TEST REPORT

Report Number: 103919786MPK-013
Project Number: G103919786
June 19, 2019

Testing performed on the
Inductive Pen
Model Number: INDPEN

to

FCC Part 15 Subpart C (15.223)
Industry Canada RSS-210 Issue 9

For

Earlens Corporation

Test Performed by:	Test Authorized by:
Intertek	Earlens Corporation
1365 Adams Court	4045 Campbell Avenue #A
Menlo Park, CA 94025 USA	Menlo Park, CA 94025 USA

Prepared by: _____ **Date:** June 19, 2019
Minh Ly

Reviewed by: _____ **Date:** June 19, 2019
Krishna Vemuri

Report No. 103919786MPK-013	
Equipment Under Test:	Inductive Pen
Trade Name:	Earlens Corporation
Model Number:	INDPEN
Applicant:	Earlens Corporation
Contact:	Patricia Ho
Address:	Earlens Corporation 4045 A Campbell Menlo Park, CA 94025
Country:	USA
Tel. Number:	(650) 739-4450
Email:	Patricia.Ho@Earlens.com
Applicable Regulation:	FCC Part 15 Subpart C (15.223) Industry Canada RSS-210 Issue 9
Date of Test:	June 6 – 12, 2019

We attest to the accuracy of this report:

Minh Ly	Hung Huynh	Krishna K Vemuri
Engineer	Engineer	Engineering Team Lead

TABLE OF CONTENTS

1.0 Summary of Tests

TEST	REFERENCE FCC 15.223	REFERENCE RSS-210	RESULTS
Field Strength of Fundamental	15.223(a)	B.3 (a)(b)	Complies
Radiated Emissions Outside the band	15.223 (b) 15.209	B.3 (c)	Complies
Line Conducted Emissions	15.207	RSS-GEN	Not Applicable[2]
Occupied Bandwidth	15.215	RSS-GEN	Complies
Antenna requirement	15.203	RSS-GEN	Complies[1]

[1] EUT utilizes an internal Antenna.
[2] EUT is battery operated.

2.0 General Description

2.1 Product Description

Earlens Corporation supplied the following description of the EUT:

The Earlens Inductive Pen is a portable, battery operated tool that features a low-inductive source. When the tip of the Inductive Pen is placed in the ear canal, the Inductive Pen emits an Inductive signal into the ear canal. The Earlens Inductive Pen is an optional tool that enables the patient to experience sound output from the Earlens after Lens placement and without use of the Processor or Ear Tip. The Inductive Pen is intended to be used by the physician or hearing professional.
For more information, refer to the following product specification, declared by the manufacturer.

Overview of the EUT

Model	INDPEN
Type of equipment	Inductive Pen
Operating frequency	Single frequency, 2.56 MHz
Number of Channel(s)	1
Type of Antenna	Internal Antenna
Applicant name & address	Earlens Corporation 4045 Campbell #A Menlo Park, CA 94025 USA

EUT receive date: June 6, 2019

EUT receive condition: The EUT was received in good condition with no apparent damage. As declared by the Applicant it is identical to the production units.

Test start date: June 6, 2019

Test completion date: June 12, 2019

2.2 Related Submittal(s) Grants

None

2.3 Test Methodology

Both AC mains line-conducted and radiated emissions measurements were performed according to the procedures in ANSI C63.4. Radiated tests were performed at an antenna to EUT distance of 10 meters, unless stated otherwise in this test report. All other measurements were made in accordance with the procedures in part 2 of CFR 47 7, ANSI C63.10: 2013 & RSS-GEN Issue 5.

2.4 Test Facility

The radiated emission test site and conducted measurement facility used to collect the data is 10m semi-anechoic chamber located in Menlo Park, California. This test facility and site measurement data have been fully placed on file with the FCC and Industry Canada (Site # 2042L-1).

2.5 Measurement Uncertainty

Compliance with the limits was based on the results of the measurements and doesn't take into account the measurement uncertainty.

Estimated Measurement Uncertainty

Measurement	Expanded Uncertainty (k=2)		
	0.15 MHz – 1 GHz	1 GHz – 2.5 GHz	> 2.5 GHz
RF Power and Power Density – antenna conducted	-	0.7 dB	-
Unwanted emissions - antenna conducted	1.1 dB	1.3 dB	1.9 dB
Bandwidth – antenna conducted	-	30 Hz	-

Measurement	Expanded Uncertainty (k=2)		
	0.15 MHz – 30MHz	30 MHz – 1 GHz	1 GHz – 18 GHz
Radiated emissions	-	4.7	5.1 dB
AC mains conducted emissions	2.1 dB	-	-

3.0 System Test Configuration

3.1 Support Equipment and description

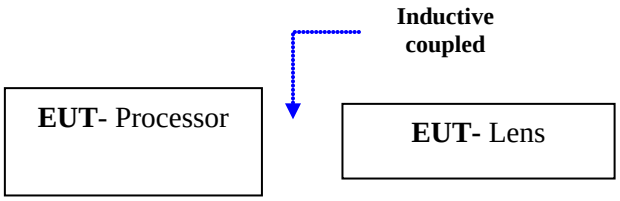
Support Equipment		
Description	**Manufacturer**	**Part Number**
Elastomeric Tympanic Lens Assembly	Earlens	AS00712

3.2 Block Diagram of Test Setup

Equipment Under Test			
Description	**Manufacturer**	**Model Number**	**Serial Number**
Inductive Pen (normal)	Earlens Corporation	INDPEN	157747-503
Inductive Pen (Rx)	Earlens Corporation	INDPEN	157747-688N

3.2 Block Diagram of Test Setup (Continued)

The diagram shown 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.



