Engineering Test Report No. 2101740-01		
Report Date	June 25, 2021	
Manufacturer Name	Midmark, RTLS Solutions Inc.	
Manufacturer Address	2600 Miller Creek Road Traverse City, MI 49684	
Model No.	Asset Tag, Model Nos.: VER-5864 and VER-5869	
Date Received	June 10, 2021	
Test Dates	June 11, 2021 through June 23, 2021	
Specifications	FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 FCC “Code of Federal Regulations” Title 47, Part15, Subpart 15B Innovation, Science, and Economic Development Canada, RSS-247 Innovation, Science, and Economic Development Canada, RSS-GEN	
Test Facility	Elite Electronic Engineering, Inc. 1516 Centre Circle, Downers Grove, IL 60515	FCC Reg. Number: 269750 IC Reg. Number: 2987A CAB Identifier: US0107
Signature	Mark E. Longinotti	
Tested by	Mark E. Longinotti	
Signature	Raymond J Klouda	
Approved by	Raymond J. Klouda, Registered Professional Engineer of Illinois – 44894	
PO Number	RTLS-2021-100	

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 and Innovation, Science, and Economic Development Canada, RSS-247 and RSS-GEN test specifications. The data presented in this test report pertains to the EUT on the test date(s) specified. Any electrical or mechanical modifications made to the EUT subsequent to the specified test date will serve to invalidate the data and void this certification. This report must not be used to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the Federal Government.

Table of Contents

1. Report Revision History

Revision	Date	Description
–	25 JUN 2021	Initial Release of Engineering Test Report No. 2101740-01

2. Introduction

2.1. Scope of Tests

This document presents the results of a series of RF emissions tests that were performed on the Midmark, RTLS Solutions Inc. Asset Tag (hereinafter referred to as the Equipment Under Test (EUT)). The EUT was manufactured and submitted for testing by Midmark, RTLS Solutions Inc. located in Traverse City, MI.

2.2. Purpose

The test series was performed to determine if the EUT meets the RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part15, Subpart 15B, Section 15.107 and 15.109 for Receivers and Part 15, Subpart C, Sections 15.247 for a Digital Modulation intentional radiator operating within the 2400-2483.5MHz band.

The test series was also performed to determine if the EUT meets the RF emission requirements of the Innovation, Science, and Economic Development Canada Radio Standards Specification RSS-Gen and Innovation, Science, and Economic Development Canada Radio Standards Specification RSS-247 for a Digital Modulation intentional radiator operating within the 2400-2483.5MHz band.

Testing was performed in accordance with ANSI C63.10-2013.

2.3. Identification of the EUT

The EUTs were identified as follows:

EUT Identification	
Product Description	Asset Tag
Model/Part No.	VER-5864 With Nordic nRF52810
S/N	Conducted Sample
Device Type	Digitally Modulated Transmission Device
Band of Operation	2400-2483.5MHz
Software/Firmware Version	Nordic direct_test_mode SDK 17.0
Conducted Output Power	4.07dBm
Rated Output Power	4dBm
Antenna Type	N/A
Manufacturer Supplied* Antenna Gain (dBi)	N/A
6dB Bandwidth	574.4kHz
Occupied Bandwidth (99% CBW)	1.04MHz
Size of EUT	1.4" x 1.65" x 0.68"

EUT Identification	
Product Description	Asset Tag
Model/Part No.	VER-5864 With Nordic nRF52832
S/N	Conducted Sample
Device Type	Digitally Modulated Transmission Device
Band of Operation	2400-2483.5MHz
Software/Firmware Version	Nordic direct_test_mode SDK 17.0
Conducted Output Power	4.37dBm
Rated Output Power	4dBm
Antenna Type	N/A
Manufacturer Supplied* Antenna Gain (dBi)	N/A

6dB Bandwidth	584.4kHz
Occupied Bandwidth (99% CBW)	1.04MHz
Size of EUT	1.4” x 1.65” x 0.68”

EUT Identification	
Product Description	Asset Tag
Model/Part No.	VER-5864 With Nordic nRF52810
S/N	Radiated Sample
Device Type	Digitally Modulated Transmission Device
Band of Operation	2400-2483.5MHz
Software/Firmware Version	Nordic direct_test_mode SDK 17.0
EIRP	3.3dBm
Rated Output Power	4dBm
Antenna Type	Integrated PCB monopole
Manufacturer Supplied* Antenna Gain (dBi)	0dBi
Size of EUT	1.4” x 1.65” x 0.68”

EUT Identification	
Product Description	Asset Tag
Model/Part No.	VER-5864 With Nordic nRF52832
S/N	Radiated Sample
Device Type	Digitally Modulated Transmission Device
Band of Operation	2400-2483.5MHz
Software/Firmware Version	Nordic direct_test_mode SDK 17.0
EIRP	4.3dBm
Rated Output Power	4dBm
Antenna Type	Integrated PCB monopole
Manufacturer Supplied* Antenna Gain (dBi)	0dBi
Size of EUT	1.4” x 1.65” x 0.68”

EUT Identification	
Product Description	Asset Tag
Model/Part No.	VER-5869 With Nordic nRF52810
S/N	Radiated Sample
Device Type	Digitally Modulated Transmission Device
Band of Operation	2400-2483.5MHz
Software/Firmware Version	Nordic direct_test_mode SDK 17.0
EIRP	4.5dBm
Rated Output Power	4dBm
Antenna Type	Integrated PCB monopole
Manufacturer Supplied* Antenna Gain (dBi)	0dBi
Size of EUT	1.4” x 1.65” x 0.68”

EUT Identification	
Product Description	Asset Tag

Model/Part No.	VER-5869 With Nordic nRF52832
S/N	Radiated Sample
Device Type	Digitally Modulated Transmission Device
Band of Operation	2400-2483.5MHz
Software/Firmware Version	Nordic direct_test_mode SDK 17.0
EIRP	5.0dBm
Rated Output Power	4dBm
Antenna Type	Integrated PCB monopole
Manufacturer Supplied* Antenna Gain (dBi)	0dBi
Size of EUT	1.4” x 1.65” x 0.68”

*- Antenna gain is supplied by the manufacturer and Elite is not responsible for the accuracy of the antenna gain.

Note: The VER-5864 and VER-5869 are electrically similar and use the same circuit boards. The VER-5864 contains both a BLE radio module and an Infrared transmitter. The VER-5869 contains only a BLE radio module and the infrared transmitter hardware is depopulated from the circuit board.

The VER-5864 and VER-5869 can be populated with either a Nordic BLE radio module, Model No. nRF52810 or a Nordic BLE radio module, Model No. nRF52832.

3. Power Input

The EUT was powered by 3 VDC from an internal CR2477 lithium coin cell battery.

4. Grounding

The EUT was not connected to ground.

5. Support Equipment

The EUT was submitted for testing along with the following support equipment:

Description	Model #
Laptop Computer	Lenovo Thinkpad T490

The laptop computer was running nRF_DTM software which was used to program the EUTs.

6. Interconnect Leads

The following interconnect cables were submitted with the test item:

Item	Description
Modified USB cable	3 wire cable used to connect the USB port of the laptop computer to the EUT during the programming process. After the EUT was programmed, the cable and laptop computer were disconnected and removed from the test chamber.

7. Modifications Made to the EUT

No modifications were made to the EUT during the testing.

8. Modes of Operation

The EUT and all peripheral equipment were energized. The unit was programmed to transmit in one of the following modes:

Mode	Description
BLE Chanel 0	2402MHz, payload = 100, power setting = 4dBm
BLE Chanel 17	2440MHz, payload = 100, power setting = 4dBm

BLE Chanel 39	2480MHz, payload = 100, power setting = 4dBm

9. Test Specifications

The tests were performed to selected portions of, and in accordance with the FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 test specification(s).

- Federal Communications Commission “Code of Federal Regulations”, Title 47, Part 15, Subpart C
- Federal Communications Commission “Code of Federal Regulations”, Title 47, Part 15, Subpart B
- ANSI C63.4-2014, “American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz”
- ANSI C63.10-2013, “American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices”
- Federal Communications Commission Office of Engineering and Technology Laboratory Division, Guidance For Compliance Measurements On Digital Transmission Systems, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 April 2, 2019 KDB 558074 D01v05r02
- RSS-247 Issue 2, February 2017, “Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices”
- RSS-Gen Issue 5, March 2019, Amendment 1, Innovation, Science, and Economic Development Canada, “Spectrum Management and Telecommunications, Radio Standards Specification, General Requirements for Compliance of Radio Apparatus”

10. Test Plan

No test plan was provided. Instructions were provided by personnel from Midmark, RTLS Solutions Inc. and used in conjunction with the FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 and Innovation, Science, and Economic Development Canada, RSS-247, and ANSI C63.4-2014 specifications.

11. Deviation, Additions to, or Exclusions from Test Specifications

There were no deviations, additions to, or exclusions from the test specifications during this test series.

12. Laboratory Conditions

Ambient Parameters	Value
Temperature	24°C
Relative Humidity	33%
Atmospheric Pressure	1014mb

13. Summary

The following EMC tests were performed and the results are shown below:

Test Description	Requirements	Test Methods	S/N	Results
6dB Bandwidth	FCC 15C 15.247 ISED RSS-247	ANSI C63.10: 2013	Conducted Sample	Conforms
Occupied Bandwidth (99%)	FCC 15C 15.247 ISED RSS-247	ANSI C63.10: 2013	Conducted Sample	Conforms
Maximum Peak Conducted Output Power	FCC 15C 15.247 ISED RSS-247	ANSI C63.10: 2013	Conducted Sample	Conforms

Effective Isotropic Radiated Power (EIRP)	FCC 15C 15.247 ISED RSS-247	ANSI C63.10: 2013	Radiated Sample	Conforms
Duty Cycle Factor Measurements	FCC 15C 15.247 ISED RSS-247	ANSI C63.10: 2013	Conducted Sample	—
Case Spurious Radiated Emissions	FCC 15C 15.247 ISED RSS-247	ANSI C63.10: 2013	Radiated Sample	Conforms
Band-Edge Compliance	FCC 15C 15.247 ISED RSS-247	ANSI C63.10: 2013	Conducted Sample and Radiated Sample	Conforms
Power Spectral Density	FCC 15C 15.247 ISED RSS-247	ANSI C63.10: 2013	Conducted Sample	Conforms

14. Sample Calculations

For Powerline Conducted Emissions:

The resultant voltage level (VL) is a summation in decibels (dB) of the receiver meter reading (MTR) and the cable loss factor (CF).

Formula 1: VL (dBuV) = MTR (dBuV) + CF (dB).

For Radiated Emissions:

The resultant field strength (FS) is a summation in decibels (dB) of the receiver meter reading (MTR), the antenna correction factor (AF), and the cable loss factor (CF). If an external preamplifier is used, the total is reduced by its gain (-PA). If a distance correction (DC) is required, it is added to the total.

Formula 1: FS (dBuV/m) = MTR (dBuV) + AF (dB/m) + CF (dB) + (- PA (dB)) + DC (dB)

To convert the Field Strength dBuV/m term to uV/m, the dBuV/m is first divided by 20. The Base 10 AntiLog is taken of this quotient. The result is the Field Strength value in uV/m terms.

