TEST REPORT

Report Number: 102661298MPK-001
Project Number: G102661298
September 06, 2016

Testing performed on the
Low Frequency RFID Reader with CAN Bus Interface
Model Number: ATR60LF Reader CAN Bus
P/N: TLS-33C-4O00-C1-00E2
FCC ID: N5GATR60LFCAN

to

FCC Part 15 Subpart C (15.209)
FCC Part 15 Subpart C (15.207)
RSS-210 Issue 9
FCC Part 15, Subpart B
Industry Canada ICES-003

Class: A

for

Brooks Automation, Inc.

Test Performed by:	Test Authorized by:
Intertek	Brooks Automation, Inc.
1365 Adams Court	46702 Bayside Pkwy
Menlo Park, CA 94025 USA	Fremont, CA 94538, USA

Prepared by: _____ **Date:** September 06, 2016
Anderson Soungpanya

Reviewed by: _____ **Date:** September 06, 2016
Krishna K Vemuri

VERIFICATION OF COMPLIANCE
Report No. 102661298MPK-001

Verification is hereby issued to the named APPLICANT and is VALID ONLY for the equipment identified hereon for use under the rules and regulations listed below.

Equipment Under Test:	Low Frequency RFID Reader with CAN Bus Interface
Model No.:	ATR60LF Reader CAN Bus
Applicant:	Brooks Automation, Inc.
Contact:	Michael Krolak
Address:	Brooks Automation, Inc. 46702 Bayside Pkwy Fremont, CA 94538, USA
Country	USA
Tel. number:	(408) 770-1705
email:	michael.krolak@brooks.com
Applicable Regulation:	FCC Part 15, Subpart C (15.209) FCC Part 15, Subpart C (15.207) RSS-210 Issue 9 FCC Part 15, Subpart B Industry Canada ICES-003
Equipment Class:	Class A
Date of Test:	July 11 – August 15, 2016

We attest to the accuracy of this report:

Anderson Soungpanya
Project Engineer

Krishna K Vemuri
Engineering Team Lead

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EXECUTIVE SUMMARY

Test	Reference FCC	Reference IC	Result
Transmitter Radiated Emissions	15.209	RSS 210 (3.1)	Complies
AC Line Conducted Emission (Transmitting mode)	15.207	RSS GEN	Complies
Radiated Emission from Digital Part and Receiver	15.109	ICES 003	Complies
AC Line Conducted Emission (Charging mode)	15.107	ICES 003	Complies
Antenna Requirement	15.203	RSS GEN	Complies – EUT is professionally installed
Occupied Bandwidth	15.215(c)	RSS GEN	Complies

1.0 Job Description

The Equipment under Test (EUT) is the Low Frequency RFID Reader with CAN Bus Interface, model number: ATR60LF Reader CAN Bus.

1.1 Client Information

The EUT has been tested at the request of:

Company: Brooks Automation, Inc.
46702 Bayside Pkwy
Fremont, CA 94538, USA

Name of contact: Michael Krolak
Telephone: (408) 770-1705
Email: michael.krolak@brooks.com

1.2 Test Plan Reference

Tests were performed to the following standards:

- FCC Part 15, Subpart C (15.209)
- FCC Part 15, Subpart C (15.207)
- RSS-210 Issue 9
- FCC Part 15, Subpart B
- Industry Canada ICES – 003

1.3 Description of Equipment Under Test (EUT)

Description	Low Frequency RFID Reader with CAN Bus Interface
Model No.	ATR60LF Reader CAN Bus
FCC Identifier	N5GATR60LFCAN
Operating Frequency	Single frequency, 134.2 kHz
Number of Channels	1
Type of Modulation	FSK
Antenna Type	Inductive Coil

EUT receive date: July 11, 2016

EUT receive condition: The EUT was received in good condition with no apparent damage.

Test start date: July 11, 2016

Test completion date: August 15, 2016

The test results in this report pertain only to the item tested.

Brooks Automation, Inc. supplied the following description of the EUT:

The Equipment under Test (EUT) is the Low Frequency RFID Reader with CAN Bus Interface, model number: ATR60LF Reader CAN Bus.

1.4 Equipment Under Test

Ref No.	Description	Model Number	Serial Number
1	Low Frequency RFID Reader with CAN Bus Interface	ATR60LF Reader CAN Bus	23

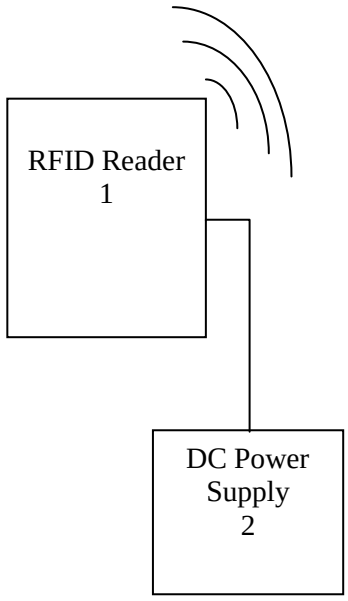
System Support Equipment

Ref No.	Description	Model Numbers	Serial Number
2	Extech DC Power Supply	382260	ITS 00486

1.5 Block Diagram of Test Setup

The diagrams showed below details the interconnection of the EUT and support equipment. For specific layout, refer to the test configuration photograph in the relevant section of this report.

Test Setup for Radiated Emissions Tests



S = Shielded **U** = Unshielded	**m** = Length in Meters

1.6 Justification

The EUT was configured for testing in a table-top configuration, as specified by Brooks Automation, Inc. The highest frequency used in the EUT is 400MHz; Radiated Emissions was tested up to 18GHz for FCC Part 15 Subpart B.

1.7 Mode(s) of Operation

EUT was continuously transmitting during the tests.

1.8 Modifications Required for Compliance

No modifications were made during compliance testing in order to bring the product into compliance.

2.0 Test Environment for Emissions Testing

2.1 Test Facility

The test facility is located at 1365 Adams Court, Menlo Park, California. The test site is a 10-meter semi-anechoic chamber. The site meets the characteristics of CISPR 16-1 and ANSI C63.4. For measurements, a remotely controlled flush-mount metal-top turntable is used to rotate the EUT a full 360 degrees. A remote controlled non-conductive antenna mast is used to scan the antenna height from one to four meters.

The A2LA certificate number for this site is 1755-01.
The Industry Canada (IC) Site Number is 2042L-1.

2.2 Test Equipment

Table 2-1 contains a list of the test equipment used during the testing.

