# RF TEST REPORT



Report No.: FCC IC\_SL16101001-SFE-020-DTS\_Rev1.0 Supersede Report No.: FCC IC\_SL16101001-SFE-020-DTS

Applicant	:	Lighthouse AI, Inc	
Product Name	:	Lighthouse	
Model No.	:	A1	
Test Standard		47 CFR 15.247	
1 CSt Standard	•	RSS 247 Iss 1: May 2015	
		ANSI C63.10: 2013	
Test Method	:	RSS Gen Iss 4: Nov 2014	
		558074 D01 DTS Meas Guidance v03r05	
FCC ID	:	2ALIS-A1	
IC ID	:	22555-A1	
Dates of test	:	02/14/2017 - 02/21/2017	
Issue Date	:	05/12/2017	
Test Result	:	⊠ Pass ☐ Fail	
Equipment complied with the specification [X]			
Equipment did not comply with the specification [ ]			

This Test Report is Issued Under the Authority of:	
Radara	Clan Ge
Rachana Khanduri Test Engineer	Chen Ge Engineer Reviewer

Issued By:
SIEMIC Laboratories
775 Montague Expressway, Milpitas, 95035 CA



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# **Laboratory Introduction**

SIEMIC, headquartered in the heart of Silicon Valley, with superior facilities in US and Asia, is one of the leading independent testing and certification facilities providing customers with one-stop shop services for Compliance Testing and Global Certifications.



In addition to testing and certification, SIEMIC provides initial design reviews and compliance management throughout a project. Our extensive experience with China, Asia Pacific, North America, European, and International compliance requirements, assures the fastest, most cost effective way to attain regulatory compliance for the global markets.

**Accreditations for Conformity Assessment** 

Country/Region	Accreditation Body	Scope
USA	FCC, A2LA	EMC, RF/Wireless, Telecom
Canada	IC, A2LA, NIST	EMC, RF/Wireless, Telecom
Taiwan	BSMI, NCC, NIST	EMC, RF, Telecom, Safety
Hong Kong	OFTA, NIST	RF/Wireless, Telecom
Australia	NATA, NIST	EMC, RF, Telecom, Safety
Korea	KCC/RRA, NIST	EMI, EMS, RF, Telecom, Safety
Japan	VCCI, JATE, TELEC, RFT	EMI, RF/Wireless, Telecom
Mexico	NOM, COFETEL, Caniety	Safety, EMC, RF/Wireless, Telecom
Europe	A2LA, NIST	EMC, RF, Telecom, Safety
Israel	MOC, NIST	EMC, RF, Telecom, Safety

### **Accreditations for Product Certifications**

Country	Accreditation Body	Scope
USA	FCC TCB, NIST	EMC, RF, Telecom
Canada	IC FCB, NIST	EMC, RF, Telecom
Singapore	iDA, NIST	EMC, RF, Telecom
EU	NB	EMC & R&TTE Directive
Japan	MIC (RCB 208)	RF, Telecom
Hong Kong	OFTA (US002)	RF, Telecom

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# **Report Revision History**

Report No.	Report Version	Description	Issue Date
FCC IC_SL1610101001-SFE-020-DTS	None	Original	03/30/2017
FCC IC_SL1610101001-SFE-020-DTS_Rev1.0	Rev1.0	Updated FCC ID	05/12/2017





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### 2 Executive Summary

The purpose of this test program was to demonstrate compliance of following product

<u>Company:</u> Lighthouse AI, Inc <u>Product:</u> Lighthouse <u>Model:</u> A1

against the current Stipulated Standards. The specified model product stated above has demonstrated compliance with the Stipulated Standard listed on 1st page.

