NORTHWEST EMC

FreeWave Technologies, Inc.

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

FCC 15.247:2016

FHSS Radio

Report # FREW0058.4

NVLAP Lab Code: 200629-0

CERTIFICATE OF TEST

NORTHWEST EMC
2014-12-10

Last Date of Test: March 18, 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 required to support this Class II permissive change.
6.5, 6.6	Spurious Radiated Emissions	Yes	Pass	
7.5	Duty Cycle Correction	Yes	N/A	
7.8.2	Carrier Frequency Separation	No	N/A	Not required to support this Class II permissive change.
7.8.3	Number of Hopping Frequencies	No	N/A	Not required to support this Class II permissive change.
7.8.4	Dwell Time	No	N/A	Not required to support this Class II permissive change.
7.8.5	Output Power	Yes	Pass	
7.8.6	Band Edge Compliance	No	N/A	Not required to support this Class II permissive change.
7.8.6	Band Edge Compliance - Hopping Mode	No	N/A	Not required to support this Class II permissive change.
7.8.7	Occupied Bandwidth	No	N/A	Not required to support this Class II permissive change.
7.8.8	Spurious Conducted Emissions	No	N/A	Not required to support this Class II permissive change.
11.10.2	Power Spectral Density	No	N/A	Not required for FHSS devices.

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

NORTHWEST EMC
REV 2014.10.14

Revision Number	Description	Date	Page Number
00	None		

ACCREDITATIONS AND AUTHORIZATIONS

NORTHWEST EMC
REV 2016.3.22

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

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.

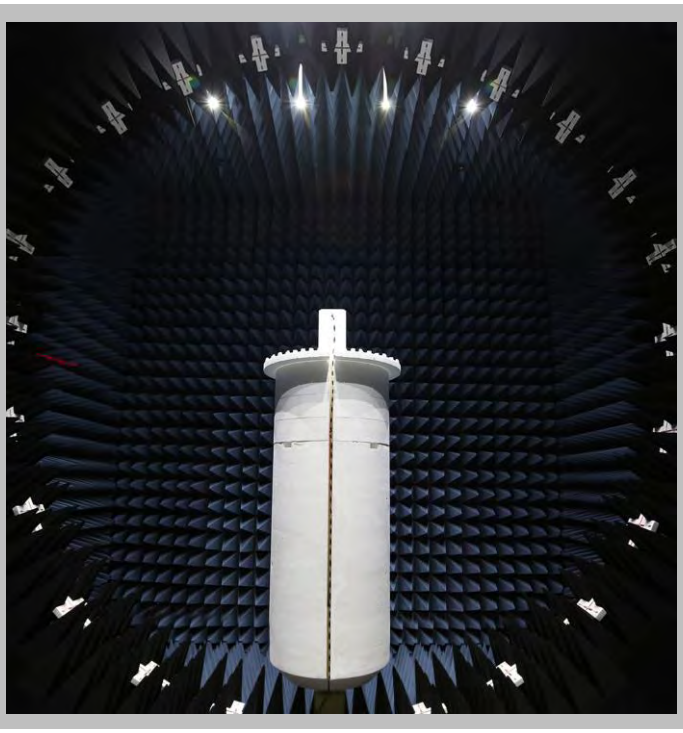
The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

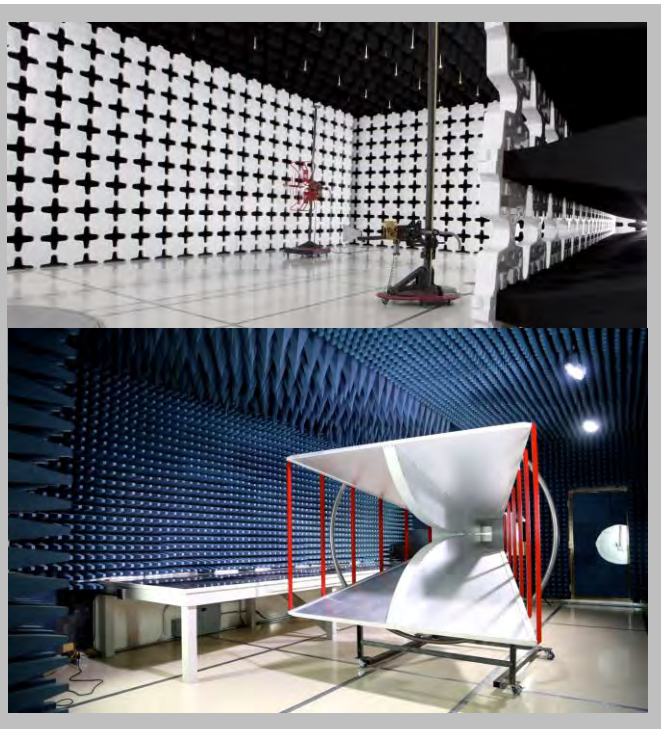
Test	+ MU	- MU
Frequency Accuracy (Hz)	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	0.3 dB	-0.3 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	5.0 dB	-5.0 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:	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 18, 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 a FHSS Mode. 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 FHSS radio under FCC 15.247 for operation in the 902-928 MHz band done under FREW0054 for FCC ID: KNYPMT0101AA

FHSS RF Power Table – FCC 15.247

Power Settings for 8.6dBi Antenna Configuration:

	Data Rate	
	115.2kb	**250kb**
Low Channel	28	28
Mid Channel	28	28
High Channel	28	28

CONFIGURATIONS

NORTHWEST EMC 2014-12-10

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

NORTHWEST EMC 2014-12-10

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

NORTHWEST EMC
2014-12-10

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	3/18/2016	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.
3	3/18/2016	Duty Cycle Correction	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

Transmitting at 115.2kb at Maximum Duty Cycle, Low Channel 2, 902.4768 MHz
Transmitting at 115.2kb at Maximum Duty Cycle, Mid Channel 56, 914.9184 MHz
Transmitting at 115.2kb at Maximum Duty Cycle, High Channel 111, 927.5904 MHz
Transmitting at 250kb at Maximum Duty Cycle, Low Channel 1, 902.5344 MHz
Transmitting at 250kb at Maximum Duty Cycle, Mid Channel 37, 914.976 MHz
Transmitting at 250kb at Maximum Duty Cycle, High Channel 73, 927.4176 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.

