Testing Tomorrow's Technology

Class 2 Permissive Change Test Report

For

Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, paragraphs 15.207, 15.209 and 15.247

And

RSS-247 Issue 2: Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices

For the

Inventek Systems

Models:
ISM43362-M3G-L44-E
ISM43362-M3G-L44-U

FCC ID: O7P-362
IC ID: 10147A-362

UST Project: 21-0267

Issue Date: November 5, 2021

Total Pages: 21

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Testing Tomorrow's Technology

I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date: November 5, 2021

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MEASUREMENT TECHNICAL REPORT

Company Name:	Inventek Systems
Address:	2 Republic Rd. Billerica, MA 01862 USA
Model(s):	ISM43362-M3G-L44-E, ISM43362-M3G-L44-U
FCC ID:	O7P-362
IC ID:	10147A-362
Date:	November 5, 2021

This report concerns (check one): ☐ Original ☒ Class II Permissive Change

Equipment type: 2400-2483.5 MHz Radio Transceiver

Technical Information:

Radio Technology:	DTS
Frequency of Operation (MHz):	2412-2462 MHz
Output Power (dBm):	19.9 dBm
Type of Modulation:	DSSS
Data/Bit Rate (M)bps:	Various
Antenna Gain (dBi):	Refer to Table 5
Software used to program EUT:	Tera Term
EUT firmware:	compliance test scripts
Power setting:	“80”

Report prepared by:

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1 General Information

1.1 Purpose of this Report

This report is prepared as a means of conveying test results and information concerning the suitability of this exact product for Class II Permissive Change certification as an intentional transmitter device and public distribution according to FCC Rules and Regulations Part 15, Section 247 and Industry Canada RSS-247. The EUT can now be co-located 20cm or less with other modularly certified radios. The test results from co-location testing presented in this report show that the EUT continues to comply with the emissions requirements of Part 15 Subpart C.

1.2 Characterization of Test Sample

The samples used for testing were received by US Tech on October 26, 2021 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the Inventek Systems eS-WiFi module. The module employs DSSS modulation techniques. The module comes with three antenna options, including a trace-antenna, but for co-location purposes, only the dipole antennas will be used, so testing was completed with the highest gain dipole. The dipole antenna information is detailed in Table 4. Both models use the same radio module: BCM43362 from Broadcom. The module (BCM43362) is part of Inventek Systems eS-WiFi module family targeting embedded WiFi 802.11 b/g/n applications. eS-WiFi modules offer a plug and play WiFi solution that enables the embedded designers to integrate WiFi into their devices. The eS-WiFi module hardware system consists of a host processor, integrated antenna and Broadcom WiFi device (BCM43362). The module provides SPI, USB and UART interfaces. The module requires no operation system and has a completely integrated TCP/IP stack that only requires a simple AT command set to establish connectivity.

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* for the intentional radiator aspect of the device and as well as FCC subpart B and C of Part 15 and per FCC KDB Publication number 558074 v05r02 for Digital Transmission Systems Operating Under section 15.247.

Per FCC Part 15, digital RF conducted and radiated emissions below 1 GHz were measured with the spectrum analyzer's resolution bandwidth (RBW) adjusted to 9 kHz and 120 kHz, respectively. All measurements performed above 1 GHz were made with a RBW of 1 MHz. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was set to 3 times the RBW or as required per the standard throughout the evaluation process.

A list of EUT and Peripherals is found in Table 1 below. A block diagram of the tested system is shown in Figure 1. Test configuration photographs for spurious and fundamental emissions are provided in separate Appendices.

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is 186022. Additionally, this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittal(s)/Grant(s)

The EUT is subject to the following FCC Equipment Authorizations:

a) Certification under Part 15 Subpart C as an intentional transmitter.

