NORTHWEST EMC

Banner Engineering Corp

Q240R Sensor

FCC 15.207:2015

FCC 15.245:2015

24.00 - 24.25 GHz Transceiver

Report # BANN0028

NVLAP Lab Code: 200881-0

CERTIFICATE OF TEST

NORTHWEST EMC
2014-12-10

Last Date of Test: August 25, 2015
Banner Engineering Corp
Model: Q240R Sensor

Radio Equipment Testing

Standards

Specification	Method
FCC 15.207:2015	ANSI C63.10:2013
FCC 15.245:2015	ANSI C63.10:2013

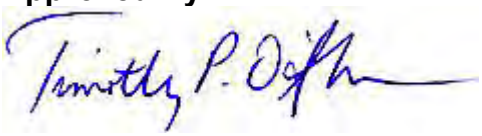
Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions	Yes	Pass	
6.5, 6.6	Field Strength of Harmonics and Spurious Radiated Emissions	Yes	Pass	
6.6	Field Strength of Fundamental	Yes	Pass	

Deviations From Test Standards

None

Approved By:



Tim O'Shea, 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 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.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.

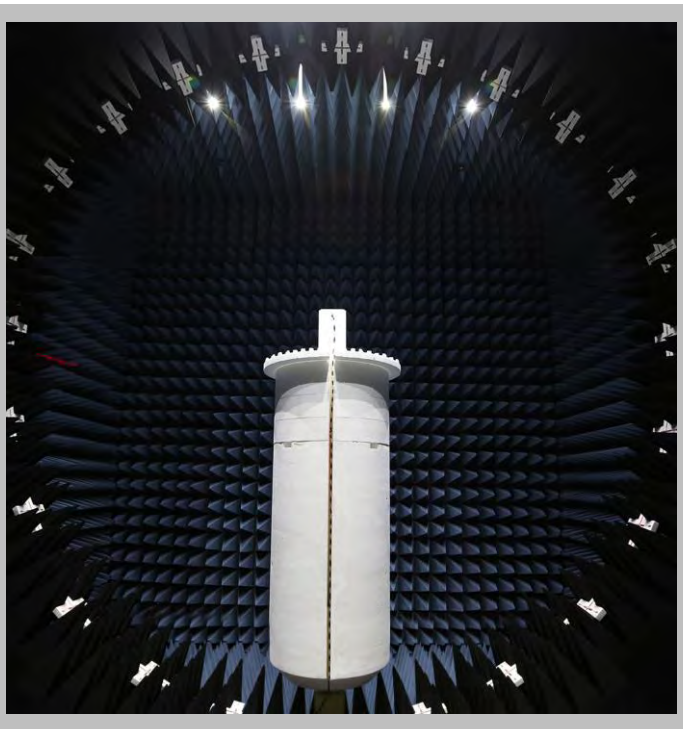
The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

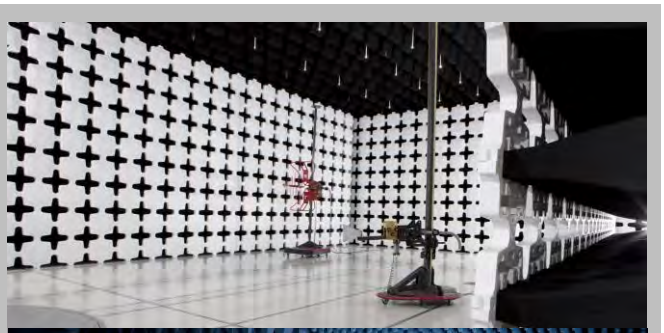
Test	+ MU	- MU
Frequency Accuracy (Hz)	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	0.3 dB	-0.3 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	5.2 dB	-5.2 dB
AC Powerline Conducted Emissions (dB)	2.4 dB	-2.4 dB

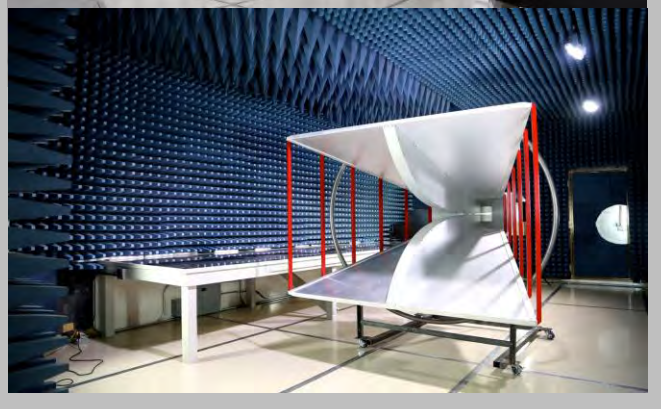
FACILITIES

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 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:	Banner Engineering Corp
Address:	9714 Tenth Ave North
City, State, Zip:	Minneapolis, MN 55441
Test Requested By:	Homayoon Homara
Model:	Q240R Sensor
First Date of Test:	August 24, 2015
Last Date of Test:	August 25, 2015
Receipt Date of Samples:	August 24, 2015
Equipment Design Stage:	Production
Equipment Condition:	No Damage

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
Radar-Based Dual-Zone Narrow-Beam Sensors for Detection of Moving and Stationary Targets. Primarily used in industrial applications such as rail yards, ports, gantry systems and the like.

Testing Objective:
Seeking to demonstrate compliance under FCC 15.245 for operation in the 24.00 - 24.25 GHz band.

CONFIGURATIONS

NORTHWEST EMC 2014-12-10

Configuration BANN0028- 1

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
24 GHz Collision Sensor	Banner Engineering Corp	Q240R Sensor	None

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Battery 12 VDC x 2	Duracell	12 Volt ProCell	None
Power/Output Monitor (Support Unit)	Banner Engineering Corp	Power/Output Monitor (Support Unit)	None

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
DC Power	Yes	10m	No	Power/Output Monitor(Test Unit)	24 GHz Collision Sensor
Banana Jack Cable (DC Power)	Unshielded	3m	No	Battery 12 VDC x 2	Power/Output Monitor(Test Unit)

Configuration BANN0028- 3

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
24 GHz Collision Sensor	Banner Engineering Corp	Q240R Sensor	None

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Power/Output Monitor (Support Unit)	Banner Engineering Corp	Power/Output Monitor (Support Unit)	None
AC Power Adapter	Banner Engineering Corp.	PSD-24-4	None

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
DC Power	Yes	10m	No	Power/Output Monitor (Test Unit)	24 GHz Collision Sensor
DC Power Cable (AC Adapter)	No	3m	No	AC Power Adapter	Power/Output Monitor
AC Power Cable	No	1.8m	No	AC Power Adapter	AC Mains

MODIFICATIONS

NORTHWEST EMC
2014-12-10

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	8/24/2015	Field Strength of Harmonics and 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.
2	8/24/2015	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.
3	8/25/2015	Powerline Conducted Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed

POWERLINE CONDUCTED EMISSIONS

NORTHWEST EMC

WTD.2015.05.26
PSA-ESCI 2015.03.03, EmiR5 2015.05.29

TEST DESCRIPTION

Using the mode of operation and configuration noted within this report, conducted emissions tests were performed. The frequency range investigated (scanned), is also noted in this report. Conducted power line measurements are made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly via separate transformer or power supplies) connected to a public power network. Equipment is tested with power cords that are normally used or that have electrical or shielding characteristics that are the same as those cords normally used. Typically those measurements are made using a LISN (Line Impedance Stabilization Network), the 50 Ω measuring port is terminated by a 50 Ω EMI meter or a 50 Ω resistive load. All 50 Ω measuring ports of the LISN are terminated by 50Ω.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Attenuator	Fairview Microwave	SA01B-20	AQP	NCR	NCR
Filter - High Pass	TTE	H97-100K-50-720B	HGN	NCR	NCR
Cable - Conducted Cable Assembly	Northwest EMC	None	MNC	NCR	NCR
LISN	Solar Electronics	9252-50-R-24-BNC	LIY	3/23/2015	3/23/2016
Receiver	Rohde & Schwarz	ESR7	ARI	5/21/2015	5/21/2016

