

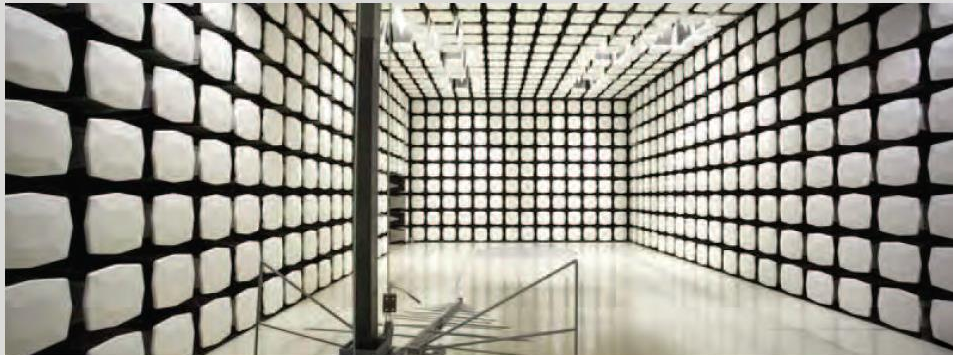


Banner Engineering Corp.

QT50R

**FCC 15.249:2018
24.0-24.25 FMCW Sensor**

Report # BANN0241.1



NVLAP LAB CODE: 200881-0

This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government. This Report shall not be reproduced, except in full without written approval of the laboratory.

CERTIFICATE OF TEST



Last Date of Test: September 10, 2018
Banner Engineering Corp.
Model: QT50R

Radio Equipment Testing

Standards

Specification	Method
FCC 15.207:2018	ANSI C63.10:2013
FCC 15.249:2018	

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	See FCC KDB Tracking Number 850604 for test method rationale.
6.6	Field Strength of Fundamental	Yes	Pass	See FCC KDB Tracking Number 850604 for test method rationale.
N/A	Harmonic Mixer Calibration Certificates	No	N/A	Not required to test. The FCC inquiry states the harmonic mixer calibration certificates need to be included in the test report as an appendix. This will be supplied by Element.

Deviations From Test Standards

None

Approved By:

Matt Nuernberg, Operations Manager

Product compliance is the responsibility of the client; therefore, the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test. This report reflects only those tests from the referenced standards shown in the certificate of test. It does not include inspection or verification of labels, identification, marking or user information.

REVISION HISTORY



Revision Number	Description	Date (yyyy-mm-dd)	Page Number
00	None		

ACCREDITATIONS AND AUTHORIZATIONS



United States

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

A2LA - Accredited by A2LA to ISO / IEC 17065 as a product certifier. This allows Element 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 – Within Element, we have a EU Notified Body validated for the EMCD and RED Directives.

Australia/New Zealand

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

Korea

MSIT / 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

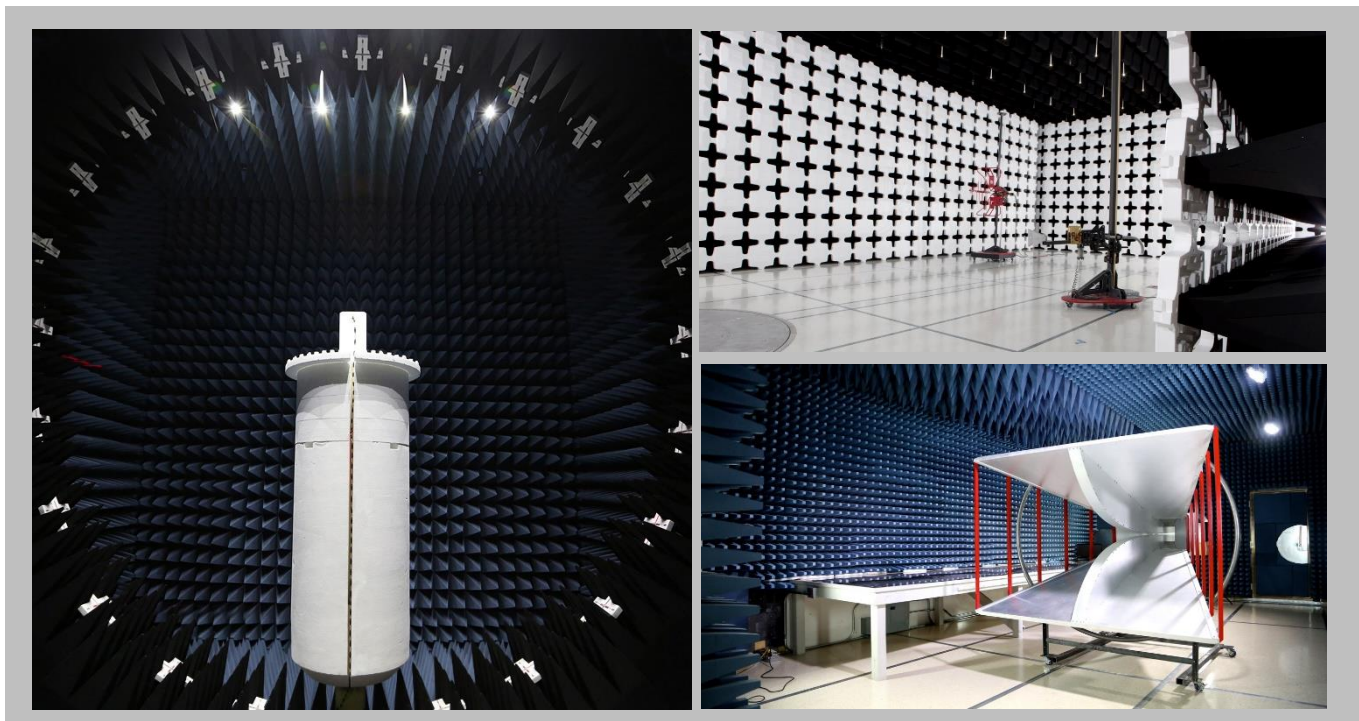
For details on the Scopes of our Accreditations, please visit:

<https://www.nwemc.com/emc-testing-accreditations>

FACILITIES



California Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Minnesota Labs MN01-10 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	New York Labs NY01-04 4939 Jordan Rd. Elbridge, NY 13060 (315) 554-8214	Oregon Labs EV01-12 6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	Texas Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Washington Labs NC01-05 19201 120 th Ave NE Bothell, WA 98011 (425)984-6600
NVLAP					
NVLAP Lab Code: 200676-0	NVLAP Lab Code: 200881-0	NVLAP Lab Code: 200761-0	NVLAP Lab Code: 200630-0	NVLAP Lab Code:201049-0	NVLAP Lab Code: 200629-0
Innovation, Science and Economic Development Canada					
2834B-1, 2834B-3	2834E-1, 2834E-3	N/A	2834D-1, 2834D-2	2834G-1	2834F-1
BSMI					
SL2-IN-E-1154R	SL2-IN-E-1152R	N/A	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI					
A-0029	A-0109	N/A	A-0108	A-0201	A-0110
Recognized Phase I CAB for ACMA, BSMI, IDA, KCC/RRR, MIC, MOC, NCC, OFCA					
US0158	US0175	N/A	US0017	US0191	US0157



MEASUREMENT UNCERTAINTY

Measurement Uncertainty

When a measurement is made, the result will be different from the true or theoretically correct value. The difference is the result of tolerances in the measurement system that cannot be completely eliminated. To the extent that technology allows us, it has been our aim to minimize this error. Measurement uncertainty is a statistical expression of measurement error qualified by a probability distribution.