Table 1. EUT and Peripherals

EUT MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID	CABLES P/D
EUT Inventek Systems	ISM4336-M3G-L44-* eS-WiFi Module	2107U	FCC ID: O7P-362 IC: 10147A-362	N/A
PERIPHERAL MANUFACTURER	**MODEL NUMBER**	**SERIAL NUMBER**	**FCC/IC ID**	**CABLES P/D**
Modular Radio #1 MMB Networks	Z357PA-40-UFL	Engineering Sample	FCC ID: XFFZ357PA20 IC: 8365AZ357PA20	N/A
Modular Radio #2 Microchip	BLE 4.2 RN4870	Engineering Sample	FCC ID: A8TBM70ABCDEFGH IC: 12246A-BM&0BLES1F2	N/A
Host Device Fluidra	Aqualink TCX	LJEB010501 20210083	None	25 ft P D
DC Bench Power Supply TekPower	HY1803D	1072531	None	6 ft P
Antennas See Table 4 for Details	--	--	--	--

S= Shielded, U= Unshielded, P= Power, D= Data

Table 2. Details of I/O Cables Attached to EUT

DESCRIPTION OF CABLE	DETAILS OF CABLE			CABLE LENGTH
Power cord	**Manufacturer**		**Part Number**	25 ft
	Various		Various	
	Shield Type	**Shield Termination**	**Back-shell**	
	N/A	N/A	N/A	

(*) Used for programming purpose only

Shield Type
N/A = None
F = Foil
B = Braided
2B = Double Braided
CND = Could Not Determine

Shield Termination
N/A = None
360 = 360 Degrees
P = Pigtail/Drain Wire
CND = Could Not Determine
MU = Metal Unshielded

Back-shell
N/A = Not Applicable
PS = Plastic Shielded
PU = Plastic Unshielded
MS = Metal Shielded

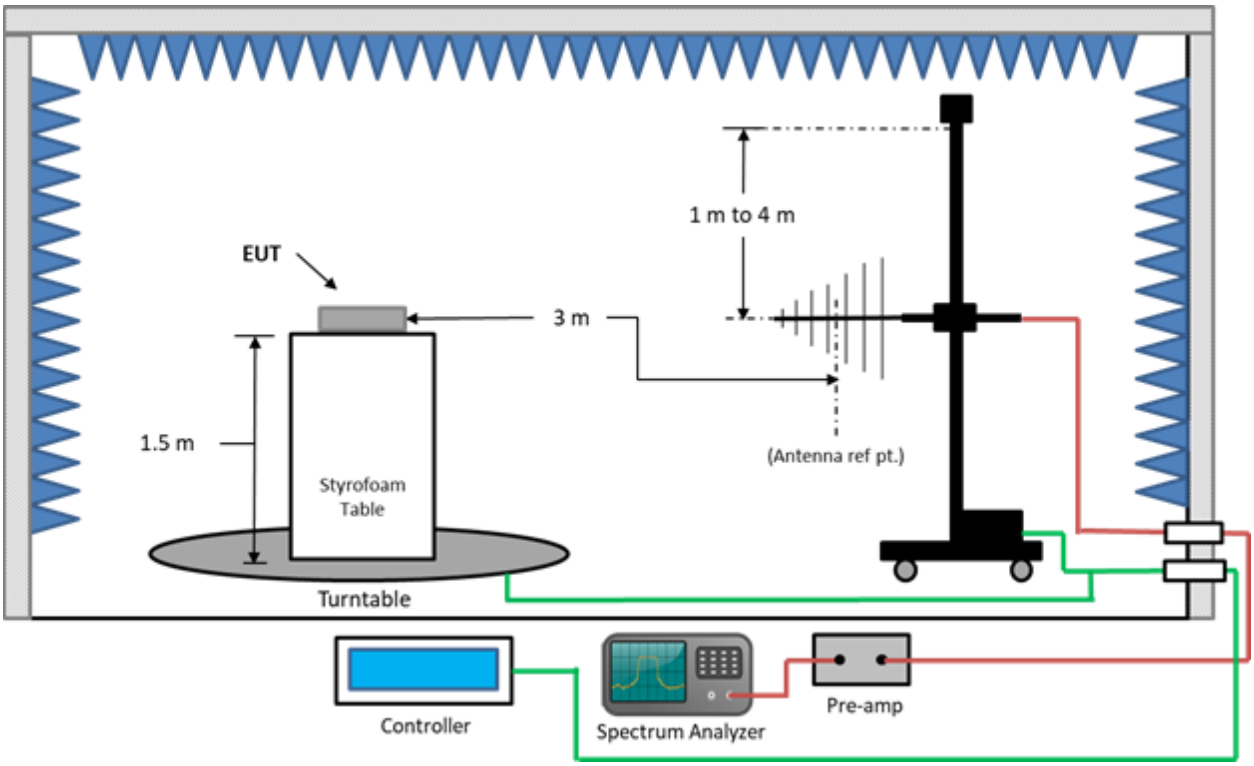


Figure 1. EUT Test Configuration Diagram

2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product.