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	2.4 dB	-2.4 dB

CONFIGURATIONS INVESTIGATED

BANN0028-3

MODES INVESTIGATED

Transmitting a swept FM-CW signal at 24.125 GHz

POWERLINE CONDUCTED EMISSIONS

NORTHWEST EMC
WTD.2015.05.26
PSA-ESCI 2015.03.03, EmiR5 2015.05.29

EUT:	Q240R Sensor	Work Order:	BANN0028
Serial Number:	None	Date:	08/25/2015
Customer:	Banner Engineering Corp	Temperature:	21.8°C
Attendees:	Homayoon Homara	Relative Humidity:	45.5%
Customer Project:	None	Bar. Pressure:	989.2 mb
Tested By:	Dustin Sparks	Job Site:	MN03
Power:	110VAC/60Hz	Configuration:	BANN0028-3

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2015	ANSI C63.10:2013

TEST PARAMETERS

Run #:	5	Line:	Neutral	Add. Ext. Attenuation (dB):	0

COMMENTS

None

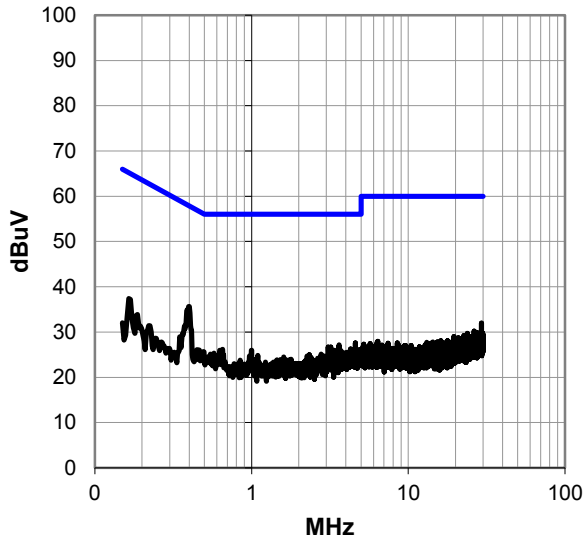
EUT OPERATING MODES

Transmitting a swept FM-CW signal at 24.125 GHz

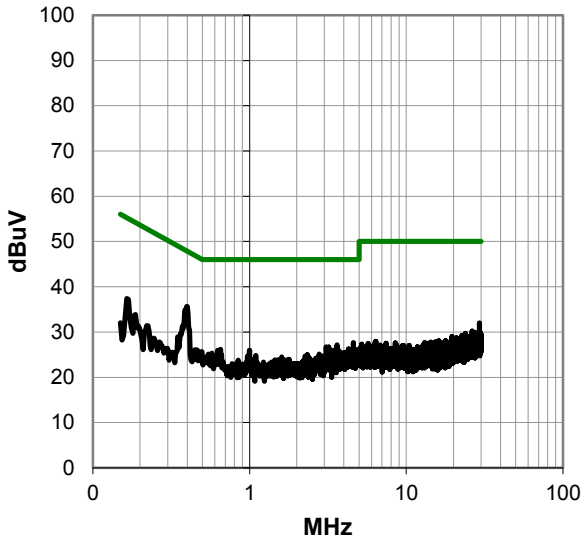
DEVIATIONS FROM TEST STANDARD

None

Peak Data - vs - Quasi Peak Limit



Peak Data - vs - Average Limit



POWERLINE CONDUCTED EMISSIONS

NORTHWEST EMC
WTD.2015.05.26
PSA-ESCI 2015.03.03, EmiR5 2015.05.29

RESULTS - Run #5

Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.396	15.4	20.2	35.6	57.9	-22.3
0.165	17.0	20.4	37.4	65.2	-27.8
29.328	9.5	22.5	32.0	60.0	-28.0
4.597	7.1	20.5	27.6	56.0	-28.4
3.612	6.8	20.4	27.2	56.0	-28.8
3.206	6.3	20.3	26.6	56.0	-29.4
3.086	6.3	20.3	26.6	56.0	-29.4
4.287	5.8	20.5	26.3	56.0	-29.7
0.654	6.0	20.2	26.2	56.0	-29.8
26.299	8.0	22.2	30.2	60.0	-29.8
4.914	5.6	20.5	26.1	56.0	-29.9
29.347	7.6	22.5	30.1	60.0	-29.9
1.001	5.8	20.2	26.0	56.0	-30.0
0.628	5.8	20.2	26.0	56.0	-30.0
26.967	7.7	22.2	29.9	60.0	-30.1
3.381	5.6	20.3	25.9	56.0	-30.1
29.049	7.5	22.4	29.9	60.0	-30.1
27.374	7.6	22.3	29.9	60.0	-30.1
3.717	5.5	20.4	25.9	56.0	-30.1
3.291	5.4	20.3	25.7	56.0	-30.3
23.908	7.8	21.9	29.7	60.0	-30.3
0.187	13.5	20.4	33.9	64.2	-30.3
29.952	7.2	22.5	29.7	60.0	-30.3
29.828	7.2	22.5	29.7	60.0	-30.3
29.515	7.2	22.5	29.7	60.0	-30.3
3.508	5.3	20.4	25.7	56.0	-30.3

Peak Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.396	15.4	20.2	35.6	47.9	-12.3
0.165	17.0	20.4	37.4	55.2	-17.8
29.328	9.5	22.5	32.0	50.0	-18.0
4.597	7.1	20.5	27.6	46.0	-18.4
3.612	6.8	20.4	27.2	46.0	-18.8
3.206	6.3	20.3	26.6	46.0	-19.4
3.086	6.3	20.3	26.6	46.0	-19.4
4.287	5.8	20.5	26.3	46.0	-19.7
0.654	6.0	20.2	26.2	46.0	-19.8
26.299	8.0	22.2	30.2	50.0	-19.8
4.914	5.6	20.5	26.1	46.0	-19.9
29.347	7.6	22.5	30.1	50.0	-19.9
1.001	5.8	20.2	26.0	46.0	-20.0
0.628	5.8	20.2	26.0	46.0	-20.0
26.967	7.7	22.2	29.9	50.0	-20.1
3.381	5.6	20.3	25.9	46.0	-20.1
29.049	7.5	22.4	29.9	50.0	-20.1
27.374	7.6	22.3	29.9	50.0	-20.1
3.717	5.5	20.4	25.9	46.0	-20.1
3.291	5.4	20.3	25.7	46.0	-20.3
23.908	7.8	21.9	29.7	50.0	-20.3
0.187	13.5	20.4	33.9	54.2	-20.3
29.952	7.2	22.5	29.7	50.0	-20.3
29.828	7.2	22.5	29.7	50.0	-20.3
29.515	7.2	22.5	29.7	50.0	-20.3
3.508	5.3	20.4	25.7	46.0	-20.3

CONCLUSION

Pass

Tested By

POWERLINE CONDUCTED EMISSIONS

NORTHWEST EMC
WTD.2015.05.26
PSA-ESCI 2015.03.03, EmiR5 2015.05.29

EUT:	Q240R Sensor	Work Order:	BANN0028
Serial Number:	None	Date:	08/25/2015
Customer:	Banner Engineering Corp	Temperature:	21.8°C
Attendees:	Homayoon Homara	Relative Humidity:	45.5%
Customer Project:	None	Bar. Pressure:	989.2 mb
Tested By:	Dustin Sparks	Job Site:	MN03
Power:	110VAC/60Hz	Configuration:	BANN0028-3

