NORTHWEST EMC

APDM, Inc.

Opal

FCC 15.247:2016

2.4 GHz DTS Radio

Report # APDM0008.2

NVLAP Lab Code: 200630-0

CERTIFICATE OF TEST

Last Date of Test: February 10, 2016
APDM, Inc.
Model: Opal

Radio Equipment Testing

Standards

Specification	Method
FCC 15.247:2016	ANSI C63.10:2013

Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions	No	N/A	Not required for a battery powered EUT.
6.5, 6.6, 11.12.1, 11.13.2	Spurious Radiated Emissions	Yes	Pass	
6.10.4	Band Edge Compliance	Yes	Pass	
11.6	Duty Cycle	Yes	Pass	
11.8.2	Occupied Bandwidth	Yes	Pass	
11.9	Output Power	Yes	Pass	
11.10	Power Spectral Density	Yes	Pass	
11.12.1	Out of Band Emissions	Yes	Pass	

Deviations From Test Standards

None

Approved By:

Kyle Holgate, Operations Manager

Product compliance is the responsibility of the client; therefore, the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test. This report reflects only those tests from the referenced standards shown in the certificate of test. It does not include inspection or verification of labels, identification, marking or user information.

REVISION HISTORY

NORTHWEST EMC
REV 2014.10.14

Revision Number	Description	Date	Page Number
00	None		

ACCREDITATIONS AND AUTHORIZATIONS

REV 2015.2.19

United States

FCC - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

A2LA - Accredited by A2LA to ISO / IEC 17065 as a product certifier. This allows Northwest EMC to certify transmitters to FCC and IC specifications.

NVLAP - Each laboratory is accredited by NVLAP to ISO 17025

Canada

IC - Recognized by Industry Canada as a Certification Body (CB). Certification chambers and Open Area Test Sites are filed with IC.

European Union

European Commission – Validated by the European Commission as a Conformity Assessment Body (CAB) under the EMC directive and as a Notified Body under the R&TTE Directive.

Australia/New Zealand

ACMA - Recognized by ACMA as a CAB for the acceptance of test data.

Korea

MSIP / RRA - Recognized by KCC's RRA as a CAB for the acceptance of test data.

Japan

VCCI - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

Taiwan

BSMI – Recognized by BSMI as a CAB for the acceptance of test data.

NCC - Recognized by NCC as a CAB for the acceptance of test data.

Singapore

IDA – Recognized by IDA as a CAB for the acceptance of test data.

Israel

MOC – Recognized by MOC as a CAB for the acceptance of test data.

Hong Kong

OFCA – Recognized by OFCA as a CAB for the acceptance of test data.

Vietnam

MIC – Recognized by MIC as a CAB for the acceptance of test data.

SCOPE

For details on the Scopes of our Accreditations, please visit:
http://www.nwemc.com/accreditations/
http://gsi.nist.gov/global/docs/cabs/designations.html

MEASUREMENT UNCERTAINTY

TMU.2015.07.10

Measurement Uncertainty

When a measurement is made, the result will be different from the true or theoretically correct value. The difference is the result of tolerances in the measurement system that cannot be completely eliminated. To the extent that technology allows us, it has been our aim to minimize this error. Measurement uncertainty is a statistical expression of measurement error qualified by a probability distribution.

A measurement uncertainty estimation has been performed for each test per our internal quality document WP 342. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) for each test is on each data sheet. Our measurement data meets or exceeds the measurement uncertainty requirements of the applicable specification; therefore, the test data can be compared directly to the specification limit to determine compliance. The calculations for estimating measurement uncertainty are based upon ETSI TR 100 028 (or CISPR 16-4-2 as applicable), and are available upon request.

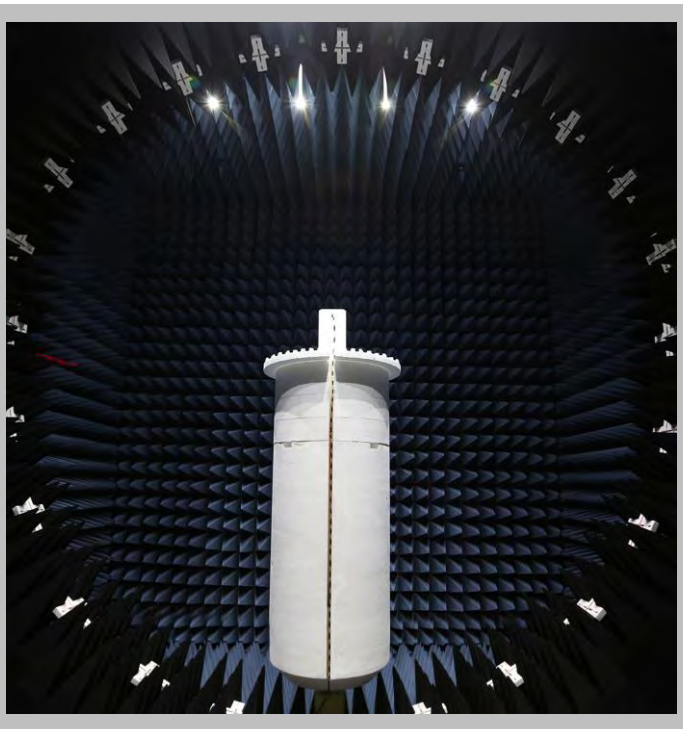
The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

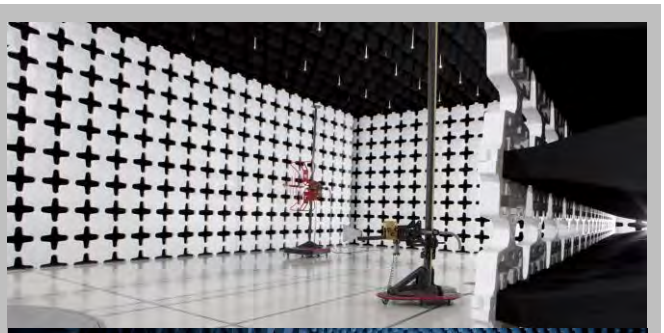
Test	+ MU	- MU
Frequency Accuracy (Hz)	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	0.3 dB	-0.3 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	5.2 dB	-5.2 dB
AC Powerline Conducted Emissions (dB)	2.4 dB	-2.4 dB

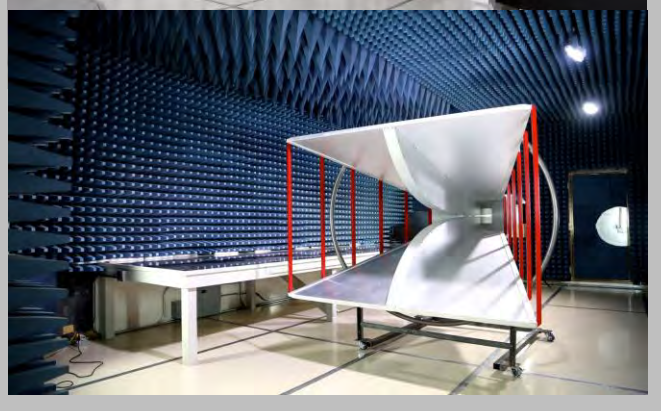
FACILITIES

NORTHWEST EMC
REV 2015.2.19

California	Minnesota	New York	Oregon	Texas	Washington
Labs OC01-13 41 Tesla Irvine, CA 92618 (949) 861-8918	Labs MN01-08, MN10 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	Labs NY01-04 4939 Jordan Rd. Elbridge, NY 13060 (315) 554-8214	Labs EV01-12 22975 NW Evergreen Pkwy Hillsboro, OR 97124 (503) 844-4066	Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Labs NC01-05 19201 120th Ave NE Bothell, WA 98011 (425)984-6600
NVLAP					
NVLAP Lab Code: 200676-0	NVLAP Lab Code: 200881-0	NVLAP Lab Code: 200761-0	NVLAP Lab Code: 200630-0	NVLAP Lab Code:201049-0	NVLAP Lab Code: 200629-0
Industry Canada					
2834B-1, 2834B-3	2834E-1	N/A	2834D-1, 2834D-*2*	2834G-1	2834F-1
BSMI					
SL2-IN-E-1154R	SL2-IN-E-1152R	N/A	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI					
A-0029	A-0109	N/A	A-0108	A-0201	A-0110
Recognized Phase I CAB for ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA					
US0158	US0175	N/A	US0017	US0191	US0157







PRODUCT DESCRIPTION

NORTHWEST EMC
2014-12-10

Client and Equipment Under Test (EUT) Information

Company Name:	APDM, Inc.
Address:	2828 SW Corbett Ave. Suite 135
City, State, Zip:	Portland, 97201
Test Requested By:	Jennifer Guyot
Model:	Opal
First Date of Test:	February 02, 2016
Last Date of Test:	February 10, 2016
Receipt Date of Samples:	February 02, 2016
Equipment Design Stage:	Production
Equipment Condition:	No Damage

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
Patient worn monitor that contains a proprietary 2.4 GHz GFSK radio that communicates with an access point (AP). The AP is wired via USB to a Dock that provides an interface via USB to a PC. The Dock is powered by an AC-DC wall bug adapter.

Testing Objective:
To demonstrate compliance of the 2.4 GHz DTS radio to FCC 15.247 requirements.

CONFIGURATIONS

NORTHWEST EMC 2014-12-10

Configuration APDM0008- 2

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Wearable wirelessly synchronized human movement monitor	APDM Inc.	Opal v2.6	SMTC1630731

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
USB	Yes	1.0m	Yes	Opal	Unterminated

MODIFICATIONS

NORTHWEST EMC
2014-12-10

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2/3/2016	Spurious Radiated Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Northwest EMC following the test.
2	2/3/2016	Out of Band Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Northwest EMC following the test.
3	2/10/2016	Duty Cycle	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Northwest EMC following the test.
4	2/10/2016	Occupied Bandwidth	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Northwest EMC following the test.
5	2/10/2016	Output Power	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Northwest EMC following the test.
6	2/10/2016	Power Spectral Density	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Northwest EMC following the test.
7	2/10/2016	Band Edge Compliance	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

SPURIOUS RADIATED EMISSIONS

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

Continuous Tx, GFSK Low Ch.2 2402 MHz
Continuous Tx, GFSK Mid Ch.40 2440 MHz
Continuous Tx, GFSK High Ch.81 2481 MHz

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

APDM0008 - 2

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	26500 MHz

SAMPLE CALCULATIONS

Radiated Emissions: Field Strength = Measured Level + Antenna Factor + Cable Factor - Amplifier Gain + Distance Adjustment Factor + External Attenuation

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Cable	ESM Cable Corp.	KMKM-72	EVY	11/4/2015	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-18002650-25-10P	AVU	11/4/2015	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-09	AIV	NCR	0 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AVD	4/16/2015	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-08	AHV	NCR	0 mo
Cable	None	Standard Gain Horns Cable	EVF	4/20/2015	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVC	4/20/2015	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-07	AHU	NCR	0 mo
Cable	N/A	Double Ridge Horn Cables	EVB	4/16/2015	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	PAG	4/16/2015	12 mo
Antenna - Double Ridge	EMCO	3115	AHC	6/13/2014	24 mo
Cable	N/A	Bilog Cables	EVA	2/10/2015	12 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AOL	2/10/2015	12 mo
Antenna - Biconilog	EMCO	3141	AXE	8/29/2014	24 mo
Attenuator	Coaxicom	3910-20	AXZ	5/24/2015	12 mo
Filter - High Pass	Micro-Tronics	HPM50111	HFO	3/31/2015	12 mo
Filter - Low Pass	Micro-Tronics	LPM50004	LFD	5/24/2015	12 mo
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	3/10/2015	12 mo

