NORTHWEST EMC

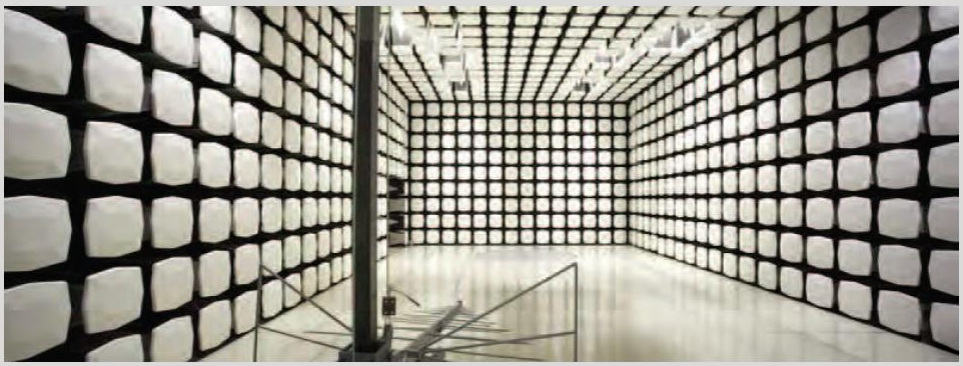
Multi-Tech Systems, Inc.

MTDOT-915

FCC 15.247:2016

902 - 928 MHz Transceiver

Report # CDVE0013.1



NVLAP TESTING

NVLAP Lab Code: 200676-0

CERTIFICATE OF TEST

NORTHWEST EMC
2014-12-10

Last Date of Test: November 23, 2016
Multi-Tech Systems, Inc.
Model: MTDOT-915

Radio Equipment Testing

Standards

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

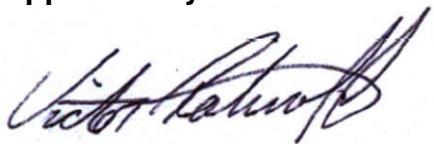
Results

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	Spurious Radiated Emissions	Yes	Pass	
7.5	Duty Cycle	No	N/A	Not required for Permissive Change for new antenna.
7.8.2	Carrier Frequency Separation	No	N/A	Not required for Permissive Change for new antenna.
7.8.3	Number of Hopping Frequencies	No	N/A	Not required for Permissive Change for new antenna.
7.8.4	Dwell Time	No	N/A	Not required for Permissive Change for new antenna.
7.8.5	Output Power	No	N/A	Not required for Permissive Change for new antenna.
7.8.6	Band Edge Compliance	No	N/A	Not required for Permissive Change for new antenna.
7.8.6	Band Edge Compliance - Hopping Mode	No	N/A	Not required for Permissive Change for new antenna.
7.8.7	Occupied Bandwidth	No	N/A	Not required for Permissive Change for new antenna.
7.8.8	Spurious Conducted Emissions	No	N/A	Not required for Permissive Change for new antenna.
11.10.2	Power Spectral Density	No	N/A	Not required for Permissive Change for new antenna.

Deviations From Test Standards

None

Approved By:



Victor Ratinoff, 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

NORTHWEST EMC
REV 2016.7.25

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

ISED - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB). Certification chambers and Open Area Test Sites are filed with ISED.

European Union

European Commission – Validated by the European Commission 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.