S = Shielded **U** = Unshielded	**F** = With Ferrite **m** = Length in Meters

3.3 Justification

The EUT was configured to continuously transmit.

All testing performed in this report was for the 2.56 MHz radio only.

For radiated emission measurements the EUT is placed on a non-conductive table.

3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was provided by Earlens Corporation.

3.5 Mode of Operation during test

Test mode: EUT was continuously transmitting.

3.6 Modifications required for Compliance

No Modifications were made e to bring the EUT into compliance.

3.7 Additions, deviations and exclusions from standards

No additions, deviations or exclusion have been made from standard.

4.0 Measurement Results

4.1 Field Strength of Fundamental and Radiated Emissions Outside the band

4.1.1 Requirements

§15.223 Operation in the band 1.705-10 MHz.

(a) The field strength of any emission within the band 1.705-10.0 MHz shall not exceed 100 microvolts/meter at a distance of 30 meters. However, if the bandwidth of the emission is less than 10% of the center frequency, the field strength shall not exceed 15 microvolts/meter or (the bandwidth of the device in kHz) divided by (the center frequency of the device in MHz) microvolts/meter at a distance of 30 meters, whichever is the higher level. For the purposes of this section, bandwidth is determined at the points 6 dB down from the modulated carrier. The emission limits in this paragraph are based on measurement instrumentation employing an average detector. The provisions in §15.35(b) for limiting peak emissions apply.

(b) The field strength of emissions outside of the band 1.705-10.0 MHz shall not exceed the general radiated emission limits in §15.209.

§15.209 Radiated emission limits; general requirements.

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

4.1.2 Procedure

Radiated Measurements Below 30 MHz

During the test the EUT is rotated and the measuring antenna angles are varied during the search for maximum signal level.

Radiated emissions are taken at ten 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. Measurements for below 30 MHz were performed at 10 meters. Data results below are corrected for distance at 10m. Limits were normalized to 10 meters.

Radiated Measurements 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 ten 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. Measurements for above 30 MHz were made at 10 meters.

Radiated emission measurements were performed from 9kHz to 1 GHz.
Analyzer resolution is:

200Hz or greater for 9kHz to 150kHz
9 kHz or greater for 150kHz to 30 MHz
120 kHz or greater for 30MHz to 1000 MHz
For those frequencies quasi-peak detector applies

Data includes 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.

Field Strength Calculation

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

FS = RA + AF + CF – AG – 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)
AG = Amplifier Gain in dB
DCF = Distance Correction Factor

Note: FS was measured with loop antenna below 30MHz

4.1.3 Test Results

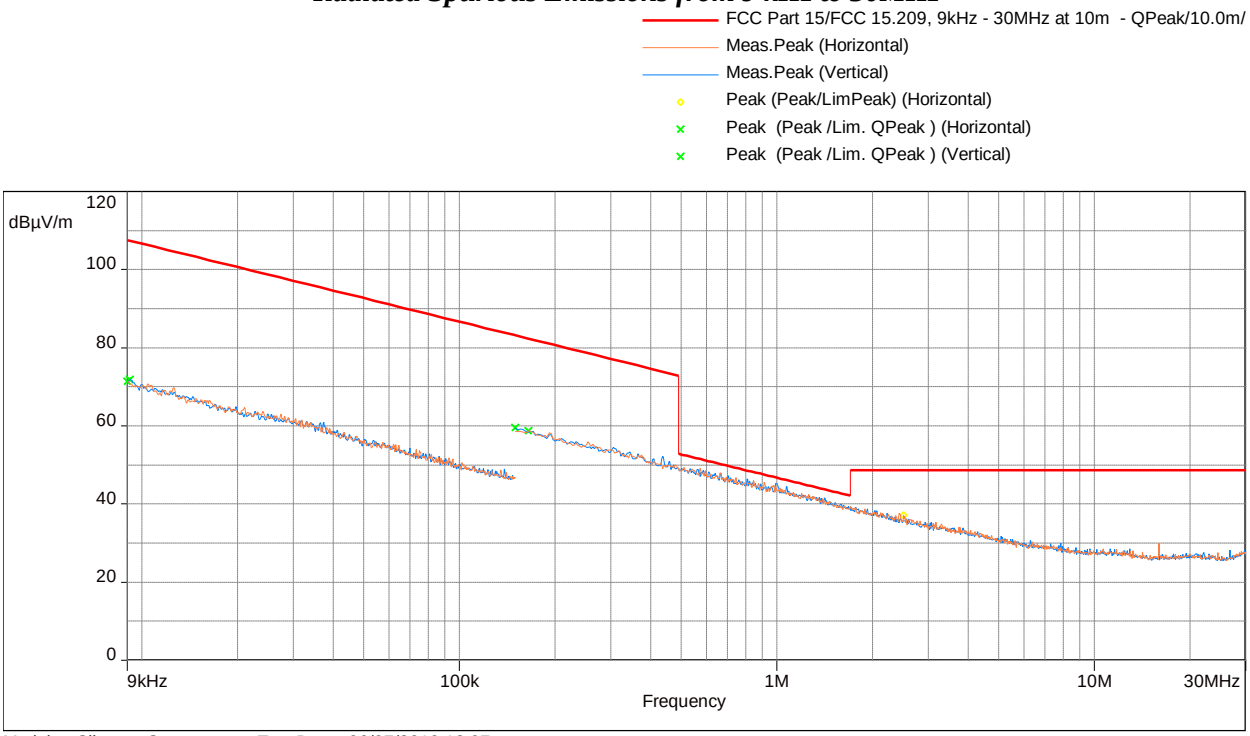
EUT Orientation	Frequency	Corrected Peak FS @10m	Limit @10m	Margin	RA@10m	Correction
Axis	(MHz)	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB
X	2.56	34.7	42.6	-7.9	20.22	14.48
Y	2.56	35.6	42.6	-7.0	21.12	14.48
Z	2.56	34.7	42.6	-7.9	20.22	14.48