Formula 2: FS (uV/m) = AntiLog [(FS (dBuV/m))/20]

15. Statement of Conformity

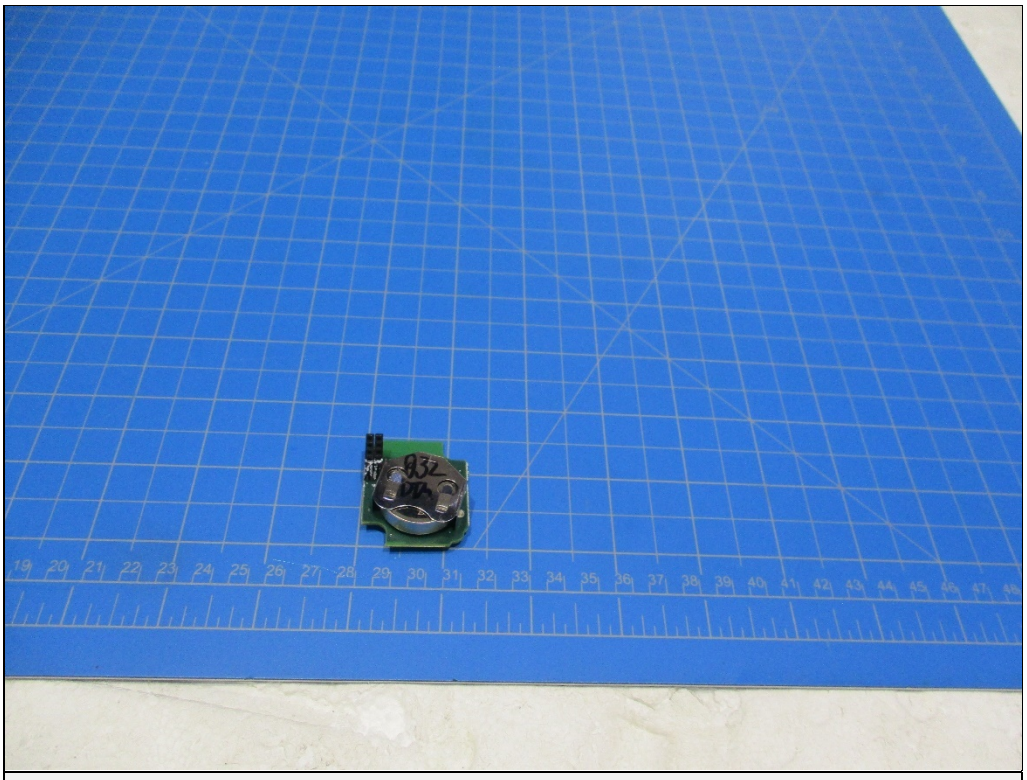
The Midmark, RTLS Solutions Inc. Asset Tag, Model Nos. VER-5864 with either a Nordic BLE radio module, Model No. nRF52810 or a Nordic BLE radio module, Model No. nRF52832and, did fully conform to the selected requirements of FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 and Innovation, Science, and Economic Development Canada, RSS-247.

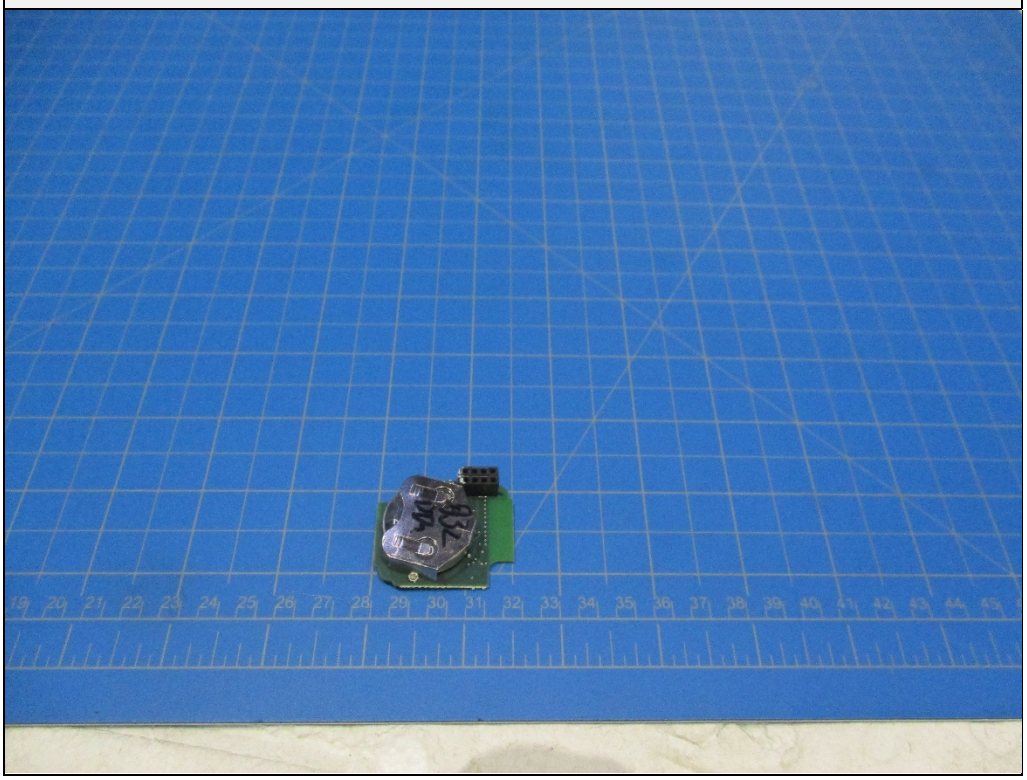
The Midmark, RTLS Solutions Inc. Asset Tag, Model Nos. VER-5869 with either a Nordic BLE radio module, Model No. nRF52810 or a Nordic BLE radio module, Model No. nRF52832and, did fully conform to the selected requirements of FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 and Innovation, Science, and Economic Development Canada, RSS-247.

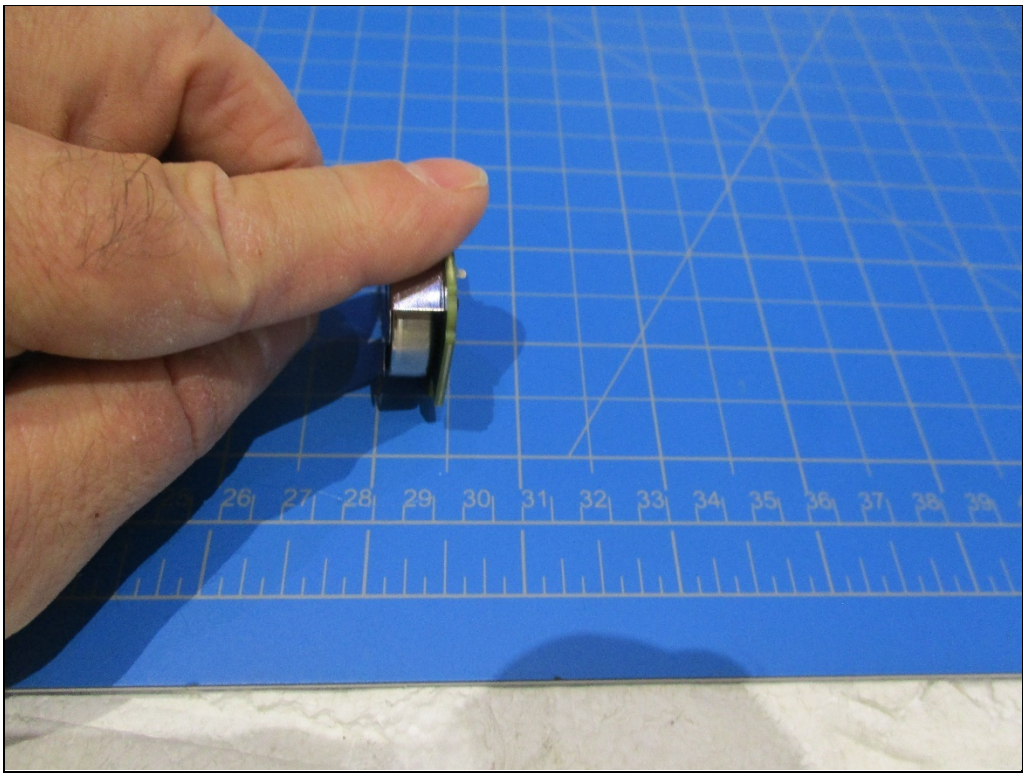
16. Certification

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 and Innovation, Science, and Economic Development Canada, RSS-247 test specifications. The data presented in this test report pertains to the EUT on the test date specified. Any electrical or mechanical modifications made to the EUT subsequent to the specified test date will serve to invalidate the data and void this certification.

