



F2 Labs
16740 Peters Road
Middlefield, Ohio 44062
United States of America
www.f2labs.com

SPURIOUS EMISSIONS TEST REPORT

Manufacturer: Heads Up Goggles, LLC
651 North Broad Street, Suite 205 #4247
Middletown, Delaware 19709 USA

Applicant: Same as Above

Product Name: Radio Module

Product Description: Radio Module

Model: RFM95CW

FCC ID: 2A4BT-SK01

Host: Heads Up SKI-1, Model SK001
Contains FCC IDs: 2A4BT-SK01, 2AC7ZESPWROOM32D

Testing Commenced: 2022-11-01

Testing Ended: 2022-02-10

Summary of Test Results: In Compliance

The EUT complies with the EMC requirements when manufactured identically as the unit tested in this report, including any required modifications and/or manufacturer's statement. Any changes to the design or build of this unit subsequent to this testing may deem it non-compliant.

Standards:

- FCC Part 15 Subpart C, Section 15.247
- FCC Part 15.209
- FCC15.207 – AC Conducted Emissions
- ANSI C63.10:2013



Order Number: F2P26715A

Applicant: Heads Up Goggles, LLC

Model: RFM95CW

Evaluation Conducted by:

Julius Chiller, EMC/Wireless Engineer

Report Reviewed by:

Ken Littell, Vice President of EMC

F2 Labs
26501 Ridge Road
Damascus, MD 20872
Ph 301.253.4500

F2 Labs
16740 Peters Road
Middlefield, OH 44062
Ph 440.632.5541

F2 Labs
8583 Zionsville Road
Indianapolis, IN 46268
Ph 317.610.0611

This test report may be reproduced in full; partial reproduction only may be made with the written consent of F2 Labs. The results in this report apply only to the equipment tested.



TABLE OF CONTENTS

Section	Title	Page
1	ADMINISTRATIVE INFORMATION	4
2	SUMMARY OF TEST RESULTS/MODIFICATIONS	5
3	ENGINEERING STATEMENT	6
4	EUT INFORMATION AND DATA	7
5	LIST OF MEASUREMENT INSTRUMENTATION	8
6	RADIATED SPURIOUS EMISSIONS	9
7	CONDUCTED EMISSIONS	16
8	PHOTOGRAPHS	21



1 ADMINISTRATIVE INFORMATION

1.1 Measurement Location:

F2 Labs in Middlefield, Ohio. Site description and attenuation data are on file with the FCC's Sampling and Measurement Branch at the FCC Laboratory in Columbia, MD.

1.2 Measurement Procedure:

All measurements were performed according to the 2013 version of ANSI C63.10 and recommended FCC procedure of measurement of DTS operating under Section 15.247 and in KDB558074. A list of the measurement equipment can be found in Section 5.

1.3 Uncertainty Budget:

The uncertainty in EMC measurements arises from several factors which affect the results, some associated with environmental conditions in the measurement room, the test equipment being used, and the measurement techniques adopted.

The measurement uncertainty budgets detailed below are calculated from the test and calibration data and are expressed with a 95% confidence factor. Note: Only measurements listed below which relate to tests included in this Test Report are applicable to it.

Measurement Range	Expanded Uncertainty	Combined Uncertainty
Radiated Emissions <1 GHz @ 3m	±5.07dB	±2.54
Radiated Emissions <1 GHz @10m	±5.09dB	±2.55
Radiated Emissions 1 GHz to 2.7 GHz	±3.62dB	±1.81
Radiated Emissions 2.7 GHz to 18 GHz	±3.10dB	±1.55
AC Power Line Conducted Emissions, 150kHz to 30 MHz	±2.76dB	±1.38

This Uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

1.4 Document History

Document Number	Description	Issue Date	Approved By
F2P26715-02E	First Issue	2022-02-10	K. Littell



2 SUMMARY OF TEST RESULTS

Test Name	Standard(s)	Results
Radiated Spurious Emissions	CFR 47 Part 15.247(d) / Part 15.209 / KDB558074	Complies
Conducted Emissions	CFR 47 Part 15.207(a)	Complies

Modifications Made to the Equipment
None



Order Number: F2P26715A

Applicant: Heads Up Goggles, LLC

Model: RFM95CW

3 ENGINEERING STATEMENT

This report has been prepared on behalf of **Heads Up Goggles, LLC** to provide documentation for the testing described herein. This equipment has been tested and found to comply with Part 15.247 of the FCC Rules using ANSI C63.10:2013 and KDB558074 standards. The test results found in this test report relate only to the items tested.



4 EUT INFORMATION AND DATA

4.1 Equipment Under Test:

Product: **Radio Module**

Model: **RFM95CW**

Serial No.: **None Specified**

FCC ID: **2A4BT-SK01**

Host: Heads Up SKI-1, Model SK001 - Contains FCC IDs: 2A4BT-SK01, 2AC7ZESPWROOM32D

4.2 Trade Name:

Heads Up Goggles, LLC

4.3 Power Supply:

No power supply is provided with the product.

4.4 Applicable Rules:

CFR 47, Part 15.247, subpart C

4.5 Equipment Category:

Radio Module-DTS

4.6 Antenna:

Molex Flexible 915 MHz Antenna with a 1dBi gain

4.7 Accessories:

Device	Manufacturer	Model Number	Serial Number
Heads Up SKI-1	Heads Up Goggles, LLC	SK001	None Specified

4.8 Test Item Condition:

The equipment to be tested was received in good condition.

4.9 Testing Algorithm:

The equipment was fully exercised with all cabling attached to the EUT and was positioned in all three orthogonal positions for maximum emissions. While the equipment was energized, the receiving antenna was scanned from 1.0 meter to 4.0 meters in both vertical and horizontal polarities while the turntable was adjusted 360 degrees to determine the maximum field strength.

