NORTHWEST EMC

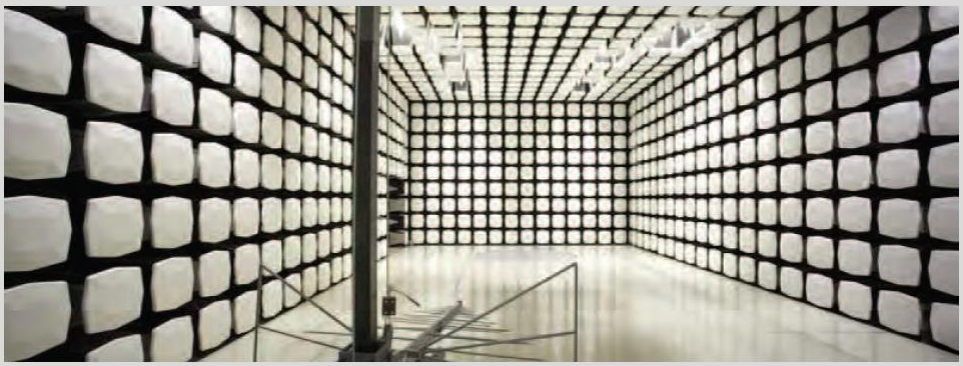
Garrett Metal Detectors

WT-1

FCC 2.1091:2016

2400-2483.5 MHz Transceiver

Report # GARR0027.1



NVLAP TESTING

NVLAP Lab Code: 201049-0

CERTIFICATE OF EVALUATION

NORTHWEST EMC
2014-12-10

Last Date of Evaluation: December 28, 2016
Garrett Metal Detectors
Model: WT-1

Radio Equipment Evaluation

Standards

Specification	Method
FCC 2.1091:2016	FCC 447498 D01 General RF Exposure Guidance v06

Results

Method Clause	Evaluation Description	Applied	Results	Comments
7.1	Maximum Permissible Exposure	Yes	Pass	

Deviations From Evaluation Standards

None

Approved By:

Donald Facteau, IT Manager

Product compliance is the responsibility of the client; therefore, the Evaluations and equipment modes of operation represented in this report were agreed upon by the client, prior to Evaluationing. The results of this Evaluation pertain only to the sample(s) Evaluationed. The specific description is noted in each of the individual sections of the Evaluation report supporting this certificate of Evaluation. This report reflects only those Evaluations from the referenced standards shown in the certificate of Evaluation. 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.