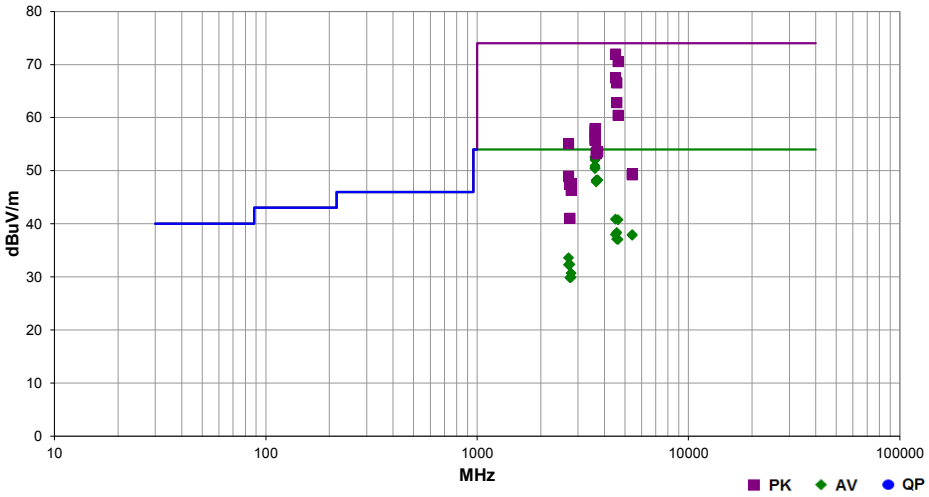
For average measurements with less than 6dB of margin, the average value was derived from the peak measurement by applying a duty cycle correction factor (DCCF), as permitted by FCC 15.35(c) for FHSS devices. Please see corresponding worksheet for measurements and calculations.

SPURIOUS RADIATED EMISSIONS

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 115.2kb 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 #	60	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



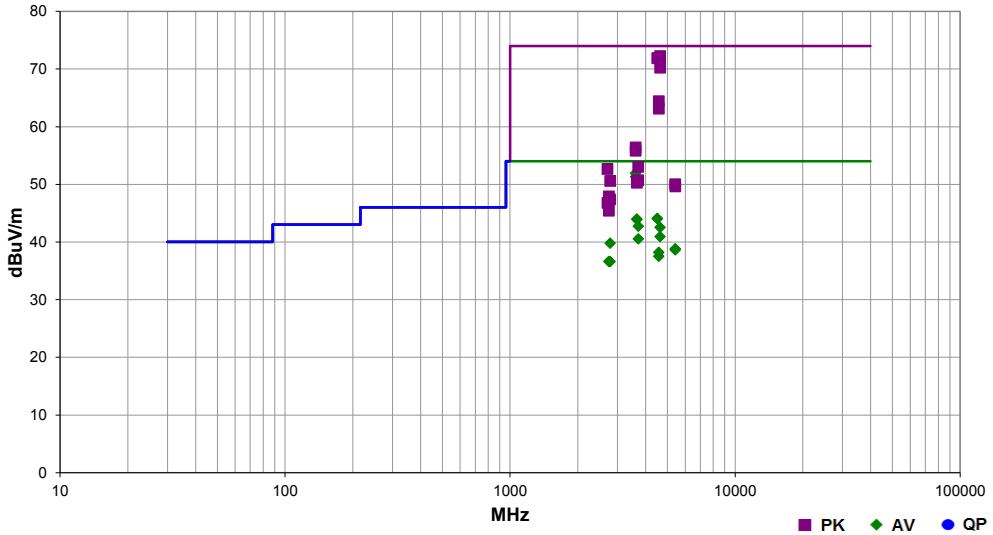
Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	DCCF (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
3609.908	54.0	3.9	1.1	48.0	3.0	-5.3	Horz	AV	0.0	52.6	54.0	-1.4	Low Ch, 115.2kb, EUT Vertical
3609.917	53.8	3.9	1.2	48.0	3.0	-5.3	Horz	AV	0.0	52.4	54.0	-1.6	Low Ch, 115.2kb, EUT Flat
3609.883	53.4	3.9	1.6	52.0	3.0	-5.3	Horz	AV	0.0	52.0	54.0	-2.0	Low Ch, 115.2kb, EUT on Side
4514.133	64.1	7.9	1.6	53.0	3.0	0.0	Horz	PK	0.0	72.0	74.0	-2.0	Low Ch, 115.2kb, EUT Flat
3609.850	52.3	3.9	1.6	33.0	3.0	-5.3	Vert	AV	0.0	50.9	54.0	-3.1	Low Ch, 115.2kb, EUT Flat
4639.275	61.4	9.2	1.6	27.0	3.0	0.0	Vert	PK	0.0	70.6	74.0	-3.4	High Ch, 115.2kb, EUT Vertical
3609.875	51.9	3.9	1.4	35.0	3.0	-5.3	Vert	AV	0.0	50.5	54.0	-3.5	Low Ch, 115.2kb, EUT Vertical
3609.933	51.8	3.9	1.6	34.0	3.0	-5.3	Vert	AV	0.0	50.4	54.0	-3.6	Low Ch, 115.2kb, EUT on Side
3710.367	48.3	5.3	1.6	43.0	3.0	-5.3	Horz	AV	0.0	48.3	54.0	-5.7	High Ch, 115.2kb, EUT Flat
3710.308	48.3	5.3	1.1	32.0	3.0	-5.3	Vert	AV	0.0	48.3	54.0	-5.7	High Ch, 115.2kb, EUT Vertical
3659.575	48.7	4.8	1.0	34.0	3.0	-5.3	Vert	AV	0.0	48.2	54.0	-5.8	Mid Ch, 115.2kb, EUT Vertical
3659.692	48.4	4.8	1.0	44.0	3.0	-5.3	Horz	AV	0.0	47.9	54.0	-6.1	Mid Ch, 115.2kb, EUT Flat
4514.283	59.6	7.9	1.6	156.0	3.0	0.0	Vert	PK	0.0	67.5	74.0	-6.5	Low Ch, 115.2kb, EUT Vertical
4576.033	58.0	8.5	1.6	165.0	3.0	0.0	Vert	PK	0.0	66.5	74.0	-7.5	Mid Ch, 115.2kb, EUT Vertical
4576.025	54.3	8.5	3.8	133.0	3.0	0.0	Horz	PK	0.0	62.8	74.0	-11.2	Mid Ch, 115.2kb, EUT Flat
4514.300	33.0	7.9	1.6	53.0	3.0	0.0	Horz	AV	0.0	40.9	54.0	-13.1	Low Ch, 115.2kb, EUT Flat
4638.367	31.6	9.2	1.6	27.0	3.0	0.0	Vert	AV	0.0	40.8	54.0	-13.2	High Ch, 115.2kb, EUT Vertical
4639.092	51.3	9.2	1.6	171.0	3.0	0.0	Horz	PK	0.0	60.5	74.0	-13.5	High Ch, 115.2kb, EUT Flat
4575.900	29.8	8.5	1.6	165.0	3.0	0.0	Vert	AV	0.0	38.3	54.0	-15.7	Mid Ch, 115.2kb, EUT Vertical
4514.150	30.1	7.9	1.6	156.0	3.0	0.0	Vert	AV	0.0	38.0	54.0	-16.0	Low Ch, 115.2kb, EUT Vertical