Table 2-1 List of Test Equipment

Equipment	Manufacturer	Model/Type	Asset #	Cal Int	Cal Due
LISN	FCC	FCC-LISN-50-50-M-H	ITS 00551	12	06/09/17
Digital Multi Meter	Fluke	87V	ITS 01019	12	03/17/17
Spectrum Analyzer	Rohde and Schwarz	FSU	ITS 00913	12	01/05/17
Passive Loop Antenna	EMCO	6512	ITS 01598	12	09/10/16
BI-Log Antenna	Antenna Research	LPB-2513	ITS 00355	12	09/11/16
Pre-Amplifier	Sonoma Instrument	310	ITS 00942	12	01/07/17
EMI Receiver	Rohde and Schwarz	ESU	ITS 01375	12	12/11/16
Horn Antenna	ETS-Lindgren	3115	ITS 00982	12	12/16/16
Pre-Amplifier	Miteq	AMF-4D-001180-24-10P	ITS 00526	12	10/06/16

2.3 Example Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor. Then by subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF – PA + DCF

Where FS = Field Strength in dB (μV/m)
RA = Receiver Amplitude (including preamplifier) in dB (μV)
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB (1/m)
PA= Preamplifier Factor in dB
DCF = Distance Correction Factor dB (for measurements made at X meters when compared to Y meter limits, 40log(X/Y) for below 30MHz and 20log(X/Y) for above 30MHz)

Assume a receiver reading of 52.0 dB (μV) is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted and the Distance Correction Factor of 10.5 dB is added, giving field strength of 42.5 dB (μV/m).

RA = 52.0 dB (μV)
AF = 7.4 dB (1/m)
CF = 1.6 dB
PA = 29.0 dB
DCF = 10.5 dB
FS = RF + AF + CF – PA + DCF
FS = 52.0 + 7.4 + 1.6 – 29.0 + 10.5
FS = 42.5 dB (μV/m)

2.4 Measurement Uncertainty

Compliance of the product is based on the measured value. However, the measurement uncertainty is included for informational purposes.

Radiated Emission:
The uncertainty in the measured field strength is estimated as follows, for a minimum confidence probability of 95 %

Freq. Range	Detection Mode	Uncertainty
30 MHz to 1000 MHz	Quasi-peak	± 4.2 dB
1 GHz to 18 GHz	Average	± 5.1 dB

Conducted Emission:
The uncertainty in the measured voltage is estimated as follows, for a minimum confidence probability of 95 %

Freq. Range	Detection Mode	Uncertainty
150 kHz to 30 MHz	Average	± 2.6 dB
	Quasi-peak	± 2.6 dB

3.0 Emissions Test Results

3.1 Transmitter Radiated Emissions

FCC: 15.209
IC: RSS-GEN

3.1.1 Test Limits

Limits for Electromagnetic Radiated Disturbance, FCC Section 15.209(b) & RSS-GEN

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

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

*** Fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz.*

3.1.2 Test Procedure

Radiated emission measurements were performed from 9 kHz to 30 MHz with the Spectrum Analyzer Resolution Bandwidth 200 Hz. In the frequency range from 9 kHz to 30 MHz the Quasi-peak value of the Field Strength (FS) is measured. The measuring receiver meets the requirements of Section One of CISPR 16 and the measuring antenna correlates to a balanced dipole.

The EUT is placed on a plastic table that is 80 cm in height on top of a turntable. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables were manipulated to produce worst-case emissions. The signal is maximized through rotation. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

Radiated emission measurements were performed from 9 kHz to 1 GHz.
Analyzer resolution was:
9 kHz or greater for frequencies below 30 MHz
100 kHz or greater for frequencies 30 MHz to 1000 MHz

Below 30 MHz
Radiated emissions are taken at 10 meter for frequencies below 30MHz. An inverse proportionality factor of 40 dB per decade should be used to normalize the measured data to the specified distance for determining compliance.

Above 30 MHz
During the test the EUT is rotated and the measuring antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

Radiated emissions are taken at 10 meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. All readings are extrapolated back to the equivalent 30 meter reading using inverse scaling with distance.

Data is included of the worst-case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included.

Equipment was setup as “Transmission Mode.” See section 1.5 for setup details.

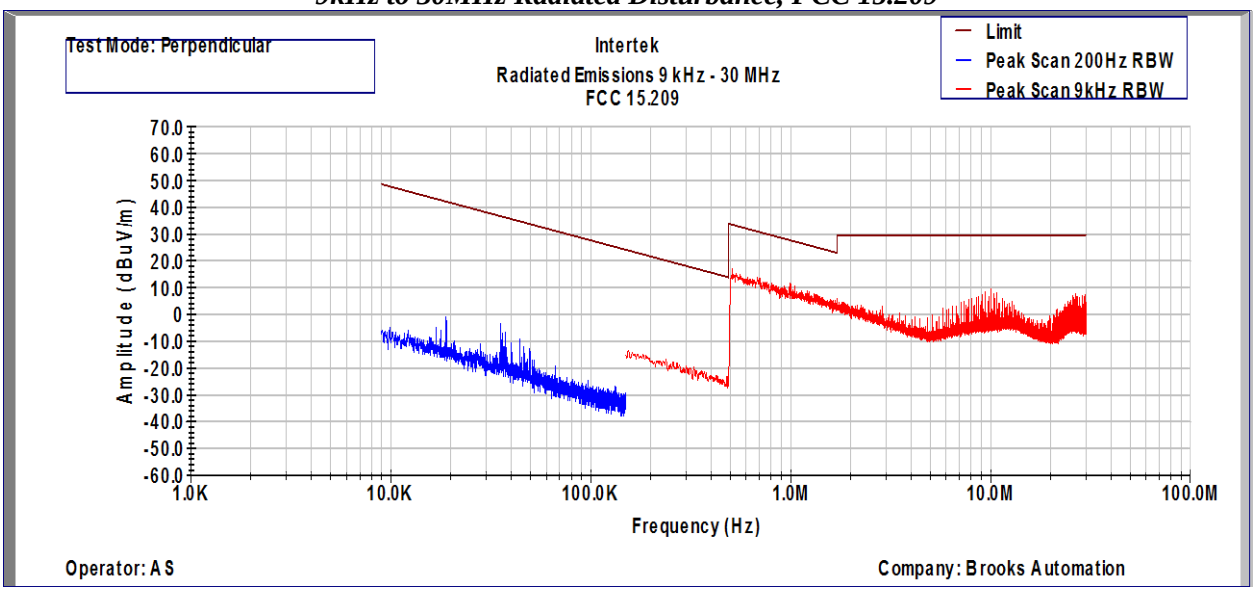
Equipment setup for radiated disturbance tests followed the guidelines of ANSI C63.4.