TEST DESCRIPTION

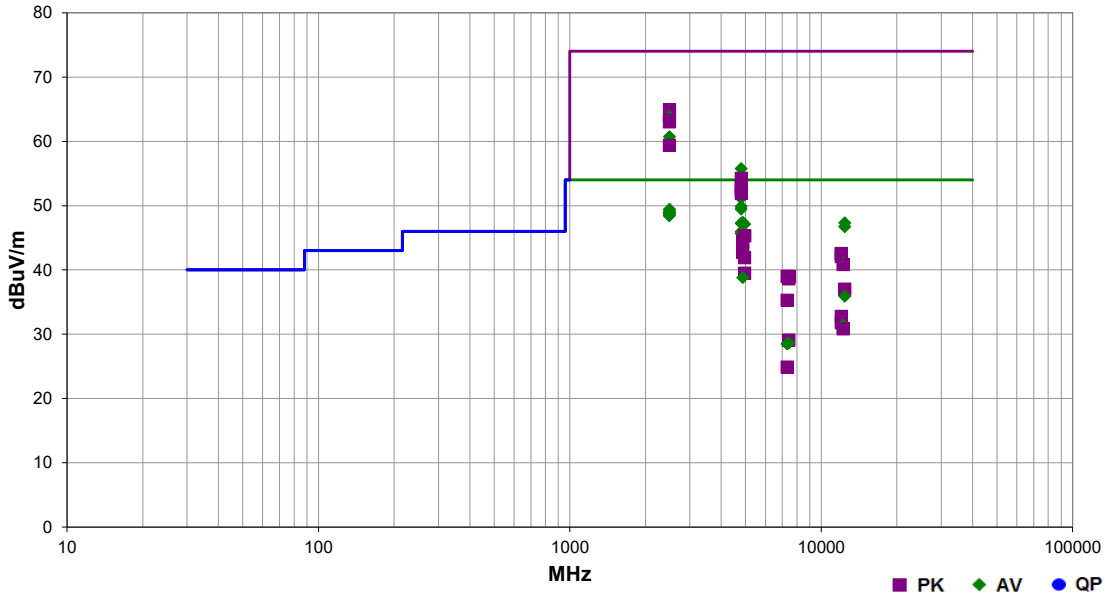
The highest gain of each type of antenna to be used with the EUT was tested. The EUT was configured for low, mid, and high band transmit frequencies. For each configuration, the spectrum was scanned throughout the specified range. In addition, measurements were made in the restricted bands to verify compliance. While scanning, emissions from the EUT were maximized by rotating the EUT on a turntable, adjusting the position of the EUT and the EUT antenna in three orthogonal axis, and adjusting measurement antenna height and polarization. A preamp and high pass filter were used for this test in order to provide sufficient measurement sensitivity.

SPURIOUS RADIATED EMISSIONS

Work Order:	APDM0008	**Date:**	02/03/16		
Project:	None	**Temperature:**	19.8 °C		
Job Site:	EV01	**Humidity:**	37.8% RH		
Serial Number:	SMTC1630731	**Barometric Pres.:**	1021 mbar	**Tested by:**	Brandon Hobbs
EUT:	Opal				
Configuration:	2				
Customer:	APDM, Inc.				
Attendees:	Andrew Greenberg, Gavin Gallino, Dave Camarillo, Tim Brandon, and Chris Andrews				
EUT Power:	Battery				
Operating Mode:	Continuous Tx				
Deviations:	None				
Comments:	See comments for EUT position, channel, and frequency				

Test Specifications	**Test Method**
FCC 15.247:2016	ANSI C63.10:2013

Run #	17	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
4804.010	43.6	7.5	1.0	330.0	3.0	0.0	Horz	AV	0.0	51.1	54.0	-2.9	Channel 2, 2402 MHz, EUT Horizontal
4804.010	42.3	7.5	1.0	185.0	3.0	0.0	Vert	AV	0.0	49.8	54.0	-4.2	Channel 2, 2402 MHz, EUT On Side
4803.960	41.9	7.5	1.0	43.0	3.0	0.0	Horz	AV	0.0	49.4	54.0	-4.6	Channel 2, 2402 MHz, EUT Vertical
2490.690	31.9	-2.5	1.0	106.0	3.0	20.0	Vert	AV	0.0	49.4	54.0	-4.6	Channel 81, 2481 MHz, EUT Vertical
2490.697	31.8	-2.5	1.0	287.0	3.0	20.0	Horz	AV	0.0	49.3	54.0	-4.7	Channel 81, 2481 MHz, EUT Horizontal
2490.840	31.5	-2.5	1.0	174.0	3.0	20.0	Horz	AV	0.0	49.0	54.0	-5.0	Channel 40, 2440 MHz, EUT Horizontal
2490.720	31.4	-2.5	1.0	261.0	3.0	20.0	Vert	AV	0.0	48.9	54.0	-5.1	Channel 2, 2402 MHz, EUT Vertical
2490.727	31.3	-2.5	1.0	207.0	3.0	20.0	Horz	AV	0.0	48.8	54.0	-5.2	Channel 2, 2402 MHz, EUT Horizontal
2490.707	31.3	-2.5	1.0	121.0	3.0	20.0	Vert	AV	0.0	48.8	54.0	-5.2	Channel 40, 2440 MHz, EUT Vertical
2490.527	31.1	-2.5	1.0	296.0	3.0	20.0	Vert	AV	0.0	48.6	54.0	-5.4	Channel 81, 2481 MHz, EUT On Side
2490.467	31.0	-2.5	1.0	171.0	3.0	20.0	Horz	AV	0.0	48.5	54.0	-5.5	Channel 81, 2481 MHz, EUT On Side
2490.217	30.9	-2.5	3.6	129.0	3.0	20.0	Vert	AV	0.0	48.4	54.0	-5.6	Channel 81, 2481 MHz, EUT Horizontal
4804.050	39.7	7.5	1.0	317.0	3.0	0.0	Horz	AV	0.0	47.2	54.0	-6.8	Channel 2, 2402 MHz, EUT On Side
4803.895	38.4	7.5	1.0	263.0	3.0	0.0	Vert	AV	0.0	45.9	54.0	-8.1	Channel 2, 2402 MHz, EUT Vertical
4803.980	38.1	7.5	4.0	243.0	3.0	0.0	Vert	AV	0.0	45.6	54.0	-8.4	Channel 2, 2402 MHz, EUT Horizontal
2490.713	47.4	-2.5	1.0	106.0	3.0	20.0	Vert	PK	0.0	64.9	74.0	-9.1	Channel 81, 2481 MHz, EUT Vertical
2490.620	46.6	-2.5	1.0	287.0	3.0	20.0	Horz	PK	0.0	64.1	74.0	-9.9	Channel 81, 2481 MHz, EUT Horizontal
2490.443	46.5	-2.5	1.0	207.0	3.0	20.0	Horz	PK	0.0	64.0	74.0	-10.0	Channel 2, 2402 MHz, EUT Horizontal
2490.727	46.3	-2.5	1.0	174.0	3.0	20.0	Horz	PK	0.0	63.8	74.0	-10.2	Channel 40, 2440 MHz, EUT Horizontal
2490.660	45.8	-2.5	1.0	261.0	3.0	20.0	Vert	PK	0.0	63.3	74.0	-10.7	Channel 2, 2402 MHz, EUT Vertical
2490.333	45.5	-2.5	1.0	121.0	3.0	20.0	Vert	PK	0.0	63.0	74.0	-11.0	Channel 40, 2440 MHz, EUT Vertical
4879.908	42.8	0.0	1.0	320.0	3.0	0.0	Horz	AV	0.0	42.8	54.0	-11.2	Channel 40, 2440 MHz, EUT Horizontal
4961.950	41.9	0.0	1.0	49.0	3.0	0.0	Horz	AV	0.0	41.9	54.0	-12.1	Channel 81, 2481 MHz, EUT Horizontal
2490.903	43.2	-2.5	1.0	296.0	3.0	20.0	Vert	PK	0.0	60.7	74.0	-13.3	Channel 81, 2481 MHz, EUT On Side
2490.610	42.5	-2.5	1.0	171.0	3.0	20.0	Horz	PK	0.0	60.0	74.0	-14.0	Channel 81, 2481 MHz, EUT On Side
4962.142	39.5	0.0	1.0	187.0	3.0	0.0	Vert	AV	0.0	39.5	54.0	-14.5	Channel 81, 2481 MHz, EUT on side
2489.747	41.9	-2.5	1.0	89.0	3.0	20.0	Vert	PK	0.0	59.4	74.0	-14.6	Channel 81, 2481 MHz, EUT Horizontal
4879.950	38.8	0.0	1.0	184.0	3.0	0.0	Vert	AV	0.0	38.8	54.0	-15.2	Channel 40, 2440 MHz, EUT on side