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2015	ANSI C63.10:2013

TEST PARAMETERS

Run #:	6	Line:	High Line	Add. Ext. Attenuation (dB):	0

COMMENTS

None

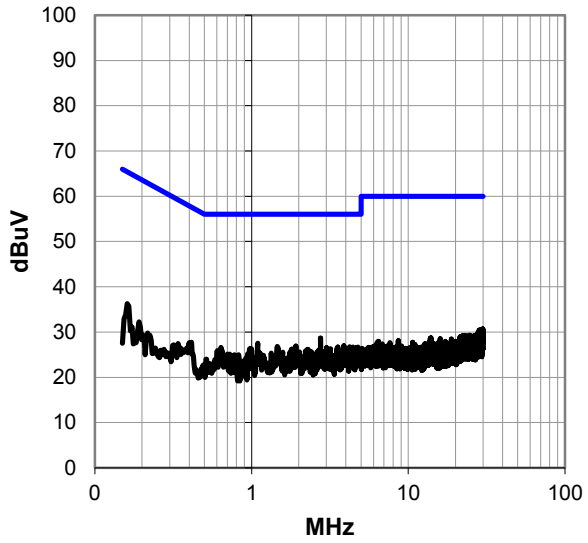
EUT OPERATING MODES

Transmitting a swept FM-CW signal at 24.125 GHz

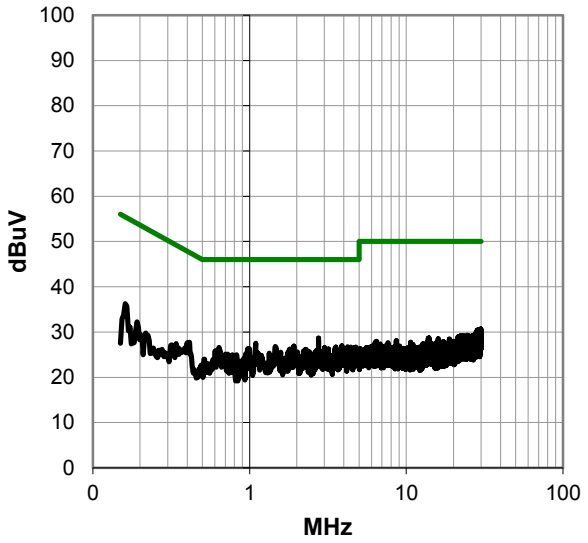
DEVIATIONS FROM TEST STANDARD

None

Peak Data - vs - Quasi Peak Limit



Peak Data - vs - Average Limit



POWERLINE CONDUCTED EMISSIONS

NORTHWEST EMC

WTD.2015.05.26
PSA-ESCI 2015.03.03, EmiR5 2015.05.29

RESULTS - Run #6

Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
2.754	8.3	20.3	28.6	56.0	-27.4
1.094	7.3	20.2	27.5	56.0	-28.5
3.881	6.5	20.4	26.9	56.0	-29.1
0.161	15.9	20.4	36.3	65.4	-29.1
1.918	6.6	20.3	26.9	56.0	-29.1
1.460	6.6	20.2	26.8	56.0	-29.2
4.217	6.3	20.5	26.8	56.0	-29.2
29.955	8.2	22.5	30.7	60.0	-29.3
4.765	6.2	20.5	26.7	56.0	-29.3
4.422	6.2	20.5	26.7	56.0	-29.3
3.552	6.3	20.4	26.7	56.0	-29.3
0.639	6.4	20.2	26.6	56.0	-29.4
4.713	6.1	20.5	26.6	56.0	-29.4
3.012	6.2	20.3	26.5	56.0	-29.5
1.478	6.2	20.2	26.4	56.0	-29.6
28.843	8.0	22.4	30.4	60.0	-29.6
29.981	7.9	22.5	30.4	60.0	-29.6
28.396	8.0	22.4	30.4	60.0	-29.6
4.545	5.9	20.5	26.4	56.0	-29.6
29.403	7.9	22.5	30.4	60.0	-29.6
3.508	6.0	20.4	26.4	56.0	-29.6
0.975	6.1	20.2	26.3	56.0	-29.7
0.993	6.1	20.2	26.3	56.0	-29.7
1.825	6.0	20.3	26.3	56.0	-29.7
4.254	5.8	20.5	26.3	56.0	-29.7
4.176	5.8	20.5	26.3	56.0	-29.7

Peak Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
2.754	8.3	20.3	28.6	46.0	-17.4
1.094	7.3	20.2	27.5	46.0	-18.5
3.881	6.5	20.4	26.9	46.0	-19.1
0.161	15.9	20.4	36.3	55.4	-19.1
1.918	6.6	20.3	26.9	46.0	-19.1
1.460	6.6	20.2	26.8	46.0	-19.2
4.217	6.3	20.5	26.8	46.0	-19.2
29.955	8.2	22.5	30.7	50.0	-19.3
4.765	6.2	20.5	26.7	46.0	-19.3
4.422	6.2	20.5	26.7	46.0	-19.3
3.552	6.3	20.4	26.7	46.0	-19.3
0.639	6.4	20.2	26.6	46.0	-19.4
4.713	6.1	20.5	26.6	46.0	-19.4
3.012	6.2	20.3	26.5	46.0	-19.5
1.478	6.2	20.2	26.4	46.0	-19.6
28.843	8.0	22.4	30.4	50.0	-19.6
29.981	7.9	22.5	30.4	50.0	-19.6
28.396	8.0	22.4	30.4	50.0	-19.6
4.545	5.9	20.5	26.4	46.0	-19.6
29.403	7.9	22.5	30.4	50.0	-19.6
3.508	6.0	20.4	26.4	46.0	-19.6
0.975	6.1	20.2	26.3	46.0	-19.7
0.993	6.1	20.2	26.3	46.0	-19.7
1.825	6.0	20.3	26.3	46.0	-19.7
4.254	5.8	20.5	26.3	46.0	-19.7
4.176	5.8	20.5	26.3	46.0	-19.7

CONCLUSION

Pass

Dustin Sparks

Tested By

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

NORTHWEST EMC

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.

POWER SETTINGS INVESTIGATED

110VAC/60Hz

CONFIGURATIONS INVESTIGATED

BANN0028 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	100 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 (mo)
Amplifier - Pre-Amplifier	Miteq	JSW45-26004000-40-5P	AVN	10/3/2014	12
Cable	Northwest EMC	TTBJ141-KMKM-72	MNQ	10/3/2014	12
Antenna - Standard Gain	ETS Lindgren	3160-10	AIC	NCR	0
Cable	ESM Cable Corp.	Standard Gain Horn Cables	MNJ	5/5/2015	12
Antenna - Standard Gain	ETS Lindgren	3160-08	AIQ	NCR	0
Antenna - Standard Gain	ETS Lindgren	3160-07	AXP	NCR	0
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AVW	3/2/2015	12
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVV	3/2/2015	12
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVX	3/2/2015	12
Cable	ESM Cable Corp.	Double Ridge Guide Horn Cables	MNI	5/5/2015	12
Antenna - Double Ridge	ETS Lindgren	3115	AJA	6/3/2014	24
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	PAD	3/2/2015	12
Cable	ESM Cable Corp.	Bilog Cables	MNH	3/30/2015	12
Antenna - Biconilog	Teseq	CBL 6141B	AYD	12/17/2013	24
Antenna - Standard Gain	ETS Lindgren	3160-09	AHG	NCR	0
Cable	Northwest EMC	18-26GHz Standard Gain Horn Cable	MNP	10/3/2014	12
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFI	1/27/2015	12
Cable - OML Mixer Set	Semplex, Inc	S119BFSS100390443	SUN	8/20/2013	36
Antenna, Horn with Mixer 90-140	OML, Inc	F60126-1	AIL	8/20/2013	36
Antenna, Horn with Mixer 60-90	OML, Inc	E60126-1	AIK	8/20/2013	36
Antenna, Horn with Mixer 40-60	OML, Inc	U51014-1	AIJ	8/20/2013	36

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 on single channel. 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 plane. A preamp was used for this test in order to provide sufficient measurement sensitivity.

