

May 17, 2023

Zebra Technologies Corporation
Thomas Warner
1 Zebra Plaza,
Holtsville NY 11742

Dear Thomas Warner,

Enclosed is the EMC Wireless test report for compliance testing of the Zebra Technologies Corporation, UWT-7010 as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15, Subpart F for Intentional Radiators.

Thank you for using the services of Eurofins Electrical and Electronic Testing NA, Inc. If you have any questions regarding these results or if Eurofins Electrical and Electronic Testing NA, Inc. can be of further service to you, please feel free to contact me.

Sincerely yours,
Eurofins Electrical and Electronic Testing NA, Inc.



Michelle Tawmging
Documentation Department

Reference: (\Zebra Technologies Corporation\WIR124171B-FCC519 Rev. 1)

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Electromagnetic Compatibility Criteria Test Report

for the

**Zebra Technologies Corporation
UWT-7010**

Tested under
the FCC Certification Rules
contained in
Title 47 of the CFR, Part 15.519 Subpart F
for Intentional Radiators

Report: WIR124171B-FCC519 Rev. 1

May 17, 2023

Prepared For:

**Zebra Technologies Corporation
1 Zebra Plaza,
Holtsville NY 11742**

Prepared By:
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Title 47 of the CFR, Part 15.519 Subpart F
for Intentional Radiators



Donald Salguero
WIR Laboratory Engineer

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements.



Michael Griffiths
Manager, Wireless Lab

Report Status Sheet

| Revision | Report Date | Reason for Revision |
|----------|--------------|------------------------|
| ∅ | May 9, 2023 | Initial Issue |
| 1 | May 17, 2023 | Updated Block Diagram. |

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List of Terms and Abbreviations

| | |
|------------------------------|--|
| AC | Alternating Current |
| ACF | Antenna Correction Factor |
| Cal | Calibration |
| <i>d</i> | Measurement Distance |
| dB | Decibels |
| dBμA | Decibels above one microamp |
| dBμV | Decibels above one microvolt |
| dBμA/m | Decibels above one microamp per meter |
| dBμV/m | Decibels above one microvolt per meter |
| DC | Direct Current |
| E | Electric Field |
| DSL | Digital Subscriber Line |
| ESD | Electrostatic Discharge |
| EUT | Equipment Under Test |
| <i>f</i> | Frequency |
| FCC | Federal Communications Commission |
| GRP | Ground Reference Plane |
| H | Magnetic Field |
| HCP | Horizontal Coupling Plane |
| Hz | Hertz |
| IEC | International Electrotechnical Commission |
| kHz | kilohertz |
| kPa | kilopascal |
| kV | kilovolt |
| LISN | Line Impedance Stabilization Network |
| MHz | Megahertz |
| μH | microhenry |
| μ | microfarad |
| μs | microseconds |
| NEBS | Network Equipment-Building System |
| PRF | Pulse Repetition Frequency |
| RF | Radio Frequency |
| RMS | Root-Mean-Square |
| TWT | Traveling Wave Tube |
| V/m | Volts per meter |
| VCP | Vertical Coupling Plane |

I. Executive Summary

A. Purpose of Test

An EMC Wireless evaluation was performed to determine compliance of the Zebra Technologies Corporation UWT-7010, with the requirements of Part 15, §15.519. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the UWT-7010. Zebra Technologies Corporation should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the UWT-7010, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.519, in accordance with Zebra Technologies Corporation, purchase order number 111558811. All tests were conducted using measurement procedure ANSI C63.10-2013.

| FCC Reference 47 CFR Part 15.519 | Description | Compliance |
|---|----------------------------------|---|
| Title 47 of the CFR, Part 15 §15.203 | Antenna Requirement | Compliant |
| Title 47 of the CFR, Part 15 §15.207(a) | Conducted Emission Limits | Not Applicable. EUT is battery powered. |
| 15.203 | -10 dB Bandwidth | Compliant |
| Title 47 of the CFR, Part 15 §15.519(b) | | |
| Title 47 of the CFR, Part 15 §15.519(c) | Radiated Emissions | Compliant |
| Title 47 of the CFR, Part 15 §15.519(d) | Radiated Emissions – GPS Band | Compliant |
| Title 47 of the CFR, Part 15 §15.519(e) | Peak and Average Power Emissions | Compliant |

Table 1. Executive Summary of EMC Wireless Part 15.519 Compliance Testing

II. Equipment Configuration

A. Overview

Eurofins Electrical and Electronic Testing NA, Inc. was contracted by Zebra Technologies Corporation to perform testing on the UWT-7010, under Zebra Technologies Corporation’s purchase order number 111558811.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Zebra Technologies Corporation, UWT-7010.

