

LIBERTY DEFENSE TECHNOLOGIES, INC.

TEST REPORT

SCOPE OF WORK

EMISSIONS TESTING – HEXWAVE SECURITY BODY SCANNER

REPORT NUMBER

105998912BOX-006

ISSUE DATE

February 10, 2025

[REVISED DATE]

Original Issue

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EMISSIONS TEST REPORT

(FULL COMPLIANCE TO TESTS PERFORMED)

Report Number: 105998912BOX-006

Project Number: G105998912

Report Issue Date: February 10, 2025

Model(s) Tested: HW2000

Model(s) Partially Tested: None

Model(s) Not Tested but declared equivalent by the client: None

Standards: CFR 47 FCC Part 15, Subpart F, §15.511 (02/2025)
FCC Waiver DA-22-133A1-c3
RSS-220 Issue 1 (March 2009) Amendment 1 (July 2018)
RSS-GEN Issue 5 April 2018 +Amendment 1 (March 2019) +Amendment
2 (February 2021)

Tested by:
Intertek Testing Services
70 Codman Hill Road
Boxborough, MA 01719
USA

Client:
Liberty Defense Technologies, Inc.
187 Ballardvale St, Suite 110
Wilmington, MA 01887
USA

Report prepared by:



Kouma Sinn / Sr. EMC Staff Engineer

Report reviewed by:



Michael F Murphy / EMC Engineering Team
Lead

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1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
3	Client Information	--
4	Description of Equipment Under Test and Variant Models	--
5	System Setup and Method	--
6	Fundamental Emissions	Pass
	CFR 47 FCC Part 15, Subpart F, §15.511 (02/2025)	
	FCC Waiver DA-22-133A1-c3	
7	RSS-220 Issue 1 (March 2009) Amendment 1 (July 2018)	Pass
	Operational Bandwidth	
	CFR 47 FCC Part 15, Subpart F, §15.511 (02/2025)	
8	FCC Waiver DA-22-133A1-c3	Pass
	RSS-220 Issue 1 (March 2009) Amendment 1 (July 2018)	
	Unwanted Emissions	
9	CFR 47 FCC Part 15C, 15.209(c) (02/2025)	Pass
	RSS-220 Issue 1 Amendment 1, July 2018	
10	Appendix A - FCC Waiver	--
10	Revision History	--

3 Client Information

This EUT was tested at the request of:

Client: Liberty Defense Technologies, Inc.
187 Ballardvale St, Suite 110
Wilmington, MA 01887
USA

Contact: Val Safran
Telephone: 888-617-7226
Email: vsafra@libertydefense.com

4 Description of Equipment Under Test and Variant Models

Manufacturer: Liberty Defense Technologies, Inc.
187 Ballardvale St, Suite 110
Wilmington, MA 01887
USA

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
SECURITY DETECTION	Liberty Defense	Hexware – HW2000	HW-05003

Receive Date:	02/04/2025
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)

HEXWAVE screens for concealed metallic and non-metallic weapons and other threats using millimeter wave, advanced 3D imaging, and Artificial Intelligence for enhanced security. The system can process people seamlessly in all types of venues both indoor and outdoor.

General justification:

The HEXWAVE is a UWB device designed as a threat detection imaging system. UWB devices are low power radio frequency devices that operate under RSS-220 6.4. UWB transmitters use narrow or short duration pulses that result in transmissions over very large bandwidths. Surveillance systems such as the HEXWAVE are designed to operate as “security fences” by establishing a stationary RF perimeter field and detecting the intrusion by persons or objects in that field. HEXWAVE System designed to operate in the 6-10.6 GHz band by sweeping through its frequency range in 200-megahertz blocks, in HEXWAVE term - “chirplets”. It sweeps a continuous waveform signal through a 200-megahertz block of spectrum with central frequency at 4.6GHz. That sweep is generated by SOM9009 module located on PCU sub-assembly. The output chirp waveform from SOM9009 is upconverted to the working frequency band, 6-10.6GHz. That up conversion happens on UP Converter Board that is part of FCB sub-assembly. LO board, that is part of FCB sub-assembly, produces 4 CW frequencies that are mixed on UC board with incoming sweep, starting from 6GHz, and spaced by 200MHz. Once SOM9009 finishes 200MHz sweep, then sweeps through the next 200-megahertz block of spectrum. These “chirplets” are grouped together in sets of four, spanning a total of 800 megahertz. Once the system finished sweeping over all group of four “chirplets” for pre-selected Tx antenna, it switches to another Tx antenna, and performs same sweep again. After completing switching between all TX antennas, Hexwave moves to the next block of “chirplets” (next 800MHz) by reprogramming LO Synthesizers frequencies to next Up conversion band(new 4 CW), and repeats same control cycle until reach 10.6 GHz.

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
100-264 VAC	15 A	50/60 Hz	1

Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Transmitter frequency sweep active

Software used by the EUT:

No.	Descriptions of EUT Exercising
1	Linux revision 18

Radio/Receiver Characteristics	
Frequency Band(s)	6-10.6 GHz
Modulation Type(s)	Chirp
Maximum EIRP	-47.07 dBm
Test Channels	Sweep Ranges: 6-10.6 GHz
Occupied Bandwidth	4.571 GHz
Equipment Type	6-10.6 GHz Radio in a host
Antenna Type and Gain	Integral antenna, +4 dBi

Variant Models:

The following variant models were not tested as part of this evaluation, but have been identified by the manufacturer as being electrically identical models, depopulated models, or with reasonable similarity to the model(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

None

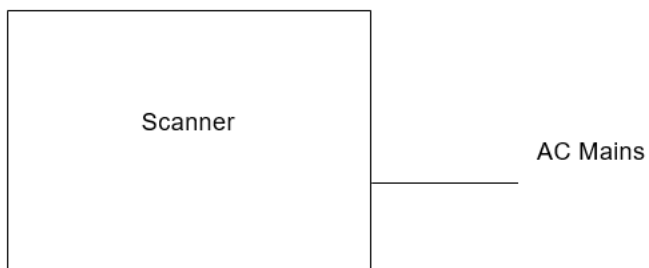
5 System Setup and Method

Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
1	AC Mains	2	None	None	AC Mains
2	Ethernet cable	3	None	None	Router
3	Ethernet cable	3	None	None	Tablet

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Ethernet router	MikroTik	RB962UiGS-5HacT2HnT-US	CC500FFFD350/226/USr2
AC adapter	Cull Power	SAW30-240-1200U	Not labeled
Galaxy Tab S7 FE	Samsung	SM-T733	R52RB0KGCJR

5.1 Method:

Configuration as required by ANSI C63.10:2013, ANSI C63.4:2014, RSS-220 Issue 1 Amendment 1, July 2018, RSS-GEN Issue 5 April 2018, and FCC Waver DA06-1589.

5.2 EUT Block Diagram:

6 Maximum EIRP

6.1 Method

Tests are performed in accordance with ANSI C63.10 and FCC Waver DA-22-133A1-c3.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucisp
Radiated Emissions, 10m	30-1000 MHz	5.6 dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.4 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.1 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.8 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.1 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB μ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

$$RA = 52.0 \text{ dB}\mu\text{V}$$

AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dB μ V/m

To convert from dB μ V to μ V or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μ V
NF = Net Reading in dB μ V

Example:

$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$
 $UF = 10^{(32 \text{ dB}\mu\text{V} / 20)} = 39.8 \mu\text{V/m}$

Alternately, when BAT-EMC Emission Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". The "Correction" includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the "Level" column.

6.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/27/2024	03/27/2025
ETS002'	1-18GHz DRG Horn Antenna	ETS Lindgren	3117	00143260	09/04/2024	09/04/2025
ROS014'	Receiver 1Hz-44GHz	Rhode & Schwarz	ESW 44	103232	06/10/2024	06/10/2025
HS004'	RF Cable HS004	Huber & Suhner	SF118A/11N/11N/2000MM	HS004	10/05/2024	10/05/2025
HS006'	RF Cable HS006	Huber & Suhner	SF118A/11N/11N/2000MM	HS006	10/05/2024	10/05/2025
145-414'	Cable 145-414	Huber + Suhner	3m Track A cable	145-414	07/15/2024	07/15/2025
HS009'	RF Cable HS009	Huber & Suhner	SF106/11N/11N/2000MM	HS009	10/05/2024	10/05/2025
BONN001'	1-18GHz low noise pre-amp	Bonn	BLMA 0118-M	1811749	07/24/2024	07/24/2025

Software Utilized:

Name	Manufacturer	Version
BAT-EMC	Nexio	2023.0.9.0

6.3 Results:

The sample tested was found to Comply.

Fundamental emissions Limits (FCC Part 15, Subpart F, §15.511, FCC Waver DA-22-133A1-c3):

- (c) The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in § 15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency in MHz	EIRP in dBm
960-1610	-53.3
1610-1990	-51.3
1990-10600	-41.3
Above 10600	-51.3

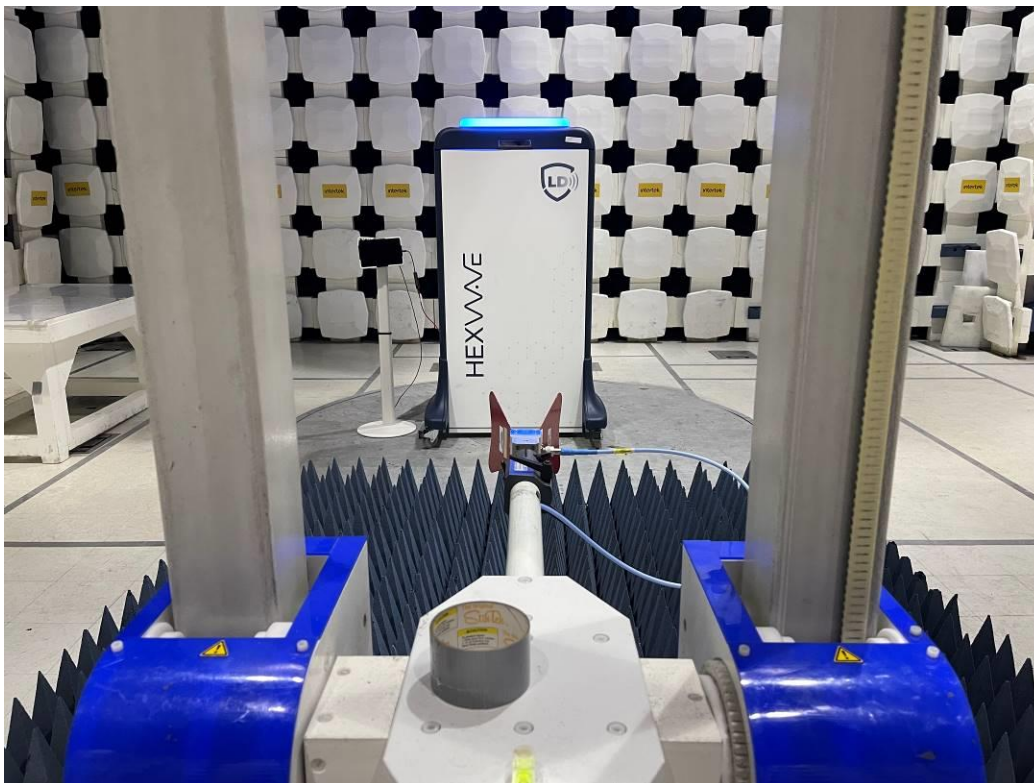
Fundamental emissions Limits (RSS-220, FCC Waver DA-22-133A1-c3):

6.4.1 Standard Specifications

- The -10 dB UWB bandwidth of a radar surveillance device shall be totally contained in the band 1.99-10.6 GHz.
- Radiated emissions at or below 960 MHz from a device shall not exceed the limits in section 3.4.
- Radiated emissions above 960 MHz from a device shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz.