**5 LIST OF MEASUREMENT INSTRUMENTATION**

Equipment Type	Asset Number	Manufacturer	Model	Serial Number	Calibration Due Date
Shielded Chamber	CL166-E	AlbatrossProjects	B83117-DF435-T261	US140023	2022-03-09
Temp/Hum. Recorder	CL262	Extech	445814	05	2022-03-19
Receiver	CL151	Rohde & Schwarz	ESU40	100319	2022-07-08
Horn Antenna	CL098	Emco	3115	9809-5580	2023-01-26
Pre-Amplifier	CL250	Com-Power	PAM-118A	18040011	2022-07-07
Pre-Amplifier	CL285	AH Systems	PAM-0307	322	2022-07-08
Antenna, JB3 Combination	CL175	Sunol Sciences	JB3	A030315	2022-09-14
Amplifier w/Monopole & 18"	CL163-Loop	A.H. Systems, Inc.	EHA-52B	100	2022-09-14
Low Loss Cable Set	CL178, CL286	Pasternack	PE3C0666-252 / PE3C066-50CM	None Spec.	2023-10-12
Pre-Amplifier	CL153	Agilent	83006-69007	MY57280115	2022-02-12
Antenna, Horn	CL114	A. H. Systems, Inc.	SAS-572	237	2023-07-30
Software:	Tile Version 3.4.B.3.		Software Verified: 2021-11-01, 2022-02-10		
Software:	EMC 32, Version 8.53.0		Software Verified: 2022-02-10		
Temp/Hum. Recorder	CL234	Extech	445814	03	2022-03-08
Spectrum Analyzer	0141	Hewlett Packard	8591E	3520A04145	2022-05-07
Transient Limiter	0202	Hewlett Packard	11947A	3107A00729	2022-02-04
LISN	CL181	Com-Power	LI-125A	191226	2023-12-01
LISN	CL182	Com-Power	LI-125A	191225	2023-12-01



6 RADIATED SPURIOUS EMISSIONS

Radiated emissions were measured in a Semi-Anechoic Chamber. All emissions generated that fall in the restricted bands per FCC Part 15.205 were examined.

6.1 Requirements:

All emissions that fall in the restricted bands defined in FCC Part 15.205 shall not exceed the maximum field strength listed in FCC Part 15.209(a).



6.2 Radiated Spurious Emissions Test Data

Test Date(s):	2022-01-18; 2022-02-10	Test Engineer:	J. Chiller
Standard(s):	CFR 47 Part 15.247(d); Part 15.209 / KDB558074	Air Temperature:	20.1°C
		Relative Humidity:	26%

Notes: Plots are peak, max hold prescan data included only to determine what frequencies to investigate and measure. The EUT was initially placed in a semi-anechoic chamber and rotated in all three orthogonal positions to maximize the emissions. Characterization measurements were then performed to determine at which frequencies significant emissions occurred. These graphs are shown below.

The equipment was fully exercised with all cabling attached to the EUT and was positioned for maximum emissions. While the equipment was energized, the receiving antenna was scanned from 1.0 meter to 4.0 meters in both vertical and horizontal polarities while the turntable was adjusted 360 degrees to determine the maximum field strength. The tables of measured results can be found below.

Emissions to be found by the EUT were measured and listed in tables. The plots are for reference only and the limit lines are not actual limit lines but merely a guide.

Scans were made on all three channels and table of results includes measurements from all three channels. Plots are just of worse case channel.