3610.842	54.0	3.9	1.1	48.0	3.0	0.0	Horz	PK	0.0	57.9	74.0	-16.1	Low Ch, 115.2kb, EUT Vertical
5414.833	27.1	10.8	1.6	21.0	3.0	0.0	Vert	AV	0.0	37.9	54.0	-16.1	Low Ch, 115.2kb, EUT Vertical
5414.742	27.0	10.8	1.6	311.0	3.0	0.0	Horz	AV	0.0	37.8	54.0	-16.2	Low Ch, 115.2kb, EUT Flat
3610.800	53.8	3.9	1.2	48.0	3.0	0.0	Horz	PK	0.0	57.7	74.0	-16.3	Low Ch, 115.2kb, EUT Flat
3610.708	53.4	3.9	1.6	52.0	3.0	0.0	Horz	PK	0.0	57.3	74.0	-16.7	Low Ch, 115.2kb, EUT on Side
4574.492	28.6	8.5	3.8	133.0	3.0	0.0	Horz	AV	0.0	37.1	54.0	-16.9	Mid Ch, 115.2kb, EUT Flat
4638.208	27.9	9.2	1.6	171.0	3.0	0.0	Horz	AV	0.0	37.1	54.0	-16.9	High Ch, 115.2kb, EUT Flat
3610.858	52.3	3.9	1.6	33.0	3.0	0.0	Vert	PK	0.0	56.2	74.0	-17.8	Low Ch, 115.2kb, EUT Flat
3610.600	51.9	3.9	1.4	35.0	3.0	0.0	Vert	PK	0.0	55.8	74.0	-18.2	Low Ch, 115.2kb, EUT Vertical
3610.217	51.8	3.9	1.6	34.0	3.0	0.0	Vert	PK	0.0	55.7	74.0	-18.3	Low Ch, 115.2kb, EUT on Side
2707.317	55.2	-0.1	2.4	34.0	3.0	0.0	Vert	PK	0.0	55.1	74.0	-18.9	Low Ch, 115.2kb, EUT Vertical
2707.358	33.7	-0.1	1.6	86.0	3.0	0.0	Horz	AV	0.0	33.6	54.0	-20.4	Low Ch, 115.2kb, EUT Flat
3711.008	48.3	5.3	1.1	32.0	3.0	0.0	Vert	PK	0.0	53.6	74.0	-20.4	High Ch, 115.2kb, EUT Vertical
3710.592	48.3	5.3	1.6	43.0	3.0	0.0	Horz	PK	0.0	53.6	74.0	-20.4	High Ch, 115.2kb, EUT Flat
3660.517	48.7	4.8	1.0	34.0	3.0	0.0	Vert	PK	0.0	53.5	74.0	-20.5	Mid Ch, 115.2kb, EUT Vertical
3659.658	48.4	4.8	1.0	44.0	3.0	0.0	Horz	PK	0.0	53.2	74.0	-20.8	Mid Ch, 115.2kb, EUT Flat
2744.692	32.4	-0.1	1.0	151.0	3.0	0.0	Horz	AV	0.0	32.3	54.0	-21.7	Mid Ch, 115.2kb, EUT Flat
2707.292	32.4	-0.1	2.4	34.0	3.0	0.0	Vert	AV	0.0	32.3	54.0	-21.7	Low Ch, 115.2kb, EUT Vertical
2782.725	30.7	0.0	1.6	120.0	3.0	0.0	Horz	AV	0.0	30.7	54.0	-23.3	High Ch, 115.2kb, EUT Flat
2782.583	29.9	0.0	1.6	30.0	3.0	0.0	Vert	AV	0.0	29.9	54.0	-24.1	High Ch, 115.2kb, EUT Vertical
2744.758	29.9	-0.1	1.6	287.0	3.0	0.0	Vert	AV	0.0	29.8	54.0	-24.2	Mid Ch, 115.2kb, EUT Vertical
5415.817	38.6	10.8	1.6	21.0	3.0	0.0	Vert	PK	0.0	49.4	74.0	-24.6	Low Ch, 115.2kb, EUT Vertical
5414.483	38.4	10.8	1.6	311.0	3.0	0.0	Horz	PK	0.0	49.2	74.0	-24.8	Low Ch, 115.2kb, EUT Flat
2707.367	49.1	-0.1	1.6	86.0	3.0	0.0	Horz	PK	0.0	49.0	74.0	-25.0	Low Ch, 115.2kb, EUT Flat
2782.850	47.6	0.0	1.6	30.0	3.0	0.0	Vert	PK	0.0	47.6	74.0	-26.4	High Ch, 115.2kb, EUT Vertical
2745.467	47.5	-0.1	1.0	151.0	3.0	0.0	Horz	PK	0.0	47.4	74.0	-26.6	Mid Ch, 115.2kb, EUT Flat
2783.192	46.3	0.0	1.6	120.0	3.0	0.0	Horz	PK	0.0	46.3	74.0	-27.7	High Ch, 115.2kb, EUT Flat
2744.542	41.1	-0.1	1.6	287.0	3.0	0.0	Vert	PK	0.0	41.0	74.0	-33.0	Mid Ch, 115.2kb, EUT Vertical