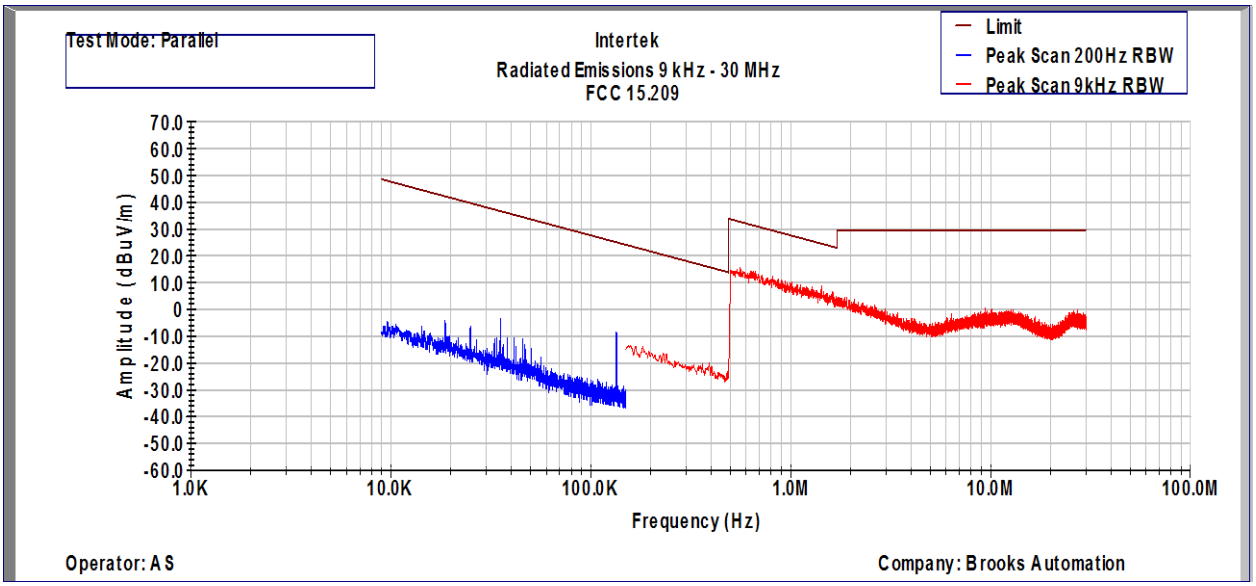
Tested By:	Anderson Soungpanya
Test Date:	July 13, 2016

3.1.3 Test Results

The EUT met the radiated disturbance requirements of FCC 15.209 for an Intentional Radiator.

9kHz to 30MHz Radiated Disturbance, FCC 15.209





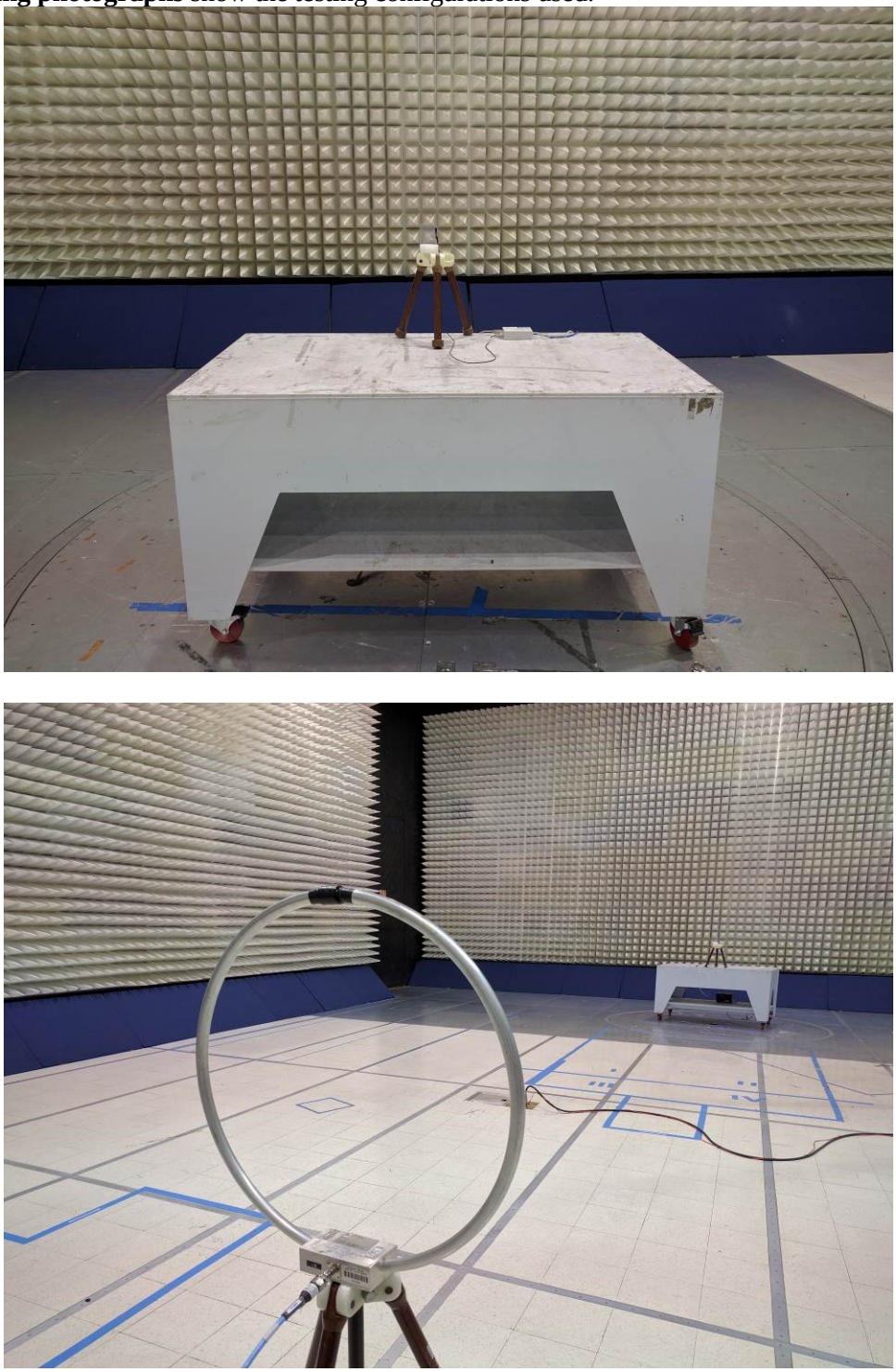
Frequency	QP Level	Limit @300m	Margin	Raw Value @10m	Cable	Amp Gain	Antenna Factor	DCF
(kHz)	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB	dB(1/m)	dB
134.2	-7.8	25	-32.8	19.3	0.8	32.2	63.4	-59.1

Note: Measurements made with antenna axis in Parallel and Perpendicular.

Result:	**Complies**

3.1.4 Test Configuration Photographs

The following photographs show the testing configurations used.