The results obtained relate only to the item(s) tested.

| | | |
|---------------------------------------|---|--|
| Model Tested: | UWT-7010 | |
| Model Covered: | UWT-7010 | |
| EUT Specifications: | Primary Power: | Internal coin cell battery. 2.4VDC to 3.6VDC |
| | FCC ID: | UZ7UWT7010 |
| | IC: | N/A |
| | Type of Modulations: | OOK |
| | Equipment Code: | UWB |
| | Peak RF Output Power: | -43.55 dBm/MHz (Average) |
| Analysis: | The results obtained relate only to the item(s) tested. | |
| Environmental Test Conditions: | Temperature: | 15-35° C |
| | Relative Humidity: | 30-60% |
| | Barometric Pressure: | 860-1060 mbar |
| Evaluated by: | Donald Salguero | |
| Report Date: | May 17, 2023 | |

Table 2. EUT Summary Table

B. References

| | |
|-----------------------------------|--|
| CFR 47, Part 15, Subpart F | Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: Radio Frequency Devices |
| ANSI C63.4:2014 | Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz |
| ISO/IEC 17025:2017 | General Requirements for the Competence of Testing and Calibration Laboratories |
| ANSI C63.10-2013 | American National Standard for Testing Unlicensed Wireless Devices |

Table 3. References

C. Test Site

All testing was performed at Eurofins Electrical and Electronic Testing NA, Inc., 914 W. Patapsco Avenue, Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology. Eurofins Electrical and Electronic Testing NA, Inc. has been accredited by the American Association for Laboratory Accreditation (A2LA) (Certificate #: 0591.01) in accordance with ISO/IEC 17025:2017.

D. Measurement Uncertainty

| Test Method | Typical Expanded Uncertainty | K | Confidence Level |
|---------------------------------------|------------------------------|---|------------------|
| RF Frequencies | ±4.52 Hz | 2 | 95% |
| RF Power Conducted Emissions | ±2.32 dB | 2 | 95% |
| RF Power Conducted Spurious Emissions | ±2.25 dB | 2 | 95% |
| RF Power Radiated Emissions | ±3.01 dB | 2 | 95% |

Table 4. Uncertainty Calculations Summary

E. Equipment Overview and Test Configuration

| | |
|---|---|
| Name of EUT/Model: | UWT-7010 |
| Description of EUT and Intended Use: | The UWT-7010 is a small battery-operated UWB tags which transmit up to 2.5nsec UWB pulses at 7.55GHz and have a magnetic receive interface at 125KHz used for provisioning. These tags are used with associated Zebra UWB receivers, a Zebra UWB Hub, and software to provide real-time precision locating of the object/person wearing the tag. |
| Selected Operation Mode(s): | For regulatory testing purposes the tags are programmed with special firmware that produces the maximum number of bits per packet at a packet rate <=200Hz. They are tested at both 1Mbps and 2Mbps data rates. The exception is the pulse measurement, where the tag is set to a mode not available to customers. A pulse is sent out at a continuous 1Mbps rate to ease triggering. |
| Rational for the selection of the Operation Mode(s): | The number of pulses per packet are set by the average emissions limit. Testing with the maximum number of bits per packet allows for testing worse case packet size and rate for both 1Mbps and 2Mbps. For pulse measurement, a pulse is sent out at a continuous 1Mbps rate to ease triggering. |
| Susceptibility Criteria: | Tags are RF transmit only devices. UWB transmissions, by regulation, operate near the noise level and are highly susceptible to any interference in their frequency band and can also be affected by high power signals near their band edges. By regulation the 10dB bandwidth is contained within the 7.125-7.9GHz frequency range. |
| Monitoring Method(s): | A configuration tool called the Zebra UWB Wand along with monitoring software shows a stream of packets being transmitted by the DUT. If the stream of data is visible then the EUT is performing its intended function. If no data is present then the EUT is not performing its intended function. |
| Emissions Class Declaration: | Class A |
| Configurations: | There is only one configuration. The EUT is an RF only device. It is tested mounted on a pedestal. |
| Rated Power Input | |
| Input Voltage Range: | Internal coin cell battery. 2.4VDC to 3.6VDC |
| AC or DC: | DC |
| Voltage Frequency: | NA |
| Number of Phases: | 1 |
| Current: | NA |