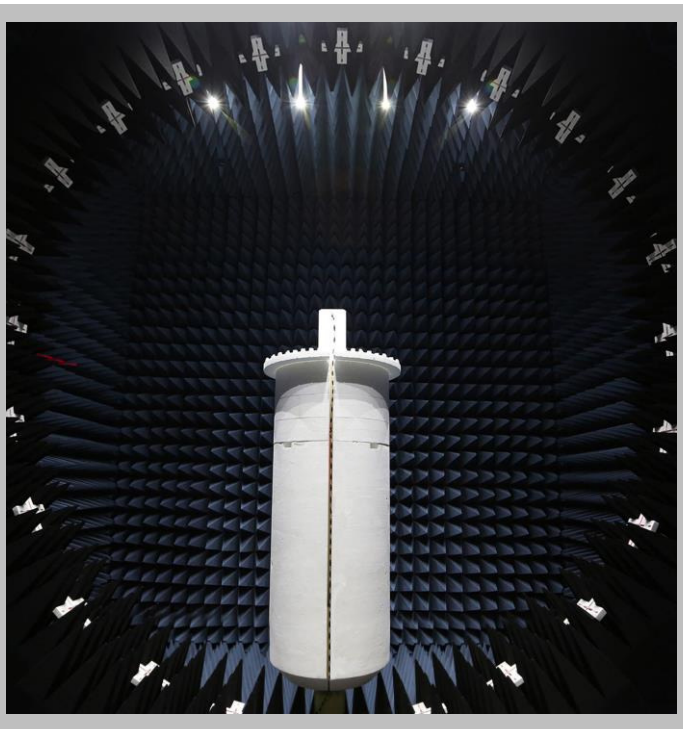
SCOPE

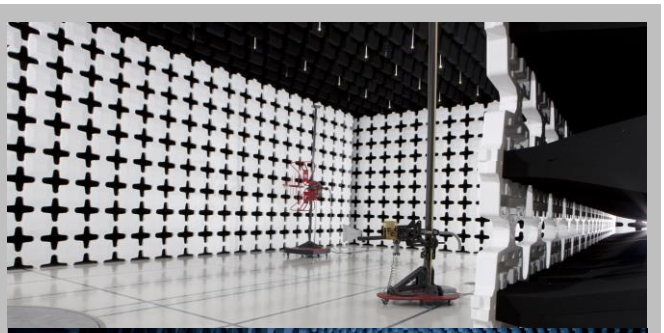
For details on the Scopes of our Accreditations, please visit:
http://www.nwemc.com/accreditations/
http://gsi.nist.gov/global/docs/cabs/designations.html

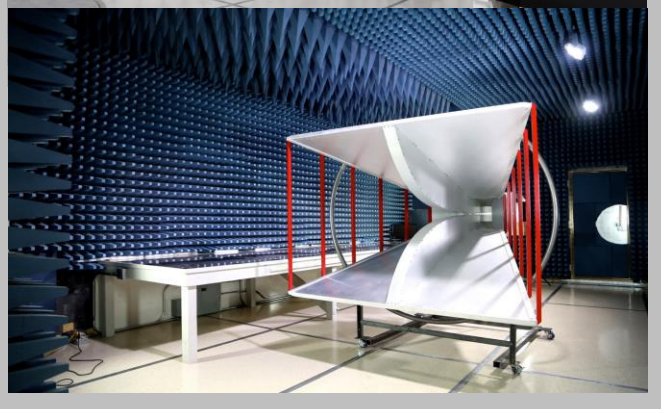
FACILITIES

NORTHWEST EMC
REV 2016.7.25

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
Innovation, Science and Economic Development 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







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 QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable test description page. 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.

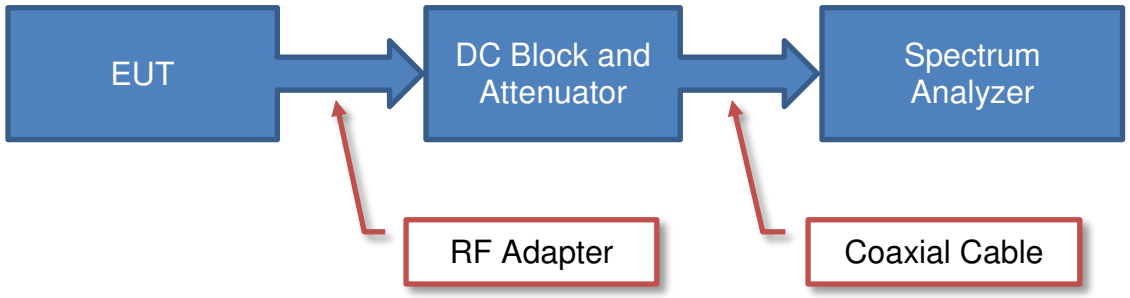
The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

