



element

Banner Engineering Corp.

Q130RA

FCC 15.207:2018

FCC 15.249:2018

24.0-24.25 GHz FMCW Sensor

Report # BANN0250.1 Rev. 1



NVLAP LAB CODE: 200881-0

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CERTIFICATE OF TEST



Last Date of Test: September 28, 2018
Banner Engineering Corp.
Model: Q130RA

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	Not required. Covered by Report BANN0240.0
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. As indicated in the Statement of Work sent with the quotation, Element's standard process is to always use the latest published version of the test methods even when earlier versions are cited in the test specification. Issuance of a purchase order was de facto acceptance of this approach. Otherwise, the client would have advised Element in writing of the specific version of the test methods they wanted applied to the subject testing.

REVISION HISTORY



Revision Number	Description	Date (yyyy-mm-dd)	Page Number
00	None		
01	Added FCC 15.207:2018	2018-11-08	Cover, 2
01	Added Powerline Conducted Emissions data	2018-11-08	11-16
01	Removed Duty Cycle and Dwell Time module	2018-11-28	Various
01	Updated Field Strength of Fundamental to reflect new duty cycle correction factor. Test Description updated to show the calculation and declared value for duty cycle.	2018-11-28	22-23

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

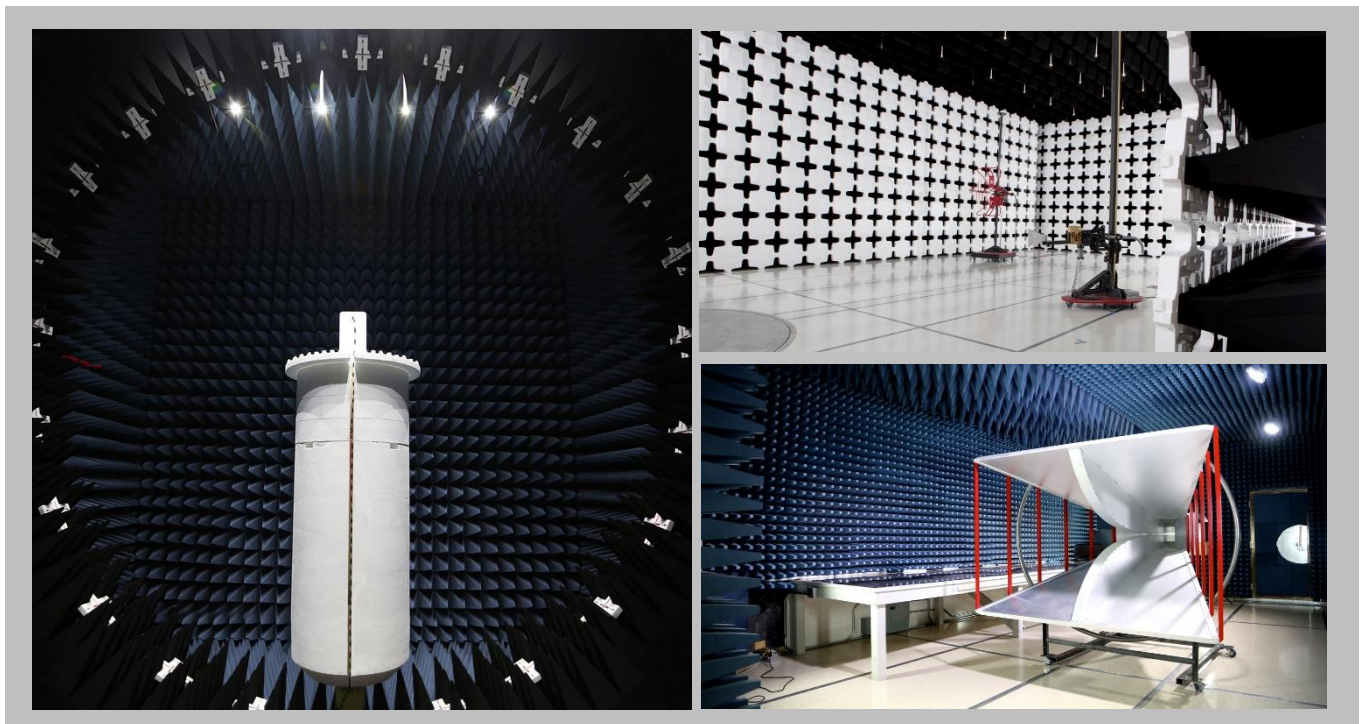
For details on the Scopes of our Accreditations, please visit:

<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.

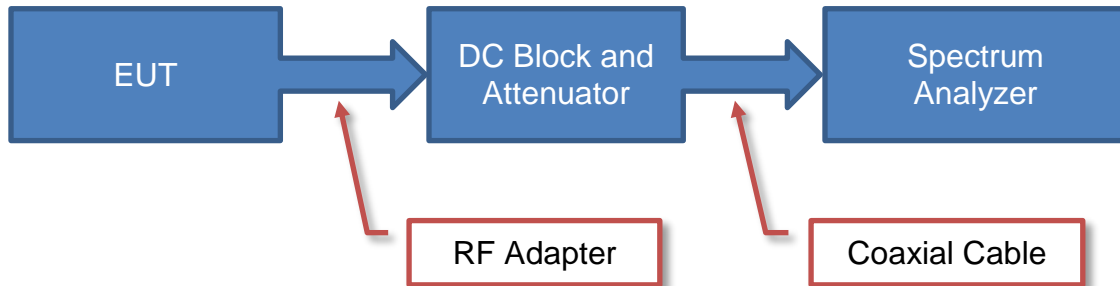
A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable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

