PRODUCT SAFETY ENGINEERING, INC.

Product Safety Engineering, Inc
12955 Bellamy Brothers Blvd.
Dade City, FL 33525
352-588-2209

TEST REPORT

15F297B
06/01/2016

FCC 15.247
BLE

Applicant:

Automatic Airflow Balancing LLC
2423 S. Orange Ave.
Orlando, FL 32806

Product:

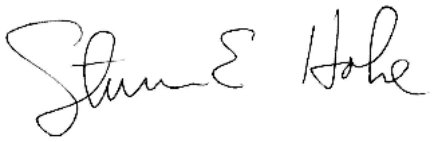
Models - TS-100
Temperature & Humidity Sensor

Test dates:

05/10/2016 - 05/13/2016

Receive Date:

05/10/2016

Prepared by: Steven E. Hoke  - EMC Site Manager

1.0 Table of Contents

PRODUCT SAFETY ENGINEERING, INC.

2.0 Test Equipment

		TEST EQUIPMENT CALIBRATION INFORMATION			
Manufacturer	Asset	Model	Description	Serial Number	Cal Due *
Hewlett Packard	57	8566B	Spectrum Analyzer	2421A00526	
Hewlett Packard	57	85662A	Display	2151A03667	
Hewlett Packard	2	85650A	Quasi-peak Adapter	2043A00209	11/24/2016
Hewlett Packard	152	8566B	Spectrum Analyzer	2532A02418	11/24/2016
Hewlett Packard	152	85662A	Display	2403A07352	11/24/2016
Hewlett Packard	/	85650A	Quasi-peak Adapter	2043A00358	
Hewlett Packard	3	8447D	Preamp 0.1 - 1,000 MHz	2944A06832	
Hewlett Packard	8	8447D	Preamp 0.1 - 1,000 MHz	2944A06901	12/4/2016
Hewlett Packard	23	8449B	Preamp 1 - 26.5 GHz	3008A00320	5/27/2016
Hewlett Packard	119	E7402A	Portable Spectrum Analyzer	US39150137	
ETS Lindgren	132	3148	Log Periodic Antenna	44783	
ETS Lindgren	137	3148	Log Periodic Antenna	75741	** 2/4/2018
ElectroMetrics	9	LPA-30	Log Periodic Antenna	2280	
Electro-Metrics	10	BIA-30	Biconical Antenna	3852	** 6/17/2016
EMCO	135	3104C	Biconical Antenna	75927	
Electro-Metrics	12	ALR30M	Magnetic Loop Antenna	824	
Electro-Metrics	146	ALR-25M	Magnetic Loop Antenna	722	** 11/18/2016
Electro-Metrics	13	EMC-30	EMI Receiver	191	
Electro-Metrics	11	3115	Double Ridge Guide Antenna	3810	** 7/16/2017
Electro-Metrics	153	3117	Double Ridge Guide Antenna	109296	
Solar	17	8028	LISN	829012/809022	
Com-Power	150/151	LI-125	LISN	191080/191081	
Schwartzbeck	29	MDS-21	Absorbing Clamp	2581	
Fisher Custom	145	FCC-TLISN-T4-02	T LISN	20454	
Fisher Custom	144	FCC-TLISN-T8-02	Fisher Custom	20452	
ATM		42-441-6	Stanard Gain Horn Antenna	E531612-01	
Solar	124	7334-1	Loop Sensor	32317	
Sun Systems		EC127	Enviromental Chamber	EC0154	
Fluke		52	Digital Thermometer	4475388	
Hewlett Packard	123	3585A	Spectrum Analyzer	1750A01006	
			* Cal Due Date Format = MM/DD/YYYY		
All equipment was calibrated one year prior to the cal due date listed unless otherwise indicated					
** These devices are on a (2) year calibration cycle					

3.0 Test Results Summary

Test	Requirement	Measured	Pass/Fail
6 dB Bandwidth	> 500 kHz	540 kHz	Pass
Peak Power Spectral Density	< 8 dBm / 3 kHz	-26.8 dBm	Pass
Peak Output Power	< 1 watt	0.125 milliwatts	Pass
Band Edges Measurements	>20 dBc	39.1 dB	Pass
Spurious Emissions	=>20 dB down	> 30 down	Pass
Powerline Conducted	Limit Table	NA	NA
RF Exposure	≤ 3.0	0.0316	Pass

Product description

The device under test is a handheld, battery operated Bluetooth low energy meter. The TS-100 connects to Apple and Android smartphones, tablets, and smart watches for the purpose of measuring temperature and humidity.