17. Photographs of EUT



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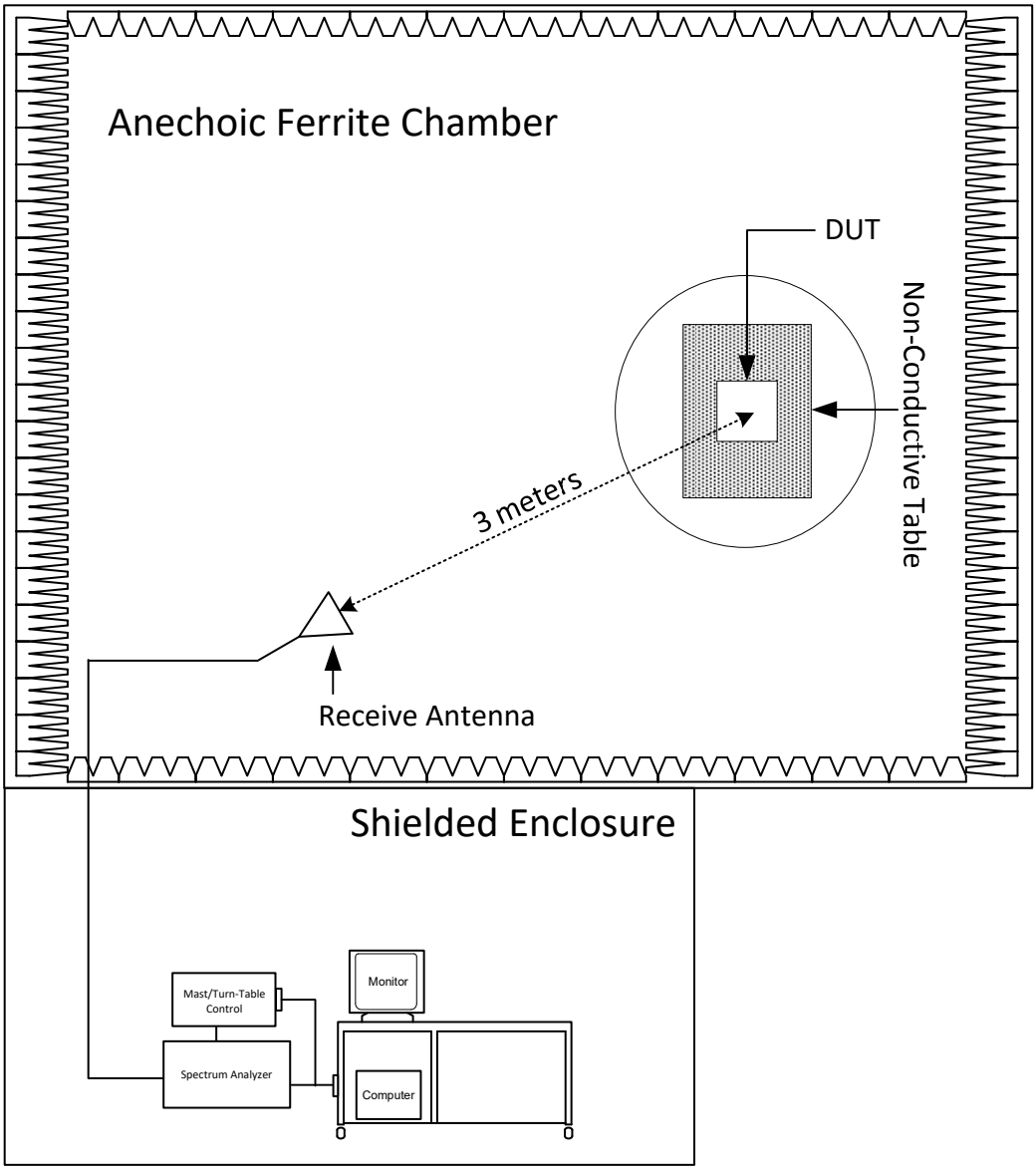
18. Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
APW0	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-30-20G20R6G	PL2926/0646	20GHZ-26.5GHZ	9/24/2020	9/24/2021
APW14	PREAMPLIFIER	PLANAR	PE2-35-120-5R0-10-12-SFF	PL22671	1-20GHz	9/24/2020	9/24/2021
NHG1	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ	NOTE 1	
NTA4	BILOG ANTENNA	TESEQ	6112D	46660	20-2000GHZ	10/5/2020	10/5/2021
NWQ2	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66659	1GHZ-18GHZ	4/7/2020	4/7/2022
RBG2	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101591	2HZ-44GHZ	3/11/2021	3/11/2022
SES0	24VDC POWER SUPPLY	P-TRANS	FS-32024-1M	001	18-27VDC	NOTE 1	
T1EM	10DB 25W ATTENUATOR	WEINSCHEL	46-10-34	CD6796	DC-18GHZ	3/19/2020	3/19/2022
T2D1	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-43	AV5814	DC-18GHZ	3/19/2020	3/19/2022
XOB2	ADAPTER	HEWLETT PACKARD	K281C,012	09407	18-26.5GHZ	NOTE 1	
XPR0	HIGH PASS FILTER	K&L MICROWAVE	11SH10-4800/X20000	001	4.8-20GHZ	9/6/2019	9/6/2021

N/A: Not Applicable I/O: Initial Only CNR: Calibration Not Required
NOTE 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

19. Block Diagram of Test Setup



Radiated Measurements Test Setup

20. 6dB Bandwidth

Test Information	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864 with Nordic nRF52810 and VER-5864 with nRF52832
Serial No	Conducted Sample
Mode	Power Setting = 4dBm

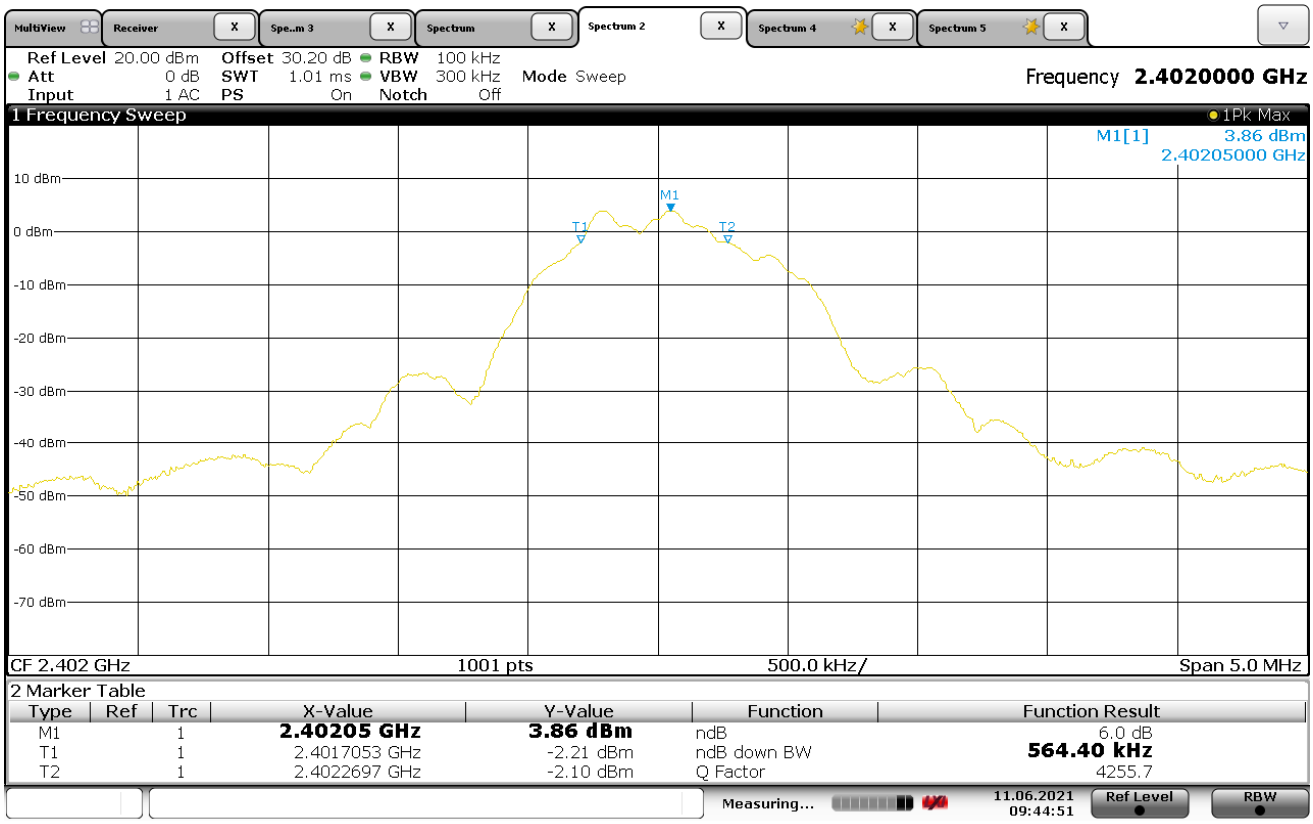
Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Antenna Conducted
Type of Test Site	Shielded Chamber
Notes	None

Requirements
Systems using digital modulation techniques shall have a minimum 6 dB bandwidth of 500 kHz.

Procedures
The antenna port of the EUT was connected to the spectrum analyzer through 30dB of attenuation. The EUT was allowed to transmit continuously. The transmit channel was set separately to low, middle, and high channels. The resolution bandwidth (RBW) was set to 100kHz, the video bandwidth (VBW) was set to the same as or 3 times greater than the RBW, and the span was set to 3 times the RBW. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined. The analyzer's display was plotted using a 'screen dump' utility.

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz)	3.1
Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz)	3.2
Radiated disturbance (electric field strength on an open area test site or alternative test site) (18 GHz – 26.5 GHz)	3.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (26.5 GHz – 40 GHz)	3.4

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	6dB BW = 564.4kHz
Notes	With Nordic nRF52810



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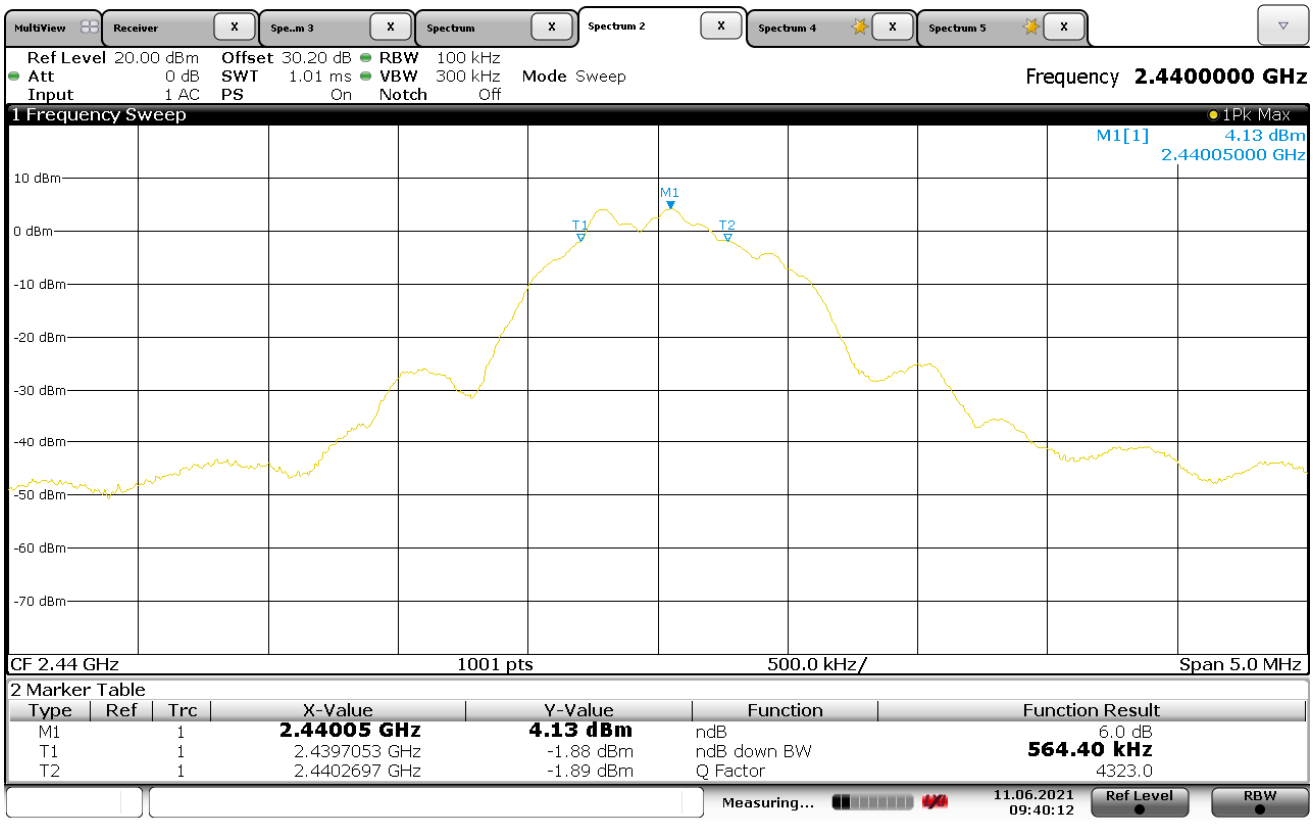
Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	6dB BW = 564.4kHz
Notes	With Nordic nRF52810