Table 3. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	9/02/2022 2 yr.
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	1937A02980	6/09/2022
PREAMP 1.0 GHz to 26.0 GHz	8449B	HEWLETT-PACKARD	3008A00480	6/25/2022
BICONICAL ANTENNA	3110B	EMCO	9306-1708	8/17/2023 2 yr.
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	6/03/2023 2 yr
HORN ANTENNA	3115	EMCO	9107-3723	2/3/2023 2 yr.
DC Bench Power Supply	HY1803D	TekPower	1072531	Not Required

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2.2 Modifications to EUT Hardware

No modifications were made by US Tech to bring the EUT into compliance with FCC Part 15.247 and RSS-247 requirements.

2.3 Frequency Range of Radiated Measurements (CFR 15.33)

2.3.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10th harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

2.3.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to the range specified in 2.4.1 above; whichever is the higher range of investigation.

2.3.3 Restricted Bands of operation

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these emissions cannot exceed the limits of 15.209. Radiated harmonics and other spurious emissions are examined for this requirement see paragraph 2.10.

2.4 EUT Antenna Requirements (CFR 15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The antenna details are as follows:

Table 4. Antennas

Manufacturer	Model	Type	Gain (dBi)	Connector
Inventek Systems	Trace	Trace Antenna	0	Permanent Integral
Inventek Systems	W24P-U	Dipole (Bow Tie) Antenna	2.15	Unique Connector
Zodiac	B0023200	Dipole	5.0	u.fl

2.5 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d))

For radiated measurements, the EUT was set into a continuous transmission mode. Below 1 GHz, the RBW of the measuring instrument was set equal to 120 kHz. Peak measurements above 1 GHz were measured using a RBW = 1 MHz, with a VBW ≥ 3 x RBW. For average measurements above 1 GHz, the emissions were measured using an average detector. The measurement of each signal detected was maximized by rotating the turntable 360° clockwise and counterclockwise and raising and lowering the receive antenna between 1 and 4 meters in height while monitoring the ever changing spectrum analyzer display with Trace A in the Max-Hold mode and Trace B in the Clear-Write mode for the largest signal visible. The emission from the EUT was measured and recorded when both maxima were simultaneously satisfied.

2.5.1 EUT Worst Case Test Configuration

On the test site, the EUT was placed on top of a polystyrene table 80 cm above the ground plane inside a semi-anechoic test chamber. The EUT was evaluated with the antenna in the vertical orientation as this was deemed to be the typical use case configuration. The test configuration photos displayed in the Test Configuration exhibit represent the final configuration used for testing.

Table 5. Peak Radiated Fundamental and Harmonic Emissions

Test: FCC Part 15.247 / 15.209								
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
Inventek module								
2411.34	74.99	0.0	27.51	102.50	--	3.0m./HORZ	--	**PK**
2464.13	74.25	0.0	27.55	101.80	--	3.0m./HORZ	--	**PK**

Test Date: October 27, 2021

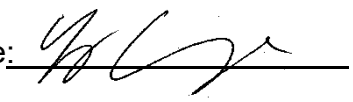
Signature:  Test Engineer: George Yang

Table 5. 802.11b Peak Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)				Client: Inventek Systems			
Project: 16-0291							
Frequency (MHz)	Test Data (dBuv)	AF+CA-AMP (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Antenna Distance/ Polarization	Margin (dB)	Detector Mode
Low Channel – PEAK							
2411.90	71.08	30.16	101.24	-	3.0m./HORZ	-	PK
4824.10	63.58	2.40	65.98	74.0	3.0m./HORZ	8.0	PK
7236.70	46.56	8.05	54.61	74.0	3.0m./HORZ	19.4	PK
Mid Channel – PEAK							
2441.75	70.98	30.13	101.11	-	3.0m./HORZ	-	PK
4884.10	62.05	2.59	64.64	74.0	3.0m./HORZ	9.4	PK
7288.30	47.06	7.77	52.24	74.0	3.0m./HORZ	21.8	PK
High Channel – PEAK							
2462.15	67.67	30.13	97.80	-	3.0m./HORZ	-	PK
4923.90	40.05	2.27	42.32	74.0	3.0m./HORZ	31.7	PK
7382.25	35.62	7.53	43.15	74.0	3.0m./HORZ	30.8	PK