| | |
|---|--------------------------------|
| Uses an external AC/DC Adapter: | False |
| The EUT can be battery powered: | False |
| Power Input Under Test | |
| Input Voltage: | NA |
| Frequency: | NA |
| Physical Description | |
| EUT Arrangement: | Floor Standing |
| System with Multiple Chassis? | False |
| Size (HxWxD) inches: | 25.45mm x 11.1mm |
| Weight (lbs.): | 8grams |
| Highest Internal Frequency (MHz): | 8MHz |
| Other Info | |
| EUT Software (Internal to EUT): | V88.0 |
| Support Software (used by support PC to exercise EUT): | Tag Interface V3.5.5 |
| Firmware: | 8-bit Microcontroller Firmware |
| Transmitter Parameters | |
| Description of your unit: | OOK |
| Modulation Type: | OOK |
| Number of Channels: | 1 |
| Frequency Range (MHz): | 7.125-7.9GHz |
| Antenna Type: | Omni |
| Antenna Gain (dB): | 1.3dBi |
| PMN: | |
| HVIN: | 102-2044-000-RB |
| FVIN: | NA |
| HMN: | NA |
| Data Rates: | 1Mbps and 2Mbps |
| Expected Power Level: | -24.45dBm at 3MHz RBW |
| Number of Antenna: | 1 |
| Number of Intentional Transmitters: | 1 |
| Number of Certified Intentional Transmitter Modules: | 1 |
| FCC ID: | UZ7UWT7010 |
| IC ID: | |

Table 5. EUT Details

| Name/Description | Model Number | Part Number | Serial Number | Rev. # |
|-------------------------|---------------------|--------------------|----------------------|---------------|
| Player Tag | UWT-7010 | UWT-7010-A-00AA | N.A. | N.A. |

Table 6. EUT List

| Port Name on EUT | Cable Desc. or reason for none | 3 Meters or Longer | Length as tested (m) | Max Length (m) | Shielded? | Termination Box ID & Port Name |
|------------------|--------------------------------|--------------------|----------------------|----------------|-----------|--------------------------------|
| NA | | No | | | No | |

Table 7. Ports and Cabling

| Name/Description | Manufacturer | Model Number | Serial Number | *Customer Supplied Calibration Data |
|------------------|--------------|--------------|---------------|-------------------------------------|
| Wand | Zebra | WND-7300 | N.A. | N.A. |

Table 8. Support Equipment

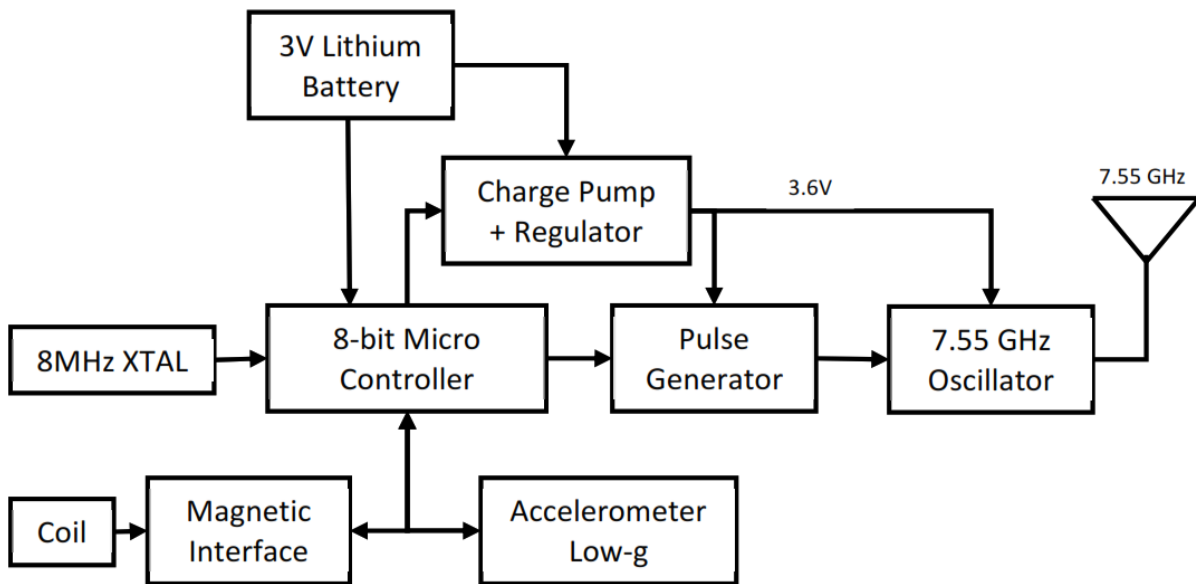


Figure 1. Block Diagram

F. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

G. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Zebra Technologies Corporation upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

Test Requirement: § 15.203: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

- a.) Antenna must be permanently attached to the unit.
- b.) Antenna must use a unique type of connector to attach to the EUT.
- c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Test Results: The EUT was **compliant** with the Antenna Requirement limits of §15.203. EUT uses built-in antenna.