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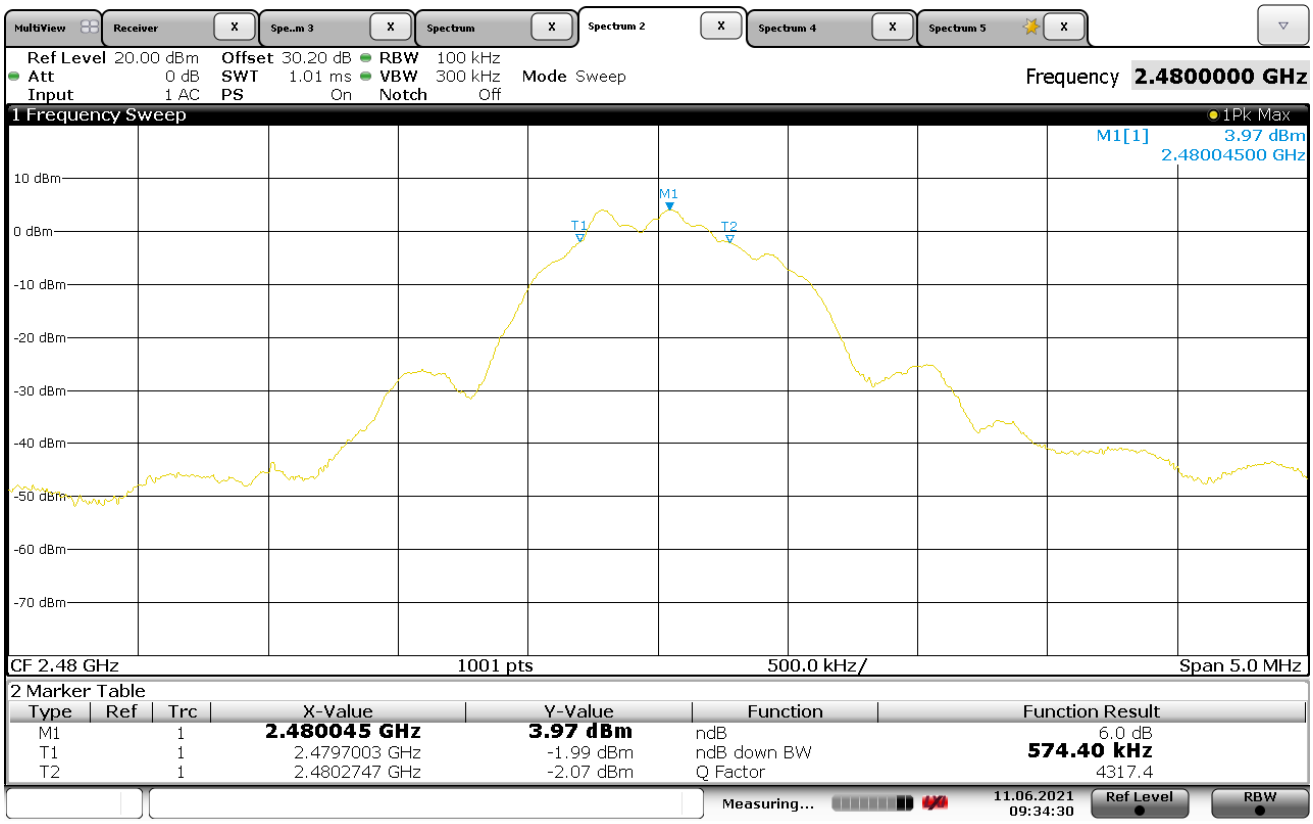
Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	6dB BW = 574.4kHz
Notes	With Nordic nRF52810



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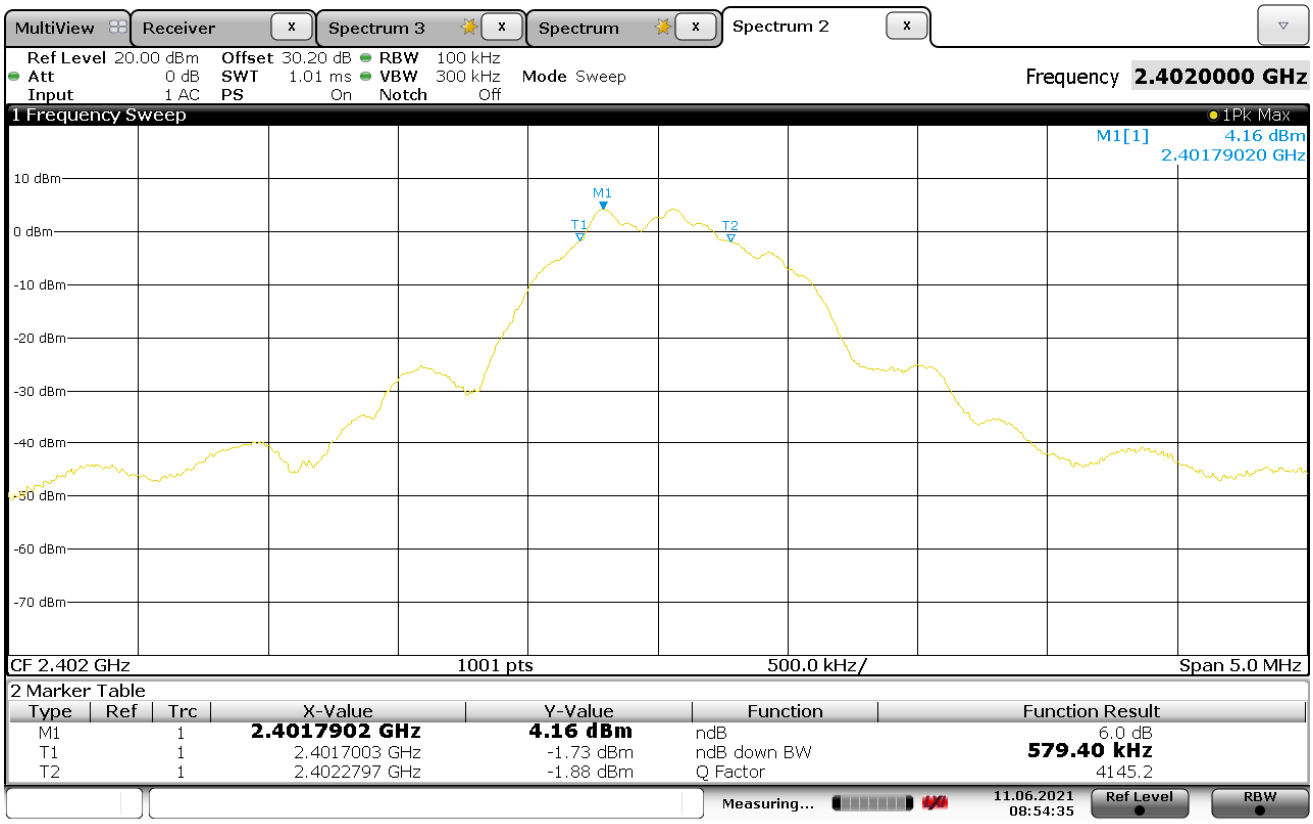
Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	6dB BW = 579.4kHz
Notes	With Nordic nRF52832



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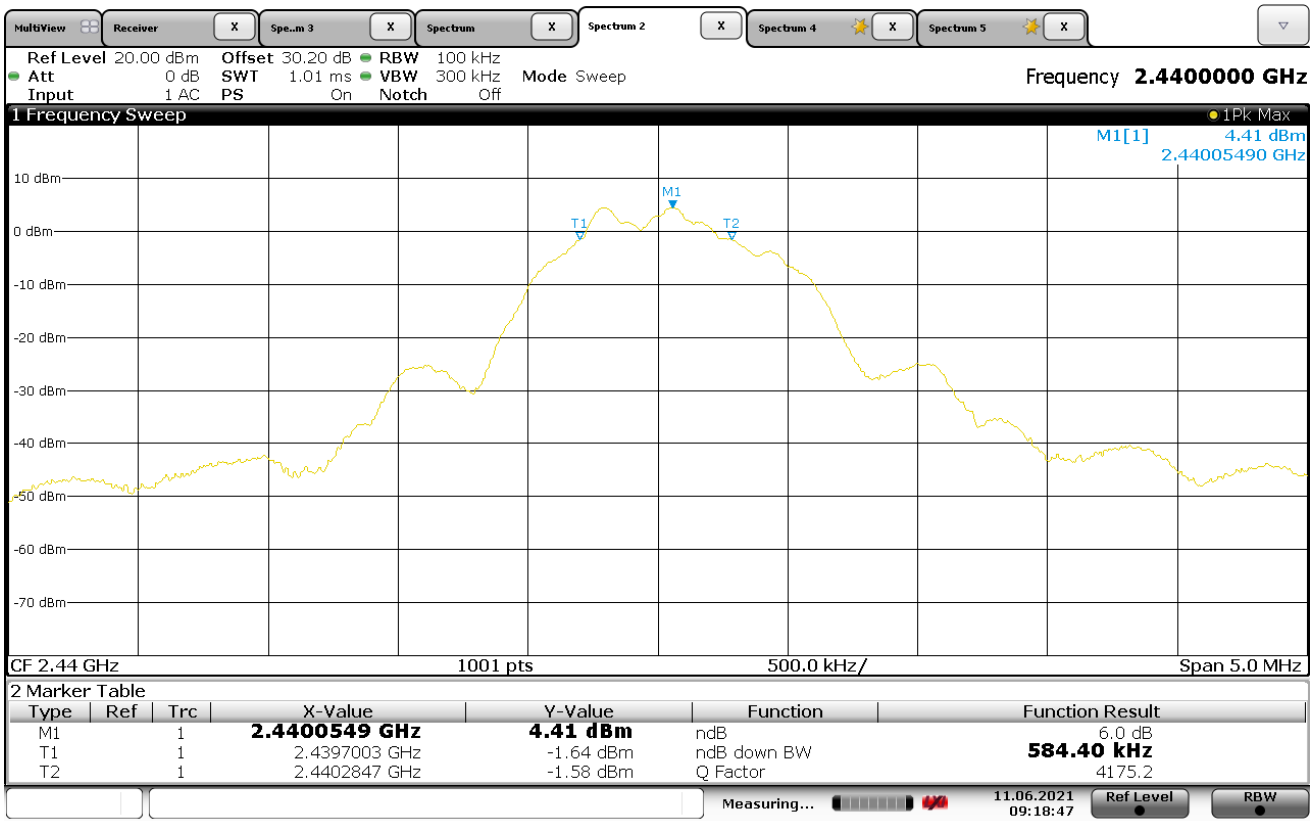
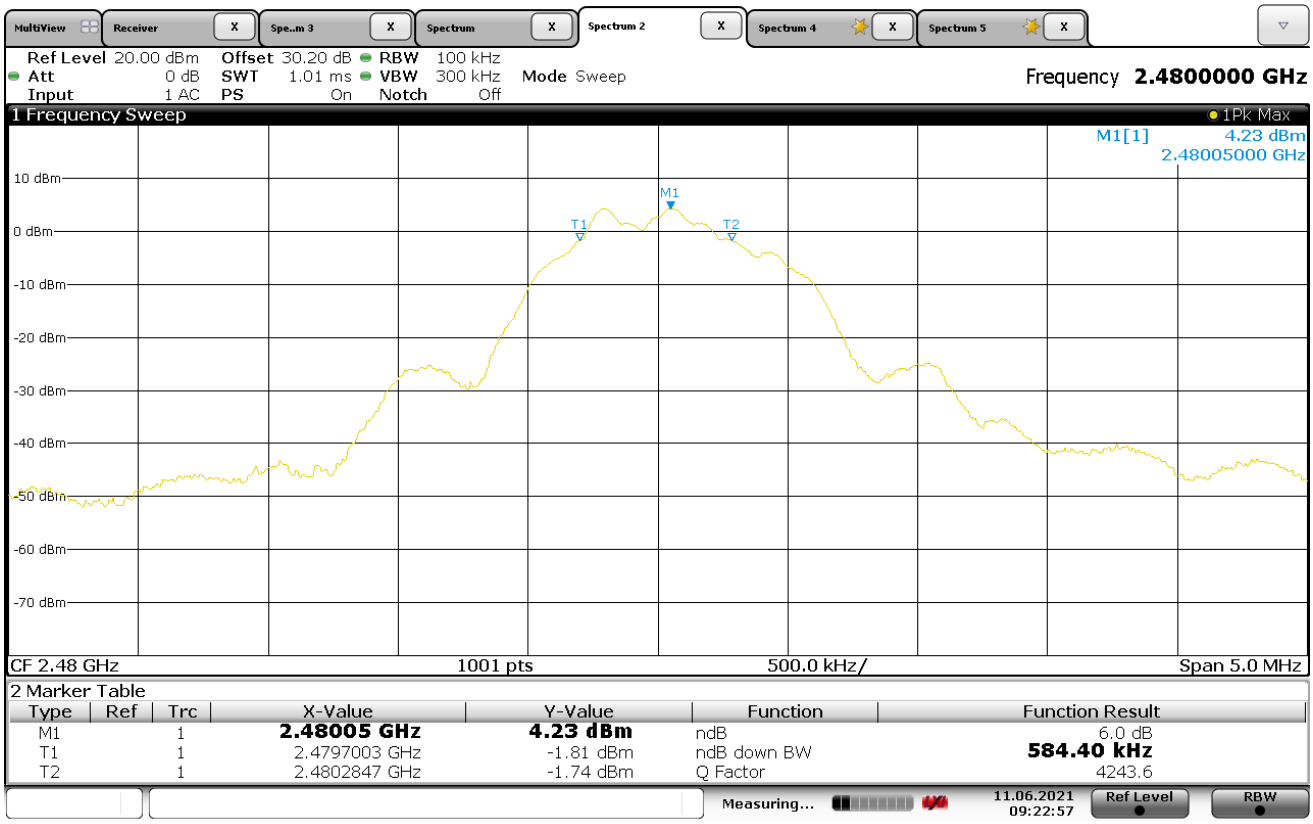
Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	6dB BW = 584.4kHz
Notes	With Nordic nRF52832