The limits were extrapolated from 3 meter test distance and field strength values called out in FCC 15.245 for the 2nd and 3rd harmonics and FCC 15.209 for the 4th harmonic. Where measurements were made above 40 GHz, the mixer factor was applied internally on the spectrum analyzer. The antenna factor was added to the reference level offset.

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

NORTHWEST EMC

XMit 2015.01.14

EUT:	Q240R Sensor			**Work Order:**	BANN0028
Serial Number:	None			**Date:**	08/24/15
Customer:	Banner Engineering Corp			**Temperature:**	23°C
Attendees:	Homayoon Homara			**Humidity:**	42%
Project:	None			**Barometric Pres.:**	1015.5
Tested by:	Trevor Buls, Jared Ison	**Power:**	110VAC/60Hz	**Job Site:**	MN05

TEST SPECIFICATIONS	Test Method
FCC 15.245:2015	ANSI C63.10:2013

COMMENTS

Sweep time increased on the spectrum analyzer to capture the high rep rate modulation pattern.

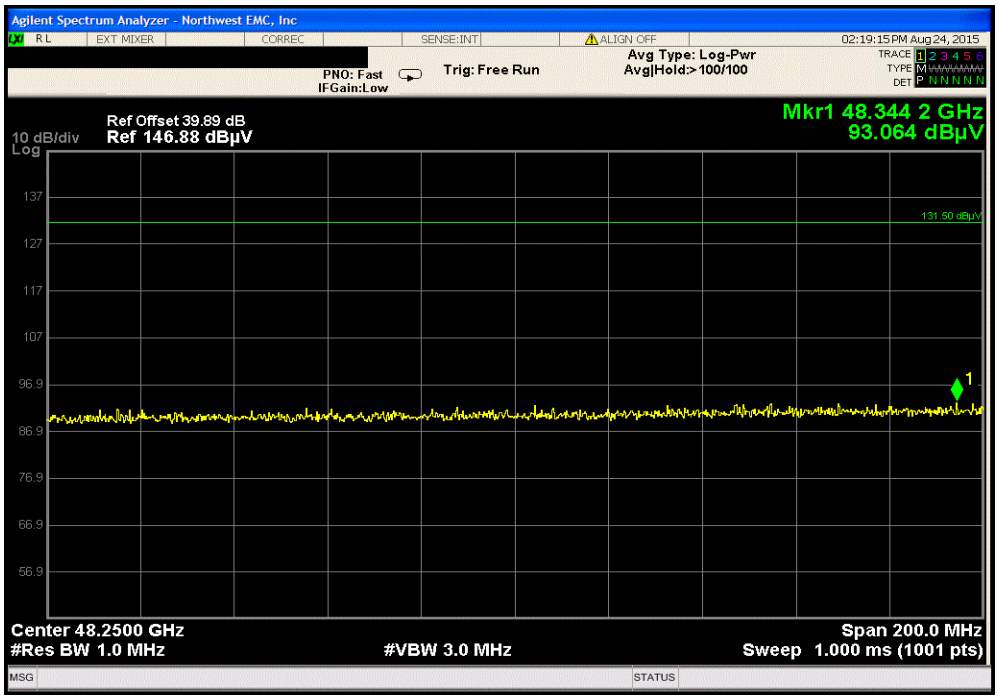
DEVIATIONS FROM TEST STANDARD

None

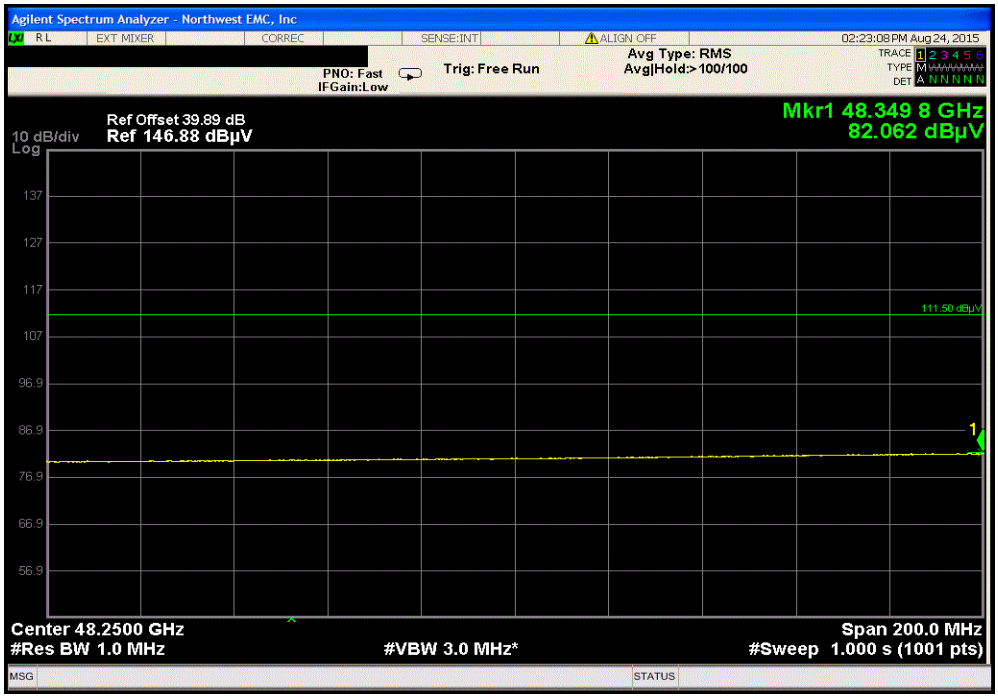
Configuration #	1	Signature

	Measurement Distance (cm)	Value (dBuV/m)	Limit (dBuV/m)	Result
2nd Harmonic: 48.250 GHz				
Peak Detector	20	93.064	131.5	Pass
RMS Average Detector	20	82.062	111.5	Pass
3rd Harmonic: 72.375 GHz				
Peak Detector	20	109.749	131.5	Pass
RMS Average Detector	20	97.959	111.5	Pass
4th Harmonic: 96.5 GHz				
Peak Detector	2	108.365	141	Pass
RMS Average Detector	2	96.488	121	Pass

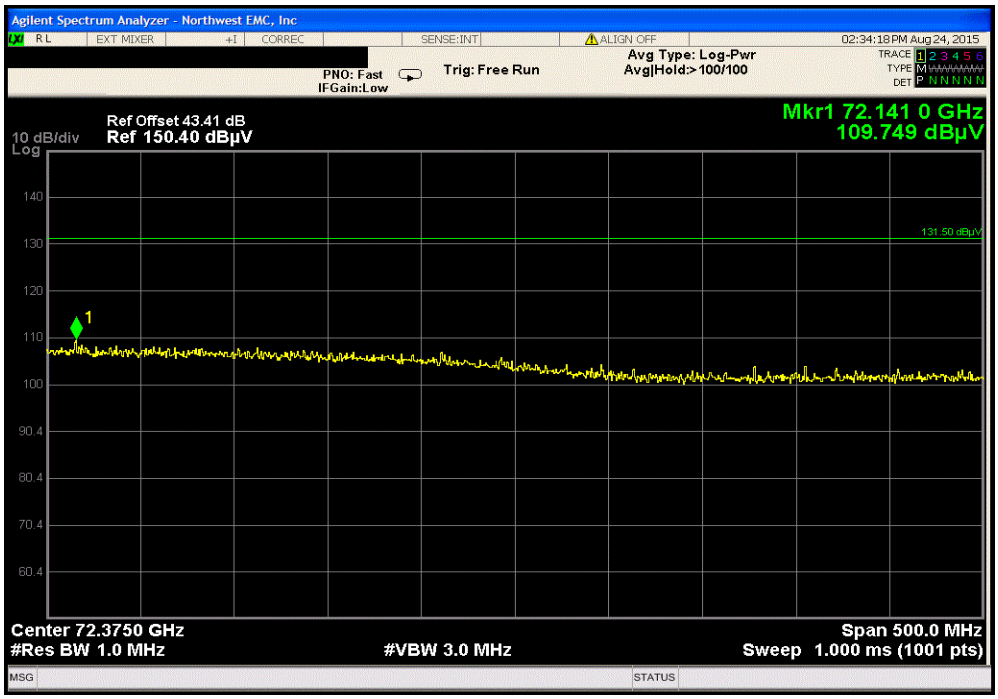
2nd Harmonic, Peak Detector: 48.250 GHz						
		Measurement Distance (cm)		Value (dBuV/m)	Limit (dBuV/m)	Result
		20		93.064	131.5	Pass