Frequency	E.i.r.p. in a Resolution Bandwidth of 1 MHz
960-1 610 MHz	-53.3 dBm
1 610-1 990 MHz	-51.3 dBm
1 990-10 600 MHz	-41.3 dBm
Above 10 600 MHz	-51.3 dBm

6.4 Setup Photographs:



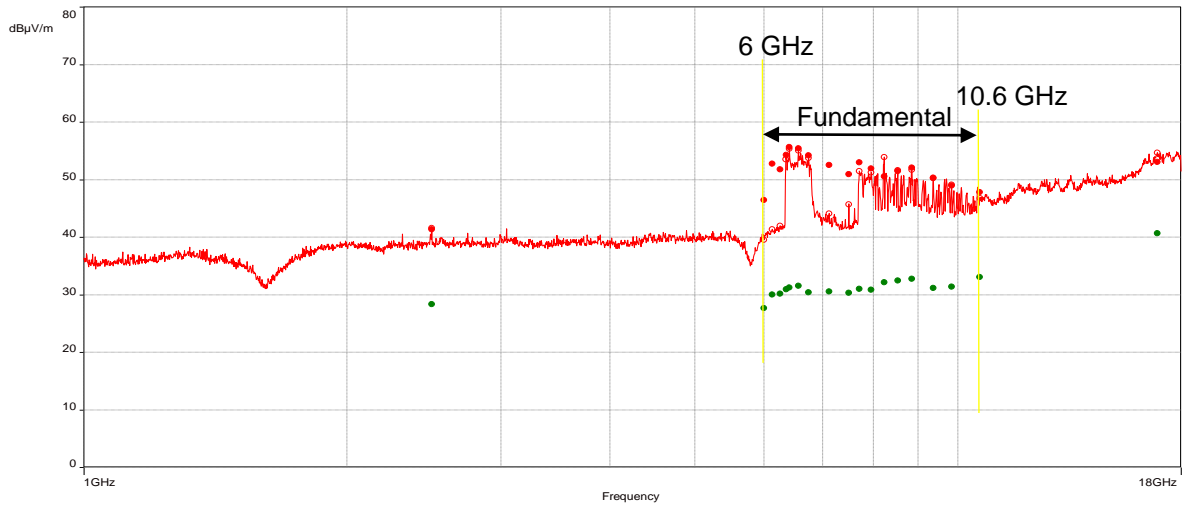
6.5 Plots/Data:

Fundamental EIRP Power From 6-10.6 GHz

Test Information:

Date and Time	2/6/2025 7:05:41 PM
Client and Project Number	Liberty Defense
Engineer	Kouma Sinn
Temperature	21.9 deg C
Humidity	17 %
Atmospheric Pressure	998.5 mbars
Comments	Scan 3: RE 1 to 18 GHz at 3m

Graph:



Results:

Peak (PASS) (19)

Frequency (MHz)	Level (dBμV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Level Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Meas.Time(s)	Correction (dB)
6000.785	46.44	-48.76	-21.30	-27.46	0.00	1.00	Vertical	1M	0.10	0.34
6134.274	52.79	-42.41	-21.30	-21.11	0.00	1.00	Horizontal	1M	0.10	0.69
6258.871	51.76	-43.44	-21.30	-22.14	0.00	1.00	Horizontal	1M	0.10	0.98
6360.795	54.30	-40.90	-21.30	-19.60	0.00	1.00	Horizontal	1M	0.10	1.09
6413.537	55.66	-39.54	-21.30	-18.24	360.00	1.00	Horizontal	1M	0.10	1.17
6570.587	55.45	-39.75	-21.30	-18.45	0.00	1.00	Horizontal	1M	0.10	1.30
6749.513	54.23	-40.97	-21.30	-19.67	0.00	1.00	Horizontal	1M	0.10	1.19
7121.765	52.52	-42.68	-21.30	-21.38	360.00	1.00	Horizontal	1M	0.10	1.27
7501.496	50.96	-44.24	-21.30	-22.94	360.00	1.00	Horizontal	1M	0.10	1.76
7717.175	53.04	-42.16	-21.30	-20.86	0.00	1.00	Vertical	1M	0.10	2.13
7960.538	51.96	-43.24	-21.30	-21.94	360.00	1.00	Vertical	1M	0.10	2.79
8237.163	50.54	-44.66	-21.30	-23.36	0.00	1.00	Horizontal	1M	0.10	3.55
8533.858	51.50	-43.70	-21.30	-22.40	360.00	1.00	Vertical	1M	0.10	4.11
8859.189	52.10	-43.10	-21.30	-21.80	0.00	1.00	Vertical	1M	0.10	4.52
9373.699	50.24	-44.96	-21.30	-23.66	0.00	1.00	Vertical	1M	0.10	3.94
9837.723	48.95	-46.25	-21.30	-24.95	360.00	1.00	Horizontal	1M	0.10	3.60
10597.518	47.86	-47.34	-21.30	-26.04	360.00	1.00	Vertical	1M	0.10	6.10

AVG (PASS) (19)

Frequency (MHz)	Level (dBμV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Level Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Meas.Time(s)	Correction (dB)
6000.785	27.69	-67.51	-41.3	-26.21	0.00	1.00	Vertical	1M	0.10	0.34
6134.274	30.06	-65.14	-41.3	-23.84	0.00	1.00	Horizontal	1M	0.10	0.69
6258.871	30.19	-65.01	-41.3	-23.71	0.00	1.00	Horizontal	1M	0.10	0.98
6360.795	30.94	-64.26	-41.3	-22.96	0.00	1.00	Horizontal	1M	0.10	1.09
6413.537	31.24	-63.96	-41.3	-22.66	360.00	1.00	Horizontal	1M	0.10	1.17
6570.587	31.56	-63.64	-41.3	-22.34	0.00	1.00	Horizontal	1M	0.10	1.30
6749.513	30.46	-64.74	-41.3	-23.44	0.00	1.00	Horizontal	1M	0.10	1.19
7121.765	30.60	-64.60	-41.3	-23.30	360.00	1.00	Horizontal	1M	0.10	1.27
7501.496	30.38	-64.82	-41.3	-23.52	360.00	1.00	Horizontal	1M	0.10	1.76
7717.175	31.01	-64.19	-41.3	-22.89	0.00	1.00	Vertical	1M	0.10	2.13
7960.538	30.85	-64.35	-41.3	-23.05	360.00	1.00	Vertical	1M	0.10	2.79
8237.163	32.19	-63.01	-41.3	-21.71	0.00	1.00	Horizontal	1M	0.10	3.55
8533.858	32.49	-62.71	-41.3	-21.41	360.00	1.00	Vertical	1M	0.10	4.11
8859.189	32.79	-62.41	-41.3	-21.11	0.00	1.00	Vertical	1M	0.10	4.52
9373.699	31.21	-63.99	-41.3	-22.69	0.00	1.00	Vertical	1M	0.10	3.94
9837.723	31.45	-63.75	-41.3	-22.45	360.00	1.00	Horizontal	1M	0.10	3.60
10597.518	33.09	-62.11	-41.3	-20.81	360.00	1.00	Vertical	1M	0.10	6.10

Notes:

EIRP (dBm) = Field Strength Level (dBuV/m) + 20*log(d) – 104.7

EIRP (dBm) = Field Strength Level (dBuV/m) -95.2, at 3 meters

EIRP Limit per FCC Part 15 Subpart F Section 15.511(c)

Product Standard: FCC Part 15, Subpart F, §15.511, RSS-220 and FCC Waver DA-22-133A1-c3					Limit applied: Per §15.511, RSS-220 and FCC Waver DA-22-133A1-c3 Pretest Verification w/BB source: Yes		
Test Date	Test Personnel/ Initials	Supervising Engineer/ Initials	Input Voltage	Mode	Atmospheric Data		
					Temp C°	Relative Humidity %	Atmospheric Pressure mbar
02/06/2025	Kouma Sinn <i>KPS</i>	N/A	120VAC 60Hz	Continuous sweep	21.9	17	998.5

Deviations, Additions, or Exclusions: None

7 Operational Bandwidth

7.1 Method

Tests are performed in accordance with ANSI C63.10 and FCC Waver DA-22-133A1-c3.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

7.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/27/2024	03/27/2025
ETS002'	1-18GHz DRG Horn Antenna	ETS Lindgren	3117	00143260	09/04/2024	09/04/2025
ROS014'	Receiver 1Hz-44GHz	Rhode & Schwarz	ESW 44	103232	06/10/2024	06/10/2025
HS004'	RF Cable HS004	Huber & Suhner	SF118A/11N/11N/2000MM	HS004	10/05/2024	10/05/2025
HS006'	RF Cable HS006	Huber & Suhner	SF118A/11N/11N/2000MM	HS006	10/05/2024	10/05/2025
145-414'	Cable 145-414	Huber + Suhner	3m Track A cable	145-414	07/15/2024	07/15/2025
HS009'	RF Cable HS009	Huber & Suhner	SF106/11N/11N/2000MM	HS009	10/05/2024	10/05/2025
BONN001'	1-18GHz low noise pre-amp	Bonn	BLMA 0118-M	1811749	07/24/2024	07/24/2025

Software Utilized:

Name	Manufacturer	Version
None	N/A	N/A

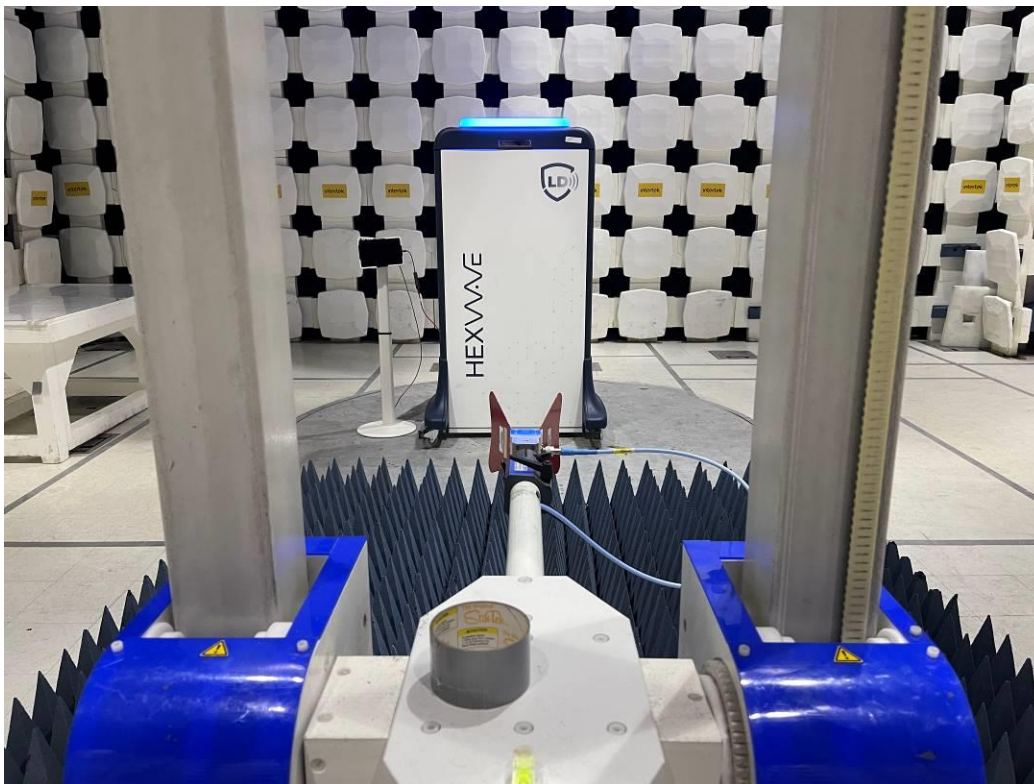
7.3 Results:

The sample tested was found to Comply.

Occupied Bandwidth Limits (FCC Part 15, Subpart F, §15.511, RSS-220, FCC Waver DA-22-133A1-c3):

The intentional emissions generated by the HEXWAVE device must be completely contained within the 6-10.6 GHz frequency range.

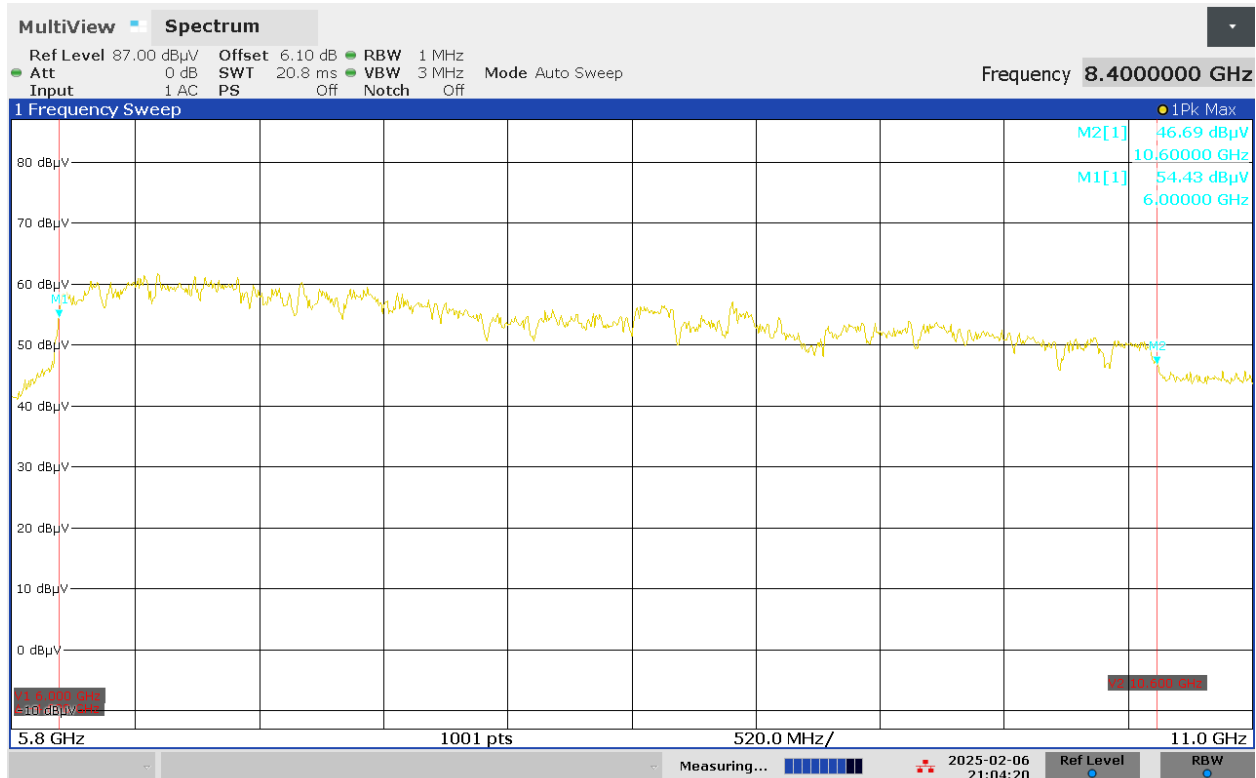
7.4 Setup Photographs:



7.5 Plots/Data:

Lower edge – M1 = 6 GHz
Upper edge – M2 = 10 GHz

The intentional emissions generated by the HEXWAVE device was completely contained within the 6-10.6 GHz frequency range.



Note: The worst-case correction factor (antenna factor, cable loss, and pre-amp gain) of 6.10 dB was compensated as Offset.

Product Standard: FCC Part 15, Subpart F, §15.511, RSS-220 and FCC Waver DA-22-133A1-c3				Limit applied: per §15.511, RSS-220 and FCC Waver DA-22-133A1-c3 Pretest Verification w/BB source: Yes			
Test Date	Test Personnel/ Initials	Supervising Engineer/ Initials	Input Voltage	Mode	Atmospheric Data		
					Temp C°	Relative Humidity %	Atmospheric Pressure mbar
02/06/2025	Kouma Sinn <i>KPS</i>	N/A	120VAC 60Hz	Continuous sweep	21.9	17	998.5

Deviations, Additions, or Exclusions: None

8 Unwanted Emissions

8.1 Method

The procedure described in Subclauses 6.3-6.6 and 9.9 of ANSI C63.10-2013 and Subclause 5.5.4 (field strength method) of ANSI C63.26-2015 were utilized to determine unwanted emissions.

Radiated emission measurements are performed from 30 MHz to 40 GHz. Measurements for frequencies less than or equal to 1 GHz are made with an EMI receiver employing a CISPR quasi-peak detector. Measurements for frequencies above 1 GHz are made with an EMI receiver or a spectrum analyzer employing an average detector and a peak detector.

Quasi-peak measurements are performed for frequencies less than or equal to 1 GHz. The quasi-peak level of radiated emissions was measured with a resolution bandwidth (RBW) of 120 kHz for frequencies between 30 MHz to 1 GHz.

Both Peak and Average measurements are performed for frequencies above 1 GHz. The peak level of radiated emissions was measured with a resolution bandwidth (RBW) of 1 MHz, a video bandwidth (VBW) of 3 MHz, and a peak detector. The average level of radiated emissions was measured with a resolution bandwidth (RBW) of 1 MHz, a video bandwidth (VBW) of 3 MHz, and an RMS detector with trace averaging.

Radiated emissions measurement is performed at 10 meters distance for frequencies below 1 GHz, 3 meters for frequency between 1 GHz and 18 GHz, and 1 meter for frequencies above 18 GHz. If the emission level is too low for measurement at that distance, a pre-amplifier is used and/or the test is performed at a closer distance.

The EUT is configured to transmit continuously at its maximum data rate. The EUT is placed 80 cm in height for frequencies below 1 GHz and 1.5 meters in height for frequency above 1 GHz. For portable or handheld devices, the EUT is manipulated through three orthogonal orientations.

For radiated emissions measurements between 30 MHz to 18 GHz, measurements are performed with the EUT rotated from 0° to 360°, the measuring antenna height scanned between 1 to 4 meters, and the measuring antenna varied for both horizontal and vertical polarization, to determine the maximum emission level.

For radiated emissions measurements between 18 GHz to 40 GHz, handheld measurement is performed at a far field distance. As the surfaces of the EUT are scanned, the test antenna is kept pointed toward the EUT and the measuring antenna polarization is varied slowly to cover all possible polarizations and orientations of the emission(s).

Data included is representative of the worst-case configuration (the configuration which resulted in the highest emission levels). Plots below are corrected for distance, cables, preamp, filters, antenna factors, and conversion factors then compared to the limits.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucisp
Radiated Emissions, 10m	30-1000 MHz	5.6 dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	4.9 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.4 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	4.9 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.6 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.6 dB	N/A

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB μ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

RA = 52.0 dB μ V
 AF = 7.4 dB/m
 CF = 1.6 dB
 AG = 29.0 dB
 FS = 32 dB μ V/m

To convert from dB μ V to μ V or mV the following was used:

$$UF = 10^{(NF / 20)} \text{ where } UF = \text{Net Reading in } \mu\text{V} \\ NF = \text{Net Reading in dB}\mu\text{V}$$

Example:

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10^{(32 \text{ dB}\mu\text{V} / 20)} = 39.8 \mu\text{V/m}$$

Alternately, when BAT-EMC Emission Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". The "Correction" includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the "Level" column.