Electromagnetic Radiated Disturbance Setup Photograph

3.2 Radiated Emissions from Digital Parts

FCC: 15.109
IC: ICES-003

3.2.1 Test Limits

Limits for Electromagnetic Radiated Disturbance, FCC Section 15.109(b)

Frequency (MHz)	Class A at 10m dB(μV/m)	Class B at 3m dB(μV/m)
30-88	39.0	40.0
88-216	43.5	43.5
216-960	46.4	46.0
Above 960	49.5	54.0

Note: Three sets of units are commonly used for EMI measurement, decibels below one milliwatt (-dBm), decibels above a microvolt (dBμV), and microvolts (μV). To convert between them, use the following formulas: 20 LOG_{10} (μV) = dBμV, dBm = dBμV-107

Alternative limits per Section 15.109(g):

Radiated Emissions Limits, CISPR 22

Frequency (MHz)	Class A at 10m dB(μV/m)	Class B at 10m dB(μV/m)
30-230	40.0	30.0
230-1000	47.0	37.0

Note: The lower limit shall apply at the transition frequency.

3.2.2 Test Procedure

Measurements of the radiated field in the frequency range of 30 MHz to 1000 MHz are made with the antenna located at a distance of 10 meters from the EUT and measurements in the frequency range above 1000 MHz are made with the antenna located at a distance of 3 meters from the EUT. The measuring receiver meets the requirements of Section One of CISPR 16 and the measuring antenna correlates to a balanced dipole.

Measurements of the radiated field below 1000 MHz are made with the antenna located at a distance of 10 meters from the EUT. If the field-strength measurements at 10m cannot be made because of high ambient noise level or for other reasons, measurements of Class B equipment may be made at a closer distance, for example 3m. An inverse proportionality factor of 20 dB per decade should be used to normalize the measured data to the specified distance for determining compliance.

The antenna is adjusted between 1m and 4m in height above the ground plane for maximum meter reading at each test frequency.

The antenna-to-EUT azimuth is varied during the measurement to find the maximum field-strength readings.

The antenna-to-EUT polarization (horizontal and vertical) is varied during the measurements to find the maximum field-strength readings.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. The table is constructed of non-conductive materials.

Floor standing EUTs are placed on a horizontal metal ground plane and isolated from the ground plane by 3 to 12 mm of insulating material.

Equipment was setup as “Transmission Mode.” See section 1.5 for setup details.

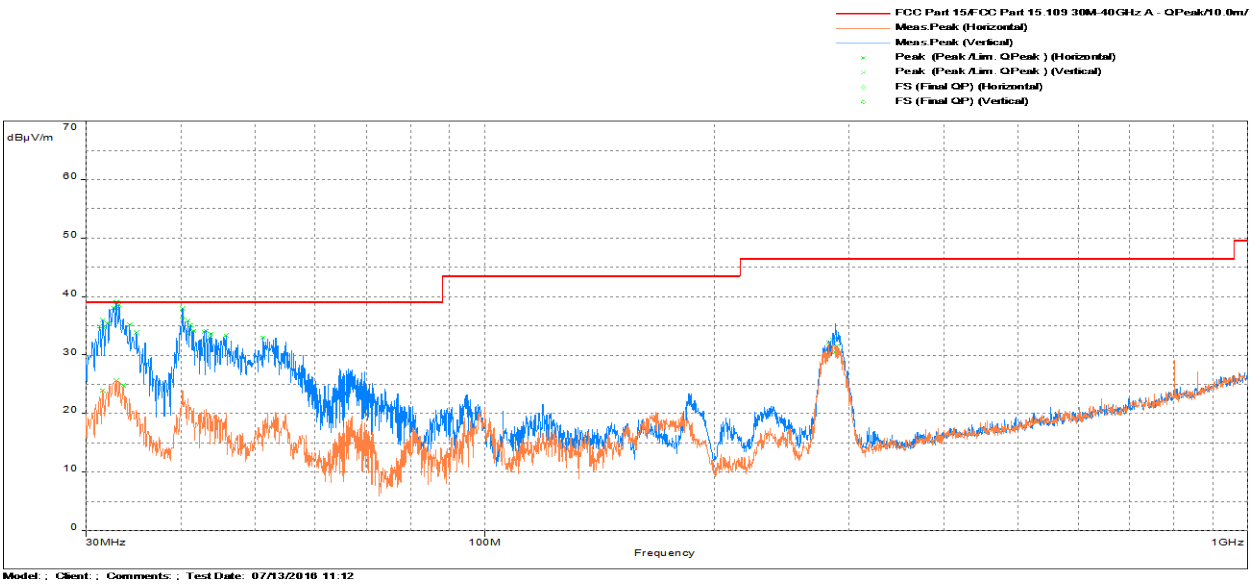
Equipment setup for radiated disturbance tests followed the guidelines of ANSI C63.4.

Tested By:	Anderson Soungpanya
Test Date:	July 13, 2016 & August 15, 2016

3.2.3 Test Results

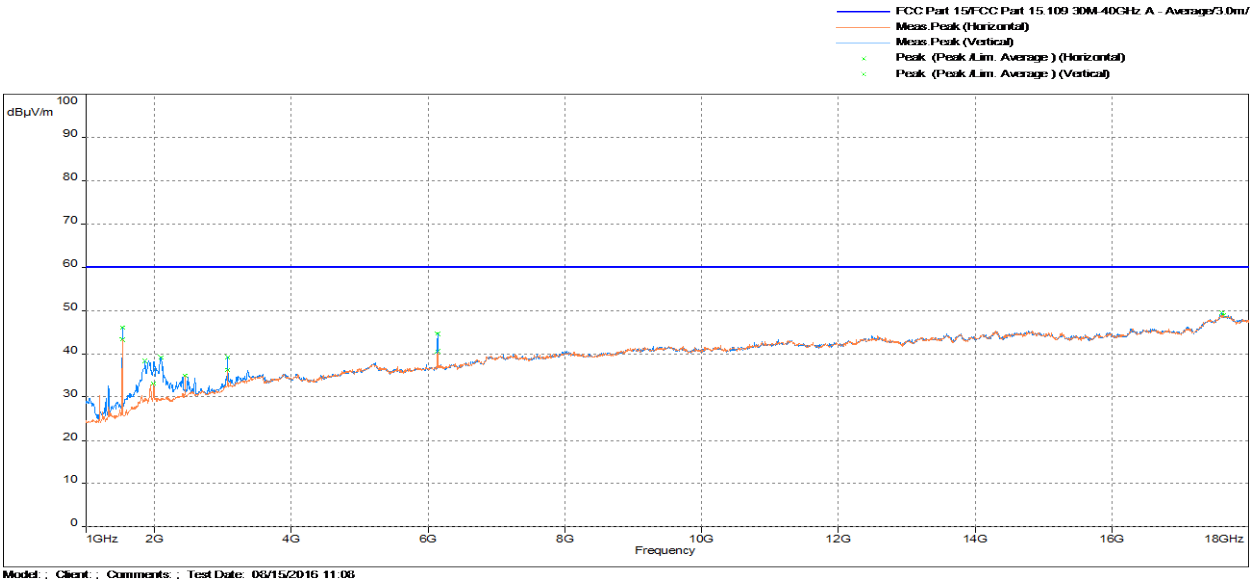
The EUT met the radiated disturbance requirements of FCC and ICES 003 for a Class A device.