SPURIOUS RADIATED EMISSIONS

Work Order:	FREW0058	**Date:**	03/18/16		
Project:	None	**Temperature:**	23 °C		
Job Site:	NC01	**Humidity:**	23% RH		
Serial Number:	402-669-0330	**Barometric Pres.:**	1021 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 250kb 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 #	61	**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)	DCCF (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
4638.467	63.1	9.2	1.6	69.0	3.0	0.0	Horz	PK	0.0	72.3	74.0	-1.7	High Ch, 250kb, EUT Flat
3610.058	52.5	3.9	1.2	49.0	3.0	-4.5	Horz	AV	0.0	51.9	54.0	-2.1	Low Ch, 250kb, EUT Flat
4514.833	64.0	7.9	1.6	63.0	3.0	0.0	Horz	PK	0.0	71.9	74.0	-2.1	Low Ch, 250kb, EUT Flat
4514.583	64.0	7.9	1.4	61.0	3.0	0.0	Vert	PK	0.0	71.9	74.0	-2.1	Low Ch, 250kb, EUT Vertical
3610.167	51.9	3.9	1.4	34.0	3.0	-4.5	Vert	AV	0.0	51.3	54.0	-2.7	Low Ch, 250kb, EUT Vertical
4638.567	61.1	9.2	1.4	58.0	3.0	0.0	Vert	PK	0.0	70.3	74.0	-3.7	High Ch, 250kb, EUT Vertical
4575.892	55.9	8.5	1.6	283.0	3.0	0.0	Vert	PK	0.0	64.4	74.0	-9.6	Mid Ch, 250kb, EUT Vertical
4512.683	36.2	7.9	1.4	61.0	3.0	0.0	Vert	AV	0.0	44.1	54.0	-9.9	Low Ch, 250kb, EUT Vertical
4512.617	36.2	7.9	1.6	63.0	3.0	0.0	Horz	AV	0.0	44.1	54.0	-9.9	Low Ch, 250kb, EUT Flat
3659.850	39.2	4.8	1.6	148.0	3.0	0.0	Horz	AV	0.0	44.0	54.0	-10.0	Mid Ch, 250kb, EUT Flat
3659.825	39.1	4.8	1.4	33.0	3.0	0.0	Vert	AV	0.0	43.9	54.0	-10.1	Mid Ch, 250kb, EUT Vertical
4576.692	54.6	8.5	1.6	181.0	3.0	0.0	Horz	PK	0.0	63.1	74.0	-10.9	Mid Ch, 250kb, EUT Flat
3709.642	37.5	5.2	1.3	140.0	3.0	0.0	Horz	AV	0.0	42.7	54.0	-11.3	High Ch, 250kb, EUT Flat
4637.475	33.4	9.1	1.6	69.0	3.0	0.0	Horz	AV	0.0	42.5	54.0	-11.5	High Ch, 250kb, EUT Flat
4637.342	31.8	9.1	1.4	58.0	3.0	0.0	Vert	AV	0.0	40.9	54.0	-13.1	High Ch, 250kb, EUT Vertical
3709.617	35.3	5.2	1.6	31.0	3.0	0.0	Vert	AV	0.0	40.5	54.0	-13.5	High Ch, 250kb, EUT Vertical
2782.200	39.8	0.0	3.6	61.0	3.0	0.0	Horz	AV	0.0	39.8	54.0	-14.2	High Ch, 250kb, EUT Flat
5414.983	28.0	10.8	1.5	121.0	3.0	0.0	Horz	AV	0.0	38.8	54.0	-15.2	Low Ch, 250kb, EUT Flat
5415.092	27.8	10.8	1.6	22.0	3.0	0.0	Vert	AV	0.0	38.6	54.0	-15.4	Low Ch, 250kb, EUT Vertical
4574.967	29.7	8.5	1.6	283.0	3.0	0.0	Vert	AV	0.0	38.2	54.0	-15.8	Mid Ch, 250kb, EUT Vertical
4575.050	29.0	8.5	1.6	181.0	3.0	0.0	Horz	AV	0.0	37.5	54.0	-16.5	Mid Ch, 250kb, EUT Flat
2744.875	36.7	-0.1	1.0	117.0	3.0	0.0	Horz	AV	0.0	36.6	54.0	-17.4	Mid Ch, 250kb, EUT Flat
2782.225	36.6	0.0	2.7	87.0	3.0	0.0	Vert	AV	0.0	36.6	54.0	-17.4	High Ch, 250kb, EUT Vertical
3609.908	52.5	3.9	1.2	49.0	3.0	0.0	Horz	PK	0.0	56.4	74.0	-17.6	Low Ch, 250kb, EUT Flat
2707.575	36.3	-0.1	1.0	116.0	3.0	0.0	Horz	AV	0.0	36.2	54.0	-17.8	Low Ch, 250kb, EUT Flat
3610.083	51.9	3.9	1.4	34.0	3.0	0.0	Vert	PK	0.0	55.8	74.0	-18.2	Low Ch, 250kb, EUT Vertical
2744.908	33.8	-0.1	1.0	330.0	3.0	0.0	Vert	AV	0.0	33.7	54.0	-20.3	Mid Ch, 250kb, EUT Vertical
3709.292	47.8	5.2	1.3	140.0	3.0	0.0	Horz	PK	0.0	53.0	74.0	-21.0	High Ch, 250kb, EUT Flat
2707.783	52.8	-0.1	2.1	354.0	3.0	0.0	Vert	PK	0.0	52.7	74.0	-21.3	Low Ch, 250kb, EUT Vertical
2707.533	32.3	-0.1	2.1	354.0	3.0	0.0	Vert	AV	0.0	32.2	54.0	-21.8	Low Ch, 250kb, EUT Vertical
3708.825	45.5	5.2	1.6	31.0	3.0	0.0	Vert	PK	0.0	50.7	74.0	-23.3	High Ch, 250kb, EUT Vertical
2782.192	50.6	0.0	3.6	61.0	3.0	0.0	Horz	PK	0.0	50.6	74.0	-23.4	High Ch, 250kb, EUT Flat
3659.850	45.7	4.8	1.6	148.0	3.0	0.0	Horz	PK	0.0	50.5	74.0	-23.5	Mid Ch, 250kb, EUT Flat
3659.750	45.5	4.8	1.4	33.0	3.0	0.0	Vert	PK	0.0	50.3	74.0	-23.7	Mid Ch, 250kb, EUT Vertical
5414.517	39.2	10.8	1.6	22.0	3.0	0.0	Vert	PK	0.0	50.0	74.0	-24.0	Low Ch, 250kb, EUT Vertical
5414.650	38.8	10.8	1.5	121.0	3.0	0.0	Horz	PK	0.0	49.6	74.0	-24.4	Low Ch, 250kb, EUT Flat
2745.175	48.0	-0.1	1.0	330.0	3.0	0.0	Vert	PK	0.0	47.9	74.0	-26.1	Mid Ch, 250kb, EUT Vertical
2782.275	47.4	0.0	2.7	87.0	3.0	0.0	Vert	PK	0.0	47.4	74.0	-26.6	High Ch, 250kb, EUT Vertical
2707.792	46.9	-0.1	1.0	116.0	3.0	0.0	Horz	PK	0.0	46.8	74.0	-27.2	Low Ch, 250kb, EUT Flat
2745.392	45.5	-0.1	1.0	117.0	3.0	0.0	Horz	PK	0.0	45.4	74.0	-28.6	Mid Ch, 250kb, EUT Flat

DUTY CYCLE CORRECTION

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	Keysight	N9010A	AFO	6/23/2015	12
Cable	Northwest EMC	Bilog Cables	NC1	8/27/2015	12
Antenna - Biconilog	Teseq	CBL 6141B	AYL	7/30/2015	24

TEST DESCRIPTION

To derive average emission measurements for a FHSS device, a duty cycle correction factor per 15.35(c) was utilized:

Duty Cycle = On time/100 milliseconds (or the period, whichever is less)

Where “On time” = N1L1 +N2L2 +….

Where N1 is the number of type 1 pulses, L1 is length of type 1 pulses (in mS), N2 is the number of type 2 pulses, L2 is the length of type 2 pulses (in mS), etc.

Therefore, Duty Cycle = (N1L1 +N2L2 +…)/100mS.