Figure 2. Table 5 from US Tech #16-0291, Issue date: 12-16-2016

The fundamental emissions remain comparable to previously recorded values as can be seen above; therefore it was not necessary to further explore the intentional emissions from the radio module.

2.6 Unwanted Emissions of the Intentional Radiator, (CFR 15.209 and 15.33(a))

The test data provided herein is to support the verification requirement for unwanted radiated emissions coming from the EUT in a transmitting state per 15.209 and was investigated from 30 MHz to 6 GHz. The EUT was put into a continuous transmit mode of operation and tested as detailed in ANSI C63.10:2013, Clause 6.4.6.

The measurement bandwidths for each frequency scan that was evaluated were set as follows:

Frequency Span	RBW / VBW
30 MHz – 1 GHz	120 kHz / 300 kHz
Above 1 GHz	1 MHz / 3 MHz

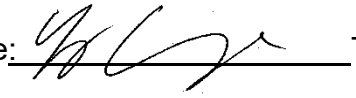
The EUT was placed on a host board located within 20 cm of two other modularly approved radio transmitters. The combined emissions as a result of all three radios being co-located on the same host were evaluated and compared to the compliance limits.

The test data shows that the product with the transmitter modules operating in standalone and simultaneous transmit conditions still comply with the FCC Limits. Data is presented in the tables and figures below.

Table 6. Spurious Radiated Emissions (30 MHz – 1 GHz)

30 MHz to 1 GHz with Class B Limits							
Test: Radiated Emissions per CFR 15.209							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarity**	**Margin (dB)**	**Detector PK / QP**
100.02	42.06	-16.65	25.41	43.5	3m./HORZ	18.1	**PK**
200.00	49.36	-11.87	37.49	43.5	3m./HORZ	6.0	**PK**
624.92	48.95	-7.89	41.06	46.0	3m./HORZ	4.9	**PK**
875.04	45.30	-5.71	39.60	46.0	3m./HORZ	6.4	**PK**
35.46	42.61	-14.27	28.34	40.0	3m./VERT	11.7	**PK**
225.02	53.00	-16.41	36.59	46.0	3m./VERT	9.4	**PK**
625.04	51.79	-8.30	43.49	46.0	3m./VERT	2.5	**PK**
875.04	46.27	-6.51	39.76	46.0	3m./VERT	6.2	**PK**

