NORTHWEST EMC

Microsoft Corporation

1640

FCC 15.249:2015

Report # MCSO1724

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

NORTHWEST EMC
2014-12-10

Last Date of Test: March 03, 2015
Microsoft Corporation
Model: 1640

Radio Equipment Testing

Standards

Specification	Method
FCC 15.249:2015	ANSI C63.10:2009

Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions	No	N/A	Not required.
6.6	Field Strength of Fundamental	Yes	Pass	
6.6	Field Strength of Harmonics and Spurious Radiated Emissions	Yes	Pass	
7.5	Duty Cycle – Non Hopping Mode	Yes	Pass	
7.5	Duty Cycle – Hopping Mode	Yes	Pass	

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.

REVISION HISTORY

NORTHWEST EMC
REV 2014.10.14

Revision Number	Description	Date	Page Number
00	None		

ACCREDITATIONS AND AUTHORIZATIONS

REV 2015.2.19

United States

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

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

NVLAP - Each laboratory is accredited by NVLAP to ISO 17025

Canada

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

European Union

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

Australia/New Zealand

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

Korea

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

Japan

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

Taiwan

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

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

Singapore

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

Israel

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

Hong Kong

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

Vietnam

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

SCOPE

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

MEASUREMENT UNCERTAINTY

TMU.2014.12.03

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.

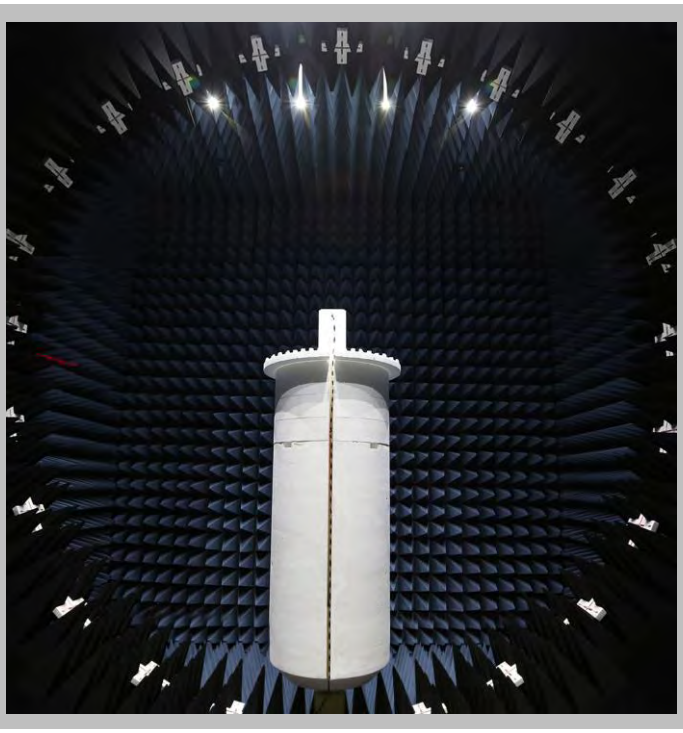
The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

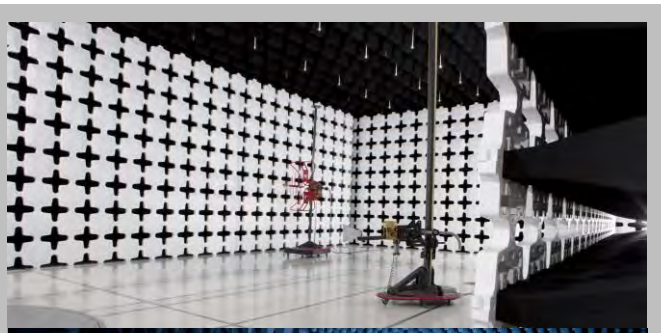
Test	+ MU	- MU
Frequency Accuracy (Hz)	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	0.3 dB	-0.3 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	4.5 dB	-4.5 dB
AC Powerline Conducted Emissions (dB)	2.9 dB	-2.9 dB

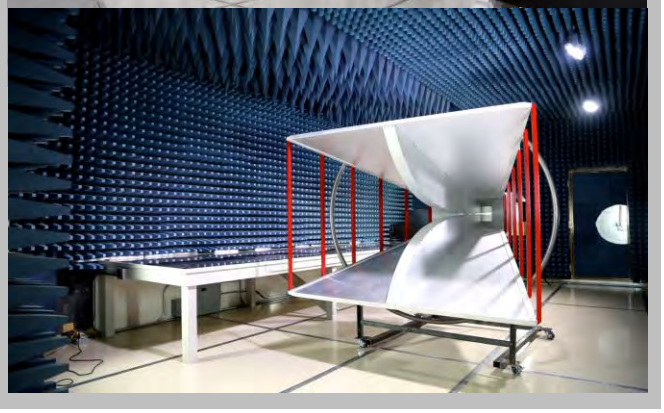
FACILITIES

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 9801 (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:	Microsoft Corporation
Address:	One Microsoft Way
City, State, Zip:	Redmond, WA 98052
Test Requested By:	Kitty Tam
Model:	1640
First Date of Test:	February 25, 2015
Last Date of Test:	March 03, 2015
Receipt Date of Samples:	February 25, 2015
Equipment Design Stage:	Production
Equipment Condition:	No Damage

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
2.4 GHz FHSS radio

Testing Objective:
Seeking to demonstrate compliance under FCC 15.249 for operation in the 2400 - 2483.5 MHz Band.

CONFIGURATIONS

NORTHWEST EMC 2014-12-10

Configuration MCSO1724- 1

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Wireless Input Device	Microsoft Corporation	1640	14501929-RF4

Configuration MCSO1724- 2

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Wireless Input Device	Microsoft Corporation	1640	3051545630036-RF1

MODIFICATIONS

NORTHWEST EMC
2014-12-10

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2/25/2015	Field Strength of Fundamental	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Northwest EMC following the test.
2	2/25/2015	Duty Cycle – Single Channel Mode	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Northwest EMC following the test.
3	2/26/2015	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.
4	3/3/2015	Duty Cycle – Hopping Mode	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

FIELD STRENGTH OF FUNDAMENTAL

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 GFSK, 250 kbps

CHANNELS TESTED

Low Channel, 2404 MHz
Mid Channel, 2440 MHz
High Channel, 2477 MHz

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

MCSO1724 - 2

FREQUENCY RANGE INVESTIGATED

Start Frequency	2400 MHz	Stop Frequency	2483.5 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, Horn	EMCO	3115	AHM	6/3/2014	24 mo
NC01 Cables	N/A	3115 Horn Cable	NC2	10/13/2014	12 mo
Spectrum Analyzer	Agilent	E4440A	AFE	10/28/2014	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

