Electromagnetic Compatibility Test Report

Tests Performed on a Midtronics, Inc.

2.4 GHz Transceiver, Model MDX-ZIGB-G3

Radiometrics Document RP-8462A

ACCREDITED
TESTING CERT #1495.01

Product Detail:	
FCC ID: Y6O-MDX-ZIGB-G3 ISED ID: 9453A-MDXZIGBG3 Equipment type: 2.4 GHz Low power transmitter	
Test Standards:	
US CFR Title 47, Chapter I, FCC Part 15 Subpart C FCC Part 15 CFR Title 47: 2016 Innovation, Science, and Economic Development Canada RSS-210, Issue 9: 2016 as required for Category I Equipment This report concerns: Original Grant for Certification FCC Part 15.249	
Tests Performed For:	*Test Facility:*
Midtronics, Inc. 7000 Monroe St. Willowbrook, IL 60527	**Radiometrics Midwest Corporation** 12 Devonwood Avenue Romeoville, IL 60446-1349 (815) 293-0772
Test Date(s): (Month-Day-Year)	
October 24 to November 7, 2016	

Document RP-8462A Revisions:

Rev.	Issue Date	Affected Sections	Revised By
0	January 30, 2017		
1	January 31, 2017	Cover	Joseph Strzelecki
2	February 10, 2017	11.2.2	Joseph Strzelecki

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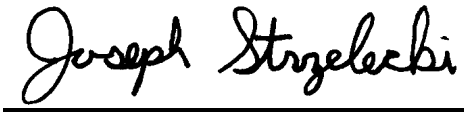
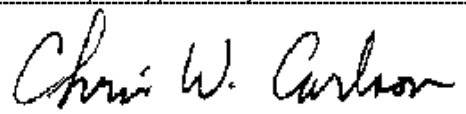
1.0 ADMINISTRATIVE DATA

Equipment Under Test:	
A Midtronics, Inc., 2.4 GHz Transceiver Model: MDX-ZIGB-G3 Serial Number: This will be referred to as the EUT in this Report	
Date EUT Received at Radiometrics: (Month-Day-Year)	*Test Date(s): (Month-Day-Year)*
October 24, 2016	October 24 to November 7, 2016
Test Report Written By:	*Test Witnessed By:*
Joseph Strzelecki Senior EMC Engineer	The tests were not witnessed by Midtronics, Inc.
Radiometrics' Personnel Responsible for Test:	*Test Report Approved By*
 Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	 Chris W. Carlson Director of Engineering NARTE EMC-000921-NE

2.0 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a 2.4 GHz Transceiver, Model MDX-ZIGB-G3, manufactured by Midtronics, Inc. The detailed test results are presented in a separate section. The following is a summary of the test results.

Emissions Tests Results

Environmental Phenomena	Frequency Range	RSS Spec	RSS section	FCC Section	Test Result
RF Radiated Emissions	30-12,500 MHz	RSS-Gen	7.1 & 8.9	15.249	Pass
RF Radiated Emissions Fundamental and Harmonics	30-25,000 MHz	RSS-210	B.10	15.249	Pass
Conducted Emissions, AC Mains	0.15 - 30 MHz	RSS-Gen	8.8	15.249	Pass
Occupied Bandwidth Test	Fundamental Freq.	RSS-Gen	6.6	15.249	Pass

Note: The RSS-210 specification is not currently covered in Radiometrics' Scope of Accreditation. This is technically very similar to FCC, CFR 47 Part 15 which is on Radiometrics scope.

2.1 RF Exposure Compliance Requirements

Since the power output is less than10 mW, the EUT meets the FCC requirement for RF. There are no power level adjustments available to the end user. The antenna is permanently attached. The detailed calculations for RF Exposure are presented in a separate document.

3.0 EQUIPMENT UNDER TEST (EUT) DETAILS

3.1 EUT Description

The EUT is a transmitter for a prosthetic arm, Model MDX-ZIGB-G3, manufactured by Midtronics, Inc. The EUT was in good working condition during the tests, with no known defects. There are two identical transmitters in the arm. The two transmitters are identified as MSP1 and MSP2 herein. The two transmitters have the same electronics, with different antennas.

3.1.1 FCC Section 15.203 & RSS GEN Antenna Requirements

There are two antenna options:

1. Internal chip antenna: The antenna is internal to the EUT and it is not readily available to be modified by the end user.
2. ½ wave Dipole Antenna: The antenna uses a non-standard "U.FL" adaptor that is internal to the product.

Therefore, it meets the 15.203 Requirements.

3.2 Related Submittals

Midtronics, Inc. is not submitting any other products simultaneously for equipment authorization related to the EUT.

4.0 TESTED SYSTEM DETAILS

4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations. The EUT was tested while connected to its charger, since this is the worst-case configuration.

The identification for all equipment, plus descriptions of all cables used in the tested system, are:

Tested System Configuration List

Item	Description	Type*	Manufacturer	Model Number	Serial Number
1	RF Module	E	Midtronics	MDX-ZIGB-G3	Sample 2V
2	Cell Guard BCU	E	Midtronics	CGBC-300	Sample 1
3	AC Adaptor	E	DVE	DSA-12PFA-09 FUS	None

* Type: E = EUT, P = Peripheral, S = Support Equipment; H = Host Computer

List of System Cables

QTY	Length (m)	Cable Description	Shielded?
1	0.5	Power leads to battery (This is a standard cable supplied to the customer)	No
1	1.2	DC Cord from AC-DC supply to BCU	No
1	1.0	Sensor input leads to BCU	No

4.2 Special Accessories

No special accessories were used during the tests to achieve compliance.

4.3 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

5.0 TEST SPECIFICATIONS

Document	Date	Title
FCC CFR Title 47	2016	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
IC RSS-210 Issue 9	2016	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands) Category I Equipment
IC RSS-Gen Issue 4	2014	General Requirements and Information for the Certification of Radiocommunication Equipment (RSS-Gen)

6.0 TEST PROCEDURE DOCUMENTS

The tests were performed using the procedures from the following specifications:

Document	Date	Title
ANSI C63.4-2014	2014	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	2013	American National Standard for Testing Unlicensed Wireless Devices

7.0 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 2005 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the test methods listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la2.org).

The following is a list of shielded enclosures located in Romeoville, Illinois used during the tests:

Chamber E: Is a custom made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber. The floor has a 9' x 9' section of microwave absorber for testing above 1 GHz.

Test Station F: Is an area that measures 10' D X 12' W X 10' H. The floor and back wall are metal shielded. This area is used for conducted emissions measurements.

A separate ten-foot long, brass plated, steel ground rod attached via a 6 inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175. Details of the site characteristics are on file with the Innovation, Science, and Economic Development Canada as site number IC 8727A-1.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

8.0 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

9.0 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification and the data contained herein was taken with calibrated test equipment. The results relate only to the EUT listed herein.