Note: Correction = AF+CF–AG

4.1.3 Test Result (Continued)

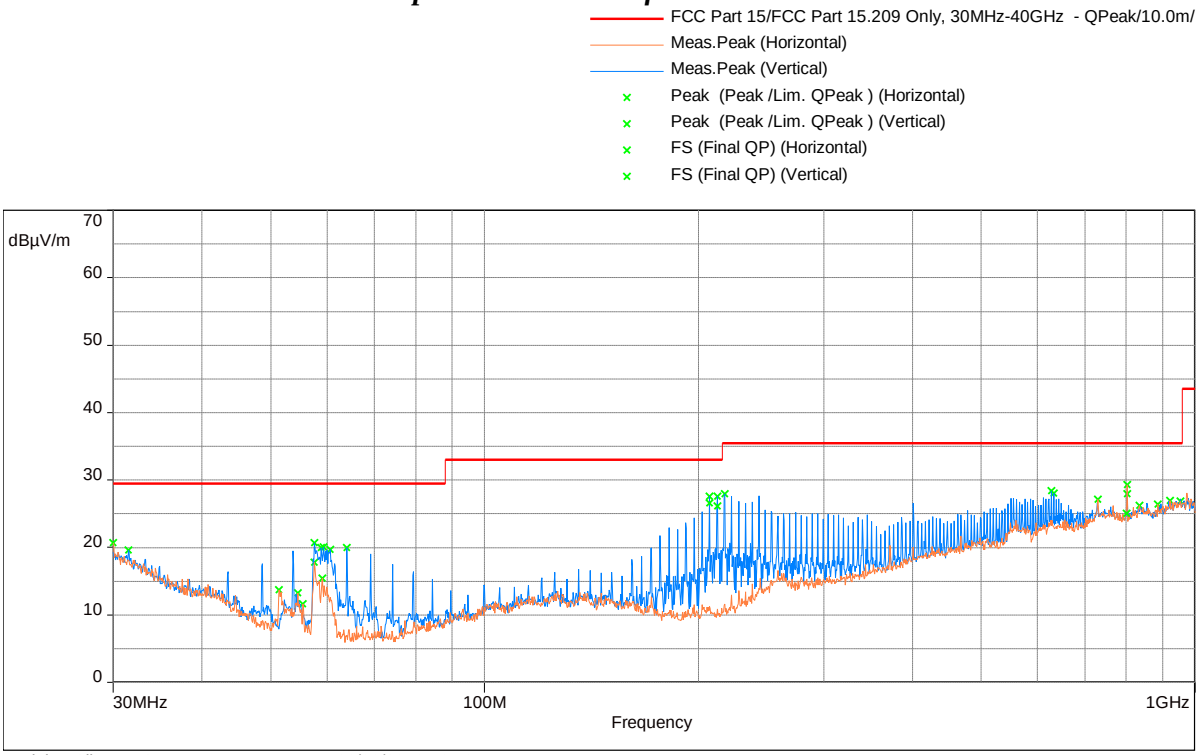
EUT in X-Axis

Radiated Spurious Emissions from 9 kHz to 30MHz



Model: ; Client: ; Comments: ; Test Date: 06/07/2019 18:07

Radiated Spurious Emissions from 30 MHz to 1000 MHz



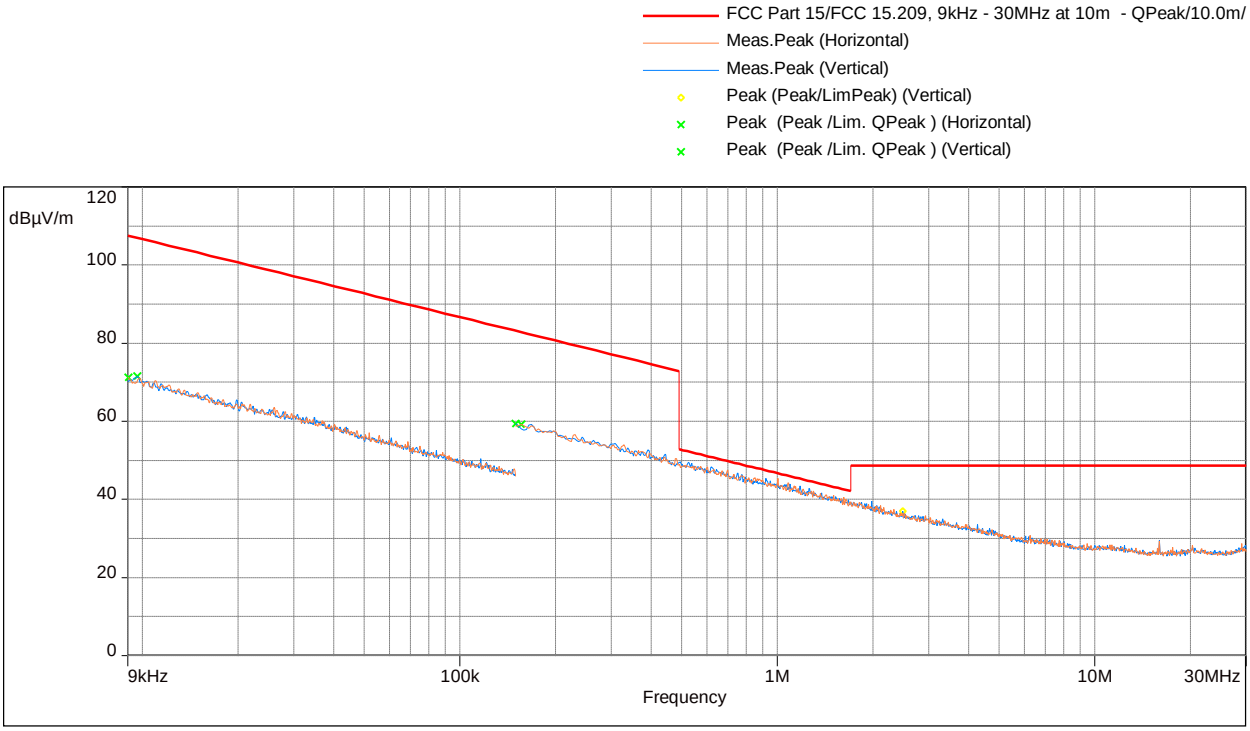
Model: ; Client: ; Comments: ; Test Date: 06/06/2019 16:46

Freq (MHz)	FS (dB(uV/m))	Limit (dB(uV/m))	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBuV)	Correction (dB)
207.348	27.5	33.0	-5.5	272.8	1.0	Vertical	42.5	-14.9
212.457	27.5	33.0	-5.5	272.8	1.0	Vertical	42.7	-15.2
217.598	27.9	35.5	-7.6	272.8	1.0	Vertical	42.9	-15.0
627.197	28.4	35.5	-7.1	100.8	2.0	Vertical	30.6	-2.2
632.305	28.0	35.5	-7.5	346.5	2.0	Vertical	30.2	-2.2
801.829	27.9	35.5	-7.6	33.0	2.0	Vertical	28.7	-0.7