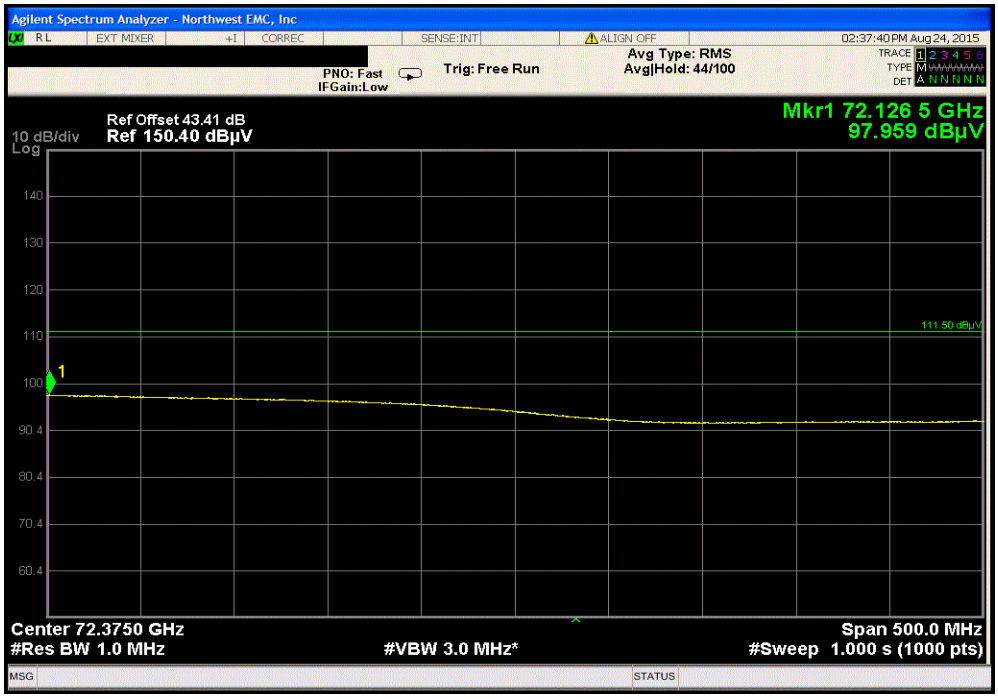
2nd Harmonic, RMS Average Detector: 48.250 GHz						
		Measurement Distance (cm)		Value (dBuV/m)	Limit (dBuV/m)	Result
		20		82.062	111.5	Pass



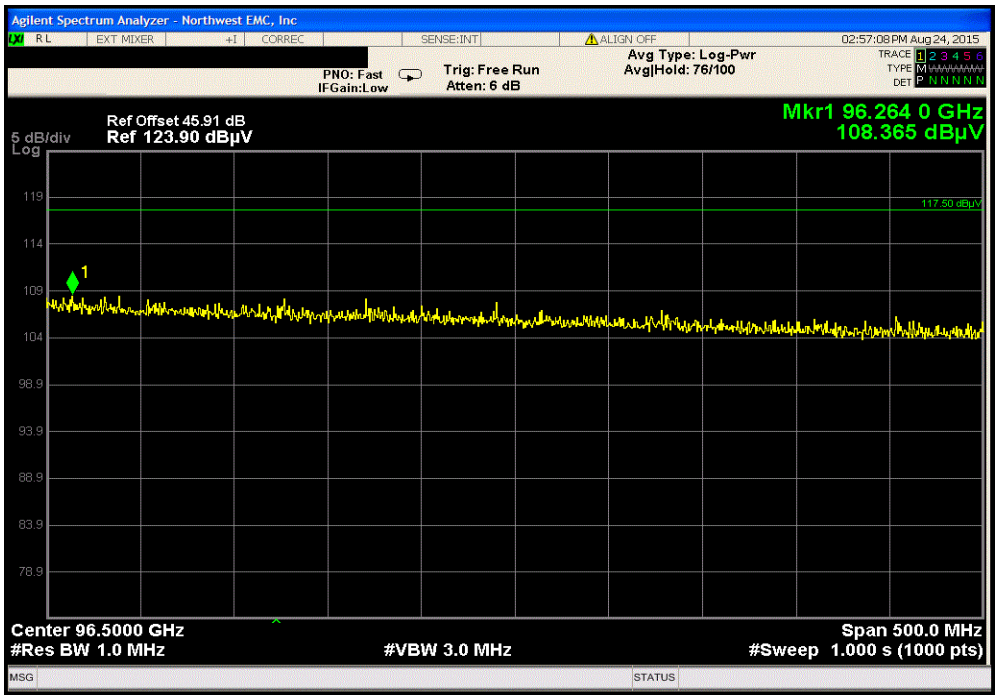
3rd Harmonic, Peak Detector: 72.375 GHz						
		Measurement Distance (cm)		Value (dBuV/m)	Limit (dBuV/m)	Result
		20		109.749	131.5	Pass



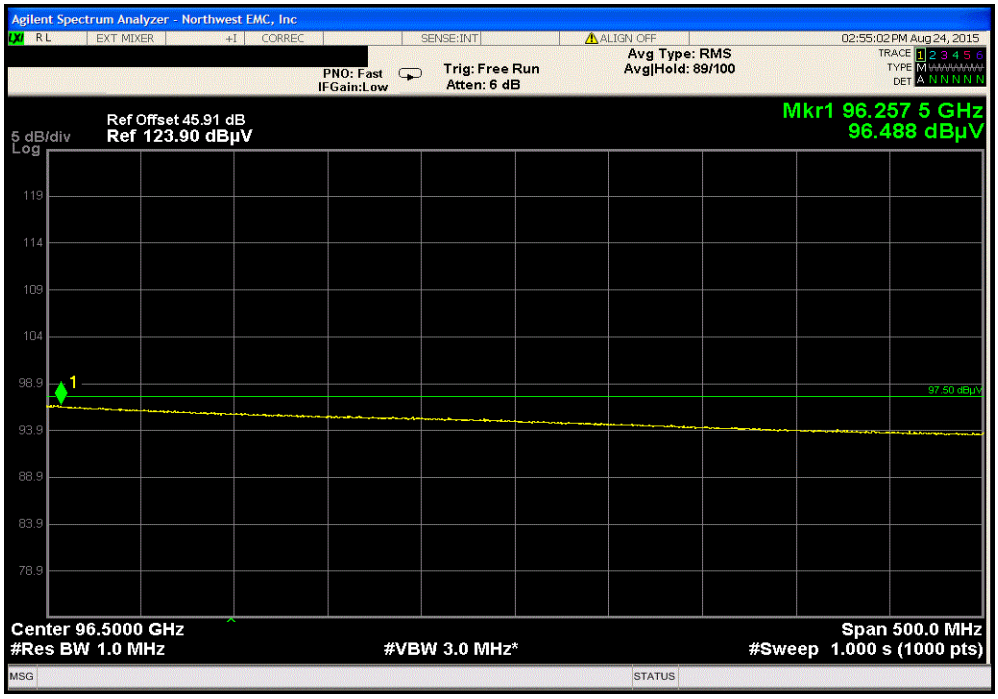
3rd Harmonic, RMS Average Detector: 72.375 GHz						
		Measurement Distance (cm)		Value (dBuV/m)	Limit (dBuV/m)	Result
		20		97.959	111.5	Pass



4th Harmonic, Peak Detector: 96.5 GHz						
		Measurement Distance (cm)		Value (dBuV/m)	Limit (dBuV/m)	Result
		2		108.365	117.5	Pass



