Project PRJ0050267

Swimmersive Co. dba Zygo
Zygo2H

Wireless Certification Report
Wireless Microphone (VHF) Section

Prepared for:

Swimmersive
16854 Mooncrest Dr
Encino, CA 91436

By

Nemko USA, Inc.
1601 North A.W. Grimes Blvd., Suite B
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21 August 2024

Written by

Veer Patel
Wireless Engineer

ANSI National Accreditation Board
ACCREDITED
ISO/IEC 17025
TESTING LABORATORY

Revision History

Revision Number	Description	Date
Draft 01	Draft for review.	7/10/2024
Final 01	Release to agency	8/2/2024
Final 02	Updated Output Power and Mask data	8/21/2024

Errata:

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Compliance Certificate

FCC MRA Designation Number: US3166
ANAB Accreditation Number: AT-3165.01

Applicant	Device & Test Identification	
Swimmersive Co. dba Zygo 16854 Mooncrest Dr Encino, CA 91436 Certificate Date: 8/21/2024	FCC ID: Industry Canada ID: Model(s): Laboratory Project ID:	2APZQ- ZYGO2H 23961- ZYGO2H Zygo2H PRJ0050267

The device named above was tested utilizing the following documents and found to be in compliance with the required criteria:

Requirement	Reference	Detail
FCC 47 CFR Part 15 C	15.236	47 CFR § 15.236 - Operation of wireless microphones in the bands 54-72 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-698 MHz. [And by reference ETSI EN 300 422-1 V1.4.2 (2011-08)]
FCC 47 CFR Part 15 C	15.236	Radiated emission limits; general requirements.
FCC 47 CFR Part 15 C	15.205	Restricted Bands of Operation
KDB 558074 D01	D01	DTS Measurement Guidance v05r02
KDB 412172	D01	Guidelines for Determining the ERP and EIRP of an RF Transmitting System
OET Bulletin 65*	Edition 97-01, and Supplement C, Ed. 01-01	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
RSS-210	Issue 10 Am 1	Annex G - Low-Power Radio Apparatus Operating in the Television Bands
RSS-Gen	Issue 5 Am 1	General Requirements and Information for the Certification of Radio Apparatus
RSS-102	Issue 5	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

*MPE is reported separately from this document. **Corresponding RSS references are listed in the body of the report.

I, Larry Finn, for Nemko USA, Inc., being familiar with the above requirements and test procedures have reviewed the test setup, measured data, and this report. I believe them to be true and accurate.

Larry Finn
Laboratory Manager

This report has been reviewed and accepted by the Applicant**.** The undersigned is responsible for ensuring that this device will continue to comply with the requirements listed above.

_____
Representative of Applicant

1.0 Introduction

1.1 Scope

This report describes the extent to which the equipment under test (EUT) conformed to the intentional radiator requirements of the United States and Canada.

Nemko USA, Inc. follows the guidelines of National Institute of Standards and Technology (NIST) for all uncertainty calculations, estimates, and expressions thereof for electromagnetic compatibility testing.

1.2 EUT Description

Table 1.2.1: Equipment Under Test		
Manufacturer / Model	**Serial #**	**Description**
Swimmersive Model: Zygo2H	none	HS PCBA prototype w/W.FL VHF RF connector and battery leads.

Table 1.2.2: Support Equipment		
Manufacturer / Model	**Serial #**	**Description**
None		

This device is a hand-held remote wireless microphone use in training aquatic athletes by sending the coach's instructions, or other recorded audio, over the air (VHF) to headset receivers worn by the athletes.

This report concerns the wireless microphone transmitter in the headset unit.

This device is powered by an internal 3.7 V Li-Ion battery that is recharged on a cradle then via cable to a USB power source.

1.3 EUT Operation

The EUT was exercised in a manner consistent with normal operations. Antenna connectors were added to the test samples only to allow conducted measurements.

1.4 Modifications to Equipment

None.

1.5 Test Site

Measurements were made at the Nemko USA, Inc. semi-anechoic facility (FCC US3166, IC 3036B-1) in Round Rock, Texas. The site is registered with the FCC under Section 2.948 and Industry Canada per RSS-GEN, and is subsequently confirmed by laboratory accreditation (ANAB). The test site is located at at 1601 North A.W. Grimes Boulevard, Suite B, Round Rock, Texas, 78665. CAB Identifier: US 0123.

1.6 Radiated Measurements

Table 1.6 1 Measurement Corrections	
Parameter	**From Sums Of**
Radiated Field Strength	Raw Measured Level + Antenna Factor + Cable Losses – Amplifier Gain
Conducted Antenna Port	Raw Measured Level + Attenuator Factor + Cable Losses
Conducted Mains Port	Raw Measured Level + LISN Factor + Cable/Filter/Limiter Losses

Additionally, measurement distance extrapolation factors (such as 1/d above 30 MHz) are applied and documented where used.

1.7 Applicable Documents and Clauses

Table 1.7.1: Applicable Documents	
Document	**Title**
47 CFR	Part 15 – Radio Frequency Devices Subpart C - Intentional Radiators
RSS-210 Issue 9 Annex G	Low-Power Radio Apparatus Operating in the Television Bands
ETSI EN 300 422-1 V1.4.2 (2011-08)	Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless microphones in the 25 MHz to 3 GHz frequency range; Part 1: Technical characteristics and methods of measurement European Standard
RSS-Gen Issue 5	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10:2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

2.0 Fundamental Power

2.1 Test Procedure

Peak power is measured using the conducted method at the antenna port.

2.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
15.236 // RSS-210 Annex G.3.1	EIRP Fundamental Power 50 mW (16.99dBm) -50% to +20% of declared power	08/20/2024