Date: 11.JUN.2021 09:18:48

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	6dB BW = 584.4kHz
Notes	With Nordic nRF52832



Date: 11.JUN.2021 09:22:56

21. Occupied Bandwidth (99%)

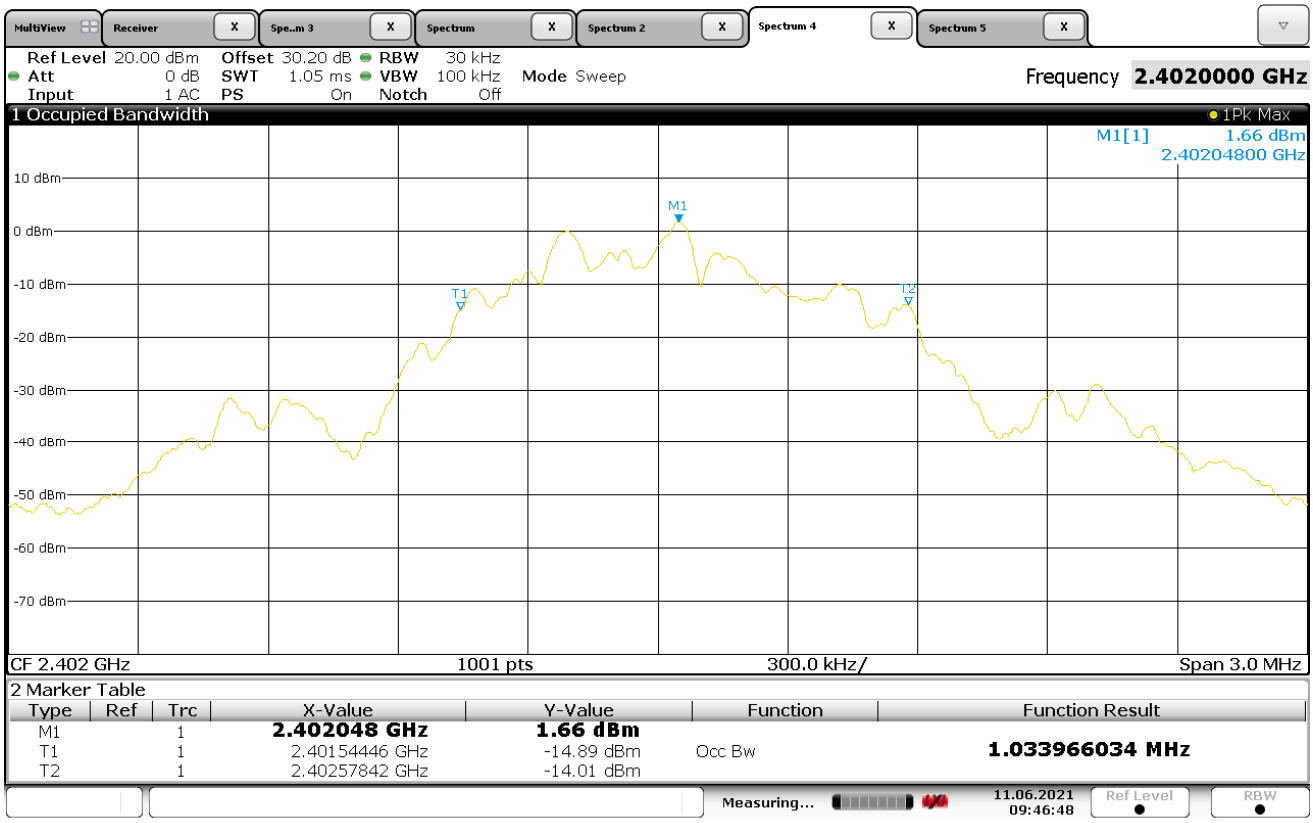
Test Information	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
Serial No	Conducted Sample
Mode	Power Setting = 4dBm

Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Antenna Conducted
Notes	None

Procedures
The antenna port of the EUT was connected to the spectrum analyzer through 30dB of attenuation. The EUT was allowed to transmit continuously. The transmit channel was set separately to low, middle, and high channels. The resolution bandwidth (RBW) was set to 1% to 5% of the actual occupied bandwidth, the video bandwidth (VBW) was set 3 times greater than the RBW, and the span was set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined. The analyzer's display was plotted using a 'screen dump' utility.

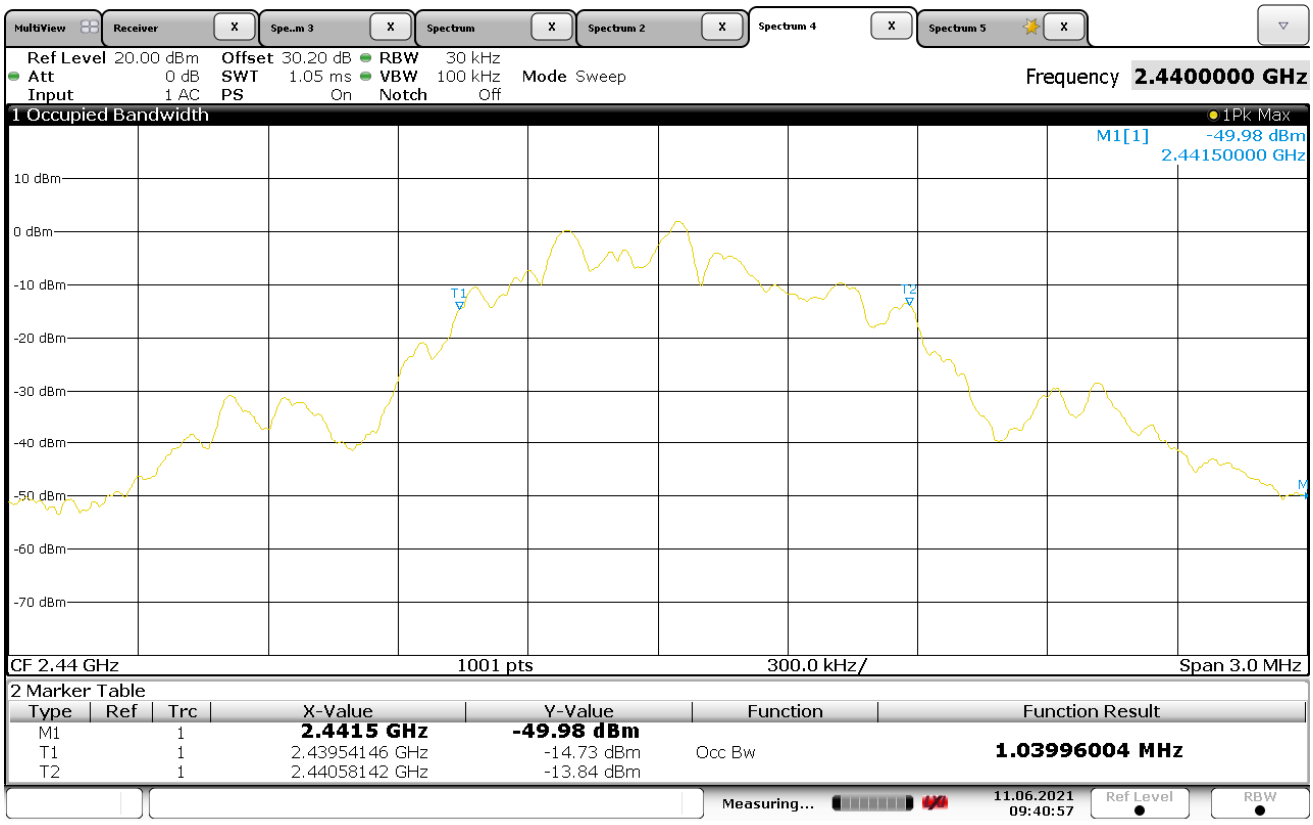
Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz)	3.1
Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz)	3.2
Radiated disturbance (electric field strength on an open area test site or alternative test site) (18 GHz – 26.5 GHz)	3.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (26.5 GHz – 40 GHz)	3.4