10.0 TEST EQUIPMENT TABLE

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-05	RMC/Celeritek	Pre-amplifier	MW110G	1001	1.0-12GHz	12 Mo.	01/05/16
AMP-20	Avantek	Pre-amplifier	SF8-0652	15221	8-18GHz	12 Mo	01/05/16
AMP-22	Anritsu	Pre-amplifier	MH648A	M23969	0.1-1200MHz	12 Mo.	01/05/16
AMP-29	HP / Agilent	Amplifier	11975A	2304A00158	2-8 GHz	12 Mo.	01/08/16
ANT-04	Tensor	Biconical Antenna	4104	2246	20-250MHz	24 Mo.	05/16/16
ANT-08	RMC	Log-Periodic Ant.	LP1000	1002	200-1000MHz	24 Mo.	10/06/16
ANT-13	EMCO	Horn Antenna	3115	2502	1.0-18GHz	24 Mo.	12/28/16
ANT-36	Ailtech (Eaton)	Horn Antenna	96001	2013	1.0-18GHz	24 Mo.	11/02/16
ANT-48	RMC	Std Gain Horn	HW2020	1001	18-26 GHz	24 Mo.	12/15/15
HPF-01	Solar	High Pass Filter	7930-100	HPF-1	0.15-30MHz	24 Mo.	03/15/16
LSN-01	Electrometrics	50 uH LISN	FCC/VDE 50/2	1001	0.01-30MHz	24 Mo.	06/23/15
MXR-02	HP / Agilent	Harmonic Mixer	11970K	2332A00489	18-26.5GHz	12 Mo.	01/08/16
REC-08	HP / Agilent	Spectrum Analyzer	8566B	2648A13481 2209A01436	30Hz-22GHz	24 Mo.	12/21/15
REC-11	HP / Agilent	Spectrum Analyzer	E7405A	US39110103	9Hz-26.5GHz	12 Mo	03/23/16
REC-20	HP / Agilent	Spectrum Analyzer	85460A/84562A	33330A00135 3410A00178	30Hz-6GHz	24 Mo.	07/13/16
REC-21	Agilent	Spectrum Analyzer	E7405A	MY45118341	9Hz-26.5 GHz	24 Mo.	12/22/15
THM-02	Fluke	Temp/Humid Meter	971	93490471	N/A	24 Mo.	08/03/15

Note: All calibrated equipment is subject to periodic checks.

Software Company	Test Software Name	Version	Applicable Tests
Radiometrics	EN550XX0	06.10.16	RF Conducted Emissions (FCC Part 15 & EN 55011/22) REC-10
Radiometrics	REREC11D	01.05.16	RF Radiated Emissions (FCC Part 15 & EN 55011/22)
Agilent	PSA/ESA-E/L/EMC	2.4.0.42	Bandwidth and screen shots

11.0 TEST SECTIONS

11.1 AC Conducted Emissions

The tests and limits are in accordance with FCC section 15.207 and RSS Gen section 8.8.

A computer-controlled analyzer was used to perform the conducted emissions measurements. The frequency range was divided into 500 subranges equally spaced on a logarithmic scale. The computer recorded the peak of each subrange. This data was then plotted on a semi-log graph generated by the computer. Adjusting the positions of the cables and orientation of the test system then maximizes the highest emissions.

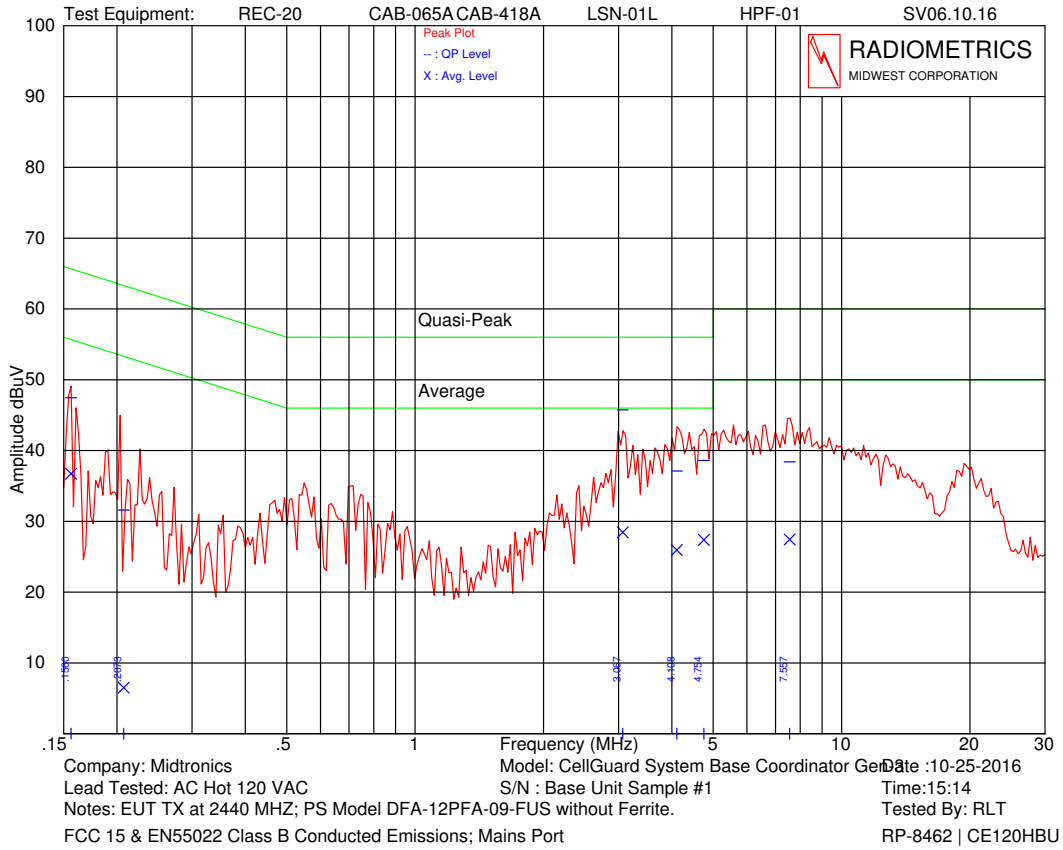
Mains Conducted emission measurements were performed using a 50 Ohm/50 uH Line Impedance Stabilization Network (LISN) as the pick-up device. Measurements were repeated on both leads within the power cord. If the EUT power cord exceeded 80 cm in length, the excess length of the power cord was made into a 30 to 40 cm bundle near the center of the cord. The LISN was placed on the floor at the base of the test platform and electrically bonded to the ground plane.