2.3 Test Results, Peak Power

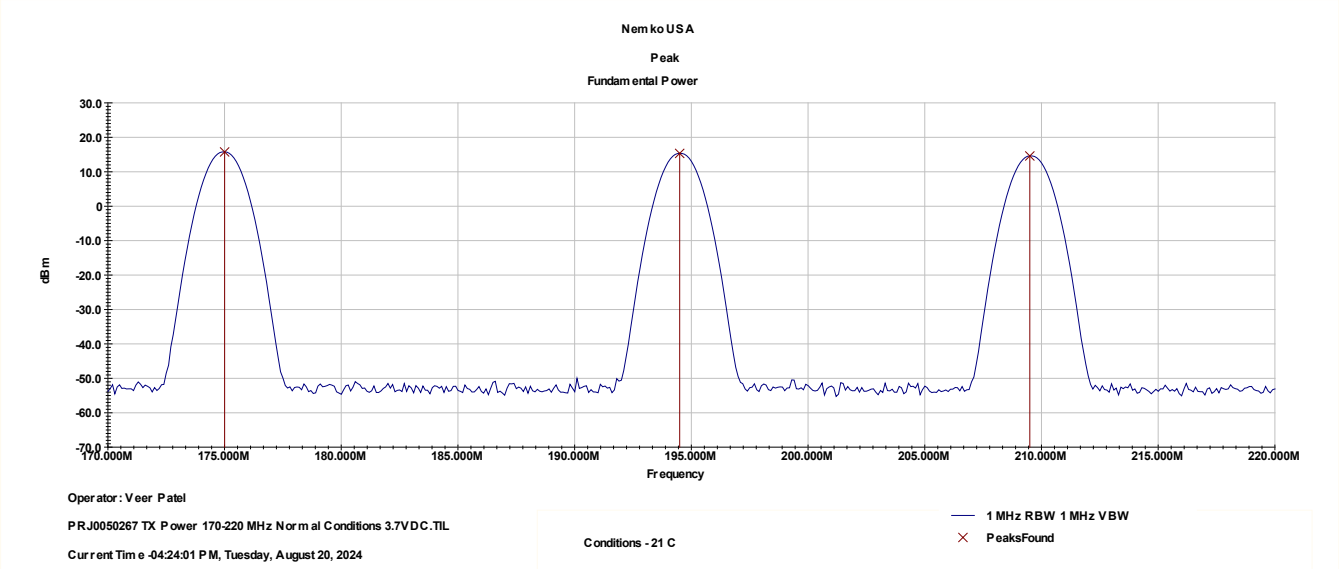
Measured in 1 MHz RBW, 1 MHz VBW.

Table 2.3.2 EIRP Power
Declared: 25 mW
Limits: +20% = 30 mW, -50% = 12.5 mW

Frequency MHz	Highest Measured Conducted Antenna Port Power dBm	Antenna Gain dBi	EIRP Power dBm	EIRP Power mW
175.0	15.736	-1.39	14.346	27.20
194.5	15.314	-1.39	13.924	24.68
209.5	14.565	-1.39	13.175	20.77

The EUT satisfied the requirement.

2.3.1 RF Output Power



3.0 Frequency Stability

3.1 Test Procedure

Frequency is measured with EUT acclimated to temperature and operating voltage extremes.

3.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
15.236 // RSS-210 Annex G.3.1	Frequency Stability +/- 0.005% or +/- 8.77 kHz	6 May 2024

3.3 Test Results

The EUT satisfied the requirements.

Table 3.3.1 Frequency Stability in MHz
Measured in 100 Hz RBW

Temperature	Voltage	Bottom Channel 175.5	Middle Channel 194.0	Top Channel 214.5
-20 C	3.3 V	175.4965	193.99611	214.495914
-20 C	3.7 V	175.496663	193.99581	214.495330
20 C	3.7 V	175.4960	193.9956	214.495160
50 C	3.7 V	175.49616	193.995739	214.49522
50 C	3.3 V	175.496060	193.99561	214.49528
Maximum Frequency Error (MHz):		0.004	0.0044	0.0048

4.0 Necessary Bandwidth Mask

4.1 Test Procedure

Bandwidth is measured by conducted means. A recording of the results is included.

4.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.236 // RSS-210 Annex G.3.1	Necessary BW Mask	08/20/2024

