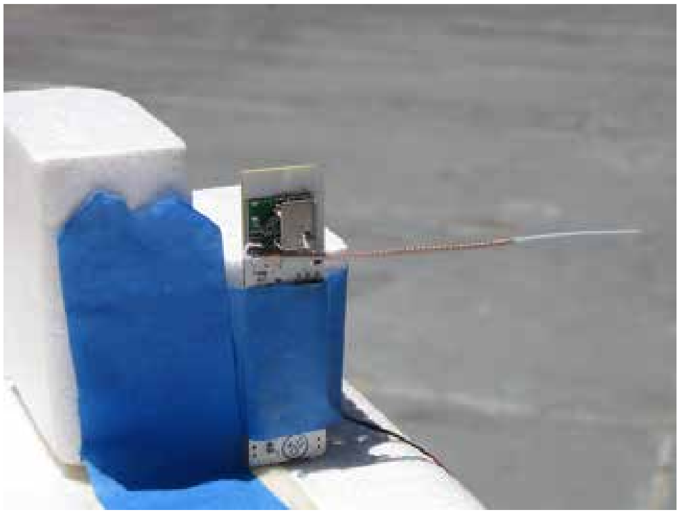

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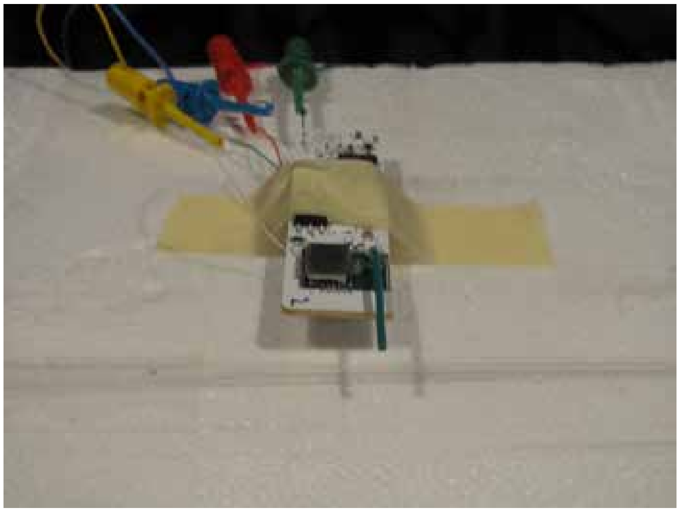
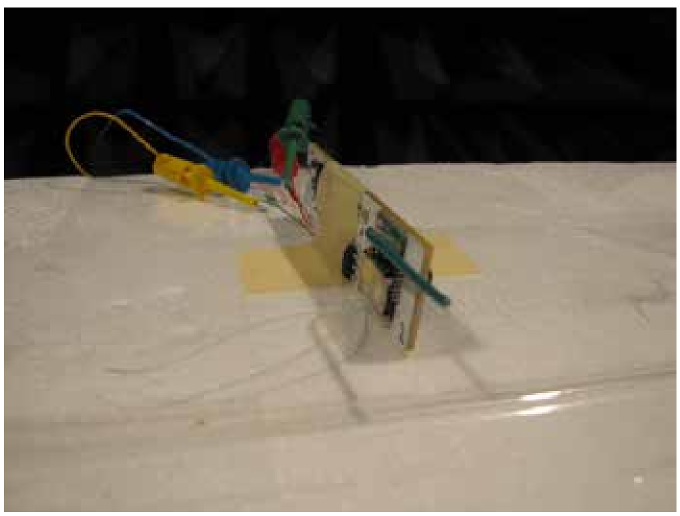
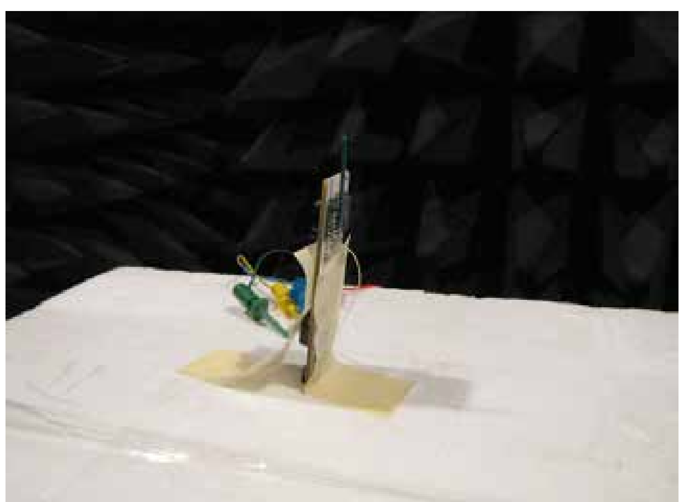
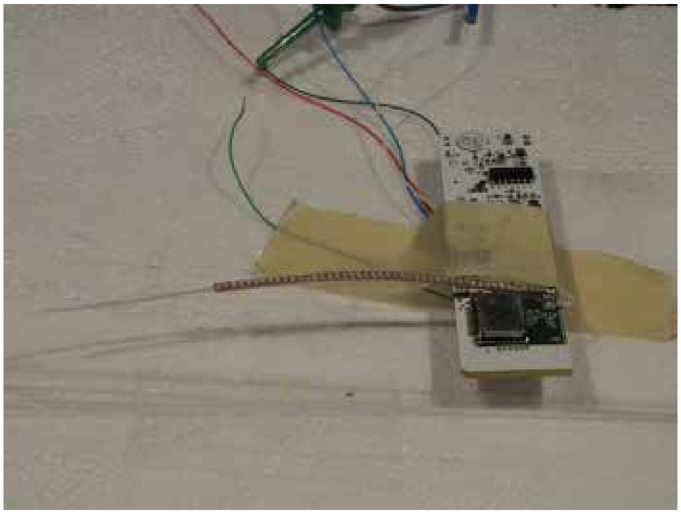


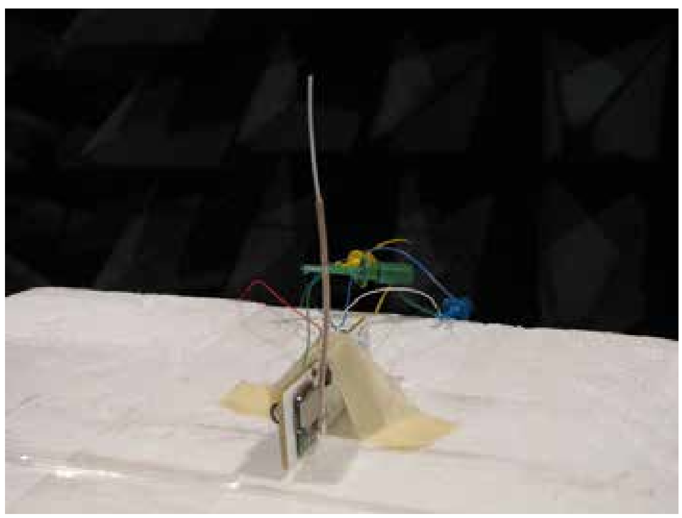


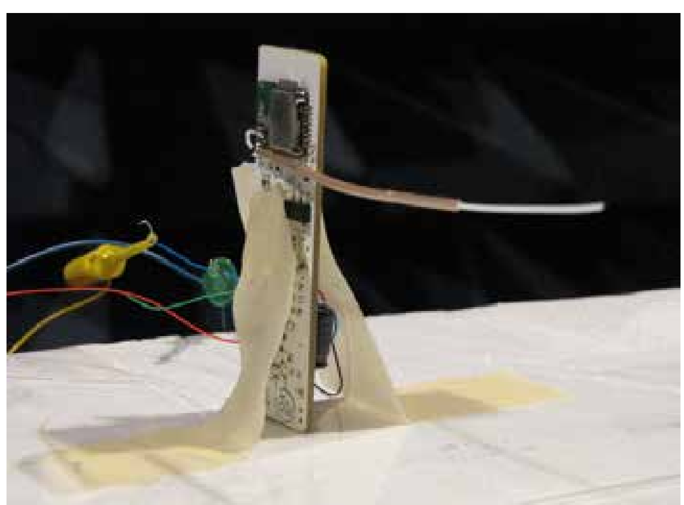


Test Setup (Radiated Emissions)

The photographs below show the test setup for radiated emission testing.