The complimentary app assists the user through taking several tests with onscreen guidance including:

1. Dry Bulb Temperature
2. Wet Bulb Temperature
3. Feels Like Temperature (compares Temperature & Humidity)
4. Dew Point
5. Relative Humidity

4.0 Test Procedures

4.1 - 6 dB bandwidth

Test Requirement: 15.247 (a)(2) The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Method: 558074 D01 DTS Meas Guidance v03r05 section 9.1.1 RBW DTS bandwidth

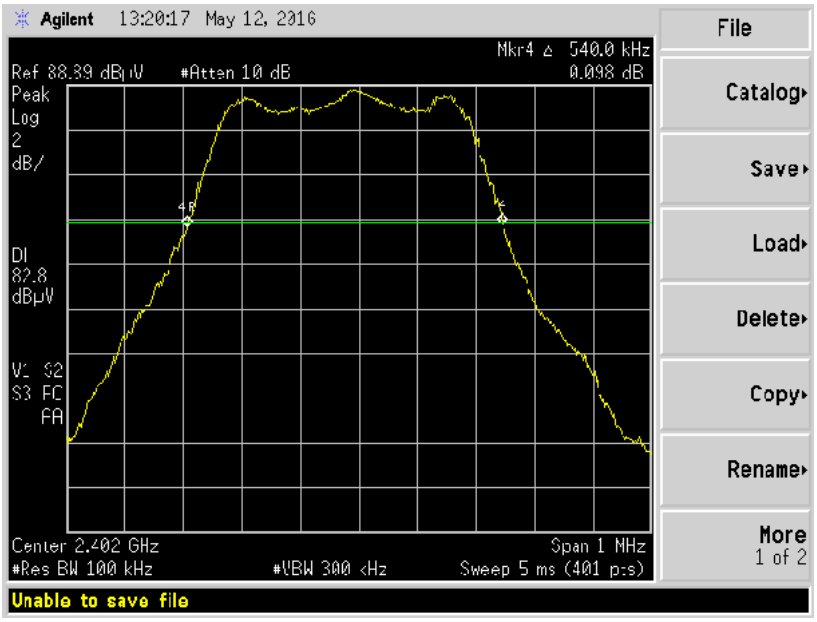
This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the *DTS bandwidth*.

a) Set the RBW *DTS bandwidth*.
b) Set VBW 3 „e RBW.
c) Set span 3 x RBW
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

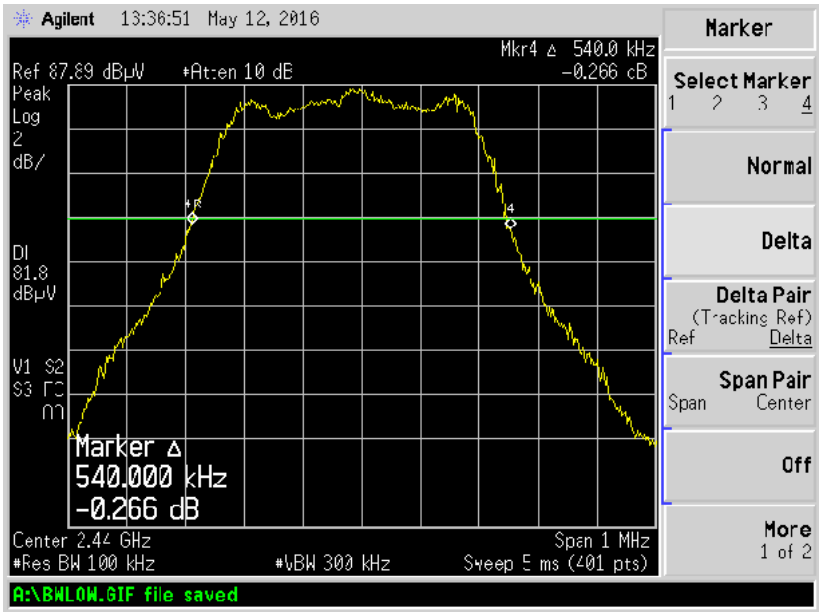
Channel No.	Frequency MHz	Mode	Data Rate	Measured 6 dB Bandwidth (KHz)	Limit	Result
0	2402	GFSK	2 Mbps	540	> 500kHz	Pass
19	2440		2 Mbps	540		Pass
39	2480		2 Mbps	540		Pass