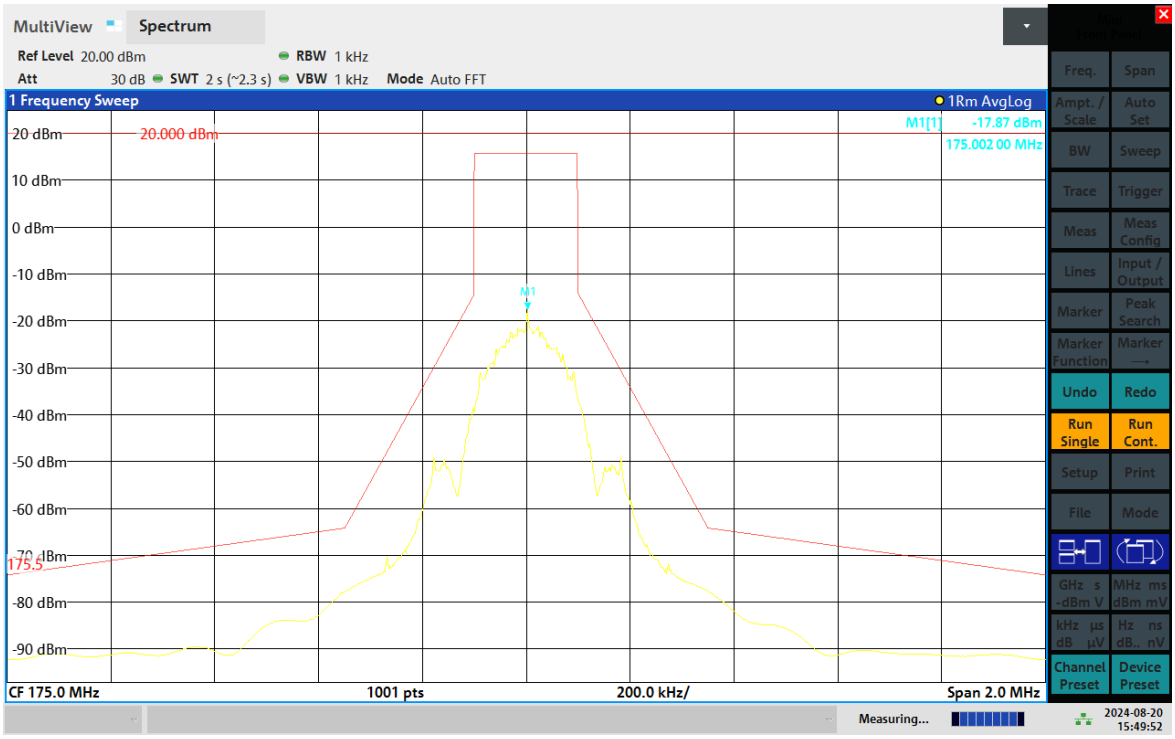
4.3 Test Results

4.3.1 Step 1: Zero Span Power, Modulated

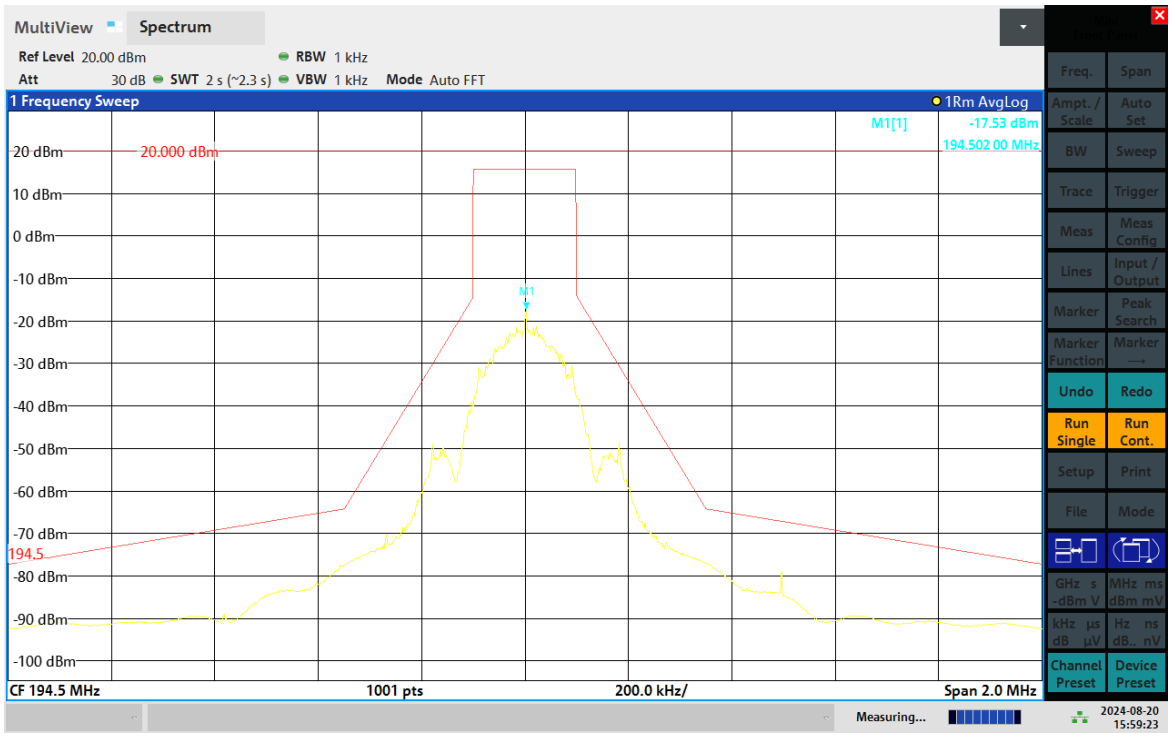
Table 4.3.1 Power in Zero Span with Modulation 100 Video Averages, Sweep Time 2 seconds, RBW/VBW 1 MHz		
Bottom Channel dBm	**Middle Channel dBm**	**Top Channel dBm**
15.81	15.78	14.61

Mask plots are presented below. The EUT satisfied the requirements.

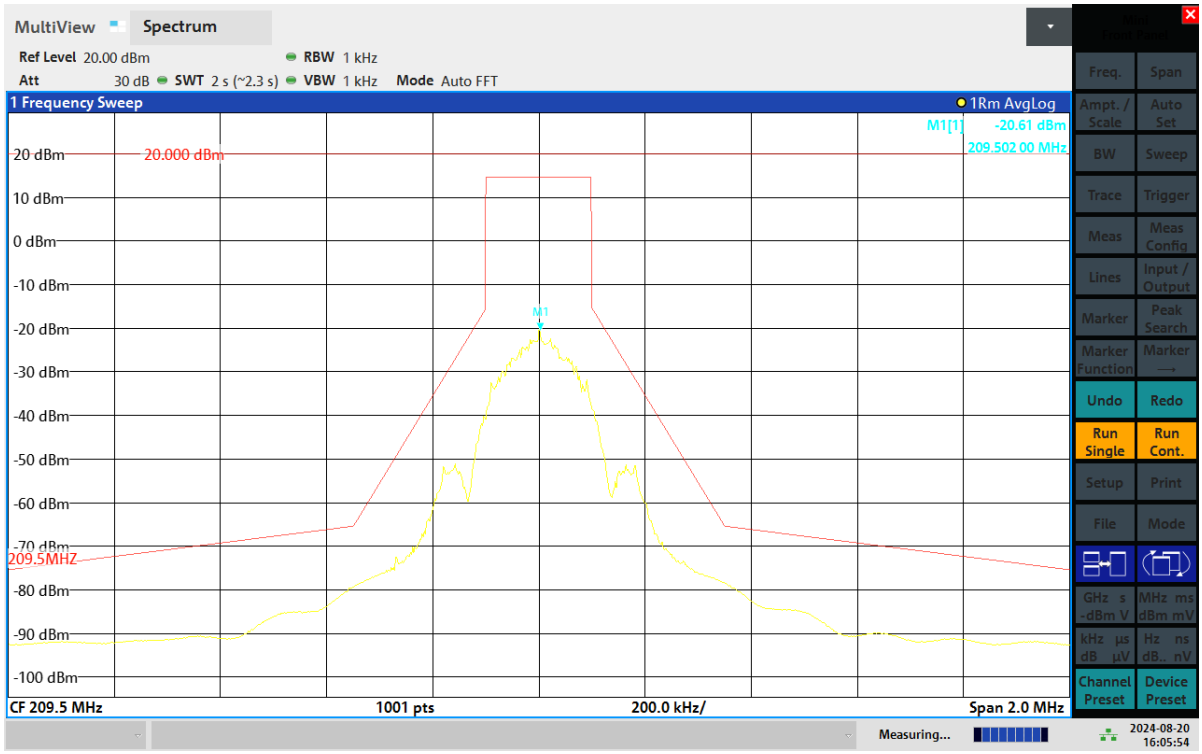
4.3.2 Step 2, 3: Mask, Max Hold



175MHz



194.5MHz


MultiView
Spectrum
Ref Level 20.00 dBm
RBW 1 kHz
Att 30 dB SWT 2 s (~2.3 s) VBW 1 kHz Mode Auto FFT
1 Frequency Sweep
1Rm AvgLog
M1[1] -20.61 dBm
209.502 00 MHz
20.000 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
209.5MHZ
-80 dBm
-90 dBm
-100 dBm
M1
CF 209.5 MHz
1001 pts
200.0 kHz/
Span 2.0 MHz
Measuring...
2024-08-20
16:05:54
Freq.
Span
Ampt. / Scale
Auto Set
BW
Sweep
Trace
Trigger
Meas
Meas Config
Lines
Input / Output
Marker
Peak Search
Marker Function
Undo
Redo
Run Single
Run Cont.
Setup
Print
File
Mode
Channel Preset
Device Preset