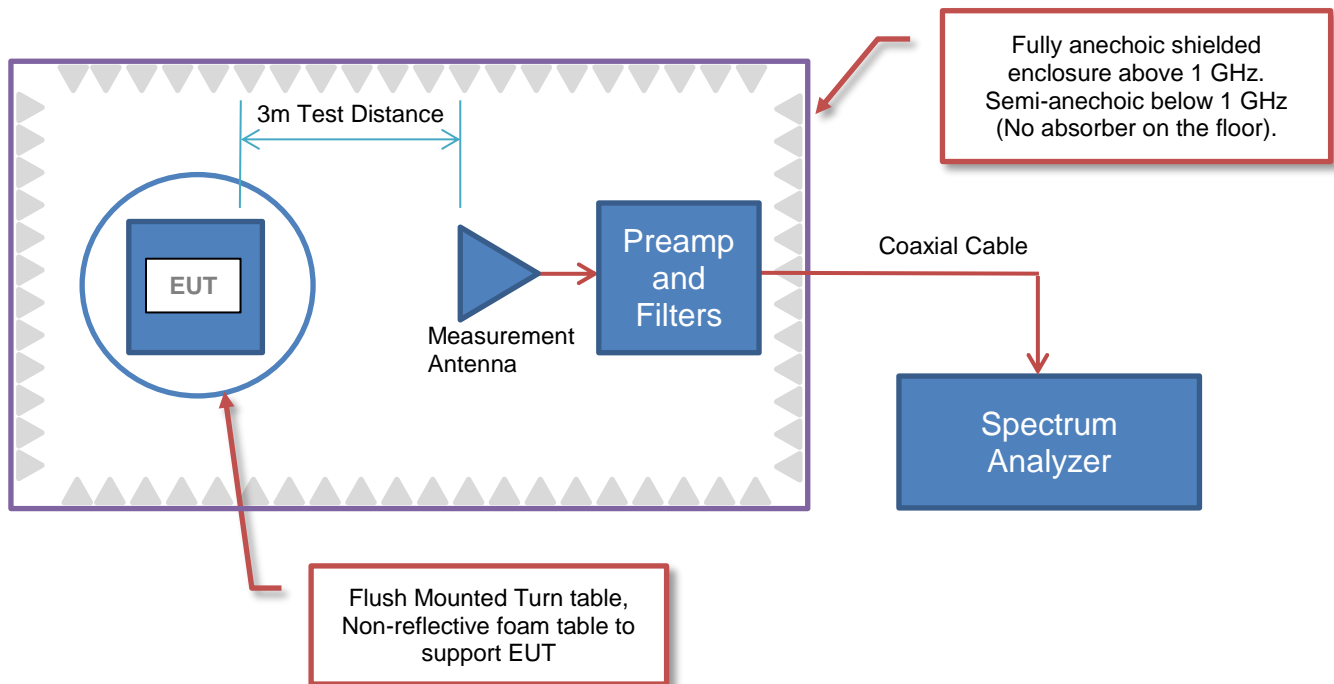
Antenna Port Conducted Measurements



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:	Q130RA
First Date of Test:	September 27, 2018
Last Date of Test:	September 28, 2018
Receipt Date of Samples:	September 27, 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 BANN0250- 1

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Q130RA	Banner Engineering Corp.	Q130RA	RD1809047

Peripherals in test setup boundary			
Description	Manufacturer	Model/Part Number	Serial Number
AC Adapter	Banner Engineering Corp.	PSD-24-4	None

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
AC Power	No	1.8 m	No	AC Mains	AC Adapter
DC Power	No	2.0 m	No	AC Adapter	Q130RA

MODIFICATIONS



Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2018-09-28	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	2018-09-28	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	2018-09-28	Field Strength of Fundamental	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

AC 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
Receiver	Rohde & Schwarz	ESR7	ARI	6/26/2018	6/26/2019
Cable - Conducted Cable Assembly	Northwest EMC	MNC, HGN, TYK	MNCA	3/14/2018	3/14/2019
LISN	Solar Electronics	9252-50-R-24-BNC	LIY	3/15/2018	3/15/2019

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	2.4 dB	-2.4 dB

CONFIGURATIONS INVESTIGATED

BANN0250-1

MODES INVESTIGATED

FMCW Transmitting

AC POWERLINE CONDUCTED EMISSIONS



EUT:	Q130RA	Work Order:	BANN0237
Serial Number:	RD1809047	Date:	09/26/2018
Customer:	Banner Engineering Corp.	Temperature:	22.3°C
Attendees:	Joel Jankord	Relative Humidity:	41.9%
Customer Project:	None	Bar. Pressure:	1021 mb
Tested By:	William Hoffa	Job Site:	MN03
Power:	110VAC/60Hz	Configuration:	BANN0250-1