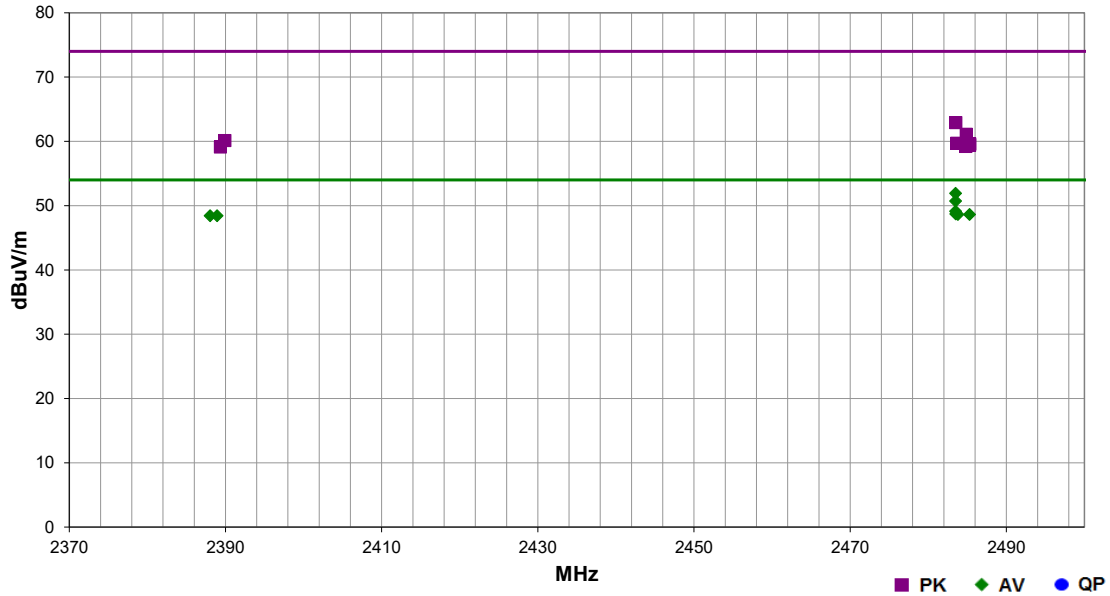
Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
12403.710	28.2	8.8	1.0	160.0	3.0	0.0	Vert	AV	0.0	37.0	54.0	-17.0	Channel 81, 2481 MHz, EUT On Side
12404.400	27.1	8.8	2.0	163.0	3.0	0.0	Horz	AV	0.0	35.9	54.0	-18.1	Channel 81, 2481 MHz, EUT Horizontal
4804.535	48.2	7.5	1.0	330.0	3.0	0.0	Horz	PK	0.0	55.7	74.0	-18.3	Channel 2, 2402 MHz, EUT Horizontal
4804.400	47.0	7.5	1.0	185.0	3.0	0.0	Vert	PK	0.0	54.5	74.0	-19.5	Channel 2, 2402 MHz, EUT On Side
4803.525	46.7	7.5	1.0	43.0	3.0	0.0	Horz	PK	0.0	54.2	74.0	-19.8	Channel 2, 2402 MHz, EUT Vertical
4803.755	45.3	7.5	1.0	317.0	3.0	0.0	Horz	PK	0.0	52.8	74.0	-21.2	Channel 2, 2402 MHz, EUT On Side
12001.410	32.7	0.1	1.0	220.0	3.0	0.0	Vert	AV	0.0	32.8	54.0	-21.2	Channel 2, 2402 MHz, EUT on side
4803.580	44.9	7.5	4.0	243.0	3.0	0.0	Vert	PK	0.0	52.4	74.0	-21.6	Channel 2, 2402 MHz, EUT Horizontal
4803.650	44.4	7.5	1.0	263.0	3.0	0.0	Vert	PK	0.0	51.9	74.0	-22.1	Channel 2, 2402 MHz, EUT Vertical
12001.180	31.7	0.1	2.8	221.0	3.0	0.0	Horz	AV	0.0	31.8	54.0	-22.2	Channel 2, 2402 MHz, EUT Horizontal
12201.360	30.3	1.1	1.0	40.0	3.0	0.0	Vert	AV	0.0	31.4	54.0	-22.6	Channel 40, 2440 MHz, EUT on side
12201.530	29.7	1.1	1.0	321.0	3.0	0.0	Horz	AV	0.0	30.8	54.0	-23.2	Channel 40, 2440 MHz, EUT Horizontal
7442.517	29.1	0.0	1.0	149.0	3.0	0.0	Vert	AV	0.0	29.1	54.0	-24.9	Channel 81, 2481 MHz, EUT on side
7443.142	28.6	0.0	1.1	285.0	3.0	0.0	Horz	AV	0.0	28.6	54.0	-25.4	Channel 81, 2481 Mhz, EUT Horizontal
7319.383	28.5	0.0	1.0	295.0	3.0	0.0	Horz	AV	0.0	28.5	54.0	-25.5	Channel 40, 2440 MHz, EUT Horizontal
4879.633	47.4	0.0	1.0	320.0	3.0	0.0	Horz	PK	0.0	47.4	74.0	-26.6	Channel 40, 2440 MHz, EUT Horizontal
12405.920	38.5	8.8	1.0	160.0	3.0	0.0	Vert	PK	0.0	47.3	74.0	-26.7	Channel 81, 2481 MHz, EUT On Side
4961.408	47.1	0.0	1.0	49.0	3.0	0.0	Horz	PK	0.0	47.1	74.0	-26.9	Channel 81, 2481 MHz, EUT Horizontal
12404.440	37.9	8.8	2.0	163.0	3.0	0.0	Horz	PK	0.0	46.7	74.0	-27.3	Channel 81, 2481 MHz, EUT Horizontal
4962.650	45.3	0.0	1.0	187.0	3.0	0.0	Vert	PK	0.0	45.3	74.0	-28.7	Channel 81, 2481 MHz, EUT on side
7319.483	24.9	0.0	1.0	246.0	3.0	0.0	Vert	AV	0.0	24.9	54.0	-29.1	Channel 40, 2440 MHz, EUT on side
4879.733	44.5	0.0	1.0	184.0	3.0	0.0	Vert	PK	0.0	44.5	74.0	-29.5	Channel 40, 2440 MHz, EUT on side
12000.230	42.5	0.1	1.0	220.0	3.0	0.0	Vert	PK	0.0	42.6	74.0	-31.4	Channel 2, 2402 MHz, EUT on side
12001.090	42.0	0.1	2.8	221.0	3.0	0.0	Horz	PK	0.0	42.1	74.0	-31.9	Channel 2, 2402 MHz, EUT Horizontal
12201.450	40.0	1.1	1.0	321.0	3.0	0.0	Horz	PK	0.0	41.1	74.0	-32.9	Channel 40, 2440 MHz, EUT Horizontal
12201.280	39.7	1.1	1.0	40.0	3.0	0.0	Vert	PK	0.0	40.8	74.0	-33.2	Channel 40, 2440 MHz, EUT on side
7443.600	39.0	0.0	1.0	149.0	3.0	0.0	Vert	PK	0.0	39.0	74.0	-35.0	Channel 81, 2481 MHz, EUT on side
7319.733	39.0	0.0	1.0	295.0	3.0	0.0	Horz	PK	0.0	39.0	74.0	-35.0	Channel 40, 2440 MHz, EUT Horizontal
7443.092	38.6	0.0	1.1	285.0	3.0	0.0	Horz	PK	0.0	38.6	74.0	-35.4	Channel 81, 2481 MHz, EUT Horizontal
7321.525	35.3	0.0	1.0	246.0	3.0	0.0	Vert	PK	0.0	35.3	74.0	-38.7	Channel 40, 2440 MHz, EUT on side

SPURIOUS RADIATED EMISSIONS

Work Order:	APDM0008	**Date:**	02/03/16		
Project:	None	**Temperature:**	19.8 °C		
Job Site:	EV01	**Humidity:**	37.8% RH		
Serial Number:	SMTC1630731	**Barometric Pres.:**	1021 mbar	**Tested by:**	Brandon Hobbs
EUT:	Opal				
Configuration:	2				
Customer:	APDM, Inc.				
Attendees:	Andrew Greenberg, Gavin Gallino, Dave Camarillo, Tim Brandon, and Chris Andrews				
EUT Power:	Battery				
Operating Mode:	Continuous Tx				
Deviations:	None				
Comments:	See comments for EUT position, channel, and frequency				

Test Specifications	**Test Method**
FCC 15.247:2016	ANSI C63.10:2013

Run #	19	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2483.500	34.4	-2.5	1.0	103.0	3.0	20.0	Vert	AV	0.0	51.9	54.0	-2.1	Channel 81, 2481 MHz, EUT Vertical
2483.500	33.2	-2.5	1.0	216.0	3.0	20.0	Horz	AV	0.0	50.7	54.0	-3.3	Channel 81, 2481 MHz, EUT Horizontal
2483.503	31.6	-2.5	1.0	327.0	3.0	20.0	Vert	AV	0.0	49.1	54.0	-4.9	Channel 81, 2481 MHz, EUT On Side
2483.530	31.2	-2.5	1.0	346.0	3.0	20.0	Horz	AV	0.0	48.7	54.0	-5.3	Channel 81, 2481 MHz, EUT Vertical
2485.290	31.1	-2.5	1.0	14.0	3.0	20.0	Horz	AV	0.0	48.6	54.0	-5.4	Channel 81, 2481 MHz, EUT On Side
2483.803	31.1	-2.5	1.0	262.0	3.0	20.0	Vert	AV	0.0	48.6	54.0	-5.4	Channel 81, 2481 MHz, EUT Horizontal
2388.927	31.1	-2.7	1.0	34.0	3.0	20.0	Horz	AV	0.0	48.4	54.0	-5.6	Channel 2, 2402 MHz, EUT Horizontal
2388.047	31.1	-2.7	1.0	100.0	3.0	20.0	Vert	AV	0.0	48.4	54.0	-5.6	Channel 2, 2402 MHz, EUT Vertical
2483.523	45.4	-2.5	1.0	103.0	3.0	20.0	Vert	PK	0.0	62.9	74.0	-11.1	Channel 81, 2481 MHz, EUT Vertical
2484.873	43.6	-2.5	1.0	216.0	3.0	20.0	Horz	PK	0.0	61.1	74.0	-12.9	Channel 81, 2481 MHz, EUT Horizontal
2389.933	42.8	-2.7	1.0	34.0	3.0	20.0	Horz	PK	0.0	60.1	74.0	-13.9	Channel 2, 2402 MHz, EUT Horizontal
2483.643	42.2	-2.5	1.0	327.0	3.0	20.0	Vert	PK	0.0	59.7	74.0	-14.3	Channel 81, 2481 MHz, EUT On Side
2485.333	42.1	-2.5	1.0	14.0	3.0	20.0	Horz	PK	0.0	59.6	74.0	-14.4	Channel 81, 2481 MHz, EUT On Side
2485.297	41.9	-2.5	1.0	346.0	3.0	20.0	Horz	PK	0.0	59.4	74.0	-14.6	Channel 81, 2481 MHz, EUT Vertical
2484.817	41.7	-2.5	1.0	262.0	3.0	20.0	Vert	PK	0.0	59.2	74.0	-14.8	Channel 81, 2481 MHz, EUT Horizontal
2389.353	41.8	-2.7	1.0	100.0	3.0	20.0	Vert	PK	0.0	59.1	74.0	-14.9	Channel 2, 2402 MHz, EUT Vertical

BAND EDGE COMPLIANCE

XMit 2015.01.14

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval (mo)
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	3/10/2015	12
Cable	N/A	Double Ridge Horn Cables	EVB	4/16/2015	12
Antenna - Double Ridge	EMCO	3115	AHC	6/13/2014	24

TEST DESCRIPTION

The EUT was set to low and high transmit frequencies. The spurious RF conducted emissions at the edges of the authorized bands were measured with the EUT set to low and high transmit frequencies in each available band. The channels closest to the band edges were selected. The measurement was made in a radiated configuration in a semi-anechoic chamber with the fundamental of the carrier full maximized for its highest radiated power. The EUT was transmitting at the data rate(s) listed in the datasheet.

The spectrum was scanned below the lower band edge and above the higher band edge.

BAND EDGE COMPLIANCE

NORTHWEST EMC

XMit 2015.01.14

EUT:	Opal			Work Order:	ADPM0008
Serial Number:	SMTC1630731			Date:	02/10/16
Customer:	APDM, Inc.			Temperature:	22.2°C
Attendees:	Andrew Greenberg, Gavin Gallino			Humidity:	41%
Project:	None			Barometric Pres.:	1022.7
Tested by:	Brandon Hobbs	Power:	Battery	Job Site:	EV01

TEST SPECIFICATIONS	Test Method
FCC 15.247:2016	ANSI C63.10:2013

COMMENTS

The EUT was maximized to its single highest oreintation for radiated measurements.