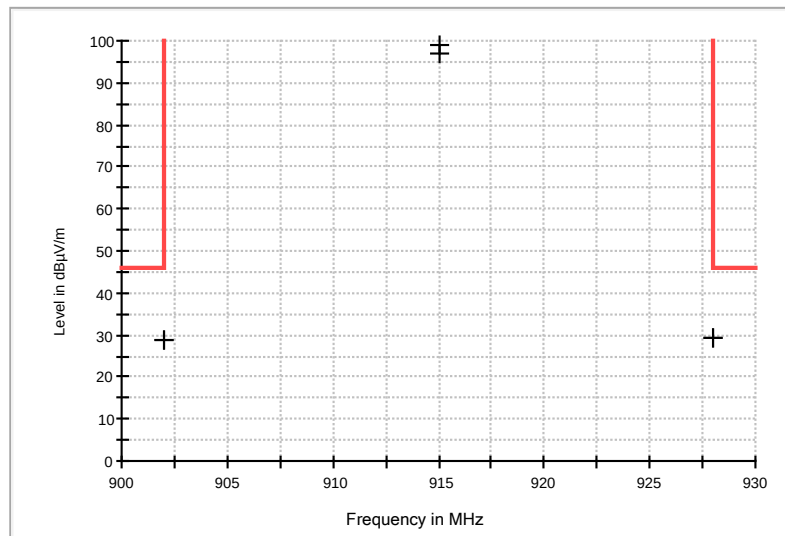
Order Number: F2P26715A

Applicant: Heads Up Goggles, LLC

Model: RFM95CW

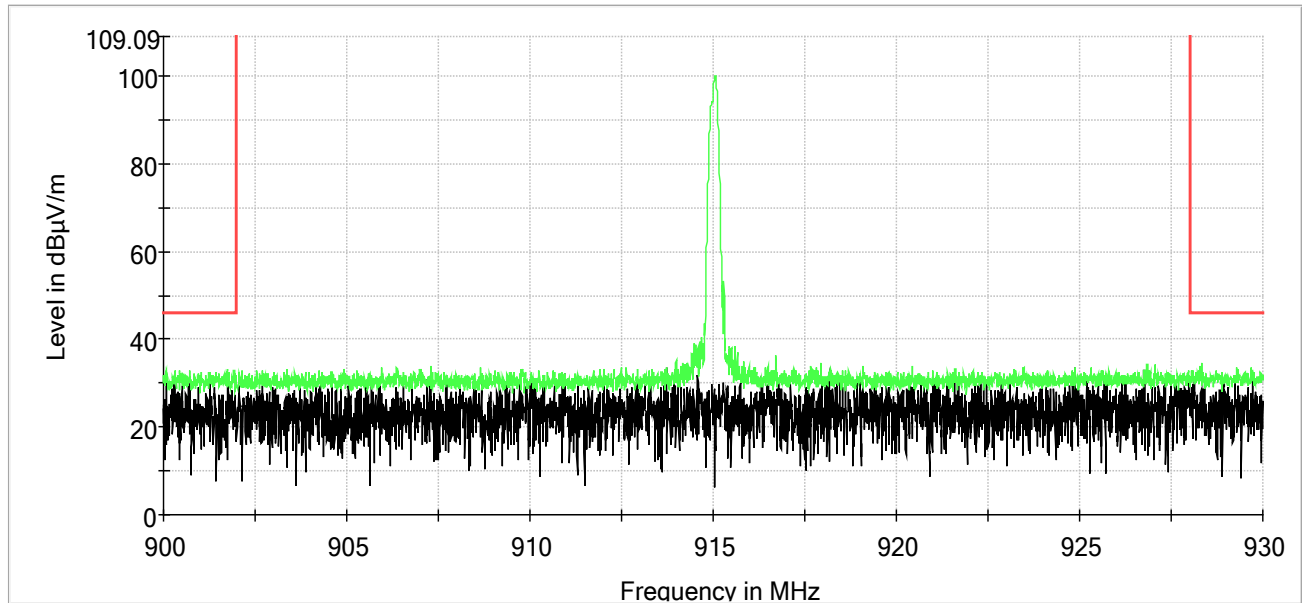
Band Edge Measurements

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (degrees)	Reading (dBμV)	Correction Factors (dB)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
902.000000	H	100.00	0.00	24.3	4.4	28.70	46.0	-17.3
902.000000	V	100.00	0.00	24.3	4.4	28.70	46.0	-17.3
915.000000	H	100.00	1.00	92.6	4.5	97.10	--	--
915.000000	V	100.00	0.00	94.6	4.5	99.10	--	--
928.000000	H	100.00	0.00	24.5	4.9	29.40	46.0	-16.6
928.000000	V	100.00	0.00	24.5	4.9	29.40	46.0	-16.6