Test Date: October 27, 2021

Signature:  Test Engineer: George Yang

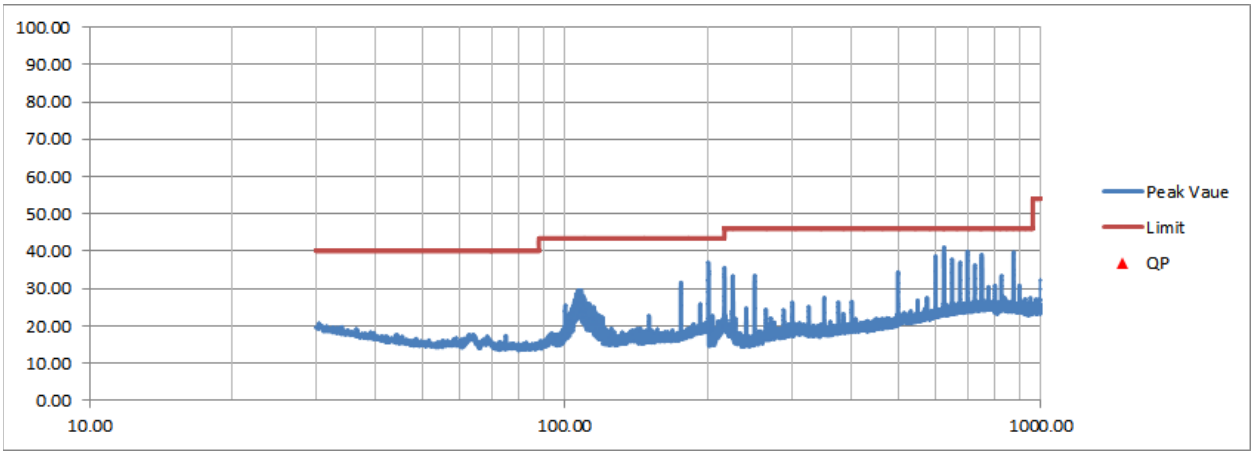


Figure 3. Horizontal Radiated Emissions

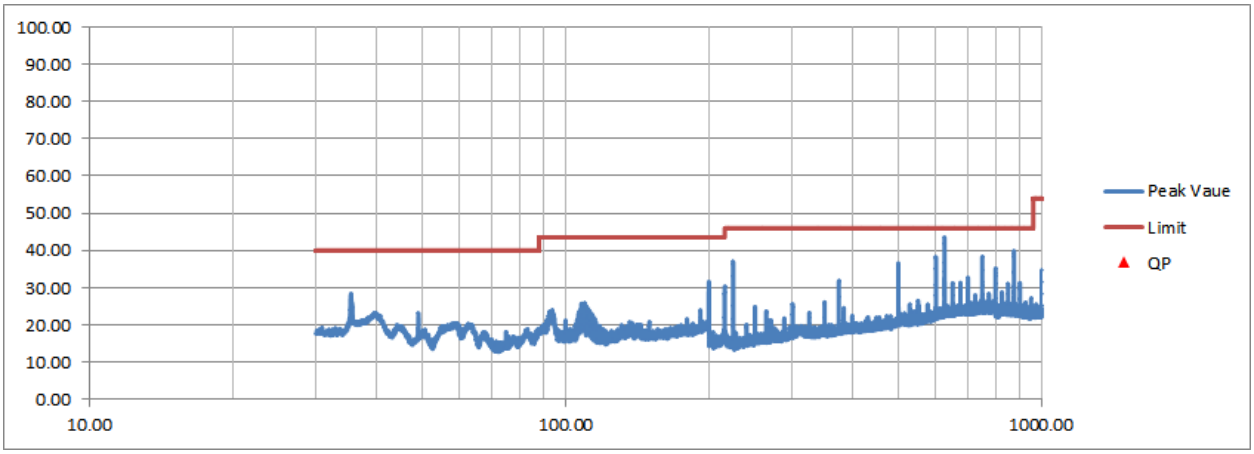
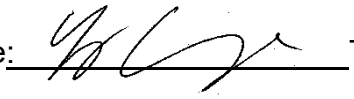


Figure 4. Vertical Radiated Emissions

Table 7. Spurious Radiated Emissions (1 GHz – 6 GHz)

1 GHz to 10 GHz with Class B Limits							
Test: Radiated Emissions per CFR 15.209							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector PK / AVG**
1728.00	55.53	-9.84	45.69	54.0	3.0m./HORZ	8.3	**AVG**