4.1.3 Test Result (Continued)

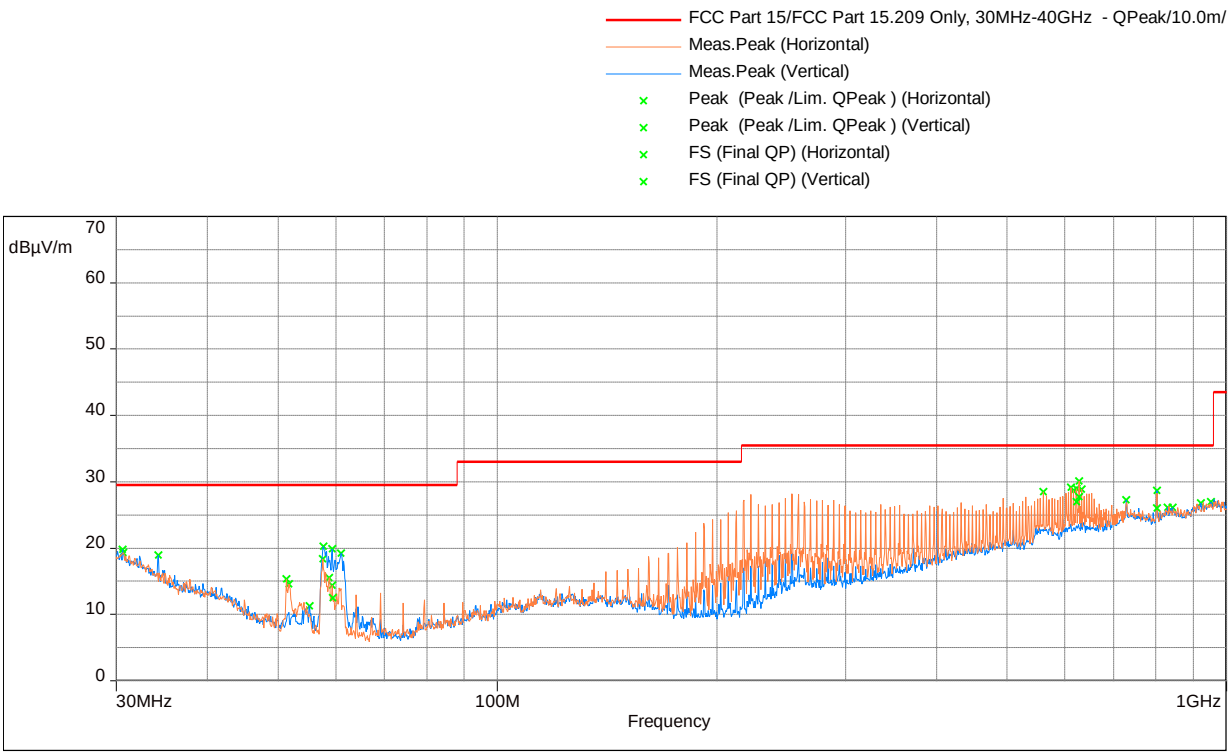
EUT in Y-Axis

Radiated Spurious Emissions from 9 kHz to 30MHz



Model: ; Client: ; Comments: ; Test Date: 06/07/2019 18:24

Radiated Spurious Emissions from 30 MHz to 1000 MHz



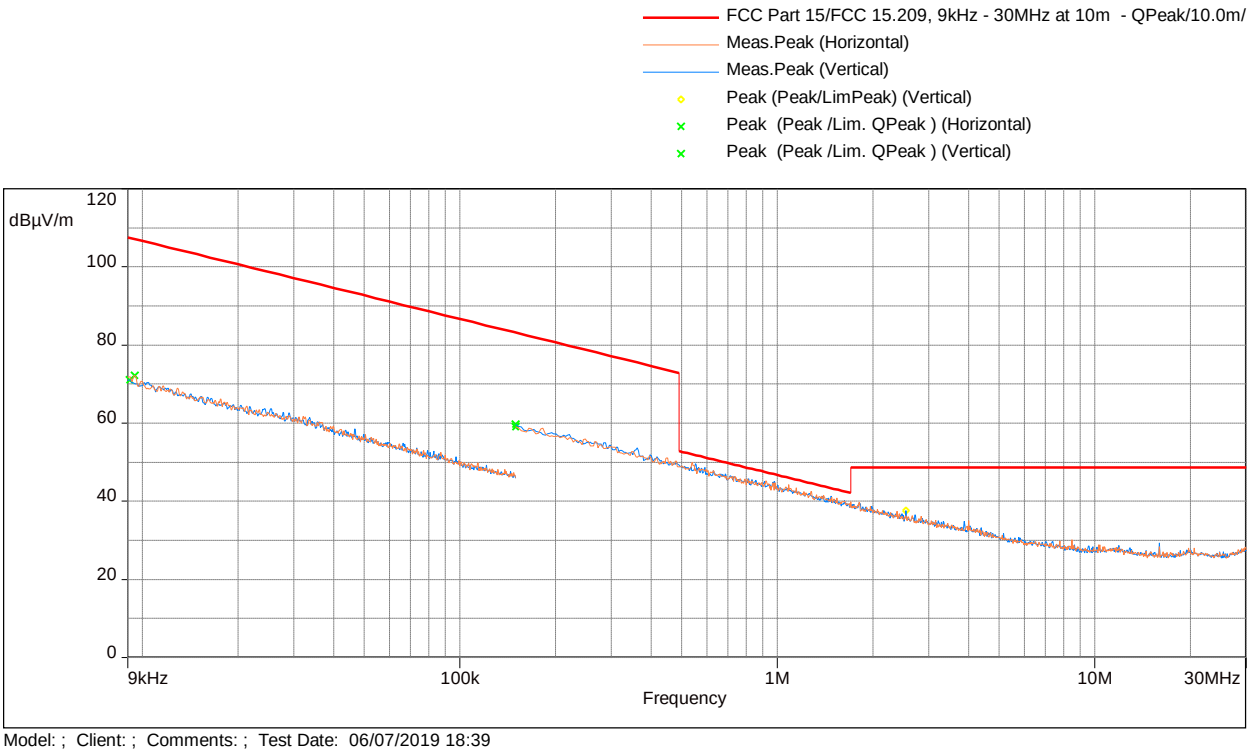
Model: ; Client: ; Comments: ; Test Date: 06/06/2019 17:27

Freq (MHz)	FS (dB(uV/m))	Limit (dB(uV/m))	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBuV)	Correction (dB)
560.655	28.5	35.5	-7.0	349.8	1.0	Horizontal	31.0	-2.5
611.838	29.1	35.5	-6.4	168.0	4.0	Horizontal	31.6	-2.5
616.979	28.7	35.5	-6.9	350.8	4.0	Horizontal	31.1	-2.5
622.088	29.0	35.5	-6.6	196.3	1.0	Horizontal	31.3	-2.4
627.197	30.1	35.5	-5.4	196.3	1.0	Horizontal	32.3	-2.2
632.338	28.9	35.5	-6.7	200.5	1.0	Horizontal	31.0	-2.2