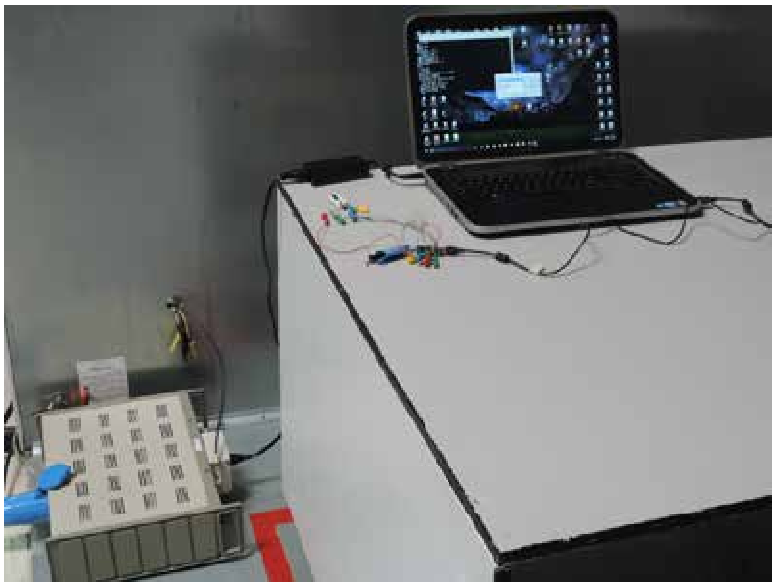


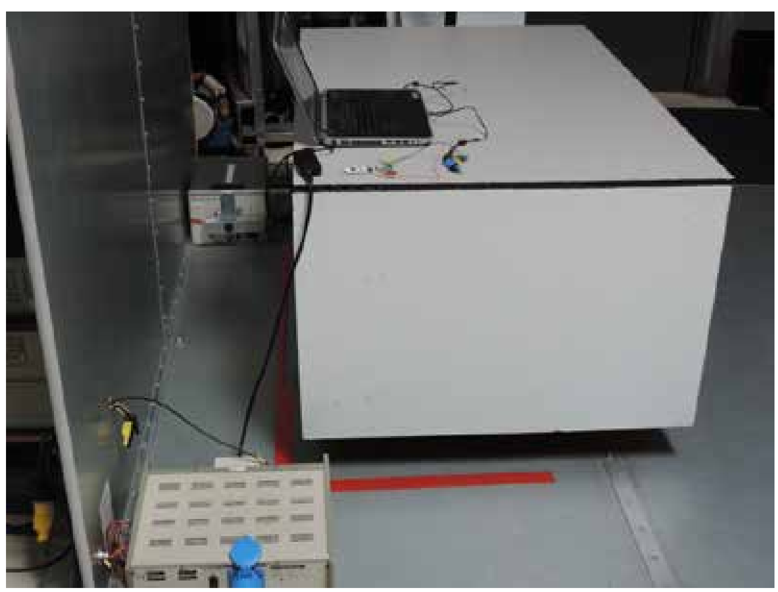




Test Setup (Conducted Emissions)

The photographs below show worst case setup for line conducted testing.





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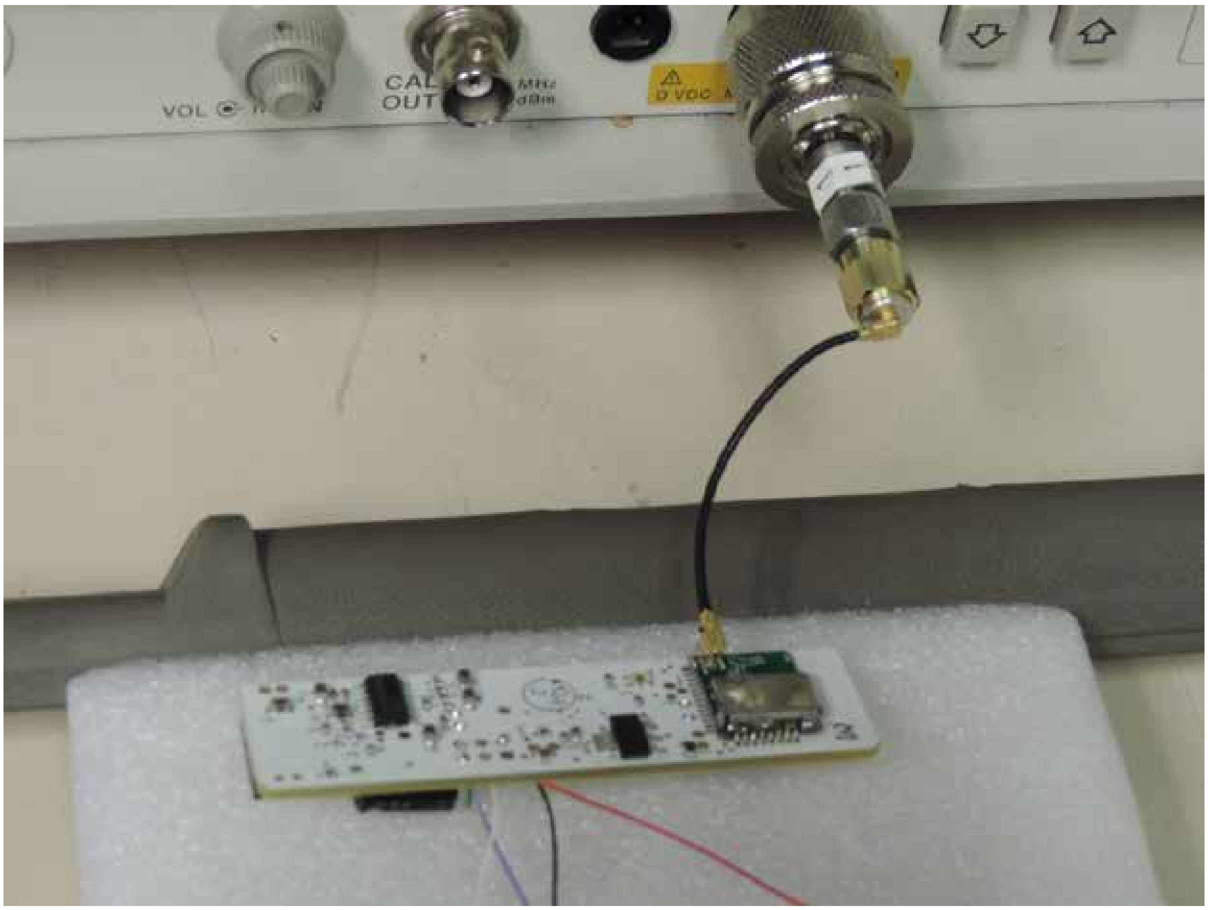
Test Setup (Conducted RF)

The photographs below show the test setup for conducted RF testing.



Test Methods for Emissions

The test procedure stated in ANSI C63.10-2013 was used to collect the test data. The emission data of the EUT was taken with the Rohde & Schwarz EMI Test Receiver, HP 8594E and HP 8566B. Incorporating the application of correction factors programmed into the Test Receiver and verified for distance, antenna, cable loss, and amplifier gain, the data was reduced as shown in the Sample Calculations. These correction factors are available upon request. The corrected data was then compared to the emission limits to determine compliance.

During radiated emission testing between 9 kHz to 1000 MHz, the EUT was placed on a nonconductive rotating table 0.8 meter above the conductive grid. The nonconductive table dimensions were 1 meter deep by 1.5 meters wide at 0.8 meter high. The EUT is centered on the tabletop and the measurement antenna was placed 10 or 3 meters from the EUT as noted in the test data.

For emissions testing, scans in the frequency range of 9 kHz to 24.835 GHz were made. Measurement bandwidths and detectors stated in ANSI C63.10 4.1.4 were used.

Measurements were made at a distance of 3 or 10 meters. Tests were performed with the measurement antenna in both horizontal and vertical orientations and the EUT in all three orthogonal orientations.

Conducted Emission Testing

For the conducted emissions testing, the EMCO LISN, Model No. 4825/2, was used for the EUT. During conducted emission testing the EUT was located on a wooden test bench measuring 0.8 meter high, 1 meter deep, and 1.5 meters in width. The vertical conducting surface was 0.4 meter from the back of the test bench. The LISNs were placed on the ground plane of the test area in accordance with ANSI C63.4-2014.

The metal plane used for conducted emission testing was grounded to the earth by a heavy gage braided wire attached to the plane. All other objects were kept a minimum of 1 meter away from the EUT during the conducted test.

For conducted emissions testing a scan of the frequency band 150 kHz to 30 MHz was made stepping every 5 kHz. Each frequency was measured at a bandwidth of 10 kHz for 20 msec. All readings within 25 dB of the limits were recorded, and those emissions were then measured using the CISPR quasi-peak and average detectors at a bandwidth of 10 kHz for a 2 second measurement time. All emissions within 6 dB of the limit were examined with additional measurements to ensure compliance with the limits. The results of the conducted emissions test are shown in test tables below.

Temperature and Humidity

The ambient temperature of the actual EUT was within the range of 10° to 40° C (50° to 104° F) unless the particular equipment requirements specify testing over a different temperature range. The humidity levels were within the range of 10% to 90% relative humidity unless the EUT operating requirements call for a different level.

Sample Calculations

An example of how the EMI Test Receiver reading is converted using correction factors is given for the emissions recorded. These correction factors are programmed into the EMI Test Receiver and verified. For radiated emissions in dBμV/m, the EMI Test Receiver reading in dBμV is corrected by using the following formula:

33.90	Meter Reading (dBμV/m)
34.01	- Pre amp Gain (dB)
12.48	+ Cable Loss (dB)
33.12	+ Antenna Factor (dB)
45.49	= Corrected Reading (dBμV/m)

This reading is then compared to the applicable specification limits and the difference will determine compliance.