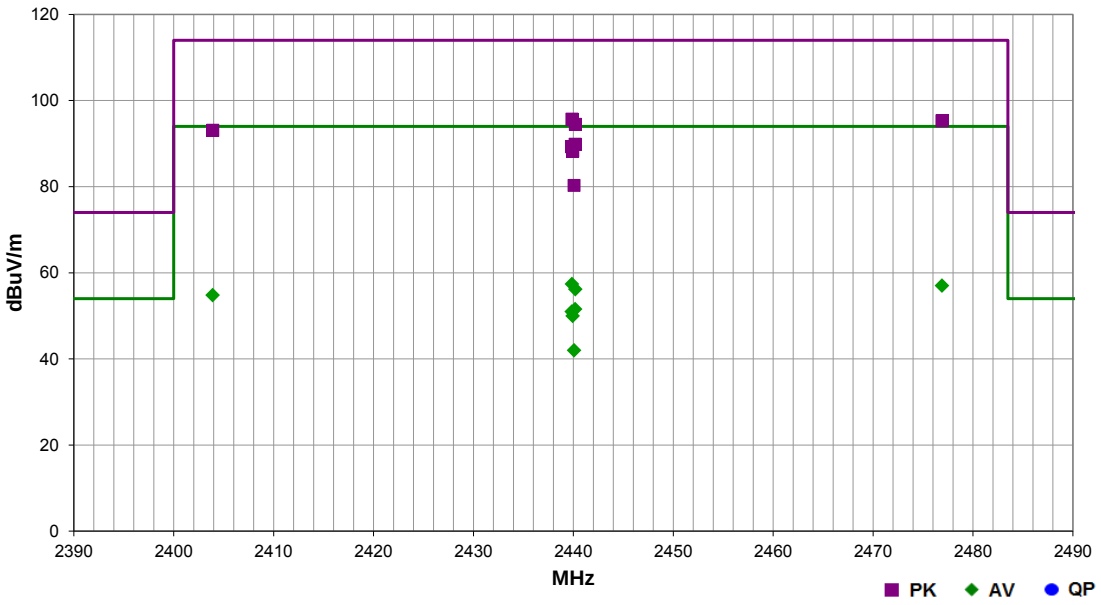
The antennas to be used with the EUT were tested. The EUT was transmitting and while set at the lowest channel, a middle channel, and the highest channel available. While scanning, emissions from the EUT were maximized by rotating the EUT, adjusting the measurement antenna height and polarization, and manipulating the EUT and EUT antenna in 3 orthogonal planes (per ANSI C63.10:2009). Measurements were made using a spectrum analyzer with a peak detector. For average measurements, a Duty Cycle Correction Factor was applied to the peak measurement to derive the average field strength of the hopping channel, per ANSI C63.10:2009, section 7.5.7.5.

FIELD STRENGTH OF FUNDAMENTAL

Work Order:	MCSO1724	**Date:**	02/25/15		
Project:	None	**Temperature:**	23 °C		
Job Site:	NC01	**Humidity:**	33% RH		
Serial Number:	3051545630036-RF1	**Barometric Pres.:**	1031 mbar	**Tested by:**	Richard Mellroth
EUT:	1640				
Configuration:	2				
Customer:	Microsoft Corporation				
Attendees:	Kitty Tam				
EUT Power:	Battery				
Operating Mode:	Transmitting GFSK, 250 kbps, maximum duty cycle. See comments next to data points for EUT channel and orientation.				
Deviations:	None				
Comments:	None				

Test Specifications	**Test Method**
FCC 15.249:2015	ANSI C63.10:2009

Run #	15	**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	Duty Cycle Correction Factor (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2439.865	60.5	35.2	2.3	35.0	3.0	0.0	Horz	PK	0.0	95.7	114.0	-18.3	Mid Ch, 2440 MHz, LED Facing Up
2476.895	60.0	35.3	2.1	122.0	3.0	0.0	Horz	PK	0.0	95.3	114.0	-18.7	High Ch, 2477 MHz, LED Facing Up
2440.200	59.3	35.2	2.3	306.0	3.0	0.0	Horz	PK	0.0	94.5	114.0	-19.5	Mid Ch, 2440 MHz, LED Facing Side
2403.905	58.1	35.0	2.3	306.0	3.0	0.0	Horz	PK	0.0	93.1	114.0	-20.9	Low Ch, 2404 MHz, LED Facing Up
2440.185	54.7	35.2	1.0	162.0	3.0	0.0	Vert	PK	0.0	89.9	114.0	-24.1	Mid Ch, 2440 MHz, EUT Vertical
2439.835	54.1	35.2	1.3	346.0	3.0	0.0	Vert	PK	0.0	89.3	114.0	-24.7	Mid Ch, 2440 MHz, LED Facing Side
2439.930	53.1	35.2	1.7	346.0	3.0	0.0	Vert	PK	0.0	88.3	114.0	-25.7	Mid Ch, 2440 MHz, LED Facing Up
2440.075	45.1	35.2	1.0	359.0	3.0	0.0	Horz	PK	0.0	80.3	114.0	-33.7	Mid Ch, 2440 MHz, EUT Vertical
2439.865	60.5	35.2	2.3	35.0	3.0	0.0	Horz	AV	-38.3	57.4	94.0	-36.6	Mid Ch, 2440 MHz, LED Facing Up
2476.895	60.0	35.3	2.1	122.0	3.0	0.0	Horz	AV	-38.3	57.0	94.0	-37.0	High Ch, 2477 MHz, LED Facing Up
2440.200	59.3	35.2	2.3	306.0	3.0	0.0	Horz	AV	-38.3	56.2	94.0	-37.8	Mid Ch, 2440 MHz, LED Facing Side
2403.905	58.1	35.0	2.3	306.0	3.0	0.0	Horz	AV	-38.3	54.8	94.0	-39.2	Low Ch, 2404 MHz, LED Facing Up
2440.185	54.7	35.2	1.0	162.0	3.0	0.0	Vert	AV	-38.3	51.6	94.0	-42.4	Mid Ch, 2440 MHz, EUT Vertical
2439.835	54.1	35.2	1.3	346.0	3.0	0.0	Vert	AV	-38.3	51.0	94.0	-43.0	Mid Ch, 2440 MHz, LED Facing Side
2439.930	53.1	35.2	1.7	346.0	3.0	0.0	Vert	AV	-38.3	50.0	94.0	-44.0	Mid Ch, 2440 MHz, LED Facing Up
2440.075	45.1	35.2	1.0	359.0	3.0	0.0	Horz	AV	-38.3	42.0	94.0	-52.0	Mid Ch, 2440 MHz, EUT Vertical

FIELD STRENGTH OF HARMONICS AND 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 GFSK, 250 kbps

CHANNELS TESTED

Low Channel, 2404 MHz
Mid Channel, 2440 MHz
High Channel, 2477 MHz

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

MCSO1724 - 2

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	26000 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
NC01 Cables	N/A	Bilog Cables	NC1	9/8/2014	12 mo
Low Pass Filter	Micro-Tronics	LPM50004	LFF	11/14/2013	24 mo
Pre-Amplifier	Miteq	AM-1616-1000	PAB	9/8/2014	12 mo
Antenna, Biconilog	EMCO	3142B	AXJ	5/16/2012	36 mo
NC01 Cables	N/A	3115 Horn Cable	NC2	10/13/2014	12 mo
High Pass Filter	Micro-Tronics	HPM50111	HHI	12/9/2014	12 mo
Attenuator	Fairview Microwave	SA18E-20	AQV	10/13/2014	12 mo
Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVZ	9/8/2014	12 mo
Antenna, Horn	EMCO	3115	AHM	6/3/2014	24 mo
NC01 Cables	N/A	Standard Gain Horn Cable	NC3	10/13/2014	12 mo
Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AOK	10/13/2014	12 mo
Antenna, Horn	EMCO	3160-07	AHP	NCR	0 mo
Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AOJ	10/13/2014	12 mo
Antenna, Horn	EMCO	3160-08	AHO	NCR	0 mo
Cable I	N/A	N/A	SUM	6/10/2014	12 mo
Pre-Amplifier	Miteq	AMF-6F-18002650-25-10P	AOD	6/10/2014	12 mo
Antenna, Horn	ETS	3160-09	AIY	NCR	0 mo
Spectrum Analyzer	Agilent	E4440A	AFE	10/28/2014	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