4.1.3 Test Result (Continued)

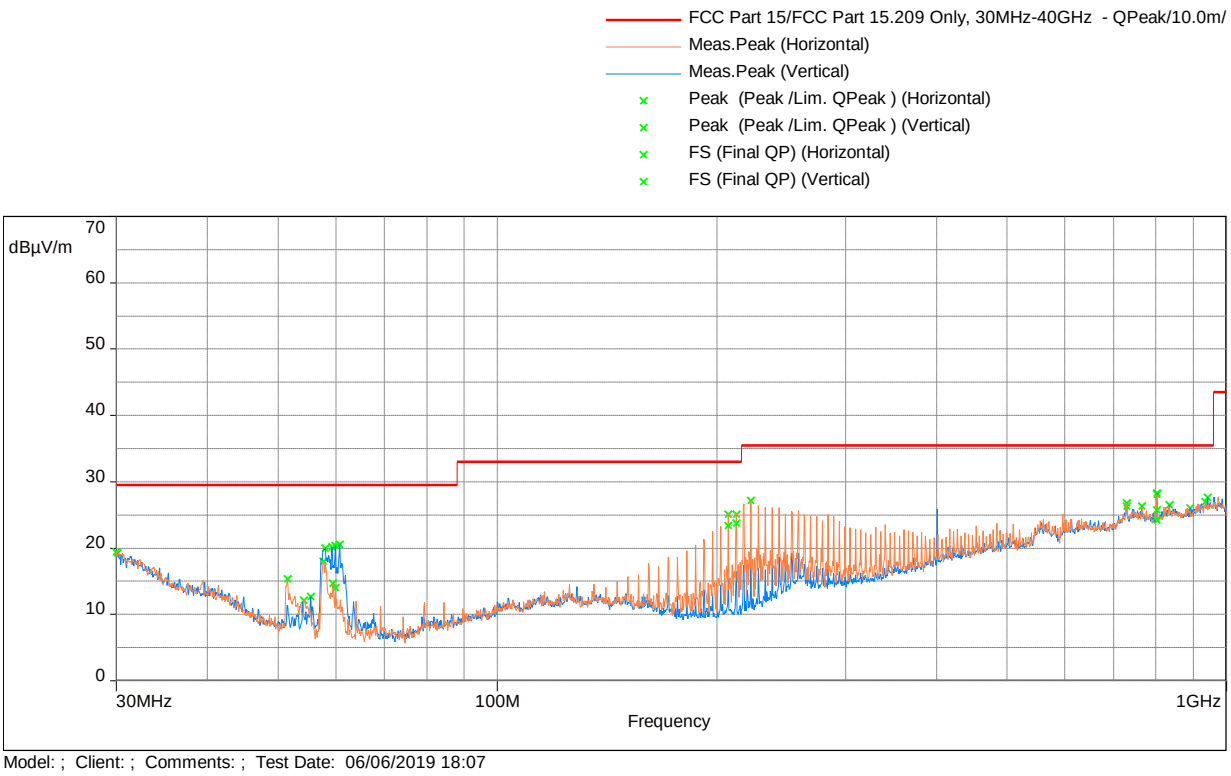
EUT in Z-Axis

Radiated Spurious Emissions from 9 kHz to 30MHz



Model: ; Client: ; Comments: ; Test Date: 06/07/2019 18:39

Radiated Spurious Emissions from 30 MHz to 1000 MHz

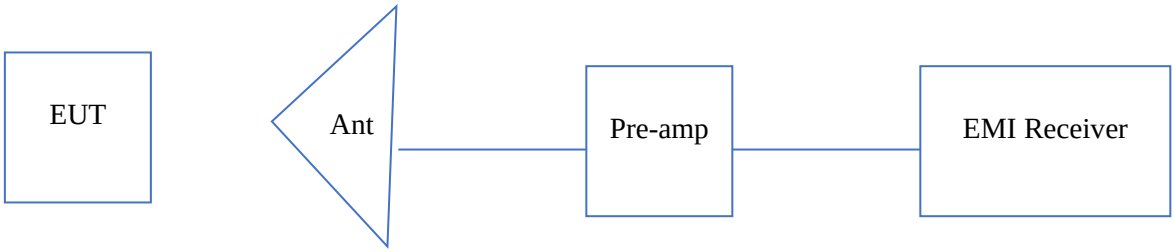


Model: ; Client: ; Comments: ; Test Date: 06/06/2019 18:07

Freq (MHz)	FS (dB(uV/m))	Limit (dB(uV/m))	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBuV)	Correction (dB)
207.348	25.1	33.0	-7.9	14.0	4.0	Horizontal	40.0	-14.9
212.457	25.1	33.0	-7.9	19.0	4.0	Horizontal	40.3	-15.2
222.707	27.1	35.5	-8.4	4.8	3.0	Horizontal	41.5	-14.4
729.014	26.7	35.5	-8.8	176.3	3.0	Horizontal	27.3	-0.6
801.829	28.1	35.5	-7.4	206.3	3.0	Horizontal	28.9	-0.7
935.495	27.0	35.5	-8.5	288.5	4.0	Horizontal	25.0	2.0

4.1.4 Test Configuration Photographs

The following photographs show the testing configurations used.



4.2 Occupied Bandwidth

FCC 15.215 &15.223

4.2.1 Requirements

§15.223 Operation in the band 1.705-10 MHz.

(a) The field strength of any emission within the band 1.705-10.0 MHz shall not exceed 100 microvolts/meter at a distance of 30 meters. However, if the bandwidth of the emission is less than 10% of the center frequency, the field strength shall not exceed 15 microvolts/meter or (the bandwidth of the device in kHz) divided by (the center frequency of the device in MHz) microvolts/meter at a distance of 30 meters, whichever is the higher level. For the purposes of this section, bandwidth is determined at the points 6 dB down from the modulated carrier. The emission limits in this paragraph are based on measurement instrumentation employing an average detector. The provisions in §15.35(b) for limiting peak emissions apply.

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage.