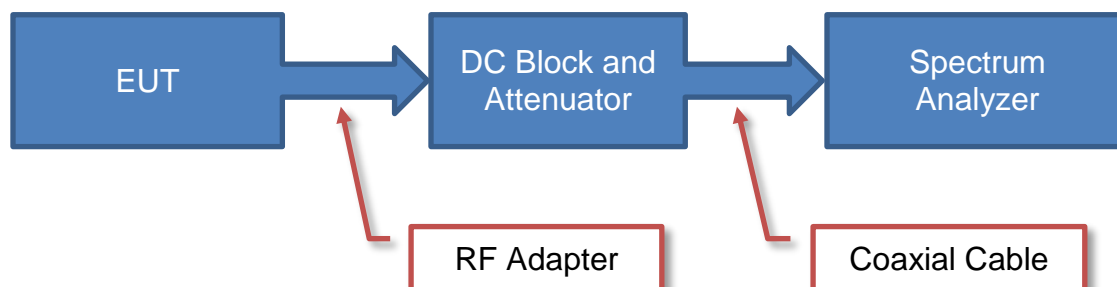
A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable test description page. 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.

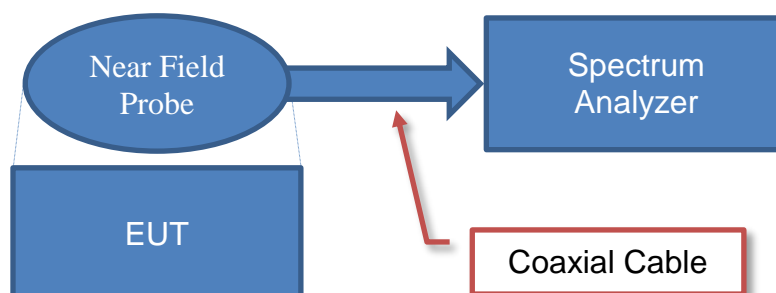
Test	+ MU	- MU
Frequency Accuracy (Hz)	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	0.3 dB	-0.3 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%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

Test Setup Block Diagrams

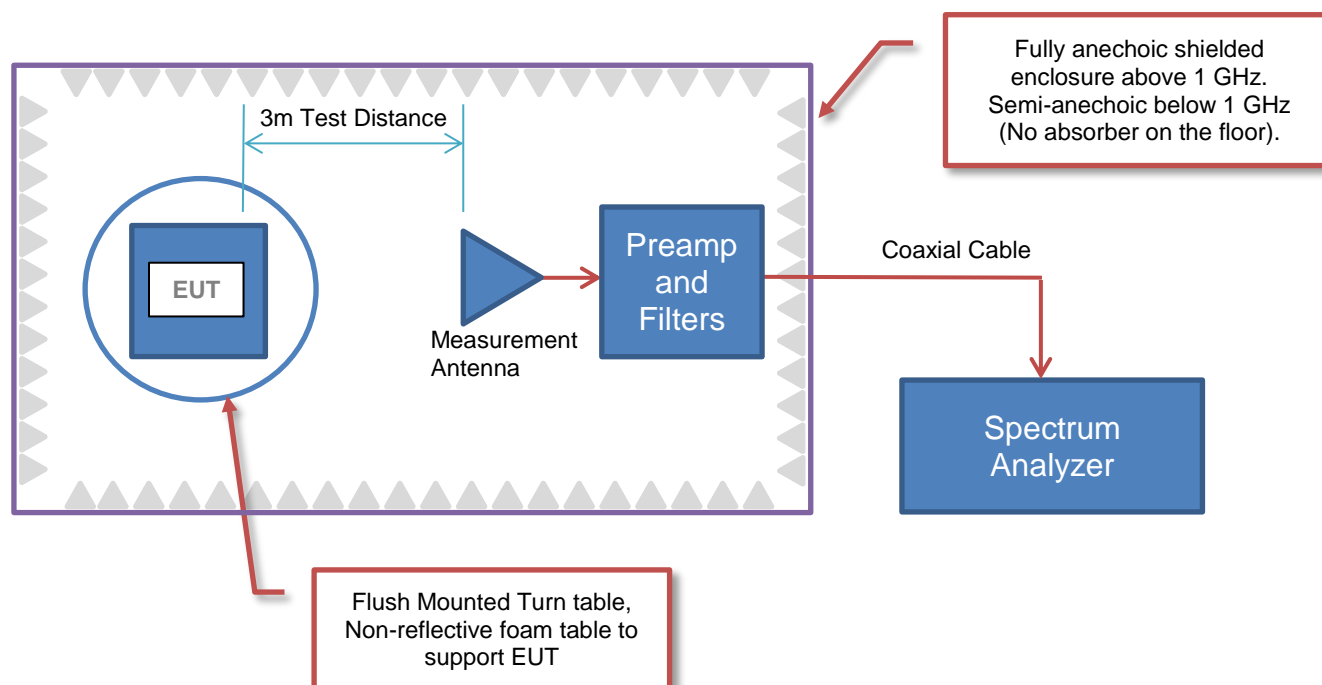
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions



PRODUCT DESCRIPTION

Client and Equipment Under Test (EUT) Information

Company Name:	Banner Engineering Corp.
Address:	9714 Tenth Avenue North
City, State, Zip:	Minneapolis, MN 55441
Test Requested By:	Joel Jankord
Model:	QT50R
First Date of Test:	September 7, 2018
Last Date of Test:	September 10, 2018
Receipt Date of Samples:	September 7, 2018
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:

24 GHz 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 15.249:2018 for operation in the 24.0-24.25 GHz band per the FCC tracking inquiry 850604.

CONFIGURATIONS



Configuration BANN0241- 1

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
QT50R	Banner Engineering Corp.	QT50R	RD1809001

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
I/O Cable	None	1.9 m	None	QT50R	TPZ

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2018-09-07	Dwell Time and Cycle Time	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	2018-09-07	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 Element following the test.
3	2018-09-10	Field Strength of Fundamental	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
4	2018-09-10	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



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. Per the standard, an insulating material was also added to ground plane between the EUT's power and remote I/O cables. 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 50ohm measuring port is terminated by a 50ohm EMI meter or a 50ohm resistive load. All 50ohm measuring ports of the LISN are terminated by 50ohm. The test data represents the configuration/ operating mode/ model that produced the highest emission levels as compared to the specification limit.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Cable - Conducted Cable Assembly	Northwest EMC	MNC, HGN, TYK	MNCA	3/14/2018	3/14/2019
Receiver	Rohde & Schwarz	ESR7	ARI	6/26/2018	6/26/2019
LISN	Solar Electronics	9252-50-R-24-BNC	LIY	3/15/2018	3/15/2019
Power Supply - DC	Agilent	U8002A	TPZ	NCR	NCR

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	2.4 dB	-2.4 dB

CONFIGURATIONS INVESTIGATED

BANN0241-1

MODES INVESTIGATED

Tx FMCW.