# 3 Customer information

Applicant Name	:	Lighthouse AI, Inc
Applicant Address	:	380 Portage Avenue, Palo Alto, CA
Manufacturer Name		Hon Hai Precision Industry CO, LTD (Foxconn)
Manufacturer Address	:	NANNING FUGUI PRECISION INDUSTRIAL CO.,LTD.
		B FACTORIES AREA, FOXCONN NANNING SCITECH PARK, NO.51, TONGLE, NANNING
		CITY, GUANGXI PROVINCE, CHINA-530031

# 4 Test site information

Lab performing tests	SIEMIC Laboratories
Lab Address	775 Montague Expressway, Milpitas, CA 95035
FCC Test Site No.	881796
IC Test Site No.	4842D-2
VCCI Test Site No.	A0133

# 5 Modification

Index	Item	Description	Note
-	-	-	-

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#### **EUT Information** 6

#### <u>6.1</u> **EUT Description**

Product Name	:	Lighthouse
Model No.	:	A1
Trade Name	:	Lighthouse Al
Serial No.	:	A1003170012
Input Power	:	100-240VAC,50/60Hz
Power Adapter Manu/Model	:	2ABS048F US
Power Adapter SN	:	11-16120136-00145
Product Hardware version	:	v3.2
Product Software version	:	build-alexandria-1079
Radio Hardware version	:	WCN-3660B-0-79WLNSP-TR-05-1
Radio Software version	:	CNSS.PR.2.0.1.2.c1-00021-M8936BAAAANAZW-1
Date of EUT received	:	02/06/2017
Equipment Class/ Category	:	DTS, UNII
Port/Connectors	:	None

#### 6.2 Radio Description

Radio Type	802.11b	802.11g	802.11n-20M	802.11n-40M	
Operating Frequency	2412-2462MHz	2412-2462MHz	2412-2462MHz	2422-2452MHz	
Modulation	DSSS (CCK, DQPSK, DBPSK)	OFDM-CCK (BPSK, QPSK, 16QAM, 64QAM)	OFDM (BPSK, QPSK, 16QAM, 64QAM)	OFDM (BPSK, QPSK, 16QAM, 64QAM)	
Channel Spacing	5MHz	5MHz	5MHz	5MHz	
Number of Channels	11	11	11	7	
Antenna Type		Dipole			
Antenna Gain (Peak)	2.4GHz: 2.6 dBi				
Antenna Connector Type	U.FL				
Note	2.4GHz and 5GHz Radio does not transmit simultaneously				

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### **EUT Power level setting**

Mode	Frequency (MHz)	Power setting
802.11-b	2412	14
802.11-b	2437	14
802.11-b	2462	14
802.11-g	2412	14
802.11-g	2437	14
802.11-g	2462	14
802.11-n-20	2412	14
802.11-n-20	2437	14
802.11-n-20	2462	14
802.11-n-40	2422	14
802.11-n-40	2437	14
802.11-n-40	2452	14





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# 6.3 EUT Photos – External





**EUT – Front View** 

EUT - Rear View





**EUT – Top View** 

EUT - Bottom View





EUT - Left Side View

EUT - Right Side View



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**Support Equipment Power Supply Top View** 

**Support Equipment Power Supply Bottom View** 





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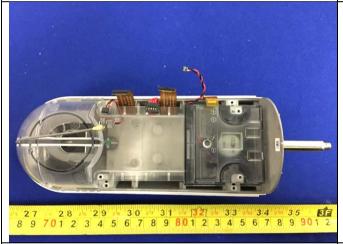
### 6.4 EUT Photos - Internal