TEST SPECIFICATIONS

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

TEST PARAMETERS

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

Class 2 power supply

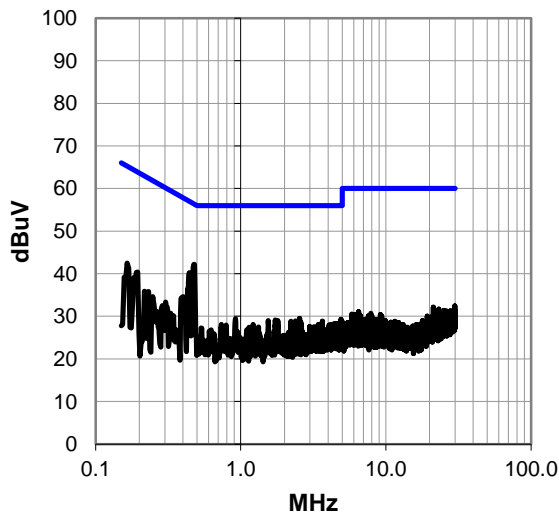
EUT OPERATING MODES

FMCW Transmitting

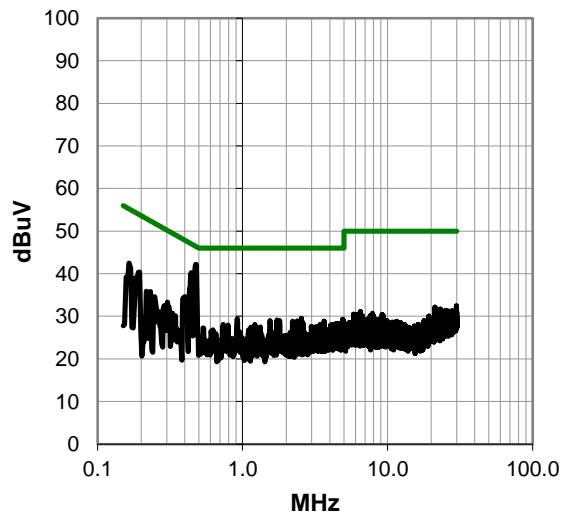
DEVIATIONS FROM TEST STANDARD

None

Peak Data - vs - Quasi Peak Limit



Peak Data - vs - Average Limit



AC POWERLINE CONDUCTED EMISSIONS



RESULTS - Run #6

Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (I)	Spec. Limit (I)	Margin (dB)
0.475	21.8	20.4	42.2	56.4	-14.2
0.441	19.8	20.4	40.2	57.0	-16.8
0.165	21.8	20.7	42.5	65.2	-22.7
0.400	14.2	20.4	34.6	57.9	-23.3
0.195	19.8	20.6	40.4	63.8	-23.4
0.389	13.9	20.4	34.3	58.1	-23.8
2.545	9.0	20.5	29.5	56.0	-26.5
0.232	15.2	20.6	35.8	62.4	-26.6
0.919	8.9	20.5	29.4	56.0	-26.6
4.899	8.6	20.7	29.3	56.0	-26.7
1.732	8.6	20.5	29.1	56.0	-26.9
0.303	12.9	20.4	33.3	60.2	-26.9
0.217	15.3	20.6	35.9	62.9	-27.0
1.545	8.5	20.5	29.0	56.0	-27.0
1.799	8.5	20.5	29.0	56.0	-27.0
2.385	8.4	20.5	28.9	56.0	-27.1
2.213	8.3	20.5	28.8	56.0	-27.2
3.646	8.1	20.7	28.8	56.0	-27.2
4.974	8.1	20.7	28.8	56.0	-27.2
0.247	14.0	20.6	34.6	61.9	-27.3
2.575	8.2	20.5	28.7	56.0	-27.3
2.616	7.9	20.5	28.4	56.0	-27.6
29.843	8.5	23.9	32.4	60.0	-27.6
4.418	7.6	20.7	28.3	56.0	-27.7
4.597	7.6	20.7	28.3	56.0	-27.7
0.736	7.6	20.5	28.1	56.0	-27.9

Peak Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (I)	Spec. Limit (I)	Margin (dB)
0.475	21.8	20.4	42.2	46.4	-4.2
0.441	19.8	20.4	40.2	47.0	-6.8
0.165	21.8	20.7	42.5	55.2	-12.7
0.400	14.2	20.4	34.6	47.9	-13.3
0.195	19.8	20.6	40.4	53.8	-13.4
0.389	13.9	20.4	34.3	48.1	-13.8
2.545	9.0	20.5	29.5	46.0	-16.5
0.232	15.2	20.6	35.8	52.4	-16.6
0.919	8.9	20.5	29.4	46.0	-16.6
4.899	8.6	20.7	29.3	46.0	-16.7
1.732	8.6	20.5	29.1	46.0	-16.9
0.303	12.9	20.4	33.3	50.2	-16.9
0.217	15.3	20.6	35.9	52.9	-17.0
1.545	8.5	20.5	29.0	46.0	-17.0
1.799	8.5	20.5	29.0	46.0	-17.0
2.385	8.4	20.5	28.9	46.0	-17.1
2.213	8.3	20.5	28.8	46.0	-17.2
3.646	8.1	20.7	28.8	46.0	-17.2
4.974	8.1	20.7	28.8	46.0	-17.2
0.247	14.0	20.6	34.6	51.9	-17.3
2.575	8.2	20.5	28.7	46.0	-17.3
2.616	7.9	20.5	28.4	46.0	-17.6
29.843	8.5	23.9	32.4	50.0	-17.6
4.418	7.6	20.7	28.3	46.0	-17.7
4.597	7.6	20.7	28.3	46.0	-17.7
0.736	7.6	20.5	28.1	46.0	-17.9

CONCLUSION

Pass

William Hoffa

Tested By

AC POWERLINE CONDUCTED EMISSIONS



EUT:	Q130RA	Work Order:	BANN0237
Serial Number:	RD1809047	Date:	09/26/2018
Customer:	Banner Engineering Corp.	Temperature:	22.3°C
Attendees:	Joel Jankord	Relative Humidity:	41.9%
Customer Project:	None	Bar. Pressure:	1021 mb
Tested By:	William Hoffa	Job Site:	MN03
Power:	110VAC/60Hz	Configuration:	BANN0250-1

TEST SPECIFICATIONS

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

TEST PARAMETERS

Run #:	7	Line:	High Line	Add. Ext. Attenuation (dB):	0
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COMMENTS

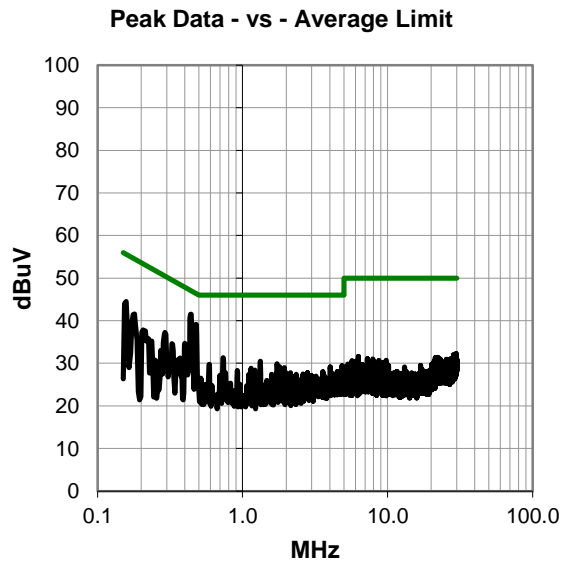
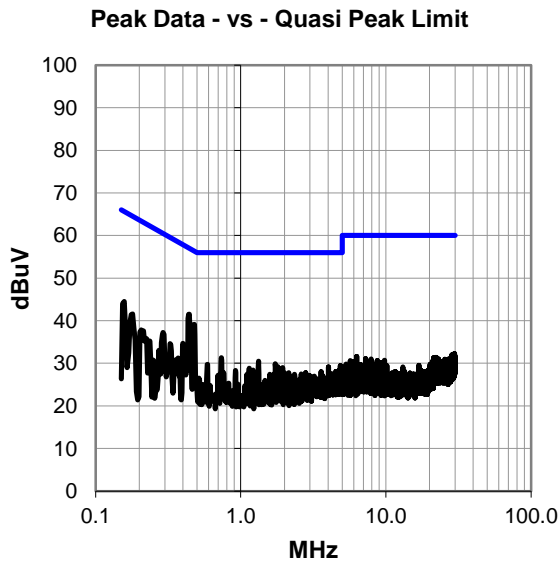
Class 2 power supply