8.2 Test Equipment Used:

Test equipment used from 30-1000 MHz

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/27/2024	03/27/2025
ROS014'	Receiver 1Hz-44GHz	Rhode & Schwarz	ESW 44	103232	06/10/2024	06/10/2025
HS004'	RF Cable HS004	Huber & Suhner	SF118A/11N/11N/2000MM	HS004	10/05/2024	10/05/2025
HS003'	10m under floor cable	Huber-Schuner	10m-1	HS003	02/27/2024	02/27/2025
IW006'	DC-18GHz cable 8.4m long	Insulated Wire	2800-NPS	IW006	05/23/2024	05/23/2025
HS005'	DC-18GHz cable 1.5m long	Huber & Suhner	SF118A/11N/11N/2000MM	HS005	10/05/2024	10/05/2025
145145'	Broadband Hybrid Antenna 30 MHz - 3 GHz	Sunol Sciences Corp.	JB3	A122313	07/11/2024	07/11/2025
PRE10'	30-1000MHz pre-amp	ITS	PRE10	PRE10	02/27/2024	02/27/2025

Test equipment used from 1-18 GHz

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/27/2024	03/27/2025
ETS002'	1-18GHz DRG Horn Antenna	ETS Lindgren	3117	00143260	09/04/2024	09/04/2025
ROS014'	Receiver 1Hz-44GHz	Rhode & Schwarz	ESW 44	103232	06/10/2024	06/10/2025
HS004'	RF Cable HS004	Huber & Suhner	SF118A/11N/11N/2000MM	HS004	10/05/2024	10/05/2025
HS006'	RF Cable HS006	Huber & Suhner	SF118A/11N/11N/2000MM	HS006	10/05/2024	10/05/2025
145-414'	Cable 145-414	Huber + Suhner	3m Track A cable	145-414	07/15/2024	07/15/2025
HS009'	RF Cable HS009	Huber & Suhner	SF106/11N/11N/2000MM	HS009	10/05/2024	10/05/2025
BONN001'	1-18GHz low noise pre-amp	Bonn	BLMA 0118-M	1811749	07/24/2024	07/24/2025

Software Utilized:

Name	Manufacturer	Version
BAT-EMC	Nexio	2023.0.9.0

Test equipment used from 18-40 GHz

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/27/2024	03/27/2025
ROS011'	ESW44 receiver 1Hz-44GHz	Rhode and Schwarz	ESW44	103296	07/10/2024	07/10/2025
EMC04'	ANTENNA, RIDGED GUIDE, 18-40 GHz	EMCO	3116	2090	02/13/2024	02/13/2025
CBLHF201 2-5M-2'	5m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252676002	02/27/2024	02/27/2025
CBLHF201 2-2M-2'	2m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252675002	02/27/2024	02/27/2025
REA006'	18GHz High Pass Filter	Reactel, Inc	7HS-18G/40G K11	(06)1	04/23/2024	04/23/2025
EMC018'	18-40GHz Pre-amp 40dB gain	The EMC Shop	PA40G	27490-01	08/06/2024	08/06/2025
ROS011'	ESW44 receiver 1Hz-44GHz	Rhode and Schwarz	ESW44	103296	06/28/2023	06/28/2024

Software Utilized:

Name	Manufacturer	Version
None	N/A	N/A

8.3 Results:

The sample tested was found to Comply.

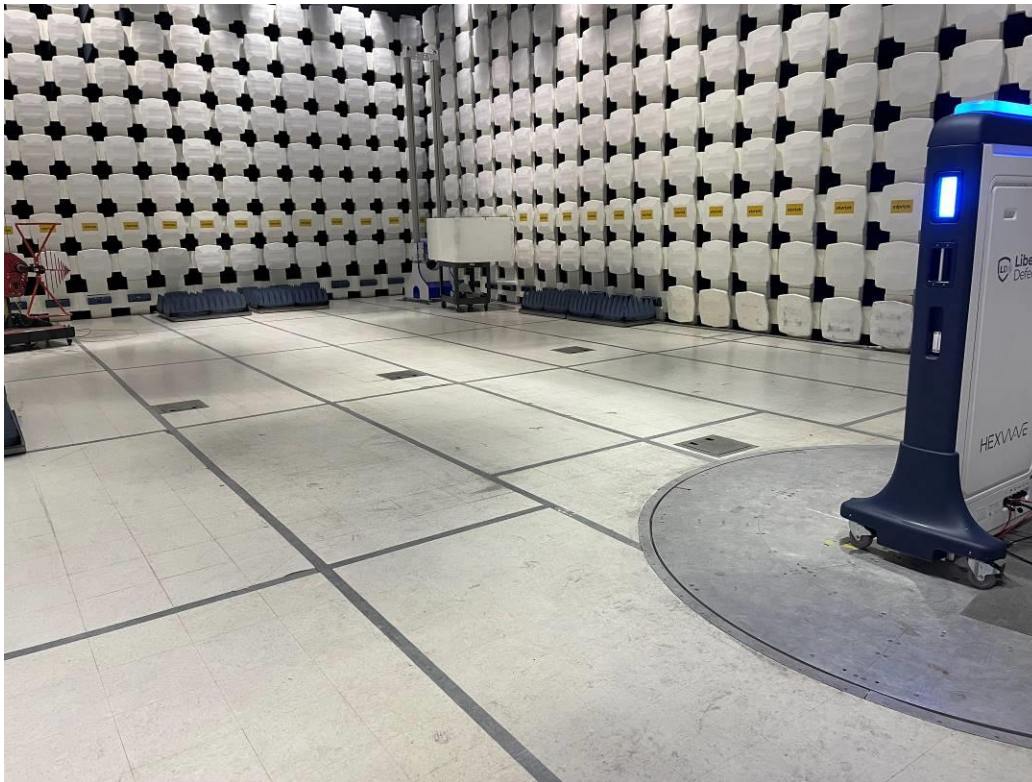
Unwanted emissions Limits (FCC Part 15, Subpart F, §15.511, RSS-220, FCC Waver DA-22-133A1-c3):

- (c) The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in § 15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

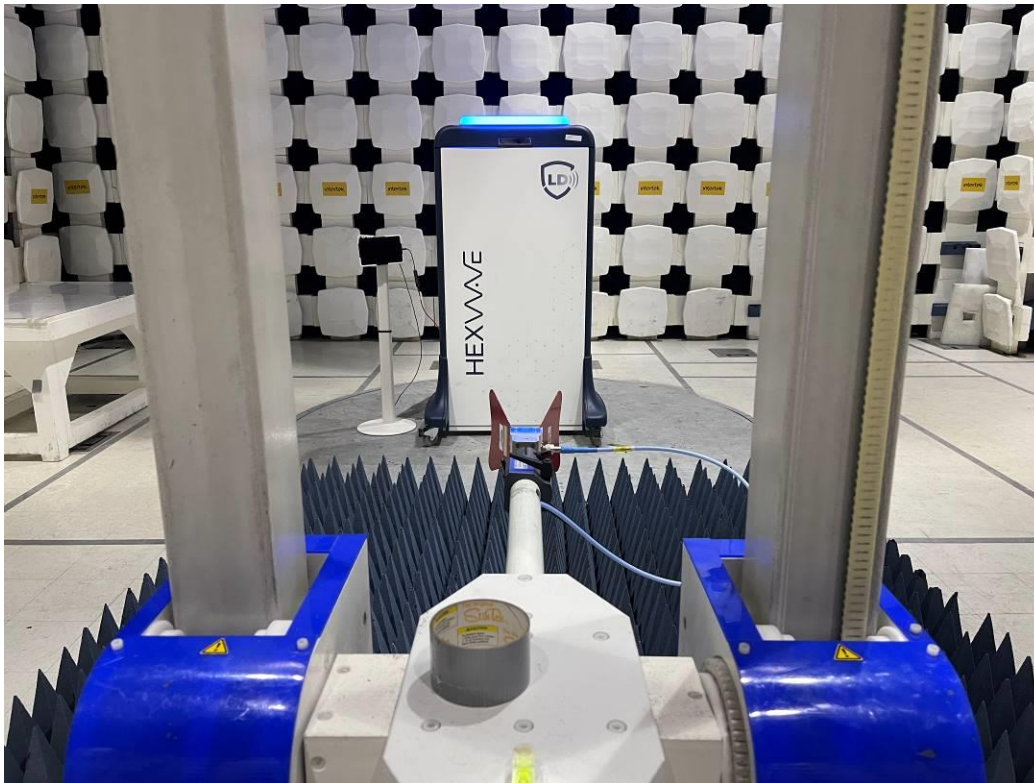
	Frequency in MHz	EIRP in dBm
band able 	960–1610	–53.3
	1610–1990	–51.3
	1990–10600	–41.3
	Above 10600	–51.3

8.4 Setup Photographs:

30-1000 MHz Test Setup



1-18 GHz Test Setup



18-40 GHz Test Setup



Note: Manual scan around the EUT.



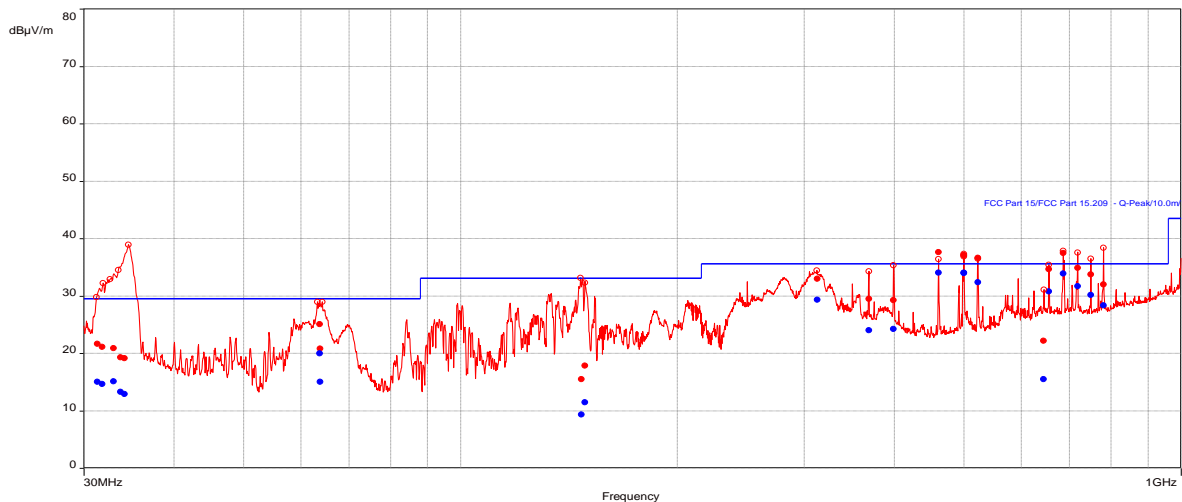
Note: Manual scan around the EUT.