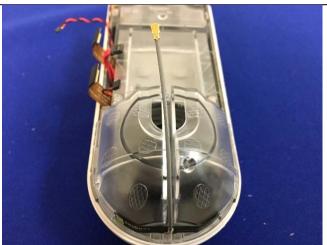




**EUT: Cover Off Front View** 

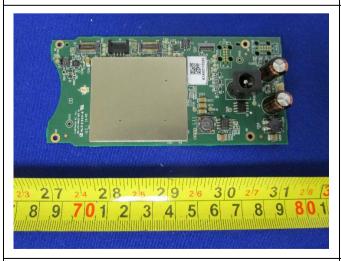
**EUT: Cover Off Rear View** 





**Internal Cover Off View** 

Internal Antenna View



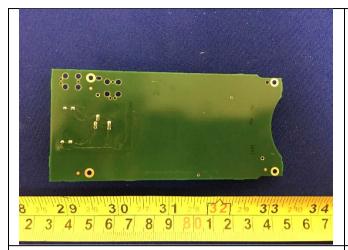


Radio Board with Shielding – Top View

Radio Board without Shielding - Top View



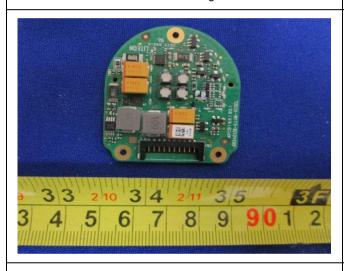
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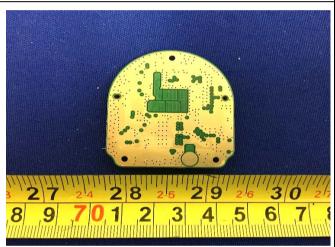


7 24 2 8 25 2 9 26 3 0 27 9 7 0 1 2 3 4 5 6 7 8

Radio Board without Shielding - Bottom View

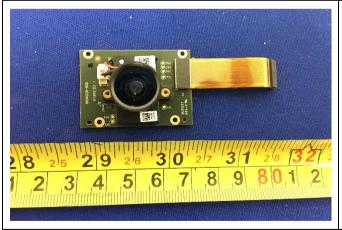
Internal PCBA 1 with Shielding Top View

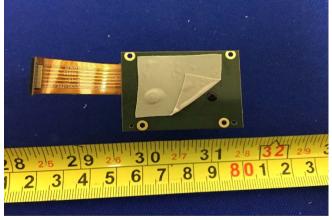




Internal PCBA 1 without Shielding Top View

Internal PCBA 1 Bottom View



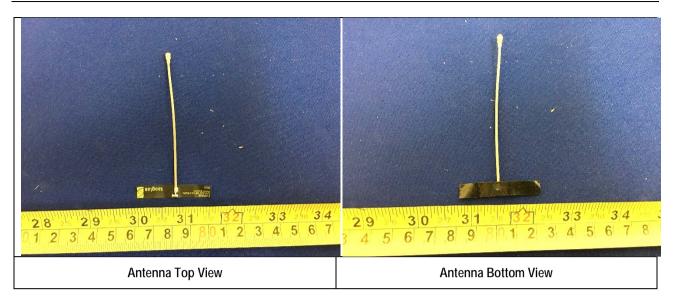


Internal PCBA 2 Top View

Internal PCBA 2 Bottom View



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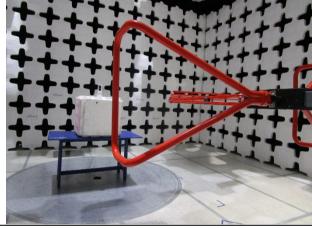
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# 6.5 EUT Test Setup Photos



AC Line Conducted Emissions – Front View

AC Line Conducted Emissions – Rear View

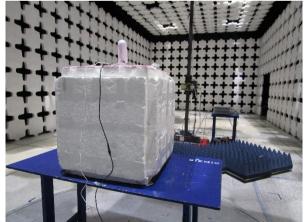




Radiated Emissions (<1GHz) - Front View

Radiated Emissions (<1GHz) - Rear View





Radiated Emissions (>1GHz) - Front View

Radiated Emissions (>1GHz) - Rear View



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# **Supporting Equipment/Software and cabling Description**

#### **Supporting Equipment** <u>7.1</u>

Item	Supporting Equipment Description	Model	Serial Number	Manufacturer	Note
1	Laptop	N/A	3YZQ162	Dell	-