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Test setup for conducted measurements

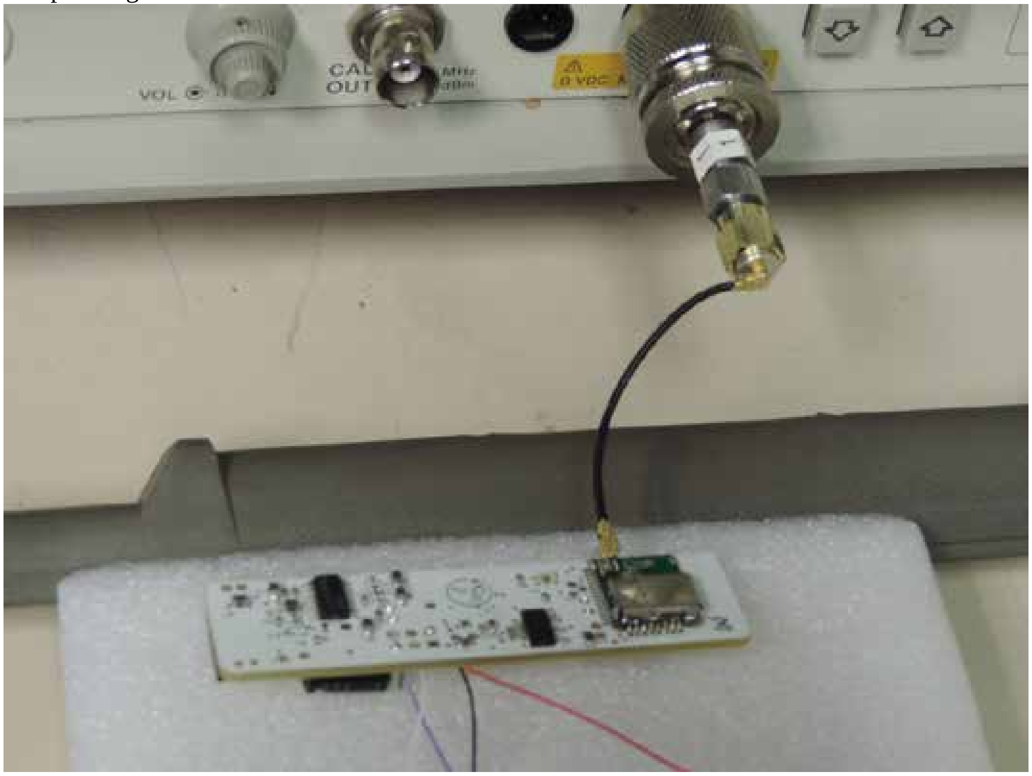
Characterization of cable and attenuator

The RF cable and external attenuator used during the conducted measurements was characterized as follows:

Cable Loss = 0.91dB
Attenuator = 10.14db

Correction factor = 11.05dB

Setup configuration



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Minimum -6dB Bandwidth

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

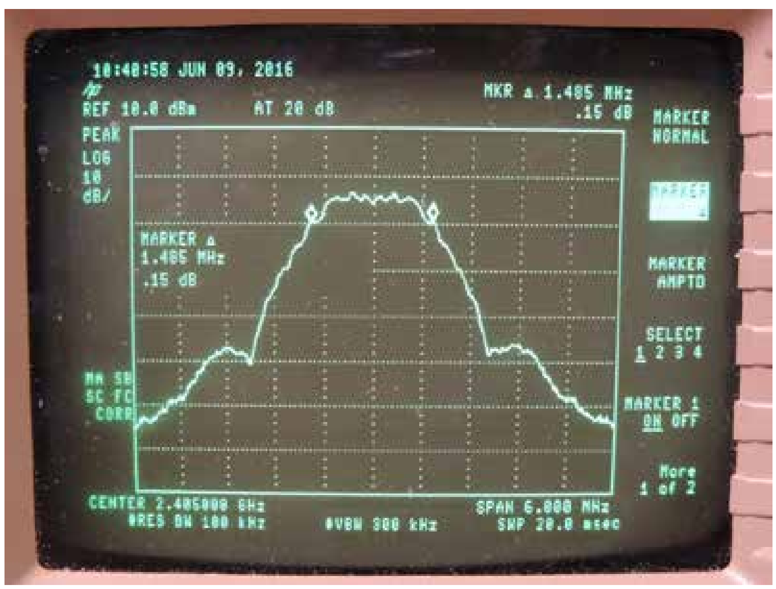
(2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

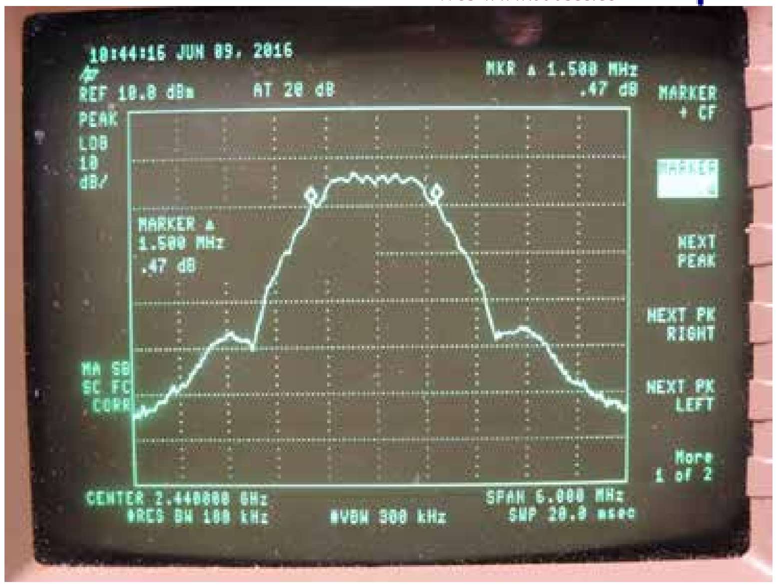
ANSI C63.10 11.8.1 Option 1

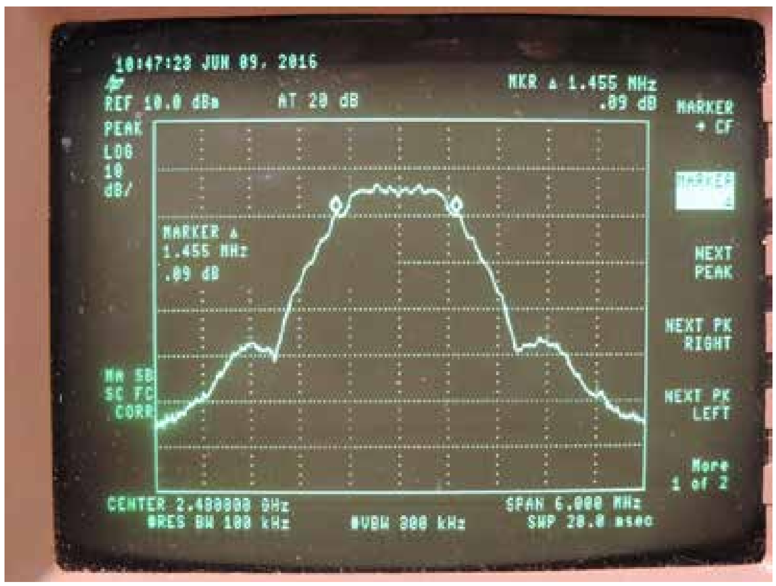
The steps for the first option are as follows:
a) Set RBW = 100 kHz.
b) Set the VBW ≥ [3 × RBW].
c) Detector = peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Table 4 – Minimum -6 dB Bandwidth

Channel	Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Result
Low	2405	1485		Pass
Mid	2440	1500	>500	Pass
High	2480	1455		Pass




10:44:16 JUN 09, 2016
REF 10.0 dBm
AT 20 dB
MKR Δ 1.500 MHz
.47 dB
PEAK
LOG
10
dB/
MARKER Δ
1.500 MHz
.47 dB
WA SB
SC FC
CORR
MARKER → CF
NEXT PEAK
NEXT PK RIGHT
NEXT PK LEFT
More 1 of 2
CENTER 2.440000 GHz
#RES BW 100 kHz
#VBW 300 kHz
SPAN 6.000 MHz
SWP 20.0 msec


10:47:23 JUN 09, 2016
REF 10.0 dBm
AT 20 dB
MKR Δ 1.455 MHz
.09 dB
PEAK
LOG
10
dB/
MARKER Δ
1.455 MHz
.09 dB
WA SB
SC FC
CORR
MARKER → CF
NEXT PEAK
NEXT PK RIGHT
NEXT PK LEFT
More 1 of 2
CENTER 2.480000 GHz
#RES BW 100 kHz
#VBW 300 kHz
SPAN 6.000 MHz
SWP 20.0 msec

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Peak Power Spectral Density

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

(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.