30MHz to 1GHz Radiated Disturbance

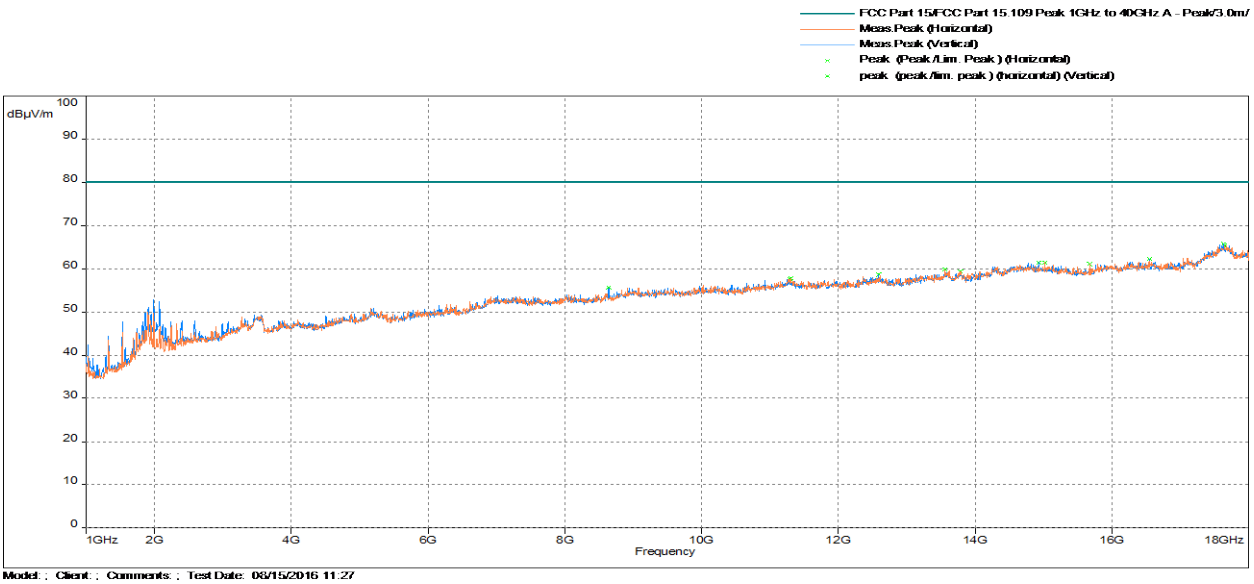


Frequency (MHz)	QP Level (dBµV/m)	Limit (dB(uV/m))	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBuV)	Correction (dB)
31.606	34.70	39.0	-4.30	300	1.00	Vertical	49.35	-14.65
32.958	38.00	39.0	-1.00	297	1.08	Vertical	52.76	-14.76
40.222	36.36	39.0	-2.64	315	1.83	Vertical	51.76	-15.41
40.894	33.76	39.0	-5.24	312	4.00	Vertical	49.25	-15.50
51.301	29.90	39.0	-9.10	9	3.07	Vertical	47.17	-17.29
286.268	30.58	46.4	-15.82	152	2.36	Horizontal	47.59	-17.00

1 to 18GHz Radiated Disturbance with Average Detector



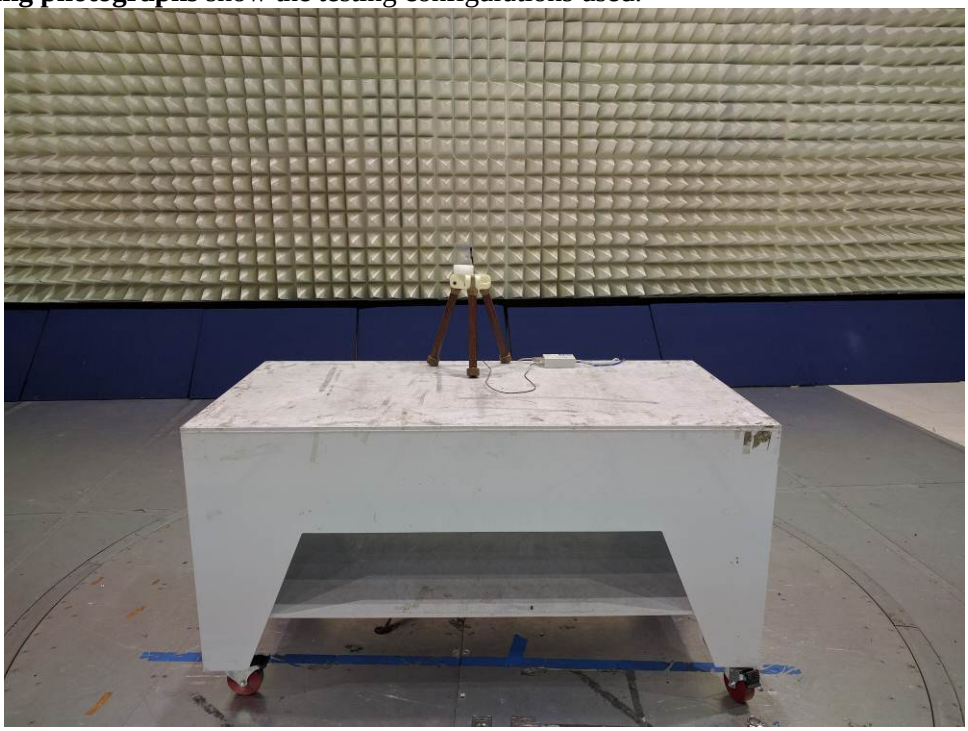
1 to 18GHz Radiated Disturbance with Peak Detector