FCC Limits of Conducted Emissions at the AC Mains Ports

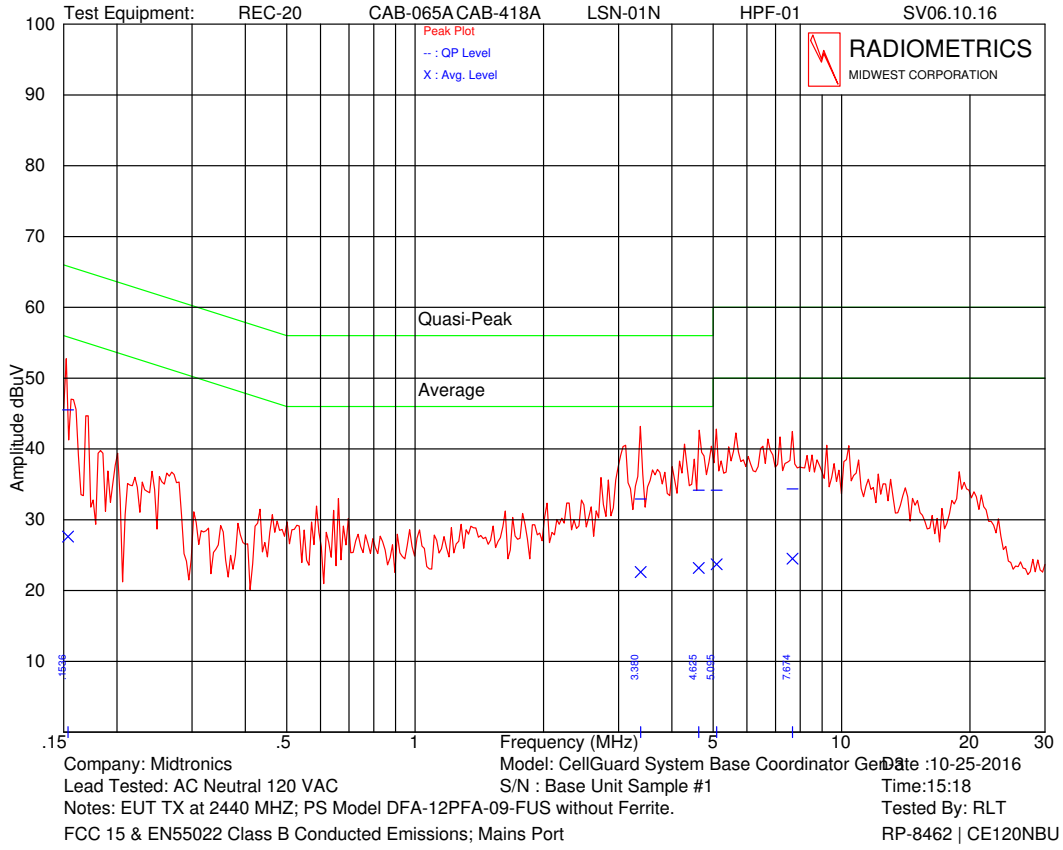
Frequency Range (MHz)	Class B Limits (dBuV)	
	Quasi-Peak	Average
0.150 - 0.50*	66 - 56	56 - 46
0.5 – 5.0	56	46
5.0 - 30	60	50
* The limit decreases linearly with the logarithm of the frequency in this range.		

The initial step in collecting conducted data is a peak detector scan and the plotting of the measurement range. Significant peaks are then marked as shown on the following table, and these signals are then measured with the quasi-peak detector. The following represents the worst case emissions from EUT charger power cord, after testing all modes of operation.

Test Date : October 25, 2016
The Amplitude is the final corrected value with cable and LISN Loss.



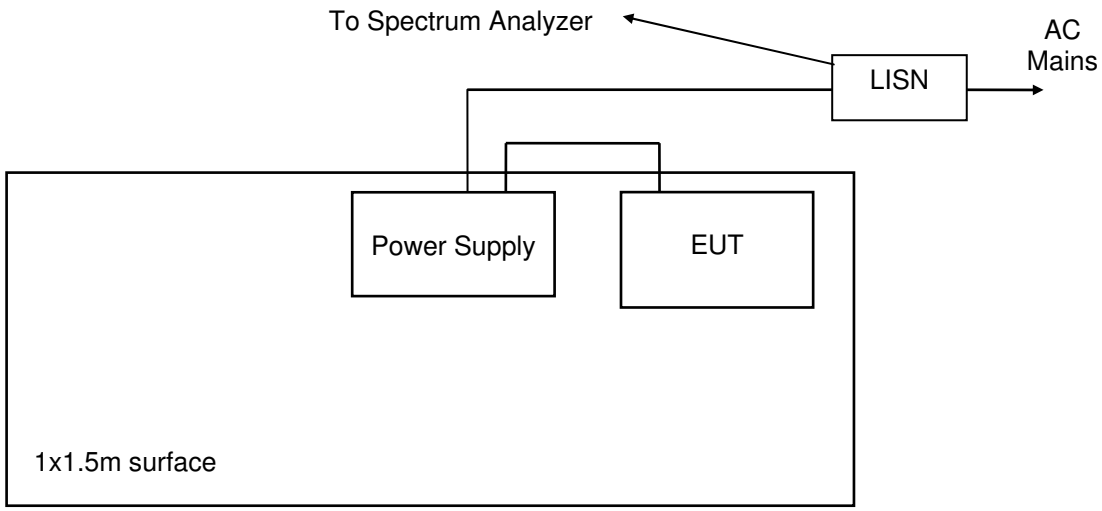
Frequency (MHz)	QP Amplitude (dBuV)	QP Limit (dBuV)	Average Amplitude (dBuV)	Average Limit (dBuV)	Margin (dB)
0.156	47.5	65.7	36.7	55.7	18.2
0.207	31.6	63.3	6.5	53.3	31.7
3.068	45.7	56.0	28.5	46.0	10.3
4.109	37.1	56.0	26.0	46.0	18.9
4.755	38.6	56.0	27.4	46.0	17.4
7.557	38.4	60.0	27.4	50.0	21.6



Frequency (MHz)	QP Amplitude (dBuV)	QP Limit (dBuV)	Average Amplitude (dBuV)	Average Limit (dBuV)	Margin (dB)
0.154	45.5	65.8	27.6	55.8	20.3
3.380	32.9	56.0	22.6	46.0	23.1
4.626	34.2	56.0	23.2	46.0	21.8
5.095	34.2	60.0	23.7	50.0	25.8
7.674	34.3	60.0	24.5	50.0	25.5

Judgment: Passed by at least 10 dB

Figure 1. Conducted Emissions Test Setup



Notes:
- LISN's at least 80 cm from EUT chassis
- Vertical conductive plane 40 cm from rear of table top
- EUT power cord bundled

11.2 Radiated RF Emissions

Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. The radiated emission measurements were performed with a spectrum analyzer. The bandwidth used from 150 kHz to 30 MHz is 9 or 10 kHz and the bandwidth from 30 MHz to 1000 MHz is 100 or 120 kHz. Above 1 GHz, a 1 MHz bandwidth is used. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists. A harmonic mixer was used from 18 to 25 GHz. Figure 4 herein lists the details of the test equipment used during radiated emissions tests.

The EUT was rotated through three orthogonal axis as per 5.10.1 of ANSI C63.10 during the radiated tests.

Final radiated emissions measurements were performed inside of an anechoic chamber at a test distance of 3 meters. The anechoic chamber is designated as Chamber E. This Chamber meets the Site Attenuation requirements of ANSI C63.4 and CISPR 16-1. Chamber E is located at 12 East Devonwood Ave. Romeoville, Illinois EMI test lab.