ANSI C63.10 11.10.2 Method PKPSD (peak PSD)

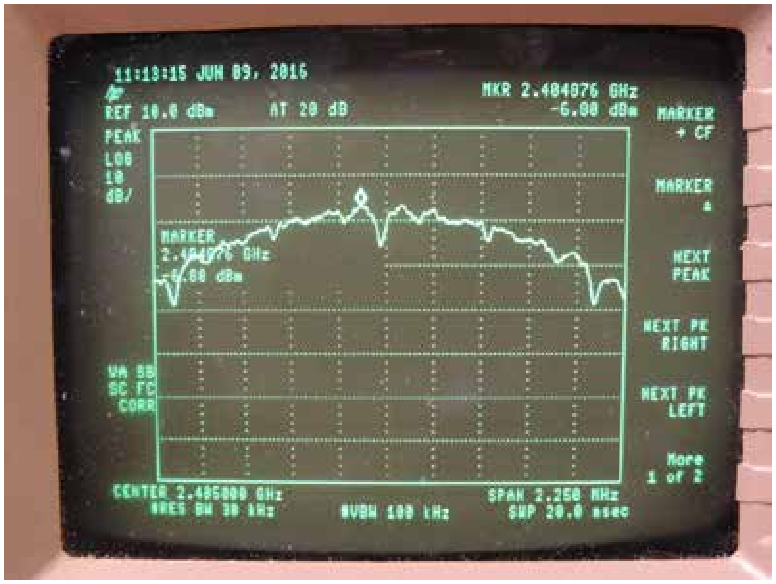
The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ [3 × RBW].
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

Table 5 – Peak Power Spectral Density

Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Result
Low	**2405**	**4.25**		**Pass**
Mid	**2440**	**4.47**	**8**	**Pass**
High	**2480**	**4.08**		**Pass**

Measurement bandwidth used was 30 kHz, attenuator and cable correction factor 11.05dB



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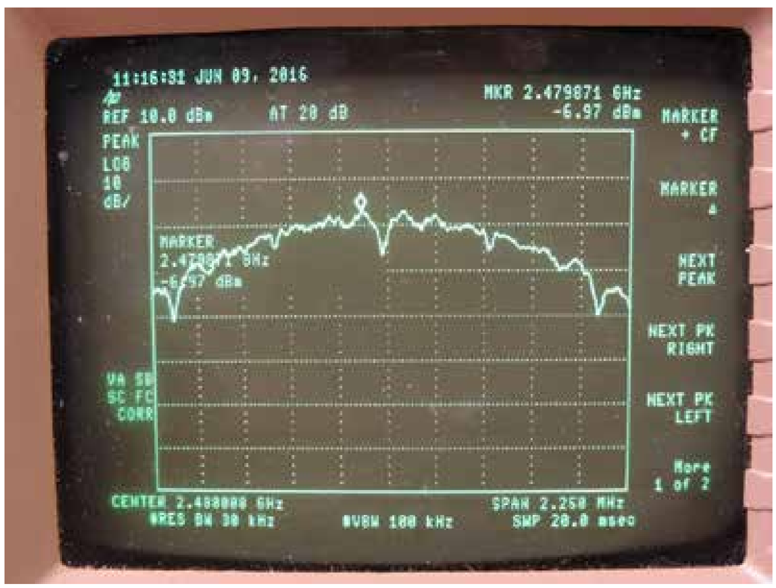


Maximum Peak Output Power

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(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.

ANSI C63.10 11.9.1.2 Integrated band power method

The following procedure can be used when the maximum available RBW of the instrument is less than the

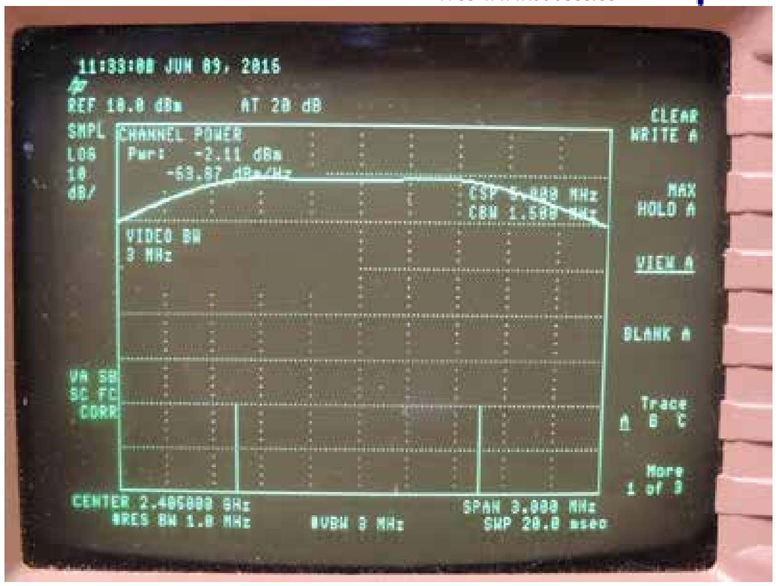
DTS bandwidth:

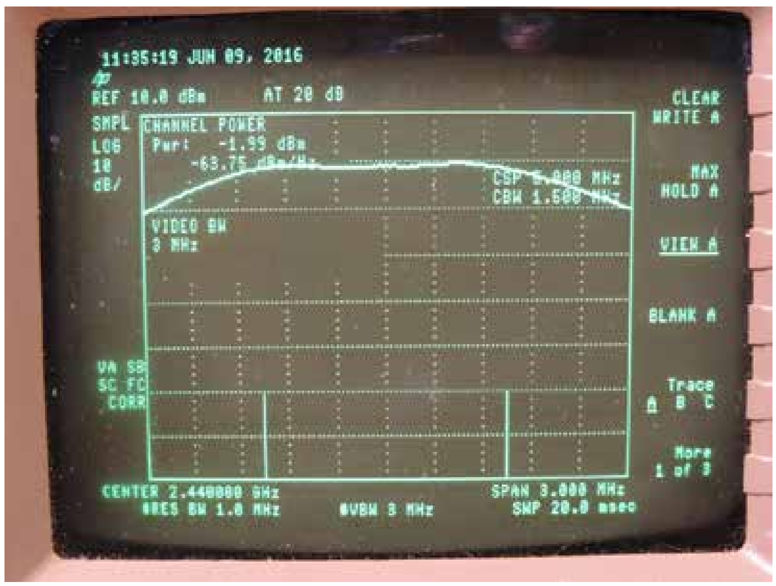
a) Set the RBW = 1 MHz.
b) Set the VBW ≥ [3 × RBW].
c) Set the span ≥ [1.5 × DTS bandwidth].
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the instrument's band/channel power measurement function with the band limits set equal to the DTS bandwidth edges (for some instruments, this may require a manual override to select the peak detector). If the instrument does not have a band power function, then sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the DTS channel bandwidth.

Table 6 – Maximum Peak Output Power

Channel	Frequency (MHz)	Maximum Transit Power (dBm)	Limit		Result
			dBm	Watts	
Low	2405	8.94	30	1	Pass
Mid	2440	9.06			Pass
High	2480	8.76			Pass

Attenuator and cable correction factor 11.05dB


11:33:08 JUN 09, 2016
REF 10.0 dBm
AT 20 dB
SMPL
LOG
10
dB/
CHANNEL POWER
Pwr: -2.11 dBm
-63.87 dBm/Hz
CBW 1.500 MHz
VIDEO BW
3 MHz
VA SB
SC FC
CORR
CLEAR
WRITE A
MAX
HOLD A
VIEW A
BLANK A
Trace
A B C
More
1 of 3
CENTER 2.405000 GHz
#RES BW 1.0 MHz
#VBW 3 MHz
SPAN 3.000 MHz
SWP 20.0 msec


11:35:19 JUN 09, 2016
REF 10.0 dBm
AT 20 dB
SMPL
LOG
10
dB/
CHANNEL POWER
Pwr: -1.99 dBm
-63.75 dBm/Hz
CBW 1.500 MHz
VIDEO BW
3 MHz
VA SB
SC FC
CORR
CLEAR
WRITE A
MAX
HOLD A
VIEW A
BLANK A
Trace
A B C
More
1 of 3
CENTER 2.440000 GHz
#RES BW 1.0 MHz
#VBW 3 MHz
SPAN 3.000 MHz
SWP 20.0 msec

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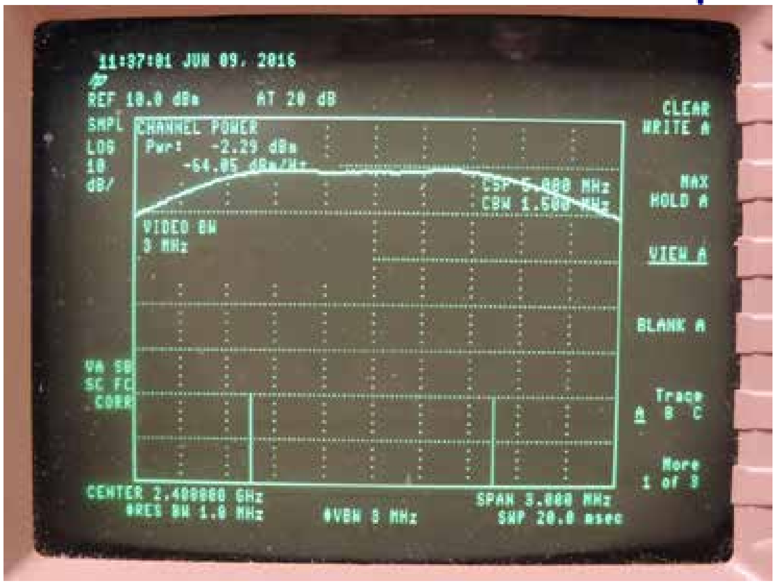