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

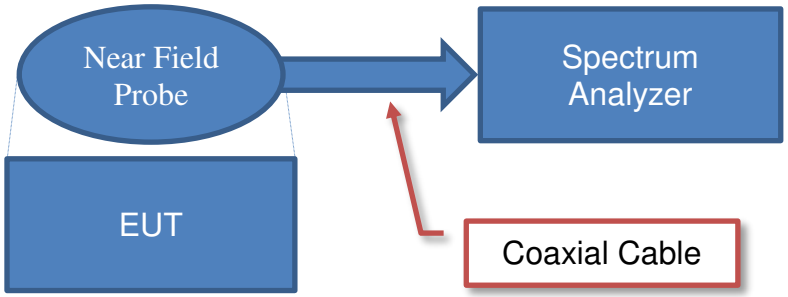
Test Setup Block Diagrams

NORTHWEST EMC
REV 2016.10.04

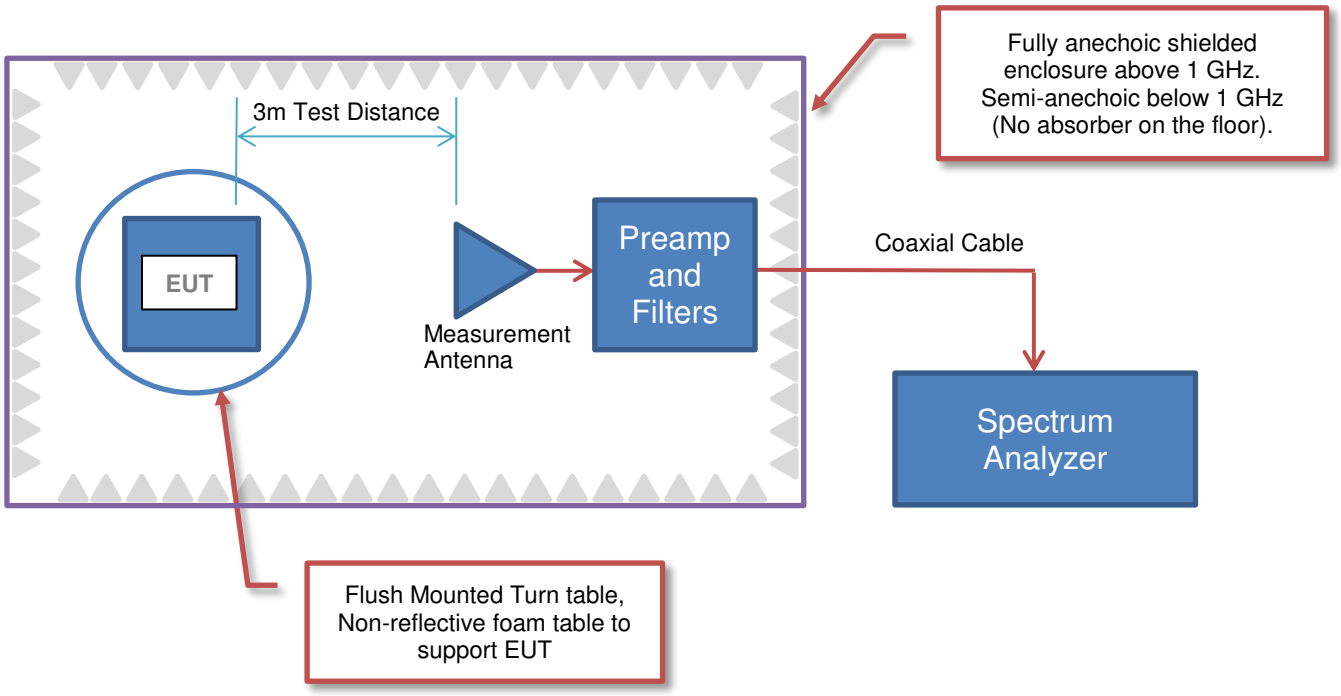
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions



PRODUCT DESCRIPTION

NORTHWEST EMC
2014-12-10

Client and Equipment Under Test (EUT) Information

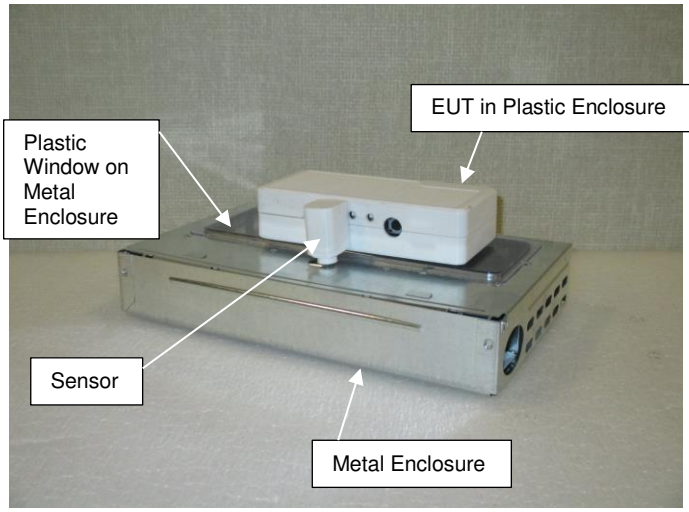
Company Name:	Multi-Tech Systems, Inc.
Address:	2205 Woodale Dr.
City, State, Zip:	Mounds View, MN 55112
Test Requested By:	Darin Hatcher of Connected Development, LLC
Model:	MTDOT-915
First Date of Test:	November 23, 2016
Last Date of Test:	November 23, 2016
Receipt Date of Samples:	November 23, 2016
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

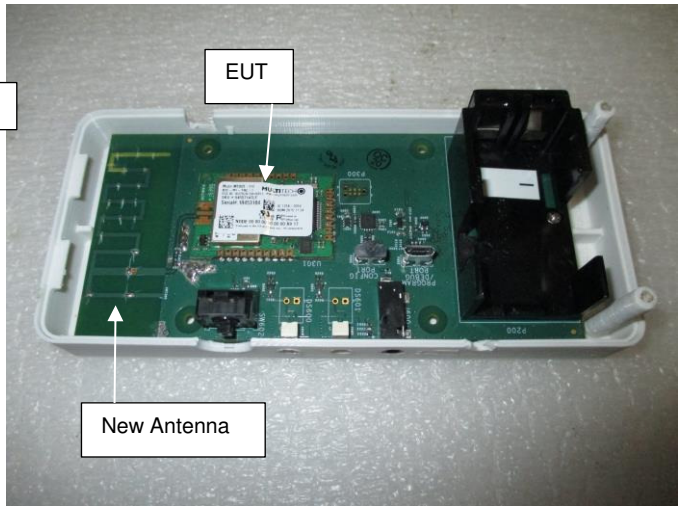
Information Provided by the Party Requesting the Test

Functional Description of the EUT:
Previously certified Long Range 868/915 MHz ISM Radio module.

Testing Objective:
Seeking to demonstrate compliance of a new antenna to Spurious Radiated Emissions requirements under FCC 15.247:2016.

Test Configuration:
The radio module was tested as shown below in a plastic enclosure. For the FCC test code to operate, the radio required the sensor which had to be in contact with the metal enclosure. Since the module was in a plastic enclosure and next to the plastic window of the metal enclosure, it was tested in a “stand-alone” configuration.