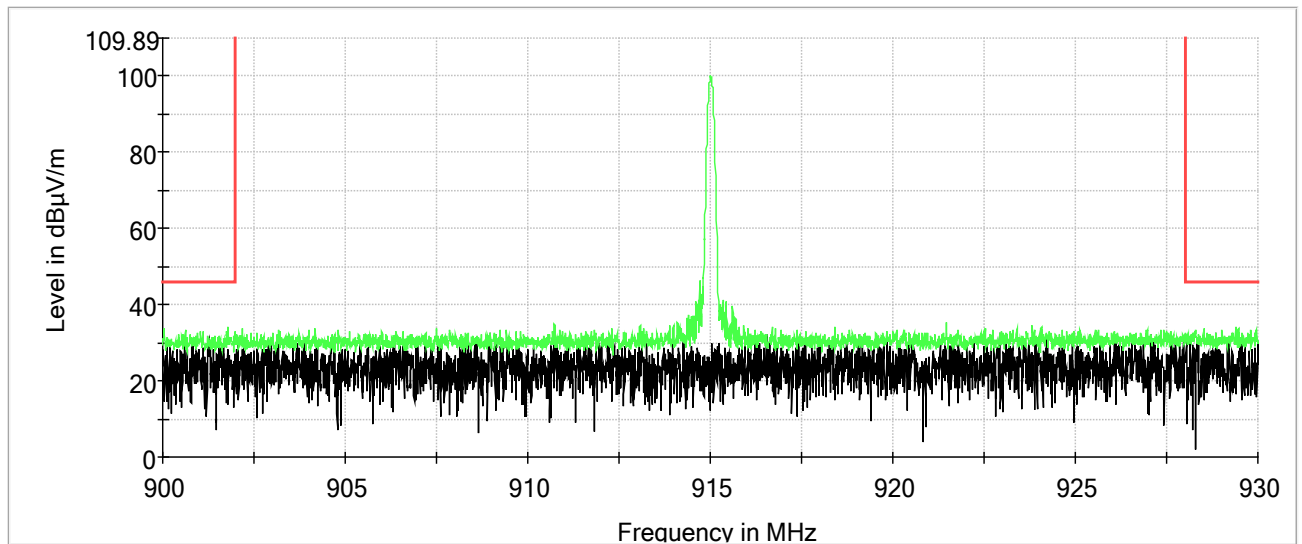




915 MHz, Band Edge, Vertical



915 MHz, Band Edge, Horizontal



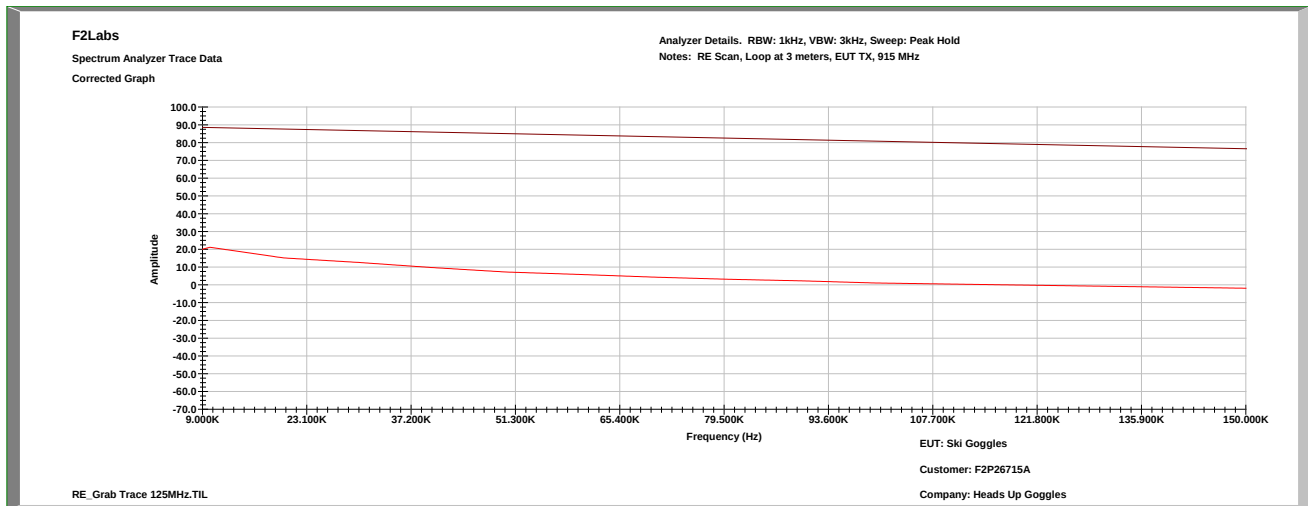


Order Number: F2P26715A

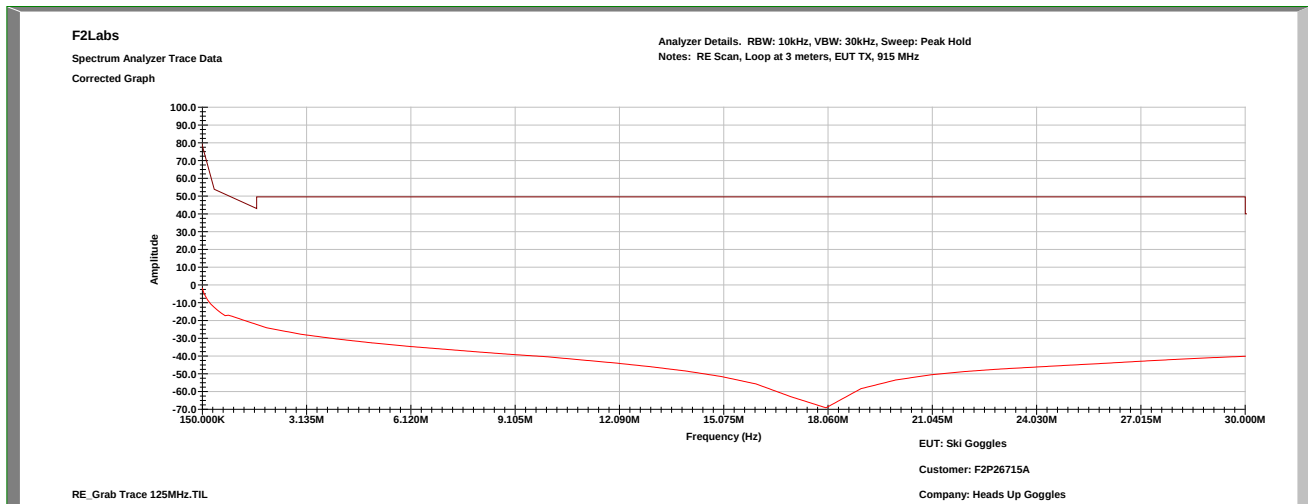
Applicant: Heads Up Goggles, LLC

Model: RFM95CW

915 MHz, Characterization Scan: 0.009 MHz to 0.15 MHz



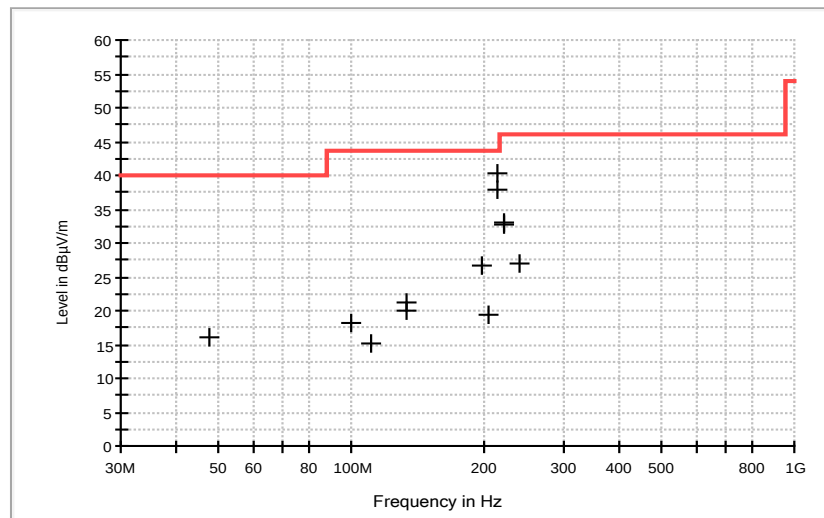
915 MHz, Characterization Scan: 0.15 MHz to 30 MHz





30 MHz to 1000 MHz

Frequency (MHz)	Antenna Polarization	Antenna Height (cm)	Azimuth (degrees)	Reading (dBμV)	Correction Factors (dB)	Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
47.840000	V	100.00	58.00	29.7	-13.5	16.20	40.00	-23.8
99.840000	V	100.00	319.00	30.3	-12.0	18.30	43.50	-25.2
110.520000	V	100.00	40.00	24.6	-9.5	15.10	43.50	-28.4
133.200000	V	100.00	0.00	29.6	-8.4	21.20	43.50	-22.3
133.200000	H	100.00	18.00	28.4	-8.4	20.00	43.50	-23.5
196.080000	H	100.00	325.00	35.8	-9.2	26.60	43.50	-16.9
203.840000	V	100.00	254.00	29.0	-9.7	19.30	43.50	-24.2
211.960000	H	100.00	85.00	48.6	-10.7	37.90	43.50	-5.6
211.960000	V	100.00	0.00	51.0	-10.7	40.30	43.50	-3.2
219.920000	H	100.00	62.00	43.3	-10.3	33.00	46.00	-13.0
219.920000	V	100.00	0.00	43.0	-10.3	32.70	46.00	-13.3
239.920000	H	100.00	52.00	36.3	-9.5	26.80	46.00	-19.2