Test Engineer: Donald Salguero

Test Date: April 11, 2023

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 / § 15.519(b) -10 dB Bandwidth

Test Requirements: § 15.519(b): The -10 dB bandwidth of a device operating under the provisions of this section must be contained between 3100 MHz and 10,600 MHz.

§ 15.503(d): *Ultra-wideband (UWB) transmitter.* An intentional radiator that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.

Test Procedure: A horn antenna was placed 3m away from the EUT. A preamp was used for making measurements. EUT was rotated along all its axis and measuring antenna height was varied until the trace was maximized. Measurement procedure section 10.1 from ANSI C63.10-2013 was used to evaluate the -10dB bandwidth.

Test Results The EUT was **compliant** with the -10 dB Bandwidth limits of § 15.203 / § 15.519 (b).

Test Engineer: Donald Salguero

Test Date: April 12, 2023

| | | |
|-----------------|-------|-----|
| Fm = | 7.425 | GHz |
| FL = | 7.16 | GHz |
| FH = | 7.76 | GHz |
| -10dB BW | 600 | MHz |

Table 9. -10dB bandwidth calc

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.519(c) Radiated Emissions

Test Requirements: §15.519(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 | -75.3 |
| 1610 – 1990 | -63.3 |
| 1990 -3100 | -61.3 |
| 3100 – 10600 | -41.3 |
| Above 10600 | -61.3 |

Test Procedure: A preamp was used for making measurements. Antenna correction factors, cable loss and Preamp factors were programmed in to spectrum analyzer. Measurements were made following ANSI C63.10-2013 section 10.3.7.

The following formula was used for converting a EIRP limit into a field strength limit based on the measurement distance:

$$\text{Field Strength (dBuV/m)} = \text{EIRP (dBm)} + 104.8 - 20\log(D)$$

Most measurements were made at distances lower than 3m to meet noise floor requirements.

Test Results: The EUT was **compliant** with the Radiated Spurious Emission limits of § 15.519(c).

Test Engineer: Donald Salguero

Test Date: April 11, 2023

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.519(d) Radiated Emissions – GPS Bands

Test Requirements: §15.519(d): In addition to the radiated emission limits specified in the table in paragraph (c) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

| Frequency in MHz EIRP in dBm | |
|------------------------------|-------|
| 1164 – 1240 | -85.3 |
| 1559 – 1610 | -85.3 |

Test Procedure: A preamp was used for making measurements. Antenna correction factors, cable loss and Preamp factors were programmed in to spectrum analyzer. Measurements were made following ANSI C63.10-2013 section 10.3.10.

The following formula was used for converting a EIRP limit into a field strength limit based on the measurement distance:

$$\text{Field Strength (dBuV/m)} = \text{EIRP (dBm)} + 104.8 - 20\log(D)$$

Test Results: The EUT was **compliant** with the Radiated Spurious Emission limits of § 15.519(d).

Test Engineer: Donald Salguero

Test Date: April 11, 2023

| Frequency (MHz) | Polarization | Uncorrected Field Strength (dBuV) | ACF (dB/m) | Cable Loss (dB) | Pre-amp Gain (dB) | Corrected Field Strength (dBuV/m) | Measuring Distance (m) | EIRP (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|--------------|-----------------------------------|------------|-----------------|-------------------|-----------------------------------|------------------------|------------|-------------|-------------|
| 1183.44 | H | 25.31 | 28.329 | 3.95 | 42.879 | 14.71 | 1.5 | -86.54 | -85.3 | -1.24 |
| 1176.75 | V | 25.02 | 28.966 | 3.95 | 42.879 | 15.057 | 1.5 | -86.19 | -85.3 | -0.89 |
| 1576.89 | H | 23.62 | 27.955 | 4.91 | 42.728 | 13.757 | 1.5 | -87.49 | -85.3 | -2.19 |
| 1576.32 | V | 23.48 | 28.297 | 4.91 | 42.728 | 13.959 | 1.5 | -87.29 | -85.3 | -1.99 |

Table 10. Radiated Emissions – GPS Bands, Test Results

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.519(c)(e) Peak and Average Power Emissions

Test Requirements: §15.519(e): There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, f[M]. That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521.