8.5 Plots/Data:

Radiated Emissions From 30-1000 MHz

Test Information:

Date and Time	2/6/2025 5:26:26 PM
Client and Project Number	Liberty Defense
Engineer	Kouma Sinn
Temperature	21.9 deg C
Humidity	17 %
Atmospheric Pressure	998.5 mbars
Comments	Scan 12: Ferrite on SBI cable, RE 30-1000MHz

Graph:**Results:**

QuasiPeak (PASS) (22)

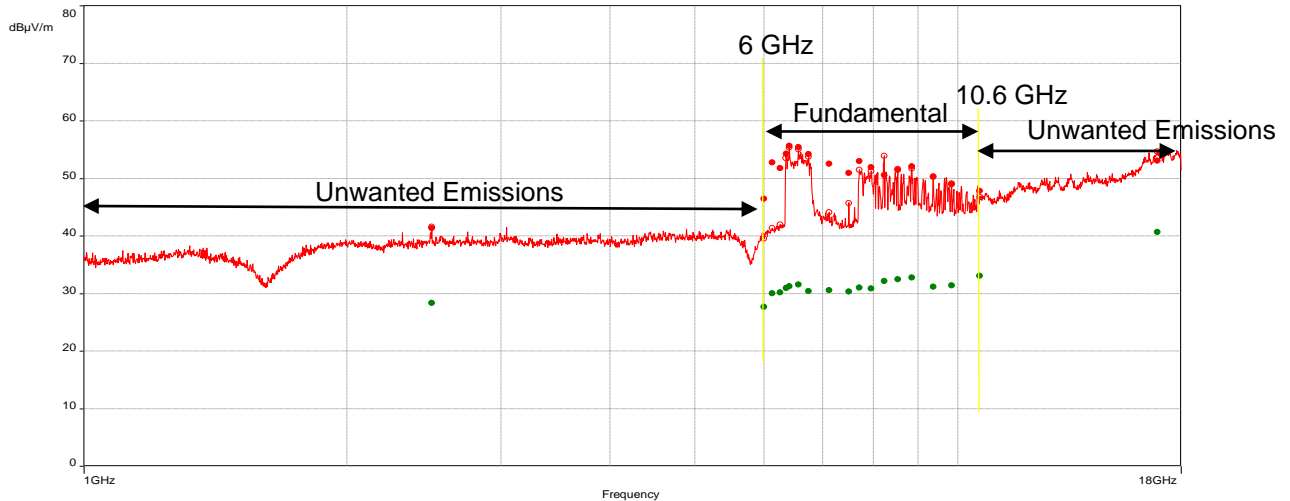
Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Meas.Time(s)	Correction (dB)
31.3423	15.05	29.54	-14.49	151.90	4.00	Vertical	120k	0.10	-13.44
31.8197	14.70	29.54	-14.84	310.70	4.00	Vertical	120k	0.10	-13.71
33.0021	15.13	29.54	-14.41	1.40	4.00	Vertical	120k	0.10	-14.72
33.7359	13.28	29.54	-16.26	345.90	4.00	Vertical	120k	0.10	-15.22
34.1681	12.93	29.54	-16.61	104.80	4.00	Vertical	120k	0.10	-15.52
63.7594	20.02	29.54	-9.52	360.00	4.00	Vertical	120k	0.10	-25.37
63.8245	15.03	29.54	-14.51	326.70	3.29	Vertical	120k	0.10	-25.37
147.1414	9.35	33.06	-23.71	354.40	2.96	Horizontal	120k	0.10	-19.85
148.7284	11.53	33.06	-21.53	98.10	3.51	Horizontal	120k	0.10	-19.91
312.7628	29.36	35.56	-6.20	183.60	1.32	Vertical	120k	0.10	-17.94
368.64	24.01	35.56	-11.55	230.70	4.00	Horizontal	120k	0.10	-16.64
398.9746	24.29	35.56	-11.27	295.50	4.00	Horizontal	120k	0.10	-15.92
460.8856	34.11	35.56	-1.45	145.40	1.40	Horizontal	120k	0.10	-14.09
499.8031	33.98	35.56	-1.58	107.70	1.00	Horizontal	120k	0.10	-13.40
499.8194	34.09	35.56	-1.47	107.80	1.00	Horizontal	120k	0.10	-13.40
522.462	32.42	35.56	-3.14	172.80	1.00	Horizontal	120k	0.10	-13.18
645.0443	15.56	35.56	-20.00	104.50	2.98	Vertical	120k	0.10	-10.54
655.926	30.79	35.56	-4.77	159.00	1.00	Horizontal	120k	0.10	-10.57
686.8126	33.91	35.56	-1.65	209.30	1.00	Horizontal	120k	0.10	-10.14
719.13	31.69	35.56	-3.87	65.20	4.00	Horizontal	120k	0.10	-9.48
750.0196	30.21	35.56	-5.35	102.80	4.00	Horizontal	120k	0.10	-9.05
780.9134	28.34	35.56	-7.22	234.50	4.00	Horizontal	120k	0.10	-8.35

Note: A ferrite sleeve (Part # was not provided) was placed on SBI cable prior to testing.

Radiated Emissions From 1-18 GHz

Test Information:

Date and Time	2/6/2025 7:05:41 PM
Client and Project Number	Liberty Defense
Engineer	Kouma Sinn
Temperature	21.9 deg C
Humidity	17 %
Atmospheric Pressure	998.5 mbars
Comments	Scan 3: RE 1 to 18 GHz at 3m

Graph:**Results:**

Peak (PASS) (19)

Frequency (MHz)	Level (dBuV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Level Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Meas.Time(s)	Correction (dB)
2500.013	41.35	-53.85	-21.30	-32.55	301.30	1.00	Horizontal	1M	0.10	-5.22
16922.823	53.09	-42.11	-31.30	-10.81	360.00	4.00	Vertical	1M	0.10	14.50

AVG (PASS) (19)

Frequency (MHz)	Level (dBuV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Level Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW	Meas.Time(s)	Correction (dB)
2500.013	28.37	-66.83	-41.3	-25.53	301.30	1.00	Horizontal	1M	0.10	-5.22
16922.823	40.66	-54.54	-51.3	-3.24	360.00	4.00	Vertical	1M	0.10	14.50

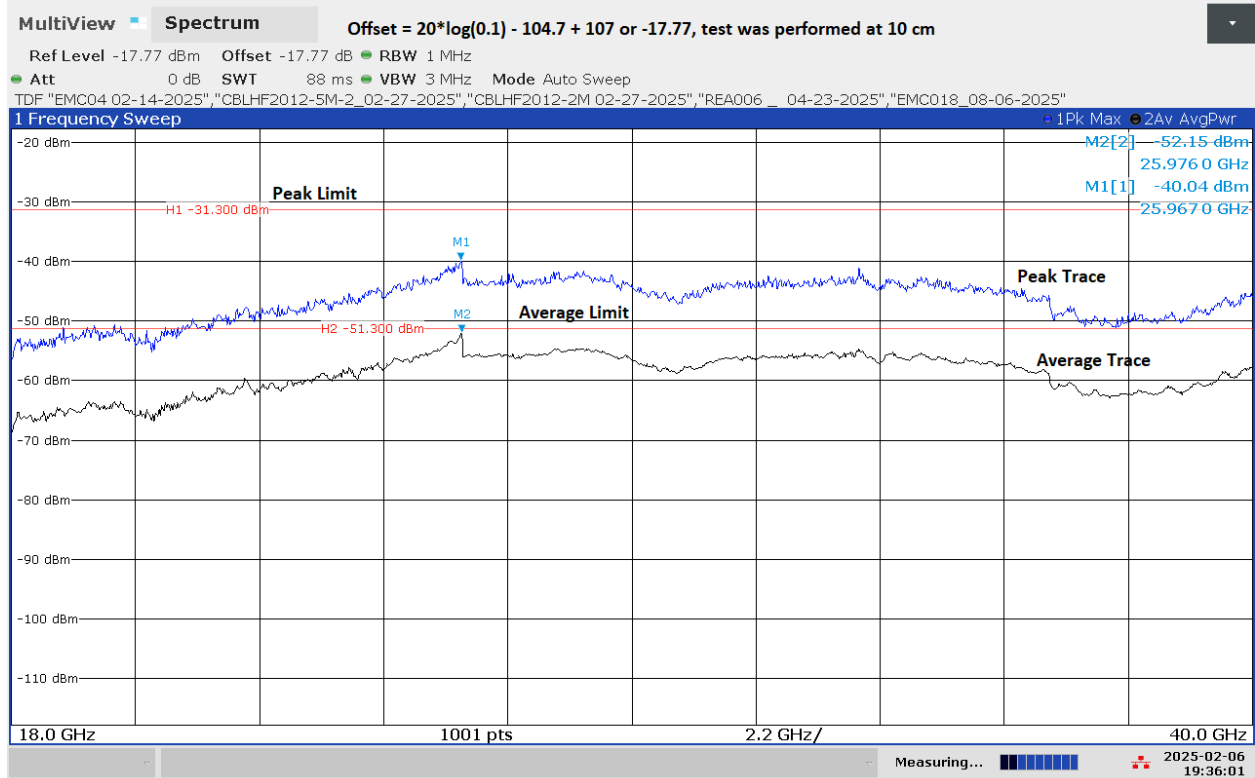
Notes:

EIRP (dBm) = Field Strength Level (dBuV/m) + 20*log(d) – 104.7

EIRP (dBm) = Field Strength Level (dBuV/m) -95.2, at 3 meters

EIRP Limit per FCC Part 15 Subpart F Section 15.511(c)

Radiated Emissions From 18-40 GHz



07:36:01 PM 02/06/2025

Product Standard: FCC Part 15, Subpart F, §15.511, RSS-220 and FCC Waver DA-22-133A1-c3				Limit applied: per §15.511, RSS-220 and FCC Waver DA-22-133A1-c3 Pretest Verification w/BB source: Yes			
Test Date	Test Personnel/ Initials	Supervising Engineer/ Initials	Input Voltage	Mode	Atmospheric Data		
					Temp C°	Relative Humidity %	Atmospheric Pressure mbar
02/06/2025	Kouma Sinn <i>KPS</i>	N/A	120VAC 60Hz	Continuous sweep	21.9	17	998.5

Deviations, Additions, or Exclusions: None

9 Appendix A - FCC Waiver DA-22-133A1-c3

Federal Communications Commission

DA 22-133

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)	
)	
Liberty Defense Holdings, Ltd.)	ET Docket No. 19-217
d/b/a Liberty Defense Technologies)	
)	
Request for Waiver of Sections 15.31(c), 15.503(d),)	
15.511(b), 15.511(f) and 15.521(d) of the)	
Commission's Rules)	

ORDER

Adopted: February 9, 2022

Released: February 9, 2022

By the Acting Chief, Office of Engineering and Technology:

I. INTRODUCTION

1. By this Order, we grant a request by Liberty Defense Holdings, Ltd. d/b/a Liberty Defense Technologies (Liberty), for a waiver of our rules governing unlicensed ultra-wideband (UWB) devices to permit the certification and marketing of its threat detection imaging system. We find that opening a path for the sale and operation of this equipment will allow this system to be deployed to protect Americans against threats in public venues and other high-traffic areas, in furtherance of the public interest, and that operation of this device under the specified waiver conditions poses no greater risk of causing harmful interference to communication services than those devices already permitted under the existing rules.