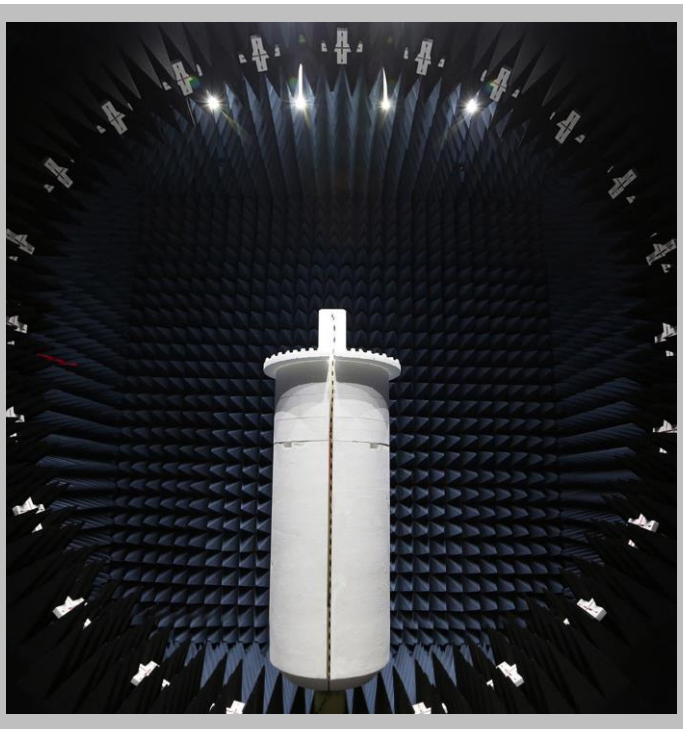
SCOPE

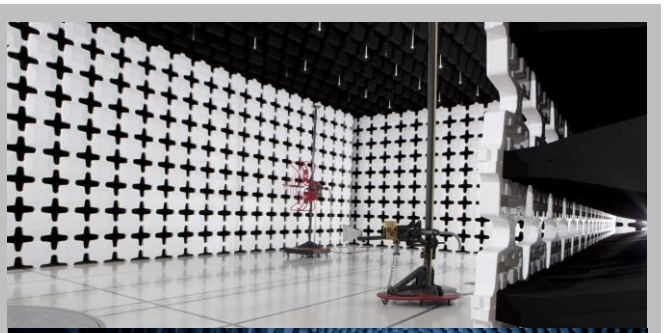
For details on the Scopes of our Accreditations, please visit:
http://www.nwemc.com/accreditations/
http://gsi.nist.gov/global/docs/cabs/designations.html

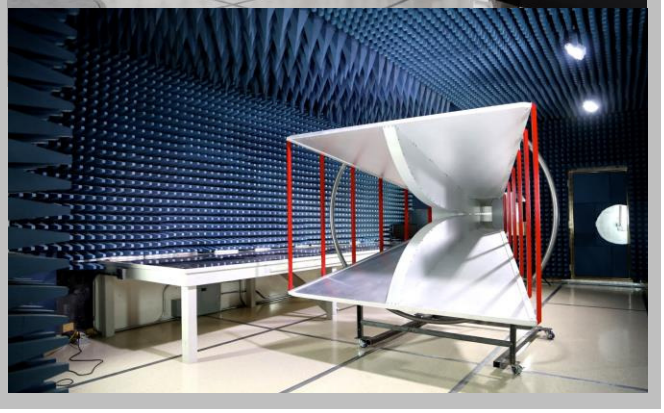
FACILITIES

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







PRODUCT DESCRIPTION

NORTHWEST EMC
2014-12-10

Client and Equipment Under Evaluation Information

Company Name:	Garrett Metal Detectors
Address:	1881 W. State Street
City, State, Zip:	Garland, TX 75042
Evaluation Requested By:	Weldon Sanders
Model:	WT-1
Date of Evaluation:	December 28, 2016

Information Provided by the Party Requesting the Evaluation

Functional Description of the Equipment:

The Garrett Z-LYNK Wireless Digital Transmission System consists of the Model WT-1 and Model WR-1 for use with Garret metal detectors to provide wireless audio functionality. The Model WT-1 and Model WR-1 use the identical radio chip and antenna.

The Model WT-1 is a part of the Garrett Z-LYNK Wireless Digital Transmission System operating in the 2.4GHz band. It is used with Garrett Metal Detectors hand-held hobby line of metal detectors and the Garrett Model WR-1. It is powered by a rechargeable 3.7 volt battery, receives audio from the detector via a short cable plugged into the headphone jack, and transmits that audio wirelessly to the WR-1 receiver. The WT-1 is mounted on the metal detector and used greater than 20 cm from the head or torso of a user.

The Model WR-1 is a part of the Garrett Z-LYNK Wireless Digital Transmission System operating in the 2.4GHz band. It is used with Garrett Metal Detectors hand-held hobby line of metal detectors and the Garrett Model WT-1. It is powered by a rechargeable 3.7 volt battery and receives audio from the detector via a wireless link from the Garrett Model WT-1. The user plugs his headphones into the WR-1. The WR-1 transmits handshake information back to the WT-1. The WR-1 has a belt clip and used within 20 cm of the torso of a user.

Objective:

To demonstrate compliance of WT-1 with FCC RF exposure requirements for 2.1091 mobile devices.