Equivalent Isotropically Radiated Power

ANSI C63.10 G.3 Power approach (logarithmic terms)

ERP/EIRP = $P_T + G_T - L_C$ (G.3)

where

ERP/EIRP is the equivalent (or effective) radiated power [in same units as P_T, typically dBW, dBm, or power spectral density (psd)], relative to either a dipole antenna (ERP) or an isotropic antenna (EIRP)

P_T is the transmitter output power, in dBW, dBm, or psd (power over a specified reference bandwidth)

G_T is the gain of the transmitting antenna, in dBd (ERP) or dBi (EIRP)

L_C is the signal attenuation in the connecting cable between the transmitter and the antenna, in dB

G.4 Relationship between ERP and EIRP

The numeric gain of an ideal half-wave dipole antenna is 1.64, and the numeric gain of an ideal isotropic antenna is 1.0. The gain of an ideal half-wave dipole antenna relative to an ideal isotropic antenna is [10 log (1.64)] or 2.15 dBi. Therefore, if the antenna gain in dBd is unknown, it may be determined from the gain in dBi via the following relationship in Equation (G.4):

G_T(dBd) = G_T(dBi) – 2.15 dB (G.4)

Alternatively, the EIRP may be determined from Equation (G.3) and then converted to ERP based on the maximum antenna gain relationship by applying Equation (G.5):

ERP = EIRP – 2.15dB (G.5)

Similarly, the EIRP may be determined from the ERP as follows in Equation (G.6):

EIRP =ERP +2.15dB (G.6)

The antenna used is a ¼ wavelength monopole with 5.19 dBi gain.

EIRP = 9.06dBm + 5.19dBi - 0 = 14.25 dBm = 0.026607 Watts

Unwanted Emissions

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

(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)).

ANSI C63.10 11.11.2 Reference level measurement

Establish a reference level by using the following procedure:
a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ [3 × RBW].
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

ANSI C63.10 11.12 Emissions in restricted frequency bands

Typical regulatory requirements for DTS specify that emissions that fall into restricted frequency bands shall comply with the general radiated emission limits.91

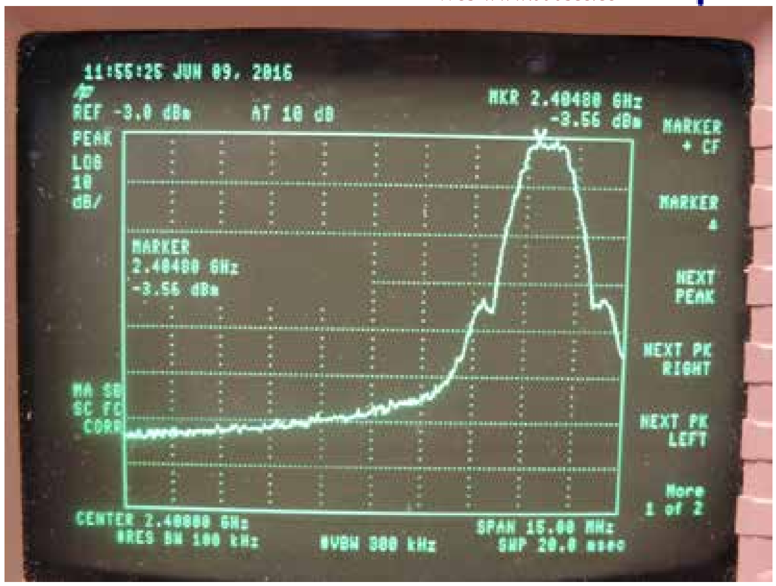
ANSI C63.10 11.12.1 Radiated emission measurements

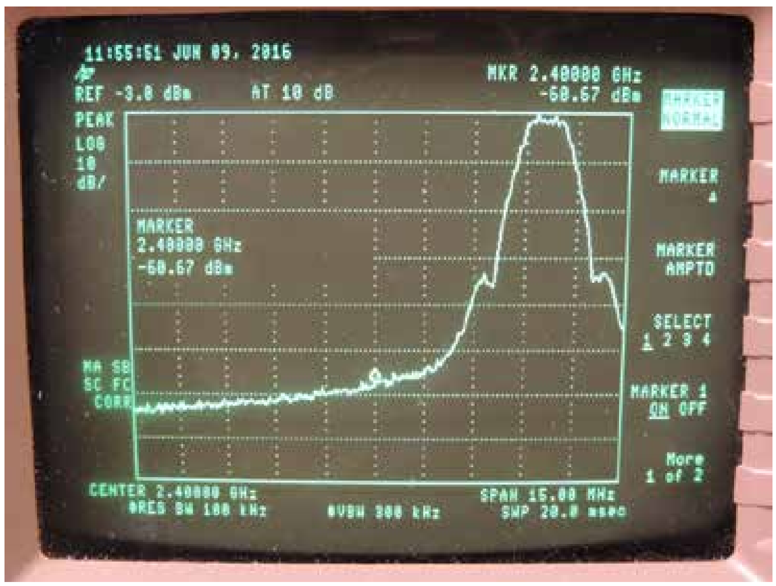
Because the typical emission requirements are specified in terms of radiated field strength levels, measurements performed to determine compliance have traditionally relied on a radiated test configuration.92 Radiated measurements remain the principal method for determining compliance to the specified requirements; however antenna-port conducted measurements are also now acceptable to determine compliance (see 11.12.2 for details). When radiated measurements are utilized, test site requirements and procedures for maximizing and measuring radiated emissions that are described in 6.3, 6.5, and 6.6 shall be followed.

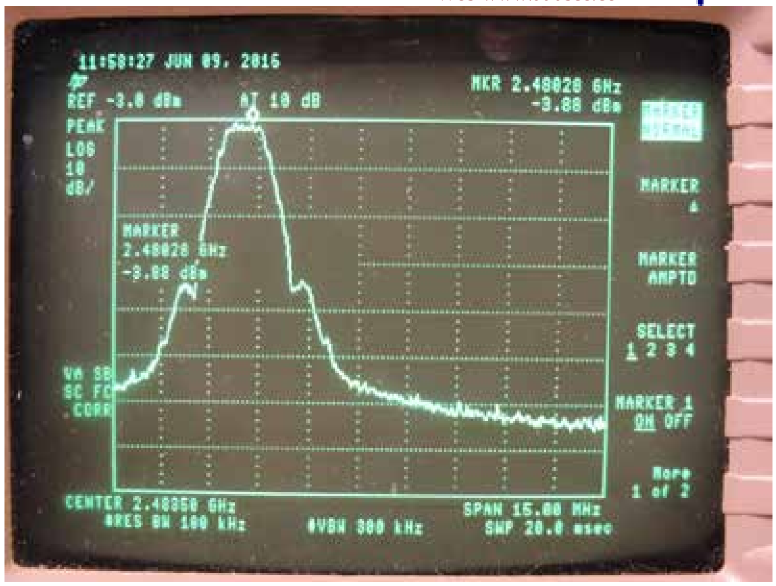
Table 7 – Unwanted Emissions

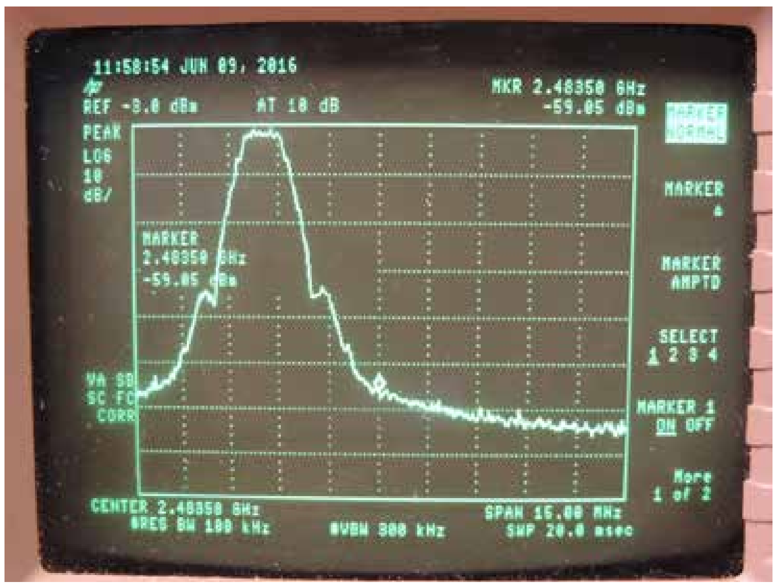
Channel	Frequency (MHz)	Within the frequency band (dB)	Outside the frequency band (dB)	dB Below >20	Result
Low	2405	7.49	-49.62	57.11	Pass
High	2480	7.17	-48.00	55.17	Pass