The entire frequency range from 30 to 25,000 MHz was slowly scanned with particular attention paid to those frequency ranges which appeared high. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded. All measurements may be performed using either the peak, average or quasi-peak detector functions. If the peak detector data exceeds or is marginally close to the limits, the measurements are repeated using a quasi-peak detector or average function as required by the specification for final determination of compliance.

The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground.

11.2.1 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

FS = RA + AF + CF - AG + HPF + PKA

Where: FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain
PKA = Peak to Average Factor (This is only used for average measurements above 1 GHz)

The Peak to average factor is used when average measurements are required. It is calculated by the highest duty cycle in percent over any 100mS transmission. The factor in dB is 20*Log(On time mSec/100mSec).

Note: The actual FCC limits are in uV/m. The data in the results table coverted the limits to dBuV/m.
100 uV/m = 40.0 dBuV/m
150 uV/m = 43.5 dBuV/m
200 uV/m = 46.0 dBuV/m
500 uV/m = 54.0 dBuV/m

11.2.2 Duty Cycle

The Peak to average factor is calculated by the highest duty cycle in percent over any 100mS transmission. The factor in dB is 20 * Log(Duty cycle/100). The transmitter operates for a maximum duration of 10 ms in any 100 ms interval for a 10% maximum duty cycle. 20 Log*(10mSec/100mSec) = -20.0 dB Peak to average Correction factor.

11.2.3 Radiated Emissions Test Results

11.2.3.1 Emissions Below 1 GHz

Test Date	October 24, 2016
Test Distance	3 Meters
Specification	FCC Part 15.209 & 15.249 & RSS-210 Section B.10
Tested by	Richard Tichgelaar
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP

Sensor with internal chip antenna

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cable & Amp Factors	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
30.5	30.3	P	H	11.1	-28.4	0.0	13.0	40.0	27.0	
33.3	36.0	P	H	11.4	-28.3	0.0	19.1	40.0	20.9	
50.3	38.0	P	H	11.3	-28.3	0.0	21.0	40.0	19.0	
85.6	36.3	P	H	8.6	-27.9	0.0	17.0	40.0	23.0	
87.8	43.3	P	H	9.2	-27.9	0.0	24.6	40.0	15.4	
101.5	32.6	P	H	11.8	-27.9	0.0	16.5	43.5	27.0	
125.2	33.3	P	H	12.1	-27.8	0.0	17.6	43.5	25.9	
162.6	39.9	P	H	15.3	-27.6	0.0	27.6	43.5	15.9	
203.8	36.9	P	H	15.9	-27.5	0.0	25.3	43.5	18.2	

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cable & Amp Factors	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
208.2	37.5	P	H	15.5	-27.5	0.0	25.5	43.5	18.0	
212.1	34.6	P	H	15.1	-27.5	0.0	22.2	43.5	21.3	
250.0	30.7	P	H	17.0	-27.3	0.0	20.4	46.0	25.6	
251.3	29.7	P	H	11.2	-27.3	0.0	13.6	46.0	32.4	
360.0	30.0	P	H	14.4	-27.1	0.0	17.3	46.0	28.7	
434.4	31.9	P	H	15.6	-27.0	0.0	20.5	46.0	25.5	
496.3	30.5	P	H	17.4	-26.9	0.0	21.0	46.0	25.0	
507.5	29.9	P	H	17.9	-27.0	0.0	20.8	46.0	25.2	
661.3	32.4	P	H	19.9	-26.1	0.0	26.2	46.0	19.8	
876.3	30.8	P	H	22.7	-25.2	0.0	28.3	46.0	17.7	
30.0	30.2	P	V	11.1	-28.3	0.0	13.0	40.0	27.0	
34.4	39.8	P	V	11.5	-28.3	0.0	23.0	40.0	17.0	
42.7	33.4	P	V	12.0	-28.3	0.0	17.1	40.0	22.9	
47.6	38.6	P	V	11.7	-28.3	0.0	22.0	40.0	18.0	
50.3	36.3	P	V	11.3	-28.3	0.0	19.3	40.0	20.7	
162.6	36.2	P	V	15.3	-27.6	0.0	23.9	43.5	19.6	
203.8	34.3	P	V	15.9	-27.5	0.0	22.7	43.5	20.8	
208.2	33.8	P	V	15.5	-27.5	0.0	21.8	43.5	21.7	
247.8	31.3	P	V	16.6	-27.3	0.0	20.6	46.0	25.4	
323.1	31.6	P	V	13.6	-27.3	0.0	17.9	46.0	28.1	
376.9	33.1	P	V	14.7	-27.1	0.0	20.7	46.0	25.3	
400.0	36.3	P	V	14.8	-27.2	0.0	23.9	46.0	22.1	
431.3	34.6	P	V	15.7	-26.9	0.0	23.4	46.0	22.6	
471.3	32.6	P	V	17.4	-26.8	0.0	23.2	46.0	22.8	
657.5	31.3	P	V	20.1	-26.1	0.0	25.3	46.0	20.7	
813.8	37.6	P	V	21.0	-25.6	0.0	33.0	46.0	13.0	
906.3	30.6	P	V	22.1	-24.9	0.0	27.8	46.0	18.2	

BCU configuration with external antenna

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cable & Amp Factors	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
30.0	30.0	P	H	11.1	-18.4	0.0	22.7	40.0	17.3	
46.0	38.0	P	H	11.9	-18.3	0.0	31.6	40.0	8.4	
71.3	34.1	P	H	6.6	-18.1	0.0	22.6	40.0	17.4	
81.2	34.4	P	H	7.2	-18.0	0.0	23.6	40.0	16.4	
132.3	36.7	P	H	11.7	-17.7	0.0	30.7	43.5	12.8	
149.9	38.3	P	H	13.2	-17.7	0.0	33.8	43.5	9.7	
208.8	37.8	P	H	15.4	-17.5	0.0	35.7	43.5	7.8	
239.6	38.1	P	H	15.6	-17.4	0.0	36.3	46.0	9.7	
250.0	44.2	Q	H	17.0	-17.4	0.0	43.8	46.0	2.2	
252.5	42.3	P	H	11.3	-17.4	0.0	36.2	46.0	9.8	
275.6	44.0	P	H	13.2	-17.4	0.0	39.8	46.0	6.2	
290.6	42.9	P	H	13.7	-17.4	0.0	39.2	46.0	6.8	
320.6	44.2	P	H	13.7	-17.3	0.0	40.6	46.0	5.4	
340.0	42.5	P	H	13.8	-17.3	0.0	39.0	46.0	7.0	
379.4	41.0	P	H	14.9	-17.2	0.0	38.7	46.0	7.3	
389.4	40.6	P	H	15.2	-17.2	0.0	38.6	46.0	7.4	
453.8	37.1	P	H	15.9	-17.1	0.0	35.9	46.0	10.1	
495.0	34.1	P	H	17.3	-17.0	0.0	34.4	46.0	11.6	
500.0	32.8	P	H	17.8	-17.0	0.0	33.6	46.0	12.4	
702.5	31.9	P	H	20.4	-15.8	0.0	36.5	46.0	9.5	
832.5	32.1	P	H	22.0	-15.3	0.0	38.8	46.0	7.2	