209.5MHz

5.0 Radiated Spurious Emissions

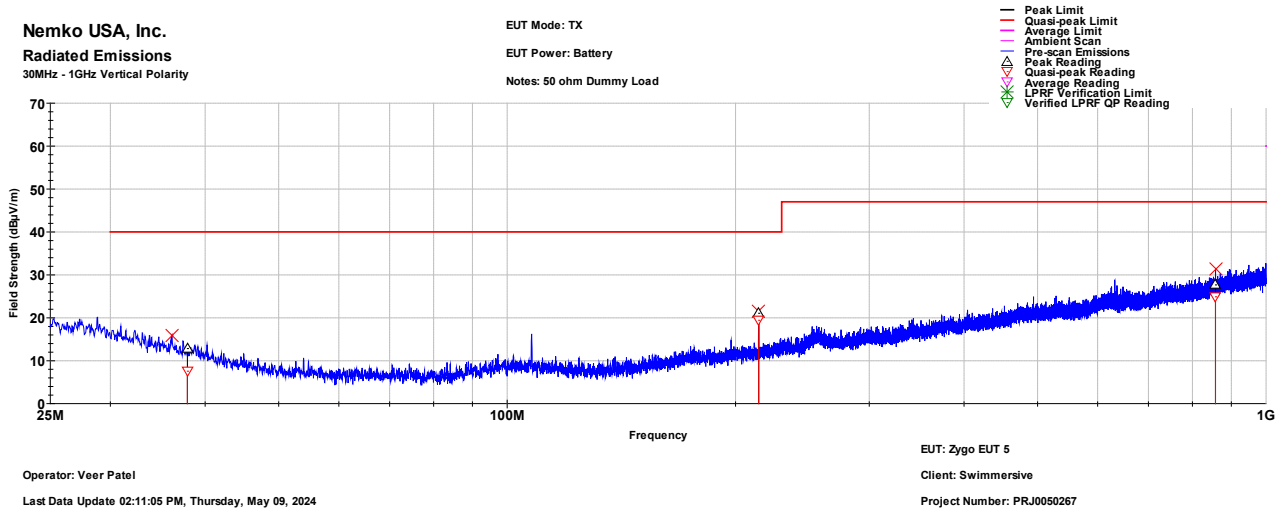
5.1 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.236 // RSS-210 Annex G.3.1	Radiated Spurious Emissions	05/06/2024

5.2 Test Results

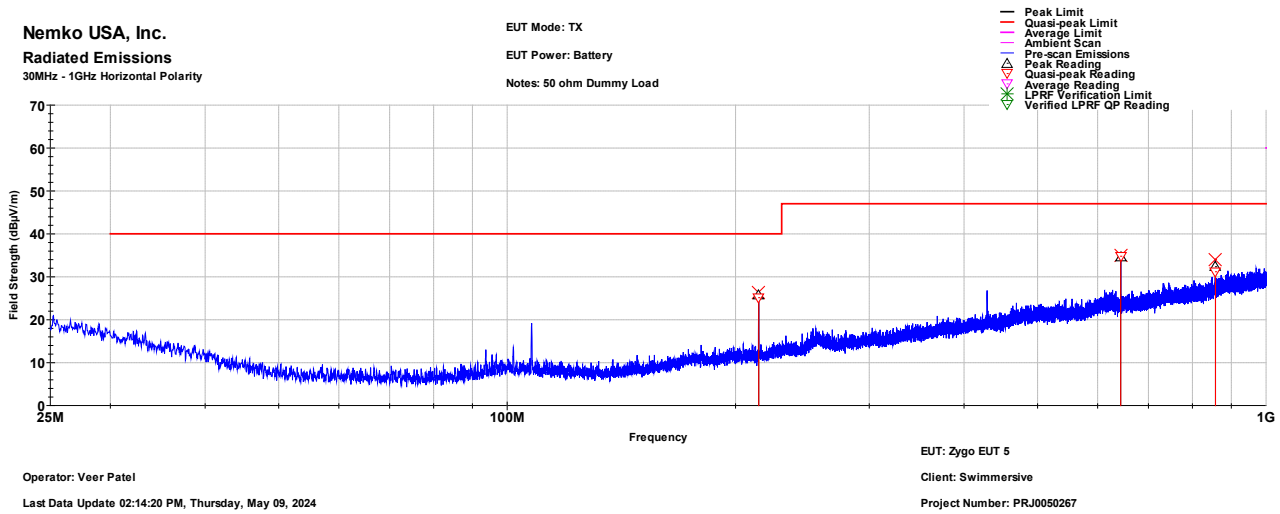
5.3 Low Channel

30MHz - 1GHz Vertical Polarity Measured Emissions Data



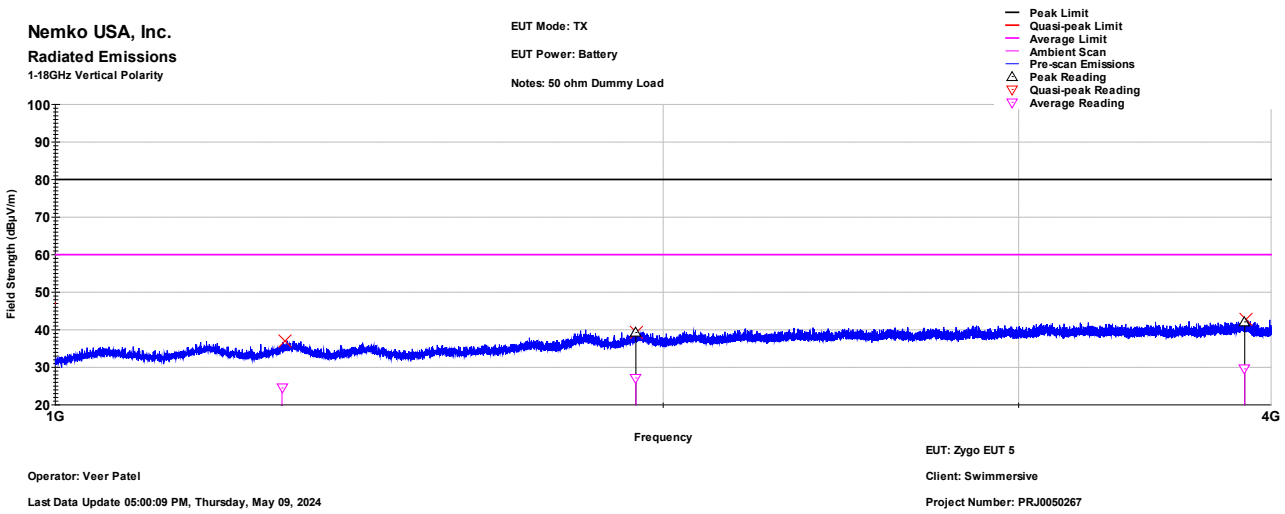
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)
37.896	57.000	174.000	7.551	40.000	-32.449	PASS	12.825
214.524	0.000	121.000	19.397	40.000	-20.603	PASS	21.031
857.972	68.000	210.000	24.864	47.000	-22.136	PASS	27.638