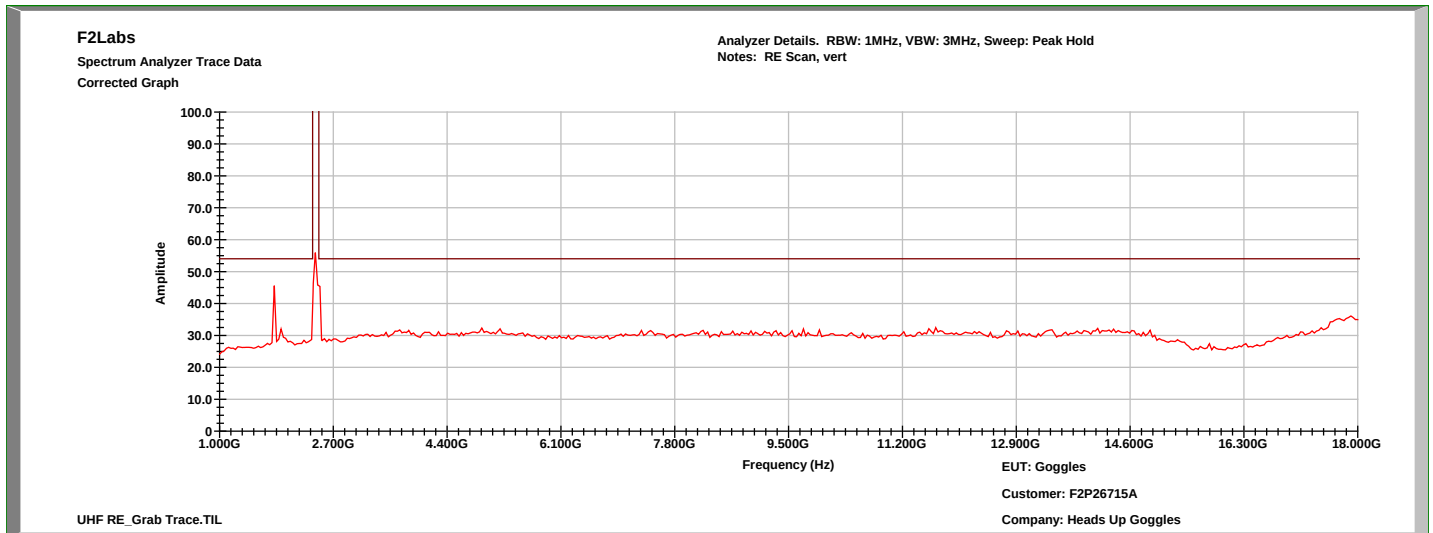


Order Number: F2P26715A

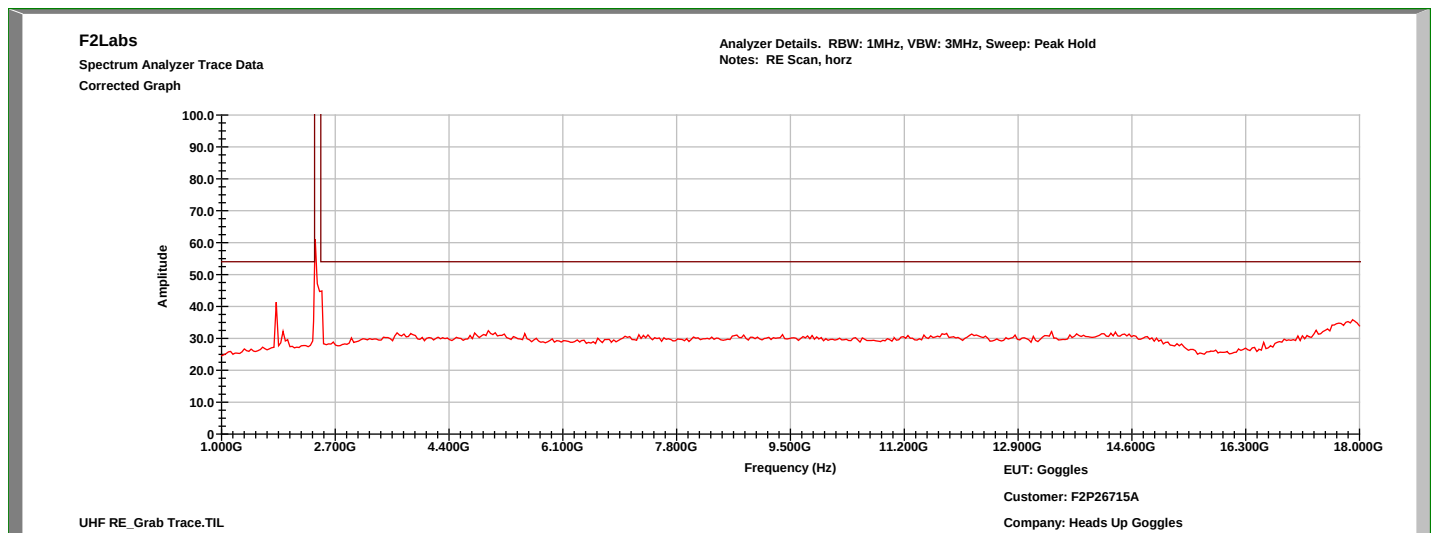
Applicant: Heads Up Goggles, LLC

Model: RFM95CW

Characterization Scan, 1 to 18 GHz, Vertical



Characterization Scan, 1 to 18 GHz, Horizontal



NOTE: The EUT also utilizes certified Bluetooth module FCC ID: 2AC7ZESPWROOM32D, which can be seen in the plots above.