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cable & Amp Factors	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
39.9	36.3	P	V	12.0	-18.3	0.0	30.0	40.0	10.0	
46.2	43.0	Q	V	11.9	-18.3	0.0	36.6	40.0	3.4	
55.8	40.4	P	V	10.2	-18.2	0.0	32.4	40.0	7.6	
58.7	40.3	P	V	9.4	-18.2	0.0	31.5	40.0	8.5	
60.3	45.9	P	V	9.0	-18.2	0.0	36.7	40.0	3.3	
70.8	40.5	P	V	6.6	-18.1	0.0	29.0	40.0	11.0	
71.8	43.5	P	V	6.5	-18.1	0.0	31.9	40.0	8.1	
98.2	39.3	P	V	11.4	-17.9	0.0	32.8	43.5	10.7	
143.9	37.8	P	V	12.2	-17.7	0.0	32.3	43.5	11.2	
216.4	38.3	P	V	14.6	-17.5	0.0	35.4	46.0	10.6	
246.7	40.8	P	V	16.5	-17.4	0.0	39.9	46.0	6.1	
253.8	46.0	P	V	11.4	-17.4	0.0	40.0	46.0	6.0	
292.5	41.3	P	V	13.8	-17.4	0.0	37.7	46.0	8.3	
320.6	40.7	P	V	13.7	-17.3	0.0	37.1	46.0	8.9	
386.3	36.7	P	V	15.3	-17.2	0.0	34.8	46.0	11.2	
425.0	33.5	P	V	16.0	-17.1	0.0	32.4	46.0	13.6	
454.4	35.2	P	V	15.9	-17.1	0.0	34.0	46.0	12.0	
502.5	33.6	P	V	17.8	-17.0	0.0	34.4	46.0	11.6	
558.8	33.0	P	V	18.9	-16.6	0.0	35.3	46.0	10.7	
670.0	31.9	P	V	20.1	-16.0	0.0	36.0	46.0	10.0	
848.8	32.3	P	V	21.9	-15.3	0.0	38.9	46.0	7.1	

Judgment: Passed by 2.2 dB

11.2.3.2 Emissions above 1 GHz

Test Date: 10/26 & 10/27/2016
Tested by: Richard Tichgelaar
Radiated Emissions per FCC 15.249 & RSS-210 B.10

Sensor with internal chip antenna

		Spectrum Analyzer Readings					EUT	Peak	Ave	Peak	Ave	Margin
hrm	Tx					Corr.	Emission	Tot. FS		Limit		Under
		Vertical		Horizontal			Freq					
#	Freq	Peak	Ave	Peak	Ave	Fact.	MHz	dBuV/m		dBuV/m		Limit
1	2405	107.9	87.9	106.1	86.1	-5.6	2405.0	102.3	82.3	114	94	11.7
BE	2405	69.6	49.6	67.8	47.8	-5.6	2400.0	64.0	44.0	74	54	10.0
2	2405	62.2	42.2	58.4	38.4	2.1	4810.0	64.3	44.3	74	54	9.7
3	2405	47.6	27.6	48.3	28.3	6.8	7215.0	55.1	35.1	74	54	18.9
1	2440	108.4	88.4	103.4	83.4	-5.2	2440.0	103.2	83.2	114	94	10.8
2	2440	65.6	45.6	54.8	34.8	2.4	4880.0	68.0	48.0	74	54	6.0
3	2440	46.0	26.0	42.9	22.9	7.2	7320.0	53.2	33.2	74	54	20.8
1	2480	106.0	86.0	103.2	83.2	-5.3	2480.0	100.7	80.7	114	94	13.3
BE	2480	70.4	50.4	67.6	47.6	-5.3	2483.5	65.1	45.1	74	54	8.9
2	2480	57.3	37.3	53.5	33.5	2.4	4960.0	59.7	39.7	74	54	14.3
3	2480	44.5	24.5	38.3	18.3	7.5	7440.0	52.0	32.0	74	54	22.0
Column numbers (see below for explanations)												
1	2	3	4	5	6	7	8	9	10	11	12	13

BCU Configuration with external antenna

		Spectrum Analyzer Readings					EUT	Peak	Ave	Peak	Ave	Margin
hrm	Tx					Corr.	Emission	Tot. FS		Limit		Under
		Vertical		Horizontal			Freq					
#	Freq	Peak	Ave	Peak	Ave	Fact.	MHz	dBuV/m		dBuV/m		Limit
1	2405	107.0	87.0	97.6	77.6	-5.6	2405.0	101.4	81.4	114	94	12.6
BE	2405	70.7	50.7	61.3	41.3	-5.6	2400.0	65.1	45.1	74	54	8.9
2	2405	59.6	39.6	48.8	28.8	2.1	4810.0	61.7	41.7	74	54	12.3
3	2405	40.8	20.8	39.3	19.3	6.8	7215.0	47.6	27.6	74	54	26.4
1	2440	108.7	88.7	96.0	76.0	-5.2	2440.0	103.5	83.5	114	94	10.5
2	2440	60.8	40.8	47.8	27.8	2.4	4880.0	63.2	43.2	74	54	10.8
3	2440	42.6	22.6	44.4	24.4	7.2	7320.0	51.6	31.6	74	54	22.4
1	2480	107.4	87.4	97.3	77.3	-5.3	2480.0	102.1	82.1	114	94	11.9
BE	2480	71.3	51.3	61.2	41.2	-5.3	2483.5	66.0	46.0	74	54	8.0
2	2480	61.5	41.5	46.8	26.8	2.4	4960.0	63.9	43.9	74	54	10.1
3	2480	42.9	22.9	44.2	24.2	7.5	7440.0	51.7	31.7	74	54	22.3
Column numbers (see below for explanations)												
1	2	3	4	5	6	7	8	9	10	11	12	13

Column #1. hrm = Harmonic; BE = Band Edge emissions
Column #2. Frequency of Transmitter.
Column #3. Uncorrected readings from the spectrum analyzer with worst case reading from all axis rotations.
Column #4. Average Reading based on peak reading reduced by the Duty cycle correction
Column #5. Uncorrected readings from the spectrum analyzer with First Axis Rotation.
Column #6. Average Reading based on peak reading reduced by the Duty cycle correction
Column #7. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor
Column #8. Frequency of Tested Emission
Column #9. Highest peak field strength at listed frequency.
Column #10. Highest Average field strength at listed frequency.
Column #11. Peak Limit.
Column #12. Average Limit.
Column #13. The margin (last column) is the worst case margin under the peak or average limits for that row.

All emissions outside of the band from 2400 to 2483.5 were below the limits of 15.209.
No other Emissions were detected from 1 to 25 GHz were within 10 dB of the limits.

Overall Judgment: Passed by 2.7 dB

11.3 Unintentional Emissions (Receive Mode)

Manufacturer	Midtronics, Inc.	Specification	RSS-GEN Section 7.1.2 & FCC Part 15.209
Model	MDX-ZIGB-G3	Test Date	October 24 & 25, 2016
Test Distance	3 Meters		
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP		
Configuration	Receive mode		

Sensor with Chip antenna.