DUTY CYCLE

NORTHWEST EMC

XMit 2016.05.06

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.	Cal. Due
Probe - Near Field Set	ETS Lindgren	7405	IPS	NCR	NCR
Cable	Fairview Microwave	SCK0963-60	TXF	10/24/2016	10/24/2017
Block - DC	Fairview Microwave	SD3379	AMM	2/25/2016	2/25/2017
Attenuator	Fairview Microwave	SA4018-20	TQY	2/25/2016	2/25/2017
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFL	10/4/2016	10/4/2017
Generator - Signal	Agilent	E4422B	TGS	3/27/2015	3/27/2018

TEST DESCRIPTION

A near-field probe was placed near the transmitter. A low-loss coaxial cable was used to connect the near-field probe to the spectrum analyzer. 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 when operating in it's typical audio transmit/receive mode.

The reference design manufacturer of the radio technology could not confirm an actual maximum duty cycle therefore an alternative method had to be used to measure the duty cycle used by the customer. A description of the test modes used are as follows: *The WT-1 and WR-1 modules function as a pair to wirelessly communicate audio from the metal detector to the headphones. Unless already paired, the audio transmitter (WT-1) module has to be triggered to look for available receiver (WR-1) modules. The WT-1 module then pairs with the WR-1 module with the strongest signal. Once paired, the WT-1 remembers its WR-1 partner even after power cycle. A previously paired WT-1 will automatically establish connection with the same WR-1 on power up as long as the WR-1 is available for connection.*

Once paired, the WT-1 digitizes the metal detector audio and transmits it over the radio link to the WR-1. This is the typical usage of the system and the radio.

If not paired or if the WR-1 is not available, the WT-1 radio does nothing until pairing is initiated or the WR-1 in memory becomes available.
If not paired or if the WT-1 is not available, the WR-1 radio sends a "pairing signal" that lets potential WT-1 modules know about availability in the WR-1 module's network.

Pairing is a one-time occurrence in most cases and the typical radio operation is when both the WT-1 and WR-1 are communicating and audio is being transmitted.

Investigation was done all three described modes. The worse case duty cycle was having both the WT-1 and WR-1 paired together and transmitting audio. This data is included in the report. The duty cycle was measured on low, mid and high channels and pulse on time, pulse number, and period were all recorded.

This particular Low Energy protocol implimentation limits transmission to 18 channels. In order to determine the total duty cycle from all channels, the worse case pulse width, period length, and number of pulses in a period were used and extrapolated to determine the duty cycle across all 18 channels. The formulas used are highlighted below.

Total Period across all channels (ms) = Total Channels * Worse case period per channel (ms) = 18 * 104.9 = 1888

Total Pulse on Time across all channels (ms) = Total Channels * Worse case # of pulses per channel * Worse case pulse width (ms) = 18 * 10 *.844 = 151.9

Duty Cycle % = (Total Pulse on Time across all channels / Total Period) * 100 = (151.9 / 1888)*100 = 8%

The duty cycle correction factor is: 20*log(0.08) = -21.9 dB.

DUTY CYCLE

NORTHWEST EMC

XMit 2016.05.06

EUT:	WR-1			**Work Order:**	GARR0027
Serial Number:	None			**Date:**	11/11/16
Customer:	Garrett Metal Detectors			**Temperature:**	23.5 °C
Attendees:	None			**Humidity:**	41% RH
Project:	None			**Barometric Pres.:**	1026 mbar
Tested by:	Jonathan Kiefer	**Power:**	Battery	**Job Site:**	TX02

TEST SPECIFICATIONS	Test Method
FCC 2.1091:2016	FCC 447498 D01 General RF Exposure Guidance v06

COMMENTS

Transmitter and Receiver paired together. The Transmitter and Receiver units utilize similar radio modules; therefore, the measurements were taken on the Receiver Unit as the representative sample EUT. This operating mode is the actual mode used to transmit and receive audio in a typical operation. These results are used to calculate the total duty cycle across all 18 channels. Duty cycle is 8%. See the previous page for the complete calculation.