POWERLINE CONDUCTED EMISSIONS



EUT:	QT50R	Work Order:	BANN0241
Serial Number:	RD1809001	Date:	09/10/2018
Customer:	Banner Engineering Corp.	Temperature:	23.5°C
Attendees:	Joel Jankord	Relative Humidity:	47%
Customer Project:	None	Bar. Pressure:	1017 mb
Tested By:	Kyle McMullan	Job Site:	MN03
Power:	110VAC/60Hz	Configuration:	BANN0241-1

TEST SPECIFICATIONS

Specification: Equipment Class B FCC 15.207:2018	Method: ANSI C63.10:2013
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TEST PARAMETERS

Run #:	3	Line:	High Line	Add. Ext. Attenuation (dB):	0
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COMMENTS

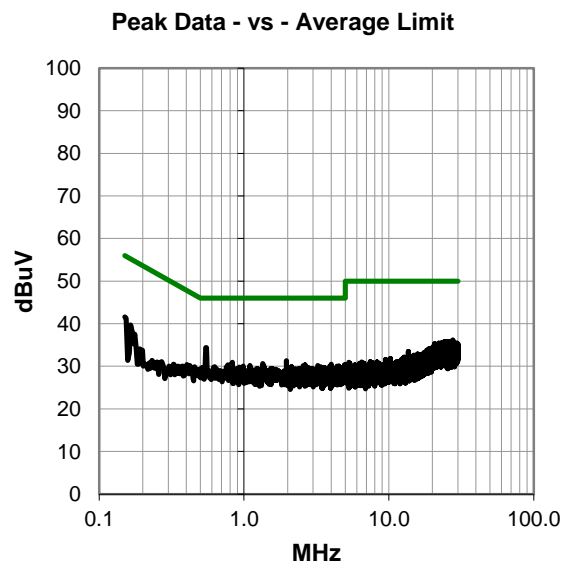
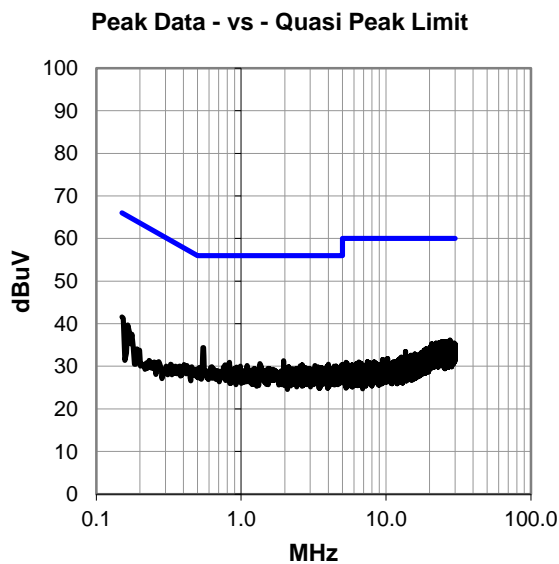
None

EUT OPERATING MODES

Tx FMCW.

DEVIATIONS FROM TEST STANDARD

None



POWERLINE CONDUCTED EMISSIONS

RESULTS - Run #3

Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.545	14.0	20.4	34.4	56.0	-21.6
27.594	12.5	23.7	36.2	60.0	-23.8
27.049	12.4	23.5	35.9	60.0	-24.1
27.806	12.2	23.7	35.9	60.0	-24.1
25.038	12.6	23.2	35.8	60.0	-24.2
25.840	12.5	23.3	35.8	60.0	-24.2
24.131	12.6	23.1	35.7	60.0	-24.3
0.150	20.9	20.7	41.6	66.0	-24.4
26.896	12.1	23.5	35.6	60.0	-24.4
23.199	12.6	22.9	35.5	60.0	-24.5
24.829	12.3	23.2	35.5	60.0	-24.5
22.132	12.6	22.8	35.4	60.0	-24.6
25.904	12.0	23.4	35.4	60.0	-24.6
27.672	11.7	23.7	35.4	60.0	-24.6
28.329	11.7	23.7	35.4	60.0	-24.6
29.511	11.5	23.9	35.4	60.0	-24.6
1.967	10.8	20.5	31.3	56.0	-24.7
20.654	12.8	22.5	35.3	60.0	-24.7
23.415	12.4	22.9	35.3	60.0	-24.7
25.531	12.0	23.3	35.3	60.0	-24.7
26.784	11.7	23.5	35.2	60.0	-24.8
29.948	11.3	23.9	35.2	60.0	-24.8
23.579	12.1	23.0	35.1	60.0	-24.9
24.866	11.9	23.2	35.1	60.0	-24.9
28.855	11.3	23.8	35.1	60.0	-24.9
22.456	12.2	22.8	35.0	60.0	-25.0

Peak Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.545	14.0	20.4	34.4	46.0	-11.6
27.594	12.5	23.7	36.2	50.0	-13.8
27.049	12.4	23.5	35.9	50.0	-14.1
27.806	12.2	23.7	35.9	50.0	-14.1
25.038	12.6	23.2	35.8	50.0	-14.2
25.840	12.5	23.3	35.8	50.0	-14.2
24.131	12.6	23.1	35.7	50.0	-14.3
0.150	20.9	20.7	41.6	56.0	-14.4
26.896	12.1	23.5	35.6	50.0	-14.4
23.199	12.6	22.9	35.5	50.0	-14.5
24.829	12.3	23.2	35.5	50.0	-14.5
22.132	12.6	22.8	35.4	50.0	-14.6
25.904	12.0	23.4	35.4	50.0	-14.6
27.672	11.7	23.7	35.4	50.0	-14.6
28.329	11.7	23.7	35.4	50.0	-14.6
29.511	11.5	23.9	35.4	50.0	-14.6
1.967	10.8	20.5	31.3	46.0	-14.7
20.654	12.8	22.5	35.3	50.0	-14.7
23.415	12.4	22.9	35.3	50.0	-14.7
25.531	12.0	23.3	35.3	50.0	-14.7
26.784	11.7	23.5	35.2	50.0	-14.8
29.948	11.3	23.9	35.2	50.0	-14.8
23.579	12.1	23.0	35.1	50.0	-14.9
24.866	11.9	23.2	35.1	50.0	-14.9
28.855	11.3	23.8	35.1	50.0	-14.9
22.456	12.2	22.8	35.0	50.0	-15.0

CONCLUSION

Pass



Tested By

POWERLINE CONDUCTED EMISSIONS



EUT:	QT50R	Work Order:	BANN0241
Serial Number:	RD1809001	Date:	09/10/2018
Customer:	Banner Engineering Corp.	Temperature:	23.5°C
Attendees:	Joel Jankord	Relative Humidity:	47%
Customer Project:	None	Bar. Pressure:	1017 mb
Tested By:	Kyle McMullan	Job Site:	MN03
Power:	110VAC/60Hz	Configuration:	BANN0241-1

