Test Report # 317155 A

Equipment Under Test:	Locator Tester
Test Date(s):	9/7/17, 9/11/17, & 10/4/17
Prepared for:	Matrix Attn: Bobby Porter 3299 Tower Drive Newburgh, IN 47630

Report Issued by:
Signature: Coty Hammerer Date: 12/6/17

Report Reviewed by: Adam Alger, Quality Systems Engineer
Signature: Adam O Alger Date: 11/03/2017

Report Constructed by:
Signature: Coty Hammerer Date: 10/4/17

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Laird Technologies Test Services in Review

The Laird Technologies, Inc. laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA is recognized through the following organizations:

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope
A2LA Certificate Number: 1255.01
Scope of accreditation includes all test methods listed herein, unless otherwise noted.

Federal Communications Commission (FCC) – USA

Accredited recognition of two 3 meter Semi-Anechoic Chambers

Accredited Test Firm Registration Number: 953492

Government of Canada

Innovation, Science and Economic Development Canada

ISED Site listing of two 3 meter Semi-Anechoic Chambers based on RSS-GEN – Issue 4
File Number: IC 3088A-2
File Number: IC 3088A-3

1 TEST REPORT SUMMARY

During **9/7/17, 9/11/17, & 10/4/17** the Equipment Under Test (EUT), **Locator Tester**, as provided by **Matrix** was tested to the following requirements:

Requirements	Description	Method	Compliant
CFR 47 Part 15 Section 209	Radiated Emissions: 9 kHz – 1 GHz	ANSI C63.10	Yes
CFR 47 Part 15 Section 207	Conducted AC Emissions: 150 kHz – 30 MHz	ANSI C63.10	Yes

Notice:

The results relate only to the item tested and described in this report. Any modifications made to the equipment under test after the specified test date(s) may invalidate the data herein.

If the resulting measurement margin is seen to be within the uncertainty value, as listed in this report, the possibility exists that this unit may not meet the required limit specification if subsequently tested.

2 CLIENT INFORMATION

Company Name	Matrix
Contact Person	Bobby porter
Address	3299 Tower Drive Newburgh, IN 47630

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	Locator Tester
Model Number	MX3-IZ Locator Tester
Serial Number	B690-B691
FCC ID	USKLOCTSTR
Additional Information	EUT has 2 ports: One for Power and a USB port for manufacturer programming and troubleshooting along with field firmware updating.

2.2 Product Description

The Locator Tester is a module that confirms proper Locator operation by simulating partial functionality of an IntelliZone™ Proximity Detection System Controller and Driver. The Locator Tester is capable of exchanging Proxtalk data with other devices via RF over the MX-3 network using the mNet protocol. Primary functions of the Locator Tester include:

- Communicating to the Locator under test via RF communication (Controller function)
- Providing magnetic signals to the Locator (Driver function).
- Analysing Locator Report data for compliance to PASS/FAIL criteria.
- Driving a multi-color LCD display for providing test status, results and other Locator information to the Locator Tester operator.

2.3 Modifications Incorporated for Compliance

None noted at time of test

2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

2.5 Additional Information

A switch mode AC Adapter, Input: 90 – 264 VAC, 47-63 Hz, 0.1 – 1.0 A with Output: 12 VDC, 2.0 A is used to power the Locator Tester. The 2.4 GHz Radio is only ever in Rx mode and can't transmit simultaneously with the 75 kHz radio. EUT came pre-programmed. Once the unit is powered on it boots up and is then in the desired test mode for all testing.

2.6 Additional Information

AC Adapter is supplied with Locator Testers. EUT was tested in 2 orientations: Flat and Vertical.

3 REFERENCES

Publication	Edition	Date
CFR 47 Part 15 Section 209	-	2017
CFR 47 Part 15 Section 207	-	2017
ANSI C63.10	-	2013

4 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k = 2.