30MHz - 1GHz Horizontal Polarity Measured Emissions Data



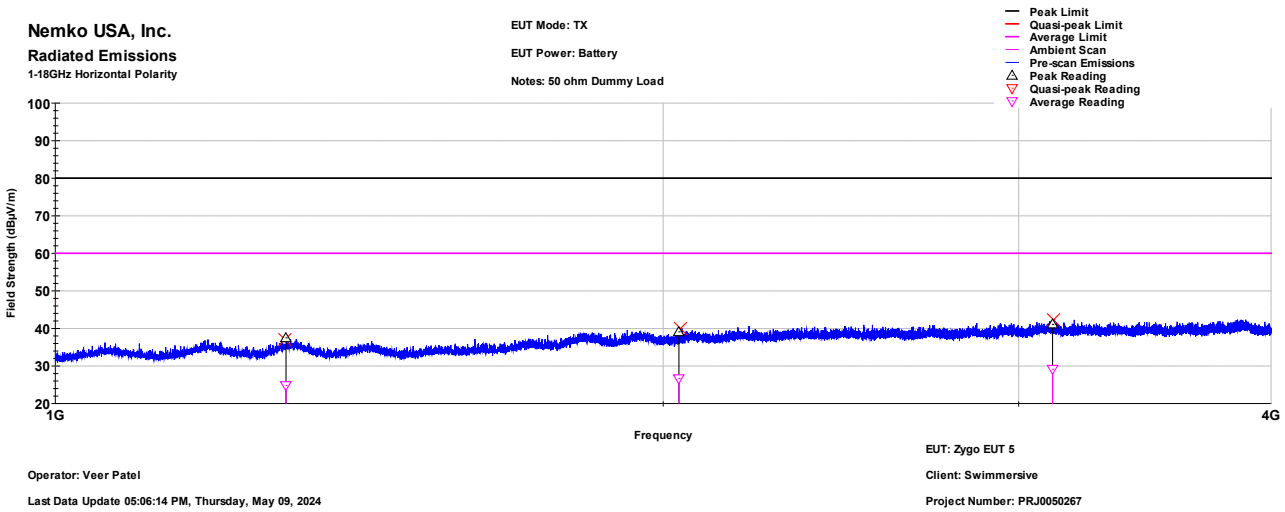
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)
214.515	67.000	379.000	25.127	40.000	-14.873	PASS	25.768
643.496	11.000	100.000	34.767	47.000	-12.233	PASS	34.551
857.972	293.000	100.000	31.166	47.000	-15.834	PASS	32.314

1GHz - 4GHz Vertical Polarity Measured Emissions Data:



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
1295.00	11	114	-904.639	80.000	-984.639	PASS	24.484	60.000	-35.516	PASS
1938.68	289	296	39.263	80.000	-40.737	PASS	27.143	60.000	-32.857	PASS
3881.73	359	276	42.089	80.000	-37.911	PASS	29.569	60.000	-30.431	PASS

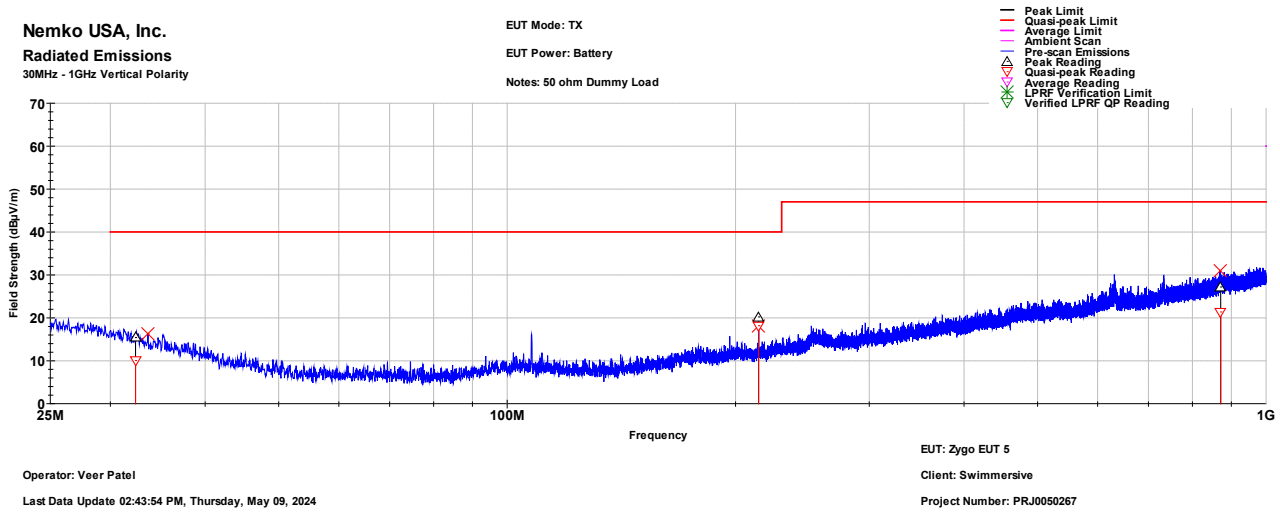
1GHz - 4GHz Horizontal Polarity Measured Emissions Data



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
1300.98	186	185	37.470	80.000	-42.530	PASS	24.799	60.000	-35.201	PASS
2036.44	335	400	39.091	80.000	-40.909	PASS	26.678	60.000	-33.322	PASS
3118.15	0	255	41.052	80.000	-38.948	PASS	29.125	60.000	-30.875	PASS