Attenuator and cable correction factor 11.05dB


11:55:25 JUN 09, 2016
REF -3.0 dBm
AT 10 dB
MKR 2.40480 GHz
-3.56 dBm
PEAK
LOG
10
dB/
MARKER
2.40480 GHz
-3.56 dBm
MARKER → CF
MARKER Δ
NEXT PEAK
NEXT PK RIGHT
NEXT PK LEFT
More 1 of 2
CENTER 2.40000 GHz
#RES BW 100 kHz
#VBW 300 kHz
SPAN 15.00 MHz
SWP 20.0 msec


11:55:51 JUN 09, 2016
REF -3.0 dBm
AT 10 dB
MKR 2.40000 GHz
-50.67 dBm
PEAK
LOG
10
dB/
MARKER
2.40000 GHz
-50.67 dBm
MARKER NORMAL
MARKER Δ
MARKER AMPTD
SELECT 1 2 3 4
MARKER 1 ON OFF
More 1 of 2
CENTER 2.40000 GHz
#RES BW 100 kHz
#VBW 300 kHz
SPAN 15.00 MHz
SWP 20.0 msec


11:58:27 JUN 09, 2016
REF -3.0 dBm
AT 10 dB
MKR 2.48028 GHz
-3.88 dBm
PEAK
LOG
10
dB/
MARKER
2.48028 GHz
-3.88 dBm
VA SB
SC FC
CORR
MARKER
MARKER AMPTD
SELECT
1 2 3 4
MARKER 1
ON OFF
More
1 of 2
CENTER 2.48350 GHz
#RES BW 100 kHz
#VBW 300 kHz
SPAN 15.00 MHz
SWP 20.0 msec


11:58:54 JUN 09, 2016
REF -3.0 dBm
AT 10 dB
MKR 2.48350 GHz
-59.05 dBm
PEAK
LOG
10
dB/
MARKER
2.48350 GHz
-59.05 dBm
VA SB
SC FC
CORR
MARKER
MARKER AMPTD
SELECT
1 2 3 4
MARKER 1
ON OFF
More
1 of 2
CENTER 2.48350 GHz
#RES BW 100 kHz
#VBW 300 kHz
SPAN 15.00 MHz
SWP 20.0 msec

Occupied Bandwidth (99% emissions bandwidth)

ANSI C63.10 6.9.3 Occupied bandwidth—power bandwidth (99%) measurement procedure

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

d) Step a) through step c) might require iteration to adjust within the specified range.

e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.

f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.

h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

Table 8 – 99% Occupied Bandwidth

Channel	Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Result
Low	2405	2000	>500	Pass
Mid	2440	1938		Pass
High	2480	1925		Pass

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12:15:32 JUN 09, 2016
REF -3.0 dBm
AT 10 dB
SMPL
LOG
10
dB/
OCCUPIED BW (99.00%)
OBW: 1.925 MHz
ΔFc: -0.025 MHz
Pwr: 5.2 dBm
CSP 5.000 MHz
CENTER
2.400000 GHz
STEP 5.000 MHz
CLEAR
WRITE A
MAX
HOLD A
VIEW A
BLANK A
Trace
A B C
More
1 of 3
CENTER 2.400000 GHz
#RES BW 10 kHz
#VBW 100 kHz
SPAN 5.000 MHz
SWP 150 msec

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AC Power Line Conducted Emissions

§15.207 Conducted limits.

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

AC Power Line Conducted Emissions Limits

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

* The level decreases linearly with the logarithm of the frequency.

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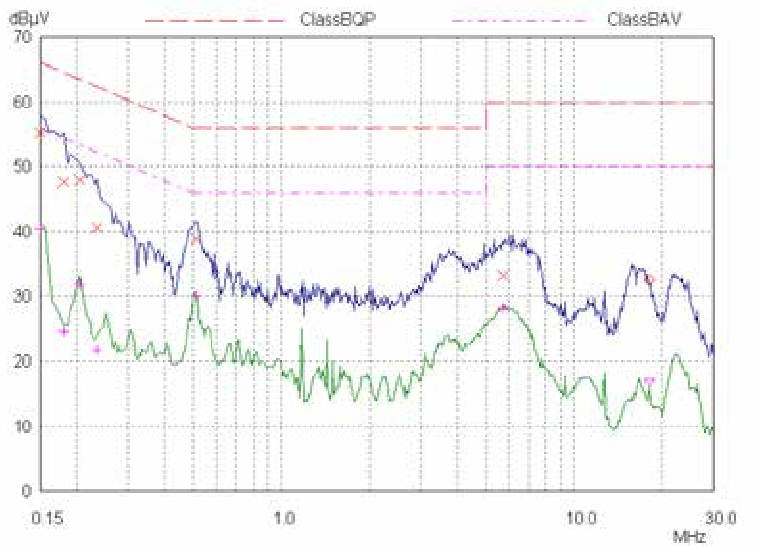
AC Power Line Conducted Data for Line

Figure 2 – Line Scan

Blue Trace: Peak Measurement Green Trace: Average Measurement



Final Measurement: x = QP / + = AV at 2 second measurement time.

Table 9 – Line Scan Data

Frequency MHz	Level dBµV	Detector	Limit dBµV	Margin dB	Phase	PE
0.15	55.23	QP	66.00	10.77	L1	gnd
0.18	47.67	QP	64.49	16.82	L1	gnd
0.205	47.92	QP	63.41	15.49	L1	gnd
0.235	40.60	QP	62.27	21.67	L1	gnd
0.51	38.92	QP	56.00	17.08	L1	gnd
5.735	33.16	QP	60.00	26.84	L1	gnd
0.15	40.45	AV	56.00	15.55	L1	gnd
0.18	24.63	AV	54.49	29.86	L1	gnd
0.205	31.74	AV	53.41	21.67	L1	gnd
0.235	21.77	AV	52.27	30.50	L1	gnd
0.51	30.10	AV	46.00	15.90	L1	gnd
5.735	28.14	AV	50.00	21.86	L1	gnd

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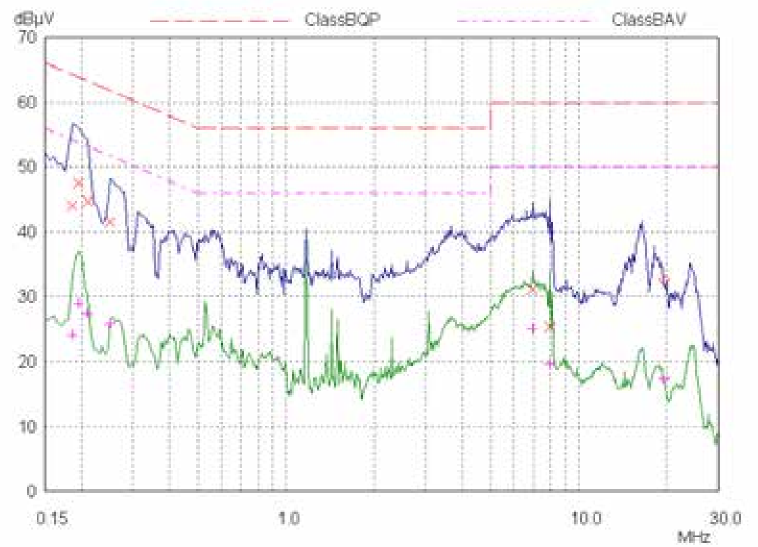
AC Power Line Conducted Data for Neutral

Figure 3 – Neutral Scan

Blue Trace: Peak Measurement Green Trace: Average Measurement



Final Measurement: x = QP / + = AV at 2 second measurement time.

Table 10 – Neutral Scan Data

Frequency MHz	Level dBµV	Detector	Limit dBµV	Margin dB	Phase	PE
0.185	44.09	QP	64.26	20.17	N	gnd
0.195	47.53	QP	63.82	16.29	N	gnd
0.21	44.72	QP	63.21	18.49	N	gnd
0.25	41.49	QP	61.76	20.27	N	gnd
6.96	31.14	QP	60.00	28.86	N	gnd
8.005	25.31	QP	60.00	34.69	N	gnd
0.185	24.14	AV	54.26	30.12	N	gnd
0.195	29.04	AV	53.82	24.78	N	gnd
0.21	27.32	AV	53.21	25.89	N	gnd
0.25	25.87	AV	51.76	25.89	N	gnd
6.96	25.06	AV	50.00	24.94	N	gnd
8.005	19.75	AV	50.00	30.25	N	gnd

Transmitter Emission

§15.209 Radiated emission limits; general requirements.

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/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

(b) In the emission table above, the tighter limit applies at the band edges.

(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 990 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

(e) The provisions in §§15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

(f) In accordance with §15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in §15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in §15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in §15.109 that are applicable to the incorporated digital device.