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	OBW = 1.03MHz
Notes	With Nordic nRF52810



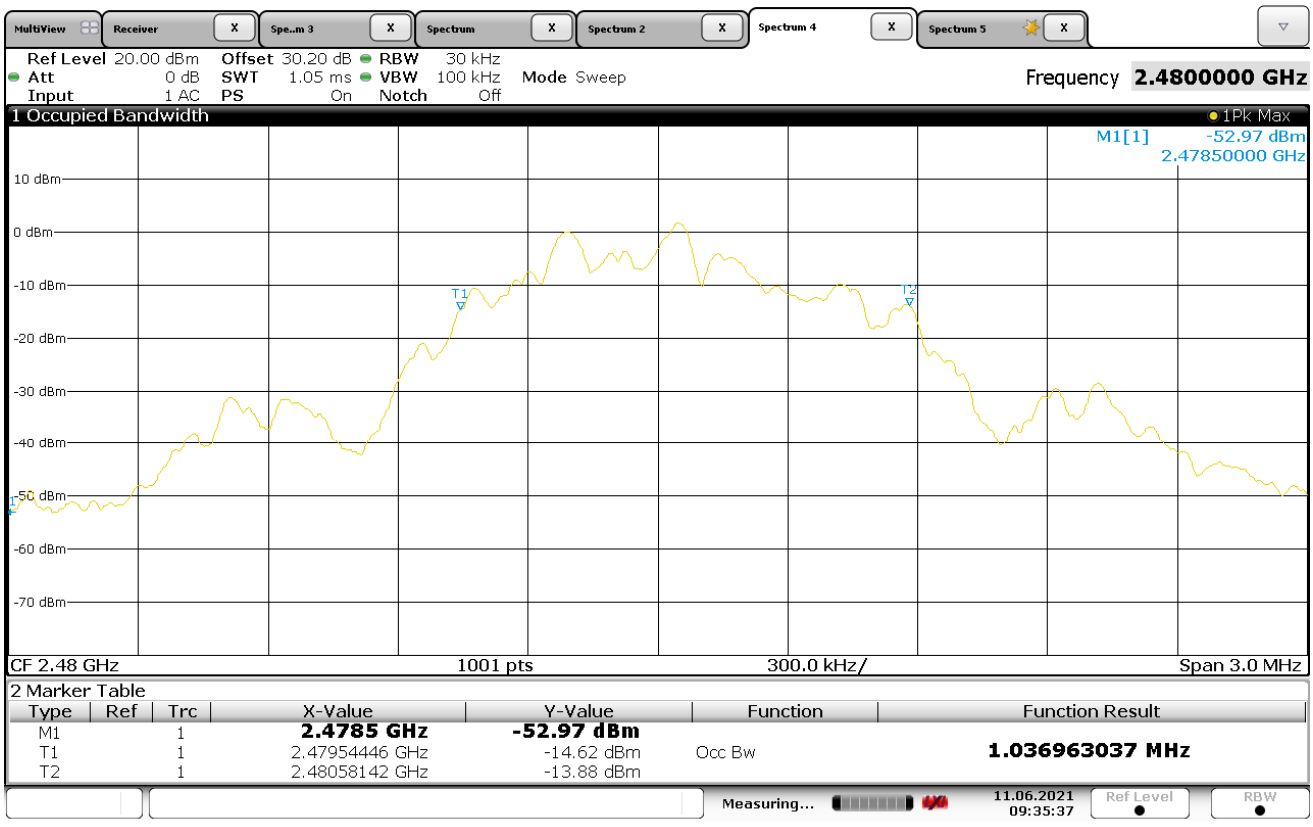
Date: 11.JUN.2021 09:46:47

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	OBW = 1.04MHz
Notes	With Nordic nRF52810



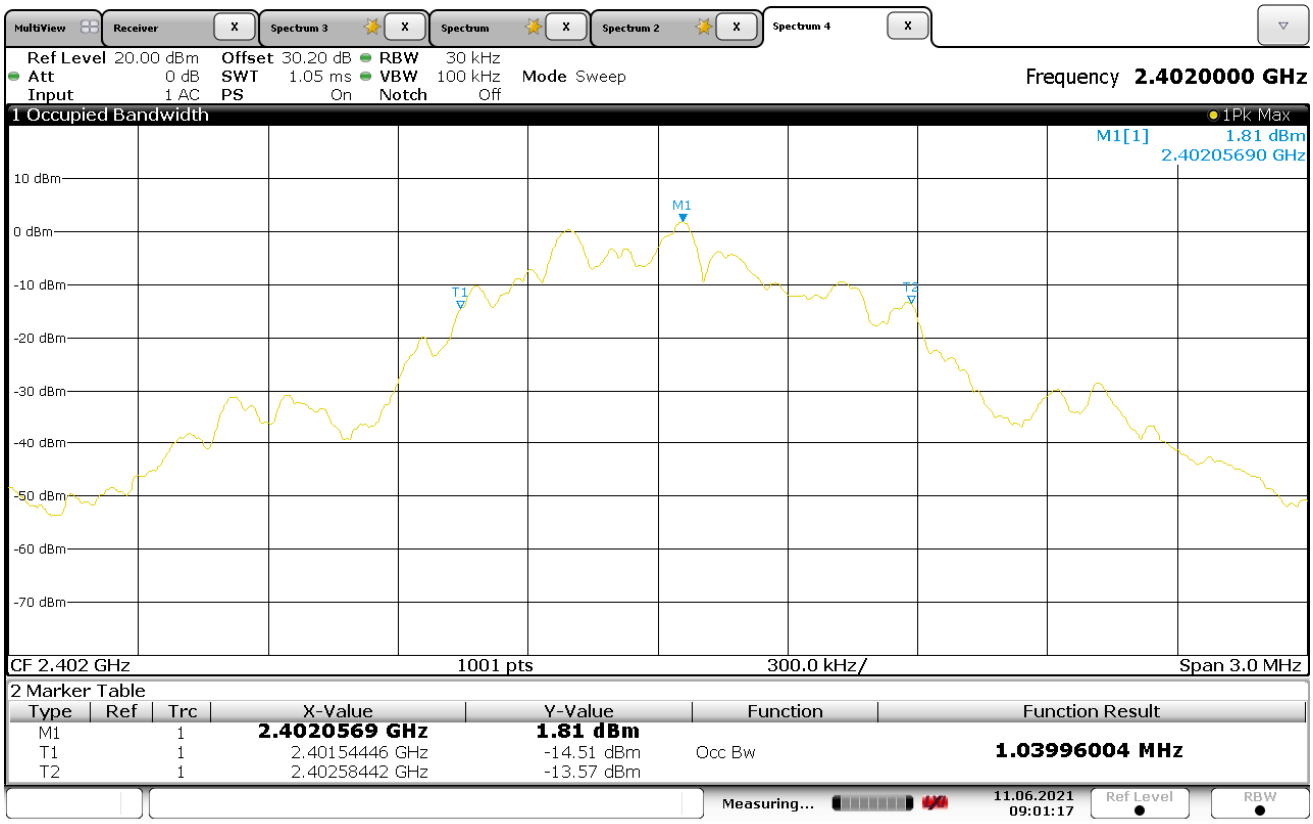
Date: 11.JUN.2021 09:40:56

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	OBW = 1.04MHz
Notes	With Nordic nRF52810



Date: 11.JUN.2021 09:35:38

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	OBW = 1.04MHz
Notes	With Nordic nRF52832



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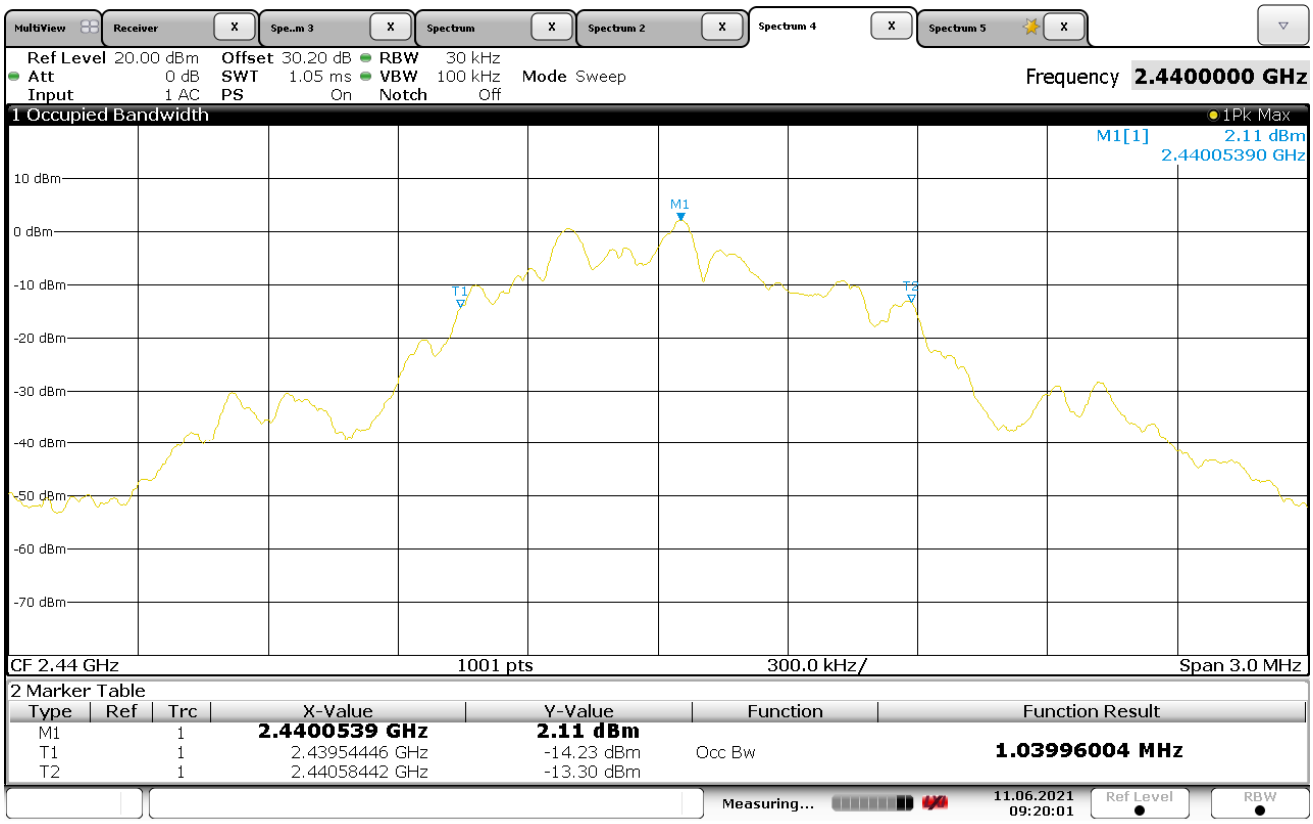
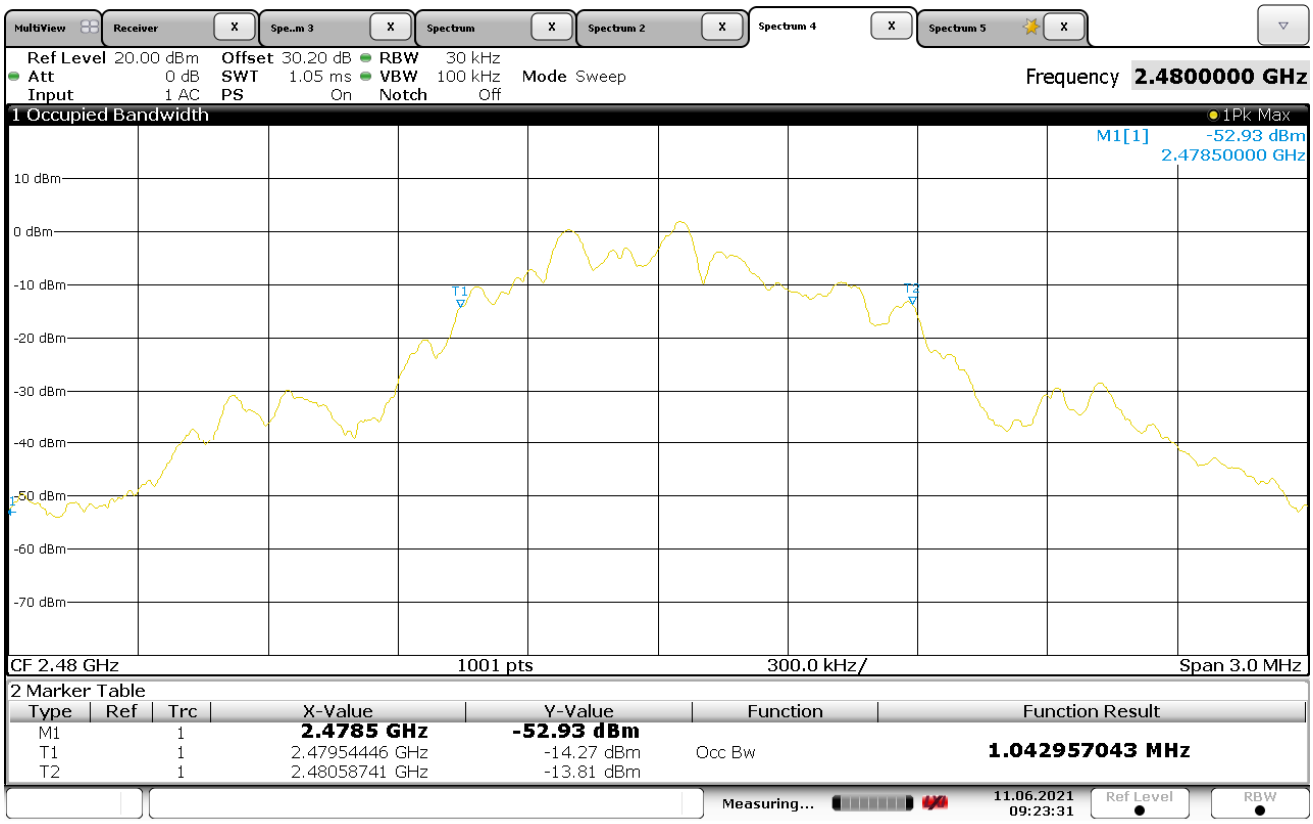
Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	OBW = 1.04MHz
Notes	With Nordic nRF52832