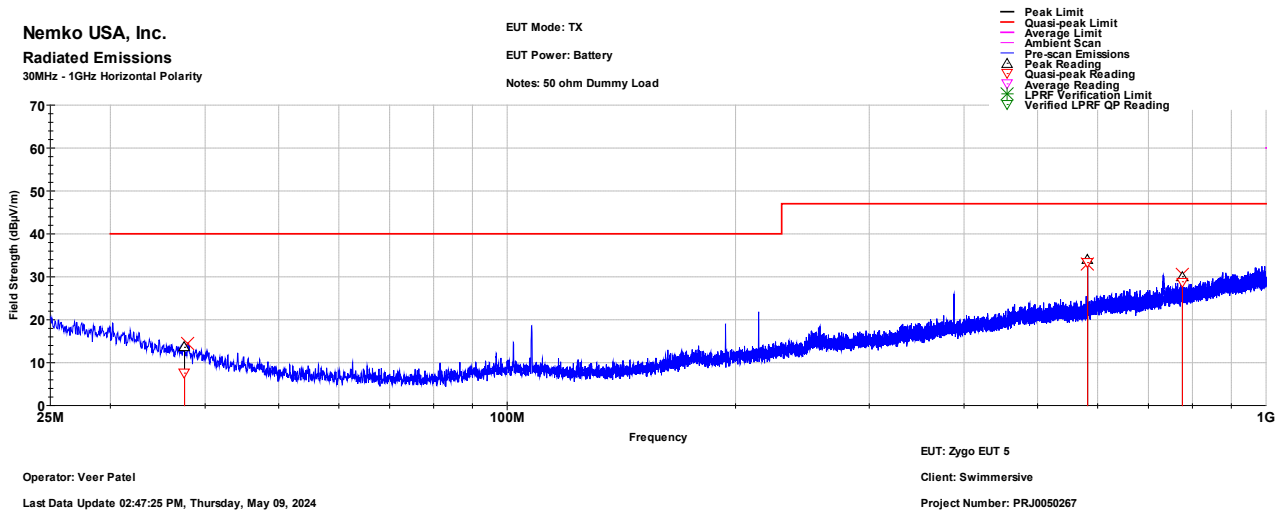
Mid Channel

30MHz - 1GHz Vertical Polarity Measured Emissions Data



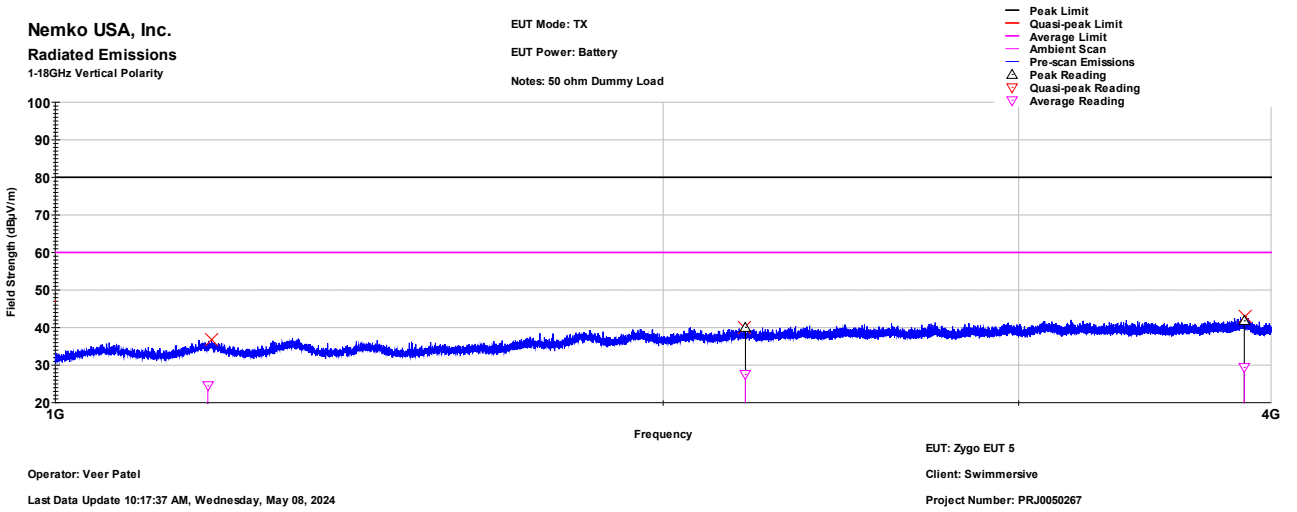
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)
32.384	11.000	284.000	10.049	40.000	-29.951	PASS	15.393
214.470	256.000	227.000	18.168	40.000	-21.832	PASS	20.200
871.493	0.000	100.000	21.362	47.000	-25.638	PASS	27.170

30MHz - 1GHz Horizontal Polarity Measured Emissions Data



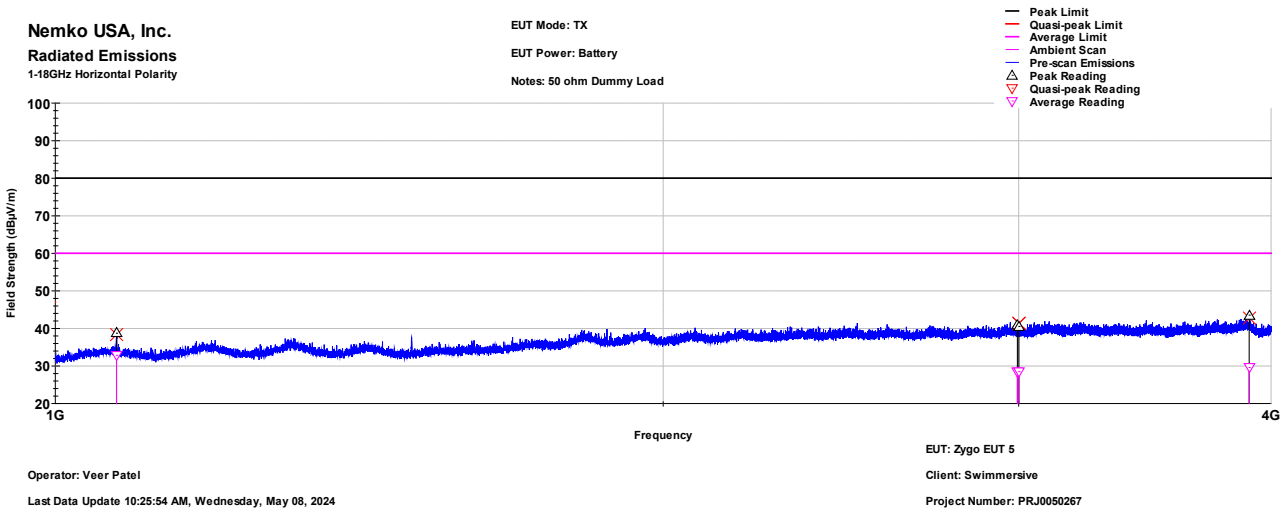
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)
37.572	0.000	383.000	7.528	40.000	-32.472	PASS	13.555
581.998	11.000	129.000	33.296	47.000	-13.704	PASS	33.969
775.976	113.000	121.000	28.840	47.000	-18.160	PASS	30.006

1GHz - 4GHz Vertical Polarity Measured Emissions Data:



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
1190.00	11	205	-905.245	80.000	-985.245	PASS	24.526	60.000	-35.474	PASS
2196.78	32	368	40.039	80.000	-39.961	PASS	27.513	60.000	-32.487	PASS
3879.93	0	116	41.783	80.000	-38.217	PASS	29.343	60.000	-30.657	PASS

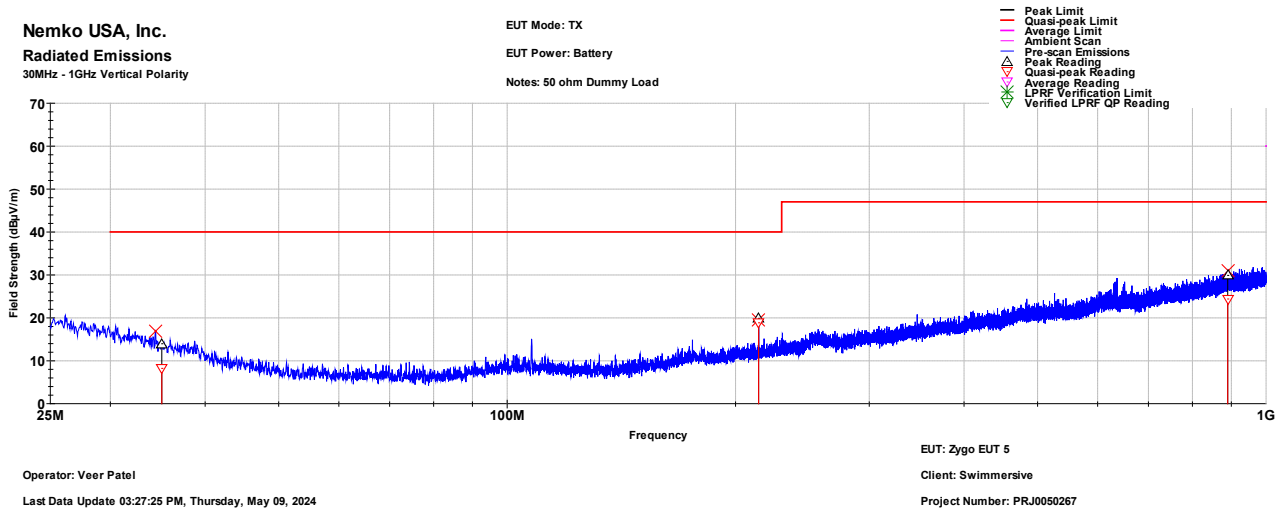
1GHz - 4GHz Horizontal Polarity Measured Emissions Data