II. BACKGROUND

2. On May 8, 2019, Liberty filed a request for waiver of the Commission's Part 15 rules to allow the marketing and operation of its surveillance system known as the HEXWAVE.¹ Liberty states that the system uses active three-dimensional imaging to detect weapons, explosives, and other threats using UWB technology, and that the HEXWAVE will enable law enforcement and security professionals to engage a target before a situation can escalate into an attack.²

3. The HEXWAVE is a UWB device that is designed to operate in the 6-10.6 GHz band by sweeping through its frequency range in 200-megahertz blocks. UWB devices are low-power radio frequency devices that operate under Part 15 Subpart F of the Commission's rules without individual licenses from the Commission.³ UWB transmitters use narrow or short duration pulses that result in transmissions over very large bandwidths. Surveillance systems such as the HEXWAVE are a particular

¹ Liberty Defense Holdings, Ltd. Request for Waiver, ET Docket No. 19-217 (filed May 8, 2019) (Liberty Waiver Request).

² *Id.* at 5.

³ 47 CFR §§ 15.501-15.525.

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type of UWB imaging device that are designed to operate as “security fences” by establishing a stationary RF perimeter field and detecting the intrusion by persons or objects in that field.⁴

4. Liberty seeks waiver of the following sections of the Commission’s rules: Section 15.503(d), which requires that a UWB transmitter at any point in time have a fractional bandwidth equal to or greater than 0.20 or a UWB bandwidth equal to or greater than 500 megahertz, regardless of the fractional bandwidth; Section 15.31(c), which requires measurements to be made with the frequency sweep stopped; and Section 15.521(d), requires that if pulse gating is employed where the transmitter is quiescent for intervals that are long compared to the nominal pulse repetition interval, measurements shall be made with the pulse train gated on.⁵ Liberty also seeks a waiver of Section 15.511’s use limitations to allow for the use of HEXWAVE devices by private security personnel.⁶ The three paragraphs of Section 15.511 subject to Liberty’s waiver request relate to eligibility requirements for the operation of such surveillance systems to law enforcement, fire or emergency rescue organizations, or by manufacturers licensees, petroleum licensees or power licensees; require that operation must be coordinated with the Federal government; and specify that surveillance systems must bear the statement that: “Operation of this device is restricted to law enforcement, fire and rescue officials, public utilities, and industrial entities.”⁷

5. The Office of Engineering and Technology (OET) sought comment on Liberty’s waiver request.⁸ While no party filed comments specifically addressing technical concerns regarding the waiver request, Liberty’s request was cited in a letter that Cisco Systems, Inc. and Hewlett Packard Enterprise Company filed in multiple proceedings asking that the Commission evaluate the UWB rules as part of a comprehensive proceeding.⁹

III. DISCUSSION

6. We are authorized to grant a waiver under Section 1.3 of the Commission’s rules if the petitioner demonstrates good cause for such action.¹⁰ Good cause, in turn, may be found “where

⁴ See *Revision of Part 15 of the Commission’s Rules Regarding Ultra-Wideband Transmission Systems*, ET Docket No. 98-153, Order, 17 FCC Rcd 13522 (2002).

⁵ 47 CFR §§ 15.503(d), 15.31(c), and 15.521(d), respectively.

⁶ See Letter from Aman Bhardwaj, President, Liberty Defense Holdings to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 19-217 (filed Oct. 2, 2019) (defining “private security personnel” to mean individuals and organizations (other than public law enforcement personnel and agencies) that primarily are engaged in the detection of crime and threats to people and property at sites at which people aggregate, including providers of (i) proprietary or contractual guard and screening services, (ii) electronic security systems integration and management services, and (iii) security consulting services).

⁷ 47 CFR § 15.511(b) introductory text, (b)(2), and (f). The specific Federal Government coordination procedures, detailed in Section 15.525, require users to disclose operational areas and other information to the Commission’s Office of Engineering and Technology, which coordinates with the Federal government through the National Telecommunications and Information Administration (NTIA).

⁸ *Office of Engineering and Technology Seeks Comment on Liberty Defense Holdings, LTD. Request for Waiver of Certain Part 15 Ultra-Wideband (UWB) Rules*, Public Notice, DA 19-706 (OET 2019); *Office of Engineering and Technology Extends Comment Cycle Deadlines on Liberty Defense Holdings, LTD. Request for Waiver of Certain Part 15 Ultra-Wideband (UWB) Rules*, Public Notice, DA 19-217 (OET 2019).

⁹ Letter from Mary L. Brown, Cisco, and Chuck Lukaszewski, Hewlett Packard, to Marlene H. Dortch, Secretary, Federal Communications Commission, in various dockets including ET Docket No. 19-217, (filed Nov. 13, 2019) (Cisco/HPE UWB Letter).

¹⁰ 47 CFR § 1.3. See also *ICO Global Communications (Holdings) Limited v. FCC*, 428 F.3d 264 (D.C. Cir. 2005); *Northeast Cellular Telephone Co. v. FCC*, 897 F.2d 1164 (D.C. Cir. 1990); *WALT Radio v. FCC*, 418 F.2d 1153 (D.C. Cir. 1969).

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particular facts would make strict compliance inconsistent with the public interest.”¹¹ To make this public interest determination, the waiver cannot undermine the purpose of the rule, and there must be a stronger public interest benefit in granting the waiver than in applying the rule.¹² The UWB standards in Part 15 were adopted to ensure that UWB devices, including surveillance devices, do not cause harmful interference to authorized radio services, including those operated by the Federal Government.¹³ As discussed below, we find that, with appropriate operational and technical limitations, granting Liberty’s request for waiver poses no greater risk of causing harmful interference to radio communications services than any other surveillance device operating under our rules. In addition, we find that there is a stronger public interest benefit in granting this waiver than in strictly applying the rules. HEXWAVE devices can provide protection and safety to the American public by passively detecting weapons and other threats in public venues. Thus, we find that the waiver standard has been met.

A. Waiver of the UWB definition in Section 15.503(d)

7. Section 15.503(d) of the Commission’s rules defines a UWB transmitter as a device that “at any point in time” has an UWB bandwidth equal to or greater than 500 megahertz or a fractional bandwidth equal to or greater than 0.20.¹⁴ Liberty describes the HEXWAVE as using a set of “chirplets.”¹⁵ It sweeps a continuous waveform signal through a 200-megahertz block of spectrum, followed by a 100 nanosecond quiet period. The device then sweeps through the next 200-megahertz block of spectrum. These chirplets are grouped together in sets of three, spanning a total of 600 megahertz.¹⁶ Each of these individual transmissions is less than 500 megahertz in bandwidth “at any point in time” and Liberty’s device does not have a 0.20 or greater fractional bandwidth. Thus, even though the device has a total bandwidth that exceeds 500 megahertz, it would not meet the definitional requirement for operation under the UWB rules because of the quiet period between each chirplet.¹⁷

8. The UWB imaging rules were designed to accommodate devices that emit impulsive or transient-like signals that are spread across a very wide bandwidth to produce an image of objects within the ground or other materials.¹⁸ The primary difference between the Liberty device and other UWB surveillance systems devices provided for in the rules is that the HEXWAVE uses an array of closely spaced transmitting/receiving antennas that transmit sequentially over a large band of spectrum to gather all the needed data. This modulation scheme is functionally equivalent to other types of UWB imaging devices in that it uses transient-like signals spread across a wide bandwidth. The risk of interference is no

¹¹ *Northeast Cellular*, 897 F.2d at 1166; see also *ICO Global Communications*, 428 F.3d at 269 (quoting *Northeast Cellular*); *WAIT Radio*, 418 F.2d at 1157-59.

¹² See, e.g., *WAIT Radio*, 418 F.2d at 1157 (stating that even though the overall objectives of a general rule have been adjudged to be in the public interest, it is possible that application of the rule to a specific case may not serve the public interest if an applicant’s proposal does not undermine the public interest policy served by the rule); *Northeast Cellular*, 897 F.2d at 1166 (stating that in granting a waiver, an agency must explain why deviation from the general rule better serves the public interest than would strict adherence to the rule).

¹³ *Revision of Part 15 of the Commission’s Rules Regarding Ultra-Wideband Transmission Systems*, ET Docket No. 98-153, First Report and Order, 17 FCC Rcd 7435 (2002) (*UWB First R&O*); see also, 47 CFR §§ 15.501-15.525.

¹⁴ 47 CFR §15.503(d).

¹⁵ Liberty Waiver Request at 6.

¹⁶ *Id.*

¹⁷ Stepped and swept frequency devices like Liberty’s have a difficult time meeting the rule’s technical specifications because the large bandwidth is achieved by stepping or sweeping a narrow signal through the broader frequency range, and therefore won’t be instantaneously wide enough to meet the rules’ specific requirements.

¹⁸ See *UWB First R&O*, 17 FCC Rcd at 7437-7440, 7450, 7476 and 7494.

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greater than that from other such UWB surveillance systems, and so a waiver in this case will not undermine the intent of our rule.

B. Waiver of the measurement procedures in Sections 15.31(c) and 15.521(d)

9. Section 15.31(c) of the Commission's rules sets forth the measurement standards for unlicensed devices to demonstrate compliance with applicable emissions limits.¹⁹ This rule requires swept frequency equipment measurements to be made with the frequency sweep stopped. Section 15.521(d) sets forth the measurement procedures for UWB devices to demonstrate compliance with applicable emissions limits.²⁰ For emissions above 960 MHz, this rule requires that, if pulse gating is used and the transmitter is quiescent for longer intervals than the nominal pulse repetition interval, measurements are made with the pulse train gated on. Liberty observes that, since this rule was adopted, the Commission has permitted other UWB transmitters operating above 960 MHz that use frequency stepping techniques to be measured using an average detector with the transmitter operating in its normal mode, *i.e.*, with the sweeping function active.²¹ Liberty claims that the HEXWAVE will meet all other emission limits and technical requirements under the UWB rules when measured with the sweeping function active.²²

10. We recognized in prior orders granting waivers of the measurement procedures for UWB transmitters, where emissions were permitted to be measured with the transmitter operating in its normal transmission mode, that the interference aspects of a transmitter employing frequency hopping, frequency stepping, or gating are quite similar, as viewed by a receiver.²³ That is because transmitters using these burst formats appear to the receiver to emit for a short period of time followed by a quiet period.²⁴ We concluded that "any requirement to stop the frequency hopping, band sequencing, or system gating serves only to add another unnecessary level of conservatism to already stringent UWB standards."²⁵ In conjunction with NTLA, we have further determined that allowing stepped frequency devices to be measured with the stepping function on would not increase the interference potential of the device above that of impulse UWB devices if all other emission limits and technical requirements are met.²⁶ Liberty's request represents an analogous situation. We find that permitting Liberty to demonstrate compliance with the UWB surveillance systems emission limits under a waiver of the measurement procedures in Sections 15.31(c) and 15.521(d) poses no greater risk of causing harmful interference to radio communications services than any other UWB imaging system operating under our rules, and therefore will not undermine the purpose of these rules.²⁷

¹⁹ 47 CFR §15.31(c).

²⁰ 47 CFR §15.521(d).