7 CONDUCTED EMISSIONS

7.1 Requirements

In accordance with FCC CFR 47 Part 15.207(a), "Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator 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 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

7.2 Procedure

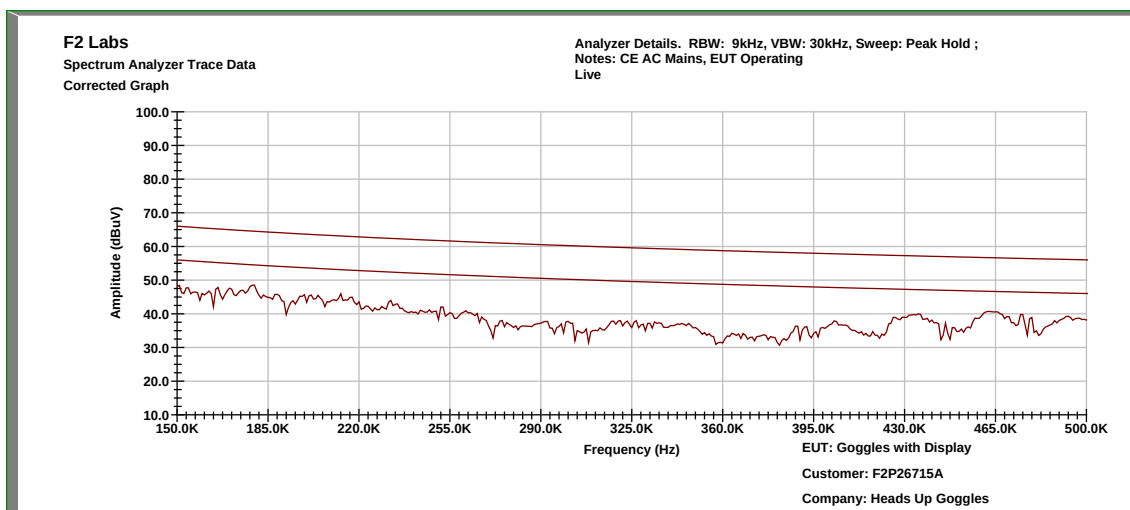
The EUT was placed on a 1.0 x 1.5 meter non-conductive table, 0.8 meter above a horizontal ground plane and 0.4 meter from a vertical ground plane. Power was provided to the EUT through a LISN bonded to a 3 x 2 meter ground plane. The LISN and peripherals were supplied power through a filtered AC power source. The output of the LISN was connected to the input of the receiver via a transient limiter, and emissions in the range 150 kHz to 30 MHz were measured. The measurements were recorded using the quasi-peak and average detectors as directed by the standard, and the resolution bandwidth during testing was 9 kHz. The raw measurements were corrected to allow for attenuation from the LISN, transient limiter and cables.



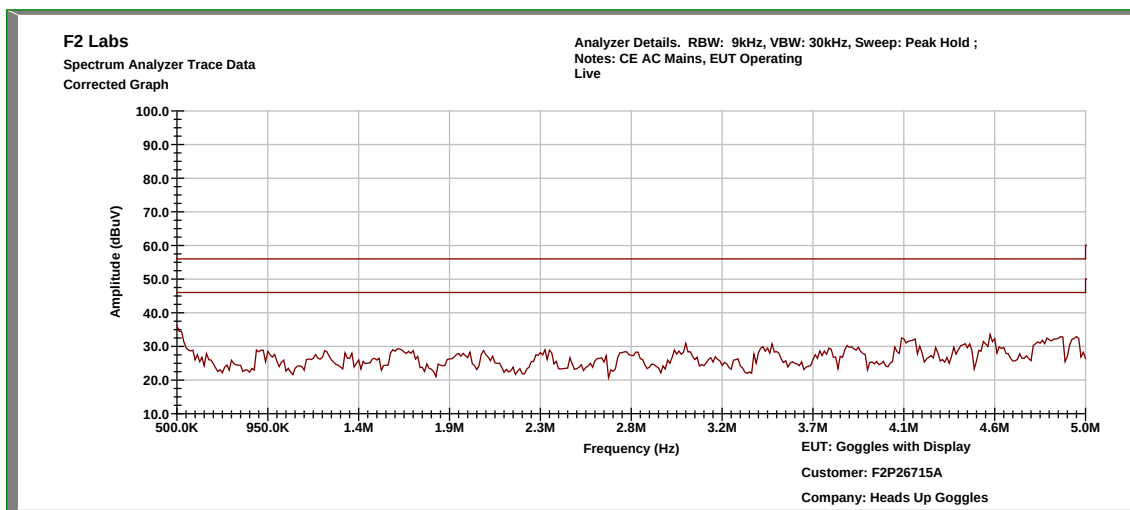
7.3 Conducted Emissions Test Data

Test Date:	2021-11-01	Test Engineer:	J. Chiller
Rule:	15.207	Air Temperature:	19.3° C
Test Results:	Complies	Relative Humidity:	50%

