H.B. Compliance Solutions

Intentional Radiator Test Report

For the

Aarcomm Systems, Inc.

Universal Charger

Tested under

The FCC Rules contained in Title 47 of the CFR, Part 15.209

Prepared for:

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Cert # ATL-0062-E

Engineering Statement: The measurements shown in this report were made in accordance with the procedure indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurement made, the equipment tested is capable of operation in accordance with the requirements of Part 15 of the FCC Rules under normal use and maintenance. All results contained herein relate only to the sample tested.

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Report Status Sheet

Revision #	Report Date	Reason for Revision
Ø	August 11, 2022	Initial Issue

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EXECUTIVE SUMMARY

1. Testing Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15.209. All tests were conducted using measurement procedure from ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9kHz to 40GHz and ANSI C63.10-2013 Procedures for Compliance Testing of Unlicensed Wireless Devices as appropriate.

Test Name	Test Method/Standard	Result	Comments
Unintentional Radiated Emissions	15.109	Pass	
A/C Power Line Conducted Emissions	15.207(a)	N/A	DC Powered Device
Occupied Bandwidth	15.215	Pass	
Radiated Fundamental Emissions	15.209(a)	Pass	
Radiated Spurious Emissions	15.209(a), 15.205, 15.35(C)	Pass	

EQUIPMENT CONFIGURATION

1. Overview

H.B Compliance Solutions was contracted by Aarcomm to perform testing on the Universal Charger under the purchase order number P17082.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Aarcomm, Universal Charger.

The tests were based on FCC Part 15 Rules. The tests described in this document were formal tests as described with the objective of the testing was to evaluate compliance of the Equipment Under Test (EUT) to the requirements of the aforementioned specifications. Aarcomm should retain a copy of this document and it should be kept on file for at least five years after the manufacturing of the EUT has been permanently discontinued. The results obtained relate only to the item(s) tested.

Product Name:	Universal Charger
Model(s) Tested:	U150
FCC ID:	2AAXWU150022
Supply Voltage Input:	Primary Power: 12-24 VDC
Frequency Range:	110kHz – 145kHz
No. of Channels:	1
Type(s) of Modulation:	Sinewave
Range of Operation Power:	0.00012 Watts (Radiated)
Emission Designator:	N/A
Channel Spacing(s)	None
Test Item:	Pre-Production
Type of Equipment:	Fixed
Antenna Requirement (§15.203):	Type of Antenna: Integral Loop Gain of Antenna: 0dBi
Environmental Test Conditions:	Temperature: 15-35°C Humidity: 30-60% Barometric Pressure: 860-1060 mbar
Modification to the EUT:	None
Evaluated By:	Staff at H.B Compliance Solutions
Test Date(s):	08/02/2022 to 08/05/2022
Firmware Number	FPM-20082-00002
PCBA Version	5-2

2. Test Facility

All testing was performed at H.B. Compliance Solutions. This facility is located at 5005 S. Ash Avenue, Suite # A-10, Tempe AZ-85282. All equipment used in making physical determination is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a GTEM chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at H.B. Compliance Solutions.

Test facility H.B. Compliance Solutions is an ANAB accredited test site. The ANAB certificate number is L2458. The scope of accreditation can be found on ANAB website www.anab.org

3. Description of Test Sample

The Aarcomm, Universal Charger charging cradle uses 124kHz to 143kHz Inductive Coupling wireless charging radio. The device is designed to chare all Aarcomm remote control products. It can operate over a wide temperature range enabling it to be mounted in a vehicle cab or indoors at a maintenance center. Device has 5W and 15W charging mode. Worst case data was used for all testing.

4. Equipment Configuration

Ref. ID	Name / Description	Model Number	Serial Number
# 1	Universal Charger (15W Mode)	U150	10126416
# 2	Universal Charger (5W Mode)	U150	-

Table 1. Equipment Configuration

5. Support Equipment

All support equipment supplied is listed in the following Support Equipment List.

Ref ID	Name / Description	Manufacturer	Model #	Serial #
# 3	15W Resistive Load	Aarcomm	None	None
# 4	DC Power Supply	Circuit Specialists	3645A	5319

Table 2. Support Equipment

6. Ports and Cabling Information

Ref ID	Port name on the EUT	Cable Description	Qty.	Length (m)	Shielded? (Y/N)	Termination Box ID & Port ID
# 5	DC Power	2 Wire	1	0.25	N	# 4

Table 3. Ports and Cabling Information

7. Method of Monitoring EUT Operation

A test receiver will be used to monitor the data transmission from the EUT.