§15.519(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 | |
|------------------------------|-------|
| 3100 – 10600 | -41.3 |

Test Procedure: A preamp was used for making measurements. EUT was rotated along all axis, receive antenna height was varied until the max level emission was found. Measurements were made at 3m.

Average measurements were made following ANSI C63.10-2013 section 10.3.7.

Peak measurements were made following ANSI C63.10-2013 sections 10.3.5 and 10.3.6. PEAK detector activated on the spectrum analyzer and having the resolution bandwidth set to 3 MHz and video bandwidth set to 3 MHz.

Therefore, the limit calculated is $0 \text{ dBm} + 20 \log(3/50) = -24.44 \text{ dBm}$.

Test Results: The EUT was **compliant** with the Peak and Average Power Output limits of §15.519(e).

Test Engineer: Donald Salguero

Test Date: April 11, 2023

| 1 | UWT-7010 | E4AA | | | | | | | | | | | |
|-------|----------|--------|-------------------------------|------------------------------|-----------------------|-----------------------------|-------------------------|-----------------|--------------------|---|---|-------------|--------|
| Plane | Pol | Remark | (E): E-field level * (dBuV/m) | (A): Read Level @ S/A (dBuV) | (Fc): Cable Loss (dB) | (Fa): Antenna Factor (dB/m) | (Gpa): Preamp gain (dB) | Ant height (cm) | Turntable (degree) | EIRP level ** (dBm/3MHz for PK, dBm/MHz for AV) | FCC Limit Line *** (RBW=3MHz for PK, RBW=1MHz for AV) | Margin (dB) | Result |
| X | V | Peak | 69.8 | 60.99 | 11.99 | 35.72 | 38.9 | 100 | 356.1 | -25.4 | -24.44 | -0.96 | PASS |
| | | Avg | 50.51 | 41.7 | 11.99 | 35.72 | 38.9 | | | -44.69 | -41.3 | -3.39 | PASS |
| | H | Peak | 60.45 | 51.65 | 11.99 | 35.71 | 38.9 | 112 | 78.5 | -34.75 | -24.44 | -10.31 | PASS |
| | | Avg | 42.1 | 33.3 | 11.99 | 35.71 | 38.9 | | | -53.1 | -41.3 | -11.80 | PASS |
| Y | V | Peak | 65.82 | 57.01 | 11.99 | 35.72 | 38.9 | 309 | 113.7 | -29.38 | -24.44 | -4.94 | PASS |
| | | Avg | 47.33 | 38.52 | 11.99 | 35.72 | 38.9 | | | -47.87 | -41.3 | -6.57 | PASS |
| | H | Peak | 70.58 | 61.78 | 11.99 | 35.71 | 38.9 | 117 | 176.7 | -24.62 | -24.44 | -0.18 | PASS |
| | | Avg | 51.65 | 42.85 | 11.99 | 35.71 | 38.9 | | | -43.55 | -41.3 | -2.25 | PASS |
| Z | V | Peak | 66.35 | 57.54 | 11.99 | 35.72 | 38.9 | 315 | 135.7 | -28.85 | -24.44 | -4.41 | PASS |
| | | Avg | 47.09 | 38.28 | 11.99 | 35.72 | 38.9 | | | -48.11 | -41.3 | -6.81 | PASS |
| | H | Peak | 69.74 | 60.94 | 11.99 | 35.71 | 38.9 | 116 | 178.5 | -25.46 | -24.44 | -1.02 | PASS |
| | | Avg | 50.66 | 41.86 | 11.99 | 35.71 | 38.9 | | | -44.54 | -41.3 | -3.24 | PASS |