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cable/ Amp Factors	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
33.3	37.3	P	H	11.4	-28.3	0.0	20.4	40.0	19.6	
50.3	32.9	P	H	11.3	-28.3	0.0	15.9	40.0	24.1	
87.8	36.0	P	H	9.2	-27.9	0.0	17.3	40.0	22.7	
98.2	36.3	P	H	11.4	-27.9	0.0	19.8	43.5	23.7	
114.2	33.9	P	H	12.5	-27.8	0.0	18.6	43.5	24.9	
162.6	41.7	P	H	15.3	-27.6	0.0	29.4	43.5	14.1	
180.1	35.1	P	H	16.9	-27.5	0.0	24.5	43.5	19.0	
193.4	35.3	P	H	16.9	-27.5	0.0	24.7	43.5	18.8	
500.0	30.9	P	H	17.8	-26.9	0.0	21.8	46.0	24.2	
682.5	31.6	P	H	21.5	-26.2	0.0	26.9	46.0	19.1	
917.5	31.5	P	H	22.9	-24.8	0.0	29.6	46.0	16.4	
998.8	30.0	P	H	23.8	-24.4	0.0	29.4	54.0	24.6	
33.8	44.2	P	V	11.4	-28.3	0.0	27.3	40.0	12.7	
39.9	38.5	P	V	12.0	-28.3	0.0	22.2	40.0	17.8	
42.7	36.1	P	V	12.0	-28.3	0.0	19.8	40.0	20.2	
48.2	39.6	P	V	11.6	-28.3	0.0	22.9	40.0	17.1	
76.2	32.6	P	V	6.3	-28.0	0.0	10.9	40.0	29.1	
83.3	35.4	P	V	7.9	-28.0	0.0	15.3	40.0	24.7	
162.6	36.0	P	V	15.3	-27.6	0.0	23.7	43.5	19.8	
180.1	34.1	P	V	16.9	-27.5	0.0	23.5	43.5	20.0	
255.0	35.5	P	V	11.5	-27.3	0.0	19.7	46.0	26.3	
256.3	41.8	P	V	11.6	-27.3	0.0	26.1	46.0	19.9	
263.8	38.6	P	V	12.1	-27.3	0.0	23.4	46.0	22.6	
265.6	35.7	P	V	12.2	-27.3	0.0	20.6	46.0	25.4	
266.9	39.8	P	V	12.3	-27.3	0.0	24.8	46.0	21.2	
271.9	38.4	P	V	12.8	-27.3	0.0	23.9	46.0	22.1	
280.0	37.3	P	V	13.5	-27.3	0.0	23.5	46.0	22.5	
315.6	40.4	P	V	14.1	-27.2	0.0	27.3	46.0	18.7	
325.0	41.7	P	V	13.6	-27.3	0.0	28.0	46.0	18.0	
367.5	36.0	P	V	14.2	-27.1	0.0	23.1	46.0	22.9	
377.5	38.5	P	V	14.8	-27.1	0.0	26.2	46.0	19.8	
388.1	37.3	P	V	15.2	-27.2	0.0	25.3	46.0	20.7	
423.1	39.2	P	V	15.8	-26.9	0.0	28.1	46.0	17.9	
456.9	36.4	P	V	16.0	-27.0	0.0	25.4	46.0	20.6	
466.9	35.5	P	V	16.9	-26.9	0.0	25.5	46.0	20.5	
483.8	33.4	P	V	17.6	-26.7	0.0	24.3	46.0	21.7	
500.0	31.1	P	V	17.8	-26.9	0.0	22.0	46.0	24.0	
511.3	30.3	P	V	18.0	-26.9	0.0	21.4	46.0	24.6	
663.8	31.6	P	V	19.7	-26.1	0.0	25.2	46.0	20.8	
865.0	30.2	P	V	23.1	-25.3	0.0	28.0	46.0	18.0	
996.3	30.1	P	V	23.6	-24.4	0.0	29.3	54.0	24.7	