References	Version / Date
CISPR 16-4-1	Ed. 2 (2009-02)
CISPR 16-4-2	Ed. 2 (2011-06)
CISPR 32	Ed. 1 (2012-01)
ANSI C63.23	2012
A2LA P103	February 4, 2016
A2LA P103c	August 10, 2015
ETSI TR 100-028	V1.3.1 (2001-03)

Measurement Type	Configuration	Uncertainty ±
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

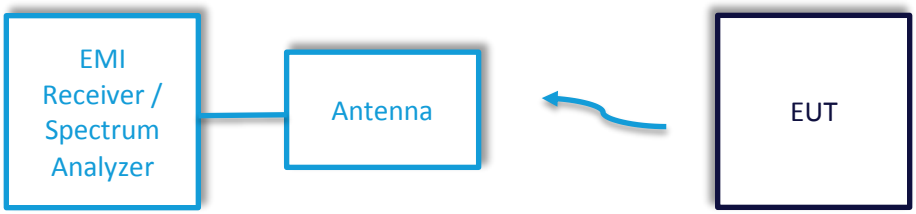
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	$1x10^{-7}$	$0.55x10^{-7}$
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

5 TEST DATA

5.1 Radiated Emissions

Description of Measurement	The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna. The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed allowing the data to be gathered and reported as corrected values. The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.
Example Calculations	Measurement (dBµV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBµV/m) Margin (dB) = Limit (dBµV/m) - Corrected Reading (dBµV/m) Example at 4000 MHz: Reading = 40 dBµV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBµV/m Average Limit = 20 log (500) = 54 dBµV/m Margin = 54 dBµV/m - 50.8 dBµV/m = 3.2 dB

Block Diagram



5.1.1 Radiated Emissions 15.209

Operator	Coty Hammerer
QA	Khairul Aidi Zainal
Test Date	9/7/17, 9/11/17, & 10/4/17
Location	Chamber 3
Temp. / R.H.	70 F/ 48%
Requirement	CFR 47 Part 15 Section 209
Method	ANSI C63.10 Section 6.4

Limits:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

Test Parameters

Frequency	9 kHz – 1 GHz
Distance	3 meters
Settings	RBW= 200 Hz, VBW=1.5 kHz for Frequency Range: 9kHz to 120 kHz RBW=9 kHz and VBW=30 kHz for Frequency Range: 120 kHz to 30 MHz
Settings	RBW= 120 kHz, VBW = 1.2 MHz for Frequency Range: 30 MHz – 1 GHz
Settings	Average Detector used for measurements from 9-90 kHz and 110-490 kHz
EUT	Tested at 120VAC/ 60 Hz and 230VAC/ 50 Hz in 2 orientations
EUT	EUT typically sits flat
Notes	120VAC/60 Hz produced same emission signatures and amplitude as 230VAC/ 50 Hz Vertical EUT orientation was worst case. The Loop Antenna was rotated 360° (about vertical axis) and the final positioning of the antenna was where the maximum emissions resulted, which was when the Loop antenna was parallel to the EUT as pictures in the test setup photos.

Instrumentation

Laird
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Date : 7-Sep-2017 Test : Radiated Emissions (209) Job : C-2738

PE : Coty Hammerer Customer : Matrix Quote : 317155

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960128	Biconical Antenna	ETS Lindgren	3110B	00062899	4/13/2017	4/13/2018	Active Calibration
2	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	4/17/2017	4/17/2018	Active Calibration
3	EE 960085	EMI Receiver	Agilent	N9038A	MY51210148	5/12/2017	5/12/2018	Active Calibration
4	AA 960006	Active Loop Antenna	EMCO	6502	9205-2753	8/28/2017	8/28/2019	Active Calibration