Result Plots

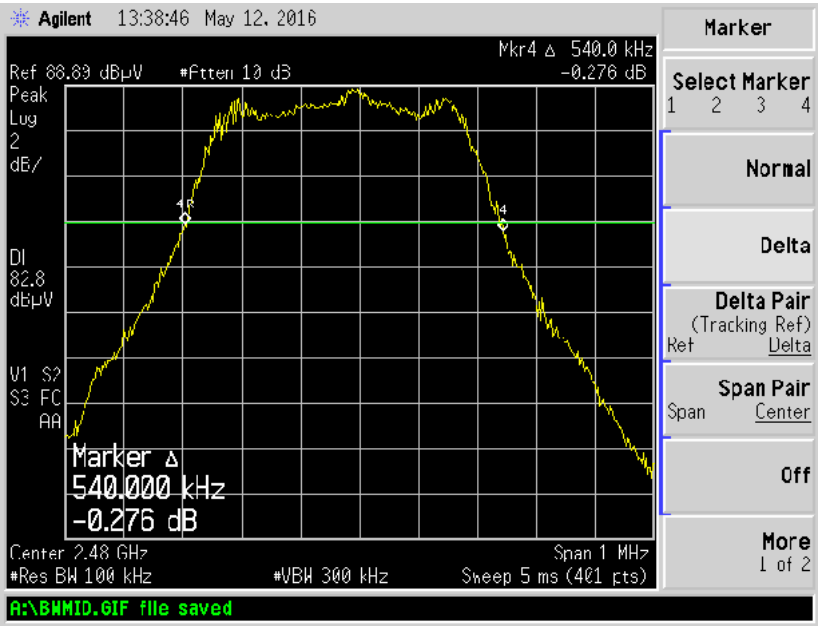
Low Channel



Mlddle Channel



High Channel



4.2 Peak Power Spectral Density Test Data

Test Requirement: 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)] paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test Method: 558074 D01 DTS Meas Guidance v03r05 10.2 Method PKPSD (peak PSD)

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate 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.

The peak power spectral density measurements were measured with the EUT set to low, medium and high transmit frequencies. The data rate of the radio was set to the maximum rate of (2) Mb/s. The measurements were made using the alternate field strength method described in FCC publication "558074 D01 DTS Meas Guidance v03r05".

The power spectral density was measured as follows:

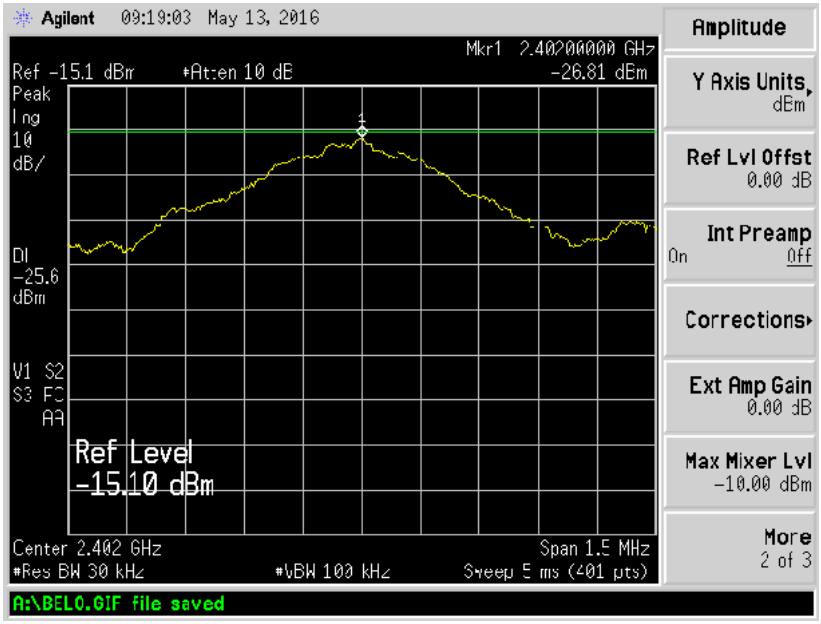
A. Tune the analyzer to the highest point of the maximized fundamental emission. Reset the analyzer to a RBW = 3 kHz, VBW > RBW, span = 300 kHz, sweep =

B. From the peak level obtained in (A), derive the field strength, E, by applying the appropriate antenna factor, cable loss, pre-amp gain, etc. Using the equation listed in (1), calculate a power level for comparison to the + 8 dBm limit.