EUT OPERATING MODES

FMCW Transmitting

DEVIATIONS FROM TEST STANDARD

None



AC POWERLINE CONDUCTED EMISSIONS



RESULTS - Run #7

Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (I)	Spec. Limit (I)	Margin (dB)
0.437	21.1	20.4	41.5	57.1	-15.6
0.475	18.7	20.4	39.1	56.4	-17.3
0.157	23.8	20.7	44.5	65.6	-21.1
0.180	20.9	20.7	41.6	64.5	-22.9
0.400	14.3	20.4	34.7	57.9	-23.2
0.292	16.8	20.4	37.2	60.5	-23.3
0.736	10.8	20.5	31.3	56.0	-24.7
0.325	14.2	20.4	34.6	59.6	-25.0
1.325	10.0	20.5	30.5	56.0	-25.5
0.206	17.2	20.6	37.8	63.4	-25.6
0.422	11.2	20.4	31.6	57.4	-25.8
1.732	9.4	20.5	29.9	56.0	-26.1
0.587	9.3	20.4	29.7	56.0	-26.3
0.415	10.5	20.4	30.9	57.5	-26.6
4.851	8.7	20.7	29.4	56.0	-26.6
1.803	8.7	20.5	29.2	56.0	-26.8
4.015	8.4	20.7	29.1	56.0	-26.9
4.970	8.4	20.7	29.1	56.0	-26.9
1.941	8.5	20.5	29.0	56.0	-27.0
4.881	8.3	20.7	29.0	56.0	-27.0
0.232	14.6	20.6	35.2	62.4	-27.2
1.142	8.3	20.5	28.8	56.0	-27.2
0.370	10.8	20.4	31.2	58.5	-27.3
4.832	7.9	20.7	28.6	56.0	-27.4
1.213	7.9	20.5	28.4	56.0	-27.6
4.925	7.7	20.7	28.4	56.0	-27.6

Peak Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (I)	Spec. Limit (I)	Margin (dB)
0.437	21.1	20.4	41.5	47.1	-5.6
0.475	18.7	20.4	39.1	46.4	-7.3
0.157	23.8	20.7	44.5	55.6	-11.1
0.180	20.9	20.7	41.6	54.5	-12.9
0.400	14.3	20.4	34.7	47.9	-13.2
0.292	16.8	20.4	37.2	50.5	-13.3
0.736	10.8	20.5	31.3	46.0	-14.7
0.325	14.2	20.4	34.6	49.6	-15.0
1.325	10.0	20.5	30.5	46.0	-15.5
0.206	17.2	20.6	37.8	53.4	-15.6
0.422	11.2	20.4	31.6	47.4	-15.8
1.732	9.4	20.5	29.9	46.0	-16.1
0.587	9.3	20.4	29.7	46.0	-16.3
0.415	10.5	20.4	30.9	47.5	-16.6
4.851	8.7	20.7	29.4	46.0	-16.6
1.803	8.7	20.5	29.2	46.0	-16.8
4.015	8.4	20.7	29.1	46.0	-16.9
4.970	8.4	20.7	29.1	46.0	-16.9
1.941	8.5	20.5	29.0	46.0	-17.0
4.881	8.3	20.7	29.0	46.0	-17.0
0.232	14.6	20.6	35.2	52.4	-17.2
1.142	8.3	20.5	28.8	46.0	-17.2
0.370	10.8	20.4	31.2	48.5	-17.3
4.832	7.9	20.7	28.6	46.0	-17.4
1.213	7.9	20.5	28.4	46.0	-17.6
4.925	7.7	20.7	28.4	46.0	-17.6