Test Date: October 27, 2021

Signature:  Test Engineer: George Yang

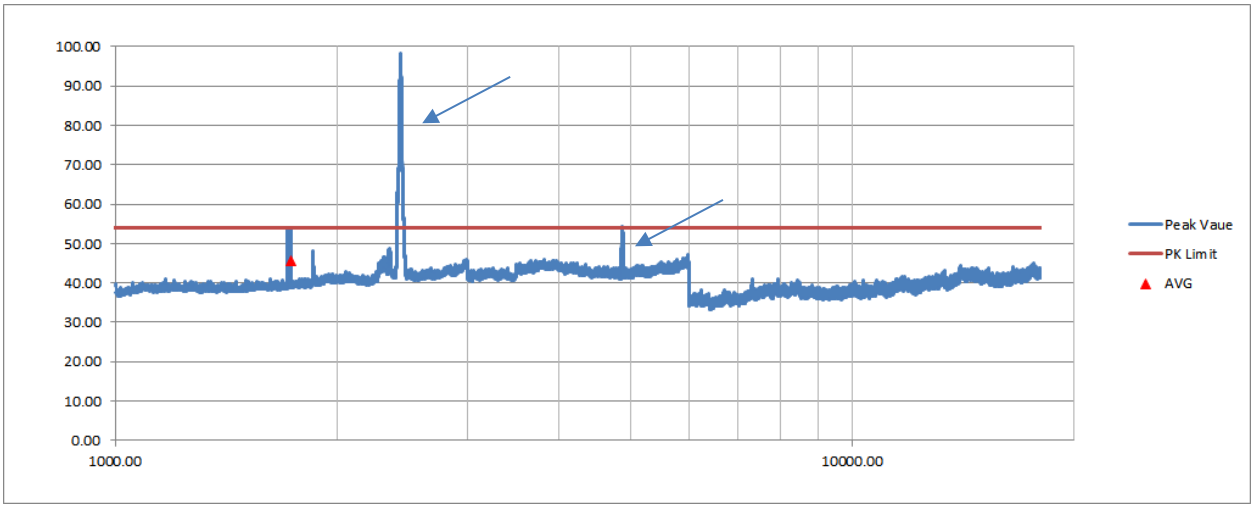


Figure 5. Horizontal Radiated Emissions above 1 GHz

Note: Fundamental and harmonics of simultaneously broadcasting 2.4 GHz radio are identified above.

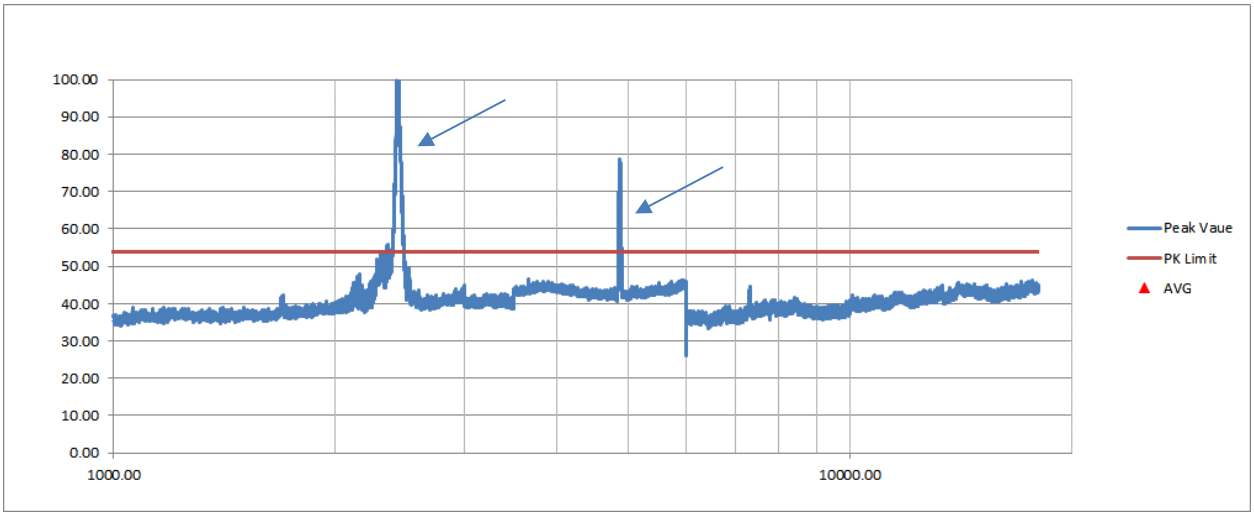


Figure 6. Vertical Radiated Emissions above 1 GHz

Note: Fundamental and harmonics of simultaneously broadcasting 2.4 GHz radio are identified above.

2.7 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4-2:2011. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

2.7.1 Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ±2.78 dB.

2.7.2 Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ±5.3 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ±5.1 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna (Above 1000 MHz) is ±5.1 dB.

3 Test Results

The re-test data shows that the product with the transmitter module operating in standalone and simultaneous transmission conditions still comply with the FCC Limits. The emissions levels are similar to those previously recorded however the client's intent is to be able to update the certification documentation with a statement that allows the EUT to be collocated therefore this test data is being presented to the TCB for consideration as a Class 2 Permissive Change in order to update the documentation on file for this module.

No other changes have been made. All else remains the same.