(g) Perimeter protection systems may operate in the 54-72 MHz and 76-88 MHz bands under the provisions of this section. The use of such perimeter protection systems is limited to industrial, business and commercial applications.

Report of Measurements Radiated Data

Radiated emissions measurements were performed from 9 kHz to 30 MHz at 3-meter distance. The loop antenna was placed at 1-meter height and was rotated about its vertical axis. The EUT was also rotated 360 degrees in front of the measurement antenna. Tests were performed with the EUT in all three orthogonal orientations. **No emissions were observed from the EUT in this frequency range.**

Measurements were performed in the frequency range of 30 MHz to 1 GHz at 10-meter distance. The Bilog antenna was searched from 1 to 4 meters in height in both horizontal and vertical orientation. The EUT was also rotated 360 degrees in front of the measurement antenna. Tests were performed with the measurement antenna in both horizontal and vertical orientations and the EUT in all three orthogonal orientations.

Measurements were performed in the frequency range of 1 GHz to 24.835 GHz at 3-meter distance. The Horn antenna was in both horizontal and vertical orientation. The EUT was also rotated 360 degrees in front of the measurement antenna and in all three orthogonal orientations. Only the second and third harmonics of the transmitter was observed, all others were baseline of the noise floor measurements. Measurements above 18 GHz were performed as exploratory at a much closer distance with the standard gain horn. No emissions were observed above the third harmonic of the fundamental frequency.

Exploratory radiated emissions measurements of the transmitter frequencies were made to determine the maximum transmit level of the EUT. All frequencies were searched for any emissions from the EUT. No other emissions were observed.

Radiated Data

Table 11 – Radiated Data

Orientation	Frequency MHz	QP Level dBmV/m	QP Limit dBmV/m	Margin dB	Azimuth, Height	Antenna, Polarization
Coax Antenna	The data below was taken at 10 meter distance.					
X	128.0	12.35	30.00	-17.65	270, 4	BiLog, H
X	256.0	12.72	37.00	-24.28	270, 3.8	BiLog, H
Y	128.0	13.27	30.00	-16.73	158, 4	BiLog, H
Y	208.8	9.03	30.00	-20.97	158, 4	BiLog, H
Y	256.0	13.02	37.00	-23.98	158, 3.9	BiLog, H
Z	128.0	15.11	30.00	-14.89	338, 4	BiLog, H
Z	256.0	12.72	37.00	-24.28	338, 3.8	BiLog, H
X	128.0	15.23	30.00	-14.77	248, 1.1	BiLog, V
X	256.0	14.28	37.00	-22.72	248, 1.1	BiLog, V
Y	128.0	15.25	30.00	-14.75	248, 1	BiLog, V
Z	256.0	14.22	37.00	-22.78	202, 1	BiLog, V
Z	128.0	15.64	30.00	-14.36	202, 1	BiLog, V
Z	208.8	9.48	30.00	-20.52	202, 1	BiLog, V
Y	208.8	9.44	30.00	-20.56	248, 1	BiLog, V
X	208.8	9.42	30.00	-20.58	248, 1.1	BiLog, V
Z	208.8	8.83	30.00	-21.17	338, 4	BiLog, H
X	208.8	8.79	30.00	-21.21	270, 3.9	BiLog, H
Y	256.0	14.42	37.00	-22.58	248, 1	BiLog, V
Jbend Antenna	The data below was taken at 10 meter distance.					
Z	128.0	14.01	30.00	-15.99	90, 1.1	BiLog, V
X	128.0	13.72	30.00	-16.28	270, 1	BiLog, V
Y	128.0	12.93	30.00	-17.07	45, 1	BiLog, V
X	128.0	12.73	30.00	-17.27	225, 4	BiLog, H

Y	128.0	12.51	30.00	-17.49	315, 4	BiLog, H
Z	128.0	12.35	30.00	-17.65	202, 4	BiLog, H
X	256.0	15.24	37.00	-21.76	270, 1	BiLog, V
Y	256.0	15.08	37.00	-21.92	45, 1	BiLog, V
Z	256.0	14.80	37.00	-22.20	90, 1.1	BiLog, V
Y	240.0	14.29	37.00	-22.71	315, 3.9	BiLog, H
Z	256.0	13.69	37.00	-23.31	202, 3.9	BiLog, H
X	256.0	13.55	37.00	-23.45	225, 3.9	BiLog, H
Z	240.0	13.13	37.00	-23.87	90, 1.1	BiLog, V
Z	240.0	13.05	37.00	-23.95	202, 4	BiLog, H
X	240.0	12.97	37.00	-24.03	225, 4	BiLog, H
Y	256.0	12.80	37.00	-24.20	315, 3.9	BiLog, H
X	240.0	12.69	37.00	-24.31	270, 1	BiLog, V
Y	240.0	12.53	37.00	-24.47	45, 1	BiLog, V

	The data below was taken at 3 meter distance						
Polarization, Orientation	**Emission Frequency MHz**	**PK Level dBμV/m**	**PK Limit dBμV/m**	**AV Level dBμV/m**	**AV Limit dBμV/m**	**PK Margin dB**	**AV Margin dB**
	Lowest Channel						
VX C	7215	71.0	74	51.0	54	-3.0	-3.0
HY C	7215	71.0	74	51.0	54	-3.0	-3.0
HX C	7215	70.3	74	50.3	54	-3.7	-3.7
HY J	4810	69.9	74	49.9	54	-4.1	-4.1
HZ C	7215	69.4	74	49.4	54	-4.6	-4.6
VY C	7215	69.1	74	49.1	54	-4.9	-4.9
VZ C	7215	69.0	74	49.0	54	-5.0	-5.0
VZ J	4810	68.8	74	48.8	54	-5.2	-5.2
HX J	4810	68.5	74	48.5	54	-5.5	-5.5
VX J bl	9620	67.7	74	47.8	54	-6.3	-6.2
VY J bl	9620	67.5	74	47.6	54	-6.5	-6.4
HY J	7215	67.6	74	47.6	54	-6.4	-6.4
HY C bl	9620	67.3	74	47.4	54	-6.7	-6.6
HZ C bl	9620	67.2	74	47.3	54	-6.8	-6.7
VX C bl	9620	67.1	74	47.2	54	-6.9	-6.8
HX J bl	9620	66.8	74	46.9	54	-7.2	-7.1
VZ C bl	9620	66.6	74	46.7	54	-7.4	-7.3
VZ J	7215	66.5	74	46.5	54	-7.5	-7.5
HY J bl	9620	66.4	74	46.5	54	-7.6	-7.5
VX J	7215	66.4	74	46.4	54	-7.6	-7.6
VZ J bl	9620	66.3	74	46.4	54	-7.7	-7.6
HX C bl	9620	66.2	74	46.3	54	-7.8	-7.7
VY J	7215	66.2	74	46.2	54	-7.8	-7.8
HZ J bl	9620	66.1	74	46.2	54	-7.9	-7.8
HZ J	7215	66.1	74	46.1	54	-7.9	-7.9
HX J	7215	66.1	74	46.1	54	-7.9	-7.9
VY C bl	9620	65.8	74	45.9	54	-8.2	-8.1
HZ J	4810	65.4	74	45.4	54	-8.6	-8.6
VX J	4810	65.3	74	45.3	54	-8.7	-8.7
HZ C	4810	64.8	74	44.8	54	-9.2	-9.2
VY J	4810	63.8	74	43.8	54	-10.2	-10.2

HX C	4810	62.8	74	42.8	54	-11.2	-11.2
VZ C	4810	62.0	74	42.0	54	-12.0	-12.0
HY C	4810	61.9	74	41.9	54	-12.1	-12.1
VY C	4810	60.9	74	40.9	54	-13.1	-13.1
VX C	4810	58.9	74	38.9	54	-15.1	-15.1