#### **Cabling Description** <u>7.2</u>

Name	Connection Start		Connection Stop		Connection Stop Length / shielding Info		Note
Ivame	From	I/O Port	To	I/O Port	Length (m)	Shielding	Note
USB	USB	EUT	USB	Laptop	USB	1	Unshielded

#### **Test Software Description** 7.3

Test Item	Software	Description
RF Testing	QRCT	Set the EUT to transmit continuously in diferent test mode



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#### **Test Summary** 8

Test Item	-	Test standard		Test Method/Procedure	Pass / Fail
Restricted Band of Operation	FCC IC	15.205 RSS Gen 8.10	FCC IC	ANSI C63.10:2013 558074 D01 DTS Meas Guidance v03r05	⊠ Pass □ N/A
	FCC	15.207(a)	FCC	ANSI C63.10:2013	⊠ Pass
AC Conducted Emissions	IC	RSS Gen 8.8	IC	RSS Gen Issue 4: 2014	□ N/A

Test Item		Test standard		Test Method/Procedure	Pass / Fail
99% Occupied Bandwidth	-	-	-	-	□ Pass
7770 Occupied Dandwidth	IC	RSS Gen 6.6	IC	RSS Gen Issue 4: 2014 -	□ N/A
6dB Bandwidth	FCC	15.247(a)(2)	FCC	558074 D01 DTS Meas Guidance v03r05	□ Pass
oub Danawidin	IC	RSS247 (5.2.1)	IC	330074 DOT DT3 Weas Guidance vosios	□ N/A
Band Edge and Radiated	FCC	15.247(d)	FCC	ANSI C63.10:2013	⊠ Pass
Spurious Emissions	IC	RSS247 (5.5)	IC	558074 D01 DTS Meas Guidance v03r05	□ N/A
Output Power	FCC	15.247(b)	FCC	558074 D01 DTS Meas Guidance v03r05	□ Pass
Output Fower	IC	RSS247 (5.4.4)	IC	330074 DOT DTS Weas Guidance vosios	□ N/A
Receiver Spurious Emissions	IC	RSS Gen (4.8)	IC	RSS Gen Issue 4: 2014	□ Pass 図 N/A
Antonno Coin . 4 dDi	FCC	15.247(e)	FCC	-	☐ Pass
Antenna Gain > 6 dBi	IC	-	IC	-	⊠ N/A
Power Spectral Density	FCC	15.247(e)	FCC	558074 D01 DTS Meas Guidance v03r05	□ Pass
Fuwer Spectral Delisity	IC	RSS247 (5.2.2)	IC	550074 DOT DTS Weas Guidance vosios	□ N/A
DE Evacuro requirement	FCC	15.247(i)	FCC		☐ Pass
RF Exposure requirement	IC	RSS Gen(5.5)	IC	RSS Gen Issue 4: 2014	⊠ N/A

The applicant shall ensure frequency stability by showing that an emission is maintained within the band of operation under all normal operating conditions as specified in the user's manual.



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### 9 Measurement Uncertainty

### 9.1 Conducted Emissions

The test is to measure the conducted emissions to the mains port of the EUT.

Some error sources that can contribute to the total uncertainty:

- Uncertainty of the receiver
- Uncertainty of the LISN
- Uncertainty of cables
- Uncertainty due to the mismatches
- Etc, see the below table for details

Source of Uncertainty	Value	Probability	Division	Sensitivity	Expanded
	(dB)	Distribution		Coefficient	Uncertainty
Receiver Reading	0.12	Rectangular	1.732	1	0.069284
Cable Insertion Loss	0.21	Normal	2	1	0.105
Filter Insertion Loss	0.25	Normal	2	1	0.125
LISN Insertion Loss	0.40	Normal	2	1	0.20
Receiver CW accuracy	0.5	Rectangular	1.732	1	0.2886836
Pulse Amplitude	1.5	Rectangular	1.732	1	0.86605081
Response					
PRF Response	1.5	Rectangular	1.732	1	0.86605081
Mismatch LISN -	0.25	U-Shape	1.414	1	0.1768033
Receiver					
LISN Impedance	2.5	Triangular	2.449	1	1.0208248
Combined Standard Unce	1.928133				
Expanded Uncertainty (	(=2)	_			3.856266

The total derived measurement uncertainty is +/- 3.86 dB.