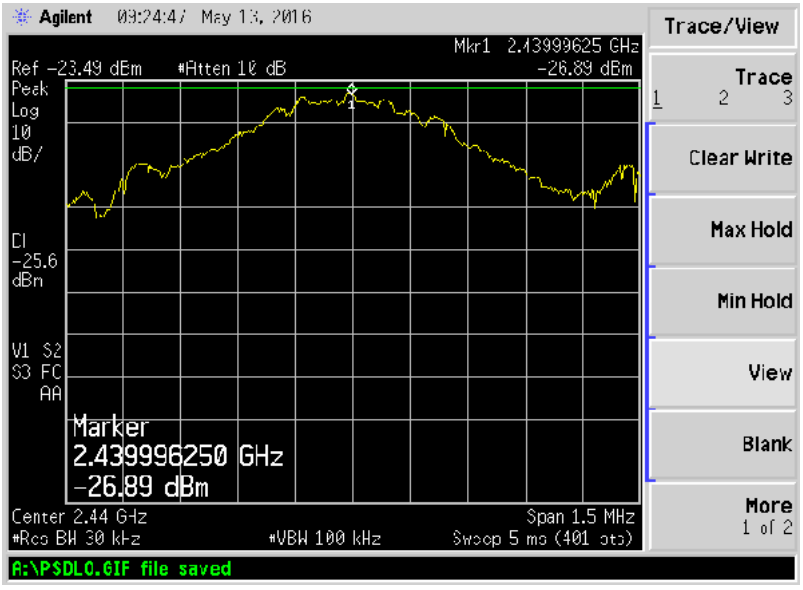
Channel No.	Frequency MHz	Mode	Data Rate	Measured Peak Power Spectral Density (dBm/3kHz)	Limit	Result
0	2402	GFSK	2 Mbps	-26.8	8 dBm / 3 kHz	Pass
19	2440		2 Mbps	-26.9		Pass
39	2480		2 Mbps	-27.2		Pass

Result Plots

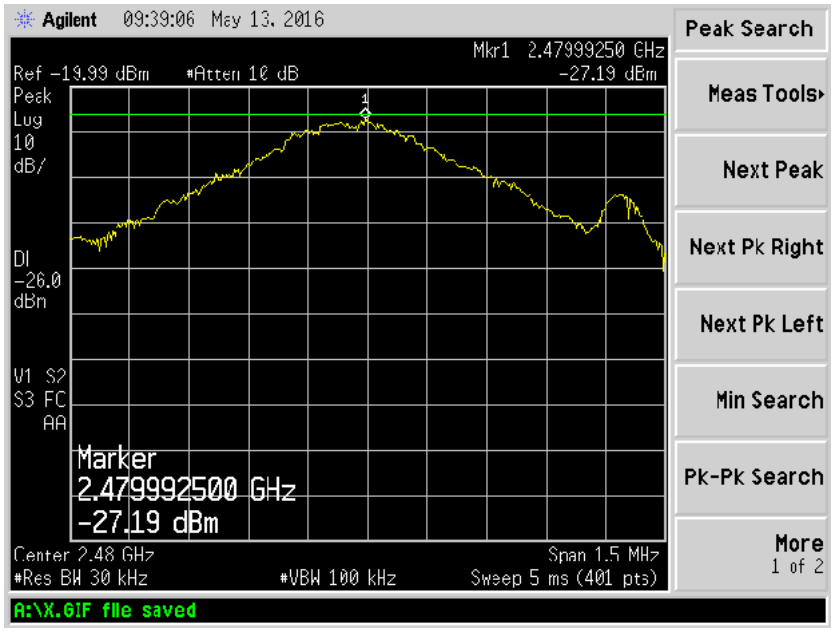
Low Channel



Middle Channel



High Channel



4.3 Peak Output Power Test Data

Test Requirement: 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.