4.2.2 Procedure

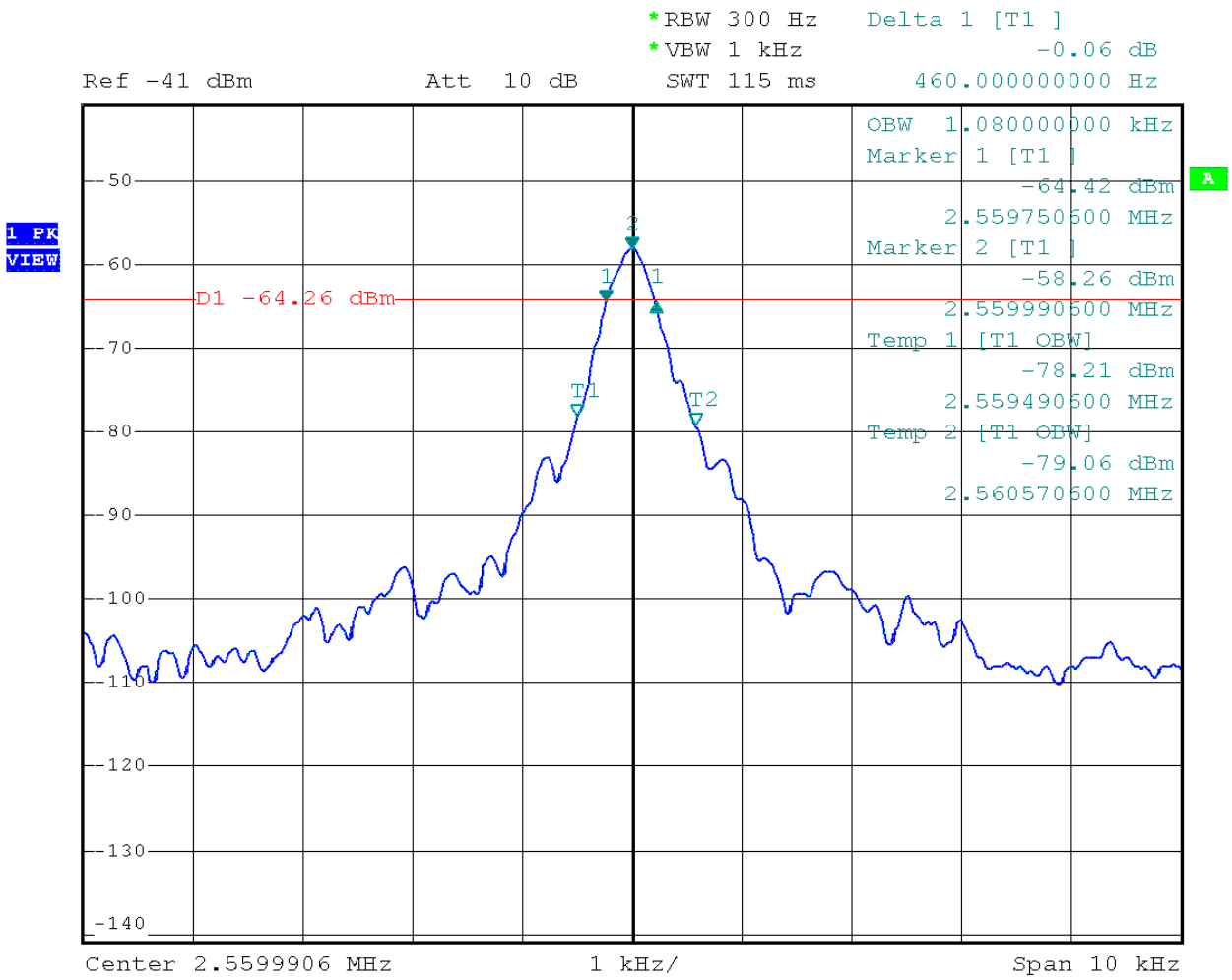
The EUT was setup to transmit in normal operating condition.

Measurements were made with the loop antenna in close proximity of the EUT. Following the procedures of ANSI 63.10, the 20dB, 6dB & 99% bandwidth measurements were taken. The following plots show Occupied Bandwidth.

4.2.3 Test Results

Frequency (MHz)	6-dB Channel Bandwidth (kHz)	20-dB Channel Bandwidth (kHz)	99% Channel Bandwidth (kHz)
2.56	0.460	1.120	1.080