Configuration CDVE0013- 1

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
MTDOT-915	Multi-Tech Systems, Inc	MTDOT-915	None
Antenna Board	Connected Development	16006-1	None
Sensor	Connected Development	None	None
Trap	Kness	104-0-004	None

MODIFICATIONS

NORTHWEST EMC
2014-12-10

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	11/23/2016	Spurious Radiated Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

SPURIOUS RADIATED EMISSIONS

NORTHWEST EMC

PSA-ESCI 2016.07.22

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

Transmit Mode: Low Channel (902.3 MHz), Mid Channel (908.5 MHz), High Channel (914.9 MHz)

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

CDVE0013 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	18000 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
Antenna - Biconilog	EMCO	3142	AXB	11/6/2015	24 mo
Filter - High Pass	Micro-Tronics	HPM50108	HFW	2/9/2016	12 mo
Filter - Band Pass/Notch	K&L Microwave	3TNF-500/1000-N/N	HFR	3/3/2016	12 mo
Filter - Low Pass	Micro-Tronics	LPM50003	LFA	10/17/2016	12 mo
Cable	Northwest EMC	10kHz-1GHz RE Cables	OCH	8/9/2016	12 mo
Amplifier - Pre-Amplifier	Miteq	AM-1402	AOZ	8/10/2016	12 mo
Cable	Northwest EMC	8-18GHz RE Cables	OCO	8/10/2016	12 mo
Cable	Northwest EMC	1-8GHz RE Cables	OCJ	8/4/2016	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-4D-010120-30-10P-1	AOP	8/4/2016	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AOF	8/10/2016	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AOE	8/10/2016	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-08	AHT	NCR	0 mo
Antenna - Standard Gain	ETS Lindgren	3160-07	AHR	NCR	0 mo
Antenna - Double Ridge	EMCO	3115	AHB	3/21/2016	24 mo
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFJ	2/9/2016	12 mo

MEASUREMENT BANDWIDTHS

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01 - 0.15	1.0	0.2	0.2
0.15 - 30.0	10.0	9.0	9.0
30.0 - 1000	100.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