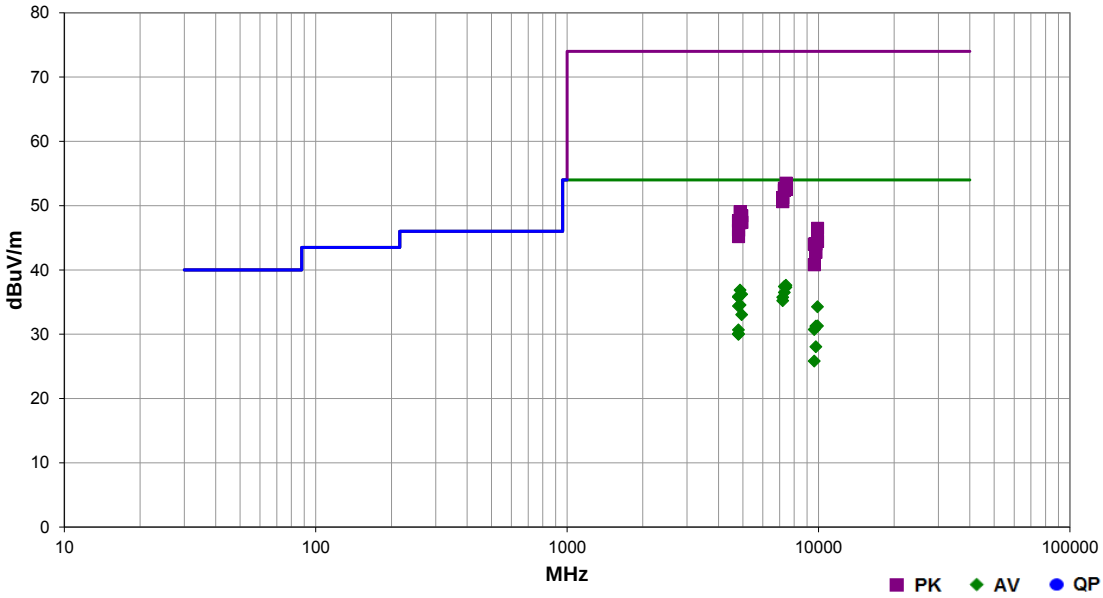
The antennas to be used with the EUT were tested. The EUT was transmitting and receiving while set at the lowest channel, a middle channel, and the highest channel available. While scanning, emissions from the EUT were maximized by rotating the EUT, adjusting the measurement antenna height and polarization, and manipulating the EUT antenna in 3 orthogonal planes (per ANSI C63.10:2009). A preamp and high pass filter were used for this test in order to provide sufficient measurement sensitivity.

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

Work Order:	MCSO1724	**Date:**	02/26/15		
Project:	None	**Temperature:**	24 °C		
Job Site:	NC01	**Humidity:**	34% RH		
Serial Number:	3051545630036-RF1	**Barometric Pres.:**	1022 mbar	**Tested by:**	Richard Mellroth
EUT:	1640				
Configuration:	2				
Customer:	Microsoft Corporation				
Attendees:	None				
EUT Power:	Battery				
Operating Mode:	Transmitting GFSK, 250 kbps, maximum duty cycle. See comments next to data points for EUT channel and orientation.				
Deviations:	None				
Comments:	None				

Test Specifications	**Test Method**
FCC 15.249:2015	ANSI C63.10:2009

Run #	17-19	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
7431.030	23.4	14.2	1.2	157.0	3.0	0.0	Vert	AV	0.0	37.6	54.0	-16.4	High Ch, 2477 MHz, EUT Vertical
7320.060	24.1	13.3	1.0	359.0	3.0	0.0	Horz	AV	0.0	37.4	54.0	-16.6	Mid Ch, 2440 MHz, LED Facing Up
7430.830	23.1	14.2	1.2	280.0	3.0	0.0	Horz	AV	0.0	37.3	54.0	-16.7	High Ch, 2477 MHz, LED Facing Up
4880.020	28.2	8.6	1.2	322.0	3.0	0.0	Horz	AV	0.0	36.8	54.0	-17.2	Mid Ch, 2440 MHz, LED Facing Up
7319.245	23.2	13.3	1.2	60.0	3.0	0.0	Vert	AV	0.0	36.5	54.0	-17.5	Mid Ch, 2440 MHz, EUT Vertical
4954.030	27.6	8.6	1.2	319.0	3.0	0.0	Horz	AV	0.0	36.2	54.0	-17.8	High Ch, 2477 MHz, LED Facing Up
4808.010	27.7	8.2	1.2	313.0	3.0	0.0	Vert	AV	0.0	35.9	54.0	-18.1	Low Ch, 2404 MHz, EUT Vertical
4808.000	27.6	8.2	1.2	331.0	3.0	0.0	Horz	AV	0.0	35.8	54.0	-18.2	Low Ch, 2404 MHz, LED Facing Up
7211.815	23.7	12.0	2.0	166.0	3.0	0.0	Horz	AV	0.0	35.7	54.0	-18.3	Low Ch, 2404 MHz, LED Facing Up
7210.775	23.2	12.0	1.2	134.0	3.0	0.0	Vert	AV	0.0	35.2	54.0	-18.8	Low Ch, 2404 MHz, EUT Vertical
4880.005	25.9	8.6	1.2	291.0	3.0	0.0	Vert	AV	0.0	34.5	54.0	-19.5	Mid Ch, 2440 MHz, EUT Vertical
4807.990	26.2	8.2	1.2	209.0	3.0	0.0	Horz	AV	0.0	34.4	54.0	-19.6	Low Ch, 2404 MHz, LED Facing Side
9908.100	36.6	-2.3	1.4	0.0	3.0	0.0	Horz	AV	0.0	34.3	54.0	-19.7	High Ch, 2477 MHz, LED Facing Up
7431.130	39.3	14.2	1.2	280.0	3.0	0.0	Horz	PK	0.0	53.5	74.0	-20.5	High Ch, 2477 MHz, LED Facing Up
4954.045	24.4	8.6	1.2	256.0	3.0	0.0	Vert	AV	0.0	33.0	54.0	-21.0	High Ch, 2477 MHz, EUT Vertical
7321.360	39.4	13.3	1.2	60.0	3.0	0.0	Vert	PK	0.0	52.7	74.0	-21.3	Mid Ch, 2440 MHz, EUT Vertical
7432.450	38.4	14.2	1.2	157.0	3.0	0.0	Vert	PK	0.0	52.6	74.0	-21.4	High Ch, 2477 MHz, EUT Vertical
7318.725	39.1	13.3	1.0	359.0	3.0	0.0	Horz	PK	0.0	52.4	74.0	-21.6	Mid Ch, 2440 MHz, LED Facing Up
9908.060	33.6	-2.3	1.2	79.0	3.0	0.0	Vert	AV	0.0	31.3	54.0	-22.7	High Ch, 2477 MHz, EUT Vertical
9760.040	34.2	-2.9	1.5	176.0	3.0	0.0	Horz	AV	0.0	31.3	54.0	-22.7	Mid Ch, 2440 MHz, LED Facing Up
7211.865	39.2	12.0	2.0	166.0	3.0	0.0	Horz	PK	0.0	51.2	74.0	-22.8	Low Ch, 2404 MHz, LED Facing Up
9616.040	34.2	-3.5	1.5	190.0	3.0	0.0	Horz	AV	0.0	30.7	54.0	-23.3	Low Ch, 2404 MHz, LED Facing Up
4807.995	22.5	8.2	1.2	159.0	3.0	0.0	Vert	AV	0.0	30.7	54.0	-23.3	Low Ch, 2404 MHz, LED Facing Side
7211.855	38.6	12.0	1.2	134.0	3.0	0.0	Vert	PK	0.0	50.6	74.0	-23.4	Low Ch, 2404 MHz, EUT Vertical
4807.840	21.9	8.2	1.2	118.0	3.0	0.0	Vert	AV	0.0	30.1	54.0	-23.9	Low Ch, 2404 MHz, LED Facing Up
4807.965	21.8	8.2	1.5	98.0	3.0	0.0	Horz	AV	0.0	30.0	54.0	-24.0	Low Ch, 2404 MHz, EUT Vertical
4880.460	40.4	8.6	1.2	322.0	3.0	0.0	Horz	PK	0.0	49.0	74.0	-25.0	Mid Ch, 2440 MHz, LED Facing Up
4954.175	39.8	8.6	1.2	319.0	3.0	0.0	Horz	PK	0.0	48.4	74.0	-25.6	High Ch, 2477 MHz, LED Facing Up