And, Duty Cycle Correction Factor (DCCF) = 20 log [(N1L1 +N2L2 +…)/100mS]

DUTY CYCLE CORRECTION

NORTHWEST EMC

XMit 2015.01.14

EUT:	Z9-T (board unit w/TTL interface), Z9-C (board unit w/RS232 interface)			**Work Order:**	FREW0058
Serial Number:	402-669-0330			**Date:**	03/18/16
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	**Job Site:**	NC01

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

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

Configuration #	2	Signature

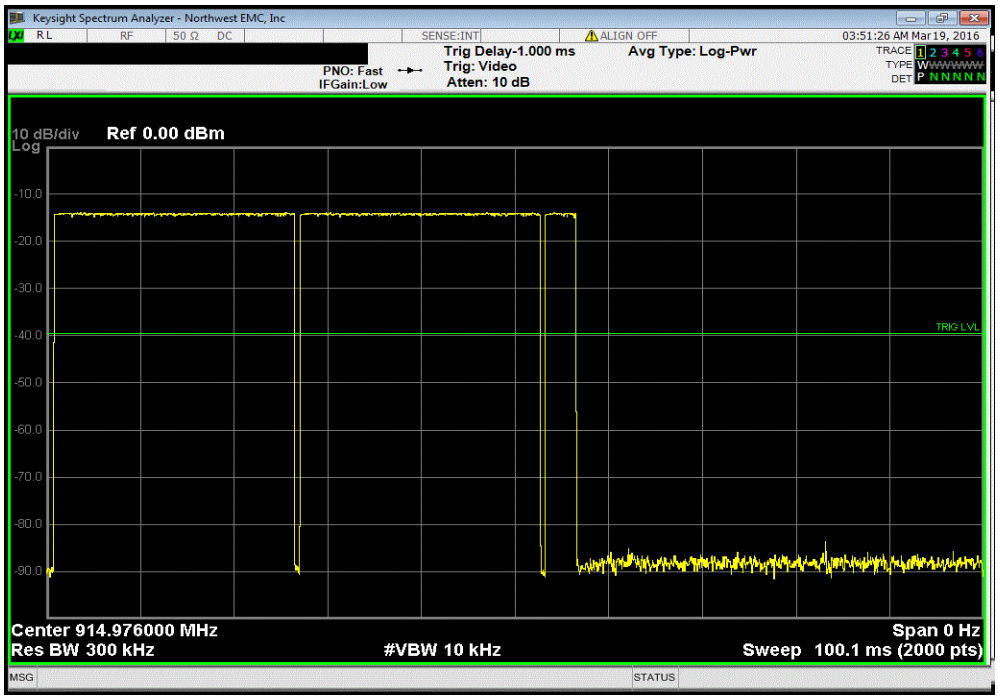
	Value (mS)	DCCF (dB)
Hopping Mode, GFSK Modulation, 115.2kb		
Transmissions in 100ms	See Graph	N/A
Pulse Width (1)	25.57	N/A
Pulse Width (2)	3.227	N/A
Duty Cycle Correction Factor	N/A	-5.3
Hopping Mode, GFSK Modulation, 250kb		
Transmissions in 100ms	See Graph	N/A
Pulse Width (1)	11.68	N/A
Pulse Width (2)	1.454	N/A
Duty Cycle Correction Factor	N/A	-4.5

DUTY CYCLE CORRECTION

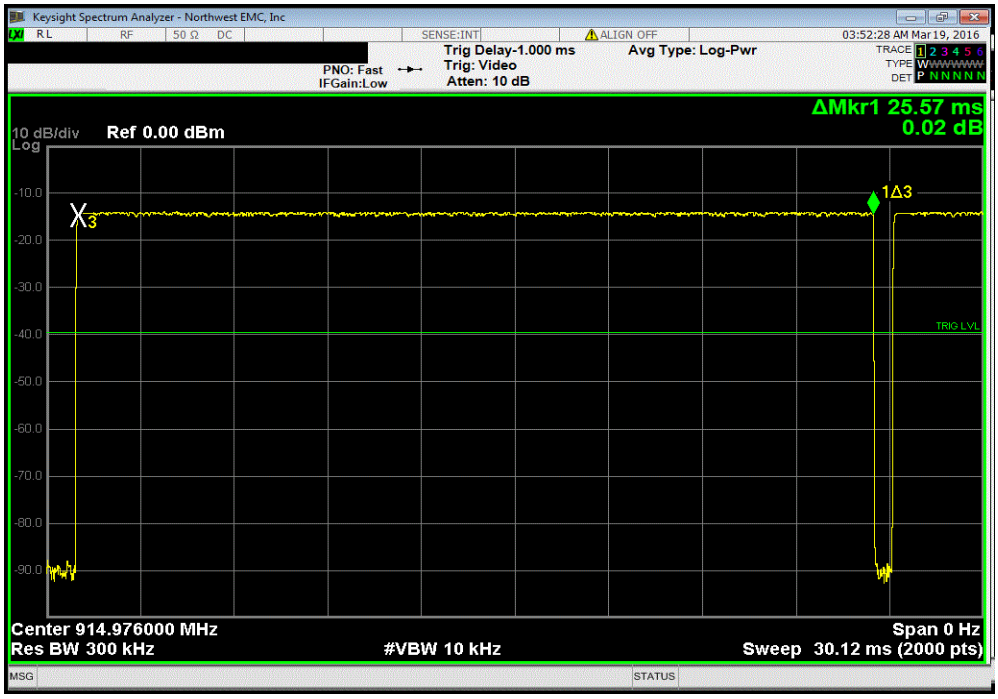
NORTHWEST EMC

XMit 2015.01.14

Hopping Mode, GFSK Modulation, 115.2kb, Transmissions in 100ms						
					Value (mS)	DCCF (dB)
					See Graph	N/A



Hopping Mode, GFSK Modulation, 115.2kb, Pulse Width (1)						
					Value (mS)	DCCF (dB)
					25.57	N/A