Date: 11.JUN.2021 09:20:02

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	OBW = 1.04MHz
Notes	With Nordic nRF52832



Date: 11.JUN.2021 09:23:32

22. Maximum Peak Conducted Output Power

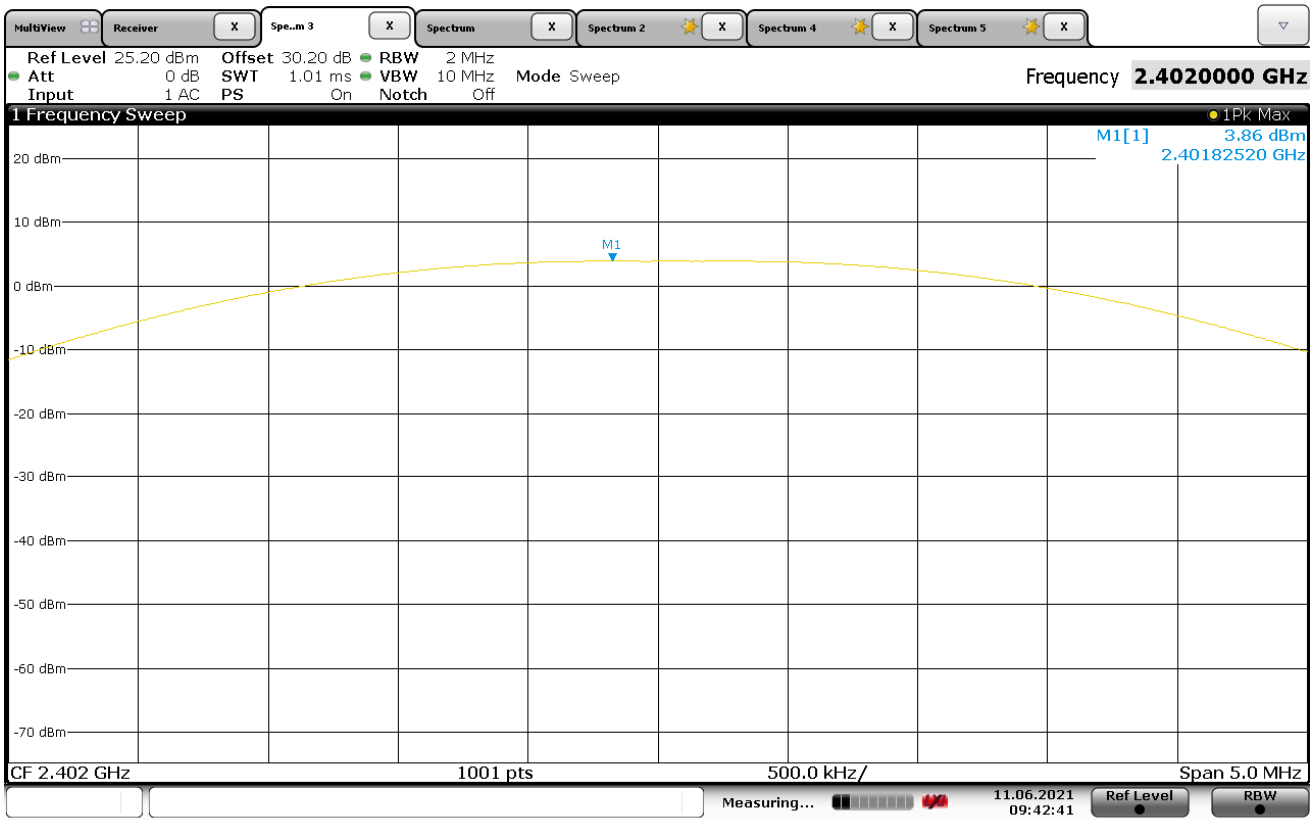
Test Information	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
Serial No	Conducted Sample
Mode	Power Setting = 4dBm

Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Antenna Conducted
Notes	None

Requirements
The output power shall not exceed 1W (30dBm).

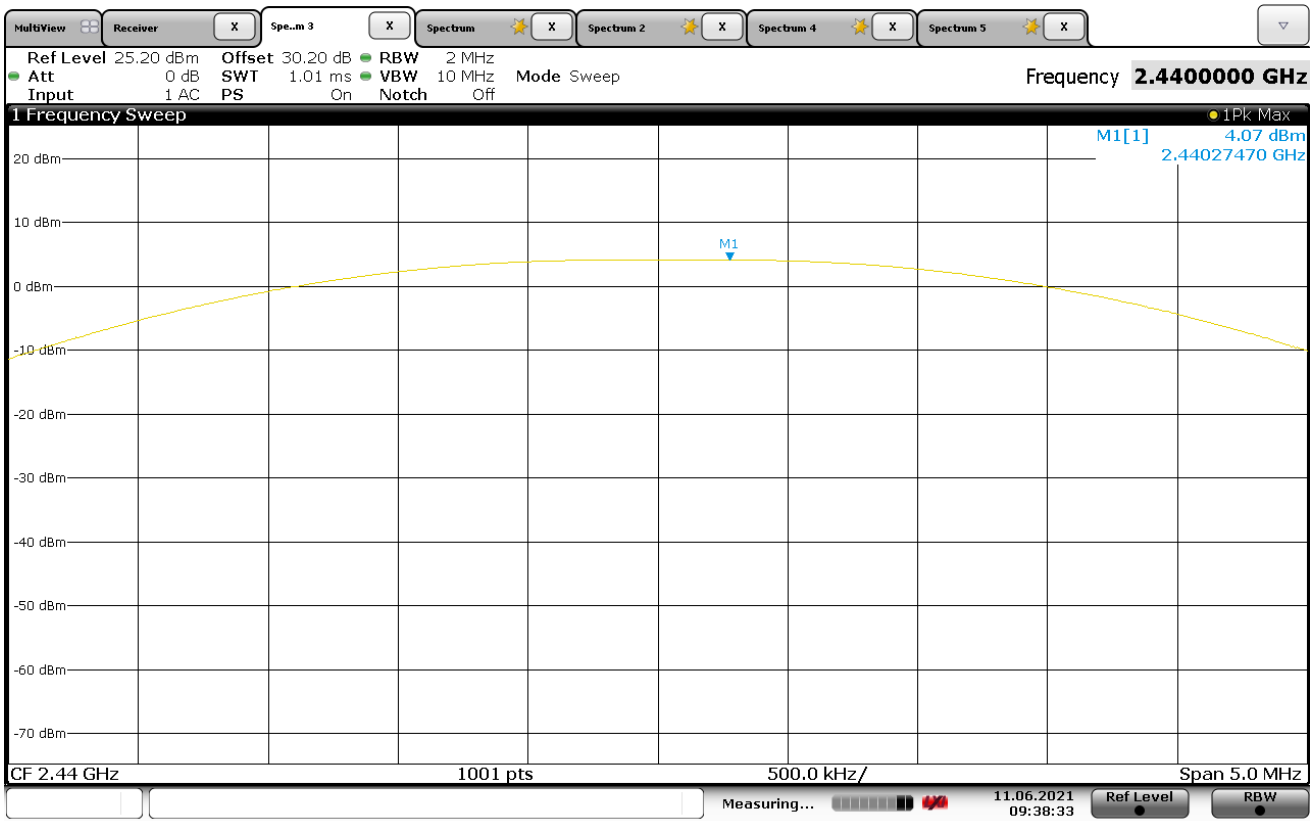
Procedures
Peak Power The antenna port of the EUT was connected to the spectrum analyzer through 30dB of attenuation. The EUT was set to transmit separately at the low, middle, and high channels. The resolution bandwidth (RBW) was set to greater than the 6dB bandwidth. The span was set to greater than 3 times the RBW. The 'Max-Hold' function was engaged. The maximum meter reading was recorded. The peak power output was calculated for the low, middle and high channels.