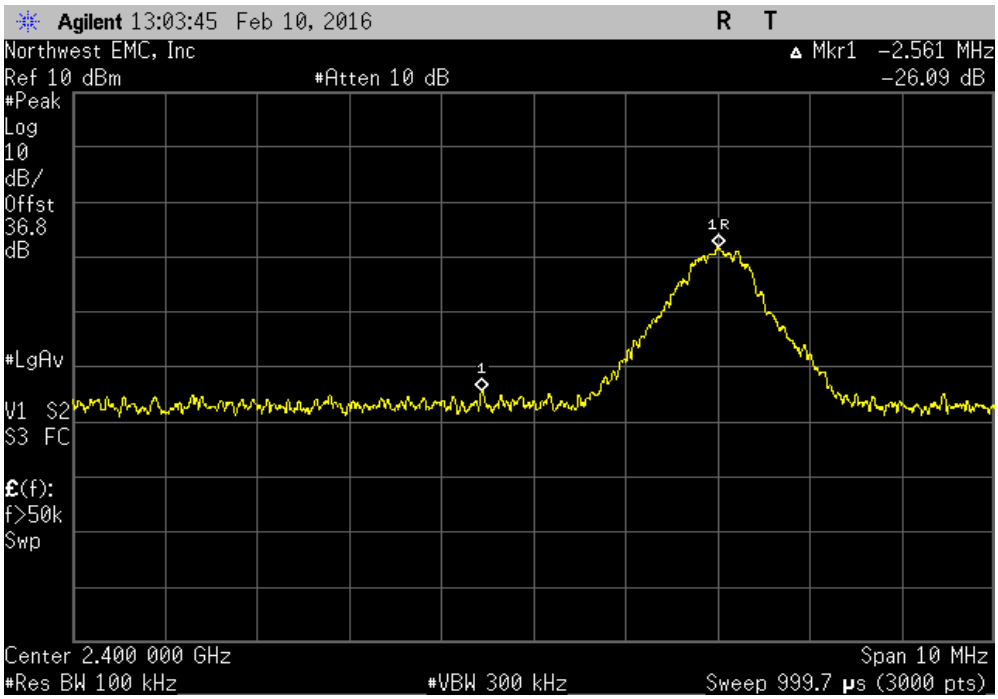
DEVIATIONS FROM TEST STANDARD

None

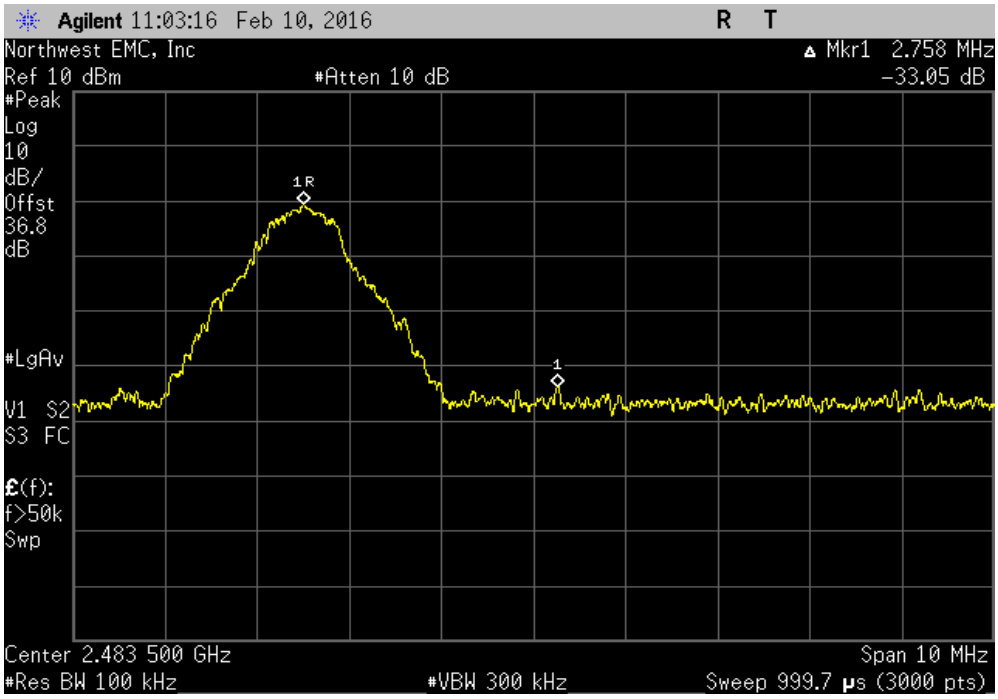
Configuration #	2	Signature

	Value (dBc)	Limit ≤ (dBc)	Result
2400 MHz - 2483.5 MHz Band			
Zigbee GFSK			
Low Channel 2, 2402 MHz	-26.09	-20	Pass
High Channel 81, 2481 MHz	-33.05	-20	Pass

2400 MHz - 2483.5 MHz Band, Zigbee GFSK, Low Channel 2, 2402 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-26.09	-20	Pass



2400 MHz - 2483.5 MHz Band, Zigbee GFSK, High Channel 81, 2481 MHz						
				Value (dBc)	Limit ≤ (dBc)	Result
				-33.05	-20	Pass



DUTY CYCLE

XMit 2015.01.14

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval (mo)
Cable	N/A	Double Ridge Horn Cables	EVB	4/16/2015	12
Antenna - Double Ridge	EMCO	3115	AHC	6/13/2014	24
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	3/10/2015	12

TEST DESCRIPTION

The Duty Cycle (x) of the single channel operation of the radio as controlled by the provided test software was measured for each of the EUT operating modes.

There is no compliance requirement to be met by this test, so therefore no Pass / Fail criteria.

The measurements were made using a zero span on the spectrum analyzer to see the pulses in the time domain. The transmit power was set to its default maximum. The duty cycle was measured radiated in the RF chamber.

DUTY CYCLE

NORTHWEST EMC

XMit 2015.01.14

EUT:	Opal			**Work Order:**	APDM0008
Serial Number:	SMTC1630731			**Date:**	02/10/16
Customer:	APDM, Inc.			**Temperature:**	22.3°C
Attendees:	Andrew Greenberg, Gavin Gallino, Dave Camarillo, and Tim Brandon			**Humidity:**	41%
Project:	None			**Barometric Pres.:**	1022.7
Tested by:	Brandon Hobbs	**Power:**	Battery	**Job Site:**	EV01

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2016	ANSI C63.10:2013

COMMENTS

Continuous Broadcast modes were provided by the client.

DEVIATIONS FROM TEST STANDARD

None

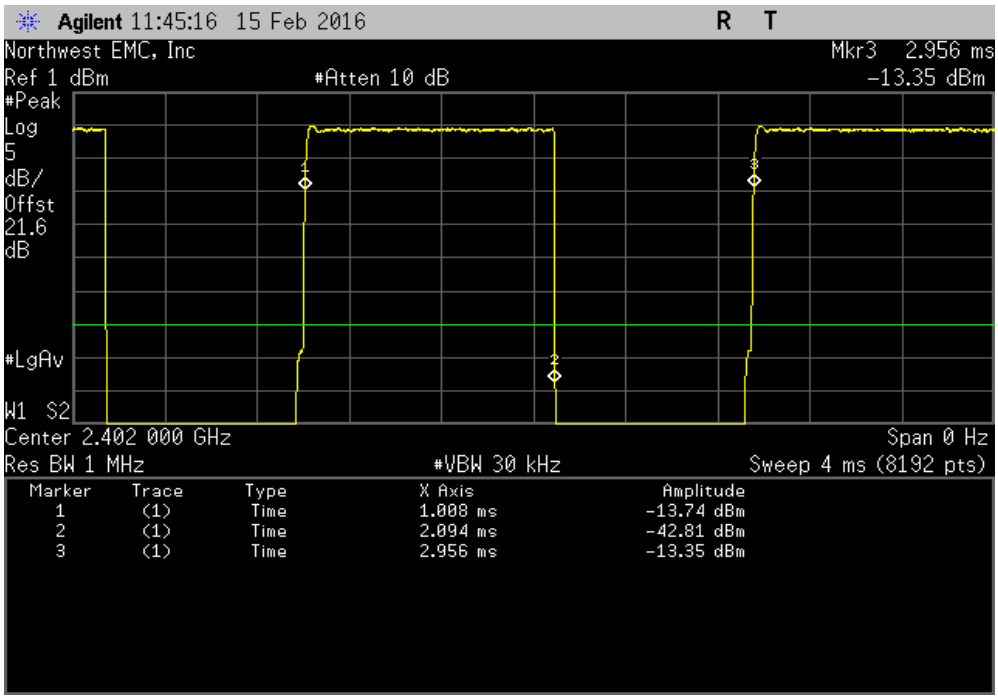
Configuration #	2	*Signature*

	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
Normal Temperature Conditions						
Zigbee GFSK						
Low Channel, 2, 2402 MHz	1.086 ms	1.948 ms	1	55.8	N/A	N/A
Low Channel, 2, 2402 MHz	N/A	N/A	5	N/A	N/A	N/A
Mid Channel, 40, 2440 MHz	1.087 ms	1.95 ms	1	55.7	N/A	N/A
Mid Channel, 40, 2440 MHz	N/A	N/A	5	N/A	N/A	N/A
High Channel, 81, 2481 MHz	1.087 ms	1.948 ms	1	55.8	N/A	N/A
High Channel, 81, 2481 MHz	N/A	N/A	5	N/A	N/A	N/A

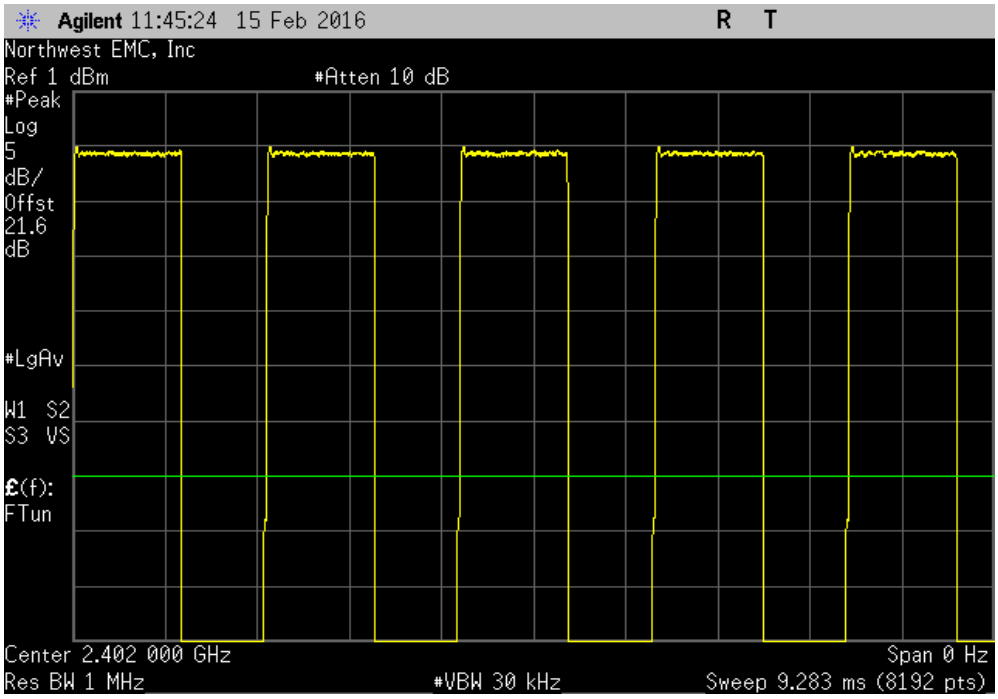
DUTY CYCLE

XMit 2015.01.14

Normal Temperature Conditions, Zigbee GFSK, Low Channel, 2, 2402 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	1.086 ms	1.948 ms	1	55.8	N/A	N/A