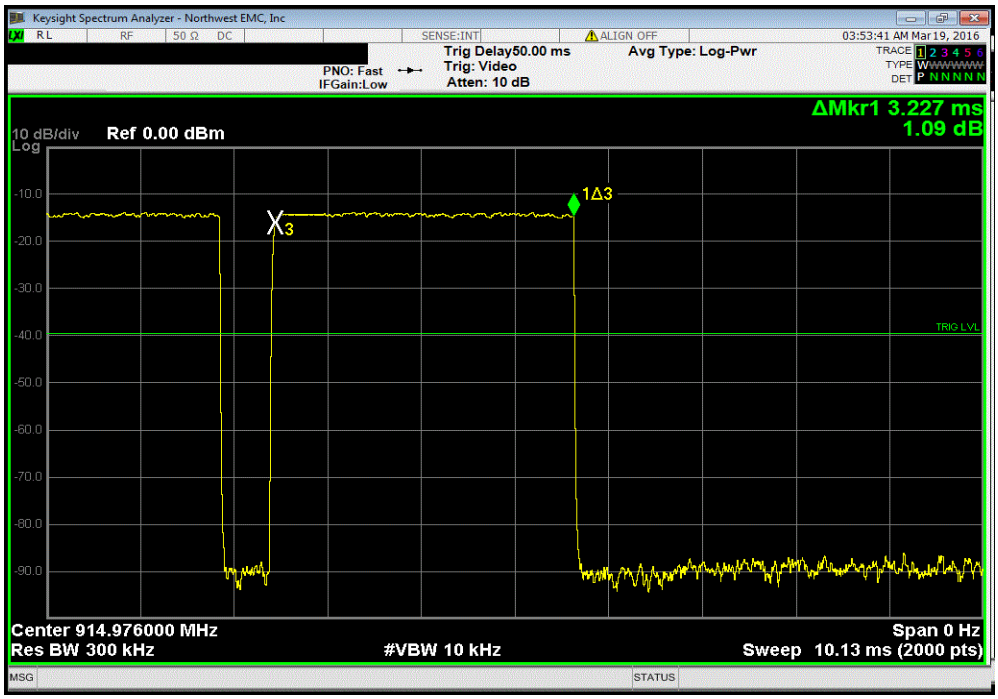


DUTY CYCLE CORRECTION

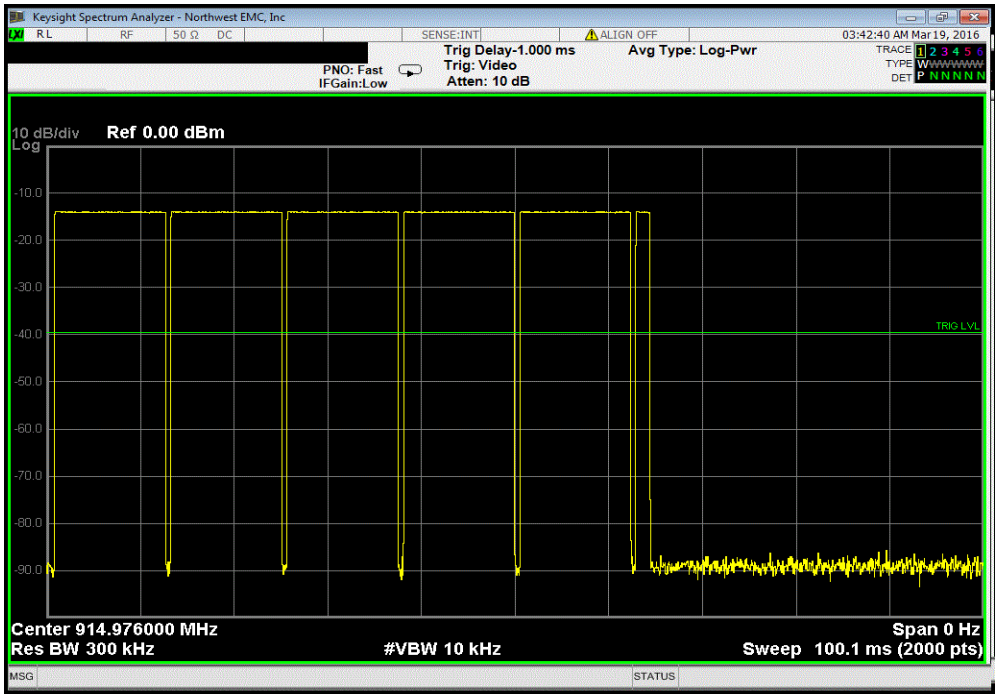
NORTHWEST EMC

XMit 2015.01.14

Hopping Mode, GFSK Modulation, 115.2kb, Pulse Width (2)						
					Value (mS)	DCCF (dB)
					3.227	N/A



Hopping Mode, GFSK Modulation, 250kb, Transmissions in 100ms						
					Value (mS)	DCCF (dB)
					See Graph	N/A

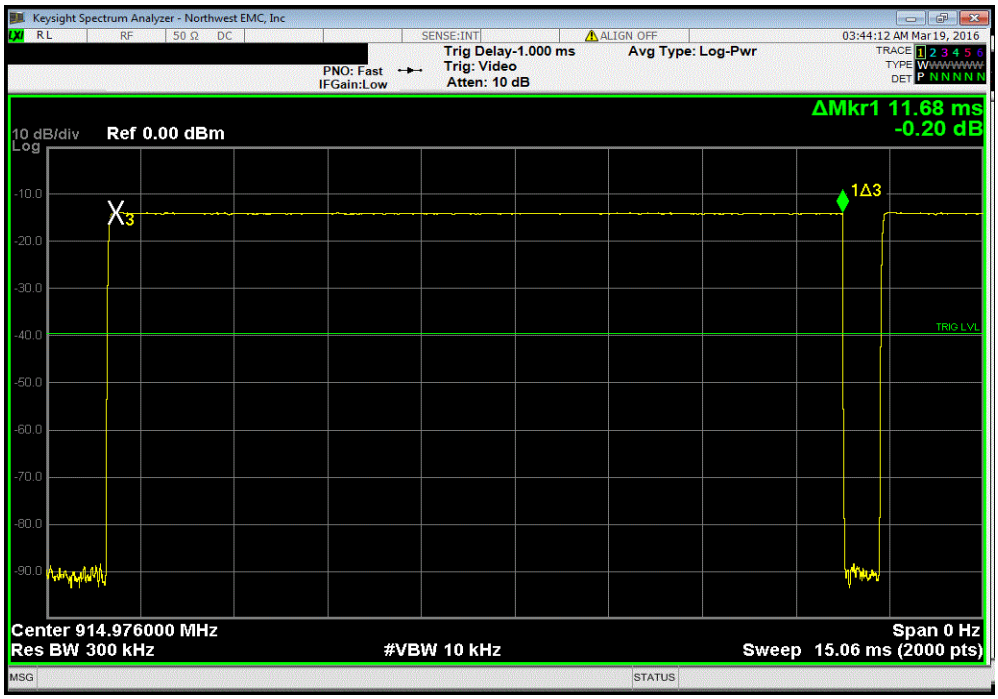


DUTY CYCLE CORRECTION

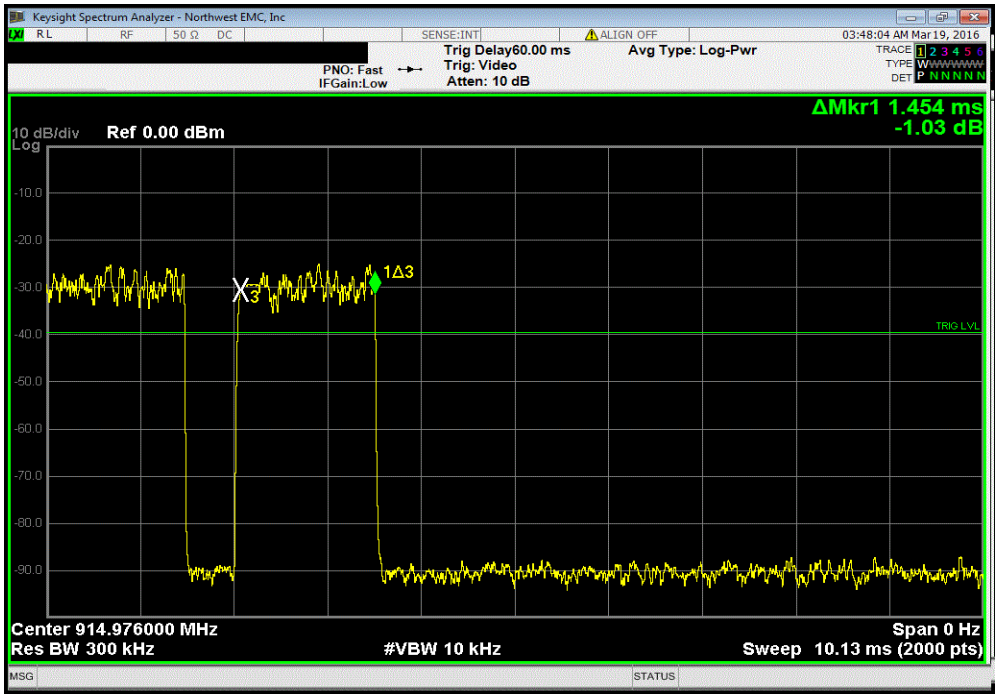
NORTHWEST EMC

XMit 2015.01.14

Hopping Mode, GFSK Modulation, 250kb, Pulse Width (1)						
					Value (mS)	DCCF (dB)
					11.68	N/A



Hopping Mode, GFSK Modulation, 250kb, Pulse Width (2)						
					Value (mS)	DCCF (dB)
					1.454	N/A



OUTPUT POWER

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	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

NORTHWEST EMC

XMit 2015.01.14

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	**Job Site:**	NC02

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.

