

NORTHWEST EMC

FreeWave Technologies, Inc.

Z9-T (board unit w/TTL interface), Z9-C (board unit w/RS232 interface)

FCC 15.247:2016

DTS Radio

Report # FREW0058.1



NVLAP Lab Code: 200629-0

This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government of the United States of America. This Report may only be duplicated in its entirety

CERTIFICATE OF TEST

Last Date of Test: March 17, 2016

FreeWave Technologies, Inc.

Model:Z9-T (board unit w/TTL interface), Z9-C (board unit w/RS232 interface)

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 requested.
6.5, 6.6, 11.12.1, 11.13.2	Spurious Radiated Emissions	Yes	Pass	
11.6	Duty Cycle	No	N/A	Not requested.
11.8.2	Occupied Bandwidth	No	N/A	Not requested.
11.9.2.2.4	Output Power	Yes	Pass	
11.10.2	Power Spectral Density	No	N/A	Not requested.
11.11	Band Edge Compliance	No	N/A	Not requested.
11.11	Spurious Conducted Emissions	No	N/A	Not requested.

Deviations From Test Standards

None

Approved By:



Rod Munro, 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

Revision Number		Description	Date	Page Number
00		None		

ACCREDITATIONS AND AUTHORIZATIONS

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 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

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.

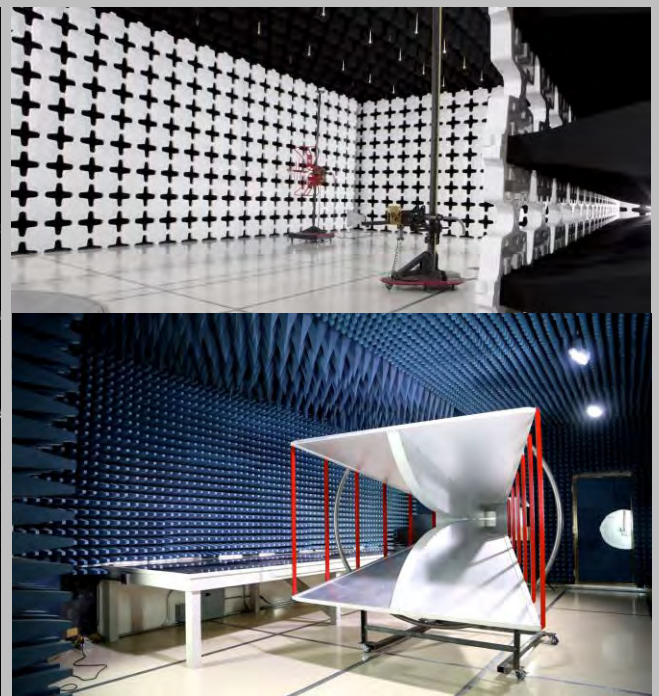
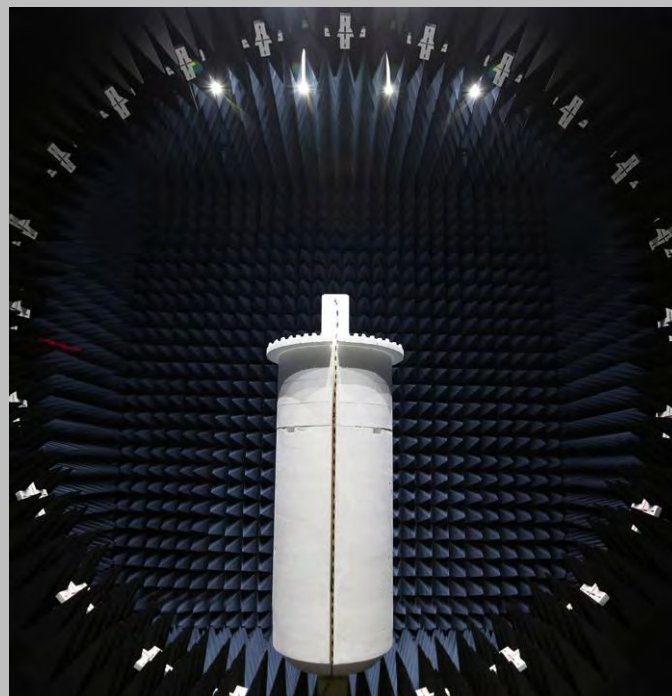
The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

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)	5.0 dB	-5.0 dB
AC Powerline Conducted Emissions (dB)	2.4 dB	-2.4 dB

FACILITIES



California Labs OC01-13 41 Tesla Irvine, CA 92618 (949) 861-8918	Minnesota Labs MN01-08, MN10 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	New York Labs NY01-04 4939 Jordan Rd. Elbridge, NY 13060 (315) 554-8214	Oregon Labs EV01-12 22975 NW Evergreen Pkwy Hillsboro, OR 97124 (503) 844-4066	Texas Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Washington Labs NC01-05 19201 120 th 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/RRR, MIC, MOC, NCC, OFCA					
US0158	US0175	N/A	US0017	US0191	US0157



PRODUCT DESCRIPTION

Client and Equipment Under Test (EUT) Information

Company Name:	FreeWave Technologies, Inc.
Address:	5395 Pearl Parkway, Suite 100
City, State, Zip:	Boulder, CO 80301
Test Requested By:	Dean Busch
Model:	Z9-T (board unit w/TTL interface), Z9-C (board unit w/RS232 interface)
First Date of Test:	March 16, 2016
Last Date of Test:	March 17, 2016
Receipt Date of Samples:	March 16, 2016
Equipment Design Stage:	Production
Equipment Condition:	No Damage

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
Industrial Radio with DTS Mode and high gain Yagi antenna. Model Z9-C consists of model Z9-T radio module combined with model MM2-MR translation board.
Testing Objective:
Seeking Class II Permissive change to add a high gain Yagi antenna to the certification of the DTS radio under FCC 15.247 for operation in the 902-928 MHz band done under FREW0054 for FCC ID: KNYPMT0101AA.

DTS RF Power Table – FCC 15.247

Power Settings for 8.6dBi Antenna Configuration:

	Data Rate		
	500kb	1Mb	4Mb
Low Channel	28	28	26
Mid Channel	28	28	26
High Channel	28	28	26

CONFIGURATIONS

Configuration FREW0058- 1

Software/Firmware Running during test	
Description	Version
Firmware	FWT0001TA.69

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
900 MHz Industrial Radio Module	FreeWave Technologies, Inc.	Z9-T	402-669-0330
Translation Board	FreeWave Technologies, Inc.	MM2-MR	402-661-3868

Peripherals in test setup boundary			
Description	Manufacturer	Model/Part Number	Serial Number
Laptop Computer	Dell	Latitude E6520	None
AC Brick	Mean Well Enterprises Co.	GS60A15	None

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
DC Power	No	1.7m	No	AC Brick	Translation Board
Serial to USB Cable	No	1.8m	No	Translation Board	Laptop Computer
AC Power	Yes	1.8m	No	AC Mains	AC Brick

CONFIGURATIONS

Configuration FREW0058- 2

Software/Firmware Running during test					
Description				Version	
Firmware				FWT0001TA.69	

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
900 MHz Industrial Radio Module	FreeWave Technologies, Inc.	Z9-T	402-669-0330
Translation Board	FreeWave Technologies, Inc.	MM2-MR	402-661-3868

Peripherals in test setup boundary			
Description	Manufacturer	Model/Part Number	Serial Number
8.6dBi Yagi Antenna	WaveLink Antenna Systems Inc.	PR0890-8-40F02N4	None
Laptop Computer	Dell	Latitude E6520	None
AC Brick	Mean Well Enterprises Co.	GS60A15	None

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
DC Power	No	1.7m	No	AC Brick	Translation Board
AC Power	Yes	1.8m	No	AC Mains	AC Brick
Serial Extension Cable	No	9.0m	No	Serial to USB Cable	Laptop
Serial to USB Cable	No	1.8m	No	Translation Board	Serial Extension Cable