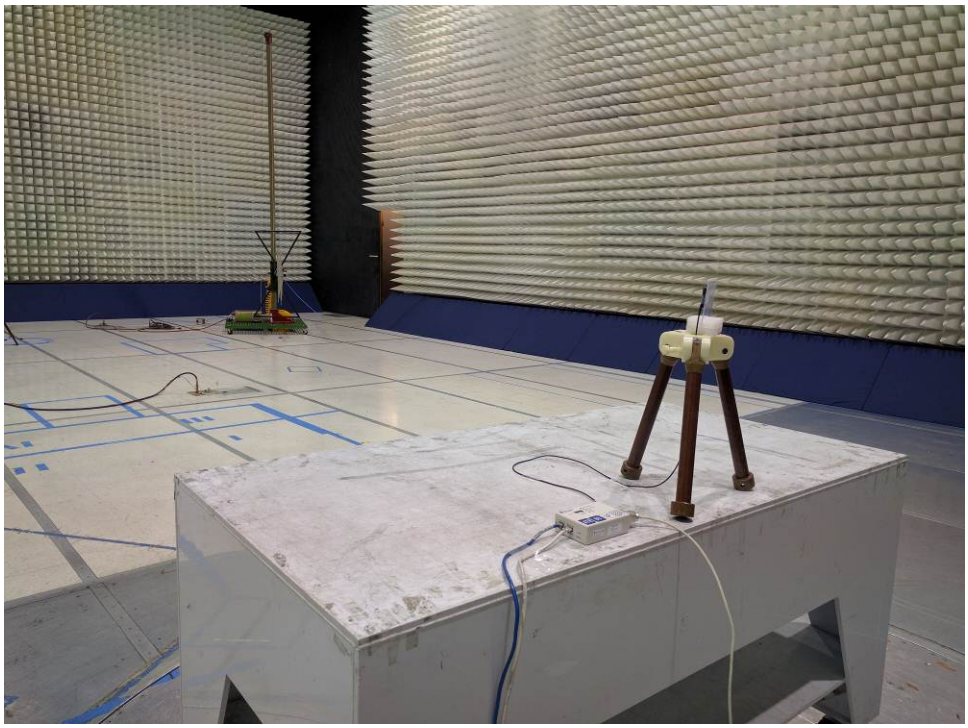


Result:	**Complies** by 1.0 dB

3.2.4 Test Configuration Photographs

The following photographs show the testing configurations used.

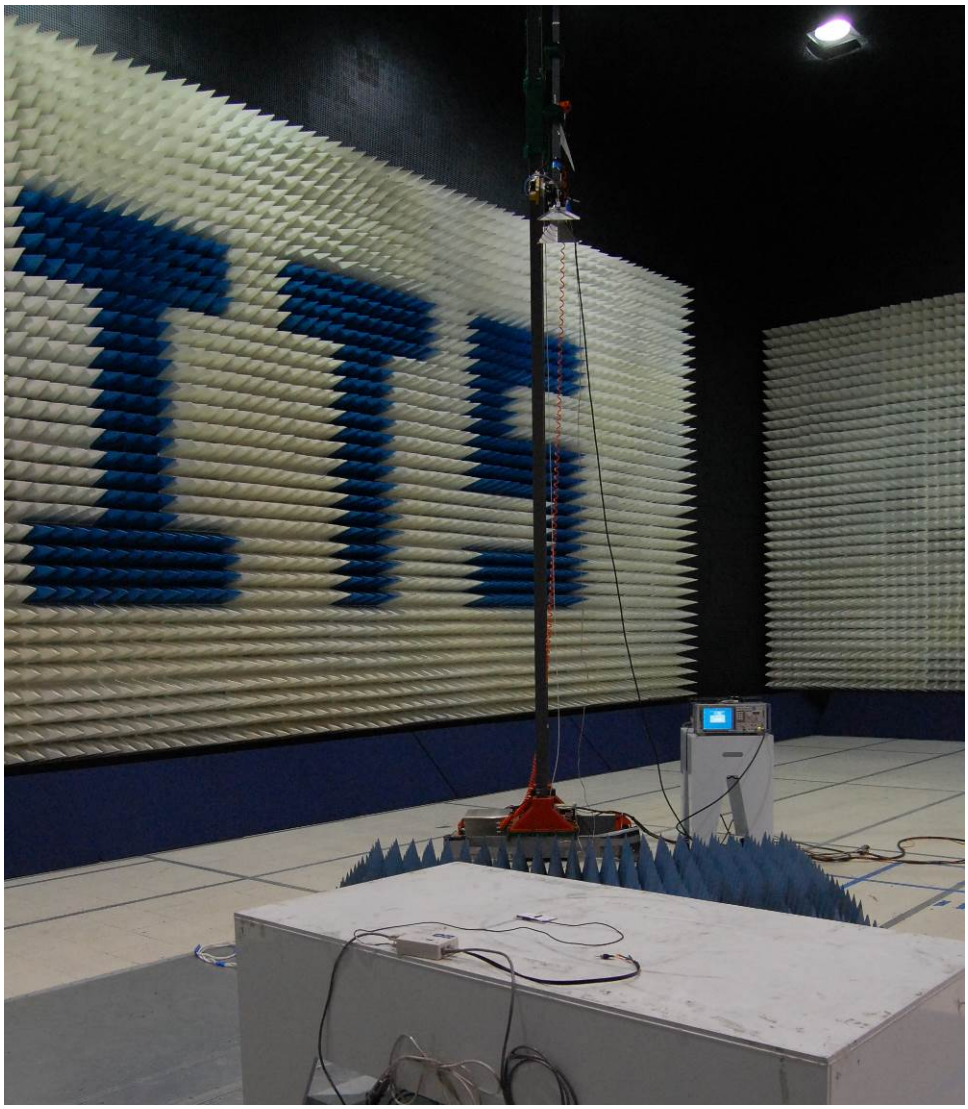




Electromagnetic Radiated Disturbance Setup Photograph

3.1.4 Test Configuration Photographs (continued)

The following photographs show the testing configurations used.



Electromagnetic Radiated Disturbance Setup Photograph

3.2 AC Mains Line-Conducted Disturbance

FCC: 15.107 & 15.207
IC: ICES-003

3.2.1 Test Limits

Limits for Electromagnetic Conducted Disturbance, FCC Section 15.207& 15.107

Frequency Band MHz	**Class B Limit dB (μV)**	
	Quasi-Peak	**Average**
0.15-0.50	66 to 56 Decreases linearly with the logarithm of the frequency	56 to 46 Decreases linearly with the logarithm of the frequency
0.50-5.00	56	46
5.00-30.00	60	50

Note: At the transition frequency the lower limit applies.

3.2.2 Test Procedure

Measurements are carried out using quasi-peak and average detector receivers in accordance with CISPR 16. An AMN is required to provide a defined impedance at high frequencies across the power feed at the point of measurement of terminal voltage and also to provide isolation of the circuit under test from the ambient noise on the power lines. An AMN as defined in CISPR 16 shall be used.

The EUT is located so that the distance between the boundary of the EUT and the closest surface of the AMN is 0.8m.

Where a flexible mains cord is provided by the manufacturer, this shall be 1m long or if in excess of 1m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4m in length.

The EUT is arranged and connected with cables terminated in accordance with the product specification.

Conducted disturbance is measured between the phase lead and the reference ground, and between the neutral lead and the reference ground. Both measured values are reported.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground plane not being part of the EUT. The table is constructed of non-conductive materials.

Floor standing EUTs are placed on a horizontal metal ground plane and isolated from the ground plane by 3 to 12 mm of insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

Equipment was setup as “Transmission Mode.” See section 1.5 for setup details.

Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.4.