Table 11. UWT-7010, Output Power Test Results, 1Mbps

| 1 | UWT-7010 | E4AA | | | | | | | | | | | |
|-------|----------|--------|-------------------------------|------------------------------|-----------------------|-----------------------------|-------------------------|-----------------|--------------------|---|---|-------------|--------|
| Plane | Pol | Remark | (E): E-field level * (dBuV/m) | (A): Read Level @ S/A (dBuV) | (Fc): Cable Loss (dB) | (Fa): Antenna Factor (dB/m) | (Gpa): Preamp gain (dB) | Ant height (cm) | Turntable (degree) | EIRP level ** (dBm/3MHz for PK, dBm/MHz for AV) | FCC Limit Line *** (RBW=3MHz for PK, RBW=1MHz for AV) | Margin (dB) | Result |
| X | V | Peak | 70.35 | 61.54 | 11.99 | 35.72 | 38.9 | 102 | 59.6 | -24.85 | -24.44 | -0.41 | PASS |
| | | Avg | 49.02 | 40.21 | 11.99 | 35.72 | 38.9 | | | -46.18 | -41.3 | -4.88 | PASS |
| | H | Peak | 60.44 | 51.64 | 11.99 | 35.71 | 38.9 | 117 | 60.2 | -34.76 | -24.44 | -10.32 | PASS |
| | | Avg | 41.7 | 32.9 | 11.99 | 35.71 | 38.9 | | | -53.5 | -41.3 | -12.20 | PASS |
| Y | V | Peak | 65.63 | 56.82 | 11.99 | 35.72 | 38.9 | 309 | 112 | -29.57 | -24.44 | -5.13 | PASS |
| | | Avg | 44.51 | 35.7 | 11.99 | 35.72 | 38.9 | | | -50.69 | -41.3 | -9.39 | PASS |
| | H | Peak | 69.98 | 61.18 | 11.99 | 35.71 | 38.9 | 100 | 176.9 | -25.22 | -24.44 | -0.78 | PASS |
| | | Avg | 48.41 | 39.61 | 11.99 | 35.71 | 38.9 | | | -46.79 | -41.3 | -5.49 | PASS |
| Z | V | Peak | 65.71 | 56.9 | 11.99 | 35.72 | 38.9 | 315 | 136.8 | -29.49 | -24.44 | -5.05 | PASS |
| | | Avg | 45.33 | 36.52 | 11.99 | 35.72 | 38.9 | | | -49.87 | -41.3 | -8.57 | PASS |
| | H | Peak | 69.54 | 60.74 | 11.99 | 35.71 | 38.9 | 112 | 200.1 | -25.66 | -24.44 | -1.22 | PASS |
| | | Avg | 48.27 | 39.47 | 11.99 | 35.71 | 38.9 | | | -46.93 | -41.3 | -5.63 | PASS |

Table 12. UWT-7010, Output Power Test Results, 2Mbps

Electromagnetic Compatibility Criteria for Intentional Radiators

Additional Testing Per FCC Waiver

Fundamental Emission contained within 7125-7900MHz

Test Requirement: DA-21-1294A1
 D. Waiver Conditions
 1) The Dart System 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 10 second receiver acknowledgement requirement in 47 CFR § 15.519(a)(1) is waived to permit the operation of the Dart UWB real-time location system.
 (b) Zebra shall ensure that the UWB bandwidth of the Dart system is fully contained within the 7125-7900 MHz frequency band.

Test Results: The EUT was **compliant** with Fundamental Emission contained within 7125-7900MHz.
 The -10dB bandwidth demonstrate that the emission is fully contained on the proposed band.

Test Engineer: Donald Salguero

Test Date: April 12, 2023

| | | |
|-----------------|-------|-----|
| Fm = | 7.425 | GHz |
| FL = | 7.16 | GHz |
| FH = | 7.76 | GHz |
| | | |
| -10dB BW | 600 | MHz |

Table 13. -10dB bandwidth calc

Pulse width 2.5ns

| | |
|--------------------------|--|
| Test Requirement: | DA-21-1294A1 D. Waiver Conditions 2) The width of the individual transmission pulses from a DART device shall not exceed 2.5 nanoseconds. |
| Test Procedure: | EUT was placed inside a RF chamber facing a receive antenna at 1m. EUT was programmed to transmit at its intended field operation. Signal pulse duration was measured from the 50% voltage level between the rising and falling edges of a single pulse. |
| Test Results: | The EUT was compliant with Pulse width limit of 2.5ns. Measured pulse width is 2.402ns. |
| Test Engineer: | Donald Salguero |
| Test Date: | March 28, 2023 |

Number of pulses/s

| | |
|--------------------------|--|
| Test Requirement: | DA-21-1294A1 D. Waiver Conditions 3) The total number of transmission pulses from an individual Dart device in any one second shall not exceed 4600. |
| Test Procedure: | EUT was placed inside a RF chamber facing a receive antenna at 1m. EUT was programmed to transmit at its intended field operation. Oscilloscope was configured first to measure the number of pulses per burst and then configured such that a single burst period was measured. Later extrapolated to a 1s transmission. |
| Test Results: | The EUT was compliant with Number of pulses/s. Pulses per burst = 100 Measured burst period = 40.801ms Bursts per second = 1s/burst period \approx 25 Pulses per second = pulses per burst * bursts per second = 2500 |
| Test Engineer: | Donald Salguero |
| Test Date: | March 28, 2023 |

Max EIRP -41.3dBm/MHz

Test Requirement: DA-21-1294A1
 D. Waiver Conditions
 4) The maximum EIRP of the Dart system shall not exceed -41.3 dBm/MHz.