Test Method: 558074 D01 DTS Meas Guidance v03r05 - 3.0 Acceptable measurement configurations

The measurement procedures described herein are based on the use of an antenna-port conducted test configuration. However, if antenna-port conducted tests cannot be performed on an EUT (e.g., portable or handheld devices with integral antenna), then radiated tests are acceptable for demonstrating compliance to the conducted emission requirements. The guidance provided herein is applicable to either antenna-port conducted or radiated compliance measurements.

If a radiated test configuration is used, then the measured power or field strength levels shall be converted to equivalent conducted power levels for comparison to the applicable output power limit. This may be accomplished by first measuring the radiated field strength or power levels using a methodology for maximum peak conducted power or maximum conducted (average) power as applicable and peak or average power spectral density as applicable. The radiated field strength or power level can then be converted to EIRP (see ANSI C63.10 for guidance). The equivalent conducted output power or power spectral density is then determined by subtracting the EUT transmit antenna gain (guidance applicable to devices utilizing multiple antenna technologies is provided in KDB 662911) from the EIRP (assuming logarithmic representation). All calculations and parameter assumptions shall be provided in the test report.

558074 D01 DTS Meas Guidance v03r05 - 9.1.1 RBW DTS bandwidth

This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the *DTS bandwidth*.

a) Set the RBW *DTS bandwidth*.
b) Set VBW 3 „e RBW.
c) Set span 3 x RBW
d) Sweep time = auto couple.
e) Detector = peak.

f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

Freq.	Measured @ 3 m	AVG/PEAK Detector	ACF	System Gain	Field Strength	Average Limit	Delta	POL H/V	Power
MHz	dBuV		dB/m	dB	dBuV/m	dBuV/m	dB		dBm
2402	79.9	AVG	28.5	25.3	83.1	94	-10.9	Horz	-12.1
2402	81.4	PEAK	28.5	25.3	84.6	114	-29.4	Horz	-10.6
2440	81.6	AVG	28.5	25.8	84.3	94	-9.7	Horz	-10.9
2440	83.5	PEAK	28.5	25.8	86.2	114	-27.8	Horz	-9.0
2480	79.8	AVG	28.6	24.5	83.9	94	-10.1	Vert	-11.3
2480	81	PEAK	28.6	24.5	85.1	114	-28.9	Vert	-10.1

EUT at (1.5) meter height

1. Calculate the transmitter's peak power using the following equation:

Where: P = (E x d) squared / (30 x G)

G = the numeric gain of the transmitting antenna over an isotropic radiator.
d = the distance in meters from which the field strength was measured.
P = the power in watts
E = the measured maximum field strength in V/m.

Example

86.2 dBuV/m = 20,417 uV/m = 0.02042 V/m

P = (0.02042 x 3)^2 / (30 x 1)

P = (0.00375) / 30

P = 0.0001251 Watts

P =0.1251 mW

P = -9.03 dBm

4.4 Band Edges Measurement

Test Requirement: 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)] 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)] §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in [§15.205(a)] §15.205(a), must also comply with the radiated emission limits specified in [§15.209(a)] §15.209(a) (see [§15.205(c)] §15.205(c)).

Test Method: ANSI C63.10 clause 6.10.5.2

The following test methodology shall be used for the restricted-band band-edge measurements:

a) For frequency-hopping systems, the hopping shall be turned OFF during this test.
b) Configure the spectrum analyzer settings as described in step e) (be sure to enter all losses between the unlicensed wireless device output and the spectrum analyzer).
c) Set the unlicensed wireless device to the lowest frequency channel.
d) Set the unlicensed wireless device to operate at maximum output power and 100% duty cycle,
or equivalent “normal mode of operation” as specified in 6.10.3.
e) Perform the test as follows:

1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.
2) Reference level offset: Corrected for gains and losses of test antenna factor, preamp gain and cable loss, so as to indicate field strength, in units of dBµV/m at 3 m, directly on the instrument display. Alternatively, the reference level offset may be set to zero and calculations shall be provided showing the conversion of raw measured data to the field strength in dBµV/m at 3 m.