Conducted Test – Live: 0.15 MHz to 0.5 MHz



Conducted Test – Live: 0.5 MHz to 5.0 MHz



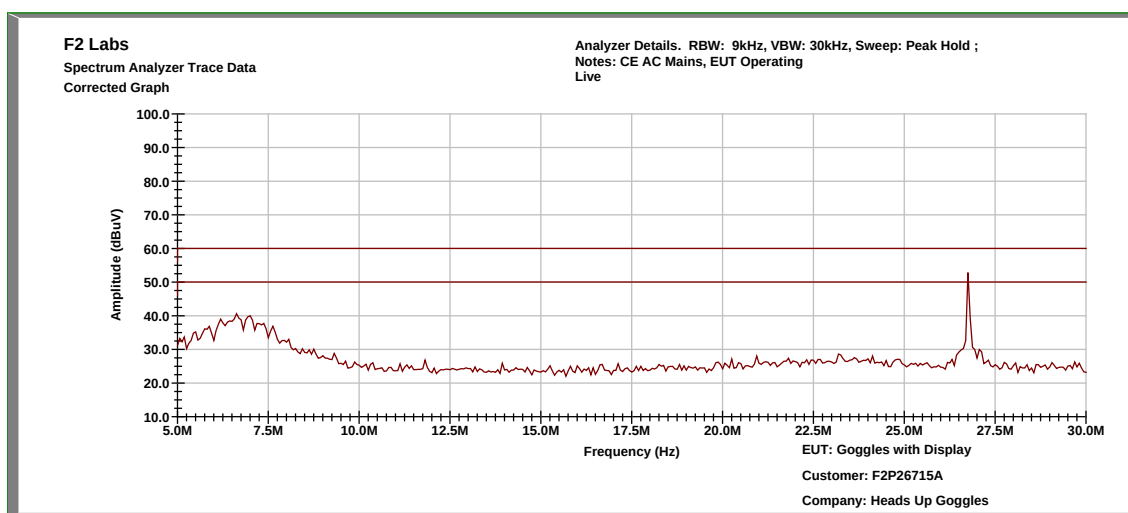


Order Number: F2P26715A

Applicant: Heads Up Goggles, LLC

Model: RFM95CW

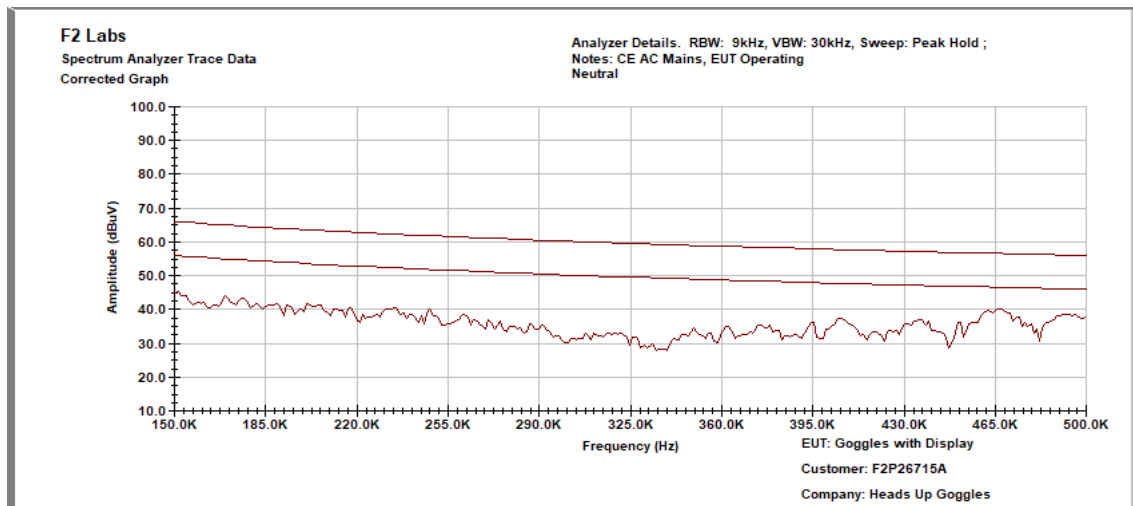
Conducted Test – Live: 5.0 MHz to 30.0 MHz



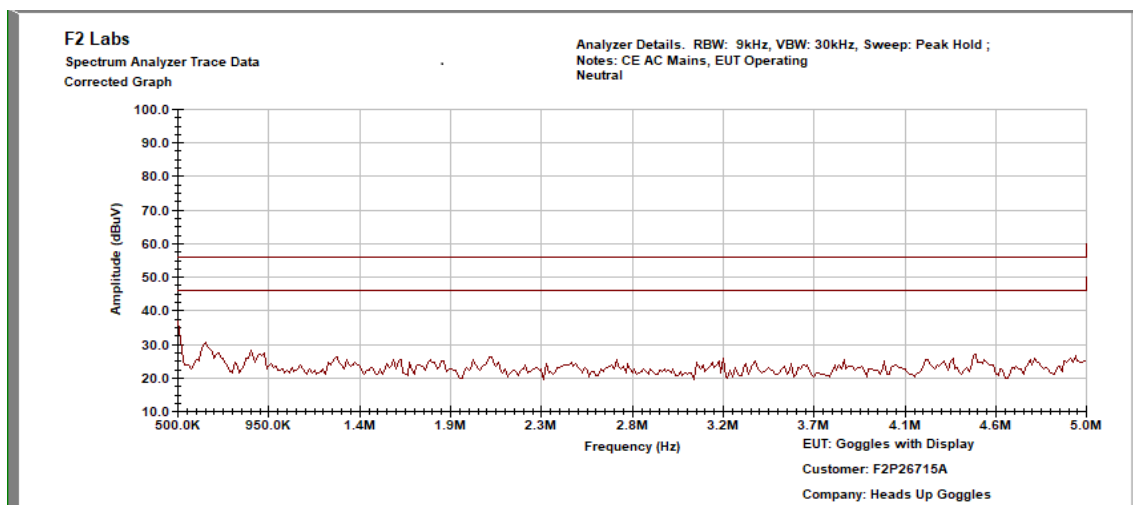
Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBμV)	Adjustment (dB)	Results (dBμV)	Limit (dBμV)	Margin (dB)
1	Live	26.75	Quasi-Peak	37.65	11.759	49.41	60.0	-10.6
			Average	35.20	11.759	46.96	50.0	-3.0