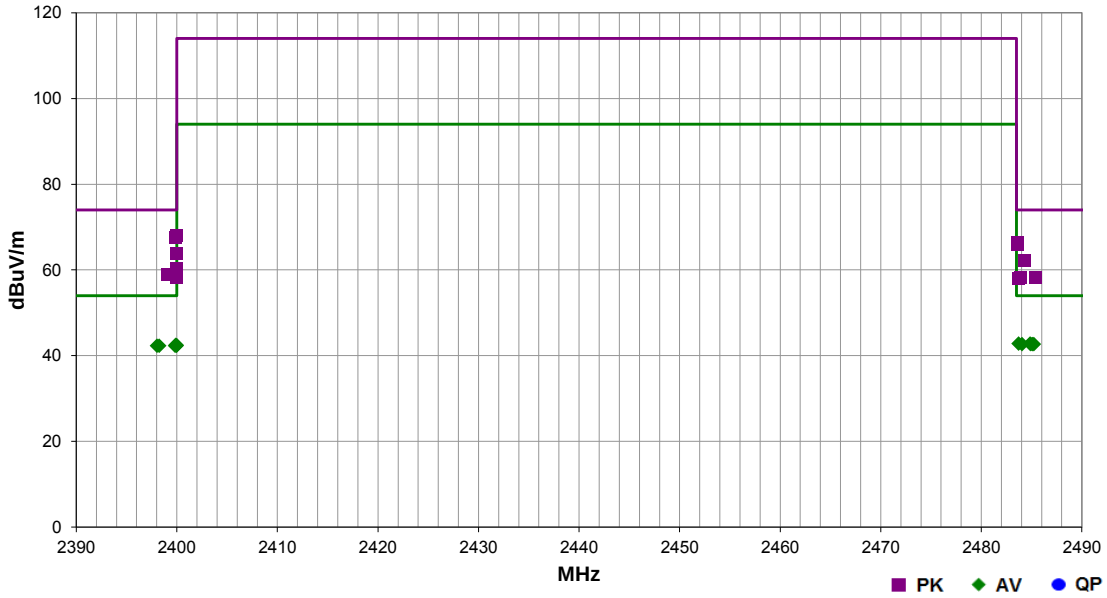
Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
9760.135	31.0	-2.9	1.2	55.0	3.0	0.0	Vert	AV	0.0	28.1	54.0	-25.9	Mid Ch, 2440 MHz, EUT Vertical
4807.970	39.5	8.2	1.2	313.0	3.0	0.0	Vert	PK	0.0	47.7	74.0	-26.3	Low Ch, 2404 MHz, EUT Vertical
4808.090	39.4	8.2	1.2	331.0	3.0	0.0	Horz	PK	0.0	47.6	74.0	-26.4	Low Ch, 2404 MHz, LED Facing Up
4807.790	39.3	8.2	1.2	209.0	3.0	0.0	Horz	PK	0.0	47.5	74.0	-26.5	Low Ch, 2404 MHz, LED Facing Side
4954.745	38.8	8.6	1.2	256.0	3.0	0.0	Vert	PK	0.0	47.4	74.0	-26.6	High Ch, 2477 MHz, EUT Vertical
4879.565	38.7	8.6	1.2	291.0	3.0	0.0	Vert	PK	0.0	47.3	74.0	-26.7	Mid Ch, 2440 MHz, EUT Vertical
9908.205	48.8	-2.3	1.4	0.0	3.0	0.0	Horz	PK	0.0	46.5	74.0	-27.5	High Ch, 2477 MHz, LED Facing Up
4808.030	38.0	8.2	1.5	98.0	3.0	0.0	Horz	PK	0.0	46.2	74.0	-27.8	Low Ch, 2404 MHz, EUT Vertical
4806.895	38.0	8.2	1.2	159.0	3.0	0.0	Vert	PK	0.0	46.2	74.0	-27.8	Low Ch, 2404 MHz, LED Facing Side
9616.290	29.3	-3.5	1.2	236.0	3.0	0.0	Vert	AV	0.0	25.8	54.0	-28.2	Low Ch, 2404 MHz, EUT Vertical
4807.500	37.0	8.2	1.2	118.0	3.0	0.0	Vert	PK	0.0	45.2	74.0	-28.8	Low Ch, 2404 MHz, LED Facing Up
9908.070	46.8	-2.3	1.2	79.0	3.0	0.0	Vert	PK	0.0	44.5	74.0	-29.5	High Ch, 2477 MHz, EUT Vertical
9760.010	47.0	-2.9	1.5	176.0	3.0	0.0	Horz	PK	0.0	44.1	74.0	-29.9	Mid Ch, 2440 MHz, LED Facing Up
9616.435	47.5	-3.5	1.5	190.0	3.0	0.0	Horz	PK	0.0	44.0	74.0	-30.0	Low Ch, 2404 MHz, LED Facing Up
9759.995	45.7	-2.9	1.2	55.0	3.0	0.0	Vert	PK	0.0	42.8	74.0	-31.2	Mid Ch, 2440 MHz, EUT Vertical
9615.625	44.3	-3.5	1.2	236.0	3.0	0.0	Vert	PK	0.0	40.8	74.0	-33.2	Low Ch, 2404 MHz, EUT Vertical