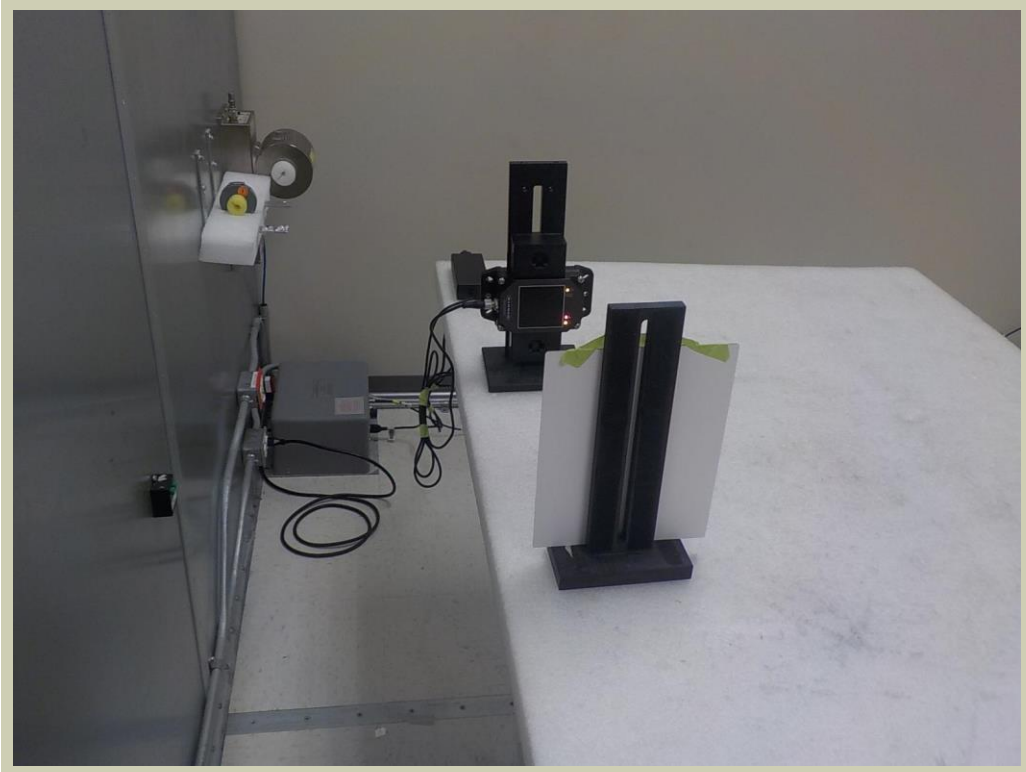
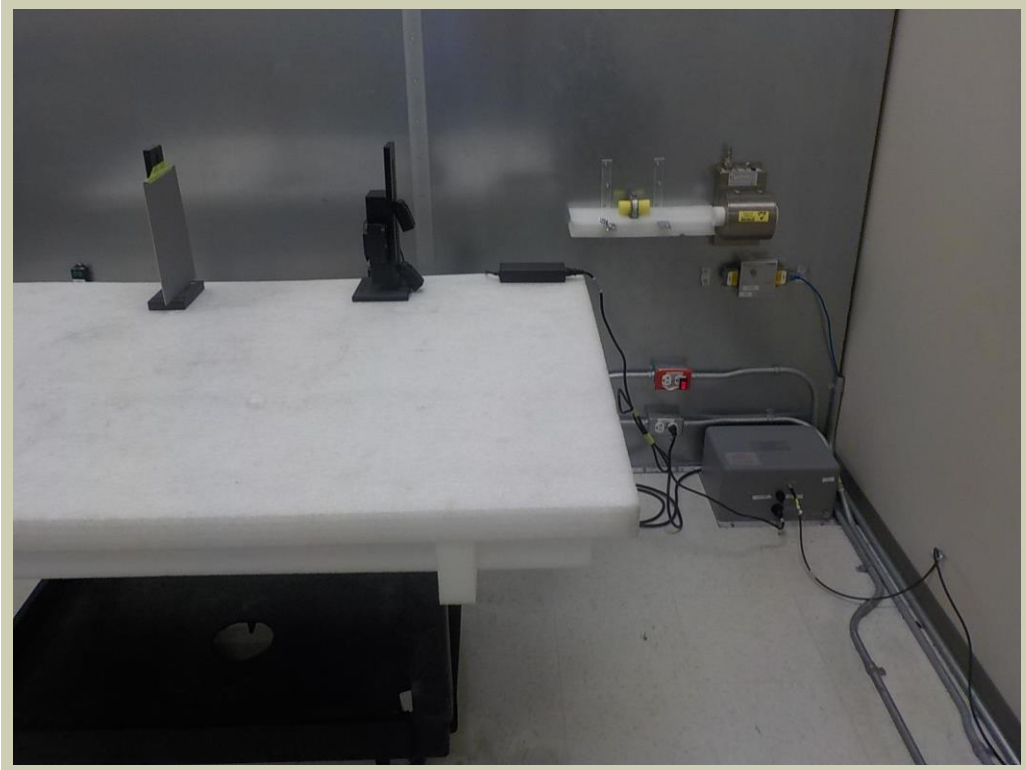
CONCLUSION

Pass

William Hoffa

Tested By

AC POWERLINE CONDUCTED EMISSIONS



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 Cables	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



XMM 2017.12.13

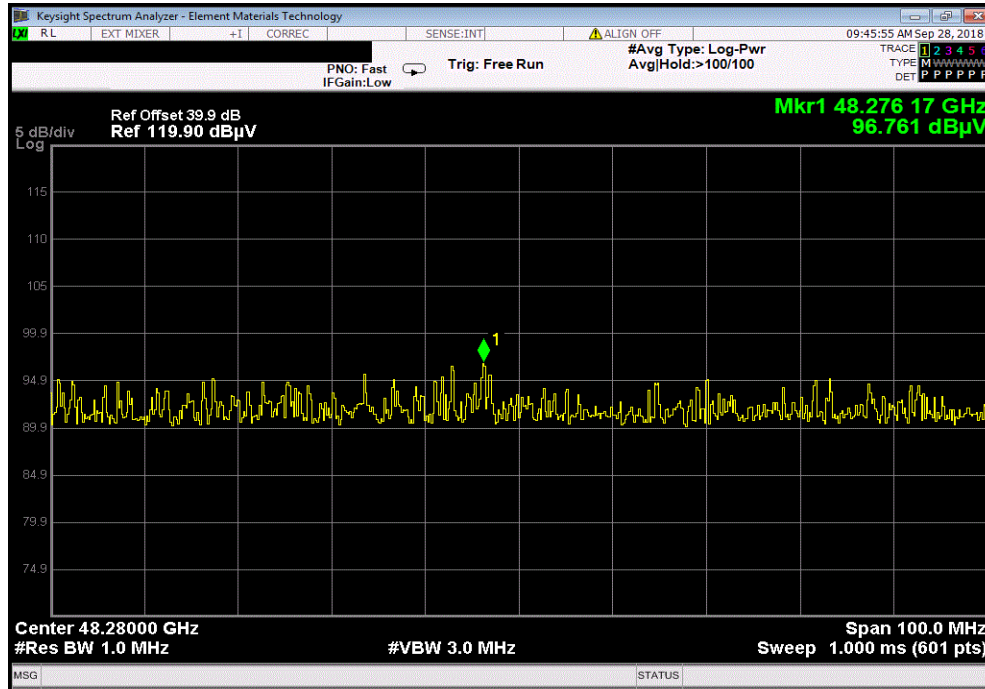
EUT: Q130RA		Work Order: BANN0250			
Serial Number: RD1809047		Date: 28-Sep-18			
Customer: Banner Engineering Corp.		Temperature: 22.6 °C			
Attendees: Joel Jankord		Humidity: 39.2% RH			
Project: None		Barometric Pres.: 1024 mbar			
Tested by: Kyle McMullan		Power: 24 VDC	Job Site: MN05		
TEST SPECIFICATIONS					
FCC 15.249:2018		Test Method			
		ANSI C63.10:2013			
COMMENTS					
None					
DEVIATIONS FROM TEST STANDARD					
None					
Configuration #	1	Signature <i>Kyle McMullan</i>			
		Raw Value at 2.7cm (dBµV/m)	Adjusted Value for 3m (dBµV/m)	Limit (dBµV/m)	Result
2nd Harmonic - 48.28 GHz					
	Peak Measurement	96.8	55.9	88	Pass
	Average Measurement	78.8	37.9	68	Pass
3rd Harmonic - 72.42 GHz					
	Peak Measurement	113.3	72.4	88	Pass
	Average Measurement	91.3	50.4	68	Pass
4th Harmonic - 96.56 GHz					
	Peak Measurement	102.9	62	88	Pass
	Average Measurement	89.6	48.7	68	Pass