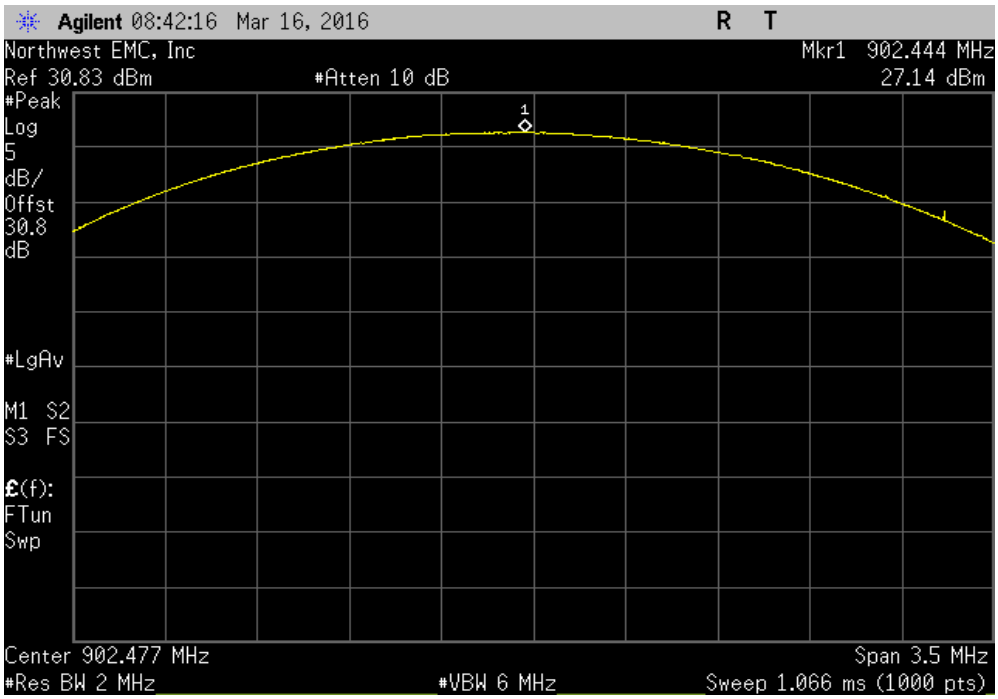
DEVIATIONS FROM TEST STANDARD

None

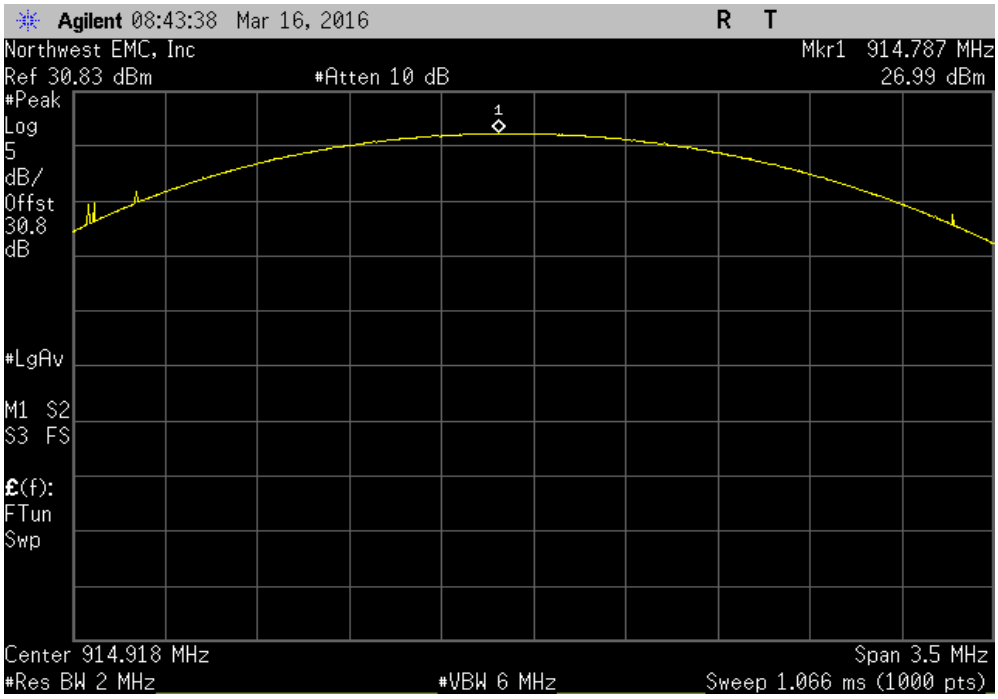
Configuration #	1	*Signature*

	Value	**Limit (<)**	**Result**
GFSK Modulation, 115.2kb			
Low Channel 2, 902.4768 MHz	27.14 dBm	27.4 dBm	Pass
Mid Channel 56, 914.9184 MHz	26.986 dBm	27.4 dBm	Pass
High Channel 111, 927.5904 MHz	26.941 dBm	27.4 dBm	Pass
GFSK Modulation, 250kb			
Low Channel 1, 902.5344 MHz	27.113 dBm	27.4 dBm	Pass
Mid Channel 37, 914.976 MHz	26.997 dBm	27.4 dBm	Pass
High Channel 73, 927.4176 MHz	27.051 dBm	27.4 dBm	Pass