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	3/16/2016	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.
2	3/17/2016	Spurious Radiated Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

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

Transmitting at 500kb at Maximum Duty Cycle, Low Channel 1, 902.7072 MHz
Transmitting at 500kb at Maximum Duty Cycle, Mid Channel 18, 914.4576 MHz
Transmitting at 500kb at Maximum Duty Cycle, High Channel 36, 927.36 MHz
Transmitting at 1Mb at Maximum Duty Cycle, Low Channel 1, 903.0528 MHz
Transmitting at 1Mb at Maximum Duty Cycle, Mid Channel 9, 914.112 MHz
Transmitting at 1Mb at Maximum Duty Cycle, High Channel 18, 927.0144 MHz
Transmitting at 4Mb at Maximum Duty Cycle, Low Channel 1, 904.5504 MHz
Transmitting at 4Mb at Maximum Duty Cycle, Mid Channel 4, 914.112 MHz
Transmitting at 4Mb at Maximum Duty Cycle, High Channel 7, 925.7472 MHz

POWER SETTINGS INVESTIGATED

12 VDC

CONFIGURATIONS INVESTIGATED

FREW0058 - 2

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	10 GHz
-----------------	--------	----------------	--------

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
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	6/23/2015	12 mo
Filter - Low Pass	Micro-Tronics	LPM50003	LFE	10/30/2015	12 mo
Filter - Band Pass/Notch	K&L Microwave	3TNF-500/1000-N/N	HHO	6/3/2015	12 mo
Antenna - Biconilog	Teseq	CBL 6141B	AYL	7/30/2015	24 mo
Filter - Low Pass	Micro-Tronics	LPM50004	LFF	1/21/2016	12 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	PAB	7/31/2015	12 mo
Cable	Northwest EMC	Bilog Cables	NC1	8/27/2015	12 mo
Filter - High Pass	Micro-Tronics	HPM50114	HFN	1/21/2016	12 mo
Antenna - Double Ridge	EMCO	3115	AHM	6/3/2014	24 mo
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVZ	7/31/2015	12 mo
Cable	Northwest EMC	3115 Horn Cable	NC2	6/17/2015	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AOK	9/21/2015	12 mo
Antenna - Standard Gain	EMCO	3160-07	AHP	NCR	0 mo
Cable	Northwest EMC	Standard Gain Horn Cable	NC3	6/17/2015	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

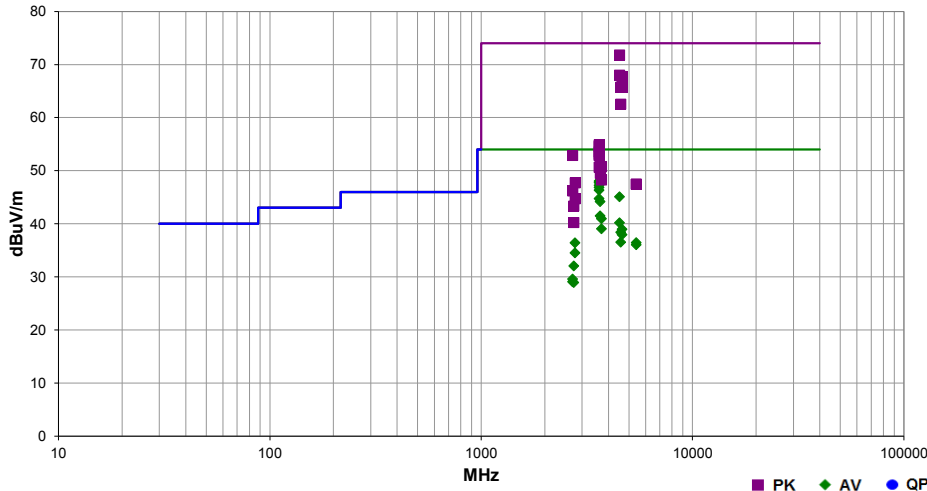
TEST DESCRIPTION

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.

Work Order:	FREW0058	Date:	03/17/16		
Project:	None	Temperature:	23 °C		
Job Site:	NC01	Humidity:	27% RH		
Serial Number:	402-669-0330	Barometric Pres.:	1030 mbar	Tested by:	Richard Mellroth
EUT:	Z9-T (board unit w/TTL interface), Z9-C (board unit w/RS232 interface)				
Configuration:	2				
Customer:	FreeWave Technologies, Inc.				
Attendees:	Dean Busch				
EUT Power:	12 VDC				
Operating Mode:	Transmitting at 500kb at Maximum Duty Cycle. See comments next to data points for EUT channel and orientation. See power table for power settings.				
Deviations:	None				
Comments:	8.6dBi Yagi antenna.				

Test Specifications	Test Method
FCC 15.247.2016	ANSI C63.10:2013

Run #	57	Test Distance (m)	3	Antenna Height(s)	1 to 4(m)	Results	Pass
-------	----	-------------------	---	-------------------	-----------	---------	------