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

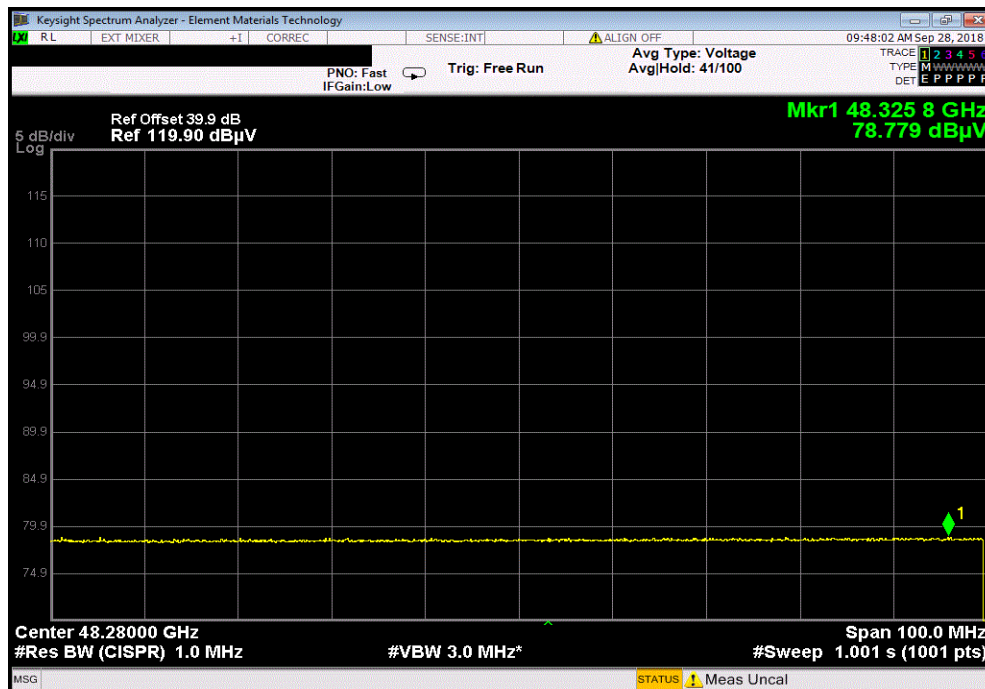


XMI 2017.12.13

2nd Harmonic - 48.28 GHz, Peak Measurement						
		Raw Value at	Adjusted Value	Limit	Result	
		2.7cm (dB μ V/m)	for 3m (dB μ V/m)	(dB μ V/m)		
		96.8	55.9	88.0	Pass	



2nd Harmonic - 48.28 GHz, Average Measurement						
		Raw Value at	Adjusted Value	Limit	Result	
		2.7cm (dB μ V/m)	for 3m (dB μ V/m)	(dB μ V/m)		
		78.8	37.9	68.0	Pass	