	Middle Channel						
HY C	7320	70.5	74	50.6	54	-3.5	-3.4
VX C	7320	69.7	74	49.8	54	-4.3	-4.2
HX C	7320	69.2	74	49.3	54	-4.8	-4.7
VY C	7320	68.9	74	49.0	54	-5.1	-5.0
VZ C	7320	68.8	74	48.9	54	-5.2	-5.1
HZ C	7320	68.7	74	48.8	54	-5.3	-5.2
HX J bl	9760	68.2	74	48.3	54	-5.8	-5.7
HY J	7320	67.5	74	47.6	54	-6.5	-6.4
VY C bl	9760	67.3	74	47.4	54	-6.7	-6.6
HX J	7320	67.3	74	47.4	54	-6.7	-6.6
VZ J	7320	67.2	74	47.3	54	-6.8	-6.7
HY J	4880	67.2	74	47.3	54	-6.8	-6.7
HY C bl	9760	67.1	74	47.2	54	-6.9	-6.8
VX J bl	9760	67.1	74	47.2	54	-6.9	-6.8
VY J	7320	66.8	74	46.9	54	-7.2	-7.1
HY J bl	9760	66.8	74	46.9	54	-7.2	-7.1
VZ C bl	9760	66.7	74	46.8	54	-7.3	-7.2
HZ C bl	9760	66.7	74	46.8	54	-7.3	-7.2
VY J bl	9760	66.6	74	46.7	54	-7.4	-7.3
HZ J bl	9760	66.6	74	46.7	54	-7.4	-7.3
HX J	4880	66.5	74	46.6	54	-7.5	-7.4
VX C bl	9760	66.4	74	46.5	54	-7.6	-7.5
HX C bl	9760	66.4	74	46.5	54	-7.6	-7.5
HZ J	7320	66.4	74	46.5	54	-7.6	-7.5
VZ J bl	9760	66.3	74	46.4	54	-7.7	-7.6
VX J	7320	65.7	74	45.8	54	-8.3	-8.2
HZ C	4880	65.5	74	45.6	54	-8.5	-8.4
HX C	4880	65.4	74	45.5	54	-8.6	-8.5
HZ J	4880	65.3	74	45.4	54	-8.7	-8.6
VZ J	4880	64.9	74	45.0	54	-9.1	-9.0
VY J	4880	64.3	74	44.4	54	-9.7	-9.6
VZ C	4880	63.2	74	43.3	54	-10.8	-10.7
HY C	4880	62.8	74	42.9	54	-11.2	-11.1
VX J	4880	62.4	74	42.5	54	-11.6	-11.5
VY C	4880	61.9	74	42.0	54	-12.1	-12.0
VX C	4880	61.1	74	41.2	54	-12.9	-12.8
	Highest Channel						
HY C	7440	69.8	74	49.9	54	-4.2	-4.1
VX C	7440	68.8	74	48.9	54	-5.2	-5.1
VZ C	7440	68.6	74	48.7	54	-5.4	-5.3
HZ C	7440	68.3	74	48.4	54	-5.7	-5.6
HX C	7440	68.1	74	48.2	54	-5.9	-5.8
HY J	7440	67.7	74	47.8	54	-6.3	-6.2

VY C	7440	67.6	74	47.7	54	-6.4	-6.3
HZ C bl	9920	67.6	74	47.6	54	-6.4	-6.4
VY J bl	9920	67.5	74	47.5	54	-6.5	-6.5
VZ J	7440	67.4	74	47.5	54	-6.6	-6.5
HZ J bl	9920	67.5	74	47.5	54	-6.5	-6.5
HY J bl	9920	67.4	74	47.4	54	-6.6	-6.6
VZ C bl	9920	67.1	74	47.1	54	-6.9	-6.9
HX J	7440	67.0	74	47.1	54	-7.0	-6.9
VZ J bl	9920	66.9	74	46.9	54	-7.1	-7.1
HX J bl	9920	66.9	74	46.9	54	-7.1	-7.1
VX C bl	9920	66.8	74	46.8	54	-7.2	-7.2
HX C bl	9920	66.8	74	46.8	54	-7.2	-7.2
VY C bl	9920	66.7	74	46.7	54	-7.3	-7.3
VX J	7440	66.6	74	46.7	54	-7.4	-7.3
HY C bl	9920	66.4	74	46.4	54	-7.6	-7.6
VX J bl	9920	66.4	74	46.4	54	-7.6	-7.6
HZ J	7440	66.3	74	46.4	54	-7.7	-7.6
HX C	4960	66.0	74	46.1	54	-8.0	-7.9
VY J	7440	66.0	74	46.1	54	-8.0	-7.9
HZ C	4960	65.5	74	45.6	54	-8.5	-8.4
HX J	4960	65.4	74	45.5	54	-8.6	-8.5
HY J	4960	65.3	74	45.4	54	-8.7	-8.6
HZ J	4960	65.1	74	45.2	54	-8.9	-8.8
VZ C	4960	63.9	74	44.0	54	-10.1	-10.0
HY C	4960	63.9	74	44.0	54	-10.1	-10.0
VY J	4960	63.9	74	44.0	54	-10.1	-10.0
VZ J	4960	63.6	74	43.7	54	-10.4	-10.3
VY C	4960	62.4	74	42.5	54	-11.6	-11.5
VX J	4960	62.3	74	42.4	54	-11.7	-11.6
VX C	4960	61.3	74	41.4	54	-12.7	-12.6
	No other emissions were observed						

Operating mode of the transmitter was 802.15.4. Only baseline noise floor was observed after the third harmonic. (bl) Note: PK – peak readings, AV – average readings, H – horizontal polarization, V – vertical polarization, X – Y – Z = three orthogonal orientations. Module antenna used C – coax, J – J-bend.

Frequency Stability

§15.215 Additional provisions to the general radiated emission limitations. (c)

The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

ANSI C63.10 6.8 Frequency stability tests

Some unlicensed wireless device requirements specify frequency stability tests with variation of supply voltage and temperature; the requirements can be found in the regulatory specifications for each type of unlicensed wireless device. The procedures listed in 6.8.1 and 6.8.2 shall be used for frequency stability tests.

ANSI C63.10 6.8.1 Frequency stability with respect to ambient temperature

a) Supply the EUT with a nominal ac voltage or install a new or fully charged battery in the EUT. If possible, a dummy load shall be connected to the EUT because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, then the EUT shall be placed in the center of the chamber with the antenna adjusted to the shortest length possible. Turn ON the EUT and tune it to one of the number of frequencies shown in 5.6.

b) Couple the unlicensed wireless device output to the measuring instrument by connecting an antenna to the measuring instrument with a suitable length of coaxial cable and placing the measuring antenna near the EUT (e.g., 15 cm away), or by connecting a dummy load to the measuring instrument, through an attenuator if necessary.

c) Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument but is strong enough to allow measurement of the operating or fundamental frequency of the EUT).

d) Turn the EUT OFF and place it inside the environmental temperature chamber. For devices that have oscillator heaters, energize only the heater circuit.

e) Set the temperature control on the chamber to the highest specified in the regulatory requirements for the type of device and allow the oscillator heater and the chamber temperature to stabilize.

f) While maintaining a constant temperature inside the environmental chamber, turn the EUT ON and record the operating frequency at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT is energized. Four measurements in total are made.

g) Measure the frequency at each of frequencies specified in 5.6.

h) Switch OFF the EUT but do not switch OFF the oscillator heater.

i) Lower the chamber temperature by not more than 10 °C, and allow the temperature inside the chamber to stabilize.

j) Repeat step f) through step i) down to the lowest specified temperature.

ANSI C63.10 6.8.2 Frequency stability when varying supply voltage

Unless otherwise specified, these tests shall be made at ambient room temperature (+15 °C to +25 °C). An antenna shall be connected to the antenna output terminals of the EUT if possible. If the EUT is equipped with or uses an adjustable-length antenna, then it shall be fully extended.

a) Supply the EUT with nominal voltage or install a new or fully charged battery in the EUT. Turn ON the EUT and couple its output to a frequency counter or other frequency-measuring instrument.

NOTE—An instrument that has an adequate level of accuracy as specified by the procuring or regulatory agency is the recommended measuring instrument.

b) Tune the EUT to one of the number of frequencies required in 5.6. Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument but is strong enough to allow measurement of the operating or fundamental frequency of the EUT).

c) Measure the frequency at each of the frequencies specified in 5.6.

d) Repeat the above procedure at 85% and 115% of the nominal supply voltage as described in 5.13.

Table 12 – Frequency stability with temperature

Channel Frequency kHz	Time	-20 C kHz	20 C kHz	50 C kHz	Change Min kHz	Change Max kHz	
2405000	**0 min**	**2405040.5**	**2405004.5**	**2404964.0**	**-38**	**41**	**Pass**
	2 min	**2405040.5**	**2405004.5**	**2404962.5**			
	5 min	**2405041.0**	**2405005.0**	**2404962.5**			
	10 min	**2405041.0**	**2405005.0**	**2404962.0**			
2480000	**0 min**	**2480043.0**	**2480007.5**	**2479968.0**	**-37**	**43.5**	**Pass**
	2 min	**2480043.5**	**2480006.5**	**2479963.5**			
	5 min	**2480043.5**	**2480006.0**	**2479963.5**			
	10 min	**2480043.5**	**2480006.0**	**2479963.0**			

Table 13 – Frequency stability with varying voltage supply

No change in frequency was observed.	**Pass**

Testing Cert #1007.01

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COMPLIANCE VERIFICATION REPORT

TEST CERTIFICATE

APPLICANT:	Stack Labs, Inc. 10054 Pasadena Ave. Cupertino, CA 95014
Trade Name:	Stack
Model:	STACK002

I HEREBY CERTIFY THAT:

The measurements shown in this report were made in accordance with the procedures indicated and that the energy emitted by this equipment, as received, was found to be within the FCC CFR 47 Part 15 Rules and Regulations Subpart C requirements. Additionally, it should be noted that the results in this report apply only to the items tested, as identified herein.

I FURTHER CERTIFY THAT:

On the basis of the measurements taken at the test site, the equipment tested is capable of operation in compliance with the requirements set forth in FCC CFR 47 Part 15.207, 15.209 and 15.247 Rules and Regulations.

On this Date: June 17, 2016

Bruce Smith
Atlas Compliance & Engineering, Inc.