Test Results: The EUT was **compliant** with Max EIRP -41.3dBm/MHz. Requirement is covered §15.119(c)(e) Peak and Average Power Emissions

Test Engineer: Donald Salguero

Test Date: March 28, 2023

| 1 | UWT-7010 | E4AA | | | | | | | | | | | |
|-------|----------|--------|-------------------------------|------------------------------|-----------------------|-----------------------------|-------------------------|-----------------|--------------------|---|---|-------------|--------|
| Plane | Pol | Remark | (E): E-field level * (dBuV/m) | (A): Read Level @ S/A (dBuV) | (Fc): Cable Loss (dB) | (Fa): Antenna Factor (dB/m) | (Gpa): Preamp gain (dB) | Ant height (cm) | Turntable (degree) | EIRP level ** (dBm/3MHz for PK, dBm/MHz for AV) | FCC Limit Line *** (RBW=3MHz for PK, RBW=1MHz for AV) | Margin (dB) | Result |
| X | V | Peak | 69.8 | 60.99 | 11.99 | 35.72 | 38.9 | 100 | 356.1 | -25.4 | -24.44 | -0.96 | PASS |
| | | Avg | 50.51 | 41.7 | 11.99 | 35.72 | 38.9 | | | -44.69 | -41.3 | -3.39 | PASS |
| | H | Peak | 60.45 | 51.65 | 11.99 | 35.71 | 38.9 | 112 | 78.5 | -34.75 | -24.44 | -10.31 | PASS |
| | | Avg | 42.1 | 33.3 | 11.99 | 35.71 | 38.9 | | | -53.1 | -41.3 | -11.80 | PASS |
| Y | V | Peak | 65.82 | 57.01 | 11.99 | 35.72 | 38.9 | 309 | 113.7 | -29.38 | -24.44 | -4.94 | PASS |
| | | Avg | 47.33 | 38.52 | 11.99 | 35.72 | 38.9 | | | -47.87 | -41.3 | -6.57 | PASS |
| | H | Peak | 70.58 | 61.78 | 11.99 | 35.71 | 38.9 | 117 | 176.7 | -24.62 | -24.44 | -0.18 | PASS |
| | | Avg | 51.65 | 42.85 | 11.99 | 35.71 | 38.9 | | | -43.55 | -41.3 | -2.25 | PASS |
| Z | V | Peak | 66.35 | 57.54 | 11.99 | 35.72 | 38.9 | 315 | 135.7 | -28.85 | -24.44 | -4.41 | PASS |
| | | Avg | 47.09 | 38.28 | 11.99 | 35.72 | 38.9 | | | -48.11 | -41.3 | -6.81 | PASS |
| | H | Peak | 69.74 | 60.94 | 11.99 | 35.71 | 38.9 | 116 | 178.5 | -25.46 | -24.44 | -1.02 | PASS |
| | | Avg | 50.66 | 41.86 | 11.99 | 35.71 | 38.9 | | | -44.54 | -41.3 | -3.24 | PASS |

