



Antenna Gain Test Report - Applicant: Tungsten Audio, LLC

Approved for Release By:

Signature: Bruno Clavier

Name & Title: Bruno Clavier, General Manager

Date of Signature 3/6/2023

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Timco Engineering, Inc., an IIA Company
849 NW State Road 45, Newberry, Florida 32669
(352) 472-5500 / testing@timcoengr.com

1. Customer Information

Applicant: Tungsten Audio, LLC
Address: 9864 E. Grand River
Suite 110 Unit 147
Brighton, Michigan, 48116, United States

2. Location of Testing

Test Laboratory

Timco Engineering Inc. is a subsidiary of Industrial Inspection & Analysis, Inc. ("IIA"). Testing was performed at Timco's permanent laboratory located at 849 NW State Road 45, Newberry, Florida 32669

FCC test firm # 578780

FCC Designation # US1070

FCC site registration is under A2LA certificate # 0955.01

ISED Canada test site registration # 2056A

EU Notified Body # 1177

For all designations see A2LA scope # 0955.01



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Testing was performed, reviewed by

Dates of Testing: 11/9/2022

Signature:

A handwritten signature in black ink, appearing to read "Tim Royer", is written over a horizontal line.

Sr. EMC Engineer
EMC-003838-NE



Name & Title:

Tim Royer, EMC Engineer

Date of Signature

3/6/2023



3. Test Sample(s) (EUT/DUT)

The test sample was received: 11/9/2022

Description of the EUT

A description as well as unambiguous identification of the EUT(s) tested. Where more than one sample is required for technical reasons (such as the use of connected units for the purpose of conducted output power testing where the product units will have integral antennas), each specific test shall identify which unit was tested.

Identification	
FCC ID:	2A8PBLSS4001
Brief Description	Bluetooth Speaker
Model(s) #	LSS4-001
Firmware version	N/A
Software version	N/A
Serial Number	N/A

Technical Characteristics	
Technology	Bluetooth Speaker
Frequency Range	2402-2483.5 MHz
Modes	Mode 1: DH5, Mode 2: 2DH5, Mode 3: 3DH5
RF O/P Power (Max.)	6.95 dB/ 0.005 W
Duty Cycle	100%
Antenna Connector	N/A
Voltage Rating (AC or Batt.)	AC Charging/ Internal Battery

Operating conditions during Testing:

No modifications of the device under test (including firmware, specific software settings, and input/output signal levels to the EUT).

Peripherals used during Testing:

A laptop was used to program the EUT.



4. Test methods & Applicable Regulatory Limits

Test methods/Standards/Guidance:

Test procedures and guidance for measuring transmitters are provided in ANSI C63.10-2013.

- 1) ANSI C63.10-2013
- 2) 353028 D01 Antennas Part 15 Transmitters v01r01

5. Applied Limits and Regulatory Limits:

- 3) FCC CFR 47 Part 15.203

6. FCC Notice:

All part 15 applications will need to show how the antenna gain was derived either from a manufacturer data sheet or a measurement. Where the gain of the antenna is inherently accounted for as a result of the measurement, such as field strength measurements on a part 15.249 or 15.231 device, so the gain does not necessarily need to be verified. However, enough information regarding the construction of the antenna shall be provided. Such information may be photographs, length of wire antenna etc.

1. Part 15 applications with equipment classes **DSC, DXX, DCD, 8CC**, etc. which do not have an EIRP limit.
We need at least the following antenna info: **Antenna photos/or drawings, including antenna dimensions.**
 - This info cannot be held short term confidential. If necessary, we will have to request the customer to provide a separate exhibit for that antenna photo/or drawing, if the internal photos are being held short term confidential. Alternatively, antenna info can be placed in the test report. That would make things easier to review and process.
(We plan on providing guidance to customers in our newsletter to identify the antenna info vs. internal photo.).
 - Any antenna technical specifications, which are deemed confidential by customer/applicant should be removed from the antenna exhibit or test report.
 - However, antenna specifications such antenna gain, antenna patterns, etc. are not considered confidential information.
 - Antenna gain reports are **NOT** required for these equipment classes because the antenna gain is already accounted for in the field strength measurement of the fundamental emission. (see attached FCC minutes)
2. Part 15 applications with equipment classes **DTS, DSS, NII, 6ID**, etc. which use the antenna gain for compliance with EIRP limits:
We need the manufacturer antenna data sheet or an antenna gain measurement report
 - The report must be a complete report, with a measurement procedure, test equipment, test setup, signatures, facility/test site descriptions, etc.
 - There is not requirement for the RF lab to be accredited.
 - The FCC has not specified or endorsed any measurement procedures. However, the FCC indicated at the TCBC conf call on June 14...
 - test labs should use good judgement when reviewing antenna datasheets with gain measured in free space because that the gain might change significantly when attached to the device... FCC



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wants test labs and manufacturers to be aware of it and take this into account. FCC does not necessarily need to see what was done, but needs to know whether gain has changed.