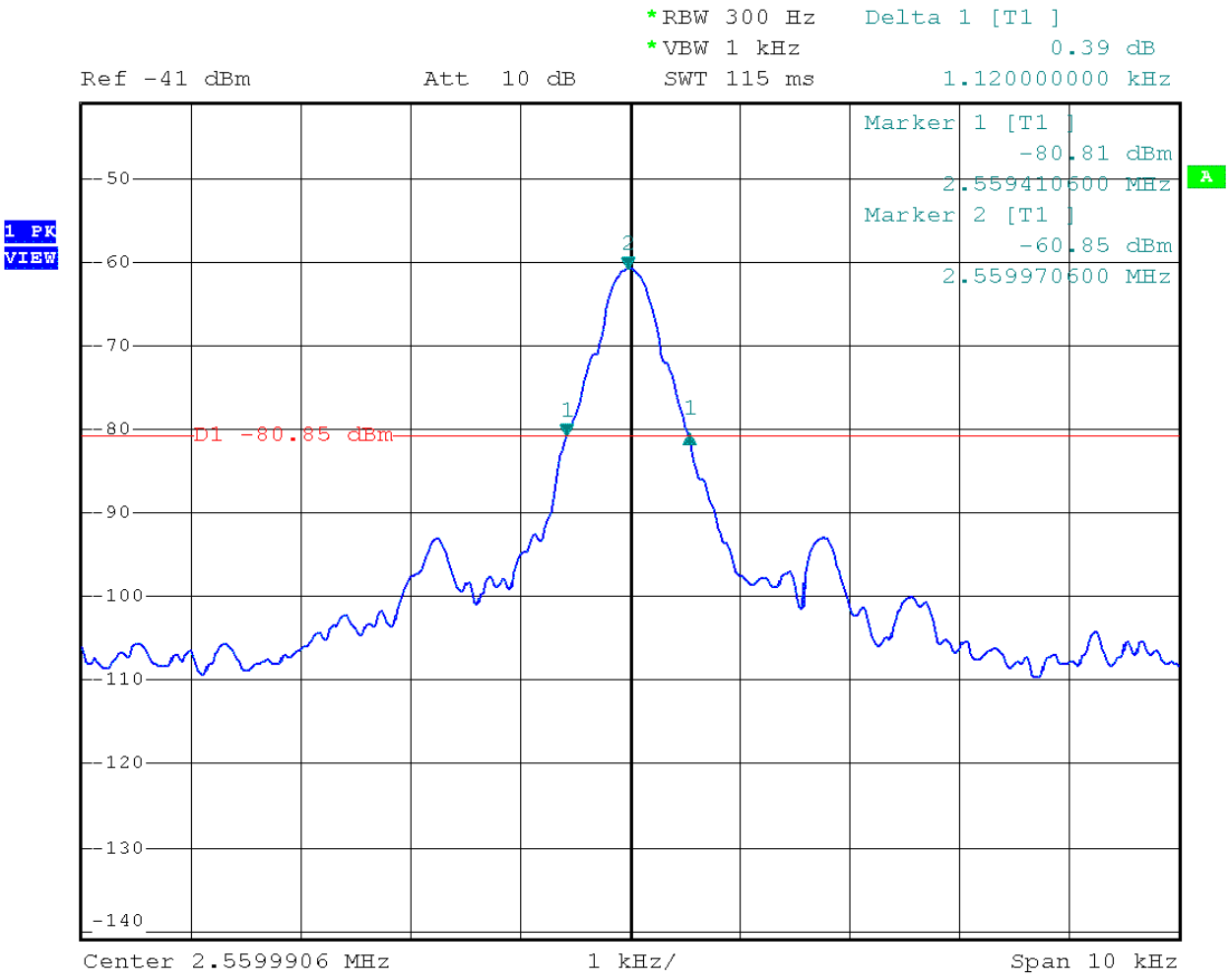
6-dB Channel Bandwidth



Date: 11.JUN.2019 20:26:25

4.2.3 Test Results (Continued)

20-dB Channel Bandwidth



Date: 11.JUN.2019 20:28:51

4.3 AC Line Conducted Emission
FCC Rule 15.207

4.3.1 Requirement

Frequency Band MHz	15.207 Limit dB(µV)	
	Quasi-Peak	Average
0.15-0.50	66 to 56 *	56 to 46 *
0.50-5.00	56	46
5.00-30.00	60	50

*Note: *Decreases linearly with the logarithm of the frequency. At the transition frequency the lower limit applies.*

4.3.2 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. Its dimensions are 1m by 1.5m, but may be extended for larger EUT.

Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an 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.

EUT was placed in transmission mode then tested for conducted emissions per 15.207 to ensure the device complies with 15.207 outside the transmitter fundamental emissions band. After, the EUT antenna is removed from the EUT and only the fundamental emission band was measured to show that the fundamental emission band is in compliance with the 15.207 limits.

4.3.3 Test Result

Not Applicable, EUT is Battery Powered

5.0 List of test equipment

Measurement equipment used for emission compliance testing utilized the equipment on the following list:

Equipment	Manufacturer	Model/Type	Asset No.	Calibration Interval	Cal Due
Bi-Log Antenna	Teseq	CBL 6111D	ITS 01058	12	09/20/19
Pre-Amplifier	Sonoma Instrument	310N	ITS 01493	12	02/27/20
EMI Receiver	Rohde and Schwarz	ESU40	ITS 00961	12	10/26/19
EMI Receiver	Rohde and Schwarz	ESR7	ITS 01607	12	10/23/19
RF Cable	Megaphase	EMC1-K1K1-236	ITS 01538	12	06/25/19
RF Cable	TRU Corporation	TRU CORE 300	ITS 00465	12	08/16/19
RF Cable	TRU Corporation	TRU CORE 300	ITS 01470	12	08/16/19
Loop Sensor	Solar Electronics	7334-1	ITS 01608	12	10/09/19
Ant-Passive Loop	Com-Power	AL-130R	ITS 01589	12	10/09/19

Software used for emission compliance testing utilized the following:

Name	Manufacturer	Version	Template/Profile
BAT-EMC	Nexio	3.17.0.10	Earlens 3-6-2019.bpp

6.0 Document History

Revision/ Job Number	Writer Initials	Reviewer Initials	Date	Change
1.0 / G103919786	ML	KV	June 19, 2019	Original document

END OF REPORT