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

Work Order:	MCSO1724	**Date:**	02/25/15		
Project:	None	**Temperature:**	23 °C		
Job Site:	NC01	**Humidity:**	33% RH		
Serial Number:	3051545630036-RF1	**Barometric Pres.:**	1031 mbar	**Tested by:**	Richard Mellroth
EUT:	1640				
Configuration:	2				
Customer:	Microsoft Corporation				
Attendees:	Kitty Tam				
EUT Power:	Battery				
Operating Mode:	Transmitting GFSK, 250 kbps, maximum duty cycle. See comments next to data points for EUT channel and orientation.				
Deviations:	None				
Comments:	None				

Test Specifications	**Test Method**
FCC 15.249:2015	ANSI C63.10:2009

Run #	16,25	**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
2399.920	50.4	-2.2	2.3	45.0	3.0	20.0	Horz	PK	0.0	68.2	74.0	-5.8	Low Ch, 2404 MHz, LED Facing Up
2399.823	49.9	-2.2	2.3	28.0	3.0	20.0	Horz	PK	0.0	67.7	74.0	-6.3	Low Ch, 2404 MHz, LED Facing Side
2483.543	48.7	-2.2	2.3	124.0	3.0	20.0	Horz	PK	0.0	66.5	74.0	-7.5	High Ch, 2477 MHz, LED Facing Up
2483.643	48.2	-2.2	2.9	204.0	3.0	20.0	Horz	PK	0.0	66.0	74.0	-8.0	High Ch, 2477 MHz, LED Facing Side
2399.907	46.2	-2.2	1.2	273.0	3.0	20.0	Vert	PK	0.0	64.0	74.0	-10.0	Low Ch, 2404 MHz, EUT Vertical
2483.717	25.0	-2.2	2.3	124.0	3.0	20.0	Horz	AV	0.0	42.8	54.0	-11.2	High Ch, 2477 MHz, LED Facing Up
2484.850	25.0	-2.2	2.9	204.0	3.0	20.0	Horz	AV	0.0	42.8	54.0	-11.2	High Ch, 2477 MHz, LED Facing Side
2484.047	24.9	-2.2	1.0	302.0	3.0	20.0	Vert	AV	0.0	42.7	54.0	-11.3	High Ch, 2477 MHz, LED Facing Side
2484.923	24.9	-2.2	1.0	8.0	3.0	20.0	Vert	AV	0.0	42.7	54.0	-11.3	High Ch, 2477 MHz, EUT Vertical
2485.087	24.9	-2.2	1.0	334.0	3.0	20.0	Horz	AV	0.0	42.7	54.0	-11.3	High Ch, 2477 MHz, EUT Vertical
2485.230	24.9	-2.2	1.0	340.0	3.0	20.0	Vert	AV	0.0	42.7	54.0	-11.3	High Ch, 2477 MHz, LED Facing Up
2399.890	24.8	-2.2	2.3	45.0	3.0	20.0	Horz	AV	0.0	42.6	54.0	-11.4	Low Ch, 2404 MHz, LED Facing Up
2399.983	24.7	-2.2	2.3	28.0	3.0	20.0	Horz	AV	0.0	42.5	54.0	-11.5	Low Ch, 2404 MHz, LED Facing Side
2399.977	24.6	-2.2	1.2	1.0	3.0	20.0	Vert	AV	0.0	42.4	54.0	-11.6	Low Ch, 2404 MHz, LED Facing Up
2399.833	24.6	-2.2	1.2	273.0	3.0	20.0	Vert	AV	0.0	42.4	54.0	-11.6	Low Ch, 2404 MHz, EUT Vertical
2398.240	24.6	-2.3	1.2	7.0	3.0	20.0	Horz	AV	0.0	42.3	54.0	-11.7	Low Ch, 2404 MHz, EUT Vertical
2398.017	24.6	-2.3	1.2	82.0	3.0	20.0	Vert	AV	0.0	42.3	54.0	-11.7	Low Ch, 2404 MHz, LED Facing Side
2484.277	44.4	-2.2	1.0	8.0	3.0	20.0	Vert	PK	0.0	62.2	74.0	-11.8	High Ch, 2477 MHz, EUT Vertical
2399.977	42.5	-2.2	1.2	1.0	3.0	20.0	Vert	PK	0.0	60.3	74.0	-13.7	Low Ch, 2404 MHz, LED Facing Up
2399.060	41.3	-2.3	1.2	7.0	3.0	20.0	Horz	PK	0.0	59.0	74.0	-15.0	Low Ch, 2404 MHz, EUT Vertical
2399.967	40.6	-2.2	1.2	82.0	3.0	20.0	Vert	PK	0.0	58.4	74.0	-15.6	Low Ch, 2404 MHz, LED Facing Side
2485.373	40.5	-2.2	1.0	302.0	3.0	20.0	Vert	PK	0.0	58.3	74.0	-15.7	High Ch, 2477 MHz, LED Facing Side
2483.883	40.4	-2.2	1.0	340.0	3.0	20.0	Vert	PK	0.0	58.2	74.0	-15.8	High Ch, 2477 MHz, LED Facing Up
2483.690	40.2	-2.2	1.0	334.0	3.0	20.0	Horz	PK	0.0	58.0	74.0	-16.0	High Ch, 2477 MHz, EUT Vertical

DUTY CYCLE - SINGLE CHANNEL MODE

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)
Spectrum Analyzer	Agilent	E4446A	AAT	6/27/2014	12
NC02 Cable	ESM Cable Corp.	TTBJ-141 KMKM-72	NC5	6/9/2014	12
Attenuator	Fairview Microwave	SA4014-20	TKE	1/16/2015	12
40GHz DC Block	Fairview Microwave	SD3379	AMJ	6/9/2014	12
Signal Generator	Agilent	N5183A	TIA	4/7/2014	36

TEST DESCRIPTION

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

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. A direct connection was made between the RF output of the EUT and a spectrum analyzer. Attenuation and a DC block were used.

The duty cycle was calculated by dividing the transmission pulse duration (T) by the total period of a single on and total off time.

If the transmit duty cycle < 98 percent, burst gating was used during some of the other tests in this report to only measure during the burst duration.

DUTY CYCLE - SINGLE CHANNEL MODE

NORTHWEST EMC

XMit 2015.01.14

EUT:	1640			**Work Order:**	MCSO1724
Serial Number:	14501929-RF4			**Date:**	02/25/15
Customer:	Microsoft Corporation			**Temperature:**	24°C
Attendees:	Kitty Tam			**Humidity:**	30%
Project:	None			**Barometric Pres.:**	1031 mb
Tested by:	Richard Mellroth	**Power:**	Battery	**Job Site:**	NC02