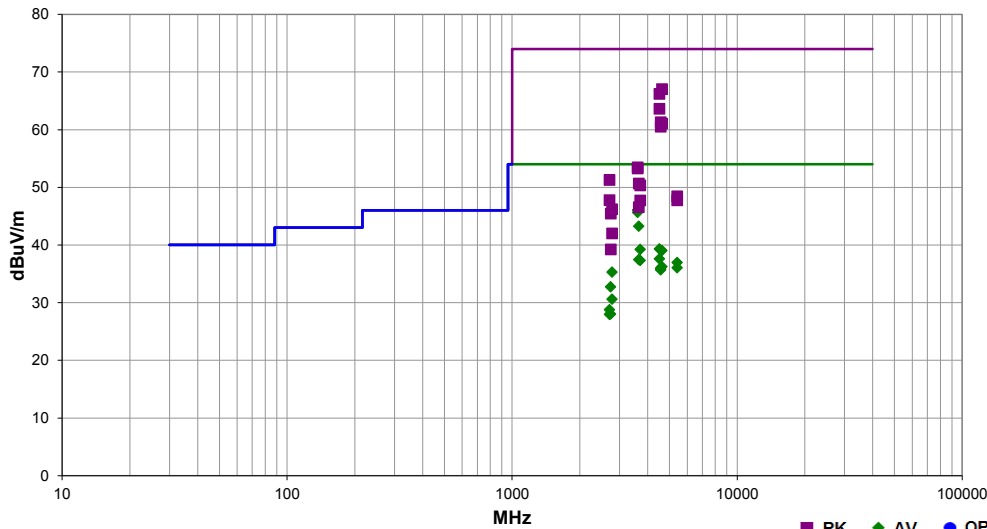


Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
4516.367	63.9	7.9	1.4	69.0	3.0	0.0	Horz	PK	0.0	71.8	74.0	-2.2	Low Ch, 500kb, EUT on Side
3610.180	44.1	3.9	1.0	130.0	3.0	0.0	Horz	AV	0.0	48.0	54.0	-6.0	Low Ch, 500kb, EUT Vertical
4516.383	60.1	7.9	1.6	24.0	3.0	0.0	Vert	PK	0.0	68.0	74.0	-6.0	Low Ch, 500kb, EUT Vertical
3610.185	43.8	3.9	1.6	107.0	3.0	0.0	Horz	AV	0.0	47.7	54.0	-6.3	Low Ch, 500kb, EUT on Side
4639.083	58.5	9.2	1.6	327.0	3.0	0.0	Horz	PK	0.0	67.7	74.0	-6.3	High Ch, 500kb, EUT Vertical
3610.200	43.3	3.9	1.6	50.0	3.0	0.0	Horz	AV	0.0	47.2	54.0	-6.8	Low Ch, 500kb, EUT Flat
3610.215	42.9	3.9	1.1	14.0	3.0	0.0	Vert	AV	0.0	46.8	54.0	-7.2	Low Ch, 500kb, EUT on Side
3610.165	42.4	3.9	1.6	29.0	3.0	0.0	Vert	AV	0.0	46.3	54.0	-7.7	Low Ch, 500kb, EUT Vertical
4638.942	56.6	9.2	1.5	61.0	3.0	0.0	Vert	PK	0.0	65.8	74.0	-8.2	High Ch, 500kb, EUT on Side
4574.475	57.2	8.5	1.3	40.0	3.0	0.0	Horz	PK	0.0	65.7	74.0	-8.3	Mid Ch, 500kb, EUT Vertical
4512.675	37.2	7.9	1.4	69.0	3.0	0.0	Horz	AV	0.0	45.1	54.0	-8.9	Low Ch, 500kb, EUT on Side
3610.180	40.8	3.9	1.6	159.0	3.0	0.0	Vert	AV	0.0	44.7	54.0	-9.3	Low Ch, 500kb, EUT Flat
3657.108	39.4	4.8	1.1	39.0	3.0	0.0	Horz	AV	0.0	44.2	54.0	-9.8	Mid Ch, 500kb, EUT Vertical
4574.300	54.0	8.5	1.6	56.0	3.0	0.0	Vert	PK	0.0	62.5	74.0	-11.5	Mid Ch, 500kb, EUT on Side
3657.125	36.7	4.8	1.3	149.0	3.0	0.0	Vert	AV	0.0	41.5	54.0	-12.5	Mid Ch, 500kb, EUT on Side
3708.775	35.7	5.2	1.0	39.0	3.0	0.0	Vert	AV	0.0	40.9	54.0	-13.1	High Ch, 500kb, EUT on Side
4512.708	32.3	7.9	1.6	24.0	3.0	0.0	Vert	AV	0.0	40.2	54.0	-13.8	Low Ch, 500kb, EUT Vertical
3708.800	33.8	5.2	1.6	332.0	3.0	0.0	Horz	AV	0.0	39.0	54.0	-15.0	High Ch, 500kb, EUT Vertical
4638.925	29.8	9.2	1.6	327.0	3.0	0.0	Horz	AV	0.0	39.0	54.0	-15.0	High Ch, 500kb, EUT Vertical
4572.917	29.9	8.5	1.3	40.0	3.0	0.0	Horz	AV	0.0	38.4	54.0	-15.6	Mid Ch, 500kb, EUT Vertical
4639.258	28.8	9.2	1.5	61.0	3.0	0.0	Vert	AV	0.0	38.0	54.0	-16.0	High Ch, 500kb, EUT on Side
4574.500	28.0	8.5	1.6	56.0	3.0	0.0	Vert	AV	0.0	36.5	54.0	-17.5	Mid Ch, 500kb, EUT on Side
5417.167	25.6	10.9	1.6	109.0	3.0	0.0	Vert	AV	0.0	36.5	54.0	-17.5	Low Ch, 500kb, EUT Vertical
2781.575	36.4	0.0	1.3	144.0	3.0	0.0	Vert	AV	0.0	36.4	54.0	-17.6	High Ch, 500kb, EUT on Side
5417.075	25.2	10.9	1.6	182.0	3.0	0.0	Horz	AV	0.0	36.1	54.0	-17.9	Low Ch, 500kb, EUT on Side
3611.800	50.9	4.0	1.0	130.0	3.0	0.0	Horz	PK	0.0	54.9	74.0	-19.1	Low Ch, 500kb, EUT Vertical
3611.630	50.6	4.0	1.6	107.0	3.0	0.0	Horz	PK	0.0	54.6	74.0	-19.4	Low Ch, 500kb, EUT on Side
2781.600	34.5	0.0	1.6	150.0	3.0	0.0	Horz	AV	0.0	34.5	54.0	-19.5	High Ch, 500kb, EUT Vertical
3611.855	49.6	4.0	1.1	14.0	3.0	0.0	Vert	PK	0.0	53.6	74.0	-20.4	Low Ch, 500kb, EUT on Side
3612.060	49.1	4.0	1.6	50.0	3.0	0.0	Horz	PK	0.0	53.1	74.0	-20.9	Low Ch, 500kb, EUT Flat
2708.725	53.0	-0.1	1.6	41.0	3.0	0.0	Vert	PK	0.0	52.9	74.0	-21.1	Low Ch, 500kb, EUT Vertical
3611.380	48.9	4.0	1.6	29.0	3.0	0.0	Vert	PK	0.0	52.9	74.0	-21.1	Low Ch, 500kb, EUT Vertical
2742.900	32.1	-0.1	1.4	140.0	3.0	0.0	Horz	AV	0.0	32.0	54.0	-22.0	Mid Ch, 500kb, EUT Vertical
3657.008	46.0	4.8	1.1	39.0	3.0	0.0	Horz	PK	0.0	50.8	74.0	-23.2	Mid Ch, 500kb, EUT Vertical
3710.425	45.5	5.3	1.0	39.0	3.0	0.0	Vert	PK	0.0	50.8	74.0	-23.2	High Ch, 500kb, EUT on Side
3611.485	46.7	4.0	1.6	159.0	3.0	0.0	Vert	PK	0.0	50.7	74.0	-23.3	Low Ch, 500kb, EUT Flat
2707.533	29.7	-0.1	1.6	123.0	3.0	0.0	Horz	AV	0.0	29.6	54.0	-24.4	Low Ch, 500kb, EUT on Side
3658.767	44.7	4.8	1.3	149.0	3.0	0.0	Vert	PK	0.0	49.5	74.0	-24.5	Mid Ch, 500kb, EUT on Side
2708.508	29.2	-0.1	1.6	41.0	3.0	0.0	Vert	AV	0.0	29.1	54.0	-24.9	Low Ch, 500kb, EUT Vertical
2743.817	29.0	-0.1	2.5	327.0	3.0	0.0	Vert	AV	0.0	28.9	54.0	-25.1	Mid Ch, 500kb, EUT on Side
3710.142	43.0	5.3	1.6	332.0	3.0	0.0	Horz	PK	0.0	48.3	74.0	-25.7	High Ch, 500kb, EUT Vertical
2782.600	47.7	0.0	1.3	144.0	3.0	0.0	Vert	PK	0.0	47.7	74.0	-26.3	High Ch, 500kb, EUT on Side
5418.467	36.6	10.9	1.6	182.0	3.0	0.0	Horz	PK	0.0	47.5	74.0	-26.5	Low Ch, 500kb, EUT on Side
5415.758	36.6	10.8	1.6	109.0	3.0	0.0	Vert	PK	0.0	47.4	74.0	-26.6	Low Ch, 500kb, EUT Vertical
2710.483	46.3	-0.1	1.6	123.0	3.0	0.0	Horz	PK	0.0	46.2	74.0	-27.8	Low Ch, 500kb, EUT on Side
2782.883	44.7	0.0	1.6	150.0	3.0	0.0	Horz	PK	0.0	44.7	74.0	-29.3	High Ch, 500kb, EUT Vertical
2744.333	43.4	-0.1	1.4	140.0	3.0	0.0	Horz	PK	0.0	43.3	74.0	-30.7	Mid Ch, 500kb, EUT Vertical
2743.900	40.3	-0.1	2.5	327.0	3.0	0.0	Vert	PK	0.0	40.2	74.0	-33.8	Mid Ch, 500kb, EUT on Side

Work Order:	FREW0058	Date:	03/17/16	
Project:	None	Temperature:	23 °C	
Job Site:	NC01	Humidity:	27% RH	
Serial Number:	402-669-0330	Barometric Pres.:	1030 mbar	
EUT: Z9-T (board unit w/TTL interface), Z9-C (board unit w/RS232 interface)				
Configuration:	2			
Customer:	FreeWave Technologies, Inc.			
Attendees:	Dean Busch			
EUT Power:	12 VDC			
Operating Mode:	Transmitting at 1Mb at Maximum Duty Cycle. See comments next to data points for EUT channel and orientation. See power table for power settings.			
Deviations:	None			
Comments:	8.6dBi Yagi antenna.			