DEVIATIONS FROM TEST STANDARD

None

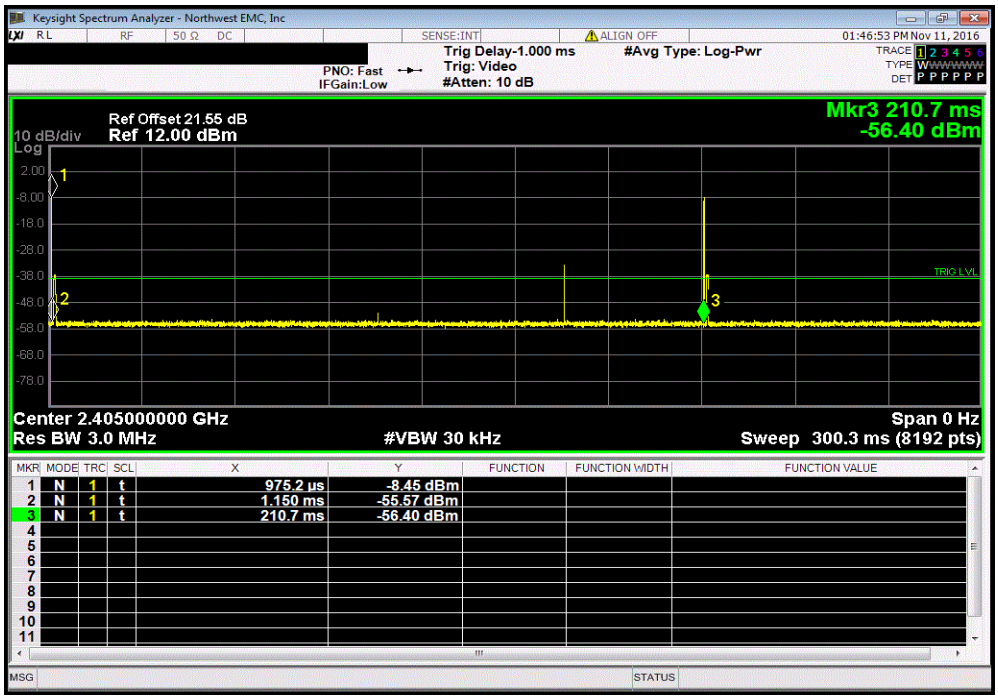
Configuration #	9	Signature Jonathan Kiefer

	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
Low Channel, 2405 MHz	174.8 us	209.732 ms	3	N/A	N/A	N/A
Low Channel, 2405 MHz	N/A	N/A	6	N/A	N/A	N/A
Mid Channel, 2445 MHz	835.4 us	104.97 ms	10	N/A	N/A	N/A
Mid Channel, 2445 MHz	N/A	N/A	43	N/A	N/A	N/A
High Channel, 2476 MHz	844 us	210.034 ms	4	N/A	N/A	N/A
High Channel, 2476 MHz	N/A	N/A	15	N/A	N/A	N/A