TEST SPECIFICATIONS	Test Method
FCC 15.249:2015	ANSI C63.10:2009

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

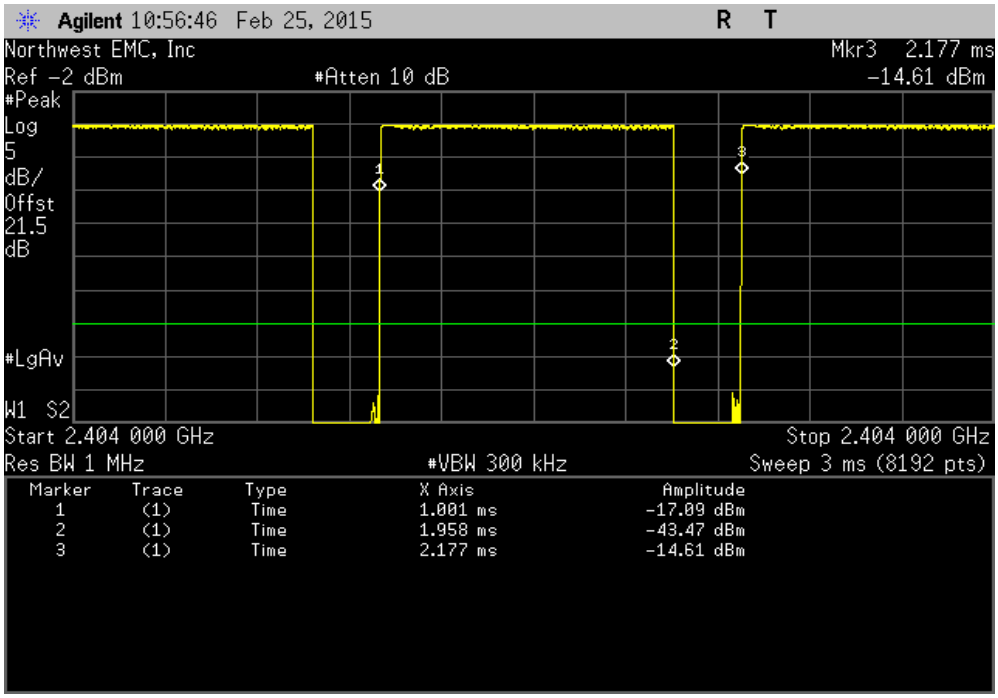
Configuration #	1	Signature

	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
GFSK, 250 kbps						
Low Channel, 2404 MHz	957 us	1.176 ms	1	81.4	N/A	N/A
Low Channel, 2404 MHz	N/A	N/A	5	N/A	N/A	N/A
Mid Channel, 2440 MHz	956.6 us	1.176 ms	1	81.3	N/A	N/A
Mid Channel, 2440 MHz	N/A	N/A	5	N/A	N/A	N/A
High Channel, 2477 MHz	955.2 us	1.176 ms	1	81.2	N/A	N/A
High Channel, 2477 MHz	N/A	N/A	5	N/A	N/A	N/A

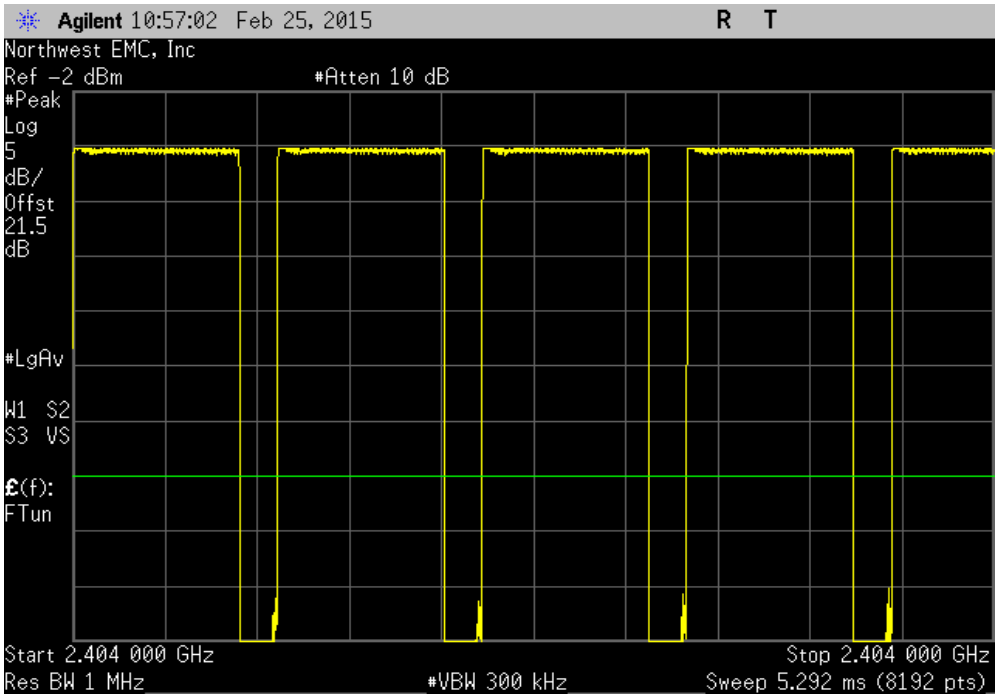
DUTY CYCLE - SINGLE CHANNEL MODE

XMit 2015.01.14

GFSK, 250 kbps, Low Channel, 2404 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	957 us	1.176 ms	1	81.4	N/A	N/A



GFSK, 250 kbps, Low Channel, 2404 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A