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

Run #	58	Test Distance (m)	3	Antenna Height(s)	1 to 4(m)	Results	Pass
-------	----	-------------------	---	-------------------	-----------	---------	------

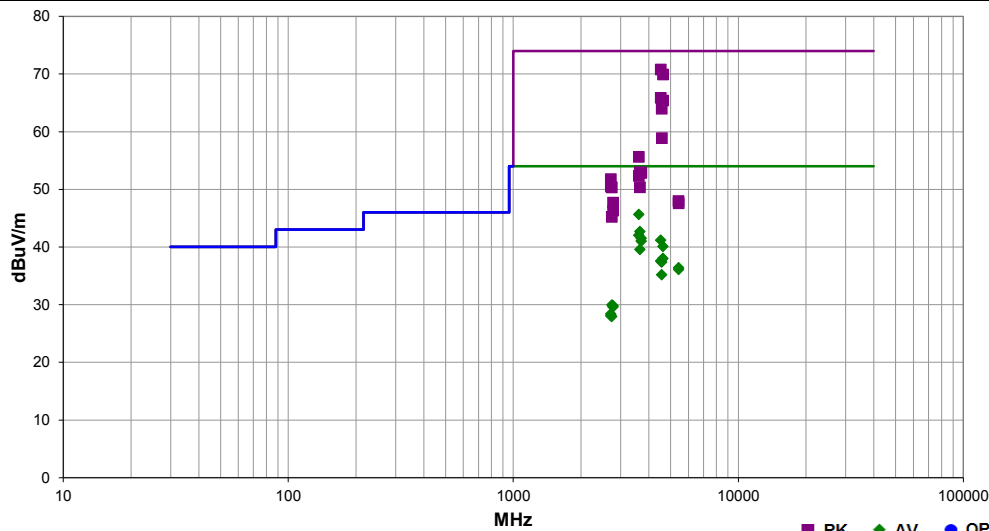


Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
4636.608	57.9	9.1	1.6	38.0	3.0	0.0	Horz	PK	0.0	67.0	74.0	-7.0	High Ch, 1Mb, EUT Vertical
4517.250	58.3	7.9	1.6	64.0	3.0	0.0	Vert	PK	0.0	66.2	74.0	-7.8	Low Ch, 1Mb, EUT on Side
3611.242	42.1	4.0	1.6	52.0	3.0	0.0	Horz	AV	0.0	46.1	54.0	-7.9	Low Ch, 1Mb, EUT Vertical
3611.258	41.7	4.0	1.1	39.0	3.0	0.0	Vert	AV	0.0	45.7	54.0	-8.3	Low Ch, 1Mb, EUT on Side
4517.342	55.7	7.9	2.9	111.0	3.0	0.0	Horz	PK	0.0	63.6	74.0	-10.4	Low Ch, 1Mb, EUT Vertical
3655.458	38.5	4.8	1.3	46.0	3.0	0.0	Horz	AV	0.0	43.3	54.0	-10.7	Mid Ch, 1Mb, EUT Vertical
4572.475	52.8	8.5	1.6	184.0	3.0	0.0	Horz	PK	0.0	61.3	74.0	-12.7	Mid Ch, 1Mb, EUT Vertical
4636.875	51.9	9.1	1.6	323.0	3.0	0.0	Vert	PK	0.0	61.0	74.0	-13.0	High Ch, 1Mb, EUT on Side
4572.808	52.0	8.5	1.3	171.0	3.0	0.0	Vert	PK	0.0	60.5	74.0	-13.5	Mid Ch, 1Mb, EUT on Side
4516.358	31.4	7.9	1.6	64.0	3.0	0.0	Vert	AV	0.0	39.3	54.0	-14.7	Low Ch, 1Mb, EUT on Side
3707.100	34.0	5.2	1.4	56.0	3.0	0.0	Horz	AV	0.0	39.2	54.0	-14.8	High Ch, 1Mb, EUT Vertical
4636.475	29.9	9.1	1.6	38.0	3.0	0.0	Horz	AV	0.0	39.0	54.0	-15.0	High Ch, 1Mb, EUT Vertical
4516.417	29.7	7.9	2.9	111.0	3.0	0.0	Horz	AV	0.0	37.6	54.0	-16.4	Low Ch, 1Mb, EUT Vertical
3655.458	32.7	4.8	1.6	316.0	3.0	0.0	Vert	AV	0.0	37.5	54.0	-16.5	Mid Ch, 1Mb, EUT on Side
3707.133	32.1	5.2	2.8	288.0	3.0	0.0	Vert	AV	0.0	37.3	54.0	-16.7	High Ch, 1Mb, EUT on Side
5416.808	26.1	10.9	1.6	39.0	3.0	0.0	Horz	AV	0.0	37.0	54.0	-17.0	Low Ch, 1Mb, EUT Vertical
4636.283	27.1	9.1	1.6	323.0	3.0	0.0	Vert	AV	0.0	36.2	54.0	-17.8	High Ch, 1Mb, EUT on Side
5417.575	25.2	10.9	1.6	186.0	3.0	0.0	Vert	AV	0.0	36.1	54.0	-17.9	Low Ch, 1Mb, EUT on Side
4571.908	27.5	8.5	1.3	171.0	3.0	0.0	Vert	AV	0.0	36.0	54.0	-18.0	Mid Ch, 1Mb, EUT on Side
4572.217	27.2	8.5	1.6	184.0	3.0	0.0	Horz	AV	0.0	35.7	54.0	-18.3	Mid Ch, 1Mb, EUT Vertical
2780.417	35.3	0.0	3.1	85.0	3.0	0.0	Horz	AV	0.0	35.3	54.0	-18.7	High Ch, 1Mb, EUT Vertical
3612.150	49.5	4.0	1.1	39.0	3.0	0.0	Vert	PK	0.0	53.5	74.0	-20.5	Low Ch, 1Mb, EUT on Side
3612.292	49.3	4.0	1.6	52.0	3.0	0.0	Horz	PK	0.0	53.3	74.0	-20.7	Low Ch, 1Mb, EUT Vertical
2741.667	32.8	-0.1	1.0	52.0	3.0	0.0	Horz	AV	0.0	32.7	54.0	-21.3	Mid Ch, 1Mb, EUT Vertical
2709.350	51.4	-0.1	2.0	52.0	3.0	0.0	Vert	PK	0.0	51.3	74.0	-22.7	Low Ch, 1Mb, EUT on Side
3655.483	45.9	4.8	1.3	46.0	3.0	0.0	Horz	PK	0.0	50.7	74.0	-23.3	Mid Ch, 1Mb, EUT Vertical
2780.367	30.6	0.0	1.6	335.0	3.0	0.0	Vert	AV	0.0	30.6	54.0	-23.4	High Ch, 1Mb, EUT on Side
3708.083	45.1	5.2	1.4	56.0	3.0	0.0	Horz	PK	0.0	50.3	74.0	-23.7	High Ch, 1Mb, EUT Vertical
2709.733	28.9	-0.1	2.0	52.0	3.0	0.0	Vert	AV	0.0	28.8	54.0	-25.2	Low Ch, 1Mb, EUT on Side
5418.492	37.6	10.9	1.6	39.0	3.0	0.0	Horz	PK	0.0	48.5	74.0	-25.5	Low Ch, 1Mb, EUT Vertical
2741.908	28.1	-0.1	1.6	182.0	3.0	0.0	Vert	AV	0.0	28.0	54.0	-26.0	Mid Ch, 1Mb, EUT on Side
2708.533	28.1	-0.1	1.6	167.0	3.0	0.0	Horz	AV	0.0	28.0	54.0	-26.0	Low Ch, 1Mb, EUT Vertical
2709.300	47.9	-0.1	1.6	167.0	3.0	0.0	Horz	PK	0.0	47.8	74.0	-26.2	Low Ch, 1Mb, EUT Vertical
5415.617	36.9	10.8	1.6	186.0	3.0	0.0	Vert	PK	0.0	47.7	74.0	-26.3	Low Ch, 1Mb, EUT on Side
3707.900	42.5	5.2	2.8	288.0	3.0	0.0	Vert	PK	0.0	47.7	74.0	-26.3	High Ch, 1Mb, EUT on Side
3655.367	41.8	4.8	1.6	316.0	3.0	0.0	Vert	PK	0.0	46.6	74.0	-27.4	Mid Ch, 1Mb, EUT on Side
2781.100	46.2	0.0	3.1	85.0	3.0	0.0	Horz	PK	0.0	46.2	74.0	-27.8	High Ch, 1Mb, EUT Vertical
2742.775	45.5	-0.1	1.0	52.0	3.0	0.0	Horz	PK	0.0	45.4	74.0	-28.6	Mid Ch, 1Mb, EUT Vertical
2781.108	42.0	0.0	1.6	335.0	3.0	0.0	Vert	PK	0.0	42.0	74.0	-32.0	High Ch, 1Mb, EUT on Side
2744.108	39.3	-0.1	1.6	182.0	3.0	0.0	Vert	PK	0.0	39.2	74.0	-34.8	Mid Ch, 1Mb, EUT on Side