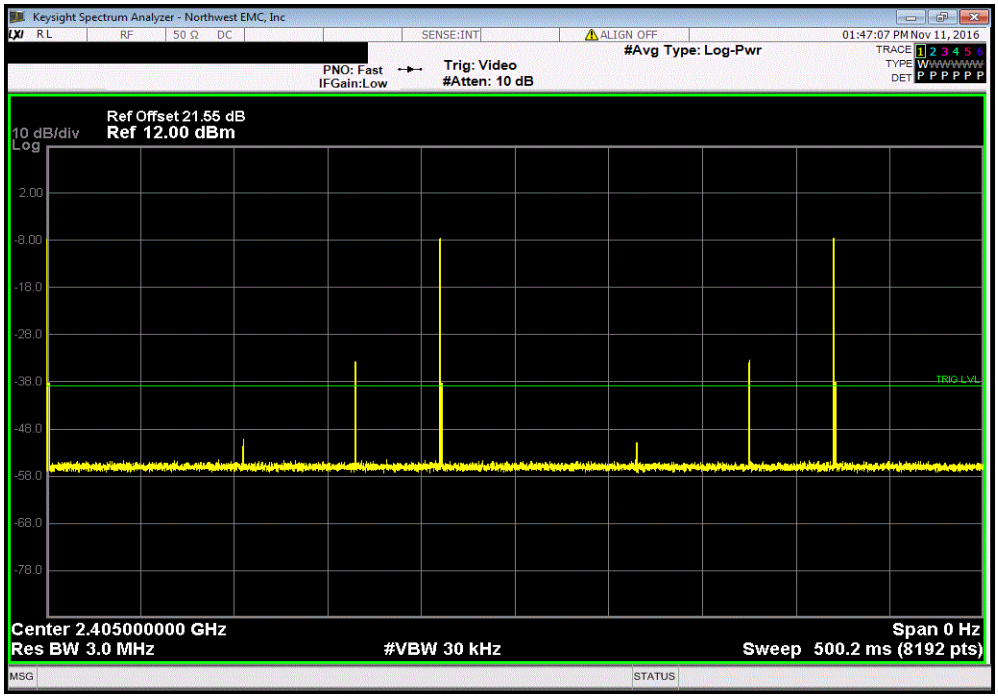
DUTY CYCLE

XMit 2016.05.06

Low Channel, 2405 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	174.8 us	209.732 ms	3	N/A	N/A	N/A



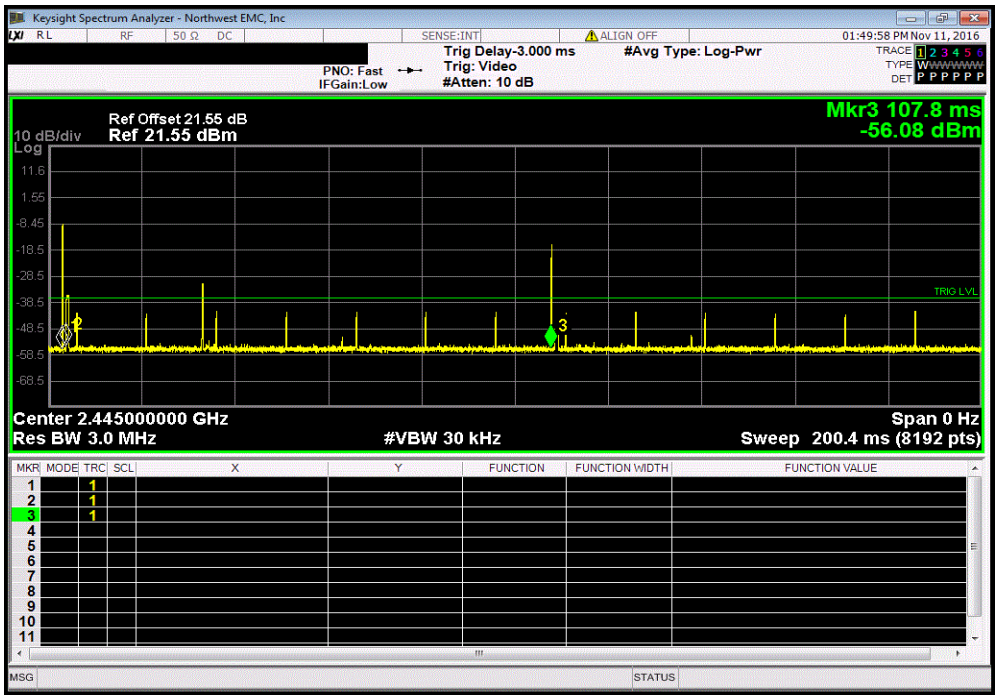
Low Channel, 2405 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	6	N/A	N/A	N/A