4th Harmonic, RMS Average Detector: 96.5 GHz						
		Measurement Distance (cm)		Value (dBuV/m)	Limit (dBuV/m)	Result
		2		96.488	97.5	Pass



FIELD STRENGTH OF THE 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 a swept FM-CW signal at 24.125 GHz

POWER SETTINGS INVESTIGATED

110VAC/60Hz

CONFIGURATIONS INVESTIGATED

BANN0028 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	18 GHz	Stop Frequency	26.5 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
Cable	Northwest EMC	18-26GHz Standard Gain Horn Cable	MNP	10/3/2014	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-09	AHG	NCR	0 mo
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFI	1/27/2015	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

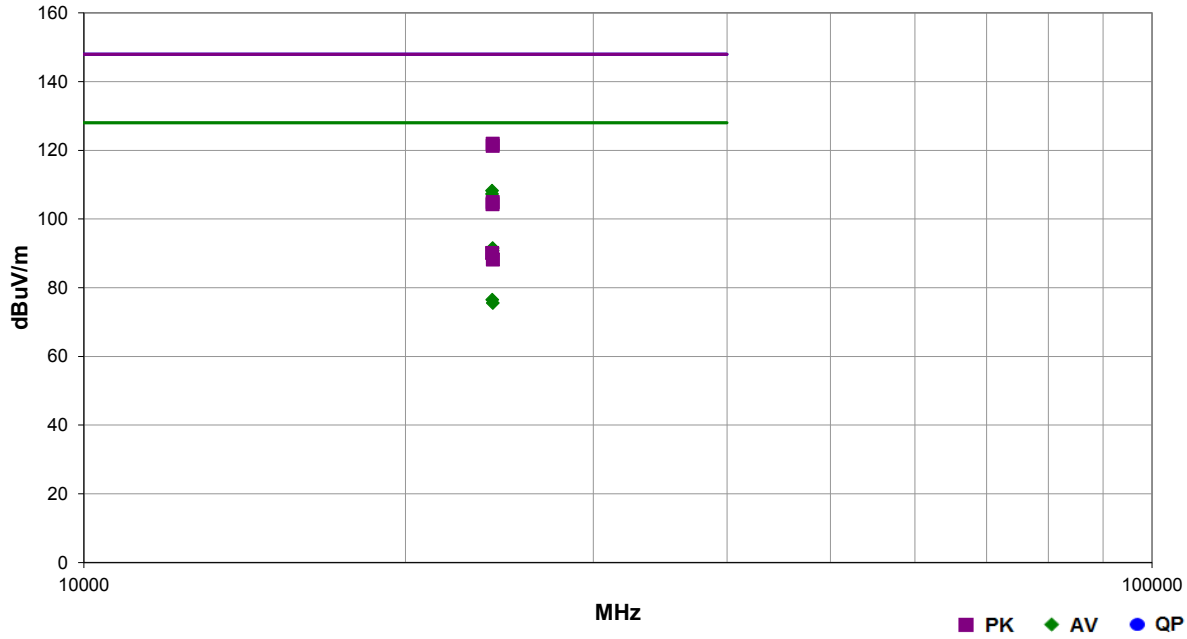
The antennas to be used with the EUT were tested. The EUT was transmitting on single channel. While scanning, emissions from the EUT were maximized by rotating the EUT, adjusting the measurement antenna height and polarization, and manipulating the EUT and EUT antenna in 3 orthogonal planes.

FIELD STRENGTH OF THE FUNDAMENTAL

Work Order:	BANN0028	**Date:**	08/24/15		
Project:	None	**Temperature:**	22.3 °C		
Job Site:	MN05	**Humidity:**	45.2% RH		
Serial Number:	None	**Barometric Pres.:**	1015.3 mbar	**Tested by:**	Trevor Buls, Jared Ison
EUT:	Q240R Sensor				
Configuration:	1				
Customer:	Banner Engineering Corp				
Attendees:					
EUT Power:	110VAC/60Hz				
Operating Mode:	Transmitting a swept FM-CW signal at 24.125 GHz				
Deviations:	None				
Comments:	Sweep time increased on the spectrum analyzer to capture the high rep rate modulation pattern.				

Test Specifications	**Test Method**
FCC 15.245:2015	ANSI C63.10:2013

Run #	3	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 2(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
24113.650	61.8	46.4	1.5	350.0	3.0	0.0	Horz	AV	0.0	108.2	128.0	-19.8	EUT On Side
24114.830	60.9	46.4	1.7	357.0	3.0	0.0	Vert	AV	0.0	107.3	128.0	-20.7	EUT Vert
24142.070	75.5	46.4	1.7	357.0	3.0	0.0	Vert	PK	0.0	121.9	148.0	-26.1	EUT Vert
24147.000	74.9	46.4	1.5	350.0	3.0	0.0	Horz	PK	0.0	121.3	148.0	-26.7	EUT On Side
24147.260	45.1	46.4	1.7	351.0	3.0	0.0	Vert	AV	0.0	91.5	128.0	-36.5	EUT On Side
24146.540	44.4	46.4	1.7	0.0	3.0	0.0	Horz	AV	0.0	90.8	128.0	-37.2	EUT Vert
24147.670	58.5	46.4	1.7	351.0	3.0	0.0	Vert	PK	0.0	104.9	148.0	-43.1	EUT On Side
24135.130	57.9	46.4	1.7	0.0	3.0	0.0	Horz	PK	0.0	104.3	148.0	-43.7	EUT Vert
24119.730	30.1	46.4	1.5	171.0	3.0	0.0	Vert	AV	0.0	76.5	128.0	-51.5	EUT Horz
24153.700	29.1	46.4	1.5	202.1	3.0	0.0	Horz	AV	0.0	75.5	128.0	-52.5	EUT Horz
24116.200	43.7	46.4	1.5	171.0	3.0	0.0	Vert	PK	0.0	90.1	148.0	-57.9	EUT Horz
24149.670	41.8	46.4	1.5	202.1	3.0	0.0	Horz	PK	0.0	88.2	148.0	-59.8	EUT Horz

NORTHWEST EMC

APPENDIX

Q240 family
EMC Test Plan

Author: Homayoon Homara
Title: *Sr. Product regulatory compliance Engineer*
Engineering Quality and Test
E-mail: hhomara@bannerengineering.com
Owner: Compliance Department

Revision 1.0

Note: Part of Banner Technical File supporting compliance to EMC directive for the "DOC". (Not Applicable since this covers only North America approval FCC & IC)

	Name	Title/Department
Approvers:	Wade Oberpriller	Chief engineer-M&I products
Reviewers:	Ashly Wise	Principal Development Engineer SW & Signal Processing
	Brad Ragozzino	Technical Marketing Engineer
	Nate Casteel	Electrical Development Engineer

Revision History

All revisions that start with zero (such as 0.5, 0.65, and the like) are preliminary drafts for internal review only.

Table 1 – Revision History

No.	Date	Author	Description
0.9	08/13/2015	Homayoon Homara	Initial draft

No.	Date	Author	Description
1.0	08/24/2015	Homayoon Homara	Incorporated feedback comments from Wade Oberpriller and NWEMC Lab.