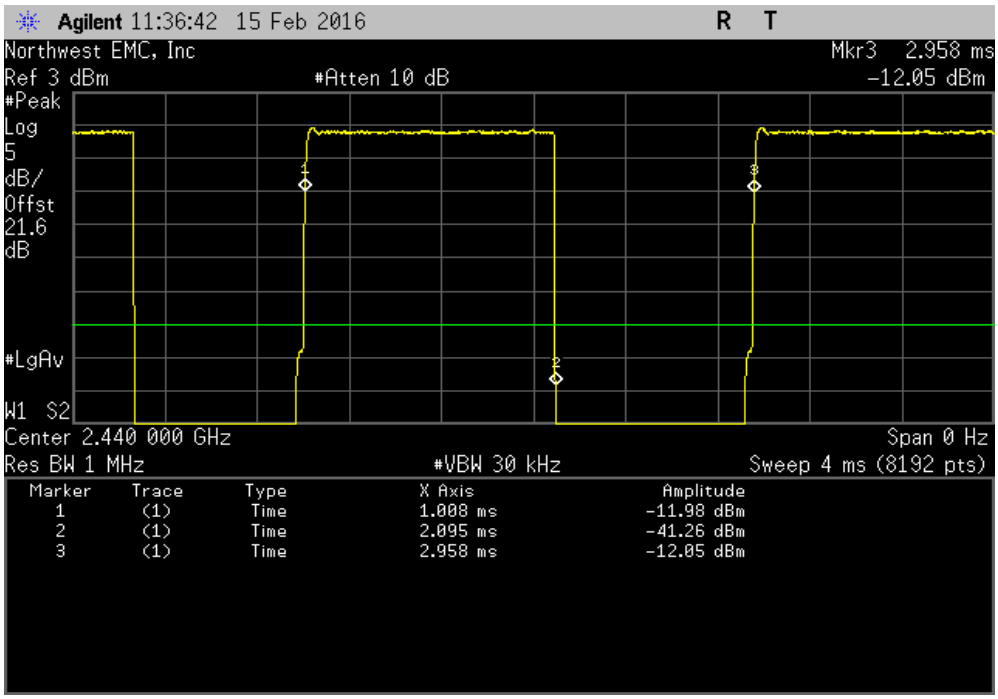
Normal Temperature Conditions, Zigbee GFSK, Low Channel, 2, 2402 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A



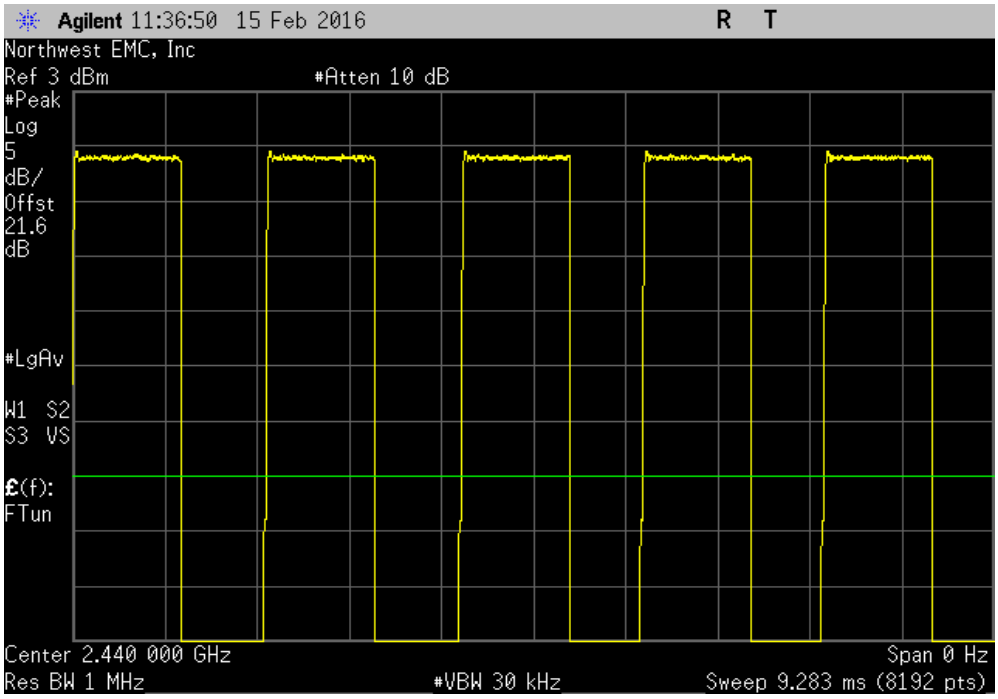
DUTY CYCLE

XMit 2015.01.14

Normal Temperature Conditions, Zigbee GFSK, Mid Channel, 40, 2440 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	1.087 ms	1.95 ms	1	55.7	N/A	N/A



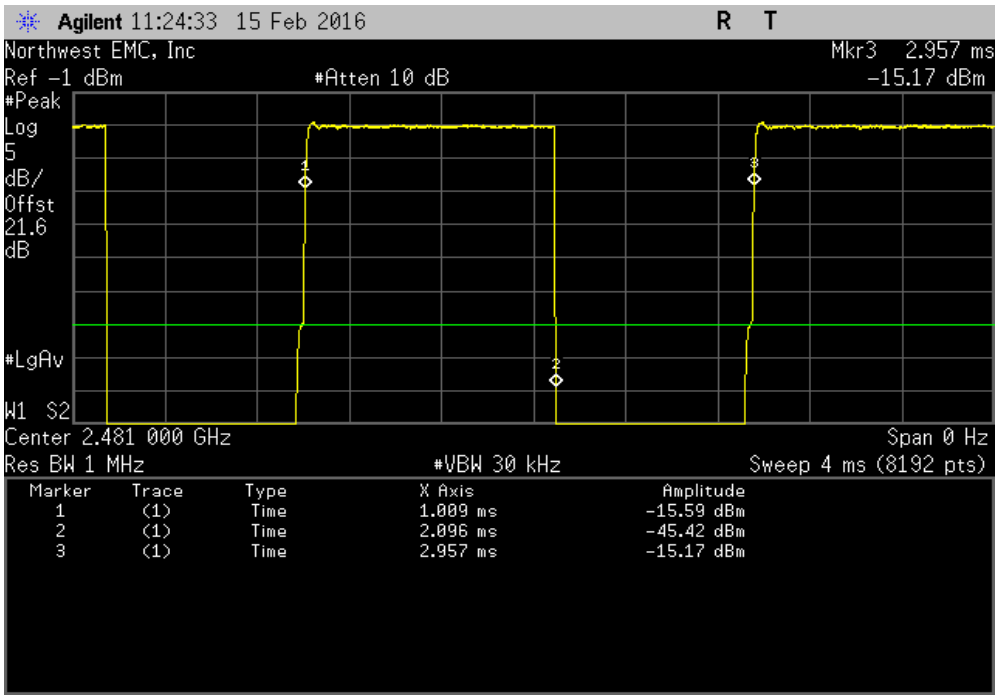
Normal Temperature Conditions, Zigbee GFSK, Mid Channel, 40, 2440 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A



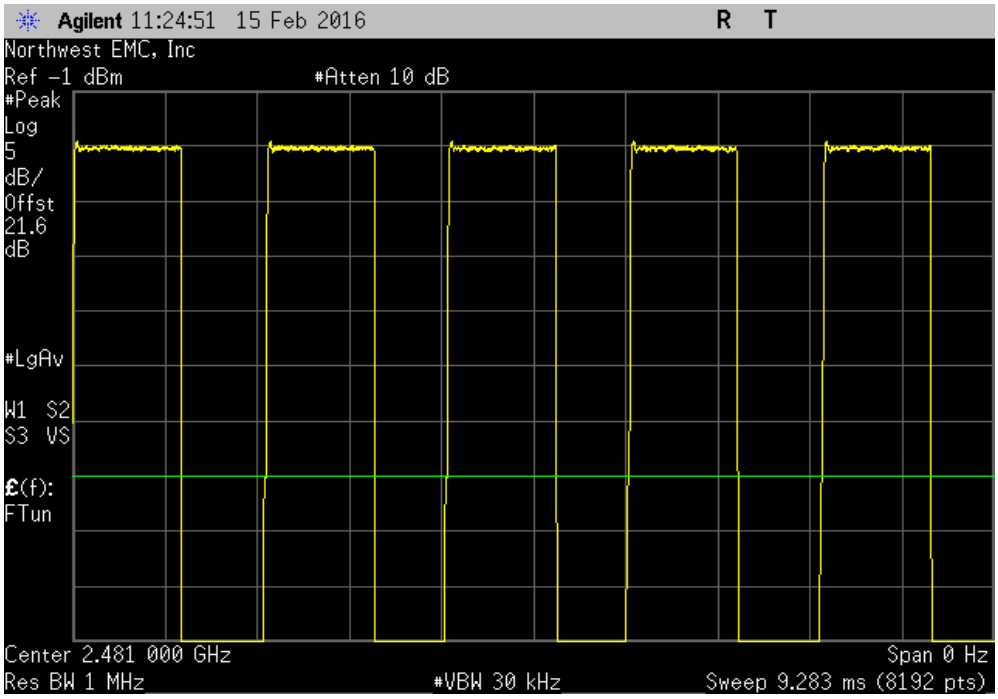
DUTY CYCLE

XMit 2015.01.14

Normal Temperature Conditions, Zigbee GFSK, High Channel, 81, 2481 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	1.087 ms	1.948 ms	1	55.8	N/A	N/A



Normal Temperature Conditions, Zigbee GFSK, High Channel, 81, 2481 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A



OCCUPIED BANDWIDTH

XMit 2015.01.14

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval (mo)
Cable	N/A	Double Ridge Horn Cables	EVB	4/16/2015	12
Antenna - Double Ridge	EMCO	3115	AHC	6/13/2014	24
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	3/10/2015	12

TEST DESCRIPTION

The 6dB occupied bandwidth was measured using 100 kHz resolution bandwidth and 300 kHz video bandwidth. The 99% emission bandwidth (EBW) was also measured at the the same time.

The EUT was set to low, medium and high transmit frequencies. The measurement was made in a radiated configuration in a semi-anechoic chamber with the fundamental of the carrier full maximized for its highest radiated power. The EUT was transmitting at the data rate(s) listed in the datasheet.

OCCUPIED BANDWIDTH

NORTHWEST EMC

XMit 2015.01.14

EUT:	Opal			**Work Order:**	APDM0008
Serial Number:	SMTC1630731			**Date:**	02/10/16
Customer:	APDM, Inc.			**Temperature:**	22.3°C
Attendees:	Andrew Greenberg, Gavin Gallino, Dave Camarillo, and Tim Brandon			**Humidity:**	41%
Project:	None			**Barometric Pres.:**	1022.7
Tested by:	Brandon Hobbs	**Power:**	Battery	**Job Site:**	EV01

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2016	ANSI C63.10:2013

COMMENTS

The EUT was maximized to its single highest oreintation for radiated measurements.