### 9.2 Radiated Emissions (30MHz to 1GHz)

The test is to measure the radiated emissions of the EUT.

Some error sources that can contribute to the total uncertainty:

- Uncertainty of the receiver
- Uncertainty of the antenna
- Uncertainty of cables
- Uncertainty due to the mismatches
- NSA Calibration
- Etc., details see the below table

Source of Uncertainty	Value (dB)	Probability Distribution	Division	Sensitivity Coefficient	Expanded Uncertainty
Receiver Reading	0.12	Rectangular	1.732	1	0.069284
Cable Insertion Loss	0.21	Normal	2	1	0.105
Filter Insertion Loss	0.25	Normal	2	1	0.125
Antenna Factor	0.65	Normal	2	1	0.325
Receiver CW accuracy	0.5	Rectangular	1.732	1	0.2886836
Pulse Amplitude Response	1.5	Rectangular	1.732	1	0.86605081
PRF Response	1.5	Rectangular	1.732	1	0.86605081
Mismatch Filter - Receiver	0.25	U-Shape	1.414	1	0.1768033
NSA Calibration	4.0	U-Shape	1.414	1	2.8288543
Combined Standard Uncertaint	3.0059131				
Expanded Uncertainty (K=2)	•				6.0118262

The total derived measurement uncertainty is +/- 6.00 dB.

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### 9.3 Radiated Emissions (1GHz to 40GHz)

The test is to measure the radiated emissions of the EUT.

Some error sources that can contribute to the total uncertainty:

- Uncertainty of the receiver
- Uncertainty of the antenna
- Uncertainty of cables
- Uncertainty due to the mismatches
- VSWR Calibration
- Etc., details see the below table

Source of Uncertainty	Value (dB)	Probability Distribution	Division	Sensitivity Coefficient	Expanded Uncertainty
Receiver Reading	0.12	Rectangular	1.732	1	0.0692840
Cable Insertion Loss	0.21	Normal	2	1	0.1050000
Filter Insertion Loss	0.25	Normal	2	1	0.1250000
Antenna Factor	0.65	Normal	2	1	0.3250000
Receiver CW accuracy	0.5	Rectangular	1.732	1	0.2886836
Pulse Amplitude Response	1.5	Rectangular	1.732	1	0.8660508
PRF Response	1.5	Rectangular	1.732	1	0.8660508
Mismatch Filter - Receiver	0.25	U-Shape	1.414	1	0.1768033
VSWR Calibration	2.0	U-Shape	1.414	1	1.4144272
Combined Standard Uncertain	4.2363				
Expanded Uncertainty (K=2	)				8.4726

The total derived measurement uncertainty is +/- 8.47 dB.

### 9.4 RF conducted measurement

The test is to measure the RF output power from the EUT.

Some error sources that can contribute to the total uncertainty:

- Uncertainty of the Reference Level Uncertainty
- Uncertainty of variable attenuators
- Uncertainty of cables
- Uncertainty due to the mismatches

Source of Uncertainty	Value (dB)	Probability Distribution	Division	Sensitivity Coefficient	Expanded Uncertainty
Reference Level	0.12	Rectangular	1.732	1	0.069284
Cable Insertion Loss	0.21	Normal	2	1	0.105
Attenuator	0.25	Normal	2	1	0.125
Mismatch	0.25	U-Shape	1.414	1	0.1768033
Combined Standard Unce	0.476087				
Expanded Uncertainty (I	0.952174				

The total derived measurement uncertainty is +/- 0.95 dB.