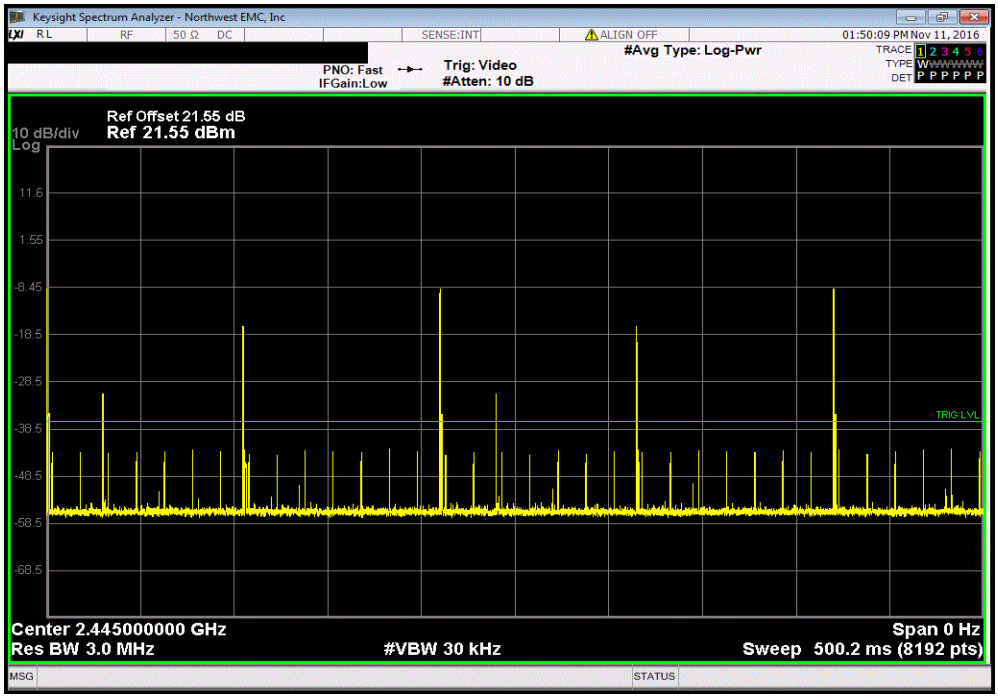
DUTY CYCLE

XMit 2016.05.06

Mid Channel, 2445 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	835.4 us	104.97 ms	10	N/A	N/A	N/A

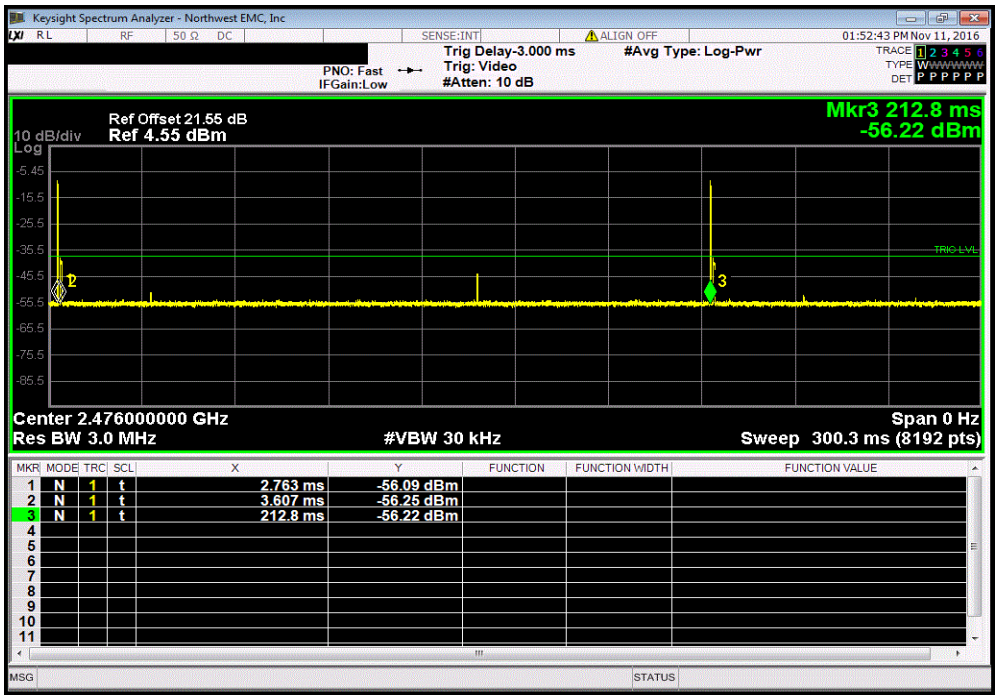


Mid Channel, 2445 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	43	N/A	N/A	N/A