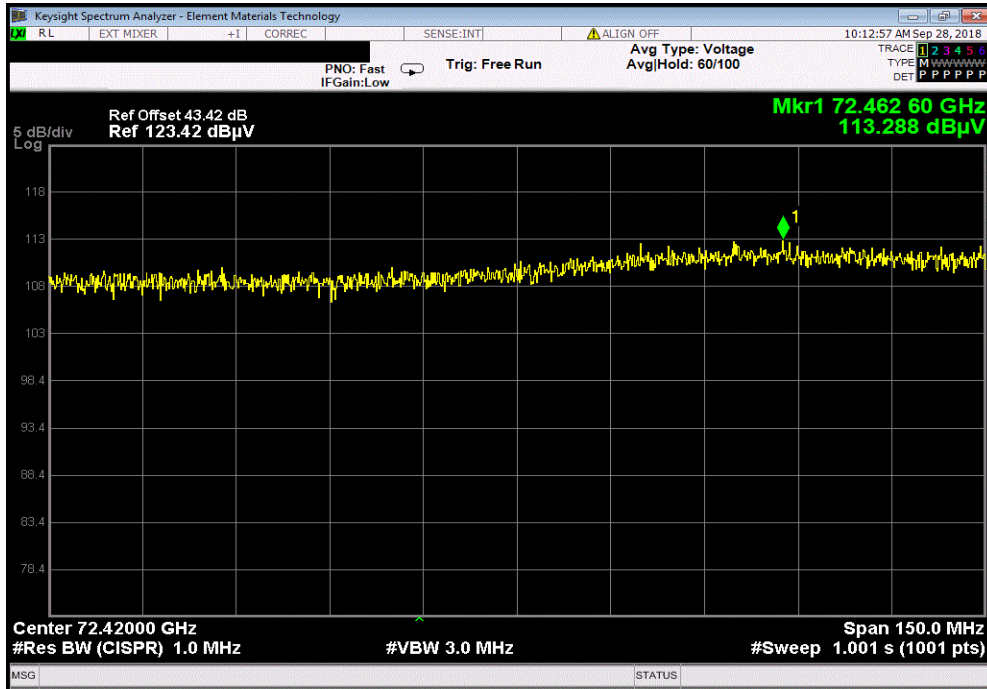


FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

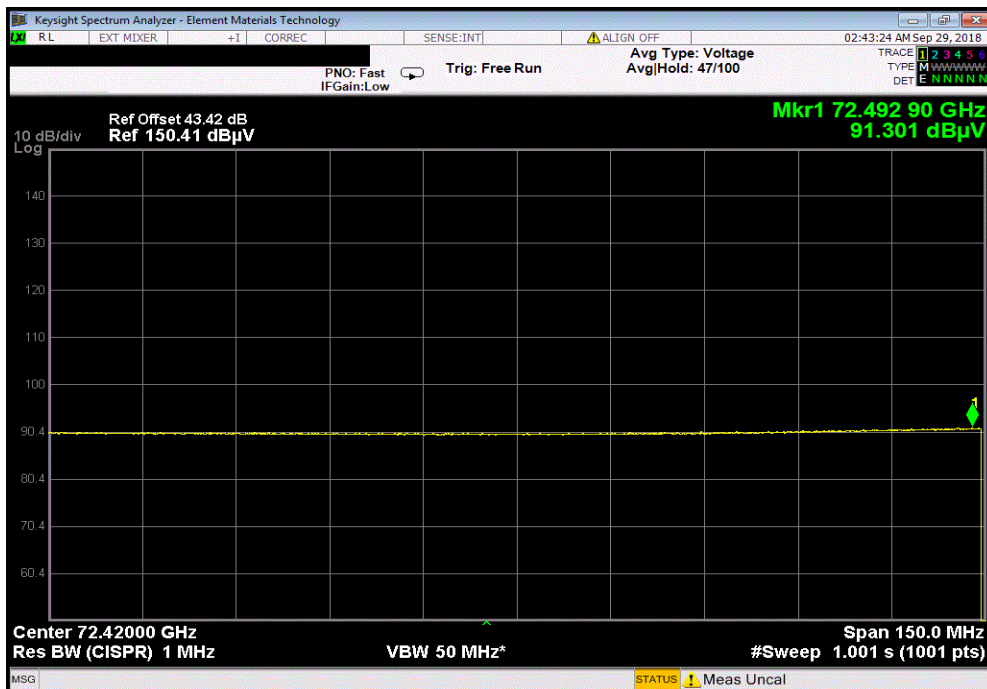


XMI 2017.12.13

3rd Harmonic - 72.42 GHz, Peak Measurement						
		Raw Value at	Adjusted Value	Limit	Result	
		2.7cm (dB μ V/m)	for 3m (dB μ V/m)	(dB μ V/m)		
		113.3	72.4	88.0	Pass	



3rd Harmonic - 72.42 GHz, Average Measurement						
		Raw Value at	Adjusted Value	Limit	Result	
		2.7cm (dB μ V/m)	for 3m (dB μ V/m)	(dB μ V/m)		
		91.3	50.4	68.0	Pass	

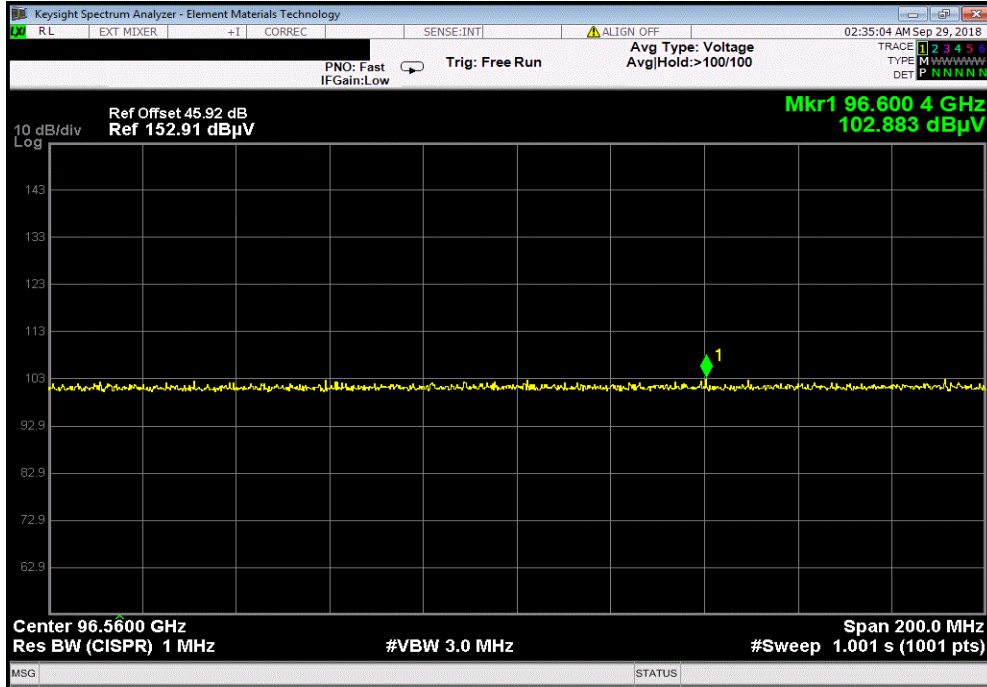


FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

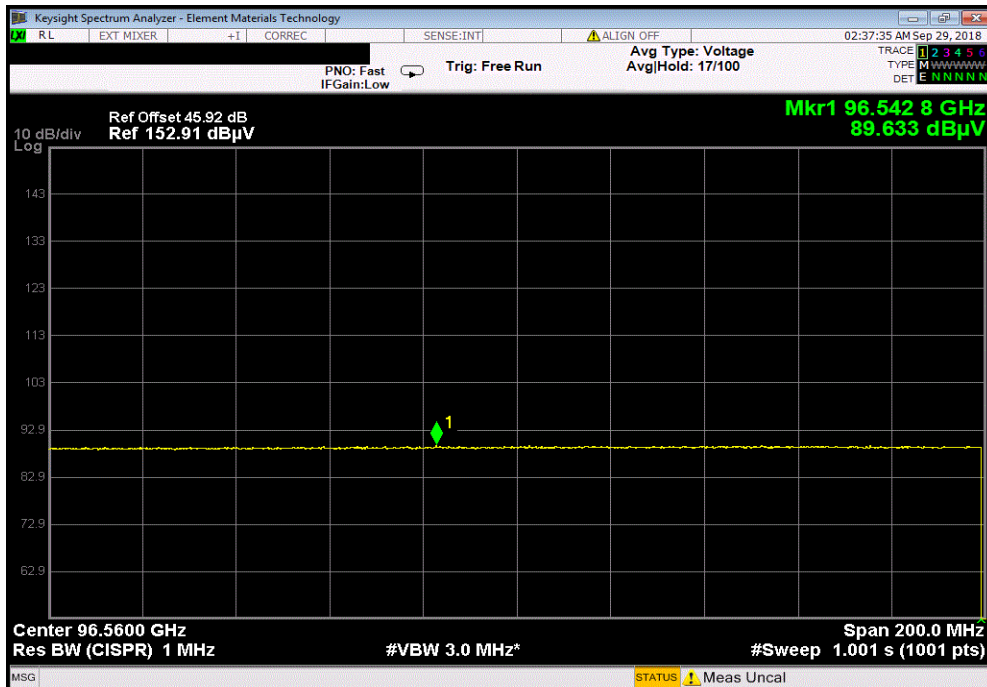


XMI 2017.12.13

4th Harmonic - 96.56 GHz, Peak Measurement						
		Raw Value at	Adjusted Value	Limit	Result	
		2.7cm (dB μ V/m)	for 3m (dB μ V/m)	(dB μ V/m)		
		102.9	62.0	88.0	Pass	