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# 10 Measurements, Examination and Derived Results

### 10.1 Conducted Emissions

### **Conducted Emission Limit**

Frequency ranges	Limit (dBuV)			
(MHz)	QP	Average		
0.15 ~ 0.5	66 – 56	56 – 46		
0.5 ~ 5	56	46		
5 ~ 30	60	50		

Spec	Item Requirement	Applicable
RSS247(A8.1)	a) For Low-power radio-frequency devices that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). The lower limit applies at the boundary between the frequency ranges.	$\boxtimes$
Test Setup	Vertical Ground Reference Plane  Test Receiver  Horizontal Ground Reference Plane  Note: 1. Support units were connected to second LISN.  2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other and other metal planes	units
Procedure	<ul> <li>The EUT and supporting equipment were set up in accordance with the requirements o top of a 1.5m x 1m x 0.8m high, non-metallic table, as shown in Annex B.</li> <li>The power supply for the EUT was fed through a 50Ω/50μH EUT LISN, connected to find the FOUT of the EUT LISN was connected to the EMI test receiver via a low-loss coal.</li> <li>All other supporting equipment was powered separately from another main supply.</li> </ul>	iltered mains.
Remark	EUT was tested at 120VAC, 60Hz	
Result	⊠ Pass ☐ Fail	
Test Data ⊠ Y	res □ N/A	

Test Data  $\boxtimes$  Yes  $\square$  N/A
Test Plot  $\boxtimes$  Yes (See below)  $\square$  N/A

Test was done by Rachana Khanduri at Conducted Emission test site.

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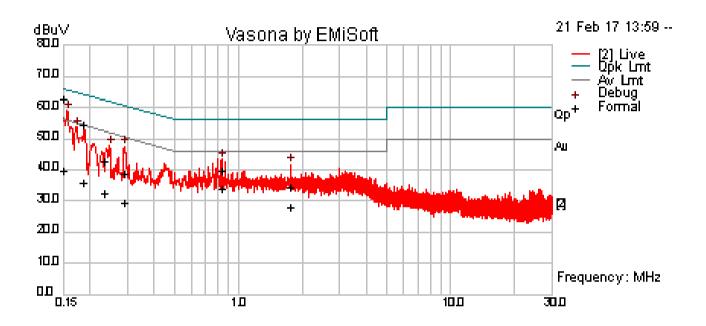




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### **Conducted Emission Test Results**

Test specification:	Conducted Emissions			
Environmental Conditions:	Temp(°C):	21		
	Humidity (%):	42		⊠ Pass
	Atmospheric(mbar):	1021	Result:	△ Pass
Mains Power:	120Vac, 60Hz		Result:	
Tested by:	Rachana Khanduri			☐ Fail
Test Date:	02/21/2017			
Remarks	conducted @ Line			



Line Plot at 120Vac, 60Hz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line / Neutral	Limit (dBuV)	Margin (dB)	Pass /Fail
0.15	50.97	10.00	1.74	62.71	Quasi Peak	Live	66.00	-3.29	Pass
0.19	43.26	10.00	1.36	54.63	Quasi Peak	Live	64.22	-9.59	Pass
0.83	29.27	10.01	0.54	39.83	Quasi Peak	Live	56.00	-16.17	Pass
0.29	28.05	10.00	0.88	38.94	Quasi Peak	Live	60.58	-21.65	Pass
0.24	31.78	10.00	1.07	42.84	Quasi Peak	Live	62.24	-19.40	Pass
1.75	24.03	10.02	0.50	34.56	Quasi Peak	Live	56.00	-21.44	Pass
0.15	27.83	10.00	1.74	39.57	Average	Live	56.00	-16.43	Pass
0.19	24.44	10.00	1.36	35.81	Average	Live	54.22	-18.41	Pass
0.83	23.48	10.01	0.54	34.03	Average	Live	46.00	-11.97	Pass
0.29	18.78	10.00	0.88	29.67	Average	Live	50.58	-20.92	Pass
0.24	21.31	10.00	1.07	32.37	Average	Live	52.24	-19.87	Pass
1.75	17.59	10.02	0.50	28.12	Average	Live	46.00	-17.88	Pass