Table 14. UWT-7010, Output Power Test Results, 1mbps

| 1 | UWT-7010 | E4AA | | | | | | | | | | | |
|-------|----------|--------|-------------------------------|------------------------------|-----------------------|-----------------------------|-------------------------|-----------------|--------------------|---|---|-------------|--------|
| Plane | Pol | Remark | (E): E-field level * (dBuV/m) | (A): Read Level @ S/A (dBuV) | (Fc): Cable Loss (dB) | (Fa): Antenna Factor (dB/m) | (Gpa): Preamp gain (dB) | Ant height (cm) | Turntable (degree) | EIRP level ** (dBm/3MHz for PK, dBm/MHz for AV) | FCC Limit Line *** (RBW=3MHz for PK, RBW=1MHz for AV) | Margin (dB) | Result |
| X | V | Peak | 70.35 | 61.54 | 11.99 | 35.72 | 38.9 | 102 | 59.6 | -24.85 | -24.44 | -0.41 | PASS |
| | | Avg | 49.02 | 40.21 | 11.99 | 35.72 | 38.9 | | | -46.18 | -41.3 | -4.88 | PASS |
| | H | Peak | 60.44 | 51.64 | 11.99 | 35.71 | 38.9 | 117 | 60.2 | -34.76 | -24.44 | -10.32 | PASS |
| | | Avg | 41.7 | 32.9 | 11.99 | 35.71 | 38.9 | | | -53.5 | -41.3 | -12.20 | PASS |
| Y | V | Peak | 65.63 | 56.82 | 11.99 | 35.72 | 38.9 | 309 | 112 | -29.57 | -24.44 | -5.13 | PASS |
| | | Avg | 44.51 | 35.7 | 11.99 | 35.72 | 38.9 | | | -50.69 | -41.3 | -9.39 | PASS |
| | H | Peak | 69.98 | 61.18 | 11.99 | 35.71 | 38.9 | 100 | 176.9 | -25.22 | -24.44 | -0.78 | PASS |
| | | Avg | 48.41 | 39.61 | 11.99 | 35.71 | 38.9 | | | -46.79 | -41.3 | -5.49 | PASS |
| Z | V | Peak | 65.71 | 56.9 | 11.99 | 35.72 | 38.9 | 315 | 136.8 | -29.49 | -24.44 | -5.05 | PASS |
| | | Avg | 45.33 | 36.52 | 11.99 | 35.72 | 38.9 | | | -49.87 | -41.3 | -8.57 | PASS |
| | H | Peak | 69.54 | 60.74 | 11.99 | 35.71 | 38.9 | 112 | 200.1 | -25.66 | -24.44 | -1.22 | PASS |
| | | Avg | 48.27 | 39.47 | 11.99 | 35.71 | 38.9 | | | -46.93 | -41.3 | -5.63 | PASS |

Table 15. UWT-7010, Output Power Test Results, 2mbps

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2017.

| Asset Number | Description | Manufacturer | Model Number | Serial Number | Calibration Date | Calibration Due Date |
|--------------|--------------------------------|----------------------|---------------------|---------------|------------------|----------------------|
| 1T4300 | SEMI-ANECHOIC CHAMBER (NSA) | EMC TEST SYSTEMS | NONE | NONE | 8/19/2021 | 8/31/2023 |
| 1T4300B | Semi-Anechoic 3m Chamber sVSWR | EMC TEST SYSTEMS | NONE | NONE | 9/30/2021 | 9/30/2023 |
| 1T4751 | Antenna - Bilog | Sunol Sciences | JB6 | A101910 | 6/1/2022 | 12/1/2023 |
| 1T4576 | Antenna, Active Horn | Com-Power | AHA-118 | 711065 | 7/8/2022 | 1/31/2024 |
| 1T4744 | Antenna, Horn | ETS-Lindgren | 3116 | 126519 | 11/27/2018 | 5/27/2020 |
| 1T8743 | Preamplifier | A.H. Systems, Inc. | PAM-0118P | 419 | Func Verify | Func Verify |
| 1T4752 | Pre-Amplifier | Miteq | JS44-18004000-35-8P | 1594792 | Func Verify | Func Verify |
| 1T4829 | Spectrum Analyzer | Agilent Technologies | E4407B | US40241669 | 3/20/2023 | 9/30/2024 |
| 1T4771 | PSA Spectrum Analyzer | Agilent Technologies | E4446A | MY51100015 | 4/26/2022 | 10/26/2023 |
| N/A | Oscilloscope, 4 Channel | Tektronix | MSO64B | B026430 | 6/23/2022 | N/A |

Table 16. Equipment List

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

V. Certification & User's Manual Information

Certification & User's Manual Information

A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

- (a) The various types of radio communication transmitting devices described throughout this chapter.
- (b) *The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.*
- (c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.
- (d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

- (a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:
 - (1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or
 - (2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.
- (d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

- (e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:
- (i) *Compliance testing;*
 - (ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or
 - (v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.
- (e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.
- (f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

- (a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.¹ *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.*
- (b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

- (a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.
- (b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

¹ In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

- (a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.
- (1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.
- (i) *If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.*
- (ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.
- (2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

Certification & User's Manual Information

1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) *In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:*

- (1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

- (2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

- (3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

- (4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

- (5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

- (a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

- (b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

END OF REPORT