Table

Frequency (kHz)	Frequency (MHz)	dnear field	Limit Distance	Limit Distance greater than dnear field (use equation 2 if yes)	Limit Distance closer to EUT than dnear field (use equation 4 if yes)	Conversion	Antenna Height (m)	Azimuth (degree)	Field Strength @ 3 m (dBµV/m)	FS Limit @ limit distance (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Notes
75.8	0.0758	630.2	300	no	yes	-80	1.00	185	64.1	-15.9	30.0	45.9	Ant. Parallel to EUT, EUT: Vert.
227.4	0.2274	210.1	300	yes	no	-77	1.00	161	51.9	-25.0	20.5	45.5	Ant. Parallel to EUT, EUT: Vert.
75.8	0.0758	630.4	300	no	yes	-80	1.00	184	61.8	-18.2	30.0	48.2	Ant. parallel to EUT, EUT: Flat
227.7	0.2277	209.8	300	yes	no	-77	1.00	185	51.3	-25.6	20.5	46.1	Ant. parallel to EUT, EUT: Flat

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
75.2	1.00	230.0	25.6	40.0	14.4	V	Flat
75.0	1.00	265.0	25.6	40.0	14.4	V	Vertical

Note: Field Strength measurements between 75.8 and 227.7 kHz, as per CFR 47 Section 15.209, require an average Detector. These measurements were taken with the analyzers Measure at Marker Function (employs the necessary detector) with the emission fully maximized also employing the required RBW/VBW values appropriate to the frequency range.

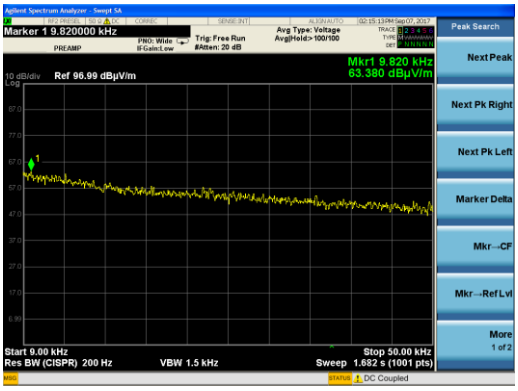
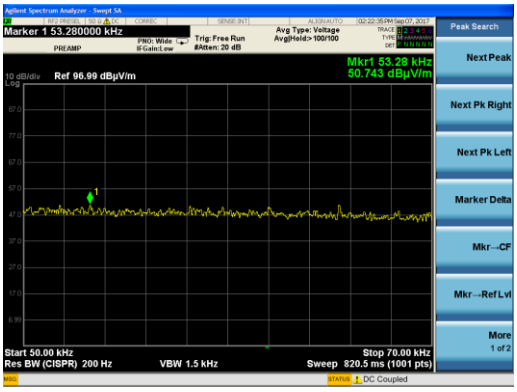
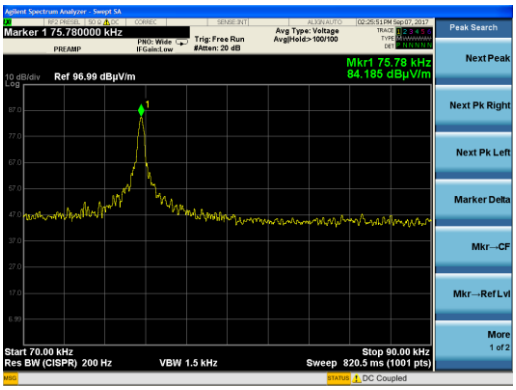
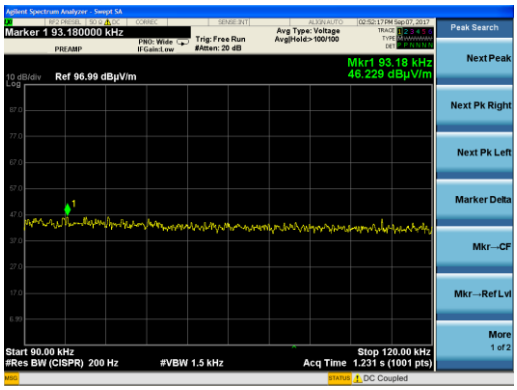
Data Table Equation References:

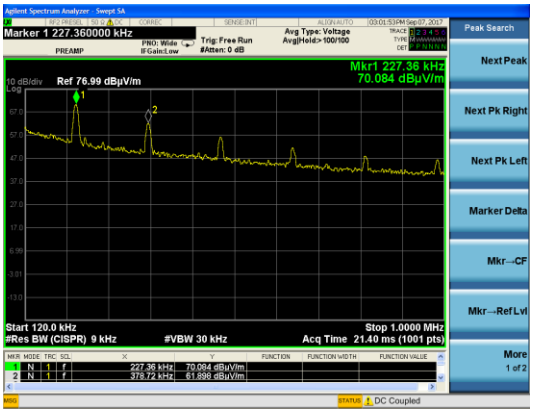
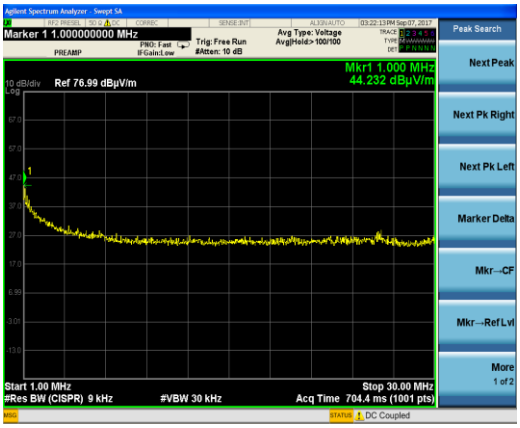
$$FS_{\text{limit}} = FS_{\text{max}} - 40\log\left(\frac{d_{\text{near field}}}{d_{\text{measure}}}\right) - 20\log\left(\frac{d_{\text{limit}}}{d_{\text{near field}}}\right) \quad (2)$$

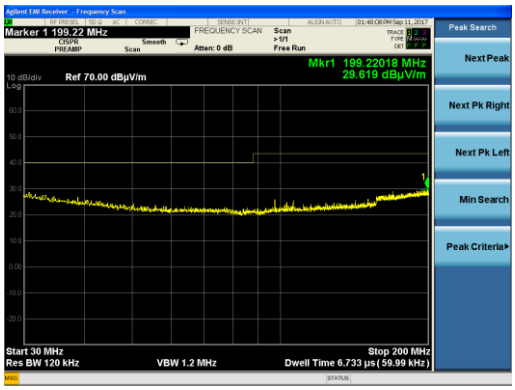
$$FS_{\text{limit}} = FS_{\text{max}} - 40\log\left(\frac{d_{\text{limit}}}{d_{\text{measure}}}\right) \quad (4)$$

Plots – Worst Case

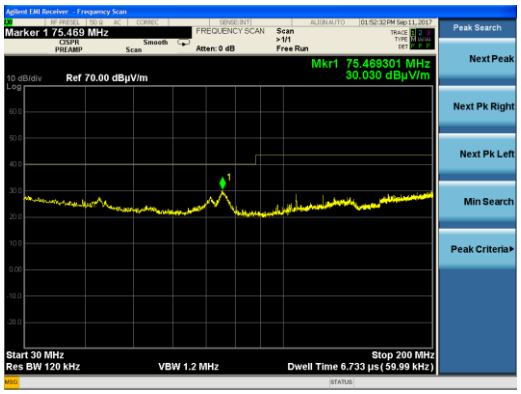
Note- Plots represent a Peak trace.