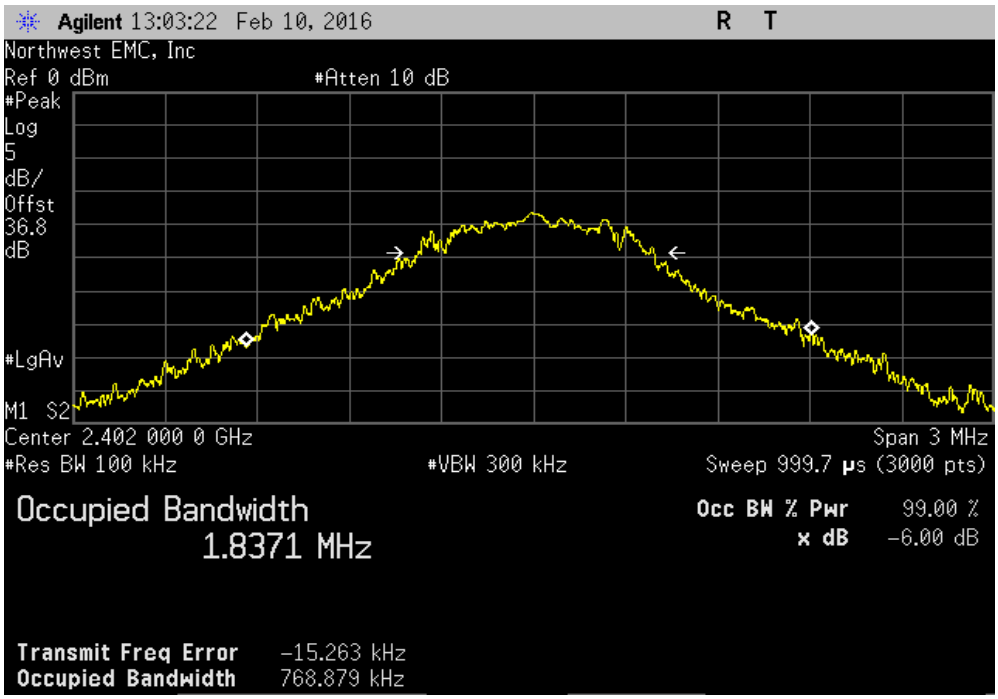
DEVIATIONS FROM TEST STANDARD

None

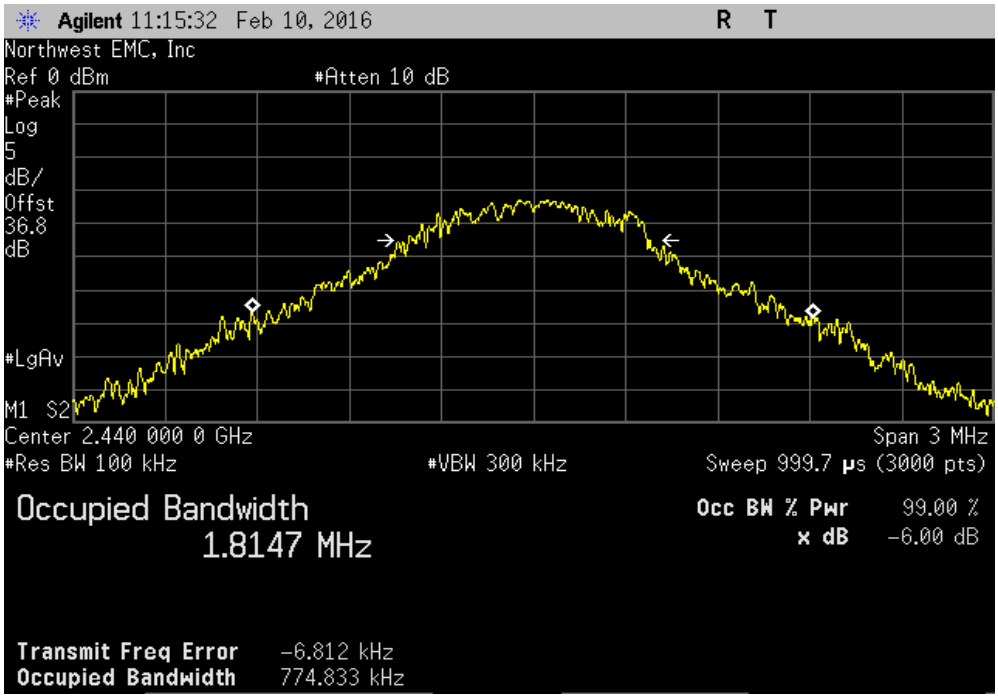
Configuration #	2	*Signature*

	Value	**Limit (>)**	**Result**
2400 MHz - 2483.5 MHz Band			
Zigbee GFSK			
Low Channel 2, 2402 MHz	768.879 kHz	500 kHz	Pass
Mid Channel 40, 2440 MHz	774.833 kHz	500 kHz	Pass
High Channel 81, 2481 MHz	834.03 kHz	500 kHz	Pass

2400 MHz - 2483.5 MHz Band, Zigbee GFSK, Low Channel 2, 2402 MHz						
				Value	Limit (>)	Result
				768.879 kHz	500 kHz	Pass



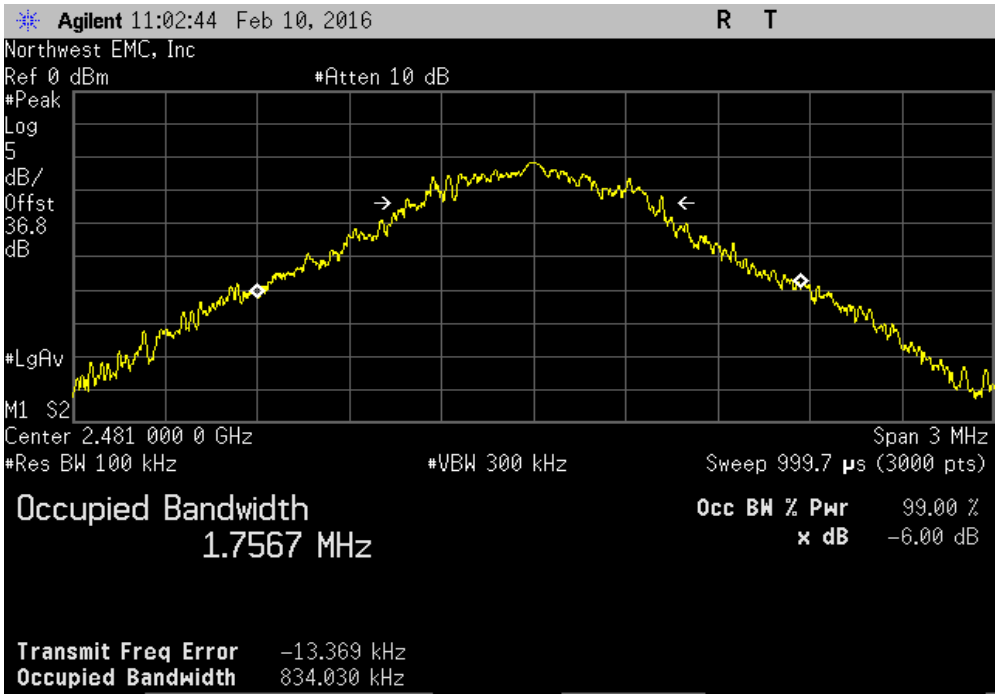
2400 MHz - 2483.5 MHz Band, Zigbee GFSK, Mid Channel 40, 2440 MHz						
				Value	Limit (>)	Result
				774.833 kHz	500 kHz	Pass



OCCUPIED BANDWIDTH

XMit 2015.01.14

2400 MHz - 2483.5 MHz Band, Zigbee GFSK, High Channel 81, 2481 MHz						
				Value	Limit (>)	Result
				834.03 kHz	500 kHz	Pass



OUTPUT POWER - RADIATED

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

Continuous Tx, GFSK Ch.2 2402 MHz
Continuous Tx, GFSK Ch.40 2440 MHz
Continuous Tx, GFSK Ch.81 2481 MHz

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

APDM0008 - 2

FREQUENCY RANGE INVESTIGATED

Start Frequency	2380 MHz	Stop Frequency	2500 MHz

SAMPLE CALCULATIONS

Radiated Emissions: Field Strength = Measured Level + Antenna Factor + Cable Factor - Amplifier Gain + Distance Adjustment Factor + External Attenuation

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Cable	N/A	Double Ridge Horn Cables	EVB	4/16/2015	12 mo
Antenna - Double Ridge	EMCO	3115	AHC	6/13/2014	24 mo
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	3/10/2015	12 mo

TEST DESCRIPTION

The peak output power was measured with the EUT set to low, medium and high transmit frequencies. A field strength measurement was made of the fundamental with the carrier fully maximized for its highest radiated power.

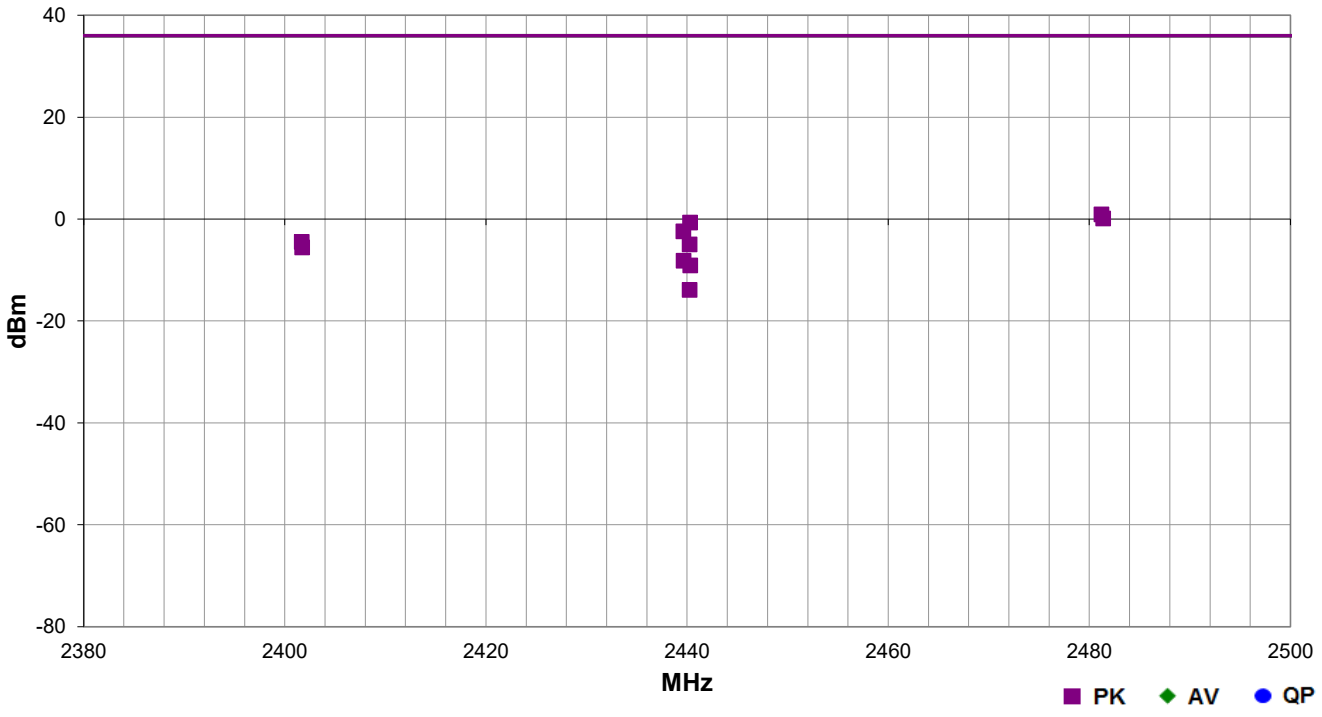
The final data was converted from field strength to a radiated power value using equations found in ANSI C63.10:2013 Annex G.2

OUTPUT POWER - RADIATED

Work Order:	APDM0008	**Date:**	02/10/16		
Project:	None	**Temperature:**	20.9 °C		
Job Site:	EV01	**Humidity:**	41.5% RH		
Serial Number:	SMTC1630731	**Barometric Pres.:**	1025 mbar	**Tested by:**	Brandon Hobbs
EUT:	Opal				
Configuration:	2				
Customer:	APDM, Inc.				
Attendees:	Andrew Greenberg, Gavin Gallino, Dave Camarillo, and Tim Brandon				
EUT Power:	Battery				
Operating Mode:	Continuous Tx, GFSK Please reference the data comments for further operational information				
Deviations:	None				
Comments:	Please reference the data comments for EUT orientation, frequency and channel.				