4th Harmonic - 96.56 GHz, Average Measurement						
		Raw Value at	Adjusted Value	Limit	Result	
		2.7cm (dB μ V/m)	for 3m (dB μ V/m)	(dB μ V/m)		
		89.6	48.7	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 from 24.0 to 24.25 GHz

POWER SETTINGS INVESTIGATED

24 VDC

CONFIGURATIONS INVESTIGATED

BANN0250 - 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	MNU	15-Mar-2018	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-09	AHG	NCR	0 mo
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	27-Apr-2018	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.

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.

FIELD STRENGTH OF FUNDAMENTAL

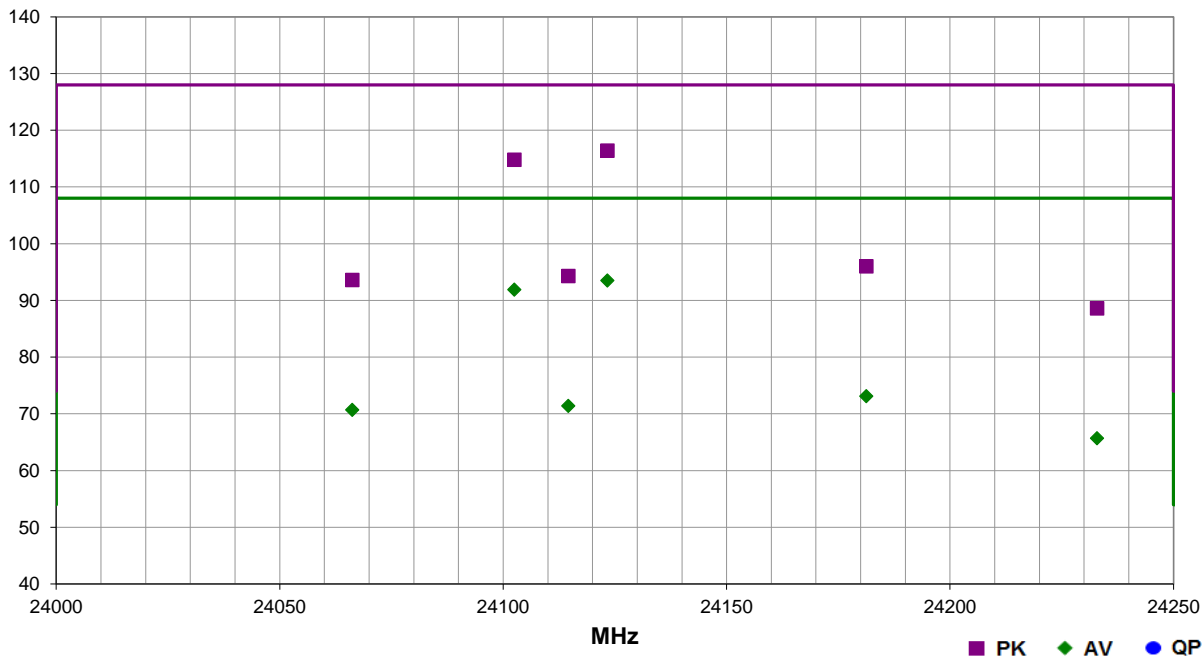


EmiR5 2018.07.19.3 PSA-ESCI 2018.05.04

Work Order:	BANN0250	Date:	27-Sep-2018	<i>Kyle McMullan</i>
Project:	None	Temperature:	22.3 °C	
Job Site:	MN05	Humidity:	42% RH	
Serial Number:	RD1809047	Barometric Pres.:	1013 mbar	
Tested by:	Kyle McMullan			
EUT:	Q130RA			
Configuration:	1			
Customer:	Banner Engineering Corp.			
Attendees:	Joel Jankord			
EUT Power:	24 VDC			
Operating Mode:	FMCW from 24.0 to 24.25 GHz			
Deviations:	None			
Comments:	None			

Test Specifications	FCC 15.249:2018	Test Method	ANSI C63.10:2013
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Run #	4	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
24123.330	78.4	47.5	1.6	29.1		0.0	Horz	PK	-9.5	116.4	128.0	-11.6	EUT On Side
24102.500	76.8	47.5	1.6	27.0		0.0	Vert	PK	-9.5	114.8	128.0	-13.2	EUT Upright
24123.330	78.4	47.5	1.6	29.1	-22.9	0.0	Horz	AV	-9.5	93.5	108.0	-14.5	EUT On Side
24102.500	76.8	47.5	1.6	27.0	-22.9	0.0	Vert	AV	-9.5	91.9	108.0	-16.1	EUT Upright
24181.250	58.0	47.5	1.6	329.0		0.0	Horz	PK	-9.5	96.0	128.0	-32.0	EUT Upright
24114.580	56.3	47.5	1.6	333.9		0.0	Vert	PK	-9.5	94.3	128.0	-33.7	EUT Screen Up
24066.250	55.6	47.5	1.6	6.0		0.0	Vert	PK	-9.5	93.6	128.0	-34.4	EUT On Side
24181.250	58.0	47.5	1.6	329.0	-22.9	0.0	Horz	AV	-9.5	73.1	108.0	-34.9	EUT Upright
24114.580	56.3	47.5	1.6	333.9	-22.9	0.0	Vert	AV	-9.5	71.4	108.0	-36.6	EUT Screen Up
24066.250	55.6	47.5	1.6	6.0	-22.9	0.0	Vert	AV	-9.5	70.7	108.0	-37.3	EUT On Side
24232.920	50.6	47.5	1.6	247.9		0.0	Horz	PK	-9.5	88.6	128.0	-39.4	EUT Screen Up
24232.920	50.6	47.5	1.6	247.9	-22.9	0.0	Horz	AV	-9.5	65.7	108.0	-42.3	EUT Screen Up

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.

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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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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: 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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