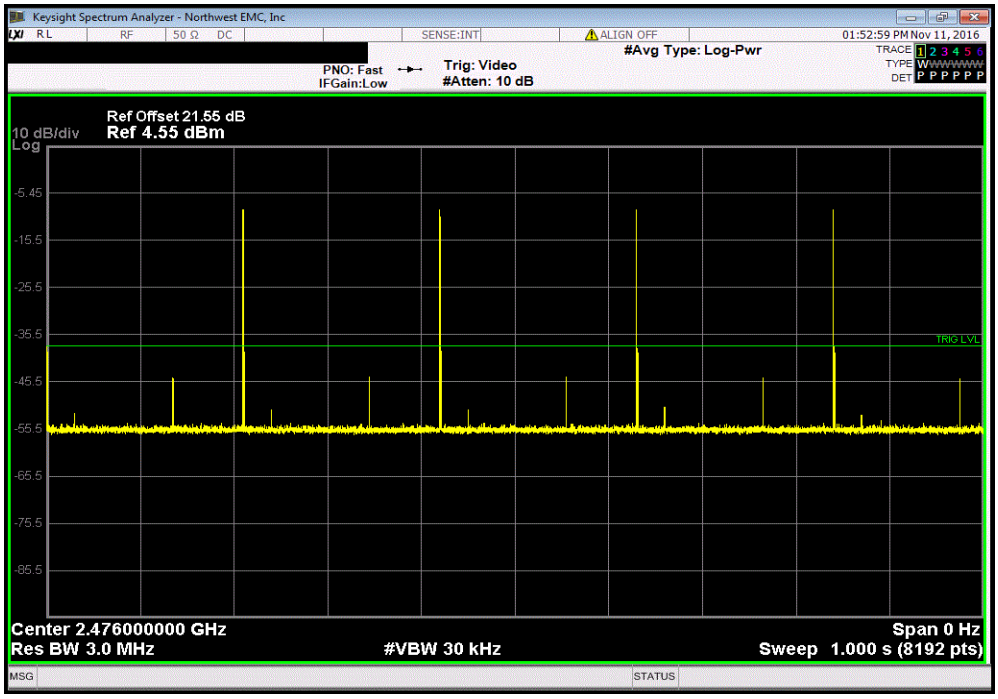


DUTY CYCLE

High Channel, 2476 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	844 us	210.034 ms	4	N/A	N/A	N/A



High Channel, 2476 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	15	N/A	N/A	N/A



MAXIMUM PERMISSIBLE EXPOSURE (MPE)

NORTHWEST EMC
EXRPT.2016.08.12.1

OVERVIEW

Human exposure to RF emissions from mobile devices (47 CFR §2.1091) may be evaluated based on the MPE limits adopted by the FCC for electric and magnetic field strength and/or power density, as appropriate, since exposures are assumed to occur at distances of 20 cm or more from persons. ANSI C95.1:2005 + Amd 1:2010 specifies a minimum separation distance of 20 cm for performing reliable field measurements to determine adherence to MPE limits. If the minimum separation distance between a transmitter and nearby persons is more than 20 cm under normal operating conditions, compliance with MPE limits may be determined at such distance from the transmitter. When applicable, operation instructions and prominent warning labels may be used to alert the exposed persons to maintain a specified distance from the transmitter or to limit their exposure durations and usage conditions to ensure compliance. If the use of warning labels on a transmitter is not effective or desirable, the alternative of performing SAR evaluation with the device at its closest range to persons under normal operating conditions may be used. The field strength and power density limits adopted by the FCC are based on whole-body averaged exposure and the assumption of RF field levels relate most accurately to estimating whole-body averaged SAR. This means some local values of exposures exceeding the stated field strength and power density limits may not necessarily imply non-compliance if the spatial average of spatially averaged RF fields over the exposed portions of a person's body does not exceed the limits.