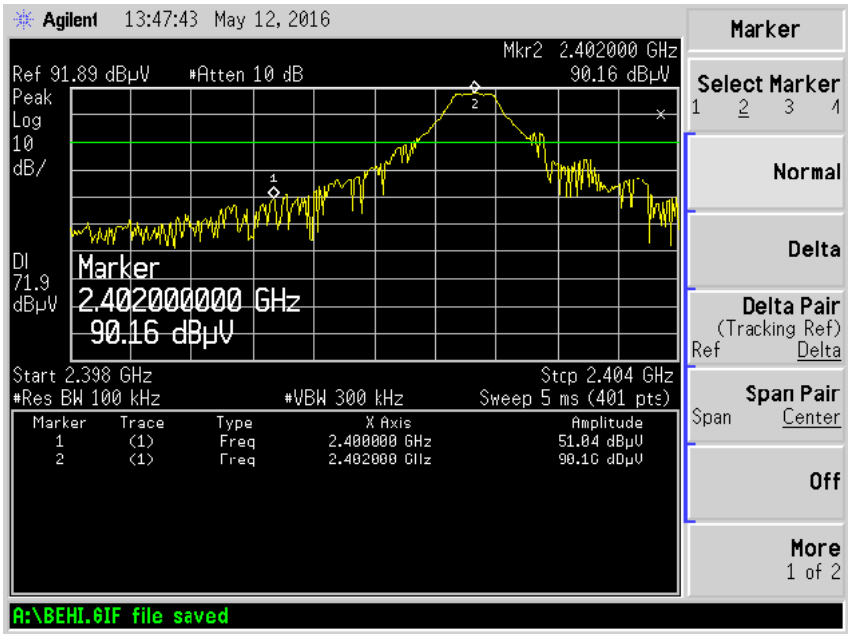
3) Reference level: As required to keep the signal from exceeding the maximum spectrum analyzer input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.
4) Attenuation: Auto (at least 10 dB preferred).
5) Sweep time: Coupled.

6) Resolution bandwidth:
   i) Below 150 kHz: 300 Hz or CISPR 200 Hz (CISPR 200 Hz required if using QP detector)
   ii) 150 kHz to 30 MHz: 10 kHz or CISPR 9 kHz, (CISPR 9 kHz required if using QP detector)
   iii) 30 MHz to 1000 MHz: 100 kHz or CISPR 120 kHz, (CISPR 120 kHz required if using QP detector)
   iv) Above 1 GHz: 1 MHz
7) Video bandwidth:
   i) VBW for Peak, Quasi-peak, or Average Detector Function: 3 × RBW
   ii) VBW for alternative average measurements using peak detector function; refer to 4.1.4.2.3
8) Detector (unless specified otherwise):
   i) QP below 1 GHz (however, peak detector measurements may be used to determine compliance with QP requirements).
   ii) Peak and average above 1 GHz
9) Trace: Max hold for final measurement; a combination of two traces, clear-write and max hold, is recommended for maximizing the emission.

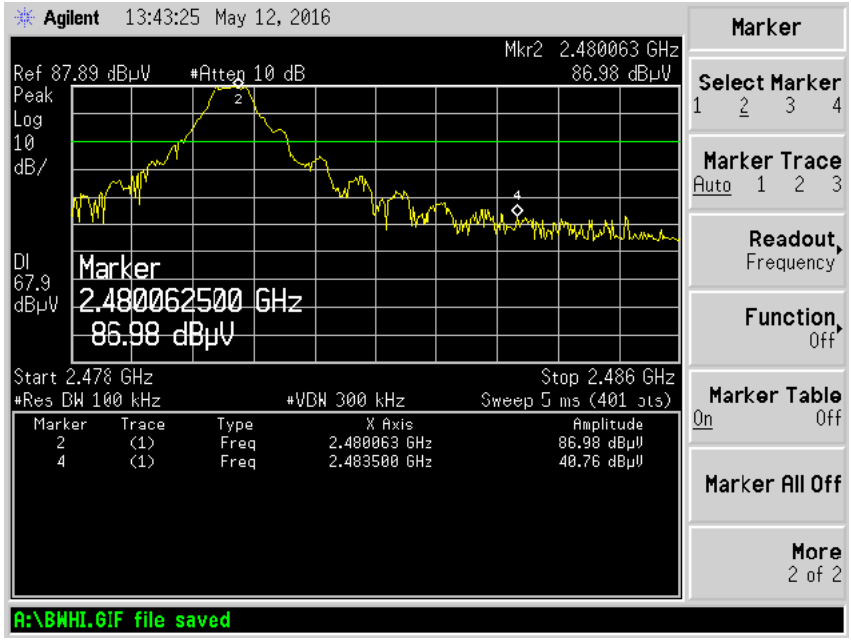
f) Using the applicable procedure(s) of 6.4, 6.5, or 6.6, orient the EUT and measurement antenna positions to produce the highest emission level.
g) Set the marker on the emission at the restricted band edge, or on the highest modulation product within the restricted band, if this level is greater than that at the band edge.
h) Repeat step d) through step g) for every applicable modulation.
i) Repeat step d) through step h) for the highest gain of each type of antenna to be used with the EUT.
j) Set the EUT to the highest frequency channel and repeat step d) through step i).
k) The band-edge measurement shall be reported by providing plot(s) of the measuring instrument display; the axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