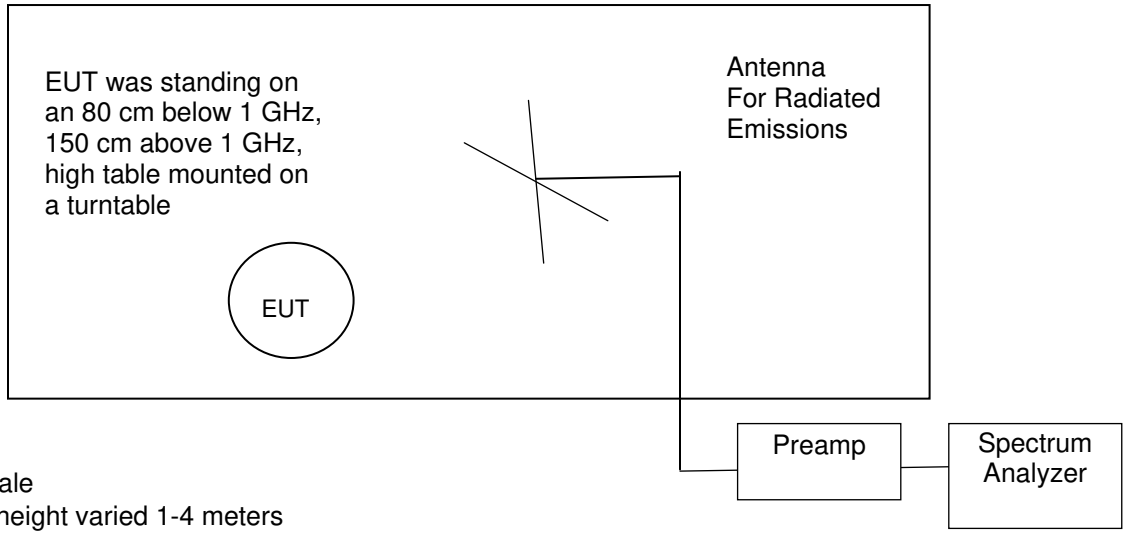
BCU with external antenna

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cable/ Amp Factors	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
35.2	30.6	P	H	11.5	-17.6	0.0	24.5	40.0	15.5	
46.0	34.3	P	H	11.9	-17.5	0.0	28.7	40.0	11.3	
66.3	33.0	P	H	7.5	-17.5	0.0	23.0	40.0	17.0	
149.9	39.0	P	H	13.2	-17.0	0.0	35.2	43.5	8.3	
150.0	37.5	Q	H	13.2	-17.0	0.0	33.7	43.5	9.8	
195.6	32.5	P	H	16.8	-17.1	0.0	32.2	43.5	11.3	
250.0	40.2	Q	H	17.0	-16.8	0.0	40.4	46.0	5.6	
283.8	33.7	P	H	13.6	-16.9	0.0	30.4	46.0	15.6	
323.8	35.6	P	H	13.6	-16.4	0.0	32.8	46.0	13.2	
331.9	36.4	P	H	13.7	-16.6	0.0	33.5	46.0	12.5	
340.0	37.1	P	H	13.8	-16.8	0.0	34.1	46.0	11.9	
343.8	37.0	P	H	13.9	-16.8	0.0	34.1	46.0	11.9	
348.1	36.3	P	H	14.0	-16.9	0.0	33.4	46.0	12.6	
351.9	36.1	P	H	14.1	-17.0	0.0	33.2	46.0	12.8	
356.3	35.6	P	H	14.2	-16.9	0.0	32.9	46.0	13.1	
363.8	35.6	P	H	14.3	-16.9	0.0	33.0	46.0	13.0	
400.0	34.0	P	H	14.8	-16.3	0.0	32.5	46.0	13.5	
454.4	32.7	P	H	15.9	-16.6	0.0	32.0	46.0	14.0	
500.0	31.0	P	H	17.8	-15.9	0.0	32.9	46.0	13.1	
501.3	30.6	P	H	17.8	-15.9	0.0	32.5	46.0	13.5	
742.5	32.0	P	H	20.7	-14.8	0.0	37.9	46.0	8.1	
801.3	35.2	P	H	20.4	-14.7	0.0	40.9	46.0	5.1	
998.8	29.9	P	H	23.8	-13.6	0.0	40.1	54.0	13.9	
34.4	35.0	P	V	11.5	-17.6	0.0	28.9	40.0	11.1	
67.9	43.0	P	V	7.2	-17.5	0.0	32.7	40.0	7.3	
76.2	41.4	P	V	6.3	-17.6	0.0	30.1	40.0	9.9	
136.7	39.4	Q	V	11.6	-16.9	0.0	34.1	43.5	9.4	
145.0	39.9	Q	V	12.3	-16.9	0.0	35.3	43.5	8.2	
203.3	35.9	P	V	16.0	-16.9	0.0	35.0	43.5	8.5	
232.9	37.9	P	V	14.8	-16.6	0.0	36.1	46.0	9.9	
250.0	40.3	Q	V	17.0	-16.8	0.0	40.5	46.0	5.5	
250.6	32.0	P	V	11.2	-16.8	0.0	26.4	46.0	19.6	
260.6	34.7	P	V	11.9	-17.0	0.0	29.6	46.0	16.4	
278.8	36.6	P	V	13.4	-17.0	0.0	33.0	46.0	13.0	
326.9	34.1	P	V	13.6	-16.5	0.0	31.2	46.0	14.8	
344.4	33.7	P	V	13.9	-16.8	0.0	30.8	46.0	15.2	
372.5	34.7	P	V	14.3	-16.8	0.0	32.2	46.0	13.8	
464.4	32.3	P	V	16.5	-16.3	0.0	32.5	46.0	13.5	
500.0	31.6	P	V	17.8	-15.9	0.0	33.5	46.0	12.5	
503.8	30.9	P	V	17.7	-16.0	0.0	32.6	46.0	13.4	
732.5	31.1	P	V	21.1	-15.0	0.0	37.2	46.0	8.8	
998.1	20.9	Q	V	23.7	-13.6	0.0	31.0	54.0	23.0	

Judgment: Pass by at least 5.5 dB
No Emissions were detected from 1 to 12.5 GHz within 10 dB of the limits.

Figure 2. Drawing of Radiated Emissions Setup

Chamber E, anechoic



Notes:
- Not to Scale
- Antenna height varied 1-4 meters
- Distance from antenna to tested system is 3 meters
- AC cords not shown. They are connected to AC outlet with low-pass filter on turntable

Frequency Range	Receive Antenna	Pre-Amplifier	Spectrum Analyzer
30 to 200 MHz	ANT-04	AMP-22	REC-11
200 to 1000 MHz	ANT-08	AMP-22	REC-11
1 to 10 GHz	ANT-13	AMP-05	REC-11
10 to 18 GHz	ANT-36	AMP-20	REC-11
18 to 25 GHz	ANT-48	AMP-29	REC-08; MXR-01