Work Order:	FREW0058	Date:	03/17/16	
Project:	None	Temperature:	23 °C	
Job Site:	NC01	Humidity:	27% RH	
Serial Number:	402-669-0330	Barometric Pres.:	1030 mbar	
EUT:	Z9-T (board unit w/TTL interface), Z9-C (board unit w/RS232 interface)			Tested by: Richard Melliroth
Configuration:	2			
Customer:	FreeWave Technologies, Inc.			
Attendees:	Dean Busch			
EUT Power:	12 VDC			
Operating Mode:	Transmitting at 4Mb at Maximum Duty Cycle. See comments next to data points for EUT channel and orientation. See power table for power settings.			
Deviations:	None			
Comments:	8.6dBi Yagi antenna.			

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

Run #	59	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
4522.650	62.8	8.0	1.5	74.0	3.0	0.0	Horz	PK	0.0	70.8	74.0	-3.2	Low Ch, 4Mb, EUT Vertical
4627.058	60.8	9.1	3.6	298.0	3.0	0.0	Vert	PK	0.0	69.9	74.0	-4.1	High Ch, 4Mb, EUT on Side
4522.217	57.9	8.0	1.6	69.0	3.0	0.0	Vert	PK	0.0	65.9	74.0	-8.1	Low Ch, 4Mb, EUT on Side
3615.525	41.6	4.0	1.3	37.0	3.0	0.0	Vert	AV	0.0	45.6	54.0	-8.4	Low Ch, 4Mb, EUT on Side
4627.133	56.3	9.1	1.5	100.0	3.0	0.0	Horz	PK	0.0	65.4	74.0	-8.6	High Ch, 4Mb, EUT Vertical
4570.133	55.5	8.5	1.6	270.0	3.0	0.0	Horz	PK	0.0	64.0	74.0	-10.0	Mid Ch, 4Mb, EUT Vertical
3656.200	37.9	4.8	2.4	44.0	3.0	0.0	Horz	AV	0.0	42.7	54.0	-11.3	Mid Ch, 4Mb, EUT Vertical
3615.525	38.0	4.0	1.6	357.0	3.0	0.0	Horz	AV	0.0	42.0	54.0	-12.0	Low Ch, 4Mb, EUT Vertical
3703.433	36.3	5.2	1.4	52.0	3.0	0.0	Horz	AV	0.0	41.5	54.0	-12.5	High Ch, 4Mb, EUT Vertical
4522.342	33.2	8.0	1.5	74.0	3.0	0.0	Horz	AV	0.0	41.2	54.0	-12.8	Low Ch, 4Mb, EUT Vertical
3703.625	35.8	5.2	1.4	34.0	3.0	0.0	Vert	AV	0.0	41.0	54.0	-13.0	High Ch, 4Mb, EUT on Side
4627.100	31.0	9.1	3.6	298.0	3.0	0.0	Vert	AV	0.0	40.1	54.0	-13.9	High Ch, 4Mb, EUT on Side
3656.117	34.8	4.8	1.6	32.0	3.0	0.0	Vert	AV	0.0	39.6	54.0	-14.4	Mid Ch, 4Mb, EUT on Side
4570.767	50.4	8.5	1.5	149.0	3.0	0.0	Vert	PK	0.0	58.9	74.0	-15.1	Mid Ch, 4Mb, EUT on Side
4626.933	28.9	9.1	1.5	100.0	3.0	0.0	Horz	AV	0.0	38.0	54.0	-16.0	High Ch, 4Mb, EUT Vertical
4522.642	29.6	8.0	1.6	69.0	3.0	0.0	Vert	AV	0.0	37.6	54.0	-16.4	Low Ch, 4Mb, EUT on Side
4569.563	28.9	8.5	1.6	270.0	3.0	0.0	Horz	AV	0.0	37.4	54.0	-16.6	Mid Ch, 4Mb, EUT Vertical
5429.008	25.5	10.9	2.4	43.0	3.0	0.0	Horz	AV	0.0	36.4	54.0	-17.6	Low Ch, 4Mb, EUT Vertical
5429.433	25.2	10.9	1.6	126.0	3.0	0.0	Vert	AV	0.0	36.1	54.0	-17.9	Low Ch, 4Mb, EUT on Side
3615.567	51.6	4.0	1.3	37.0	3.0	0.0	Vert	PK	0.0	55.6	74.0	-18.4	Low Ch, 4Mb, EUT on Side
4569.767	26.7	8.5	1.5	149.0	3.0	0.0	Vert	AV	0.0	35.2	54.0	-18.8	Mid Ch, 4Mb, EUT on Side
3655.617	48.2	4.8	2.4	44.0	3.0	0.0	Horz	PK	0.0	53.0	74.0	-21.0	Mid Ch, 4Mb, EUT Vertical
3701.150	47.7	5.2	1.4	34.0	3.0	0.0	Vert	PK	0.0	52.9	74.0	-21.1	High Ch, 4Mb, EUT on Side
3701.075	47.7	5.2	1.4	52.0	3.0	0.0	Horz	PK	0.0	52.9	74.0	-21.1	High Ch, 4Mb, EUT on Side
3615.558	48.3	4.0	1.6	357.0	3.0	0.0	Horz	PK	0.0	52.3	74.0	-21.7	Low Ch, 4Mb, EUT Vertical
2712.058	51.9	-0.1	1.6	40.0	3.0	0.0	Vert	PK	0.0	51.8	74.0	-22.2	Low Ch, 4Mb, EUT on Side
2713.300	50.6	-0.1	1.9	73.0	3.0	0.0	Horz	PK	0.0	50.5	74.0	-23.5	Low Ch, 4Mb, EUT Vertical
3655.583	45.6	4.8	1.6	32.0	3.0	0.0	Vert	PK	0.0	50.4	74.0	-23.6	Mid Ch, 4Mb, EUT on Side
2740.958	50.4	-0.1	3.9	52.0	3.0	0.0	Horz	PK	0.0	50.3	74.0	-23.7	Mid Ch, 4Mb, EUT Vertical
2742.875	30.0	-0.1	3.9	52.0	3.0	0.0	Horz	AV	0.0	29.9	54.0	-24.1	Mid Ch, 4Mb, EUT Vertical
2777.633	29.8	0.0	1.6	162.0	3.0	0.0	Horz	AV	0.0	29.8	54.0	-24.2	High Ch, 4Mb, EUT Vertical
2778.125	29.6	0.0	1.6	216.0	3.0	0.0	Vert	AV	0.0	29.6	54.0	-24.4	High Ch, 4Mb, EUT on Side
2713.583	28.5	-0.1	1.6	40.0	3.0	0.0	Vert	AV	0.0	28.4	54.0	-25.6	Low Ch, 4Mb, EUT on Side
2713.458	28.2	-0.1	1.9	73.0	3.0	0.0	Horz	AV	0.0	28.1	54.0	-25.9	Low Ch, 4Mb, EUT Vertical
5425.017	37.1	10.9	2.4	43.0	3.0	0.0	Horz	PK	0.0	48.0	74.0	-26.0	Low Ch, 4Mb, EUT Vertical
2740.908	28.0	-0.1	1.6	236.0	3.0	0.0	Vert	AV	0.0	27.9	54.0	-26.1	Mid Ch, 4Mb, EUT on Side
2775.817	47.7	0.0	1.6	216.0	3.0	0.0	Vert	PK	0.0	47.7	74.0	-26.3	High Ch, 4Mb, EUT on Side
5427.942	36.7	10.9	1.6	126.0	3.0	0.0	Vert	PK	0.0	47.6	74.0	-26.4	Low Ch, 4Mb, EUT on Side
2775.708	46.3	0.0	1.6	162.0	3.0	0.0	Horz	PK	0.0	46.3	74.0	-27.7	High Ch, 4Mb, EUT Vertical
2741.100	45.3	-0.1	1.6	236.0	3.0	0.0	Vert	PK	0.0	45.2	74.0	-28.8	Mid Ch, 4Mb, EUT on Side