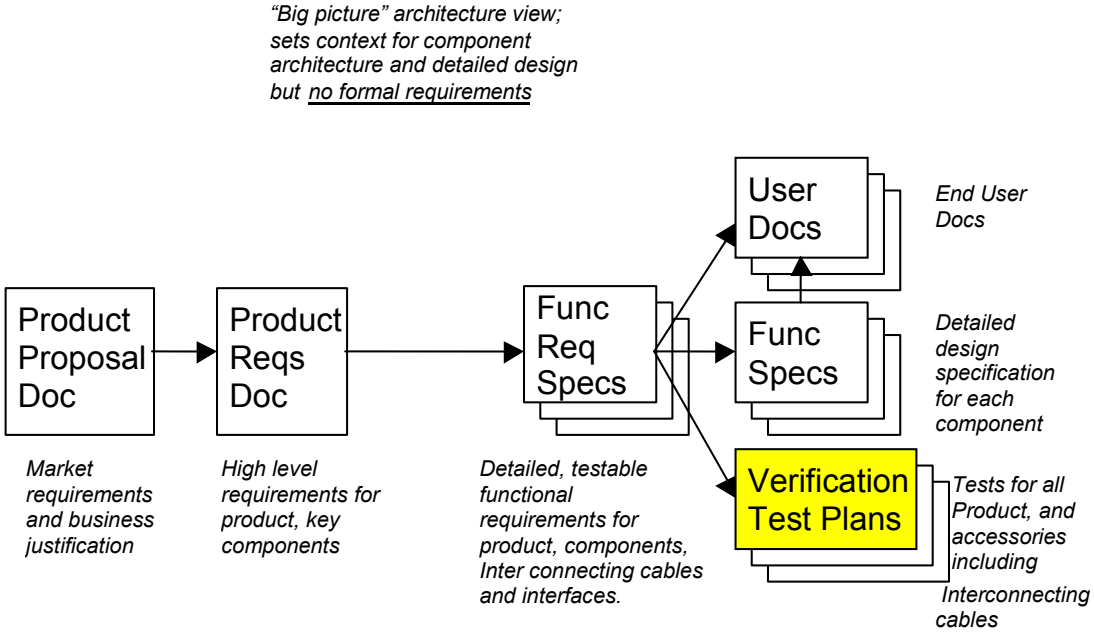
1. Overview

1.1 Document Overview

This document provides the detailed verification test information for the Banner Q240 family products. This document details the tests that will be done and the methods that will be used.

Figure 1 shows the relative positioning of the verification plans in the overall product requirements process flow.

Figure 1 - Product Specification Document Flow



1.2 Product Overview

This document defines the scope, approach, and resource dependencies of EMC verification for the Q240 family.

These devices are radar-Based Dual Zone Narrow Band Sensors for detection of moving and stationary targets. The following is a short list of some of the applications in the field ensuring moving equipment collision avoidance:

- Onboard mobile equipment such as forklifts, mining vehicles, entry/exit application for gate control. Vehicle detection (Park meter automation and Drive through lane)

- Indoor overhead gantry
- Outdoor crane to crane
- Ship detection, ship container detection, Rail car detection

The sensors are to be supplied by a Class 2 source for NA or Class III source for Europe.

Sensor emits a well-defined beam of high-frequency radio waves from an internal antenna. Some of this emitted energy is reflected back to the receiving antenna. Signal processing electronics determine the distance from the sensor to the object based on the time delay of the return signal. The sensor can be configured to two independent sensing zones.

The two sensing zones are factory pre-set to default distances; they can be reconfigured for different distances using the DIP switches on the side of the sensor. The sensitivity is precalibrated at the factory, assuming that the sensing field will be clear of obstacles. The sensitivity can be adjusted using the DIP switches on the side of the sensor.

1.2.1 Product Nomenclature

The end product options are as listed in the nomenclature below:

NOMENCLATURE (Complete Assembly):

Q240RA	-US	AF2	Q
I	II	III	IV

I. Basic Type Designation
Q240RA - Radar Sensor

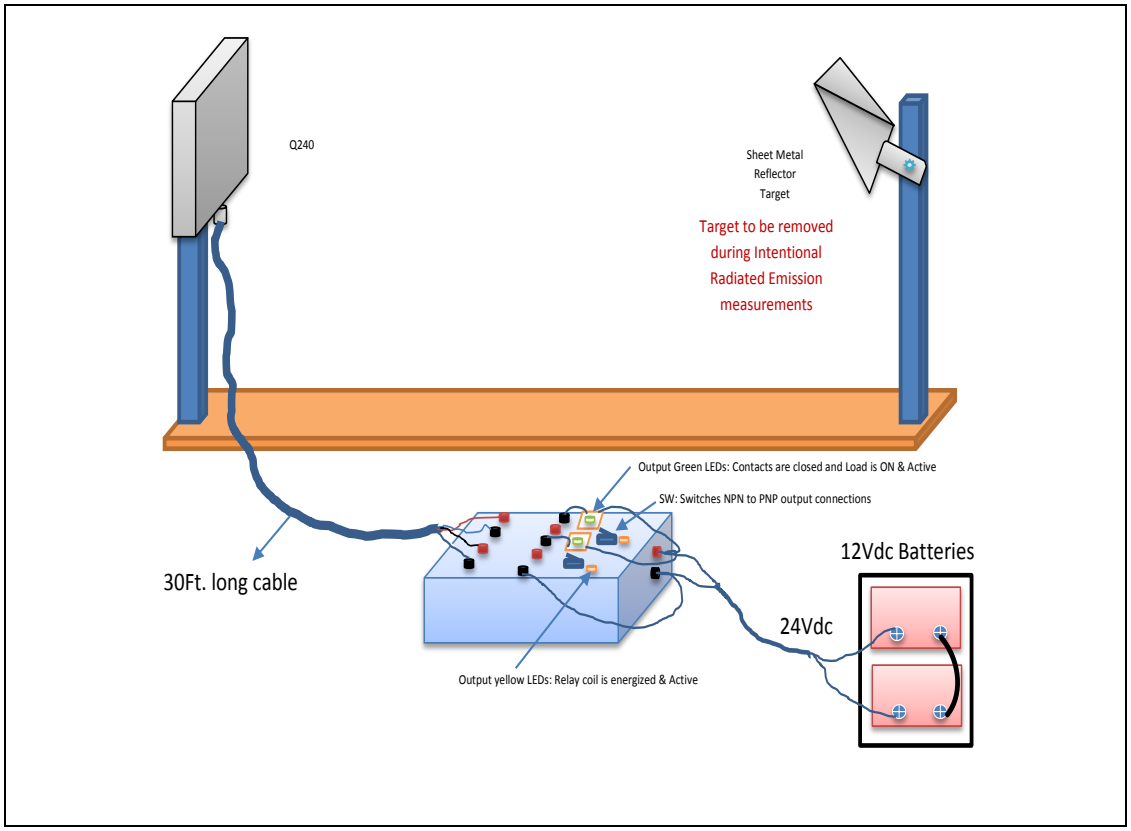
II. Diameter
US - US, Canada, Brazil, Mexico model “North & South America”

III. Field & Zone
AF2 – Adjustable Field 2 Zone
XXXX – Any other SW feature not impacting emission or product safety

IV. Supply Connection
Q – Euro Integral Quick Disconnect Connector

1.2.2 Hardware Level Block Diagrams

Figure 2 –DC Test set-up Block Diagrams



1.2.3 Power Requirements

The external DC supply 12-30Vdc

Table 2 – Power Delivery Components

Component function	Location	Manufacturer	Part Number	Watt
DC Power supply Not provided with the unit “Customer to supply the power source”.	External Class 2 for NA & Class III for Europe.	N/A	N/A	N/A

1.2.4 Output Specifications

Table 3 – Sensing Range, Connection, Output selections

Models	Sensing Range	Connection	Output
All family models	Two independent sensing zone;1 to 40+ meters (131ft)	5-pin M12/Euro-style quick disconnect	DIP-Switch-Selectable NPN or PNP; N.O. or N.C.