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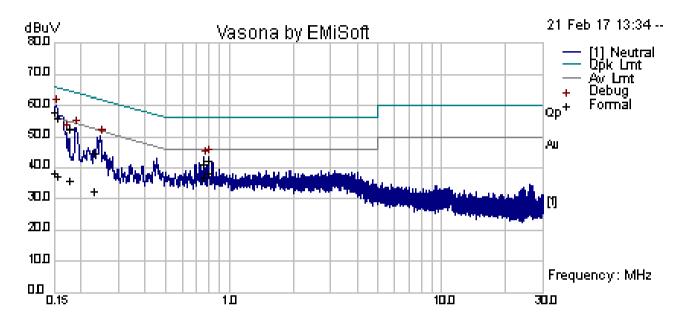




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### **Conducted Emission Test Results**

Test specification:	Conducted Emissions			
Environmental Conditions:	Temp(°C):	21		
	Humidity (%):	42		⊠ Pass
	Atmospheric(mbar): 1021		Result:	△ Pass
Mains Power:	120Vac, 60Hz		Result:	
Tested by:	Rachana Khanduri			☐ Fail
Test Date:	02/21/2017			
Remarks	conducted @ Neutral			



Neutral Plot at 120Vac, 60Hz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line / Neutral	Limit (dBuV)	Margin (dB)	Pass /Fail
0.15	46.09	10.00	1.74	57.83	Quasi Peak	Neutral	66.00	-8.17	Pass
0.18	40.88	10.00	1.45	52.33	Quasi Peak	Neutral	64.67	-12.34	Pass
0.23	33.29	10.00	1.09	44.39	Quasi Peak	Neutral	62.45	-18.06	Pass
0.80	31.69	10.01	0.55	42.25	Quasi Peak	Neutral	56.00	-13.75	Pass
0.76	30.56	10.01	0.55	41.13	Quasi Peak	Neutral	56.00	-14.87	Pass
0.16	44.44	10.00	1.68	56.12	Quasi Peak	Neutral	65.74	-9.62	Pass
0.15	26.62	10.00	1.74	38.36	Average	Neutral	56.00	-17.64	Pass
0.18	24.41	10.00	1.45	35.86	Average	Neutral	54.67	-18.82	Pass
0.23	21.34	10.00	1.09	32.44	Average	Neutral	52.45	-20.01	Pass
0.80	27.56	10.01	0.55	38.13	Average	Neutral	46.00	-7.87	Pass
0.76	26.15	10.01	0.55	36.71	Average	Neutral	46.00	-9.29	Pass
0.16	25.48	10.00	1.68	37.16	Average	Neutral	55.74	-18.58	Pass

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# 10.2 6dB & 99% Bandwidth

### Requirement(s):

Spec	Requirement			Applicable			
§ 15.247 RSS247 (5.2.1)	6dB BW≥500KHz;			$\boxtimes$			
RSS Gen 4.6.1	The transmitter shall be operated at its maximum carrier power measured under normal test conditions. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual. The trace data points are recovered and directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth						
Test Setup	Spectrum Analyzer						
Test Procedure	558074 D01 DTS Meas Guidance v03r05, 8.1 I  6dB Emission bandwidth measurement procedu  - Set RBW = 100 kHz.  - Set the video bandwidth (VBW) ≥ 3 x  - Detector = Peak.  - Trace mode = max hold.  - Sweep = auto couple.  - Allow the trace to stabilize.  - Measure the maximum width of the entwo outermost amplitude points (upper the maximum level measured in the fu	ure  RBW.  nission that is constand lower frequen	ncies) that are attenuated by 6	dB relative to			
Test Date	02/14/2017	Environmental condition	Temperature Relative Humidity Atmospheric Pressure	23°C 42% 1021mbar			
Remark	N/A						
Result	⊠ Pass ☐ Fail						

Test Data	Yes	□ N/A

Test Plot  $\square$  N/A

Test was done by Rachana Khanduri at RF test site.