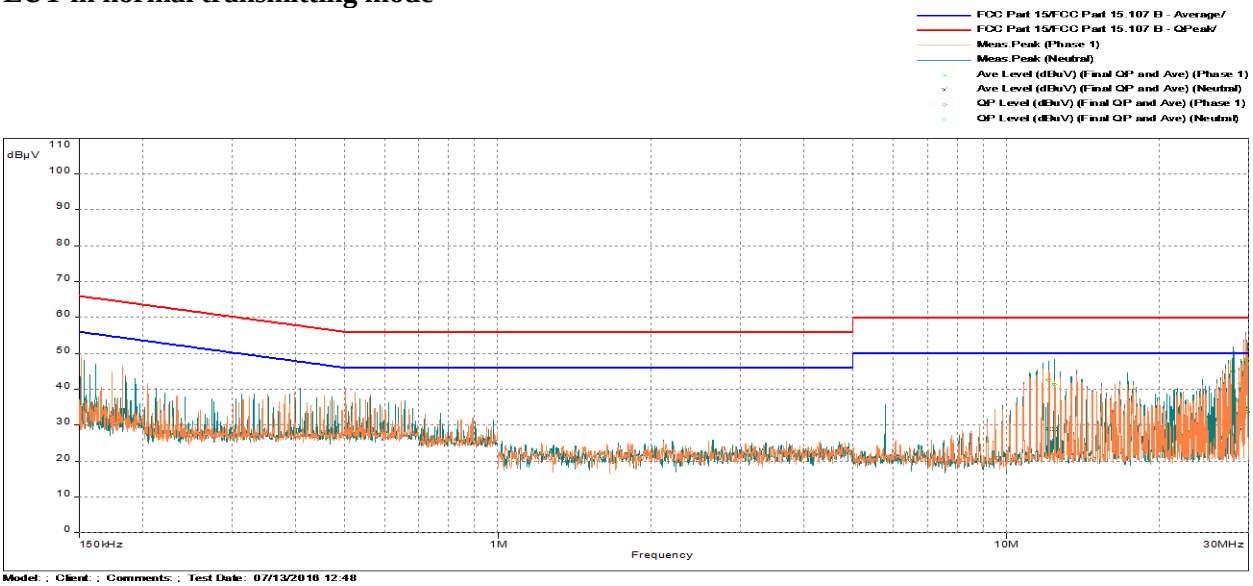
Date of Test:	July 13, 2016
Results	**Complies**

3.2.3 Test Results

The EUT met the conducted disturbance requirement of FCC and ICES 003 for a Class B device.

FCC and ICES 003 Conducted Disturbance at AC Mains

EUT in normal transmitting mode

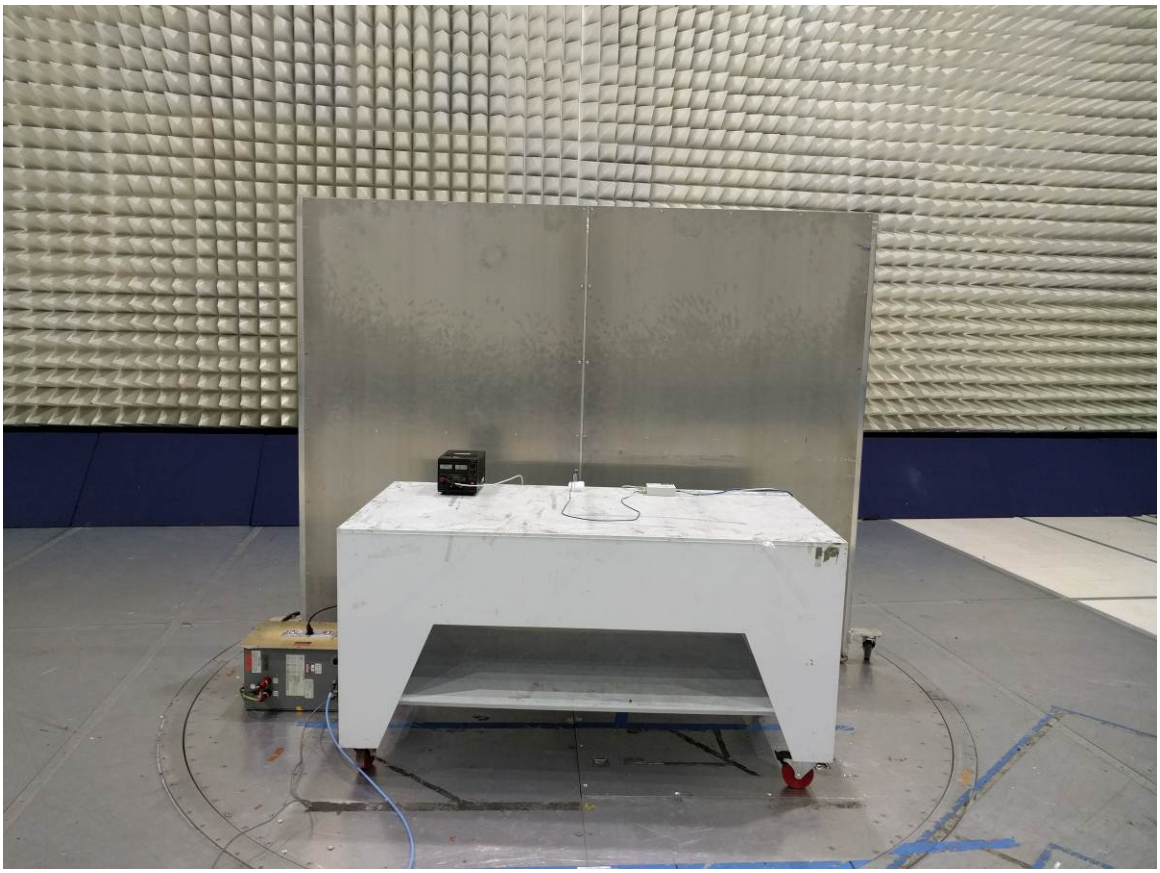


Frequency (MHz)	Ave Level (dBuV)	QP Level (dBuV)	Ave Limit (dBuV)	QP Limit (dBuV)	Ave Margin (dB)	QP Margin (dB)	Line	Correction (dB)
27.574	27.84	40.97	50	60	-22.16	-19.03	Phase 1	11.22
29.323	32.80	45.82	50	60	-17.20	-14.18	Phase 1	11.22
29.592	34.81	47.97	50	60	-15.19	-12.03	Phase 1	11.22
29.727	33.45	46.55	50	60	-16.55	-13.45	Phase 1	11.22
12.105	28.91	42.61	50	60	-21.09	-17.39	Neutral	11.15
12.432	28.87	41.42	50	60	-21.13	-18.58	Neutral	11.15
27.978	32.01	45.01	50	60	-17.99	-14.99	Neutral	11.22
28.920	28.79	41.59	50	60	-21.21	-18.41	Neutral	11.22
29.323	33.40	46.51	50	60	-16.60	-13.49	Neutral	11.22
29.592	35.03	48.22	50	60	-14.97	-11.78	Neutral	11.22
29.727	34.13	47.29	50	60	-15.87	-12.71	Neutral	11.22

Results	**Complies** by 11.78 dB

3.2.4 Test Configuration Photographs

The following photographs show the testing configurations used.