OUTPUT POWER

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	E4440A	AFE	6/22/2015	12
Block - DC	Fairview Microwave	SD3379	AMJ	6/6/2015	12
Attenuator	S.M. Electronics	SA18H-10	REJ	9/18/2015	12
Attenuator	S.M. Electronics	SA18H-20	REK	9/28/2015	12
Cable	ESM Cable Corp.	TTBJ-141 KMKM-72	NC5	6/6/2015	12
Generator - Signal	Agilent	N5183A	TIA	4/7/2014	24

TEST DESCRIPTION

The transmit frequency was set to the required channels in each band. The transmit power was set to its default maximum. A direct connection was made between the RF output of the EUT and a spectrum analyzer. Attenuation and a DC block were used. The reference level offset on the spectrum analyzer was adjusted to compensate for cable loss and the external attenuation used between the RF output and the spectrum analyzer input.

Prior to measuring peak transmit power the DTS bandwidth (B) and the transmission pulse duration (T) were measured. Both are required to determine the method of measuring Maximum Conducted Output Power. The transmission pulse duration (T) was measured using a zero span on the spectrum analyzer to see the pulses in the time domain.

The method found in ANSI C63.10:2013 Section 11.10.2 was used because the RBW on the analyzer was greater than the DTS Bandwidth of the radio..

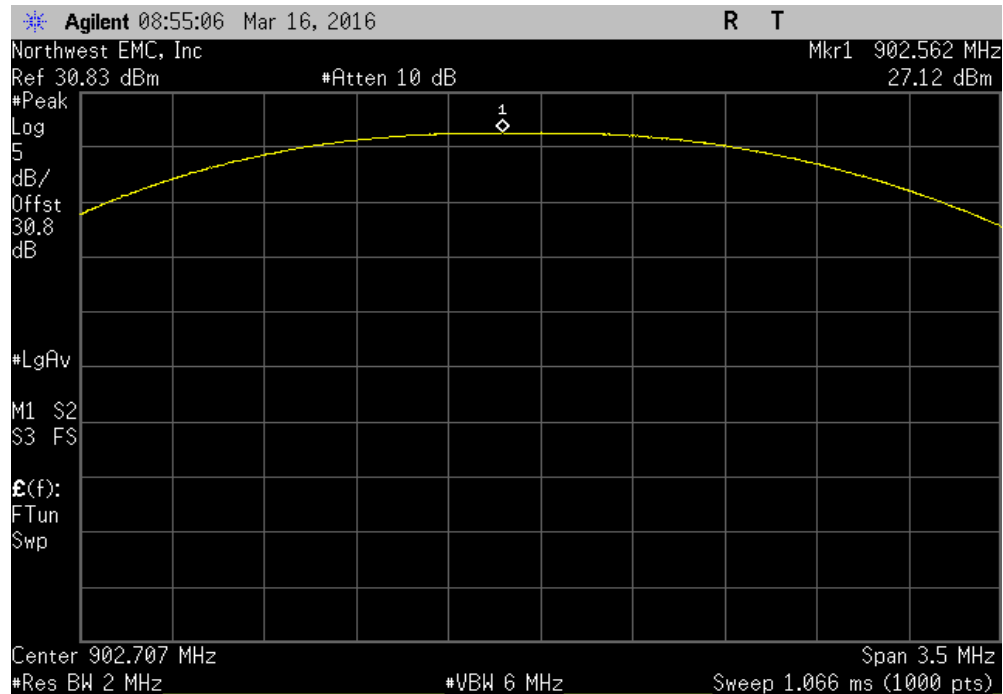
De Facto EIRP Limit: Per 47 CFR 15.247 (b)(1-3), the EUT meets the de facto EIRP limit of +36 dBm.

OUTPUT POWER

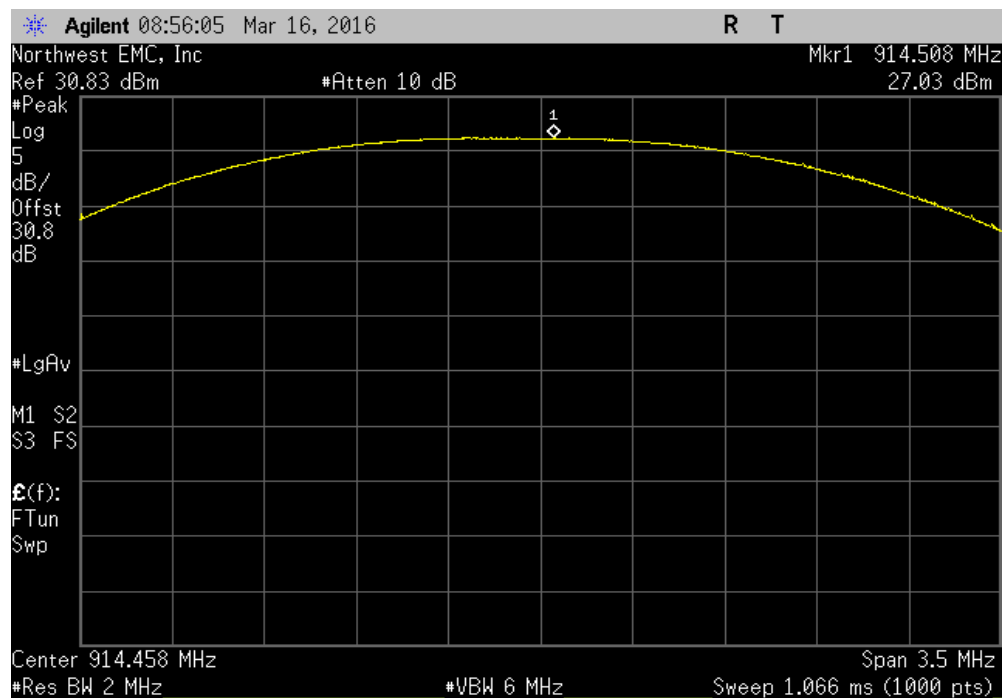
EUT: Z9-T (board unit w/TTL interface), Z9-C (board unit w/RS232 interface)		Work Order: FREW0058	
Serial Number: 402-669-0330		Date: 03/16/16	
Customer: FreeWave Technologies, Inc.		Temperature: 24°C	
Attendees: Dean Busch		Humidity: 31%	
Project: None		Barometric Pres.: 1027 mbar	
Tested by: Richard Mellroth		Power: 12 VDC	
TEST SPECIFICATIONS		Test Method	
FCC 15.247:2016		ANSI C63.10:2013	
COMMENTS			
See Power Table for EUT power settings. Verifying output power levels for use with 8.6dBi antenna.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	1	Signature 	
		Value	Limit (<) Result
GFSK Modulation, 500kb			
	Low Channel 1, 902.7072 MHz	27.117 dBm	27.4 dBm Pass
	Mid Channel 18, 914.4576 MHz	27.03 dBm	27.4 dBm Pass
	High Channel 36, 927.36 MHz	27.025 dBm	27.4 dBm Pass
GFSK Modulation, 1Mb			
	Low Channel 1, 903.0528 MHz	27.151 dBm	27.4 dBm Pass
	Mid Channel 9, 914.112 MHz	27.125 dBm	27.4 dBm Pass
	High Channel 18, 927.0144 MHz	27.131 dBm	27.4 dBm Pass
GFSK Modulation, 4Mb			
	Low Channel 1, 904.5504 MHz	27.029 dBm	27.4 dBm Pass
	Mid Channel 4, 914.2272 MHz	27.023 dBm	27.4 dBm Pass
	High Channel 7, 925.7472 MHz	27.046 dBm	27.4 dBm Pass