Result Plots

Low Channel



High Channel



4.5 Radiated Spurious Emissions Test Data

Test Requirement: 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)] 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)] §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in [§15.205(a)] §15.205(a), must also comply with the radiated emission limits specified in [§15.209(a)] §15.209(a) (see [§15.205(c)] §15.205(c)).

Freq.	Measured			System	Adj AVERAGE	Average	Delta	Restricted
	@ 3 m	AVG/PEAK	ACF	Gain		Limit		Band
MHz	dBuV	Detector	dB/m	dB	dBuV/m	dBuV/m	dB	Yes/No
4804	38.5	AVG	33	19.3	52.2	54	-1.8	YES
4804	42	PEAK	33	19.3	55.7	74	-18.3	YES
7206	27	AVG	36.1	10.2	52.9	54	-1.1	YES
7206	29.1	PEAK	36.1	10.2	55	74	-19	YES
**9608	28	AVG	37.6	25.8	39.8	63.5	-23.7	NO
**9608	41	PEAK	37.6	25.8	52.8	83.5	-30.7	NO
**12010	28.4	AVG	39.2	25	42.6	63.5	-20.9	YES
**12010	41	PEAK	39.2	25	55.2	83.5	28.3	YES
4880	39.6	AVG	33.1	19.3	53.4	54	-0.6	YES
4880	41.5	PEAK	33.1	19.3	55.3	74	-18.7	YES
7320	27.3	AVG	36.5	10.3	53.5	54	-0.5	YES
7320	33	PEAK	36.5	10.3	59.2	74	-14.8	YES
**9760	28.1	AVG	37.9	25	41	63.5	-22.5	NO
**9760	41	PEAK	37.9	25	53.9	83.5	29.6	NO
**12200	28.3	AVG	38.9	24.9	42.3	63.5	-21.2	YES
**12200	41	PEAK	38.9	24.9	55	83.5	-28.5	YES
4960	38.8	AVG	33.3	19.3	52.8	54	-1.2	YES
4960	40	PEAK	33.3	19.3	54	74	-20	YES
7440	26.8	AVG	36.6	9.9	53.5	54	-0.5	YES
7440	27.5	PEAK	36.6	9.9	54.2	74	-19.8	YES
**9920	28.1	AVG	38.1	25.5	40.7	63.5	-22.8	NO
**9920	41	PEAK	38.1	25.5	53.6	83.5	-29.9	NO
**12400	28.3	AVG	38.9	25	42.2	63.5	-21.3	YES
**12400	41	PEAK	38.9	25	54.9	83.5	-28.6	YES

** Low Loss setup includes: 1 Meter Measurement Distance, (2) Short RF Cables #L3 & #L4 , 30 dB PA

4.6 Powerline conducted interference:

Test Requirement: 15.207 (a) The AC powerline conducted emissions measurements were not applicable for this battery operated device.

* EUT is battery operated - Not applicable

4.7 RF Exposure

KDB 447498 D01 General RF Exposure Guidance v06 was used for the SAR test exclusion method.

(P (mW)/5mm) * (√test freq (GHz)) ≤ 3.0

P=0.1 mW

0.1/5 * √2.5 = 0.0316

0.0316 ≤ 3.0