	
Loop Ant. Parallel, EUT Vert., 9-50 kHz	Loop Ant. Parallel, EUT Vert., 50-70 kHz
	
Loop Ant. Parallel, EUT Vert., 70-90 kHz	Loop Ant. Parallel, EUT Vert., 90-120 kHz

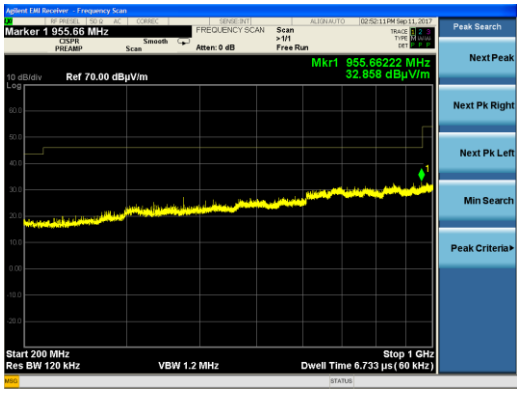
	
Loop Ant. Parallel, EUT Vert., 120-1000 kHz	Loop Ant. Parallel, EUT Vert., 1-30 MHz



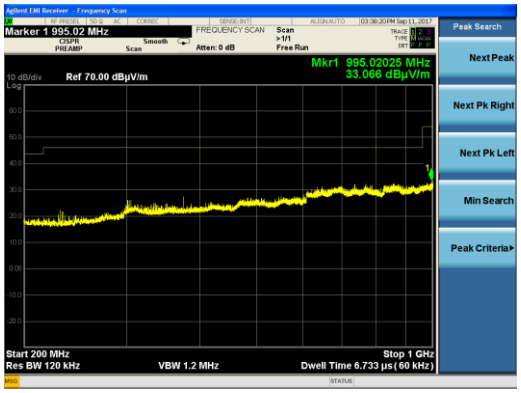
Hor., EUT: Vert., 30-200 MHz



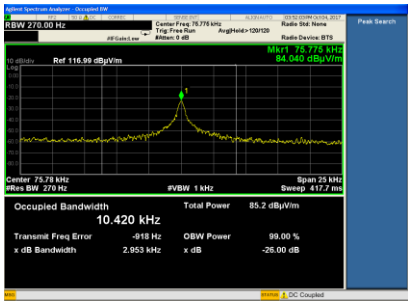
Vert., EUT: Vert., 30-200 MHz



Hor., EUT: Vert., 30-200 MHz



Vert., EUT: Vert., 30-200 MHz



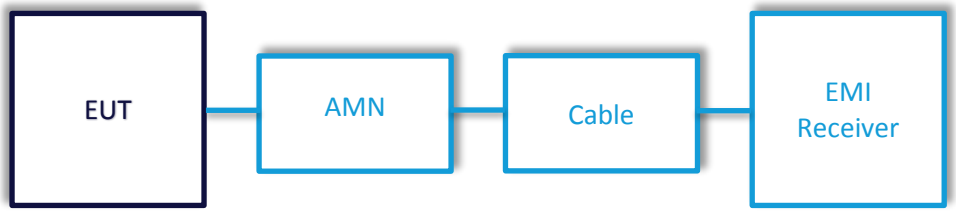
Loop Ant. Parallel, EUT Vert., 99% OBW

Note: All emissions were higher with EUT: Vertical and Loop Antenna Parallel. All plots above represent EUT powered at 120VAC/ 60 Hz.

5.2 AC Mains Conducted Emissions

Description of Measurement	A line impedance stabilization network (LISN) or artificial mains network (AMN) allows the emissions of the power supply conductors to be measured while isolating the EUT from the supply mains. The AMN, cable, and other necessary measurement system correction factors are loaded onto the EMI receiver when the measurements are performed. The data is gathered and reported as the corrected values. Maximum emissions are determined with a peak max hold trace then measurements at a selection of the highest points are made with quasi-peak and average detectors. Results are recorded and compared to limit for each line. (e.g. line and neutral)
Example Calculations	Measurement (dBµV) + Cable factor (dB) + Other (dB) = Corrected Reading (dBµV) Margin (dB) = Limit (dBµV) - Corrected Reading (dBµV)

Block Diagram



5.2.1 AC Mains Conducted Emissions

Operator	Coty Hammerer
QA	Adam Alger
Test Date	9/7/17
Location	Ground Plane Area
Temp. / R.H.	70 F/ 49%
Requirement	CFR 47 Part 15 Section 207
Method	ANSI C63.10 Section 6.2