8. Mode of Operation

The EUT will be configured to transmit at maximum power level. A resistive test load was provided to keep the unit in continuous transmit mode. These settings were created for testing purpose only. Testing was performed drawing a maximum load from a receiver device that was placed on the charging surface. This was modified to include power resistors to draw 15W of load from the wireless receiver. Additionally, a second wireless receiver was provided that was configured to operate at a maximum draw of 5W.

9. Modifications

9.1 Modifications to EUT

No modifications were made to the EUT

9.2 Modifications to Test Standard

No Modifications were made to the test standard.

10. Disposition of EUT

The test sample including all support equipment submitted to H.B Compliance Solutions for testing will be returned to Aarcomm upon completion of testing & certification

Criteria for Un-Intentional Radiators

1. Radiated Emissions

Test Requirement(s):	§15.109	Test Engineer(s):	Sean E.
Test Results:	Pass	Test Date(s):	08/03/2022

Test Procedures:

The final radiated emissions test was performed using the parameters described above as worst case. That final test was conducted at a facility that meets the ANSI C63.4 TEM waveguides requirements. The frequency range noted in the data sheets was scanned/tested at that facility. Emissions were maximized as specified, by varying table azimuth, and manipulating cables.

Using the mode of operation and configuration noted within this report, a final radiated emissions test was performed. The frequency range investigated (scanned), is also noted in this report. Radiated emissions measurements were made at the EUT azimuth such that the maximum radiated emissions level will be detected. This requires the use of a turntable.

Tests were made with the EUT rotated on X,Y,Z planes to obtain the maximum signal strength. Though specified in the report, the measurement distance shall be 3 meters.

Test Limits:

Frequency Range (MHz)	Distance (Meters)	Field Strength	
		uV/m	dBuV/m
0.009 – 0.490	300	2400/F(kHz)	67.6-20log(F)
0.490 – 1.705	30	24000/F(kHz)	87.6-20log(F)
1.705 – 30.0	30	30	29.54
30 – 88	3	100	40.0
88 – 216	3	150	43.5
216 – 960	3	200	46.0
960 – 1000	3	500	54.0
Note: Emissions limits are based on measurements employing CISPR QP detector except for bands 9-90kHz, 110-490kHz and above 1000MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector			

Table 4. Radiated Emissions Limit – FCC Limits from Section 15.209

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
30 MHz to 1 GHz	120 kHz	120 kHz	N/A
1 GHz to 11 GHz	1MHz	N/A	1MHz
Measurements were made using the bandwidths and detectors specified. The video filter was at least as wide as the IF bandwidth of the measuring receiver.			

Table 5. Radiated Emissions – Measurement Bandwidth

Emissions Tests Calculations

In the case of indoor measurements, radiated emissions measurements are made by the manipulation of correction factors using TILE4 software. This is done automatically by the software during the final measurement process.

In both cases, the level of the Field Strength of the interfering signal is calculated by adding the Antenna Factor, Cable Factor and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

FS = RA + AF + (CF –AG)

Where: FS = Field Strength

RA = Receiver (indicated) Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

This laboratory uses an approach of combining the CF and AG using an end-to-end measurement of the entire cabling system, including the test cable, any in-line amplifiers, attenuators, or transient protection networks, all measured in-situ.

For a sample calculation, assume a receiver reading of 52.5 dBuV is obtained. With an antenna factor of 7.4 and a combined cable factor (CF + AG) of -27.9:

FS = 52.5 + 7.4 + (-27.9) = 32 dBuV/m

FS = 32 dBuV/m

If desired, this can be converted into its corresponding level in uV/m:

FS = 10^((32 dBuV/m)/20) = 39.8 uV/m

Test Setup:

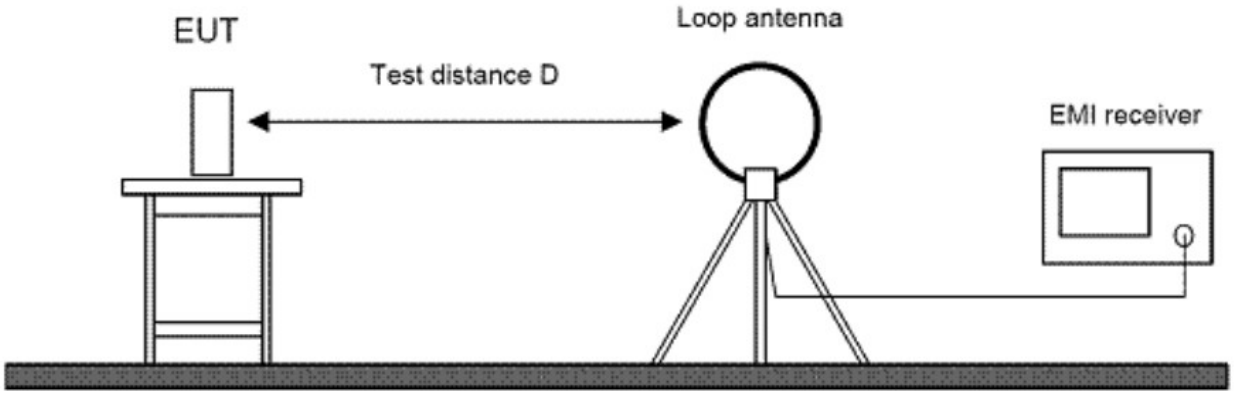


Figure 1. Radiated Emissions Test Setup (9kHz - 30MHz)

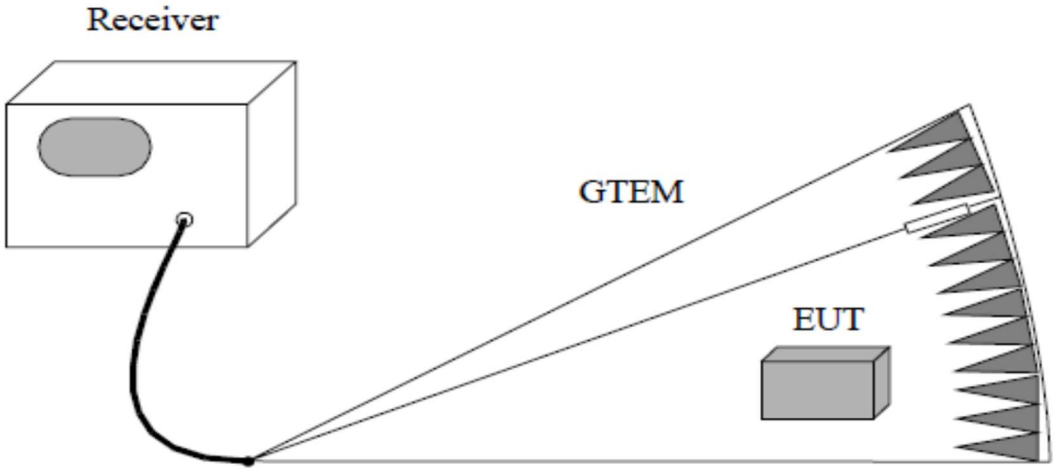
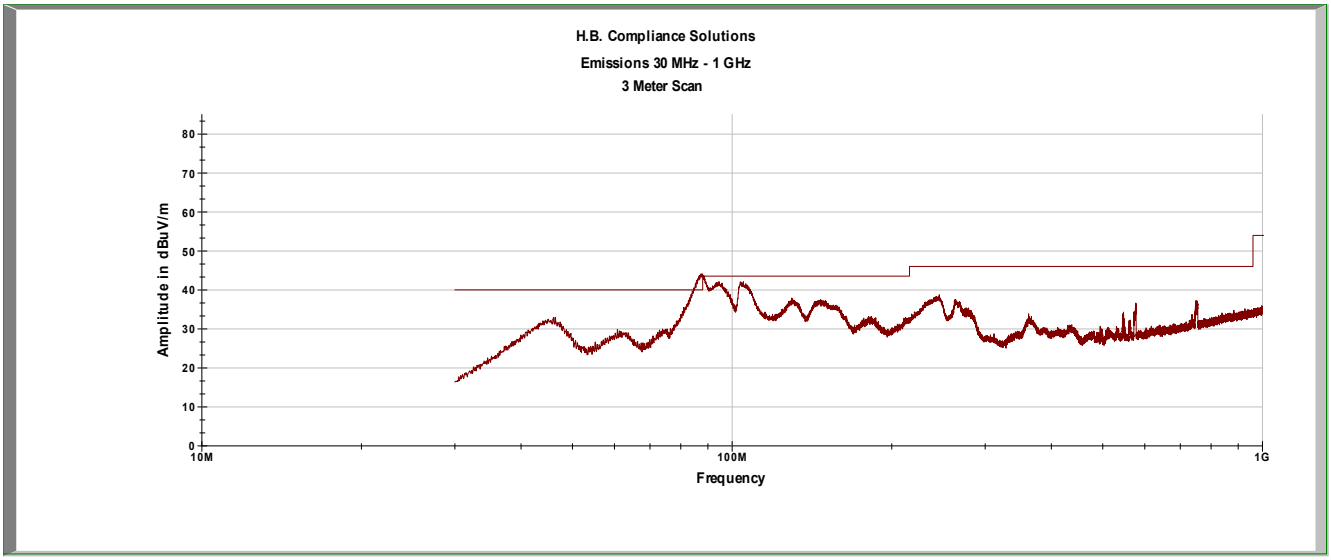