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
1072.42	181	266	38.707	80.000	-41.293	PASS	32.845	60.000	-27.155	PASS
2995.46	203	379	40.854	80.000	-39.146	PASS	28.555	60.000	-31.445	PASS
3000.73	186	348	40.503	80.000	-39.497	PASS	28.545	60.000	-31.455	PASS
3901.62	95	255	43.527	80.000	-36.473	PASS	29.566	60.000	-30.434	PASS

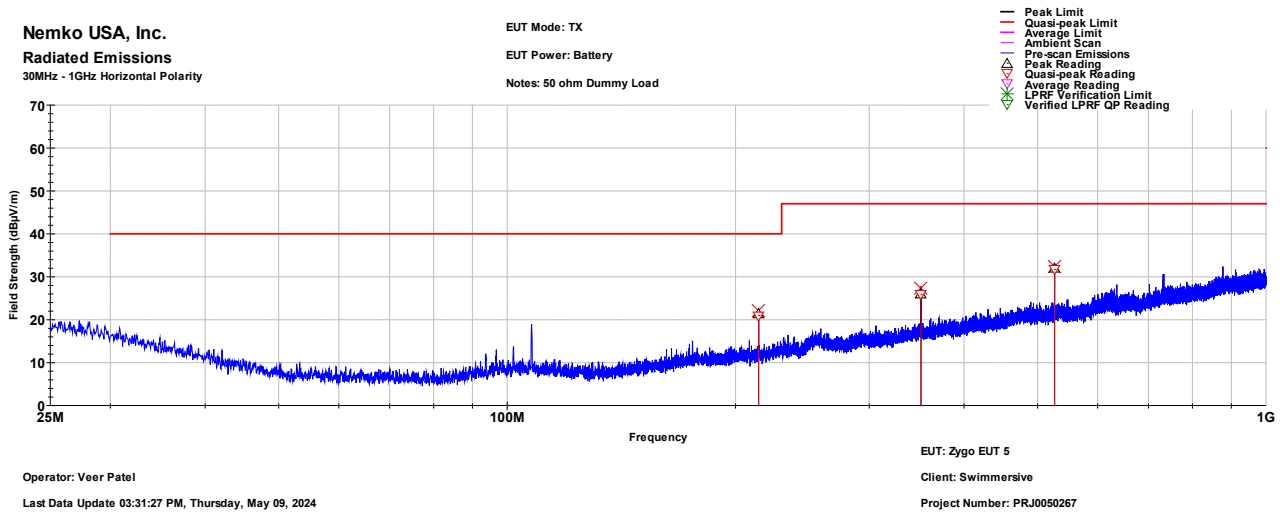
Top Channel

30MHz - 1GHz Vertical Polarity Measured Emissions Data



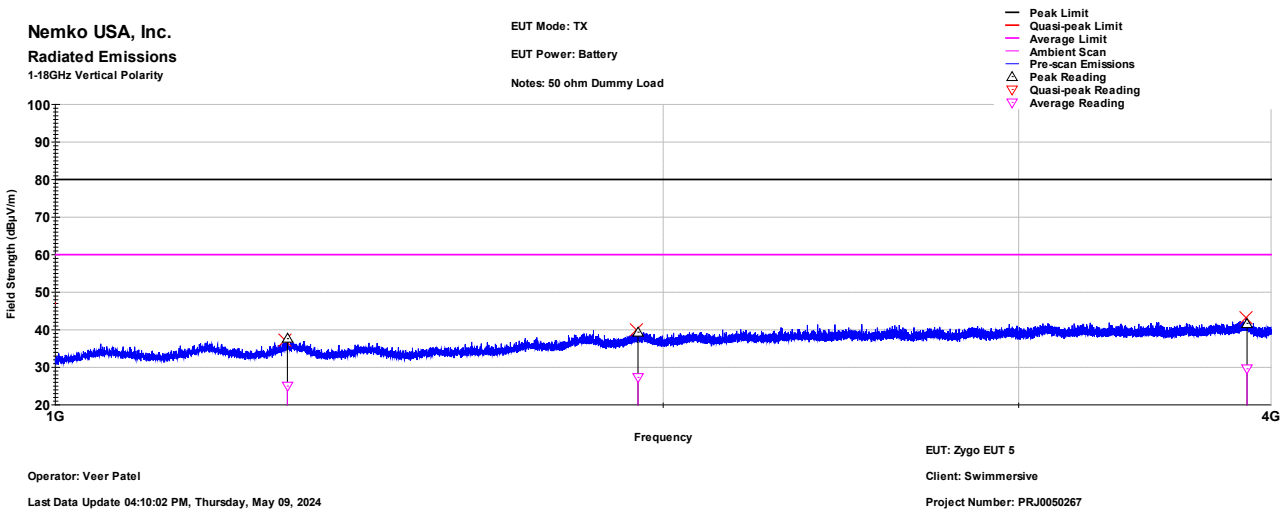
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)
35.069	239.000	251.000	8.213	40.000	-31.787	PASS	13.957
214.491	359.000	227.000	18.840	40.000	-21.160	PASS	19.860
890.324	338.000	250.000	24.388	47.000	-22.612	PASS	29.867