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

NORTHWEST EMC

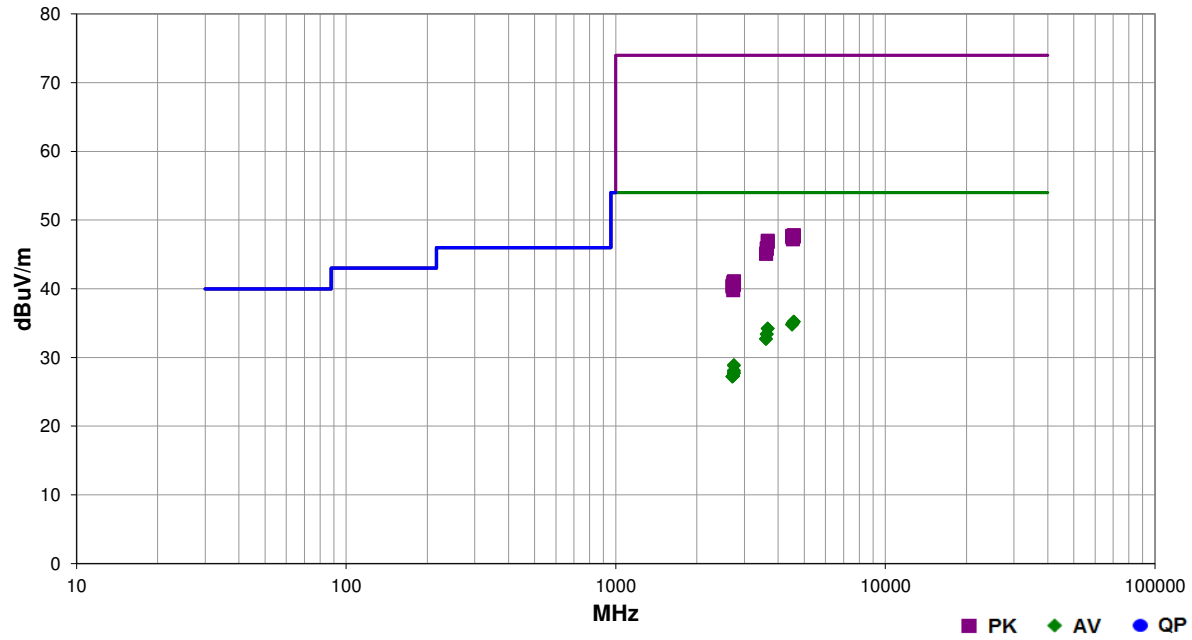
PSA-ESCI 2016.07.22

EmiR5 2016.08.26

Work Order:	CDVE0013	**Date:**	11/23/16		
Project:	None	**Temperature:**	20.3 °C		
Job Site:	OC10	**Humidity:**	52.2% RH		
Serial Number:	18453104	**Barometric Pres.:**	1021 mbar	**Tested by:**	Mark Baytan
EUT:	MTDOT-915				
Configuration:	1				
Customer:	Multi-Tech Systems, Inc.				
Attendees:	None				
EUT Power:	Battery				
Operating Mode:	Transmit Mode: Low Channel (902.3 MHz), Mid Channel (908.5 MHz), High Channel (914.9 MHz)				
Deviations:	None				
Comments:	None				

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

Run #	23	**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
4574.492	24.0	11.2	1.0	75.0	3.0	0.0	Horz	AV	0.0	35.2	54.0	-18.8	High Ch, EUT Vert
4574.489	24.0	11.2	1.0	99.0	3.0	0.0	Vert	AV	0.0	35.2	54.0	-18.8	High Ch, EUT Vert
4542.496	24.0	11.0	1.0	283.0	3.0	0.0	Horz	AV	0.0	35.0	54.0	-19.0	Mid Ch, EUT Vert
4542.457	24.0	11.0	1.0	342.0	3.0	0.0	Vert	AV	0.0	35.0	54.0	-19.0	Mid Ch, EUT Vert
4511.482	24.0	10.8	1.0	105.0	3.0	0.0	Horz	AV	0.0	34.8	54.0	-19.2	Low Ch, EUT Vert
4511.548	24.0	10.8	1.0	311.0	3.0	0.0	Vert	AV	0.0	34.8	54.0	-19.2	Low Ch, EUT Vert
3659.506	25.2	9.0	3.5	226.0	3.0	0.0	Horz	AV	0.0	34.2	54.0	-19.8	High Ch, EUT Vert
3659.534	25.2	9.0	1.0	324.0	3.0	0.0	Vert	AV	0.0	34.2	54.0	-19.8	High Ch, EUT Vert
3633.985	24.9	8.5	1.0	351.0	3.0	0.0	Horz	AV	0.0	33.4	54.0	-20.6	Mid Ch, EUT Vert
3634.002	24.9	8.5	1.0	186.0	3.0	0.0	Vert	AV	0.0	33.4	54.0	-20.6	Mid Ch, EUT Vert
3609.153	24.7	8.0	1.0	323.0	3.0	0.0	Horz	AV	0.0	32.7	54.0	-21.3	Low Ch, EUT Vert
3609.195	24.7	8.0	1.0	209.0	3.0	0.0	Vert	AV	0.0	32.7	54.0	-21.3	Low Ch, EUT Vert
2744.650	25.7	3.2	2.7	214.0	3.0	0.0	Vert	AV	0.0	28.9	54.0	-25.1	High Ch, EUT Vert
2744.678	25.6	3.2	1.0	184.0	3.0	0.0	Vert	AV	0.0	28.8	54.0	-25.2	High Ch, EUT Horz
2744.675	24.9	3.2	1.0	144.0	3.0	0.0	Horz	AV	0.0	28.1	54.0	-25.9	High Ch, EUT Vert
2744.650	24.7	3.2	1.0	316.0	3.0	0.0	Horz	AV	0.0	27.9	54.0	-26.1	High Ch, EUT Horz
4574.536	36.6	11.2	1.0	99.0	3.0	0.0	Vert	PK	0.0	47.8	74.0	-26.2	High Ch, EUT Vert
4542.541	36.7	11.0	1.0	283.0	3.0	0.0	Horz	PK	0.0	47.7	74.0	-26.3	Mid Ch, EUT Vert