Figure 2. Radiated Emissions Test Setup (30MHz – 1GHz)



Plot 1 – Radiated Emissions – 30MHz to 1GHz

Frequency (MHz)	Measured Level (dBuV/m)	Measurement Detector	Limit (dBuV)*	Margin (dB)
0.1941	44.06	Average	101.84	-57.78
0.2558	45.26	Average	99.45	-54.19
0.3741	55.86	Average	96.14	-40.28
1.125	46.16	Quasi Peak	66.58	-20.42
1.52	43.43	Quasi Peak	63.97	-20.54
1.623	42.12	Quasi Peak	63.40	-21.28

Table 6. Final Measurement Results for Radiated Emissions below 30MHz

***Note: The limits have been extrapolated from 300 meters to 3 meters by adding 40*Log(300/3) dB or from 30 meters by adding 40*Log(30/3) as referenced in ANSI C63.10 Section 6.4.4**

Frequency (MHz)	Measured Level (dBuV/m)	Measurement Detector	Limit (dBuV)	Margin (dB)
46.10	32.94	Peak	40.0	-7.06
87.68	32.82	Quasi Peak	40.0	-7.18
94.54	29.87	Quasi Peak	43.5	-13.63
104.95	31.99	Quasi Peak	43.5	-11.51
129.52	37.92	Peak	43.5	-5.58
245.86	38.76	Peak	46.0	-7.24

Table 7. Final Measurement Results for Radiated Emissions Above 30MHz

Criteria for Intentional Radiators

Occupied Bandwidth

Test Requirement(s):	15.215(c)	Test Engineer(s):	Sean E.
Test Results:	Pass	Test Date(s):	08/02/2022

Test Procedure: As required by 47 CFR 15.215(c): The bandwidth of the emission shall be determined at the points 20dB down from the modulated carrier.

Customer provided a test mode internal to the EUT to control the RF modulation. The EUT antenna was attached and the waveform was received by the test antenna which was connected to the spectrum analyzer. The measured highest peak power was set relative to zero dB reference. The RBW of the Spectrum Analyzer was set to 30Hz and VBW>RBW.

Frequency (kHz)	20dB Bandwidth (kHz)	99% Bandwidth (kHz)
124.75	1.663	1.426

Table 8. Occupied Bandwidth Summary, Test Results

Test Setup:

Figure 4. Occupied Bandwidth Test Setup

The following pages show measurements of Occupied Bandwidth plot:

Plot 4 – 20dB BW (15W Mode) – With Load

Plot 5 – 20dB BW (5W Mode) – With Load

5. Radiated Spurious Emissions

Test Requirement(s):	§15.209	Test Engineer(s):	Sean E.
Test Results:	Pass	Test Date(s):	08/04/2022

Test Procedures: As required by 47 CFR 15.209, Radiated emission measurements were made in accordance with the procedures of the ANSI C63.10 - 2013.

The EUT was placed on a wooden table inside a GTEM chamber. The EUT was set on continuous transmit.

The measurement distance was set at 3 meters from the EUT. During the tests, EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The frequency range up to the 10th harmonic was investigated.