TEST SPECIFICATIONS

Specification: Equipment Class B FCC 15.207:2018	Method: ANSI C63.10:2013
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TEST PARAMETERS

Run #:	4	Line:	Neutral	Add. Ext. Attenuation (dB):	0
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COMMENTS

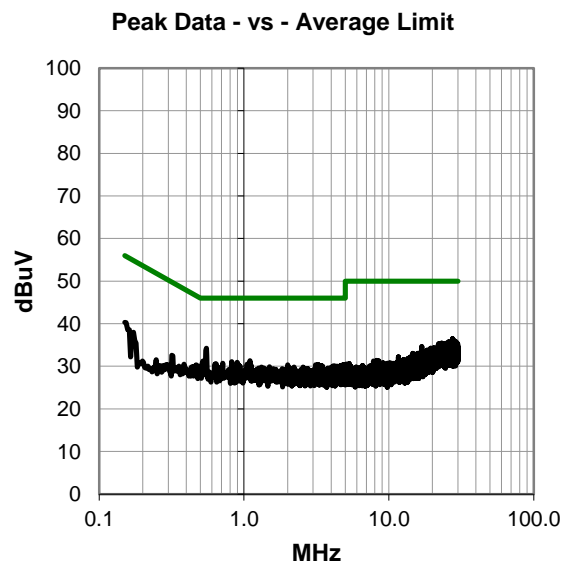
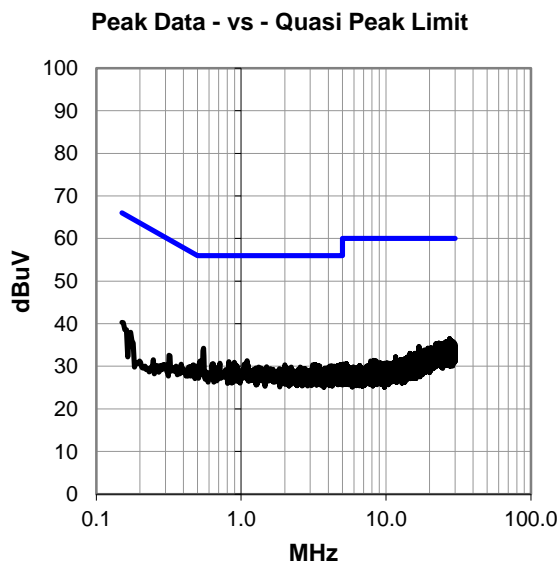
None

EUT OPERATING MODES

Tx FMCW.

DEVIATIONS FROM TEST STANDARD

None



POWERLINE CONDUCTED EMISSIONS

RESULTS - Run #4

Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.549	13.8	20.4	34.2	56.0	-21.8
27.508	12.8	23.7	36.5	60.0	-23.5
28.187	12.3	23.7	36.0	60.0	-24.0
27.180	12.3	23.6	35.9	60.0	-24.1
27.817	12.2	23.7	35.9	60.0	-24.1
28.511	12.0	23.8	35.8	60.0	-24.2
25.889	12.4	23.3	35.7	60.0	-24.3
28.761	11.9	23.8	35.7	60.0	-24.3
29.097	11.9	23.8	35.7	60.0	-24.3
25.788	12.2	23.3	35.5	60.0	-24.5
28.131	11.8	23.7	35.5	60.0	-24.5
23.191	12.5	22.9	35.4	60.0	-24.6
25.128	12.1	23.3	35.4	60.0	-24.6
27.344	11.8	23.6	35.4	60.0	-24.6
29.127	11.6	23.8	35.4	60.0	-24.6
29.623	11.5	23.9	35.4	60.0	-24.6
1.098	10.8	20.5	31.3	56.0	-24.7
22.143	12.5	22.8	35.3	60.0	-24.7
24.329	12.1	23.2	35.3	60.0	-24.7
28.855	11.5	23.8	35.3	60.0	-24.7
29.821	11.4	23.9	35.3	60.0	-24.7
23.725	12.1	23.1	35.2	60.0	-24.8
24.090	12.1	23.1	35.2	60.0	-24.8
0.519	10.8	20.4	31.2	56.0	-24.8
0.822	10.6	20.5	31.1	56.0	-24.9
25.504	11.8	23.3	35.1	60.0	-24.9

Peak Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.549	13.8	20.4	34.2	46.0	-11.8
27.508	12.8	23.7	36.5	50.0	-13.5
28.187	12.3	23.7	36.0	50.0	-14.0
27.180	12.3	23.6	35.9	50.0	-14.1
27.817	12.2	23.7	35.9	50.0	-14.1
28.511	12.0	23.8	35.8	50.0	-14.2
25.889	12.4	23.3	35.7	50.0	-14.3
28.761	11.9	23.8	35.7	50.0	-14.3
29.097	11.9	23.8	35.7	50.0	-14.3
25.788	12.2	23.3	35.5	50.0	-14.5
28.131	11.8	23.7	35.5	50.0	-14.5
23.191	12.5	22.9	35.4	50.0	-14.6
25.128	12.1	23.3	35.4	50.0	-14.6
27.344	11.8	23.6	35.4	50.0	-14.6
29.127	11.6	23.8	35.4	50.0	-14.6
29.623	11.5	23.9	35.4	50.0	-14.6
1.098	10.8	20.5	31.3	46.0	-14.7
22.143	12.5	22.8	35.3	50.0	-14.7
24.329	12.1	23.2	35.3	50.0	-14.7
28.855	11.5	23.8	35.3	50.0	-14.7
29.821	11.4	23.9	35.3	50.0	-14.7
23.725	12.1	23.1	35.2	50.0	-14.8
24.090	12.1	23.1	35.2	50.0	-14.8
0.519	10.8	20.4	31.2	46.0	-14.8
0.822	10.6	20.5	31.1	46.0	-14.9
25.504	11.8	23.3	35.1	50.0	-14.9

CONCLUSION

Pass



Tested By

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS



XMI 2017.12.13

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
Mixer/Antenna	OML, Inc.	M08HWAX	AIL	25-Aug-16	25-Aug-19
Mixer/Antenna	OML, Inc.	M12HWAX	AIK	25-Aug-16	25-Aug-19
Mixer/Antenna	OML, Inc.	M19HWAX	AIJ	25-Aug-16	25-Aug-19
Cable	OML, Inc.	S119BFSS100390443	SUN	NCR	NCR
Power Supply - DC	Agilent	U8002A	TPZ	NCR	NCR
Antenna	AH Systems	SAS-588	AJO	NCR	NCR
Amplifier - Pre-Amplifier	Miteq	JSW45-26004000-40-5P	AVN	12-Sep-17	12-Sep-18
Cable	Northwest EMC	TTBJ141-KMKM-72	MNQ	12-Sep-17	12-Sep-18
Cable	ESM Cable Corp	TTBJ141 KMKM-72	MNP	12-Sep-17	12-Sep-18
Antenna - Standard Gain	ETS Lindgren	3160-09	AHG	NCR	NCR
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AVW	13-Feb-18	13-Feb-19
Antenna - Standard Gain	ETS Lindgren	3160-08	AIQ	NCR	NCR
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVV	13-Feb-18	13-Feb-19
Cable	ESM Cable Corp.	Standard Gain Horn Cables	MNJ	12-Jul-18	12-Jul-19
Antenna - Standard Gain	ETS Lindgren	3160-07	AXP	NCR	NCR
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVT	13-Feb-18	13-Feb-19
Cable	ESM Cable Corp.	Double Ridge Guide Horn	MNI	21-Nov-17	21-Nov-18
Antenna - Double Ridge	ETS Lindgren	3115	AJA	27-Jun-18	27-Jun-20
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AVO	9-Nov-17	9-Nov-18
Cable	ESM Cable Corp.	Bilog Cables	MNH	9-Nov-17	9-Nov-18
Antenna - Biconilog	Teseq	CBL 6141B	AYD	25-Jan-18	25-Jan-20
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	27-Apr-18	27-Apr-19