- Confidential information about the antenna can be made confidential but photos/drawings, gain, antenna patterns, test setups are not considered confidential.

7. Calculation Procedure

Conducted ERP and measured dBuV/m are converted and compared. The difference was compared to the stated antenna gain (dBi) to ensure that it doesn't exceed the manufacture stated.

8. Equations

$$E = \text{EIRP} - 20 \log d + 104.8 \quad (\text{ANSI C63.10-2013 sec 11.12.2.2})$$

where

E is the electric field strength in dBuV/m

EIRP is the equivalent isotropically radiated power in dBm

d is the specified measurement distance

$$\text{V/m to dB}\mu\text{V/m: dB}\mu\text{V/m} = 20 \log(\text{V/m}) + 120$$

$$\text{eirp} = p_t \times g_t = (E \times d)^2 / 30 \quad (\text{Poynting's theorem}) \quad (\text{KDB 412172 Determining ERP and ERIP DR01})$$

where:

p_t = transmitter output power in watts,

g_t = numeric gain of the transmitting antenna (unitless),

E = electric field strength in V/m,

d = measurement distance in meters (m).

Note that $4\pi r^2$ is the surface area of a sphere and 120π (377 ohms) is the impedance of free space.



9. List of Test Equipment

Test Equipment						
Type	Device	Manufacturer	Model	SN#	Current Cal	Cal Due
Antenna	Biconical 1057	Eaton	94455-1	1057	10/16/20	10/16/2023
Antenna, NSA	Log-Periodic 1243	Eaton	96005	1243	5/4/21	5/3/2024
Antenna	Double-Ridged Horn/ETS Horn 1	ETS-Lindgren	3117	00035923	2/25/20	2/24/2023
CHAMBER	CHAMBER	Panashield	3M	N/A	3/12/19	12/21/2023
Pre-amp	Pre-amp	RF-LAMBDA	RLNA00M45GA	NA	2/27/19	7/26/2025
Receiver	EMI Test Receiver R&S ESU 40	Rohde & Schwarz	ESU 40	100320	5/27/21	5/26/2024
Receiver	EMI Test Receiver R&S ESW44	Rohde & Schwarz	ESW44	103049	10/13/21	10/12/2024
Signal Generator	Signal Generator HP 8648C	HP	8648C	35537A01679	3/29/19	8/03/2025

Software			
Software	Author	Version	Validation on
ESU Firmware	Rohde & Schwarz	4.43 SP3; BIOS v5.1-24-3	2018
RSCcommander	Rohde & Schwarz	1.6.4	2014
ScopeExplorer	LeCroy	v2.25.0.0	2009
Field Strength	Timco	v4.10.7.0	2016



10. RF Exposure Results

Tuned Frequency (MHz)	Conducted PO (dBm)	Field Strength (dBuV/m)	Stated Antenna Gain (dBi)									
2402.00	6.95	76.79	0.00									
Fundamental Frequency (MHz)	Coax Loss (dB)	Antenna Correction Factor (dB)	Distance (m)	Field Strength (dBuV/m)	Radiated ERP (dBm)	ERP (W)	Conducted ERP (dBm)	Conducted ERP (W)	Calculated Field Strength from Conducted power (dBuV/m)	Antenna Gain Calculated from field strength (dBi)	Antenna Gain Calculated from Power (dBi)	
2402.00	5.62	31.88	3.00	76.79	-20.59	0.000008735292	6.95	0.004954501908	102.18	-25.39	-27.54	
						Measured Gain is less than Stated Gain						

RESULT: Pass



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11. ANNEX-B – Test Setup Photographs

Test setup photographs are located in a separate supplementary ANNEX-B document.

12. History of Test Report Changes

Test Report #	Revision #	Description	Date of Issue
TR_5070-22_FCC Antenna_	1	Initial release	3/6/2023



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END OF TEST REPORT