²¹ Liberty Waiver Request at 8-9 (citing waiver requests by the Multi-band OFDM Alliance Special Interest Group, Curtiss-Wright Controls, and Kyma Medical Technologies Ltd.).

²² *Id.* at 15.

²³ See, e.g., *Petition for Waiver of the Part 15 UWB Regulations Filed by the Multi-band OFDM Alliance Special Interest Group*, ET Docket No. 04-352, Order, 20 FCC Rcd 5528 (2005) (MBOA-SIG Waiver Order).

²⁴ *Id.*, 20 FCC Rcd at 5535.

²⁵ *Id.*, 20 FCC Rcd at 5534.

²⁶ See *Curtiss-Wright Controls Inc. Request for Waiver of Part 15 of the Commission's Rules Applicable to Ultra-Wideband Devices*, ET Docket No. 10-167, Order, 27 FCC Rcd 234 at 242 (OET 2012) (CWCI Waiver Order). See also MBOA-SIG Waiver Order, 20 FCC Rcd at 5531-5536.

²⁷ Our reliance on the MBOA-SIG Waiver Order and the CWCI Waiver Order in this instance only relates to the measurement procedures in Section 15.521(d).

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C. Waiver of the eligibility, operational, and disclosure requirements in Section 15.511

11. Section 15.511(b) includes eligibility requirements and coordination requirements with the Federal Government under section 15.525 applicable to UWB surveillance systems.²⁸ The eligibility requirements limit the use of fixed surveillance systems to applications associated with law enforcement, firefighting, emergency rescue, manufacturers licensees, petroleum licensees, or power licensees. This provision is intended to ensure that surveillance systems are used infrequently with a low proliferation rate to avoid causing harmful interference to authorized users.²⁹ Section 15.511(f) mandates that a surveillance system carry a statement that the operation of the system is restricted to law enforcement, fire and rescue, public utilities, and industrial entities.³⁰

12. In its waiver request, Liberty argues that while the list of eligible users does not include private security professionals, reliance on such private security teams is an important component of efforts to protect vulnerable facilities and public gatherings nationwide.³¹ A waiver of the eligibility requirements set forth in the introductory text of Section 15.511(b) would permit security professionals that do not qualify under the law enforcement provision to operate HEXWAVE devices. We find that Liberty has made a persuasive case that use under the requested waiver will be sufficiently limited so as not to undermine the purpose of the rule, and that grant of a waiver of this section would be consistent with our prior decisions. The HEXWAVE is intended for use by trained security professionals in limited locations. According to Liberty, HEXWAVE's price point will have the practical effect of limiting deployment to high priority events.³² In addition, the use scenario – detection of concealed weapon detection – is exactly the type of targeted law enforcement use that would already be permissible under Section 15.511(b), but for the fact that the HEXWAVE operators may not themselves be law enforcement officers. Moreover, grant of a limited waiver in this instance is consistent with precedent, where we found that expanding eligibility requirements to permit a narrow and specific application was justified where such use would be infrequent and with a low proliferation rate.³³

13. Therefore, for purposes of this waiver, we adopt a narrowly tailored definition of “private security personnel” suggested by Liberty in its waiver petition,³⁴ to mean individuals and organizations (other than public law enforcement personnel and agencies) that primarily are engaged in the detection of crime and threats to people and property at sites at which people aggregate, including providers of (i) proprietary or contractual guard and screening services, (ii) electronic security systems integration and management services, and (iii) security consulting services, which could include security staff who also hold private security licenses or adhere to federal, state, or local private security laws. This definition is designed to ensure that eligibility to use the HEXWAVE is not extended to members of the general public who are not otherwise involved in security-related activities.

²⁸ 47 CFR §15.511(b) introductory text and (b)(2).

²⁹ *UWB First R&O*, 17 FCC Rcd at 7499-7504, paras. 185-201 (2002). Private security firms did not request to be included in the original list of permissible uses during the rulemaking and the Commission did not discuss private security firm users in its decision.

³⁰ 47 CFR §15.511(f).

³¹ Liberty Waiver Request at 10.

³² *Id.* at 10-11.

³³ See *Headlight, Inc. Request for waiver of Part 15 of the Commission's Rules Applicable to Ultra-Wide Band Devices*, ET Docket No. 16-44, Order, 32 FCC Rcd 1511 at 1514 (OET 2017) (allowing use of a UWB device mounted on farming machinery operated in fields that are located in rural or predominantly agricultural areas by parties eligible for licensing under the Part 90 rules).

³⁴ See *supra* note 6.

14. To further ensure that the purpose of the rule is not undermined, we will limit the number of devices that may be deployed under this waiver to 100 in the first year following the effective date of this Order, to an additional 200 in the second year, and to an additional 300 in the third year for a total of 600 devices at the end of the third year.³⁵ In the fourth year and all subsequent years, Liberty may deploy up to 300 additional devices per year. Our decision to limit the number of devices and to allow for their gradual deployment is a cautious approach, so that harmful interference issues can be identified and addressed in the extremely unlikely event that they were to occur. If no interference issues arise, starting in the fourth year the FCC, in coordination with NTIA, would consider a request by Liberty to increase the number of devices that may be deployed each year. Devices deployed under the terms of this waiver may continue to operate after the three-year deployment period ends, provided there is no harmful interference to authorized operations.³⁶ As an additional precautionary measure, Liberty has agreed to limit the parameters for the HEXWAVE system to those described in its *Ex Parte* presentation.³⁷ More specifically Liberty on its own motion has agreed to limit the total transmit time of the HEXWAVE system during a cycle to less than 54 milliseconds and each cycle will be repeated with a period of no less than 100 milliseconds. This will ensure that the total transmit time will be kept to a minimum.

15. We also find that a waiver of the Section 15.511(b)(2) coordination requirement, with appropriate conditions, is warranted. The HEXWAVE will be limited in number and only used in specialized settings (e.g., hotels, schools, and sporting venues). As noted in the *Kyma Medical Order*, the coordination process for UWB devices was primarily put into place to keep track of ground penetrating radars that would potentially be used for extended periods in outdoor locations.³⁸ Unlike the HEXWAVE, ground penetrating radars are prolific commercial devices that are widely deployed throughout the United States. In addition, Liberty has agreed to operational restrictions to protect certain Federal government operations. The 7.145-7.235 GHz and 8.4-8.5 GHz bands are allocated to the space research service and are used to receive low-power signals from space by NASA and radio astronomers. To protect these operations, Liberty has agreed that operations of HEXWAVE devices should be prohibited in certain locations and should require coordination with either NASA or radio astronomy at other locations.

16. To satisfy Federal government coordination interests, we will require Liberty to create and maintain a record of installations of all devices operating under this waiver, including the identity of the customer, the type of installation (e.g., airport or government building, commercial venue), and street address and/or geographical coordinates, and must maintain a record of any instances of harmful interference caused to Federal government operations. Liberty must make this information available to the Commission and/or NTIA upon request. Liberty must also inform purchasers that HEXWAVE devices may not be resold to third parties for use at another installation in the United States without prior notice and unless arrangements are made for the third-party buyer to meet all the waiver conditions. We will also require Liberty to actively maintain location information, have the capability of detecting any abnormal operation, and possess the ability to remotely cease transmission of a HEXWAVE system upon notice of interference.³⁹ These requirements are consistent with those suggested by Liberty and will assist it and the

³⁵ This matches the deployment numbers that Liberty has endorsed in the record. See Letter from Aman Bhardwaj, President, Liberty Defense Holdings to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 19-217 (filed Apr. 24, 2020).

³⁶ Liberty must file a modification of its waiver to deploy more than 600 devices or to extend the deployment period beyond three years.

³⁷ See Liberty *Ex Parte* Notice filed September 11, 2019, at 2.

³⁸ See *Kyma Medical Technologies Ltd. Request for Waiver of Part 15 of the Commission's Rules Applicable to Ultra-Wideband Devices*, ET Docket No. 15-119, Order, 31 FCC Rcd 9705, 9710 (OET 2016).

³⁹ See Liberty *Ex Parte* filed December 7, 2021.

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Commission in addressing questions that may arise regarding the deployment and operation of HEXWAVE devices.⁴⁰

17. We also grant a waiver of Section 15.511(f), to properly reflect the waiver of Section 15.511(b) by requiring a modified statement of who may operate the HEXWAVE system. Each HEXWAVE device will be required to bear the following (or a substantially similar) statement in a conspicuous location on the device: "Operation of this device is restricted to law enforcement, fire and rescue officials, private security personnel, public utilities, and industrial entities. Operation by any other party is a violation of 47 U.S.C. 301 and could subject the operator to serious legal penalties."⁴¹

D. Waiver conditions

18. This waiver is conditioned on Liberty meeting the specified waiver conditions. We further note that Liberty is not requesting a relaxation of the restrictive emission limits that are an integral part of our UWB rules, and which we have acknowledged to be conservative and extremely protective of incumbent services.⁴² Because the HEXWAVE must comply with these rules, and because it can operate under a waiver of the four rules we have identified in a manner consistent with the use characteristics associated with other UWB surveillance applications without increasing the potential for harmful interference to authorized users, we find good cause to grant the waiver request. We also find good cause to grant this waiver without first resolving the issues Cisco and Hewlett Packard have raised in their letter.⁴³ Liberty's request is narrowly tailored, can be granted without raising the potential for causing harmful interference to authorized services, and can help realize important public safety benefits. By contrast, Cisco and Hewlett Packard raise general questions of Commission practice and policy that will remain available for our consideration later and in an appropriate context.

19. Accordingly, pursuant to the delegated authority in Sections 0.31 and 0.241 of the Commission's rules, we waive the requirements of Sections 15.31(c), 15.503(d), the introductory text of 15.511(b), 15.511(b)(2), 15.511(f), and 15.521(d) of our rules to permit the certification and marketing of the HEXWAVE System. This waiver is subject to the following conditions:

- 1) The HEXWAVE device shall be certified by the Commission and must comply with the technical specifications applicable to operation under Part 15 of 47 CFR, except as permitted below:
 - (a) the instantaneous bandwidth requirement in 47 CFR §15.503(d) is waived to permit operation of the swept-frequency UWB surveillance system;
 - (b) the measurement requirements in 47 CFR §15.31(c) and 47 CFR § 15.521(d) are waived to permit the HEXWAVE device to be tested with the frequency sweep active, rather than stopped, to demonstrate compliance with the maximum permitted average power in Section 15.511;
 - (c) the eligible user requirements specified in the introductory text of 47 CFR §15.511(b) are relaxed to also allow use by private security personnel defined as "Individuals and organizations (other than public law enforcement personnel and agencies) that primarily are engaged in the detection of crime and threats to people and property at sites at which people aggregate, including

⁴⁰ See *L-3 Communications Security and Detections Systems, Inc. Request for Waiver of Sections 15.31(c), 15.35(b) and 15.205(a) of the Commission's Rules to Permit the Deployment of Security Screening Portal Devices that Operate in the 20-40 GHz Range*, ET Docket No. 16-45, Order, 31 FCC Rcd 12310 (OET 2016) (mandating a similar detailed recordkeeping requirement as a condition to granting a waiver).