TEST DESCRIPTION

The measurement was made in a radiated configuration of the fundamental with the carrier fully maximized for its highest radiated power. The EUT was transmitting in FMCW mode. The testing was done at distances closer than 3m as called out in the data sheets. While scanning, emissions from the EUT were maximized by rotating the EUT, adjusting the measurement antenna orientation and polarization, and manipulating the EUT and EUT antenna in 3 orthogonal planes (per ANSI C63.10:2009). The specification limit was adjusted for the closer test distances at 20 dB per decade.

The analyzer display was offset with the value of the test equipment losses (mixers, duplexers, and cables) specific to each band and the antenna factor.

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS



XMI 2017.12.13

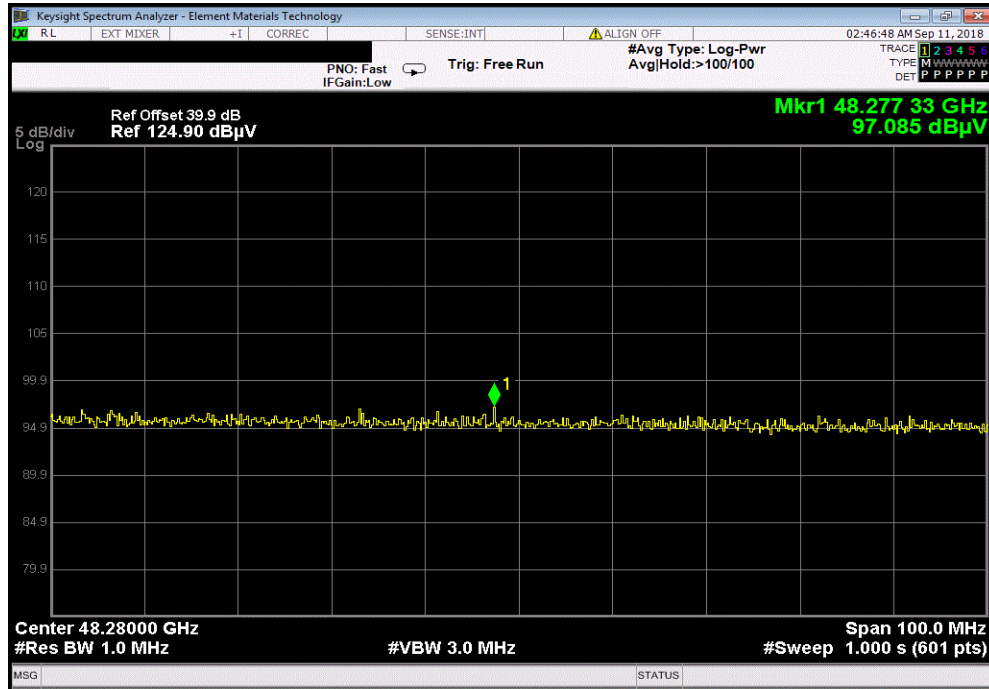
EUT: QT50R		Work Order: BANN0241	
Serial Number: RD1809001		Date: 10-Sep-18	
Customer: Banner Engineering Corp.		Temperature: 23.3 °C	
Attendees: Joel Jankord		Humidity: 45.6% RH	
Project: None		Barometric Pres.: 1019 mbar	
Tested by: Kyle McMullan		Power: 24VDC	
Job Site: MN06			
TEST SPECIFICATIONS		Test Method	
FCC 15.249:2018		ANSI C63.10:2013	
COMMENTS			
See FCC KDB Tracking Number 850604 for test method rationale.			
DEVIATIONS FROM TEST STANDARD			
None			
Configuration #	1	Signature <i>Kyle McMullan</i>	
		Raw Value at 1.7cm (dBµV/m)	Adjusted Value for 3m (dBµV/m)
		Limit (dBµV/m)	Result
Tx FMCW			
2nd Harmonic - 48.28 GHz			
	Peak Measurement	97.1	52.2
	Average Measurement	79.1	34.2
3rd Harmonic - 72.42 GHz			
	Peak Measurement	112.9	68.0
	Average Measurement	91.5	46.6
4th Harmonic - 96.56 GHz			
	Peak Measurement	104.6	59.7
	Average Measurement	89.3	44.4

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

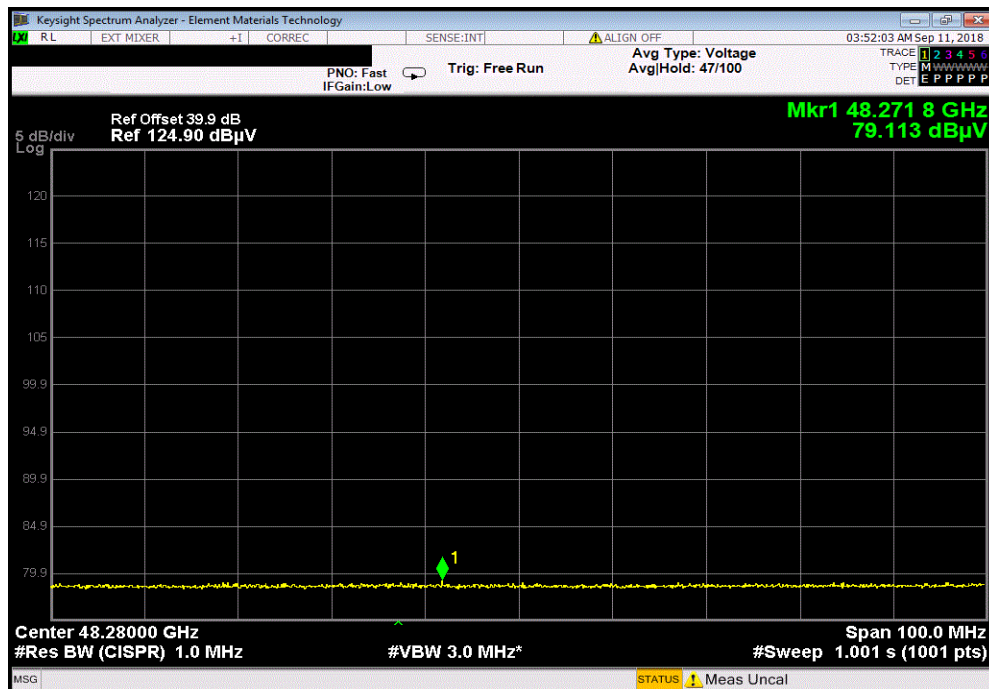


XMI 2017.12.13

Tx FMCW, 2nd Harmonic - 48.28 GHz, Peak Measurement						
	Raw Value at 1.7cm (dBµV/m)	Adjusted Value for 3m (dBµV/m)	Limit (dBµV/m)	Result		
	97.1	52.2	88.0	Pass		