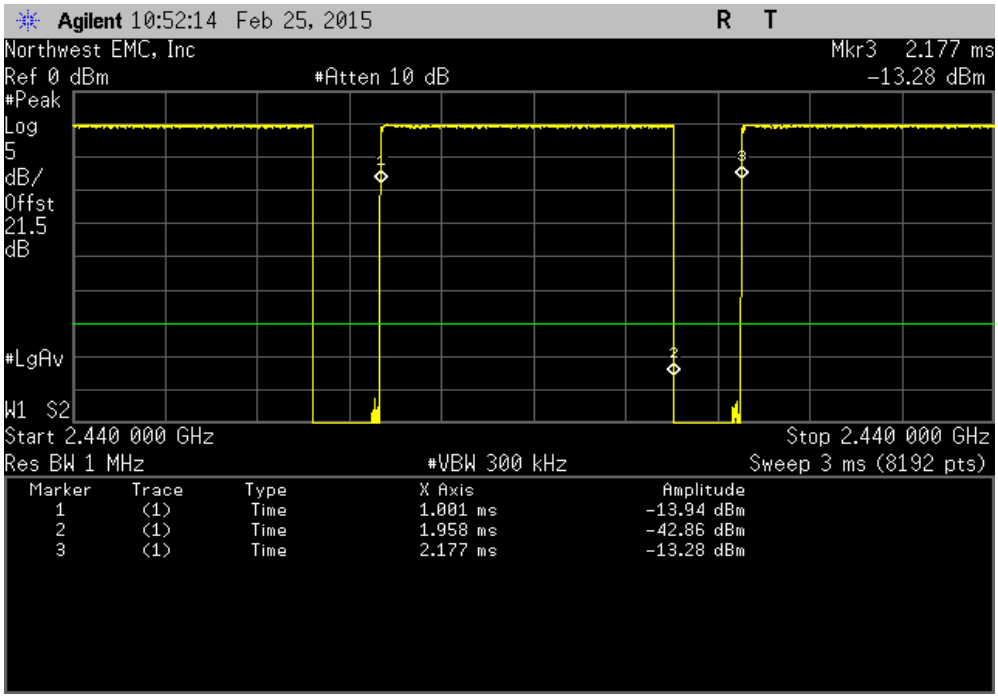


DUTY CYCLE - SINGLE CHANNEL MODE

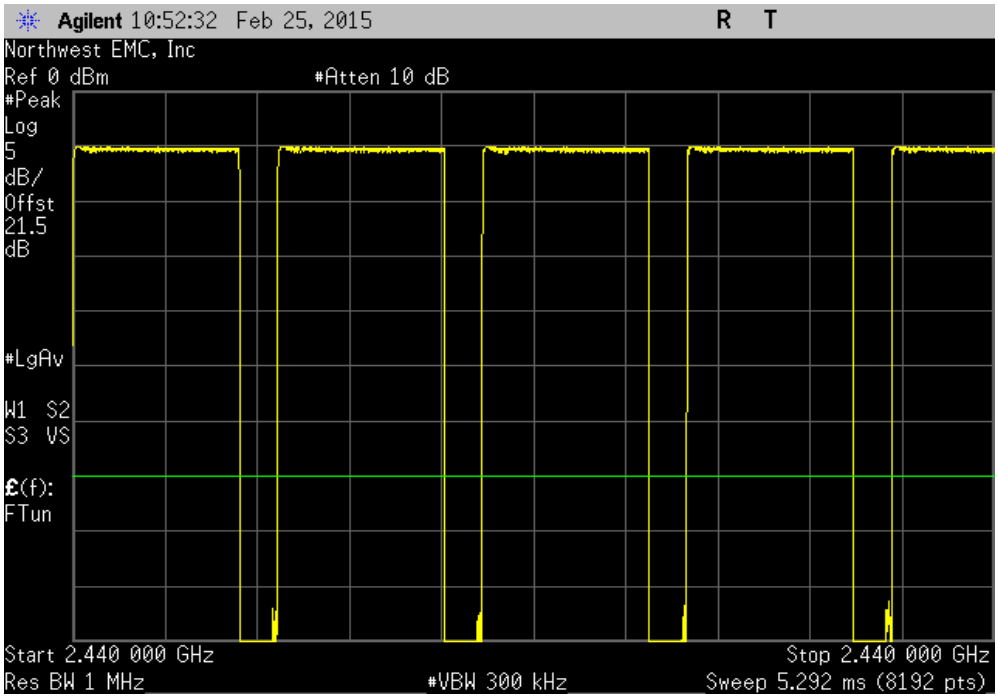
NORTHWEST EMC

XMit 2015.01.14

GFSK, 250 kbps, Mid Channel, 2440 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	956.6 us	1.176 ms	1	81.3	N/A	N/A



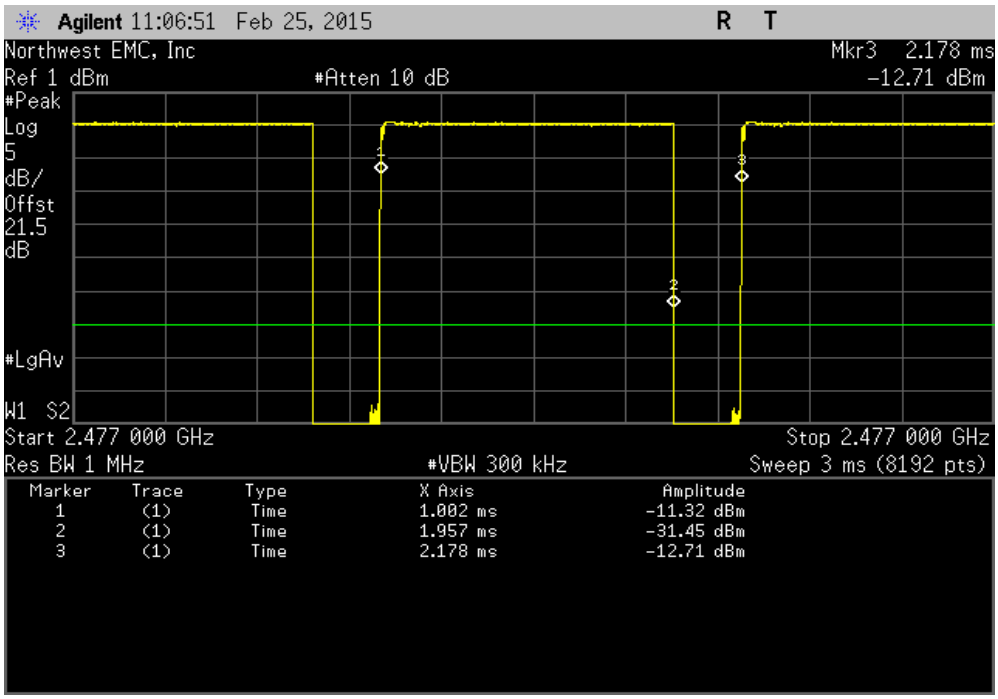
GFSK, 250 kbps, Mid Channel, 2440 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A



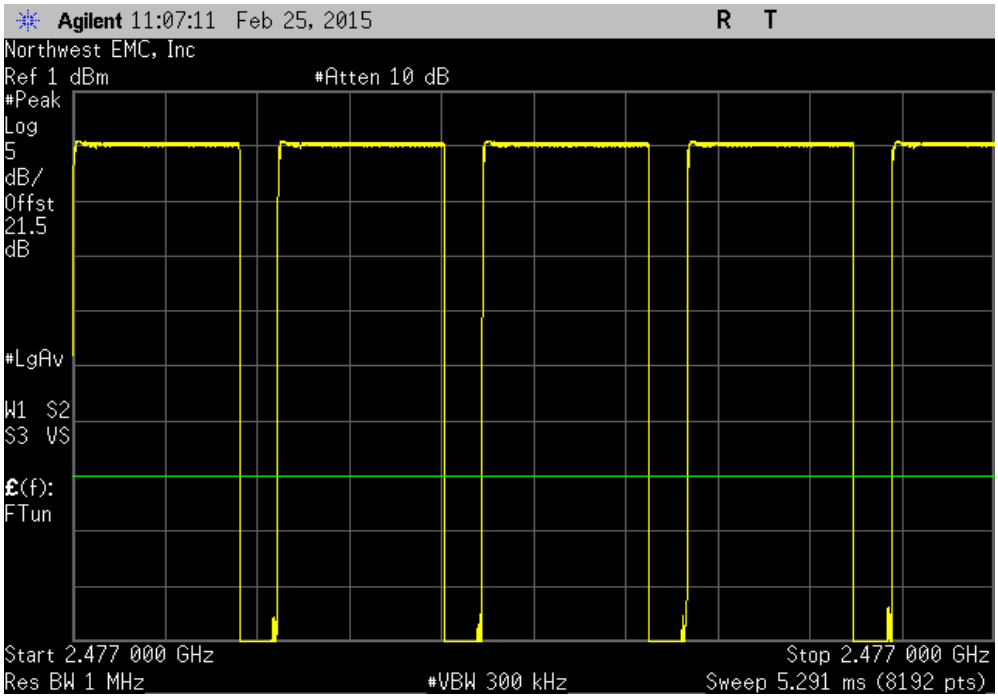
DUTY CYCLE - SINGLE CHANNEL MODE

XMit 2015.01.14

GFSK, 250 kbps, High Channel, 2477 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	955.2 us	1.176 ms	1	81.2	N/A	N/A



GFSK, 250 kbps, High Channel, 2477 MHz						
	Pulse Width	Period	Number of Pulses	Value (%)	Limit (%)	Results
	N/A	N/A	5	N/A	N/A	N/A



DUTY CYCLE - HOPPING MODE

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)
Spectrum Analyzer	Agilent	E4446A	AAT	6/27/2014	12
NC02 Cable	ESM Cable Corp.	TTBJ-141 KMKM-72	NC5	6/9/2014	12
Attenuator	Fairview Microwave	SA4014-20	TKE	1/16/2015	12
40GHz DC Block	Fairview Microwave	SD3379	AMJ	6/9/2014	12
Signal Generator	Agilent	N5183A	TIA	4/7/2014	36

TEST DESCRIPTION

The Pulse Width and Hopping Period of the hopping channel operation of the radio as controlled by the provided test software was measured. 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. A direct connection was made between the RF output of the EUT and a spectrum analyzer. Attenuation and a DC block were used.