30MHz - 1GHz Horizontal Polarity Measured Emissions Data



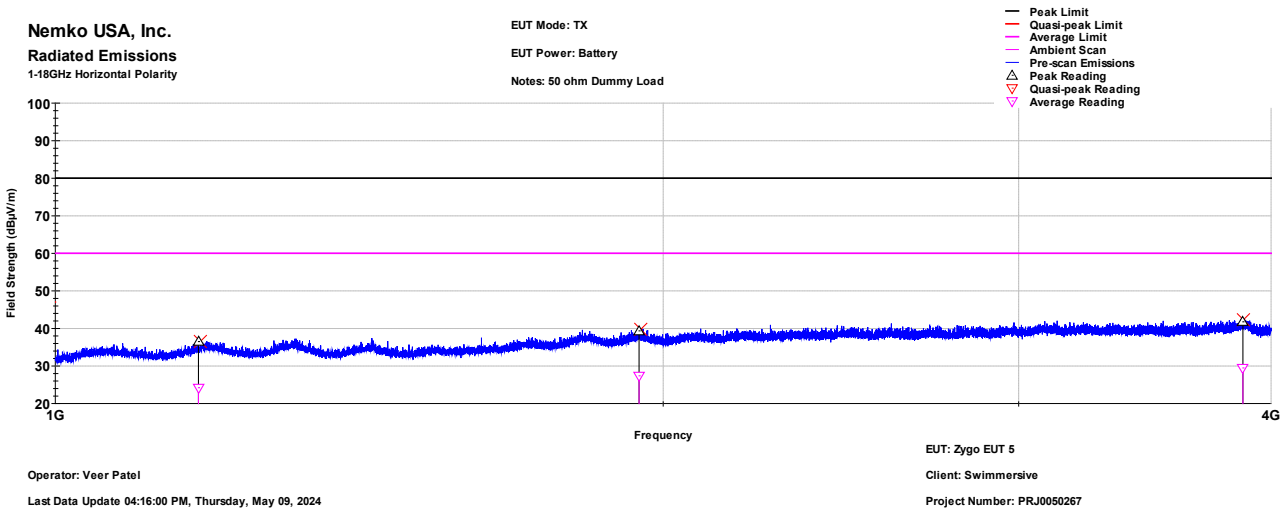
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results	Peak Reading (dBµV)
214.509	236.000	139.000	20.950	40.000	-19.050	PASS	21.245
351.011	158.000	250.000	25.832	47.000	-21.168	PASS	25.983
526.462	11.000	121.000	31.707	47.000	-15.293	PASS	32.016

1GHz - 4GHz Vertical Polarity Measured Emissions Data:



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
1303.07	189	245	37.609	80.000	-42.391	PASS	24.965	60.000	-35.035	PASS
1943.49	359	205	39.351	80.000	-40.649	PASS	27.302	60.000	-32.698	PASS
3892.01	62	195	41.691	80.000	-38.309	PASS	29.613	60.000	-30.387	PASS

1GHz - 4GHz Horizontal Polarity Measured Emissions Data



Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
1177.40	223	400	36.476	80.000	-43.524	PASS	24.197	60.000	-35.803	PASS
1945.83	359	400	39.356	80.000	-40.644	PASS	27.368	60.000	-32.632	PASS
3873.95	95	400	41.756	80.000	-38.244	PASS	29.468	60.000	-30.532	PASS

6.0 Equipment

6.1 Radiated Emissions

Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
Keysight	E4440A-AYZ	PSA Spectrum Analyzer	MY46186204	7/14/2024
Agilent	11713A	Switch Driver	MY44321972	NCR
ETS-Lindgren	3142C	Antenna, Biconilog, 26 MHz-3GHz	49383	4/17/2025
HP	8447D	Preamp, .1-1300MHz	1937A02800	10/28/2024
Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, 100MHz-18GHz	None	1/26/2025
ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	99232	10/12/2024
evissaP	eP7123R-432	Cable, RF, N-N, 36', DC-18GHz	None	2/15/2026
evissaP	eP7123R-384	Cable, RF, N-N, 32', DC-18GHz	None	2/14/2026
evissaP	eP7031R-22FT	Cable, RF, N-N, 22', DC-18GHz	None	3/1/2026
evissaP	eP7031R-30FT	Cable, RF, N-N, 30', DC-18GHz	None	3/1/2026
evissaP	eP7101R-12	Cable, RF, SMA-SMA, 12", 2.92mm, DC-40GHz	None	3/1/2026
TDK	254	Enclosure, Shielded, RFI/EMI, NSA, 3m & 10m, 30MHz - 1 GHz	23177	2/3/2026
evissaP	eP7033R-6FT	Cable, RF, SMA-N, 6', DC-18GHz	None	3/1/2026
evissaP	eP7101R-12	Cable, RF, SMA-SMA, 12", 2.92mm, DC-40GHz	None	3/1/2026
evissaP	eP7033R-6FT	Cable, RF, SMA-N, 6', DC-18GHz	None	3/1/2026
evissaP	eP7033R-6FT	Cable, RF, SMA-N, 6', DC-18GHz	None	3/1/2026

6.2 Fundamental Power, Bandwidth, Duty Cycle, Mask, Conducted Spurious

Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
Rohde & Schwarz	FSV3044	Analyzer, Signal, 44GHz	101602	2/9/2025
MCE/Weinschel	34-20-34	Attenuator,20dB 25W, DC-4GHz	BP7921	4/11/2025
MCE/Weinschel	34-20-34	Attenuator,20dB 25W, DC-4GHz	BP7923	4/11/2025
C397	eP7101R-132	Cable,RF,SMA-SMA,11',2.92mm,DC	None	3/1/2025

7.0 Measurement Bandwidths

Radiated Emissions Spectrum Analyzer Bandwidth and Measurement Time - Peak Scan				
Frequency Band Start (MHz)	**Frequency Band Stop (MHz)**	**6 dB Bandwidth (kHz)**	**Number of Ranges Used**	**Measurement Time per Range**
0.009	0.15	0.3	2	Multiple Sweeps
0.15	30	9	6	Multiple Sweeps
30	1000	120	2	Multiple 800 mS Sweeps
1000	6000	1000	2	Multiple Sweeps
6000	18000	1000	2	Multiple Sweeps
18000	26500	1000	2	Multiple Sweeps

*Notes:
1. The settings above are specifically calculated for the E4440A series of spectrum analyzers, which have 8,000 data points per range.
2. The measurement receiver resolution bandwidth setting was 300 Hz for quasi-peak measurements from 9-150 kHz.
3. The measurement receiver resolution bandwidth setting was 9 kHz for quasi-peak measurements from 0.15-30 MHz.
4. The measurement receiver resolution bandwidth setting was 120 kHz for quasi-peak measurements from 30-1000 MHz.
5. The measurement receiver resolution bandwidth setting was 1 MHz for average measurements from 1-18 GHz.

Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty

All uncertainty calculations, estimates and expressions thereof shall be in accordance with ANAB policy. Since Nemko USA, Inc. operates in accordance with ANAB Document Number AR 2250: 2021/06/16, all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by ANAB Document Number AR 2250.

1. Rationale and Summary of Expanded Uncertainty.

Each piece of instrumentation at Nemko USA that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacturer's statements or specifications of the calibration tolerances, or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting stated uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations, but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a priori, or u-shaped) will be stated for each Type B evaluation.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of Nemko USA's measurements is shown as Table 1. These are the worst-case uncertainties considering all operative influence factors.

Table 1: Summary of Measurement Uncertainties

Type of Measurement	Frequency Range	Meas. Dist.	Expanded Uncertainty U, dB (k=2)
Mains Conducted Emissions	150 kHz to 30 MHz	N/A	2.82
Telecom Conducted Emissions	150 kHz to 30 MHz	N/A	3.48
Radiated Emissions	30 to 1,000 MHz	10 m	4.82
	1 to 18 GHz	3 m	5.09
	18 to 26 GHz	3 m	4.42
	26 to 40 GHz	0.1 m	5.97

End of Report