Tx FMCW, 2nd Harmonic - 48.28 GHz, Average Measurement						
	Raw Value at 1.7cm (dBµV/m)	Adjusted Value for 3m (dBµV/m)	Limit (dBµV/m)	Result		
	79.1	34.2	68.0	Pass		

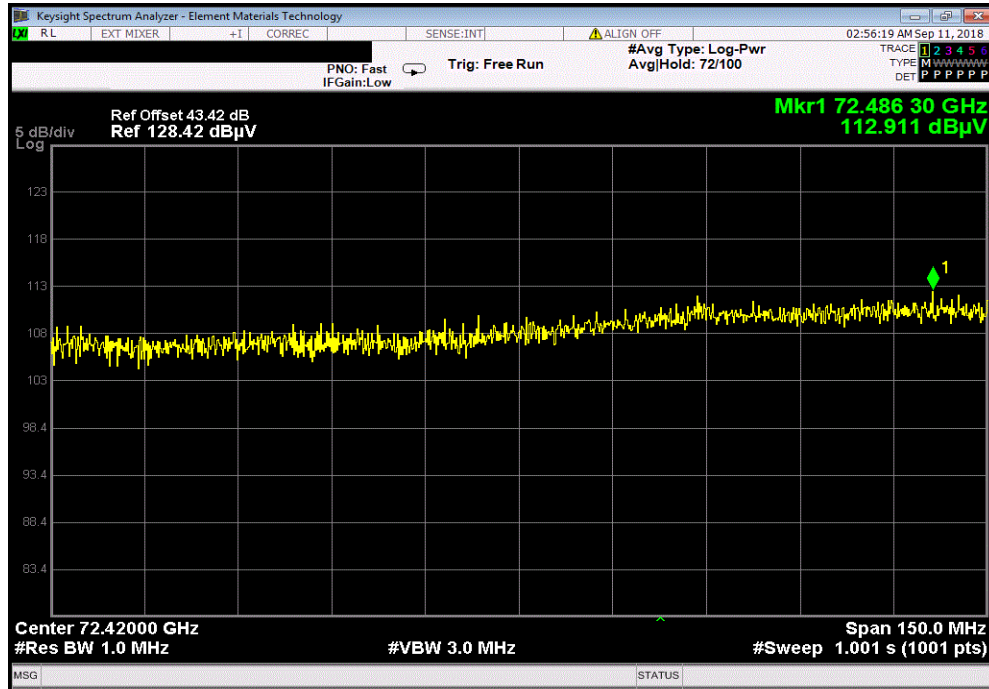


FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

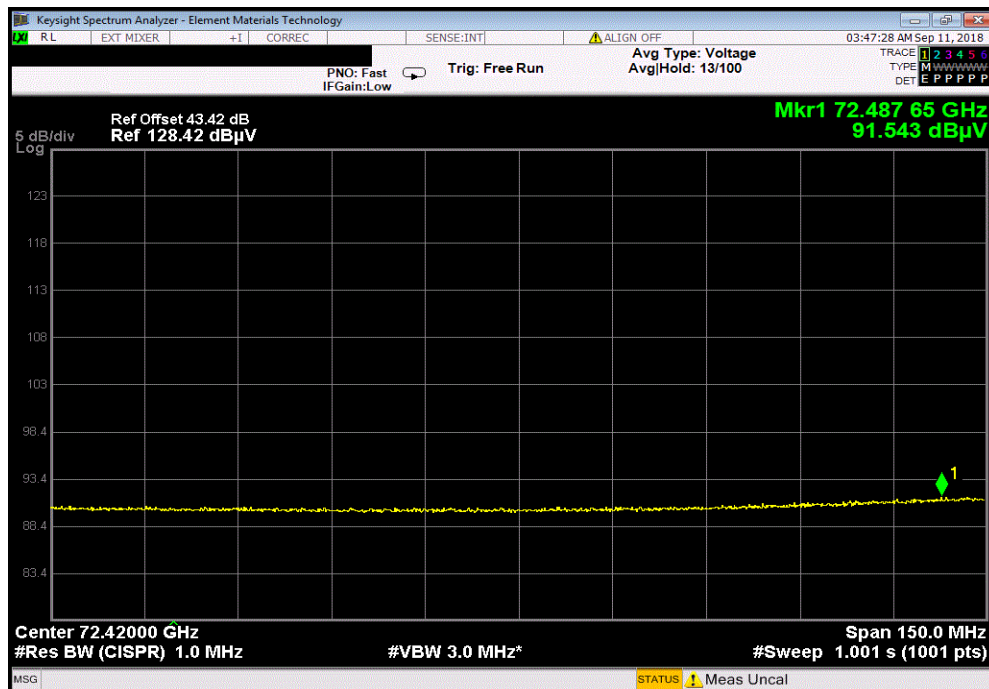


XMI 2017.12.13

Tx FMCW, 3rd Harmonic - 72.42 GHz, Peak Measurement						
	Raw Value at 1.7cm (dBµV/m)	Adjusted Value for 3m (dBµV/m)	Limit (dBµV/m)	Result		
	112.9	68.0	88.0	Pass		



Tx FMCW, 3rd Harmonic - 72.42 GHz, Average Measurement						
	Raw Value at 1.7cm (dBµV/m)	Adjusted Value for 3m (dBµV/m)	Limit (dBµV/m)	Result		
	91.5	46.6	68.0	Pass		