Test Specifications	**Test Method**
FCC 15.247:2016	ANSI C63.10:2013

Run #	75	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



	Freq (MHz)	Antenna Height (meters)	Azimuth (degrees)	Polarity/ Transducer Type	Detector	EIRP (Watts)	EIRP (dBm)	Spec. Limit (dBm)	Compared to Spec. (dB)	Comments
	2481.195	1.2	98.0	Horz	PK	1.23E-03	0.9	36.0	-35.1	High Ch.81 2481MHz, EUT Horz
	2481.365	1.0	94.0	Vert	PK	1.03E-03	0.1	36.0	-35.9	High Ch.81 2481MHz, EUT Vert
	2440.300	1.0	278.0	Vert	PK	8.54E-04	-0.7	36.0	-36.7	Mid Ch.40 2440Mhz, EUT Vert
	2439.625	1.0	187.0	Horz	PK	5.77E-04	-2.4	36.0	-38.4	Mid Ch.40 2440Mhz, EUT Horz
	2401.695	1.0	95.0	Horz	PK	3.57E-04	-4.5	36.0	-40.5	Low Ch.2 2402MHz, EUT Horz
	2440.260	1.0	140.0	Horz	PK	3.17E-04	-5.0	36.0	-41.0	Mid Ch.40 2440Mhz, EUT On Side
	2401.733	1.0	95.0	Vert	PK	2.77E-04	-5.6	36.0	-41.6	Low Ch.2 2402MHz, EUT Horz
	2439.645	4.0	81.0	Vert	PK	1.52E-04	-8.2	36.0	-44.2	Mid Ch.40 2440Mhz, EUT On Side
	2440.310	3.9	308.0	Vert	PK	1.23E-04	-9.1	36.0	-45.1	Mid Ch.40 2440Mhz, EUT Horz
	2440.250	1.0	58.0	Horz	PK	4.09E-05	-13.9	36.0	-49.9	Mid Ch.40 2440Mhz, EUT Vert

POWER SPECTRAL DENSITY

XMit 2015.01.14

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval (mo)
Cable	N/A	Double Ridge Horn Cables	EVB	4/16/2015	12
Antenna - Double Ridge	EMCO	3115	AHC	6/13/2014	24
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	3/10/2015	12

TEST DESCRIPTION

The maximum power spectral density measurements were measured with the EUT set to the required transmit frequencies in each band. The EUT was transmitting at the lowest, middle, and maximum data rate for each modulation type available.

The final data was converted from a field strength to a radiated power value. The equations in section 9.5 of ANSI C63.10:2013, were used to derive this conversion formula:

dBm/m (field strength) + 11.77 = dBm EIRP

Per the procedure outlined in ANSI C63.10:2013 Section 11.10.2, the peak power spectral density was measured.

POWER SPECTRAL DENSITY

NORTHWEST EMC

XMit 2015.01.14

EUT:	Opal			**Work Order:**	APDM0008
Serial Number:	SMTC1630731			**Date:**	02/10/16
Customer:	APDM, Inc.			**Temperature:**	22.3°C
Attendees:	Andrew Greenberg, Gavin Gallino, Dave Camarillo, and Tim Brandon			**Humidity:**	41%
Project:	None			**Barometric Pres.:**	1022.7
Tested by:	Brandon Hobbs	**Power:**	Battery	**Job Site:**	EV01

TEST SPECIFICATIONS	**Test Method**
FCC 15.247:2016	ANSI C63.10:2013

COMMENTS

The EUT was maximized to its single highest oreintation for radiated measurements. The Friis equation was used to covert field strength measurements to EIRP.

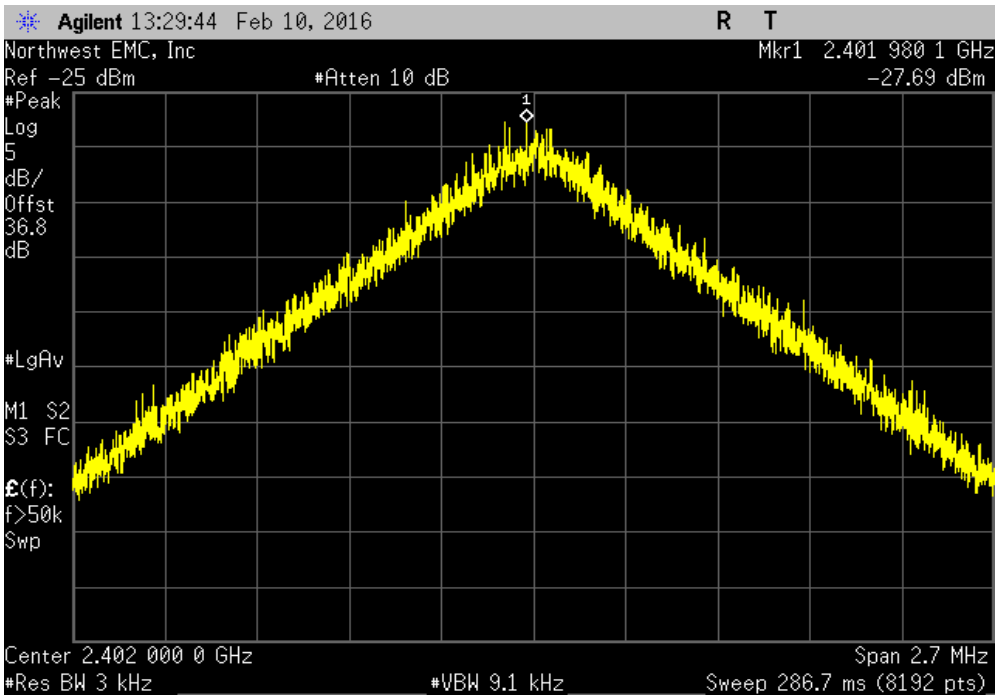
DEVIATIONS FROM TEST STANDARD

None

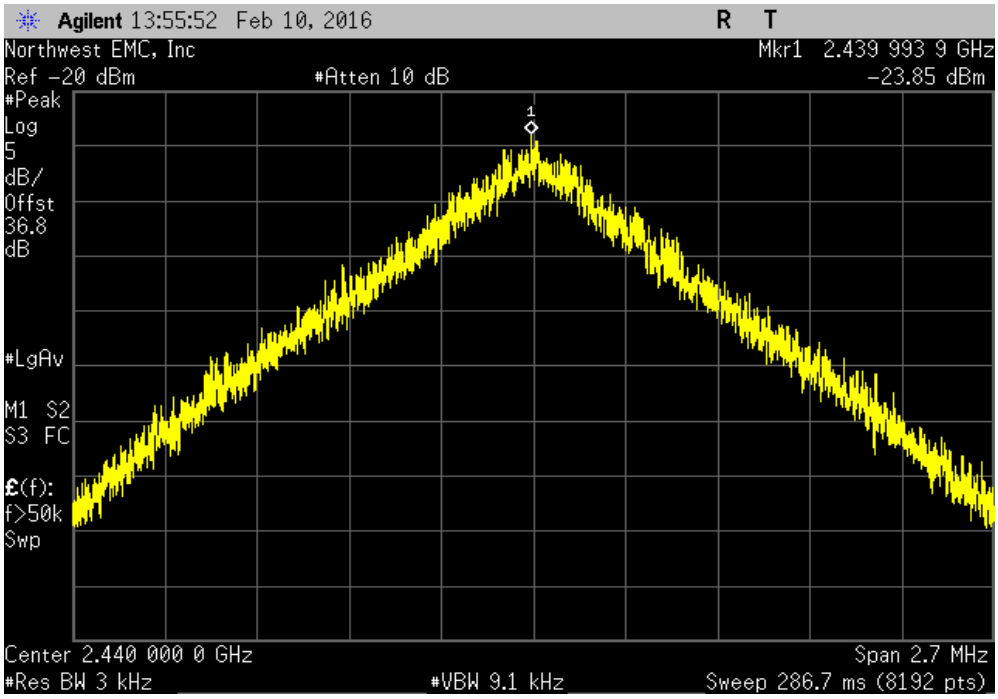
Configuration #	2	*Signature*

	Value dBm/3kHz	dBm/m to dBm	EIRP dBm/3kHz	Limit < dBm/3kHz	Results
2400 MHz - 2483.5 MHz Band					
Zigbee GFSK					
Low Channel 2, 2402 MHz	-27.69	11.77	-15.92	8	Pass
Mid Channel 40, 2440 MHz	-23.851	11.77	-12.081	8	Pass
High Channel 81, 2481 MHz	-22.753	11.77	-10.983	8	Pass

2400 MHz - 2483.5 MHz Band, Zigbee GFSK, Low Channel 2, 2402 MHz						
		Value dBm/3kHz	dBm/m to dBm	EIRP dBm/3kHz	Limit < dBm/3kHz	Results
		-27.69	11.77	-15.92	8	Pass



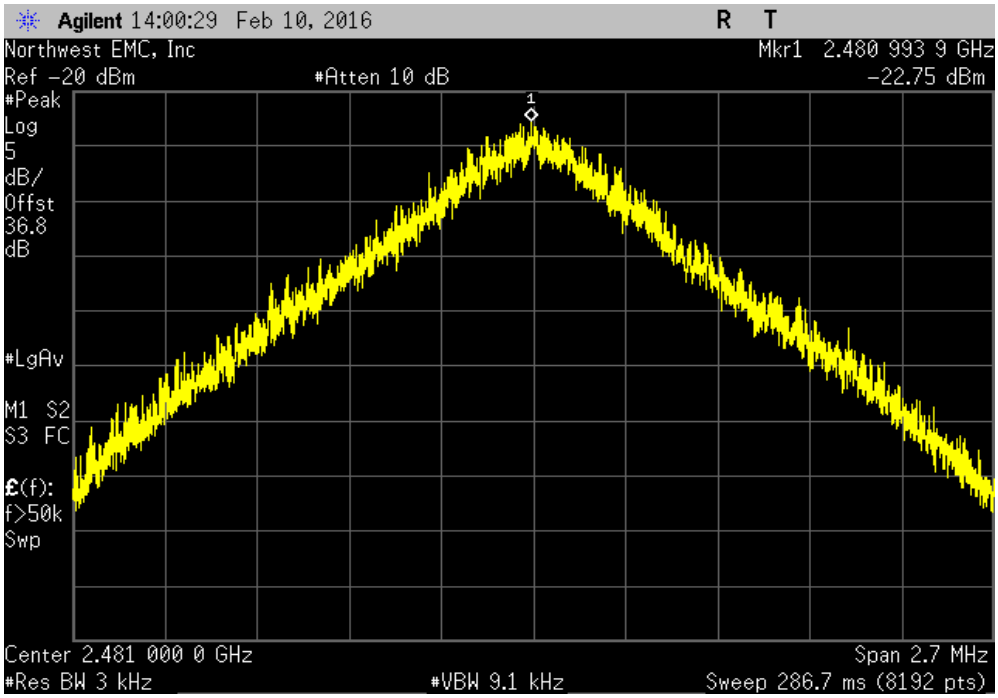
2400 MHz - 2483.5 MHz Band, Zigbee GFSK, Mid Channel 40, 2440 MHz						
		Value dBm/3kHz	dBm/m to dBm	EIRP dBm/3kHz	Limit < dBm/3kHz	Results
		-23.851	11.77	-12.081	8	Pass



POWER SPECTRAL DENSITY

XMit 2015.01.14

2400 MHz - 2483.5 MHz Band, Zigbee GFSK, High Channel 81, 2481 MHz						
		Value dBm/3kHz	dBm/m to dBm	EIRP dBm/3kHz	Limit < dBm/3kHz	Results
		-22.753	11.77	-10.983	8	Pass