OUTPUT POWER

GFSK Modulation, 500kb, Low Channel 1, 902.7072 MHz						
				Value	Limit (<)	Result
				27.117 dBm	27.4 dBm	Pass

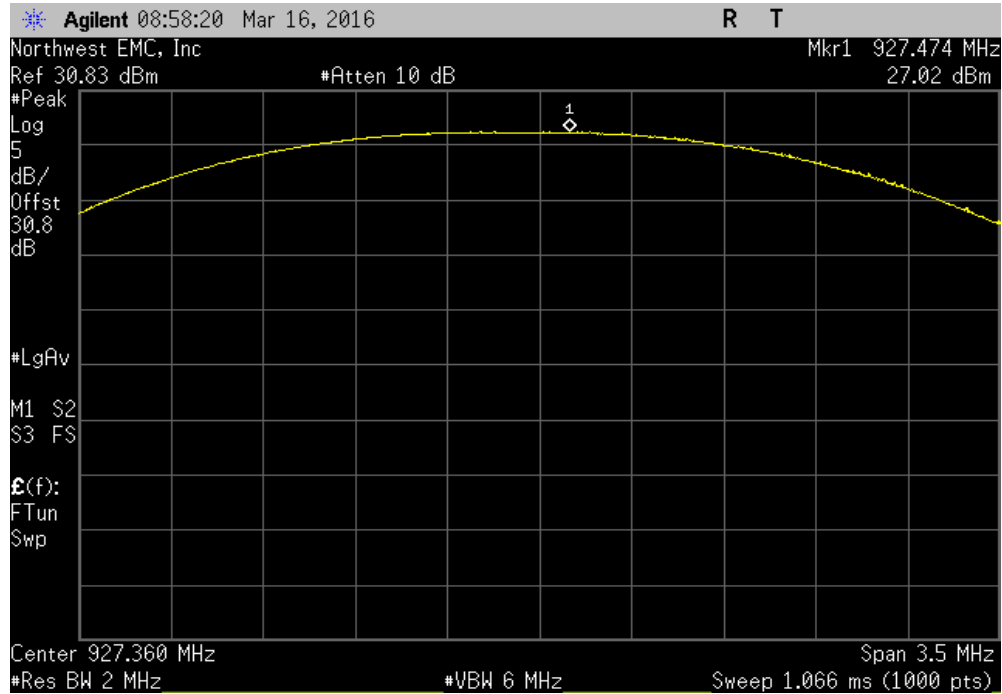


GFSK Modulation, 500kb, Mid Channel 18, 914.4576 MHz						
				Value	Limit (<)	Result
				27.03 dBm	27.4 dBm	Pass

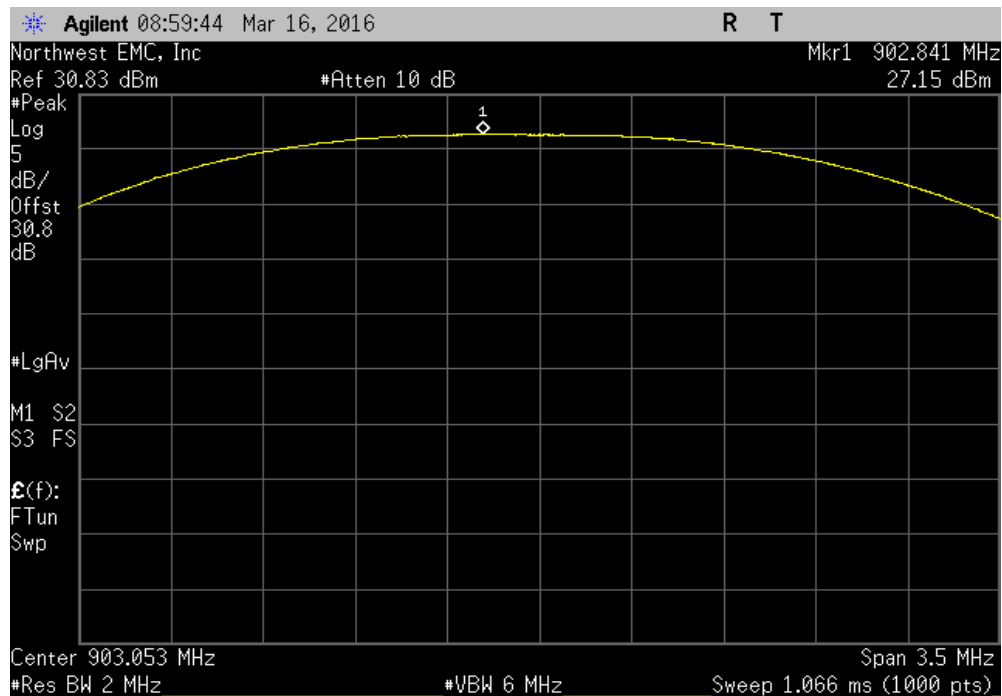


OUTPUT POWER

GFSK Modulation, 500kb, High Channel 36, 927.36 MHz						
				Value	Limit (<)	Result
				27.025 dBm	27.4 dBm	Pass

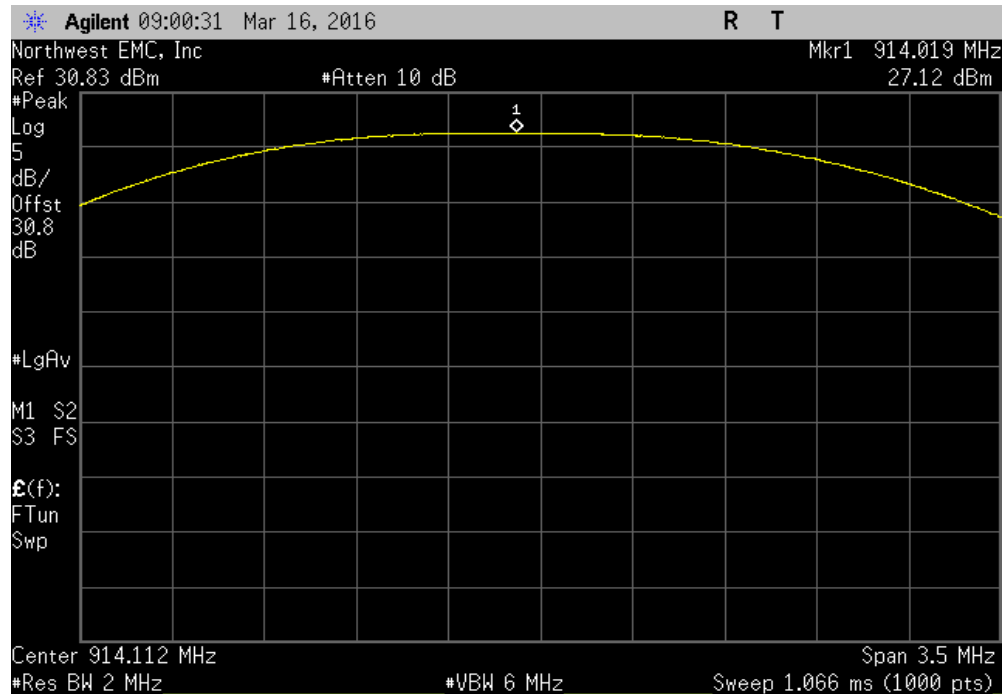


GFSK Modulation, 1Mb, Low Channel 1, 903.0528 MHz						
				Value	Limit (<)	Result
				27.151 dBm	27.4 dBm	Pass