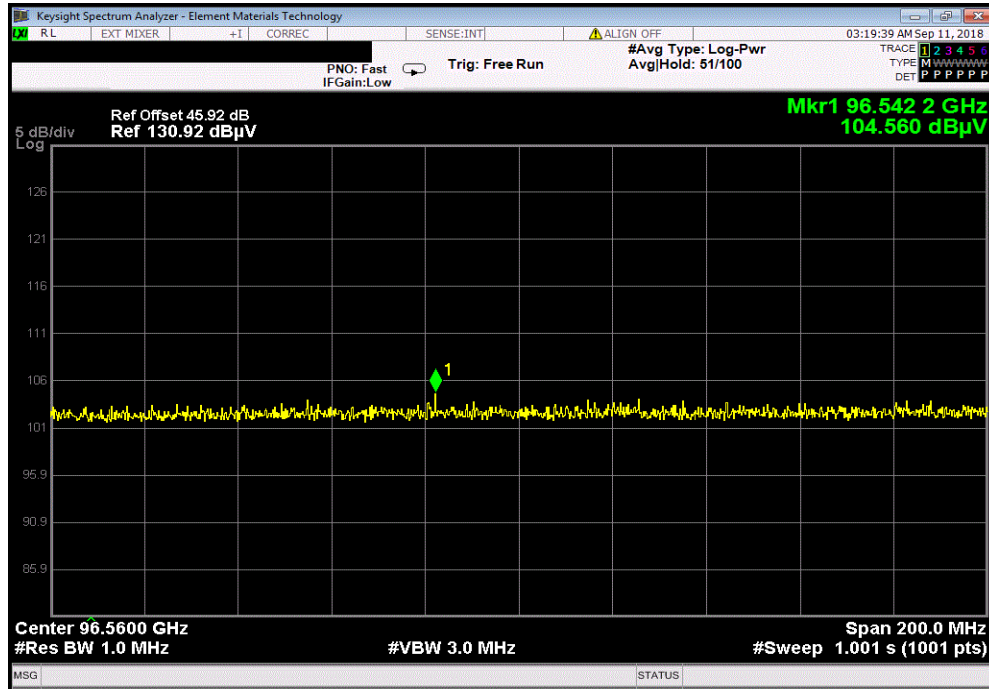


FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

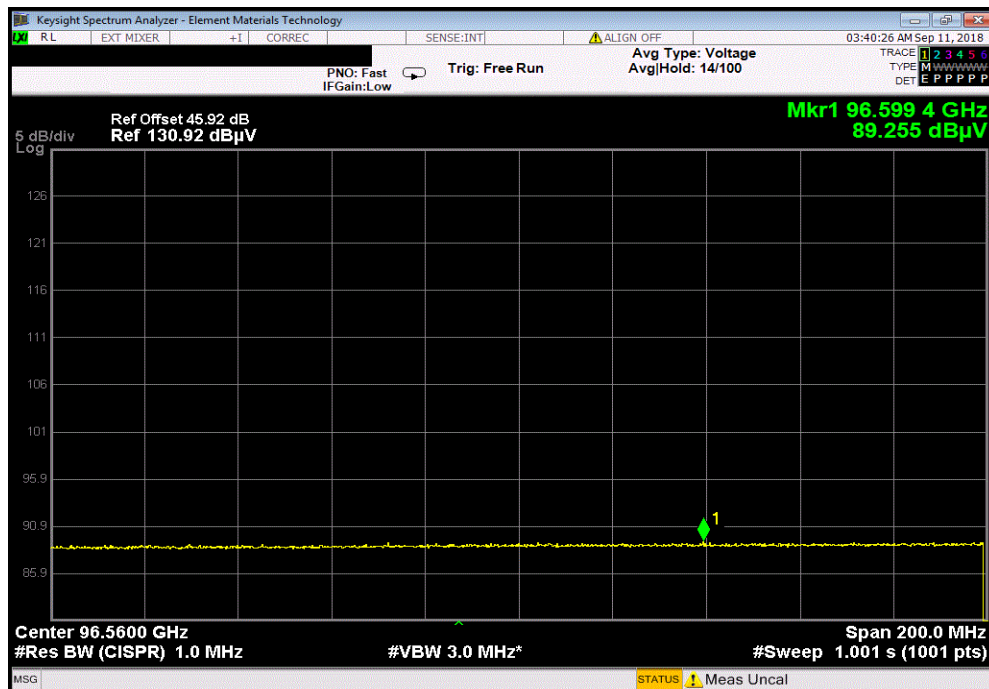


XMI 2017.12.13

Tx FMCW, 4th Harmonic - 96.56 GHz, Peak Measurement						
	Raw Value at	Adjusted Value	Limit			
	1.7cm (dBμV/m)	for 3m (dBμV/m)	(dBμV/m)	Result		
	104.6	59.7	88.0	Pass		



Tx FMCW, 4th Harmonic - 96.56 GHz, Average Measurement						
	Raw Value at	Adjusted Value	Limit			
	1.7cm (dBμV/m)	for 3m (dBμV/m)	(dBμV/m)	Result		
	89.3	44.4	68.0	Pass		



FIELD STRENGTH OF FUNDAMENTAL



PSA-ESCI 2018.05.04

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

FMCW Mode

POWER SETTINGS INVESTIGATED

24VDC

CONFIGURATIONS INVESTIGATED

BANN0241 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency | 24 GHz | Stop Frequency | 24.25 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	ESM Cable Corp	TTBJ141 KMKM-72	MNP	12-Sep-2017	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-09	AHG	NCR	0 mo
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	27-Apr-2018	12 mo
Power Supply - DC	Agilent	U8002A	TPZ	NCR	0 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.

The peak emissions were measured. The average value was calculated based off of the average factor found using the methods in KDB 890966 D01 v01r01 section F. As declared by the manufacturer, the sweep time was 2 ms, the cycle time was 2 ms, and the frequency range swept was 195 MHz.

Dwell Time = Signal Sweep Time (s) / Frequency Span (MHz) = 0.002 / 195 = 1.03×10^{-5}

Average Factor = Dwell Time(s) / Cycle Time (s) = 1.03×10^{-5} / 0.002 = 0.00513

The linear average Fctor was then converted to dB terms for ease of calculations using the formula guidance in TR 14-1007.


Average Factor (dB) = $10 \times \text{LOG}(\text{Average Factor}) = 10 \times \text{LOG}(0.00513) = -22.9 \text{ dB}$