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
4511.488	36.9	10.8	1.0	311.0	3.0	0.0	Vert	PK	0.0	47.7	74.0	-26.3	Low Ch, EUT Vert
2744.650	24.5	3.2	2.5	289.0	3.0	0.0	Horz	AV	0.0	27.7	54.0	-26.3	High Ch, EUT on SIde
2744.689	24.5	3.2	1.0	275.0	3.0	0.0	Vert	AV	0.0	27.7	54.0	-26.3	High Ch, EUT on SIde
4574.521	36.4	11.2	1.0	75.0	3.0	0.0	Horz	PK	0.0	47.6	74.0	-26.4	High Ch, EUT Vert
4511.462	36.7	10.8	1.0	105.0	3.0	0.0	Horz	PK	0.0	47.5	74.0	-26.5	Low Ch, EUT Vert
2725.506	24.2	3.1	1.0	215.0	3.0	0.0	Horz	AV	0.0	27.3	54.0	-26.7	Mid Ch, EUT Vert
2725.457	24.2	3.1	1.0	143.0	3.0	0.0	Vert	AV	0.0	27.3	54.0	-26.7	Mid Ch, EUT Vert
4542.519	36.2	11.0	1.0	342.0	3.0	0.0	Vert	PK	0.0	47.2	74.0	-26.8	Mid Ch, EUT Vert
2706.868	24.2	3.0	1.0	290.0	3.0	0.0	Horz	AV	0.0	27.2	54.0	-26.8	Low Ch, EUT Vert
2706.913	24.2	3.0	1.0	52.0	3.0	0.0	Vert	AV	0.0	27.2	54.0	-26.8	Low Ch, EUT Vert
3659.490	38.0	9.0	1.0	324.0	3.0	0.0	Vert	PK	0.0	47.0	74.0	-27.0	High Ch, EUT Vert
3659.471	37.8	9.0	3.5	226.0	3.0	0.0	Horz	PK	0.0	46.8	74.0	-27.2	High Ch, EUT Vert
3634.047	37.4	8.5	1.0	186.0	3.0	0.0	Vert	PK	0.0	45.9	74.0	-28.1	Mid Ch, EUT Vert
3634.019	37.3	8.5	1.0	351.0	3.0	0.0	Horz	PK	0.0	45.8	74.0	-28.2	Mid Ch, EUT Vert
3609.165	37.1	8.0	1.0	323.0	3.0	0.0	Horz	PK	0.0	45.1	74.0	-28.9	Low Ch, EUT Vert
3609.168	37.1	8.0	1.0	209.0	3.0	0.0	Vert	PK	0.0	45.1	74.0	-28.9	Low Ch, EUT Vert
2744.741	37.9	3.2	2.7	214.0	3.0	0.0	Vert	PK	0.0	41.1	74.0	-32.9	High Ch, EUT Vert
2744.672	37.8	3.2	1.0	184.0	3.0	0.0	Vert	PK	0.0	41.0	74.0	-33.0	High Ch, EUT Horz
2744.748	37.7	3.2	1.0	316.0	3.0	0.0	Horz	PK	0.0	40.9	74.0	-33.1	High Ch, EUT Horz
2725.491	37.8	3.1	1.0	143.0	3.0	0.0	Vert	PK	0.0	40.9	74.0	-33.1	Mid Ch, EUT Vert
2744.666	37.6	3.2	1.0	144.0	3.0	0.0	Horz	PK	0.0	40.8	74.0	-33.2	High Ch, EUT Vert
2744.701	37.4	3.2	2.5	289.0	3.0	0.0	Horz	PK	0.0	40.6	74.0	-33.4	High Ch, EUT on SIde
2744.730	37.4	3.2	1.0	275.0	3.0	0.0	Vert	PK	0.0	40.6	74.0	-33.4	High Ch, EUT on SIde
2706.935	37.5	3.0	1.0	290.0	3.0	0.0	Horz	PK	0.0	40.5	74.0	-33.5	Low Ch, EUT Vert
2706.938	37.3	3.0	1.0	52.0	3.0	0.0	Vert	PK	0.0	40.3	74.0	-33.7	Low Ch, EUT Vert
2725.514	36.7	3.1	1.0	215.0	3.0	0.0	Horz	PK	0.0	39.8	74.0	-34.2	Mid Ch, EUT Vert