COMPLIANCE WITH FCC 2.1091

"Mobile devices that operate in the Cellular Radiotelephone Service, the Personal Communications Services, the Satellite Communications Services, the General Wireless Communications Service, the Wireless Communications Service, the Maritime Services and the Specialized Mobile Radio Service authorized under subpart H of part 22 of this chapter, parts 24, 25, 26 and 27 of this chapter, part 80 of this chapter (ship earth stations devices only) and part 90 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if they operate at frequencies of 1.5 GHz or below and their effective radiated power (ERP) is 1.5 watts or more, or if they operate at frequencies above 1.5 GHz and their ERP is 3 watts or more. Unlicensed personal communications service devices, unlicensed millimeter wave devices and unlicensed NII devices authorized under §§15.253, 15.255, and 15.257, and subparts D and E of part 15 of this chapter are also subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if their ERP is 3 watts or more or if they meet the definition of a portable device as specified in §2.1093(b) requiring evaluation under the provisions of that section. All other mobile and unlicensed transmitting devices are categorically excluded from routine environmental evaluation for RF exposure prior to equipment authorization or use, except as specified in §§1.1307(c) and 1.1307(d) of this chapter. Applications for equipment authorization of mobile and unlicensed transmitting devices subject to routine environmental evaluation must contain a statement confirming compliance with the limits specified in paragraph (d) of this section as part of their application."

The device will only be used with a separation distance between the antenna and the body of the user or nearby persons as shown in the table below and can therefore be considered a mobile transmitter per 47 CFR 2.1091(b).

COMPLIANCE WITH FCC KDB 447498 D01 General RF Exposure Guidance v06

"KDB 447498 D01 General RF Exposure Guidance v06" provides the procedures, requirements, and authorization policies for mobile and portable devices.

Devices operating in standalone mobile device exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously are covered in section 7.1.

Devices containing multiple transmitters capable of simultaneous transmissions are covered in section 7.2.

MAXIMUM PERMISSIBLE EXPOSURE (MPE)

NORTHWEST EMC
EXRPT.2016.08.12.1

LIMITS

Limits for General Population /Uncontrolled Exposure: 47 CFR 1.1310

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
0.3 - 1.34	614	1.63	*(100)	30
1.34 - 30	824/f	2.19/f	*($180/f^2$)	30
30 - 300	27.5	0.073	0.2	30
300 - 1500			f/1500	30
1500 - 100000			1	30

f = frequency in MHz
*** = Plane-wave equivalent power density**

ASSESSMENT

The exposure level for the radio is evaluated at a 20 cm distance from the radio's transmitting antenna using the general equation:

$$S = \frac{P * G}{4 * \pi * R^2}$$

Where: S = power density (mW/cm^2)
P = power input to the antenna (mW)
G = numeric power gain relative to an isotropic radiator
R = distance to the center of the radiation of the antenna (20 cm = limit for MPE estimates)
P*G = EIRP

Solving for S, the maximum power density 20 cm from the transmitting antenna is determined. This level is then compared to the applicable limit for the transmit frequency. If limits were not met at the 20 cm boundary the evaluation distance is increased until the limit is met as shown in the table below.

For co-located radios, the ratio of the calculated level to the limit is determined. The ratios for each co-located radio are summed. If the sum is less than or equal to one, then the device is excluded from testing and is deemed compliant.

The standalone MPE and summed MPE ratios are summarized in the following table:

Radio	Transmit Frequency (MHz)	Measured Conducted Output Power (mW)	Duty Cycle	Highest Antenna Gain (dBi)	Minimum Antenna Cable Loss (dB)	Minimum Separation Distance (cm)	Power Density (mW/cm^2)	Limit (mW/cm^2)	Compliant
2400-2483.5 MHz Transceiver	2445	3.603	0.08	5.44	0	20	0.00020	1.0	Yes