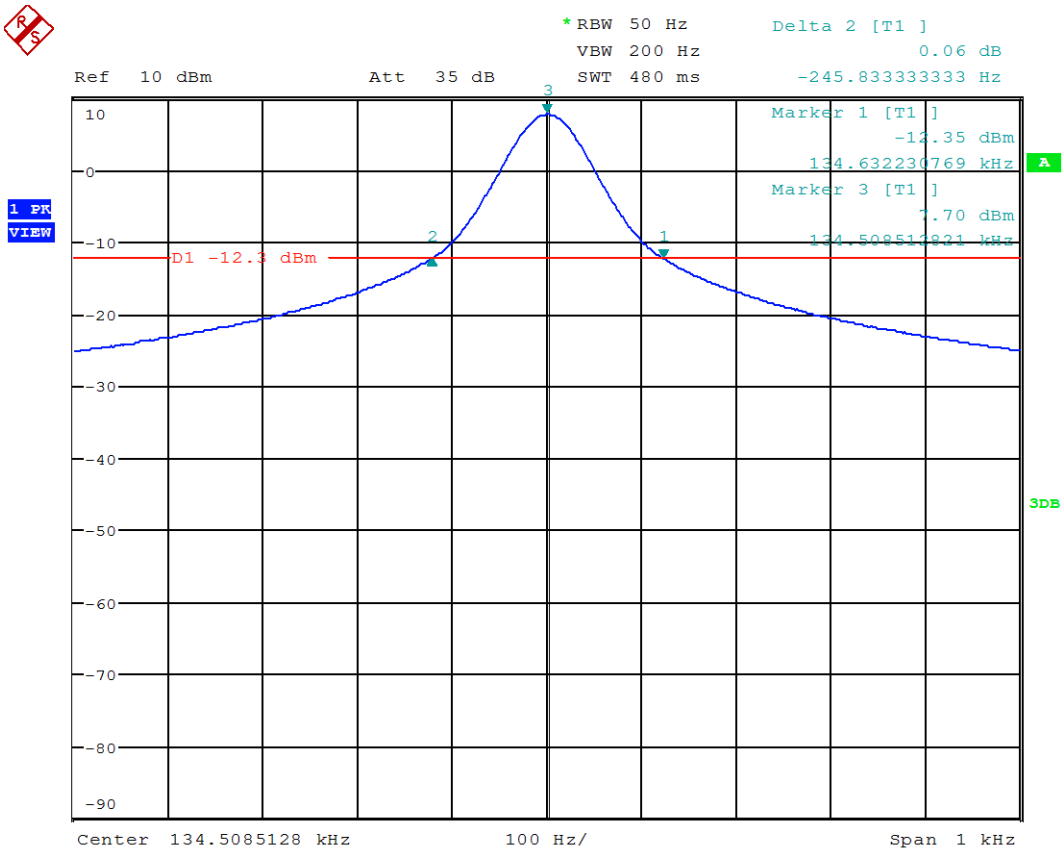
AC Mains Line-Conducted Disturbance Setup Photograph

3.3 Occupied Bandwidth

Equipment was setup as “Transmission Mode.” See section 1.5 for setup details.

Measurements were made with the loop antenna at 10 cm distance using a Spectrum Analyzer. The spectrum analyzer reading was plotted.

Plot 1, 20dB Bandwidth



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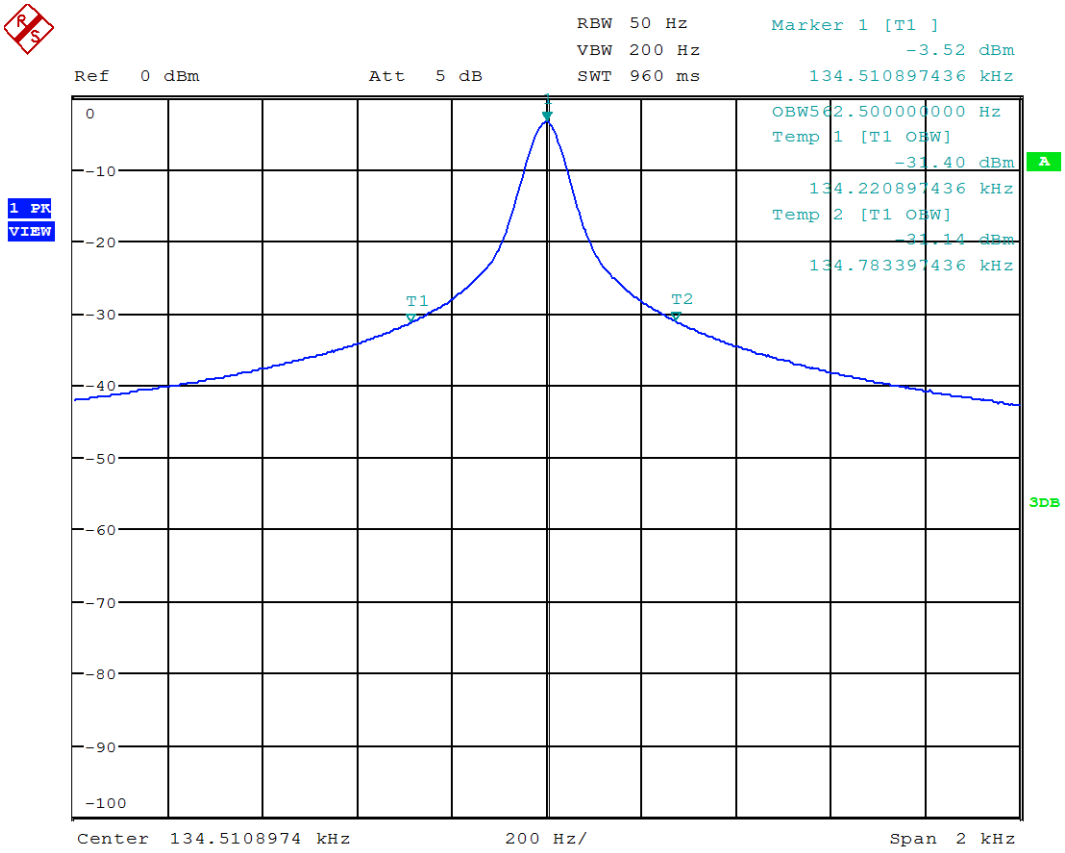
Plot 2, 99% Bandwidth



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4.0 Document History

Revision/ Job Number	Writer Initials	Reviewer Initials	Date	Change
1.0 / G102661298	AS	KV	September 06, 2016	Original document