Frequency Range	Detector Setting	Resolution Bandwidth	Video Bandwidth	Span
9kHz – 150kHz	Quasi Peak*	200Hz	As Specified in §15.35	Zero
150kHz-30MHz	Quasi Peak*	9kHz	As Specified in §15.35	Zero
30MHz – 1000 MHz	Quasi Peak	120kHz	As Specified in §15.35	Zero
1000 MHz – 5GHz	Peak	1MHz	1MHz	As necessary
1000 MHz – 5GHz	Average	1MHz	As Specified in §15.35	As necessary

Table 9 - Analyzer Settings

***Note: Measurements made in the frequency ranges of 9kHz-90kHz and 110kHz-490kHz were done with an average detector.**

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical

Frequency (MHz)	Peak Measurement @ 3m (dBuV/m)	Quasi-Peak Amp. (dBuV/m)	FCC Quasi-Peak Limit (dBuV/m)	FCC Peak Limit (dBuV/m)	Quasi-Peak Margin (dB)	Peak Margin (dB)	Comment
0.1247	97.86	96.86	105.47	125.47	-8.61	-27.61	Fundamental
0.1427	90.63	89.61	105.47	125.47	-15.86	-34.84	Fundamental
0.138	92.16	91.16	105.47	125.47	-14.31	-33.31	Fundamental

Table 10 – Fundamental Field Strength

Frequency (MHz)	Measurement Detector	Measured Amp. (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)	Comment
0.2588	Average	45.26	99.45	-54.19	
0.3741	Average	55.86	96.14	-40.28	
0.4211	Quasi Peak	54.36	95.12	-40.76	
1.125	Quasi Peak	46.16	66.58	-20.42	
1.520	Quasi Peak	43.43	63.97	-20.54	
1.623	Quasi Peak	42.12	63.40	-21.28	

Table 11 - Radiated Spurious Emission Data

***Note: The limits have been extrapolated from 300 meters to 3 meters by adding 40*Log(300/3) dB or from 30 meters by adding 40*Log(30/3) as referenced in ANSI C63.10 Section 6.4.4**

Remark:

To get a maximum emission level from the EUT, the EUT was moved throughout the X-axis, Y-axis and Z-Axis. Worst case is X-axis.

Test Equipment

Equipment	Manufacturer	Model	Serial #	Last Cal Date	Cal Due Date
Power Supply	Hewlett Packard	E3610A	KR83021468	NCR	None
Spectrum Analyzer	Hewlett Packard	8595EM	3801A00177	May-04-22	May-04-23
Spectrum Analyzer	Agilent	E4443A	US41420164	Mar-15-22	Mar-15-23
DMM	Fluke	77 III	72550270	Apr-29-22	Apr-29-23
Combiner/Splitter	Mini-Circuits	ZFSC-2-2	None	Verified	
High Pass Filter	Mini-Circuits	VHF-3100+	15542	Verified	
6dB Attenuator	Bird	75-A-MFN-06	0641	NCR	None
EMI Receiver	Hewlett Packard	8566B	2747A05264	Dec-07-21	Dec-07-22
Signal Generator	Agilent	E4432B	US40053021	NCR	N/A
Attenuator 20dB	Mini Circuits	CAT-20	10012	NCR	None
Loop Antenna	Electro-Metrics	ALR 25	443	May-04-21	May-04-23
Antenna	EMCO	GTEM 5417	1063	Verified	

Table 12 – Test Equipment List

***Statement of Traceability:** Test equipment is maintained and calibrated on a regular basis. All calibrations have been performed by a 17025 accredited test facility, traceable to National Institute of Standards and Technology (NIST)

6. Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. These measurements figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2. Instrumentation measurement uncertainty has **not** been taken into account to determine compliance.

The following measurement uncertainty values have been calculated as show in the table below:

Measured Parameter	Measurement Unit	Frequency Range	Expanded Uncertainty
Conducted Emissions (AC Power)	dBuV or dBuA	150kHz – 30MHz	± 4.3dB
Radiated Emission below 30MHz	dBuV/m	9kHz-30MHz	± 2.96dB
Radiated Emissions below 1GHz	dBuV/m	30 – 1000MHz	± 5.6dB
Radiated Emissions above 1GHz	dBuV/m	1 – 26.5GHz	± 4.1dB

The reported expanded uncertainty has been estimated at a 95% confidence level (k=2)

END OF TEST REPORT