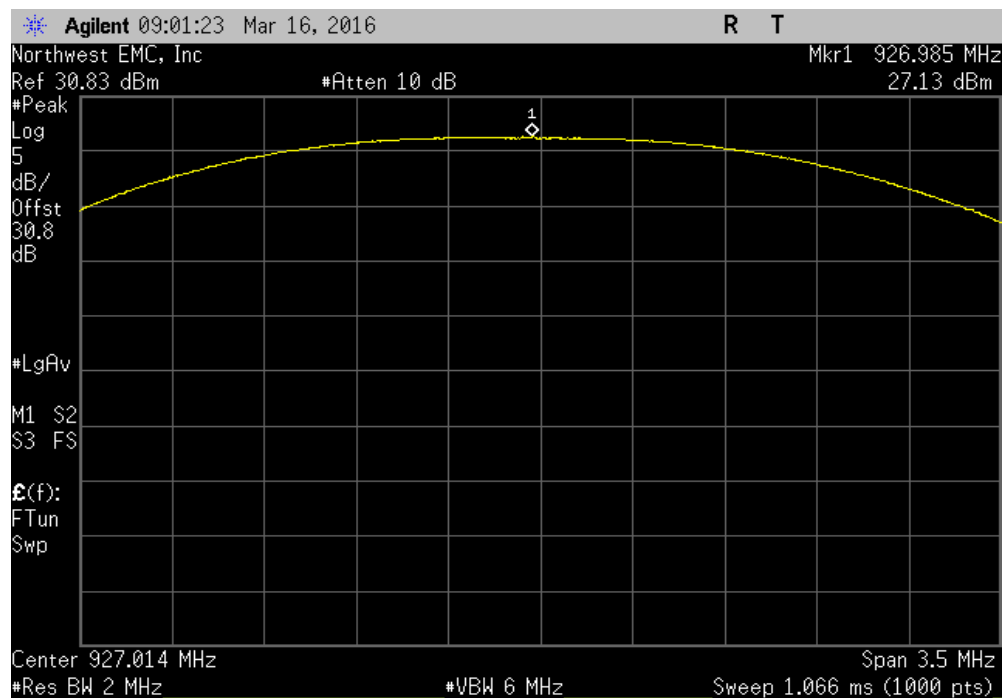


OUTPUT POWER

GFSK Modulation, 1Mb, Mid Channel 9, 914.112 MHz						
				Value	Limit (<)	Result
				27.125 dBm	27.4 dBm	Pass

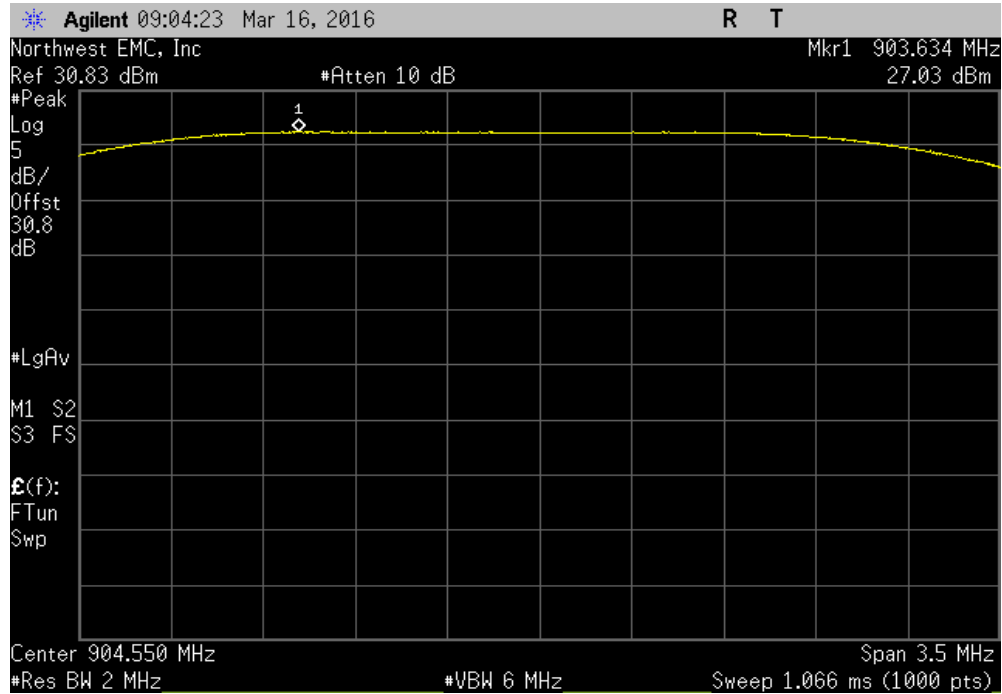


GFSK Modulation, 1Mb, High Channel 18, 927.0144 MHz						
				Value	Limit (<)	Result
				27.131 dBm	27.4 dBm	Pass

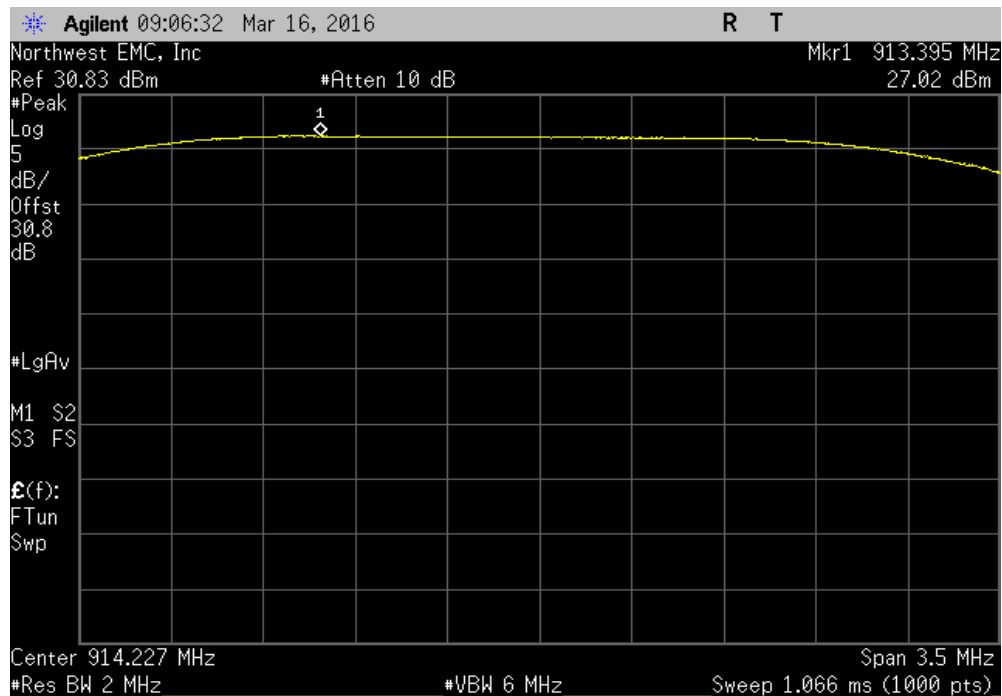


OUTPUT POWER

GFSK Modulation, 4Mb, Low Channel 1, 904.5504 MHz						
				Value	Limit (<)	Result
				27.029 dBm	27.4 dBm	Pass



GFSK Modulation, 4Mb, Mid Channel 4, 914.2272 MHz						
				Value	Limit (<)	Result
				27.023 dBm	27.4 dBm	Pass



OUTPUT POWER

GFSK Modulation, 4Mb, High Channel 7, 925.7472 MHz						
				Value	Limit (<)	Result
				27.046 dBm	27.4 dBm	Pass