FIELD STRENGTH OF FUNDAMENTAL



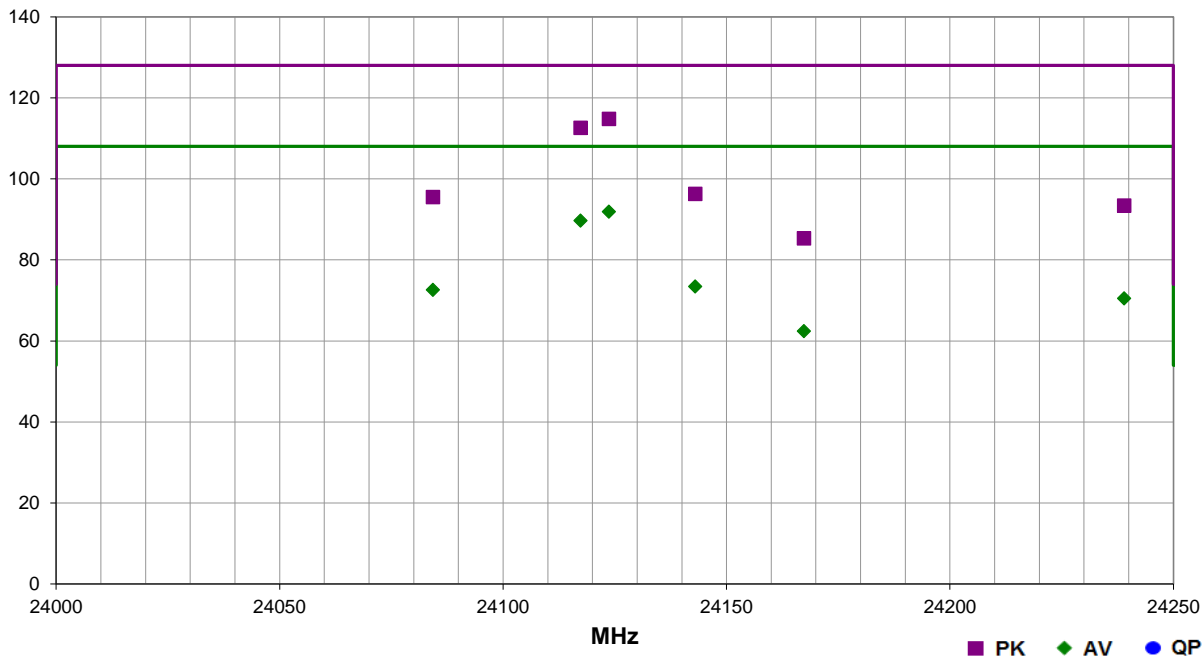
EmiR5 2018.05.07

PSA-ESCI 2018.05.04

Work Order:	BANN0241	Date:	7-Sep-2018		
Project:	None	Temperature:	23.2 °C		
Job Site:	MN05	Humidity:	46.1% RH		
Serial Number:	RD1809001	Barometric Pres.:	1030 mbar	Tested by:	Kyle McMullan
EUT:	QT50R				
Configuration:	1				
Customer:	Banner Engineering Corp.				
Attendees:	Joel Jankord				
EUT Power:	24VDC				
Operating Mode:	FMCW Mode				
Deviations:	None				
Comments:	None				

Test Specifications	Test Method
FCC 15.249:2018	ANSI C63.10:2013

Run #	26	Test Distance (m)	1	Antenna Height(s)	1 to 1.25(m)	Results	Pass
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Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
24123.670	78.3	46.0	1.5	125.0		0.0	Vert	PK	-9.5	114.8	128.0	-13.2	EUT On Side
24117.330	76.1	46.0	1.5	123.1		0.0	Horz	PK	-9.5	112.6	128.0	-15.4	EUT Vert
24123.670	78.3	46.0	1.5	125.0	-22.9	0.0	Vert	AV	-9.5	91.9	108.0	-16.1	EUT On Side
24117.330	76.1	46.0	1.5	123.1	-22.9	0.0	Horz	AV	-9.5	89.7	108.0	-18.3	EUT Vert
24143.000	59.8	46.0	1.5	231.0		0.0	Vert	PK	-9.5	96.3	128.0	-31.7	EUT Horz
24084.330	59.0	46.0	1.5	101.1		0.0	Horz	PK	-9.5	95.5	128.0	-32.5	EUT On Side
24239.000	56.9	46.0	1.5	131.1		0.0	Vert	PK	-9.5	93.4	128.0	-34.6	EUT Vert
24143.000	59.8	46.0	1.5	231.0	-22.9	0.0	Vert	AV	-9.5	73.4	108.0	-34.6	EUT Horz
24084.330	59.0	46.0	1.5	101.1	-22.9	0.0	Horz	AV	-9.5	72.6	108.0	-35.4	EUT On Side
24239.000	56.9	46.0	1.5	131.1	-22.9	0.0	Vert	AV	-9.5	70.5	108.0	-37.5	EUT Vert
24167.330	48.8	46.0	1.5	89.0		0.0	Horz	PK	-9.5	85.3	128.0	-42.7	EUT Horz
24167.330	48.8	46.0	1.5	89.0	-22.9	0.0	Horz	AV	-9.5	62.4	108.0	-45.6	EUT Horz

APPENDIX

Certificate of Compliance

Certificate No: 6213416C-U51014-1

Manufacturer: OML, Inc.

Model/Part No: M19HWAX (M19HWA Funct Verif
w/2 sets of data) **Serial/ID No:** U51014-1

Description: WR-19 Mixer Functional Verification Service, Test Data, and USB
Stick, and 2nd set of data

Date of Test: August 25, 2016

Temperature: (23 +/- 5) deg C

Humidity: 20 to 65% RH

Procedure:

This certifies that the above product was tested in compliance with OML specifications using applicable OML's procedures.

As Received : Physical Condition: Good
Within Tolerance: Yes

As Shipped: At the completion of the test, the product COMPLIED with the performance capability.

Remarks:

Traceability Information: Traceability is to national standards administered by U.S. NIST, NRC Canada, Euromet members (NPL, PTB, BNM, etc.) or other recognized standards laboratories. Some measurements are traceable to natural physical constants, consensus standards or ratio type measurements. Supporting documentation relative to traceability is available for review by appointment.

In the absence of power standards above 110 GHz, power measurements and conversion loss measurements above 110 GHz are to confirm operation functionality and traceable only to OML.

This certificate shall not be reproduced, except in full, without the written approval of OML.



Mitzi Chow, Material Manager

08/25/2016

Date

OML Inc.

300 Digital Drive, Morgan Hill, CA 95037 USA Tel. (408) 779 2698 Fax (408) 778 0491

Certificate of Compliance

Certificate No: 6213416B-E60126-1

Manufacturer: OML, Inc.

Model/Part No: M12HWAX (M12HWA Funct Verif
w/2 sets of data) **Serial/ID No:** E60126-1

Description: WR-12 Mixer Functional Verification Service, Test Data, and USB
Stick, and 2nd set of data

Date of Test: August 25, 2016

Temperature: (23 +/- 5) deg C

Humidity: 20 to 65% RH

Procedure:

This certifies that the above product was tested in compliance with OML specifications using applicable OML's procedures.

As Received : Physical Condition: Good
Within Tolerance: Yes

As Shipped: At the completion of the test, the product COMPLIED with the performance capability.

Remarks:

Traceability Information: Traceability is to national standards administered by U.S. NIST, NRC Canada, Euromet members (NPL, PTB, BNM, etc.) or other recognized standards laboratories. Some measurements are traceable to natural physical constants, consensus standards or ratio type measurements. Supporting documentation relative to traceability is available for review by appointment.

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08/25/2016

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Certificate of Compliance

Certificate No: 6213416A-F60126-1

Manufacturer: OML, Inc.

Model/Part No: M08HWAX (M08HWA Funct Verif
w/2 sets of data) **Serial/ID No:** F60126-1

Description: WR-08 Mixer Functional Verification Service, Test Data, and USB
Stick, and 2nd set of data

Date of Test: August 25, 2016

Temperature: (23 +/- 5) deg C

Humidity: 20 to 65% RH

Procedure:

This certifies that the above product was tested in compliance with OML specifications using applicable OML's procedures.

As Received : Physical Condition: Good
Within Tolerance: Yes

As Shipped: At the completion of the test, the product COMPLIED with the performance capability.

Remarks:

Traceability Information: Traceability is to national standards administered by U.S. NIST, NRC Canada, Euromet members (NPL, PTB, BNM, etc.) or other recognized standards laboratories. Some measurements are traceable to natural physical constants, consensus standards or ratio type measurements. Supporting documentation relative to traceability is available for review by appointment.

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Report No. BANN0241.1

26/26