Conducted Test – Neutral: 0.15 MHz to 0.5 MHz



Conducted Test – Neutral: 0.5 MHz to 5.0 MHz



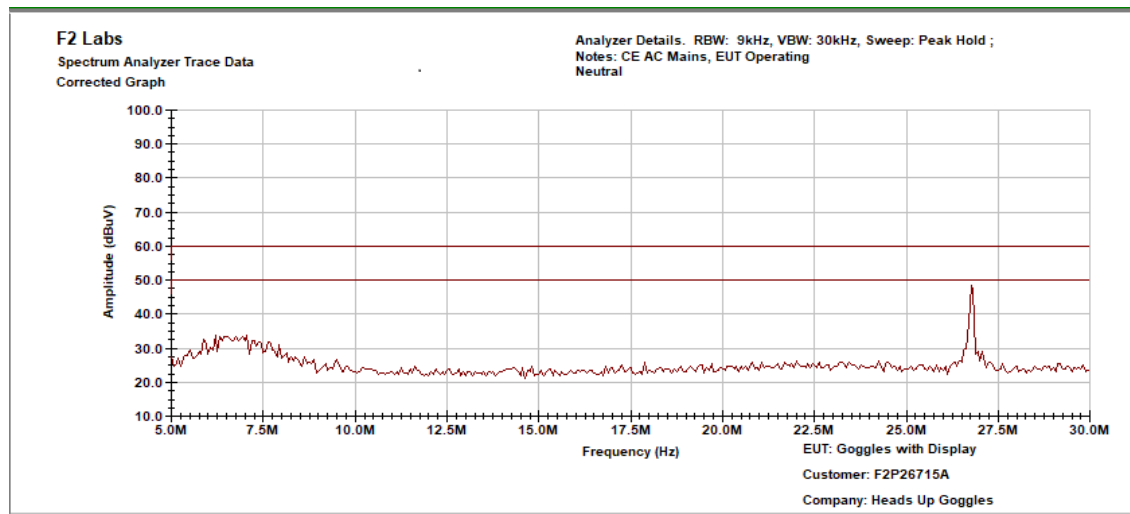


Order Number: F2P26715A

Applicant: Heads Up Goggles, LLC

Model: RFM95CW

Conducted Test – Neutral: 5.0 MHz to 30.0 MHz



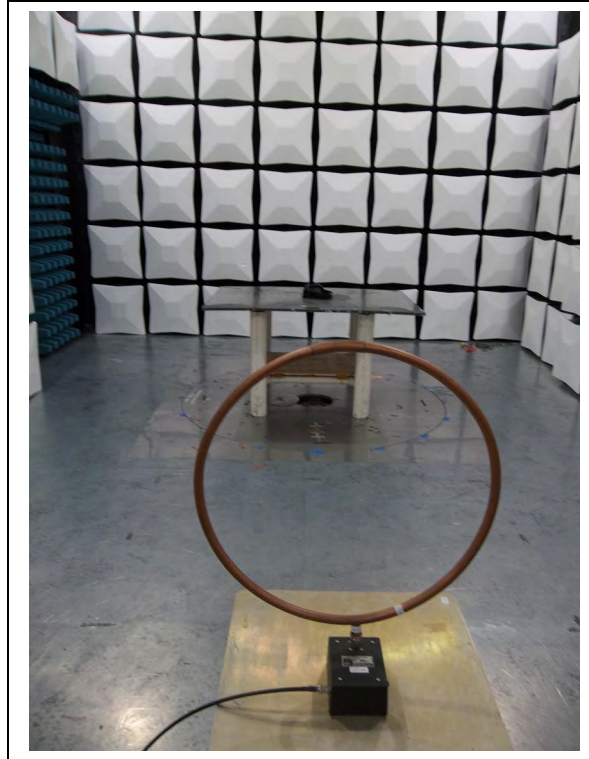
Top Discrete Measurements

No.	Conductor	Frequency (MHz)	Detector	Level (dBμV)	Adjustment (dB)	Results (dBμV)	Limit (dBμV)	Margin (dB)
1	Neutral	26.75	Quasi-Peak	38.96	11.759	50.72	60.0	-9.3
			Average	29.48	11.759	41.24	50.0	-8.8

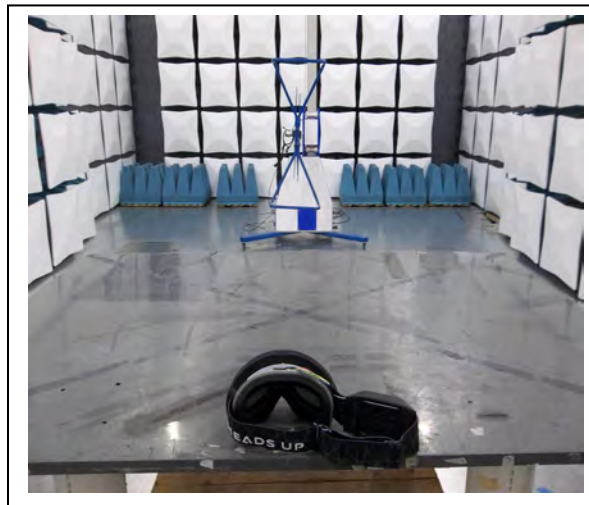


8 PHOTOGRAPHS

Radiated Spurious Emissions, 0.009 MHz to 30 MHz

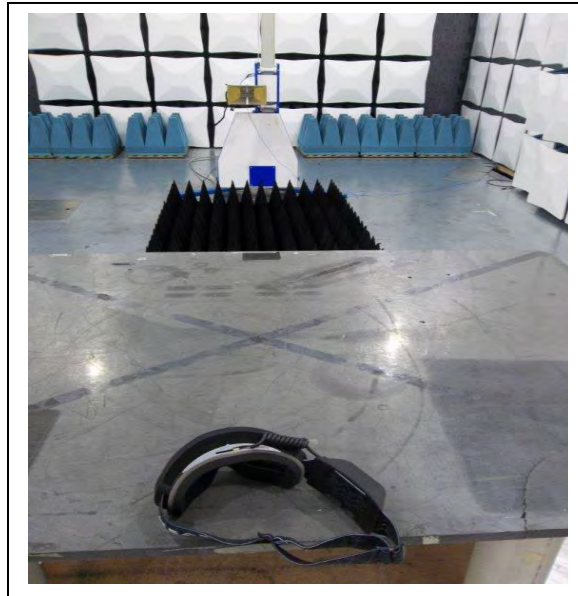


Radiated Spurious Emissions, 30 MHz to 1000 MHz





Radiated Spurious Emissions, 1 GHz to 18 GHz



AC Conducted Emissions