1.3 Certifications Test Requirements

Test repeatability is a high priority for EMC considerations. Therefore, it is imperative that the unit under test be supplied with all necessary hardware to ensure an accurate and successful evaluation. To that end, these elements must be addressed:

- Hard Ware "HW" stability: Banner practice is to introduce HW in two phases: an initial "Rev 0" prototype, followed with a "Rev 1" version that will be released for manufacture.
    - For Rev 0 material, any manufacturing and component quality issues must largely be addressed prior to delivering the evaluation unit(s) to the EMC/Compliance group. Of course, it is understood that prototype material (by its nature) may have defects not fully shaken-out, but overall the HW must be stable to the point that multiple successive "bring up/ turning the power on/off" produce similar (successful) results. Ideally, the product will have cycled through at least one pass of Early Integration Test (EIT), but in any case, it should be stable when turned on. EMC tests at this phase are intended to identify design errors in time to be addressed prior to tape-out of the Rev 1 version. The focus of such tests will be Radiated Emissions (RE), Conducted Emissions (CE), ESD and Surge if applicable.
    - Rev 1 material is expected to be much more stable, and will be subjected to the full suite of EMC qualifications tests (explained below). The product must be substantially as it would be if delivered into a customer's hands. No known instability is acceptable, and any problems uncovered during EMC qualification must be addressed immediately. Agency certification is the target outcome of EMC tests of Rev 1 material.

EMC tests are designed to evaluate the product for compliance to certain government regulations in each of two major categories: Emissions, and Immunity.

- Emissions tests consist of the following categories:
    - Radiated Emissions (RE)
        - Low frequency (30MHz to 1GHz) data shall be measured at 10m
    - Conducted Emissions (CE)

    For Emissions, the worst case scenario must be considered and series of test may be conducted to determine that.

    Immunity can be separated into these subcategories: Not applicable for NA

    - Radiated Immunity-N/A

- Electro-Static Discharge (ESD)-N/A
- Conducted Immunity-N/A
- Surge-N/A
- Electrical Fast Transients (EFT)-N/A
- Magnetic Field Immunity-N/A

In Immunity tests, the test suite attempts to mimic a typical application, while monitoring for any malfunctions. Constant visual check for any abnormality will determine EUT level of degradation. Device being tested for susceptibility shall be categorized as having met one of these three levels of acceptance:

A. The system will continue to operate normally, with no degradation of performance.
B. Some degradation of performance is allowed provided there is no catastrophic failure noted or operator intervention to restore apparatus function. Light flickering is considered to be acceptable. The system will self-recover after test stimulus is removed.
C. Temporary loss of function. Operator intervention required to restore full functionality.

Note: Hardware failures are not acceptable for any of these levels.

At a minimum, test lab must have appropriate accreditation such as those established by the following authorizing agencies:

FCC, NVLAP, Industry Canada, CE, VCCI, KCC, etc.

Note: For Q240 tests, the test lab shall be approved by FCC, CI, CE, and VCCI.

Applicable tests must conform to the appropriate standards and test reports must include reference to the particular agency and specification for which conformance is claimed.

1.4 Engineering Justification

This configuration will be used for emissions test, both Radiated (RE) and Conducted (CE). The configuration has been sized such that it is representative of a typical installation at a customer site.

EUT under the test has all the features to represent the worst case scenario. The product will be tested with sensing mode actives “ON” that represent the worst case EMI profile.

Any option of cable could be used for all the test and represent the entire set since the construction of the cables are all the same. The EUT will be tested with shielded but the shielded is unterminated on both ends “MQDEC2-5XX may be followed by RA”. RA is the right angle connector and XX is length of the cable (06, 15, 30 or 50 ft.).

2. Electromagnetic Compatibility

Tests Performed:

- Unintentional Radiated Emission
- Unintentional Conducted Emission
- Unintentional Radiated Emission high frequency
- Field Strength of Harmonics and Spurious Radiated Emission “Intentional Radator”
- Intentional Radiated Field Strength of Fundamental Emission
- Intentional Radiated Powerline Conducted Emission
- 99% Emission Bandwith of the transmitter
- Conducted telecom ports-N/A
- Radiated Immunity-N/A
- Conducted Immunity-N/A
- Electrical Fast Transient-N/A
- Electro Static Discharge-N/A
- Magnetic Field Immunity-N/A
- Surge immunity-N/A

Table2. Emissions specifications

Characteristic	**State**	**Standard (EN61000-6-3, EN 61000-6-4) and test criteria**
Radiated emissions High frequency radiated emissions	Operating- system is on constant transmitting and receive mode.	FCC Part 15.109:2015, FCC Part 15.109(g):2015 ICES-003 2012 30MHz-1GHz @ 10m distance 1GHz to 100GHz @3m distance Target is all emissions 4dB or more below the limit.
Conducted emissions “AC Power line” for both unintentional and intentional portion of the system (AC only) Note: DC conducted emission is performed only for verification purpose using AC power brick.	Operating- system is on constant transmitting and receive mode.	FCC Part 15.207:2015, ICES-003 2012 150khZ to 30MHz FCC Part 15.107:2015 ICES-003 2012 150khZ to 30MHz Target is all emissions 4dB or more below the limit.
Field Strength of Harmonics and Spurious Radiated Emission	Operating- system is on constant transmitting and receive mode.	FCC Part 15:245:2015 30 MHz up to the 5th harmonic of fundamental or 100 GHz, whichever is lower. Radio transmitting on either

"Intentional Radiator"		low, mid or high channel at approximately 100% duty cycle, modulated.
Field Strength of Fundamental	Operating- system is on constant transmitting mode and receiving end is in listening mode. Target is removed.	FCC Part 15:245:2015 Radiated 3 meter testing on the transmitter fundamental frequency
99% Emission Bandwidth	Operating- system is on transmitting mode and receiving end is in listening mode. Target is removed.	RSS210;2010 "Canada" Direct connect to a connector on the device to measure bandwidth of the transmitter. . Radio transmitting on either low, mid or high channel at approximately 100% duty cycle, modulated.
Harmonic emission (for AC only)	N/A	N/A
Flicker emission (for AC only, if applicable)	N/A	N/A

Table3. Immunity specifications [1]

Characteristic	State	Standard (EN61000-6-2 2005, EN 61000-6-1:2007) and test criteria
ESD	N/A	N/A
Radiated immunity	N/A	N/A
Fast transient/burst	N/A	N/A
Surge voltages (AC only)	N/A	N/A
Conducted immunity	N/A	N/A
Voltage dip/interruption (applies to a range of 200-240V AC) (AC only)	N/A	N/A
Power frequency magnetic field immunity	N/A	N/A

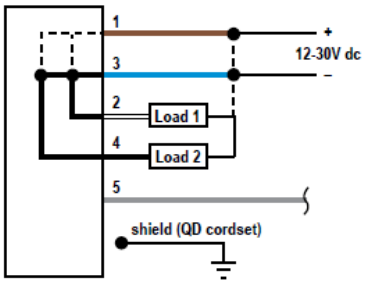
Product test configuration will include all specified options and accessories, and be operating in a mode that maximizes emissions or sensitivity for immunity.

Immunity test are not performed in accordance with the standards noted in this table “Not applicable for this product family since it is only covering North America”.

3. Cables

- Cables are all shielded.
- Min 2 meter cables are used for the main power and have the following options:
  - 5 Pin Euro integral QD with straight or right angle connector6 ft. to 50 ft. long.

Wiring Connection



Wiring Key:

1. Brown
2. White
3. Blue
4. Black
5. Gray (Do not connect)

NOTE: Banner recommends that the shield wire (QD cordsets only) be connected to earth ground or dc common. Shielded cordsets are recommended for all QD models.

A References

A.1 Related Documents

A.1.1 Banner product specification document

A.1.2 Marketing document

A.2 Terminology

CE	Conducted Emissions
RE	Radiated Emissions
RFI	Radio Frequency Interference
EFT	Electrical Fast Transient
ESD	Electro-Static Discharge

B Configuration Table References

B.1 Configuration

Table 3- Configuration

Product family	Model number	Serial Number & date code
R-Gage Q240	Q240RA-US-AF2Q	Production 2015-05-06T08;59;00

B.2 Surport Equipment

Table 4

Item	Component & MFG	Q'ty	P/N or model No.	Remark
1*	Banner, Plug-In Power Supply	1	PDS-24-4	Input: 100-270VAC Output: 24Vdc
2.	Power & configuration box	1	N/A	Input:24Vdc Output: 24Vdc

* Note: It is only used for conducted emission verification testing.