OUT OF BAND EMISSIONS

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

Continuous Tx, GFSK Low Ch.2 2402 MHz
Continuous Tx, GFSK Mid Ch.40 2440 MHz
Continuous Tx, GFSK High Ch.81 2481 MHz

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

APDM0008 - 2

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	26500 MHz

SAMPLE CALCULATIONS

Radiated Emissions: Field Strength = Measured Level + Antenna Factor + Cable Factor - Amplifier Gain + Distance Adjustment Factor + External Attenuation

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Cable	ESM Cable Corp.	KMKM-72	EVY	11/4/2015	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-18002650-25-10P	AVU	11/4/2015	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-09	AIV	NCR	0 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AVD	4/16/2015	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-08	AHV	NCR	0 mo
Cable	None	Standard Gain Horns Cable	EVF	4/20/2015	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVC	4/20/2015	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-07	AHU	NCR	0 mo
Cable	N/A	Double Ridge Horn Cables	EVB	4/16/2015	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	PAG	4/16/2015	12 mo
Antenna - Double Ridge	EMCO	3115	AHC	6/13/2014	24 mo
Cable	N/A	Bilog Cables	EVA	2/10/2015	12 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AOL	2/10/2015	12 mo
Antenna - Biconilog	EMCO	3141	AXE	8/29/2014	24 mo
Attenuator	Coaxicom	3910-20	AXZ	5/24/2015	12 mo
Filter - High Pass	Micro-Tronics	HPM50111	HFO	3/31/2015	12 mo
Filter - Low Pass	Micro-Tronics	LPM50004	LFD	5/24/2015	12 mo
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	3/10/2015	12 mo

TEST DESCRIPTION

The highest gain of each type of antenna to be used with the EUT was tested. The EUT was configured for low, mid, and high band transmit frequencies. For each configuration, the spectrum was scanned throughout the specified range. In addition, measurements were made across the band to verify compliance. While scanning, emissions from the EUT were maximized by rotating the EUT on a turntable, adjusting the position of the EUT and the EUT antenna in three orthogonal axis, and adjusting measurement antenna height and polarization. A preamp and high pass filter were used for this test in order to provide sufficient measurement sensitivity.

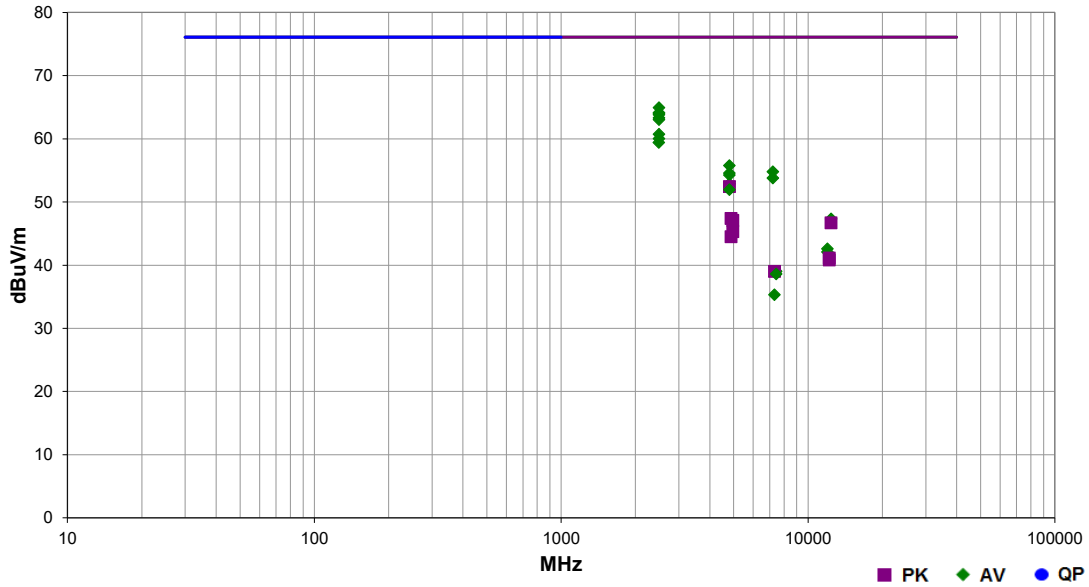
The Limit was derived from the highest maximized point of the fundamental output power then placed 20dBc down from that point. Compliance was determined by comparing the peak emissions to the maximum fundamental value.

OUT OF BAND EMISSIONS

Work Order:	APDM0008	**Date:**	02/03/16		
Project:	None	**Temperature:**	19.8 °C		
Job Site:	EV01	**Humidity:**	37.8% RH		
Serial Number:	SMTC1630731	**Barometric Pres.:**	1021 mbar	**Tested by:**	Brandon Hobbs
EUT:	Opal				
Configuration:	2				
Customer:	APDM, Inc.				
Attendees:	Andrew Greenberg, Gavin Gallino				
EUT Power:	Battery				
Operating Mode:	Continuous Tx				
Deviations:	None				
Comments:	The Limit was derived from the maximized output power of the fundamental. The limit line seen in the graph below represents the 20dBc from the maximized fundamental output power is the data. See comments for EUT position, channel, and frequency All points seen in the unstricted bands were more then 20dB below the 20dBc limit line.				

Test Specifications	**Test Method**
FCC 15.247:2016	ANSI C63.10:2013

Run #	17	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBc)	Compared to Spec. (dBc)	Comments
2481.195	59.2	36.9	1.2	98.0	3.0	0.0	Horz	PK	0.0	96.1			High Ch.81 2481MHz, EUT Horz, Maximum fundamental output power
2490.713	47.4	-2.5	1.0	106.0	3.0	20.0	Vert	PK	0.0	64.9	-20.0	-31.2	Channel 81, 2481 MHz, EUT Vertical
2490.620	46.6	-2.5	1.0	287.0	3.0	20.0	Horz	PK	0.0	64.1	-20.0	-32.0	Channel 81, 2481 MHz, EUT Horizontal
2490.443	46.5	-2.5	1.0	207.0	3.0	20.0	Horz	PK	0.0	64.0	-20.0	-32.1	Channel 2, 2402 MHz, EUT Horizontal
2490.727	46.3	-2.5	1.0	174.0	3.0	20.0	Horz	PK	0.0	63.8	-20.0	-32.3	Channel 40, 2440 MHz, EUT Horizontal
2490.660	45.8	-2.5	1.0	261.0	3.0	20.0	Vert	PK	0.0	63.3	-20.0	-32.8	Channel 2, 2402 MHz, EUT Vertical
2490.333	45.5	-2.5	1.0	121.0	3.0	20.0	Vert	PK	0.0	63.0	-20.0	-33.1	Channel 40, 2440 MHz, EUT Vertical
2490.903	43.2	-2.5	1.0	296.0	3.0	20.0	Vert	PK	0.0	60.7	-20.0	-35.4	Channel 81, 2481 MHz, EUT On Side
2490.610	42.5	-2.5	1.0	171.0	3.0	20.0	Horz	PK	0.0	60.0	-20.0	-36.1	Channel 81, 2481 MHz, EUT On Side
2489.747	41.9	-2.5	1.0	89.0	3.0	20.0	Vert	PK	0.0	59.4	-20.0	-36.7	Channel 81, 2481 MHz, EUT Horizontal
4804.535	48.2	7.5	1.0	330.0	3.0	0.0	Horz	PK	0.0	55.7	-20.0	-40.4	Channel 2, 2402 MHz, EUT Horizontal
7206.105	41.0	13.8	1.0	61.0	3.0	0.0	Vert	PK	0.0	54.8	-20.0	-41.4	Channel 2, 2402 MHz, EUT On Side
4804.400	47.0	7.5	1.0	185.0	3.0	0.0	Vert	PK	0.0	54.5	-20.0	-41.6	Channel 2, 2402 MHz, EUT On Side
4803.525	46.7	7.5	1.0	43.0	3.0	0.0	Horz	PK	0.0	54.2	-20.0	-41.9	Channel 2, 2402 MHz, EUT Vertical
7206.835	40.0	13.8	1.0	295.0	3.0	0.0	Horz	PK	0.0	53.8	-20.0	-42.4	Channel 2, 2402 MHz, EUT Horizontal
4803.755	45.3	7.5	1.0	317.0	3.0	0.0	Horz	PK	0.0	52.8	-20.0	-43.3	Channel 2, 2402 MHz, EUT On Side
4803.580	44.9	7.5	4.0	243.0	3.0	0.0	Vert	PK	0.0	52.4	-20.0	-43.7	Channel 2, 2402 MHz, EUT Horizontal
4803.650	44.4	7.5	1.0	263.0	3.0	0.0	Vert	PK	0.0	51.9	-20.0	-44.2	Channel 2, 2402 MHz, EUT Vertical
4879.633	47.4	0.0	1.0	320.0	3.0	0.0	Horz	PK	0.0	47.4	-20.0	-48.7	Channel 40, 2440 MHz, EUT Horizontal
12405.920	38.5	8.8	1.0	160.0	3.0	0.0	Vert	PK	0.0	47.3	-20.0	-48.8	Channel 81, 2481 MHz, EUT On Side
4961.408	47.1	0.0	1.0	49.0	3.0	0.0	Horz	PK	0.0	47.1	-20.0	-49.0	Channel 81, 2481 MHz, EUT Horizontal
12404.440	37.9	8.8	2.0	163.0	3.0	0.0	Horz	PK	0.0	46.7	-20.0	-49.4	Channel 81, 2481 MHz, EUT Horizontal
4962.650	45.3	0.0	1.0	187.0	3.0	0.0	Vert	PK	0.0	45.3	-20.0	-50.8	Channel 81, 2481 MHz, EUT on side
4879.733	44.5	0.0	1.0	184.0	3.0	0.0	Vert	PK	0.0	44.5	-20.0	-51.6	Channel 40, 2440 MHz, EUT on side
12000.230	42.5	0.1	1.0	220.0	3.0	0.0	Vert	PK	0.0	42.6	-20.0	-53.6	Channel 2, 2402 MHz, EUT on side
12001.090	42.0	0.1	2.8	221.0	3.0	0.0	Horz	PK	0.0	42.1	-20.0	-54.1	Channel 2, 2402 MHz, EUT Horizontal
12201.450	40.0	1.1	1.0	321.0	3.0	0.0	Horz	PK	0.0	41.1	-20.0	-55.0	Channel 40, 2440 MHz, EUT Horizontal
12201.280	39.7	1.1	1.0	40.0	3.0	0.0	Vert	PK	0.0	40.8	-20.0	-55.3	Channel 40, 2440 MHz, EUT on side

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBc)	Compared to Spec. (dBc)	Comments
7443.600	39.0	0.0	1.0	149.0	3.0	0.0	Vert	PK	0.0	39.0	-20.0	-57.1	Channel 81, 2481 MHz, EUT on side
7319.733	39.0	0.0	1.0	295.0	3.0	0.0	Horz	PK	0.0	39.0	-20.0	-57.1	Channel 40, 2440 MHz, EUT Horizontal
7443.092	38.6	0.0	1.1	285.0	3.0	0.0	Horz	PK	0.0	38.6	-20.0	-57.5	Channel 81, 2481 MHz, EUT Horizontal
7321.525	35.3	0.0	1.0	246.0	3.0	0.0	Vert	PK	0.0	35.3	-20.0	-60.8	Channel 40, 2440 MHz, EUT on side