The resulting measurements will be used to calculated and apply a Duty Cycle Corretion Factor (DCCF) for Radiated Field Strength measurements.

The Duty Cycle Correction Factor is calculated in dB as: DCCF(dB) = 20 * LOG[T(ms)/100ms]

Where T(ms) represents the total on time of the pulse train in a 100ms period.

DUTY CYCLE - HOPPING MODE

NORTHWEST EMC

XMit 2015.01.14

EUT:	1640			**Work Order:**	MCSO1724
Serial Number:	14501929-RF4			**Date:**	03/03/15
Customer:	Microsoft Corporation			**Temperature:**	24°C
Attendees:	Kitty Tam			**Humidity:**	30%
Project:	None			**Barometric Pres.:**	1031 mb
Tested by:	Richard Mellroth	**Power:**	Battery	**Job Site:**	NC02

TEST SPECIFICATIONS	Test Method
FCC 15.249:2015	ANSI C63.10:2009

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

Configuration #	1	Signature

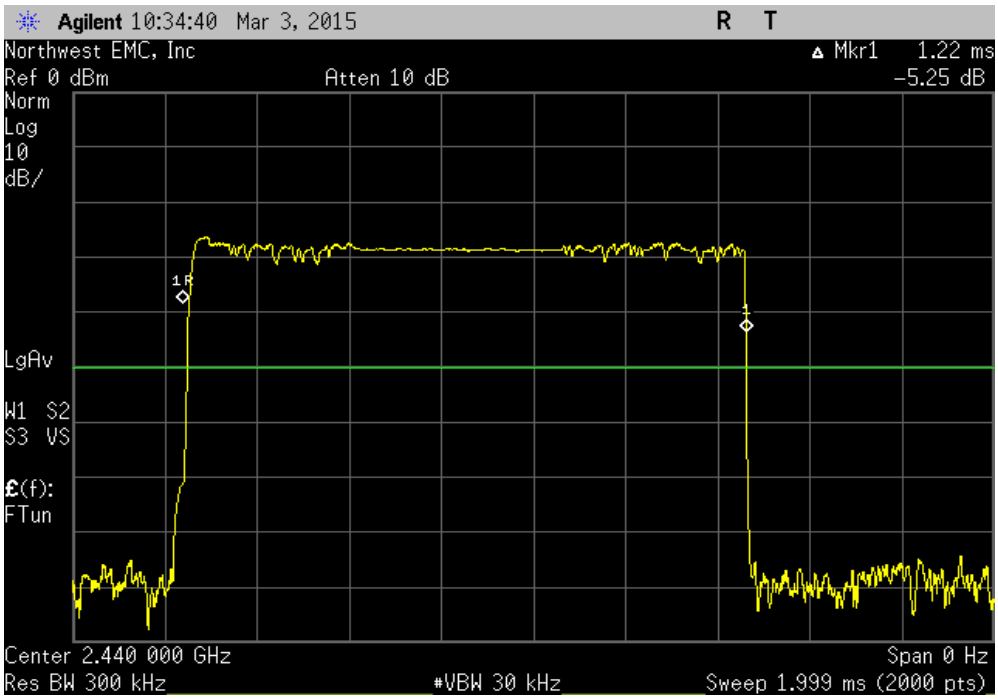
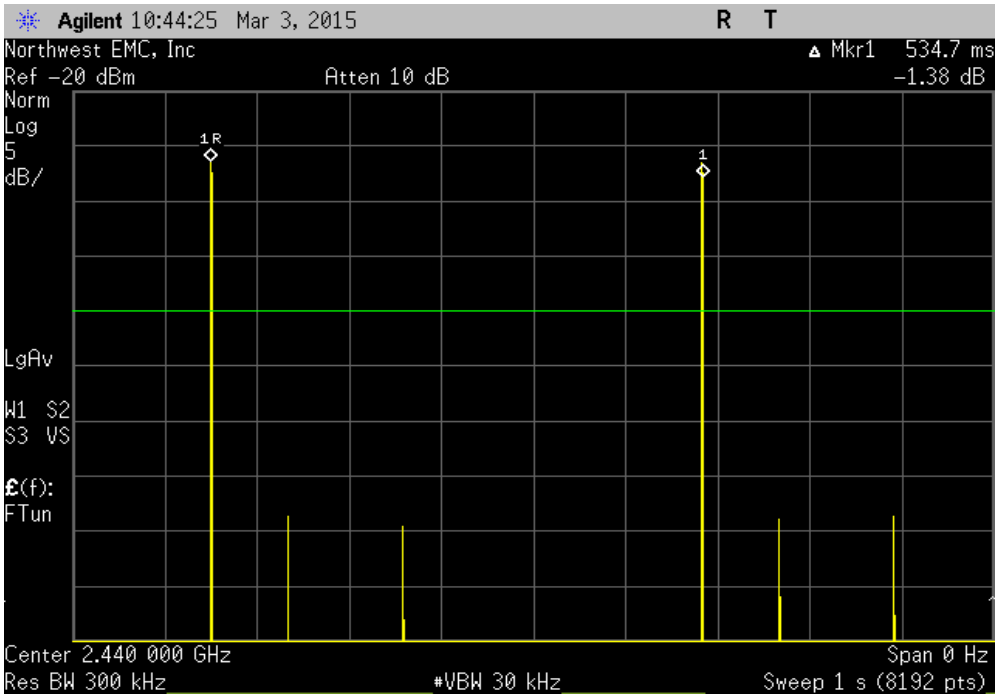
	Pulse Width (ms)	Period (ms)	Number of Hops in 100ms	On Time (ms) During 100ms	DCCF (dB)	Results
Hopping Mode, GFSK, 250 kbps						
Mid Channel, 2440 MHz	1.22	N/A	N/A	N/A	N/A	N/A
Mid Channel, 2440 MHz	N/A	534.7	1	1.22	-38.27	N/A

DUTY CYCLE - HOPPING MODE

NORTHWEST EMC

XMit 2015.01.14

Hopping Mode, GFSK, 250 kbps, Mid Channel, 2440 MHz						
	Pulse Width (ms)	Period (ms)	Number of Hops in 100ms	On Time (ms) During 100ms	DCCF (dB)	Results
	1.22	N/A	N/A	N/A	N/A	N/A



Hopping Mode, GFSK, 250 kbps, Mid Channel, 2440 MHz						
	Pulse Width (ms)	Period (ms)	Number of Hops in 100ms	On Time (ms) During 100ms	DCCF (dB)	Results
	N/A	534.7	1	1.22	-38.27	N/A