Limits:

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

Test Parameters

Frequency	150 kHz – 30 MHz
Distance	40 cm from closest point of EUT to Vertical Ground Plane
Settings	80 cm from EUT to LISN and Horizontal Ground Plane
Settings	RBW-9 kHz, VBW=90 kHz
EUT	Powered at 120VAC/ 60 Hz and 230VAC/ 50 Hz
EUT	75 kHz Radio Transmitting, 2.4 GHz Radio only in Rx mode always

Instrumentation

Laird
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Date : 7-Sep-2017 Test : Conducted Emissions (207) Job : C-2738

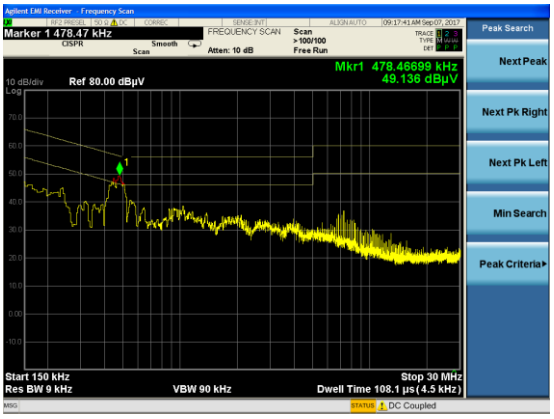
PE : Coty Hammerer Customer : Matrix Quote : 317155

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960088	EMI Receiver	Agilent	N9038A	MY51210138	3/2/2017	3/2/2018	Active Calibration
2	EE 960089	LISN	COM-POWER	LI-215A	191943	8/28/2017	8/28/2018	Active Calibration

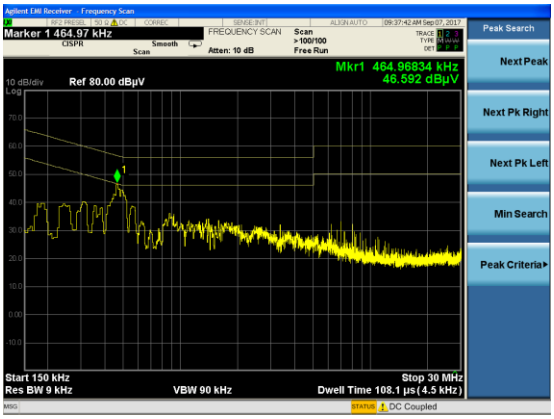
Table

Frequency (MHz)	Line	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Notes
0.464	1	45.50	56.62	11.12	28.00	46.62	18.62	120VAC/ 60 Hz
0.475	1	46.00	56.43	10.43	30.20	46.43	16.23	120VAC/ 60 Hz
0.485	1	45.00	56.26	11.26	29.40	46.26	16.86	120VAC/ 60 Hz
0.470	2	43.50	56.52	13.02	27.00	46.52	19.52	120VAC/ 60 Hz
0.490	2	42.00	56.17	14.17	25.80	46.17	20.37	120VAC/ 60 Hz
0.442	2	40.00	57.03	17.03	25.10	47.03	21.93	120VAC/ 60 Hz
0.475	2	43.60	56.43	12.83	28.10	46.43	18.33	230VAC/ 50 Hz
0.505	2	43.40	56.00	12.60	26.90	46.00	19.10	230VAC/ 50 Hz

Plots - Worst Case



L1, 120VAC/ 60 Hz



L2, 120VAC/ 60 Hz

Note: Peak trace was used in the above plots. The Analyzer Measure at Marker Function, employing the proper detectors with the listed RBW/VBW values at the given frequency, were used to record measurements.

6 REVISION HISTORY

Version	Date	Notes	Person
0	10/4/17	Initial Draft	Coty Hammerer
1	11/2/17	Revisions	Coty Hammerer
2	12/6/17	Revisions	Coty Hammerer
3	12/19/17	TCB Comments Addressed	Coty Hammerer

END OF REPORT