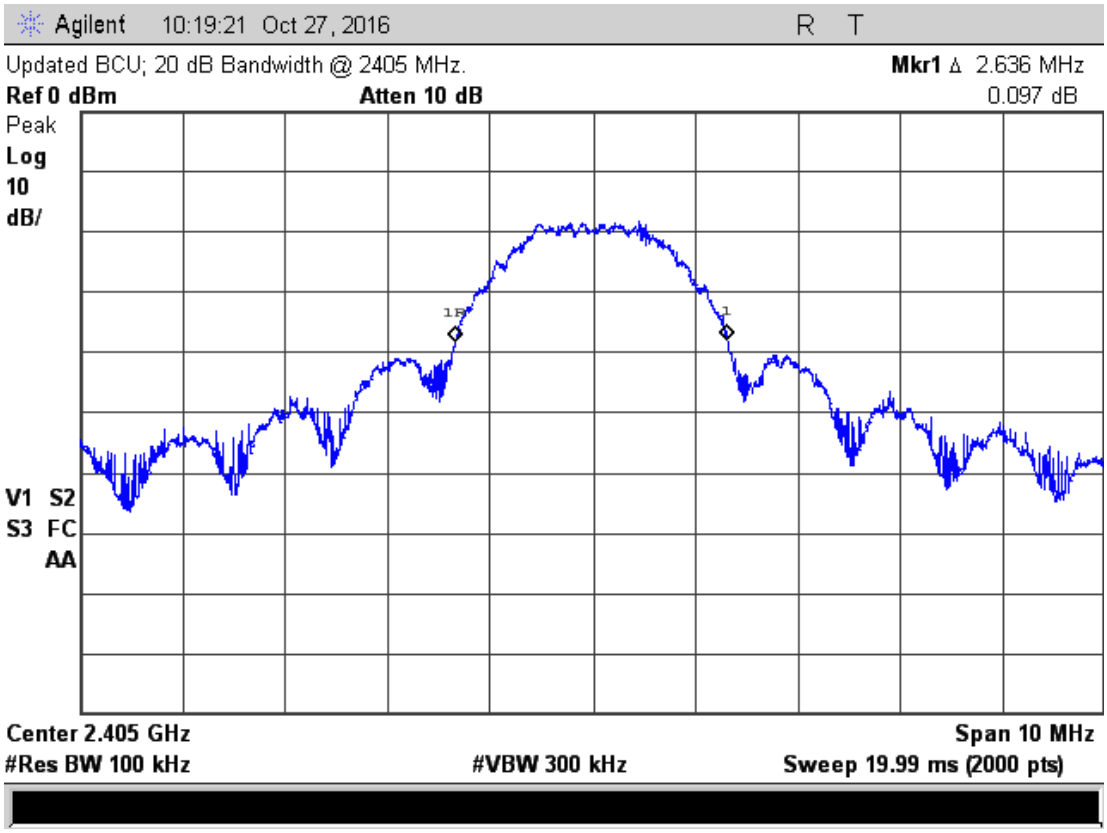
11.4 Occupied Bandwidth Data

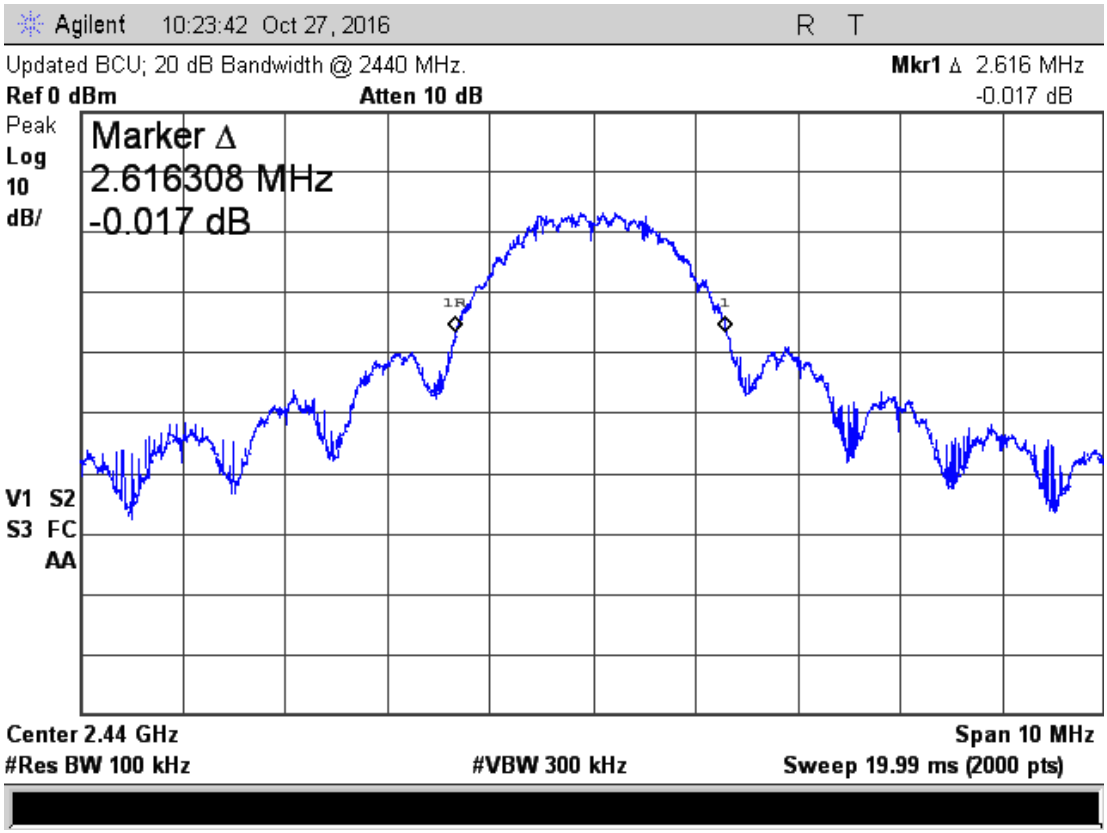
The occupied bandwidth of the RF output was measured using a spectrum analyzer. The bandwidth was measured using the peak detector function and a narrow resolution bandwidth. A broadband antenna was used to receive the modulated signal. The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The spectrum analyzer display was digitized and plotted. A limit was drawn on the plots based on the level of the modulated carrier. The 99% bandwidth was measured using the procedures of RSS-GEN section 6.6.

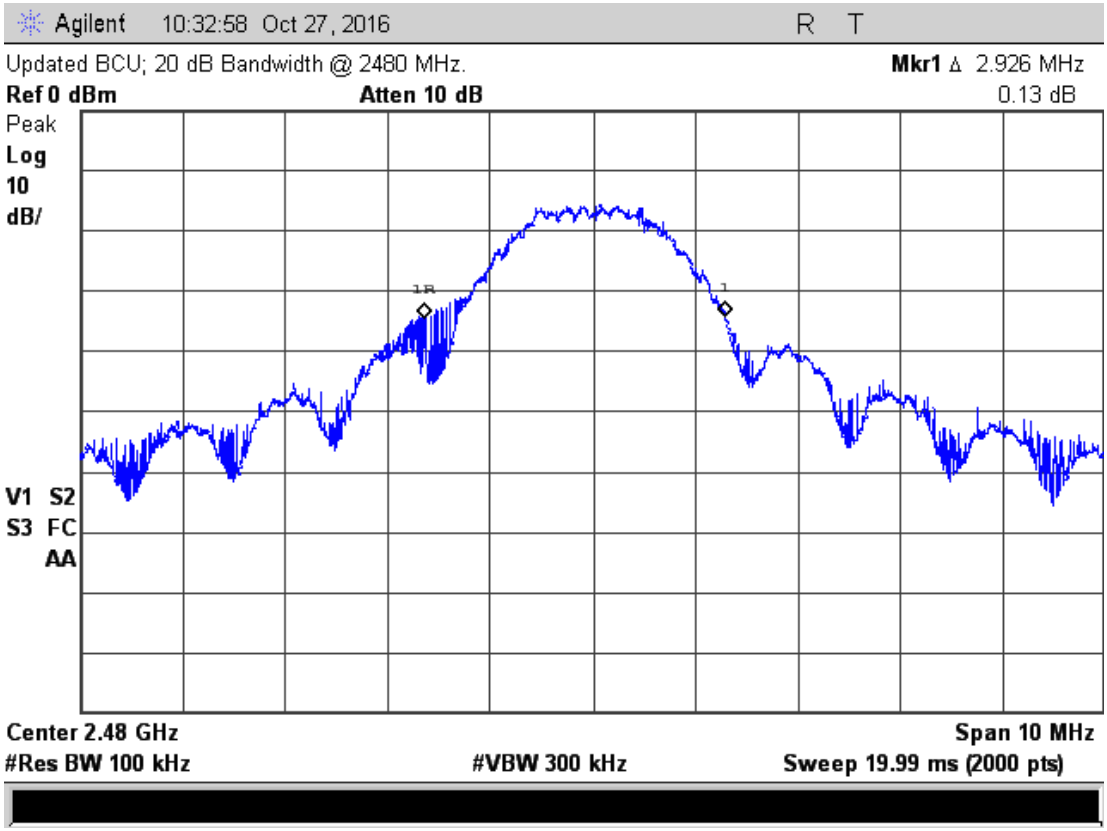
Test Date: 10/27/2016
Tested by: Richard Tichgelaar

EUT MHz	99% BW MHz
2405	2.636
2440	2.616
2480	2.926

Figure 3. Occupied Bandwidth Plots







11.4.1 Measurement Instrumentation Uncertainty

Measurement	Uncertainty
Conducted Emissions, LISN method, 150 kHz to 30 MHz	2.7 dB
Radiated Emissions, E-field, 3 meters, 30 to 200 MHz	3.3 dB
Radiated Emissions, E-field, 3 meters, 200 to 1000 MHz	4.9 dB
Radiated Emissions, E-field, 3 meters, 1 to 18 GHz	4.8 dB
Bandwidth using marker delta method at a span of 10 MHz	4 kHz
Temperature THM-02	0.6 Deg C

The uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2 in accordance with CISPR 16-4-2.