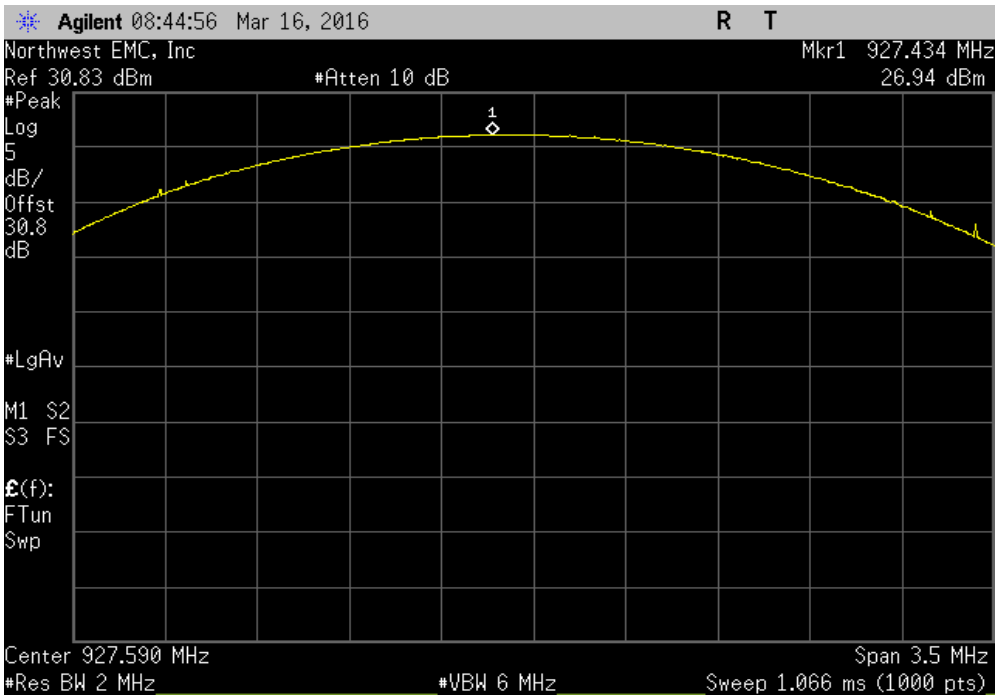
GFSK Modulation, 115.2kb, Low Channel 2, 902.4768 MHz						
				Value	Limit (<)	Result
				27.14 dBm	27.4 dBm	Pass



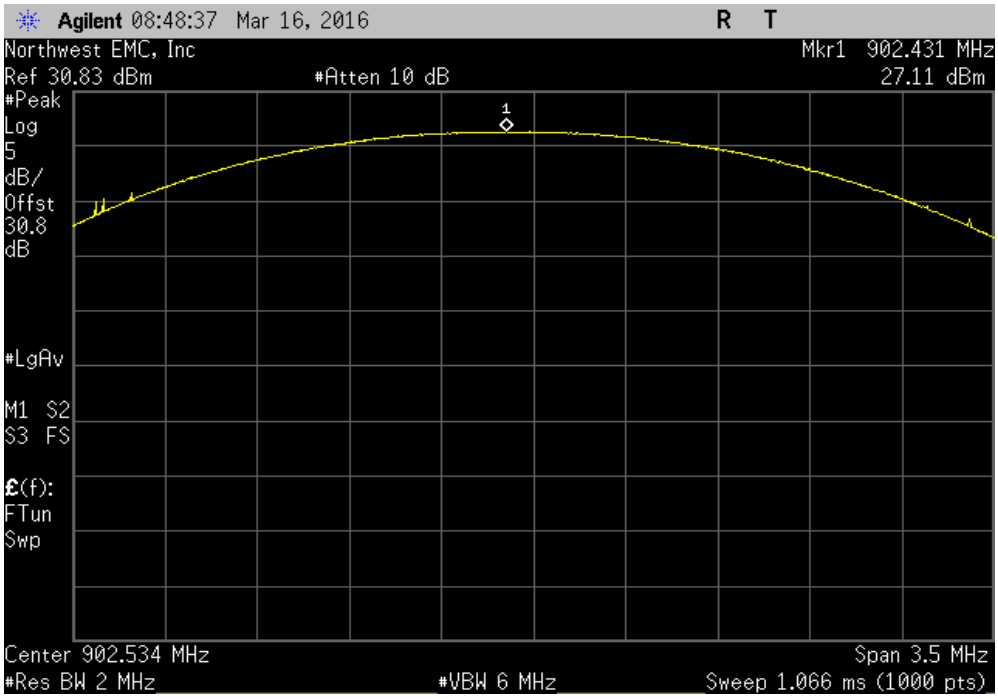
GFSK Modulation, 115.2kb, Mid Channel 56, 914.9184 MHz						
				Value	Limit (<)	Result
				26.986 dBm	27.4 dBm	Pass



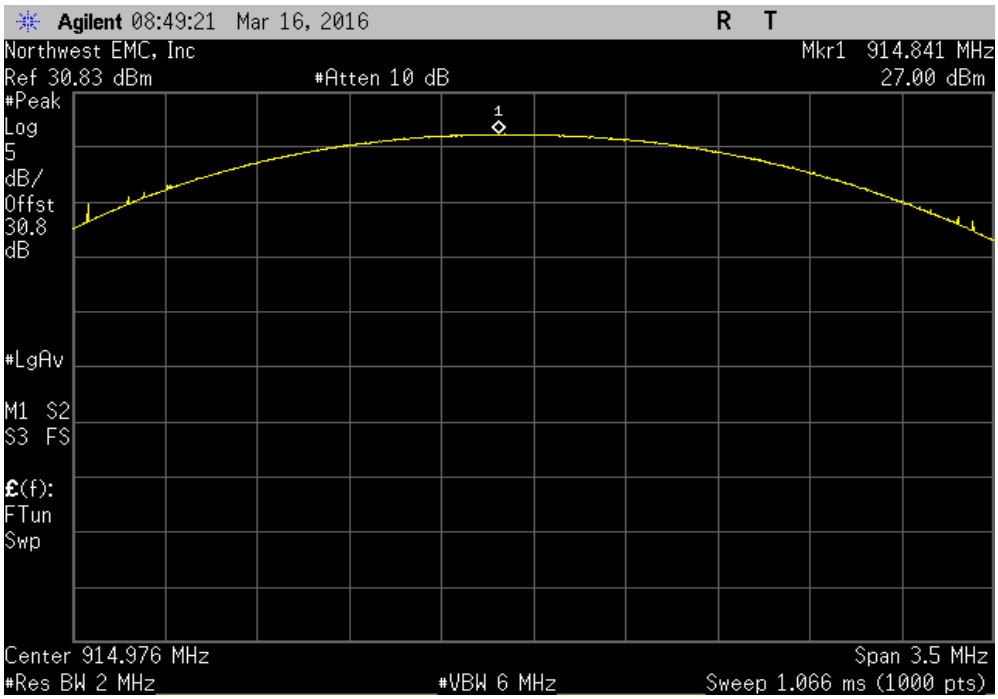
GFSK Modulation, 115.2kb, High Channel 111, 927.5904 MHz						
				Value	Limit (<)	Result
				26.941 dBm	27.4 dBm	Pass



GFSK Modulation, 250kb, Low Channel 1, 902.5344 MHz						
				Value	Limit (<)	Result
				27.113 dBm	27.4 dBm	Pass



GFSK Modulation, 250kb, Mid Channel 37, 914.976 MHz						
				Value	Limit (<)	Result
				26.997 dBm	27.4 dBm	Pass



GFSK Modulation, 250kb, High Channel 73, 927.4176 MHz						
				Value	Limit (<)	Result
				27.051 dBm	27.4 dBm	Pass