⁴¹ See Liberty Waiver Request at Exhibit A.

⁴² See *UWB First R&O*, 17 FCC Rcd 7435, 7437, para. 1 (stating that "we are concerned, however, that the standards we are adopting may be overprotective and could unnecessarily constrain the development of UWB technology").

⁴³ See Cisco/HPE UWB Letter, *supra* note 9.

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- providers of (i) proprietary or contractual guard and screening services, (ii) electronic security systems integration and management services, and (iii) security consulting services”;
- (d) the coordination requirement of 47 CFR §15.511(b)(2) to coordinate directly with the Commission and NTIA is waived;
- (e) in lieu of the labeling requirement of 47 CFR §15.511(f), each HEXWAVE system shall bear the following or substantially similar statement in a conspicuous location on the device:
“Operation of this device is restricted to law enforcement, fire and rescue officials, private security personnel, public utilities, and industrial entities. Operation by any other party is a violation of 47 U.S.C. 301 and could subject the operator to serious legal penalties.”
- (f) Liberty’s sale of the HEXWAVE system will be limited to law enforcement, fire, and rescue officials, private security personnel, public utilities, and industrial entities as described in conditions (1)(c) and (1)(e).
- 2) Liberty shall create and maintain a record of all devices sold under this waiver, which record shall include all information set forth in 47 CFR § 15.525(b) to include latitude and longitude information. This record shall be made available to the Commission and to NTIA upon request.
 - 3) The maximum EIRP of the HEXWAVE system shall not exceed -41.3 dBm/MHz.
 - 4) The intentional emissions generated by the HEXWAVE device must be completely contained within the 6-10.6 GHz frequency range.
 - 5) The total transmit time of the HEXWAVE system during a cycle will be less than 54 milliseconds and each cycle will be repeated with a period of no less than 100 milliseconds.
 - 6) Each HEXWAVE system will be operated such that no two antennas within a single HEXWAVE system will transmit concurrently.
 - 7) This waiver shall apply to the HEXWAVE systems as described herein and provided no changes are made to the transmitter that would increase the system’s EIRP.
 - 8) Liberty shall:
 - a) maintain a database, accessible to the FCC and NTIA upon request, of any instance in which a deployed HEXWAVE system caused harmful interference to federal operations;
 - b) in every instance know the exact location of the deployment of each HEXWAVE system due to the terms of its customer agreements and its ability to remotely monitor operating HEXWAVE systems, and contractually require Liberty’s approval for its customer to move a HEXWAVE system; and
 - c) maintain remote connectivity to each HEXWAVE to continuously monitor systems operating in the field. Liberty will take corrective action if there is abnormal operation by a HEXWAVE system, including terminating operation in the event of interference.
 - 9) Liberty shall inform purchasers that the HEXWAVE device may not be resold or leased by such purchasers to third parties for use at another installation in the United States without prior notice to Liberty and unless appropriate arrangements are made for the third-party buyer to meet all of the conditions of this waiver.
 - 10) Liberty shall disclose in a manner that would be conspicuous to both initial and subsequent purchasers of HEXWAVE that these devices may only be operated on a non-interference basis to existing and future authorized services and operators of these devices will be required to mitigate any instances of harmful interference that may occur.
 - 11) Liberty shall limit the number of systems installed under this waiver to one hundred (100) installations during the first twelve months following the grant of this waiver and to an additional

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two hundred (200) during the second twelve months and to an additional three hundred (300) during the third twelve months, for a total of no more than six hundred (600) systems at the end of three years. In the fourth year and all subsequent years Liberty may install up to three hundred (300) additional systems per year; any request by Liberty to modify this limit may be considered by the FCC in coordination with NTIA.

12) Liberty shall avoid outdoor deployment within 20 km of the sites listed in footnote US 131:

Arecibo Observatory, PR.....	18° 20' 37" N, 66° 45' 11" W
Green Bank Telescope (GBT), WV.....	38° 25' 59" N, 79° 50' 23" W
Very Large Array (VLA), Socorro, NM....	34° 04' 44" N, 107° 37' 06" W

Very Long Baseline Array (VLBA) Stations:

Brewster, WA.....	48° 07' 52" N, 119° 41' 00" W
Fort Davis, TX.....	30° 38' 06" N, 103° 56' 41" W
Hancock, NH.....	42° 56' 01" N, 71° 59' 12" W
Kitt Peak, AZ.....	31° 57' 23" N, 111° 36' 45" W
Los Alamos, NM.....	35° 46' 30" N, 106° 14' 44" W
Mauna Kea, HI.....	19° 48' 05" N, 155° 27' 20" W
North Liberty, IA.....	41° 46' 17" N, 91° 34' 27" W
Owens Valley, CA.....	37° 13' 54" N, 118° 16' 37" W
Pie Town, NM.....	34° 18' 04" N, 108° 07' 09" W
St. Croix, VI.....	17° 45' 24" N, 64° 35' 01" W

Coordination is required for outdoor operations within 20 km of the above referenced sites. The following points of contact must be notified for coordination (please cc esm@nsf.gov):

VLA/VLBA:

Dan "Mert" Mertely
nrao-rfi@nrao.edu
 phone: (575) 835-7128

Arecibo:
 Angel Vazquez
angel@naic.edu
 phone: (787) 878-2612 ext.304

Coordination is required for any operations within the National Radio Quiet Zone (NRQZ). The NRQZ and GBT PoC is:

Paulette Woody
nrqz@gb.nrao.edu
 Phone: (304) 456-2107 (normal); (615) 796-6395 (Google voice) or 304-456-9951 (H)

Notification to esm@nsf.gov and the VLA/VLBA point of contact is required for any operation/deployment within the geographic area bounded by:

31.367224° N, 109.031505° W
 31.367224° N, 103.077521° W
 34.386150° N, 103.077521° W
 34.386150° N, 109.031505° W

Except for within the city limits of Las Cruces, Alamogordo, Roswell, and Carlsbad in NM, and

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El Paso, TX. This would assist radio astronomy operations. NSF may request coordination of operations in the future, as the VLA does make use of the frequency range involved, and such coordination may assist with telescope scheduling.

13) Outdoor deployment shall be avoided within 10 km of the sites listed in Table 1:

Table 1. Exclusion Zone Sites

Location	Latitude (dd mm ss)	Longitude (ddd mm ss)
AK, Anchorage	61 09 24 N	149 59 07 W
AK, Fairbanks	64 51 32 N	147 51 04 W
AK, U of AK	64 51 37 N	147 50 50 W
AK, North Pole	64 48 18 N	147 30 00 W
AK, North Pole West AS4	64 47 37 N	147 32 18 W
AK, North Pole West AS5	64 47 42 N	147 32 18 W
AK, Poker Flat	65 07 00 N	147 27 35 W
CA, Goldstone (DSS-14)	35 25 33 N	116 53 19 W
CA, Goldstone (DSS-24)	35 20 24 N	116 52 29 W
CA, Goldstone (DSS-25)	35 20 15 N	116 52 31 W
CA, Goldstone (DSS-26)	35 20 09 N	116 52 23 W
HI, South Point	19 00 50 N	155 39 47 W
SD, Sioux Falls	43 44 10 N	096 37 21 W
VA, Wallops Island	37 55 28 N	075 28 35 W
VA, Wallops Island	37 55 35 N	075 28 32 W

The outdoor deployment Coordination Zone Sites that should be subject to a 1.2 km coordination zone are identified in Table 2.

Table 2. Coordination Zone Sites

Location	Latitude (dd mm ss)	Longitude (ddd mm ss)
CA, La Jolla	32 52 11 N	117 15 07 W
CA, Orange	33 47 38 N	117 51 00 W
CA, Pasadena	34 12 06 N	118 10 27 W
CA, Poway	32 56 18 N	117 02 42 W
DE, Newark	39 41 01 N	075 45 18 W
FL, St. Petersburg	27 45 36 N	082 37 55 W
FL, Tallahassee	30 23 10 N	084 13 53 W
HI, Honolulu	21 17 54 N	157 48 59 W
IN, Indianapolis	39 47 42 N	086 03 43 W
IN, Lafayette	40 25 48 N	086 54 54 W
KY, Morehead	38 11 31 N	083 26 20 W
LA, Baton Rouge	30 24 43 N	091 10 44 W

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Location	Latitude (dd mm ss)	Longitude (ddd mm ss)
MD, Greenbelt	38 59 57 N	076 51 18 W
MD, Lanham	38 57 40 N	076 50 24 W
MD, Suitland	38 51 07 N	076 56 31 W
MI, Peach Mountain	42 23 56 N	083 56 08 W
MS, Stennis Space Center	30 22 05 N	089 37 01 W
MT, Missoula	46 55 34 N	114 05 35 W
NJ, New Brunswick	40 28 48 N	074 26 13 W
NM, Albuquerque	35 05 02 N	106 37 16 W
NY, New York	40 49 12 N	073 57 00 W
OR, Corvallis	44 34 04 N	123 16 39 W
TX, Austin	30 23 42 N	097 44 06 W
TX, Irving	32 52 41 N	096 59 53 W
UT, Salt Lake City	40 46 00 N	111 53 13 W
WI, Madison	43 04 15 N	089 24 24 W

The point of contact for coordination is Bryan Rhodes NASA, Frequency Assignment Program Manager bryan.a.rhodes@nasa.gov.

- 14) This waiver and its conditions shall apply only to the UWB devices described herein and are not to be considered to apply generally to any other UWB operations where further analysis would be necessary to assess the potential for impact to other authorized users.

- 15) A copy of this Order shall be provided with the application for certification of the device.

IV. ORDERING CLAUSES

20. Accordingly, pursuant to authority delegated in Sections 0.31 and 0.241 of the Commission's rules, 47 CFR §§ 0.31, 0.241, and Section 1.3 of the Commission's rules, 47 CFR § 1.3, IT IS ORDERED that the Request for Waiver filed by Liberty Defense Holdings, Ltd. on May 8, 2019 IS GRANTED consistent with the terms of this Order. This action is taken pursuant to Sections 4(i), 302, 303(e), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154(i), 302, 303(e), and 303(r). This action is effective upon release of this Order.

21. IT IS FURTHER ORDERED that, if no applications for review are timely filed, this proceeding SHALL BE TERMINATED and the docket CLOSED.

FEDERAL COMMUNICATIONS COMMISSION

Ronald T. Repasi
Acting Chief
Office of Engineering and Technology

10 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	02/10/2025	105998912BOX-006	KPS <i>KPS</i>	MFM <i>MFM</i>	Original Issue