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	Output Power = 2.43mW (3.86dBm)
Notes	With Nordic nRF52810



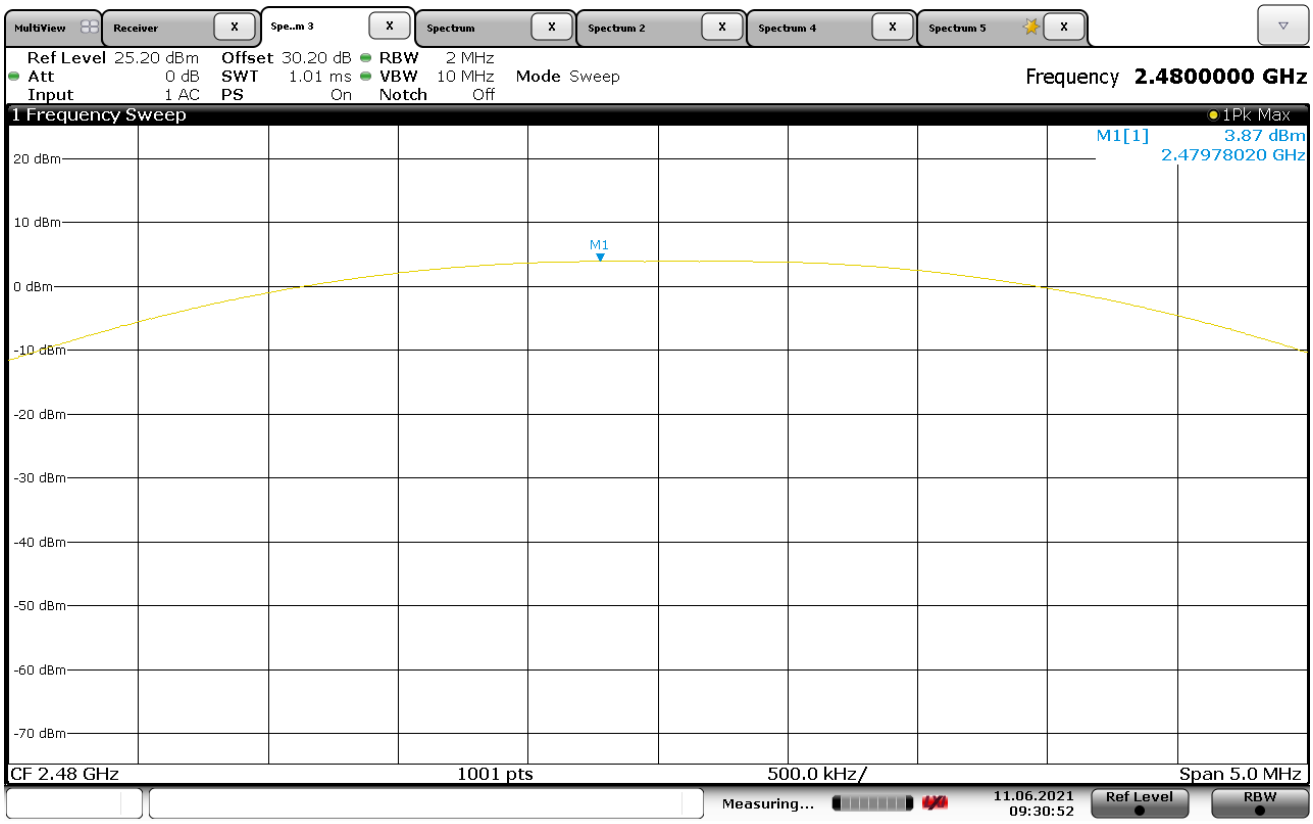
Date: 11.JUN.2021 09:42:41

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	Output Power = 2.55mW (4.07dBm)
Notes	With Nordic nRF52810



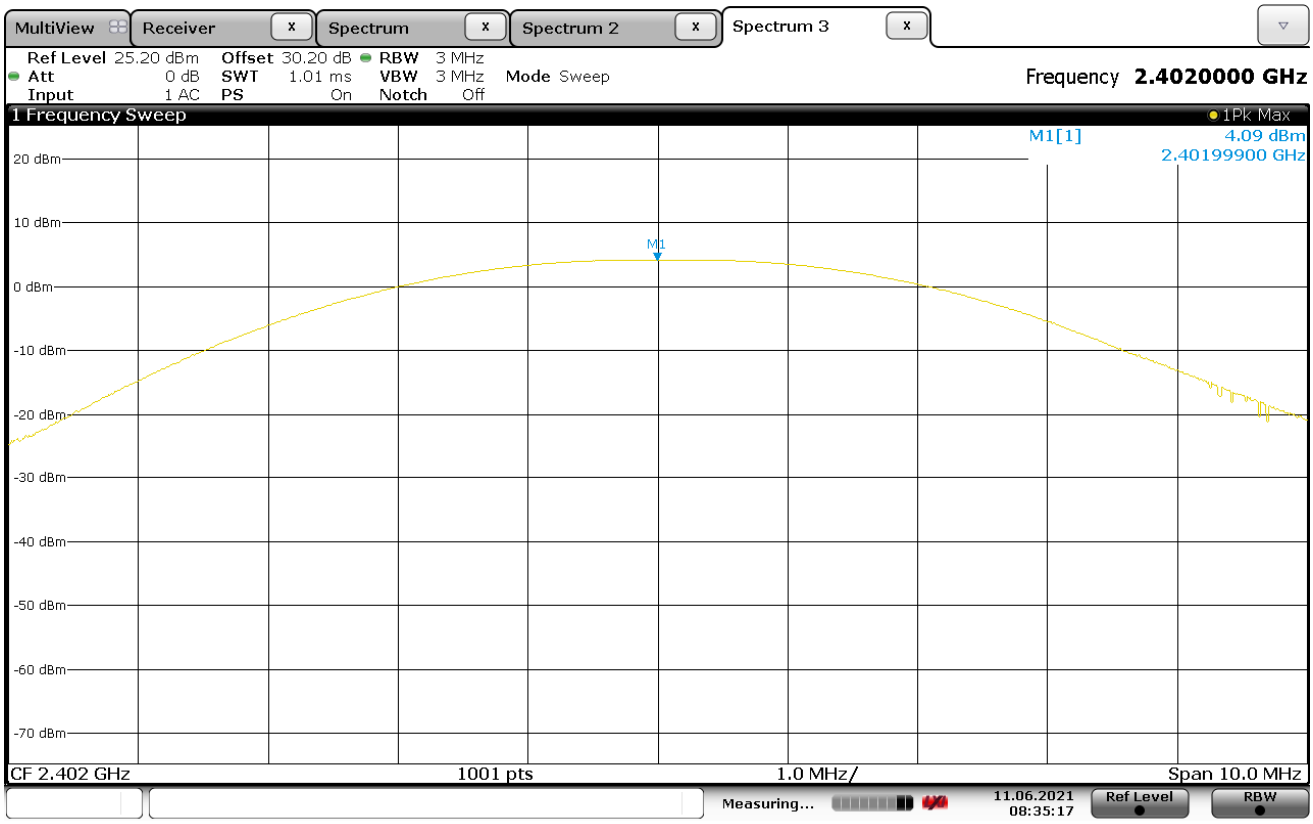
Date: 11.JUN.2021 09:38:33

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	Output Power = 2.43mW (3.87dBm)
Notes	With Nordic nRF52810



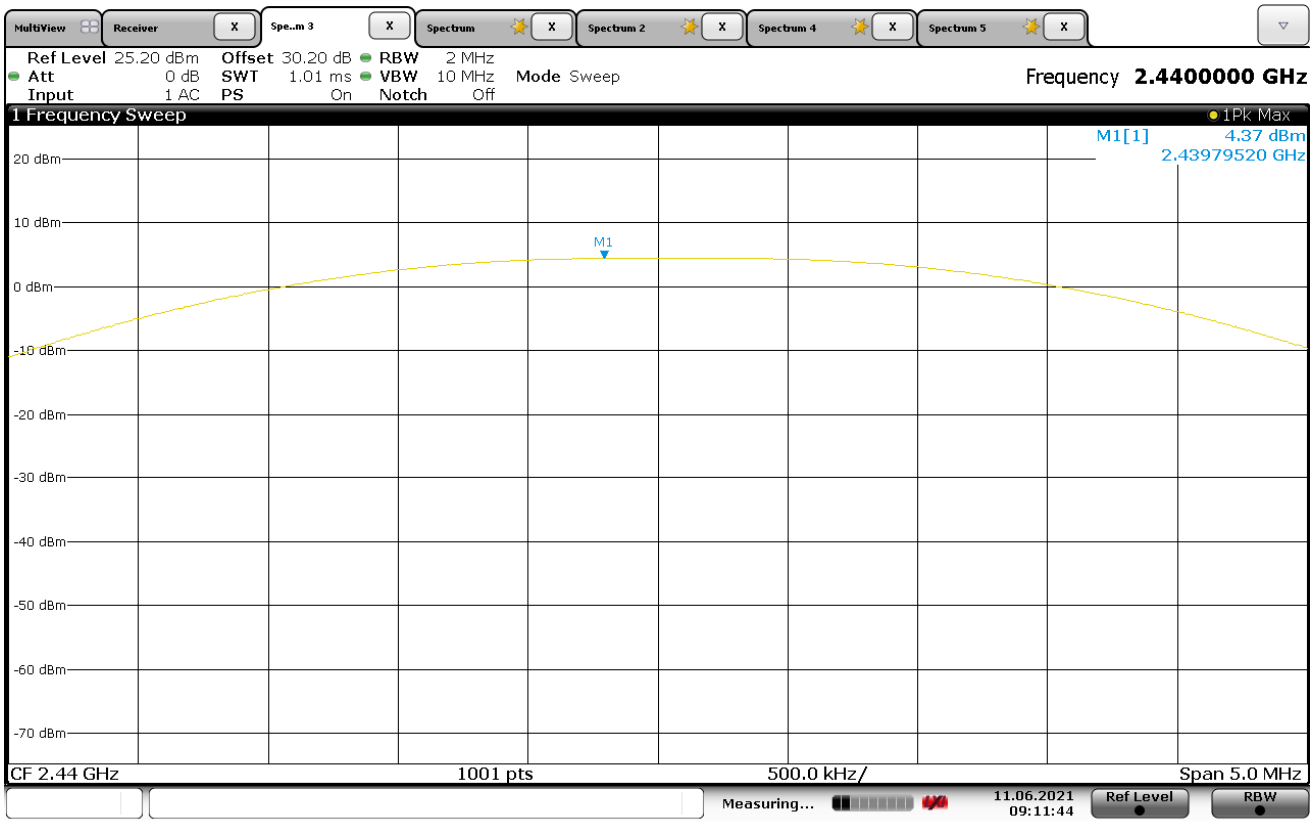
Date: 11.JUN.2021 09:30:53

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	Output Power = 2.56mW (4.09dBm)
Notes	With Nordic nRF52832



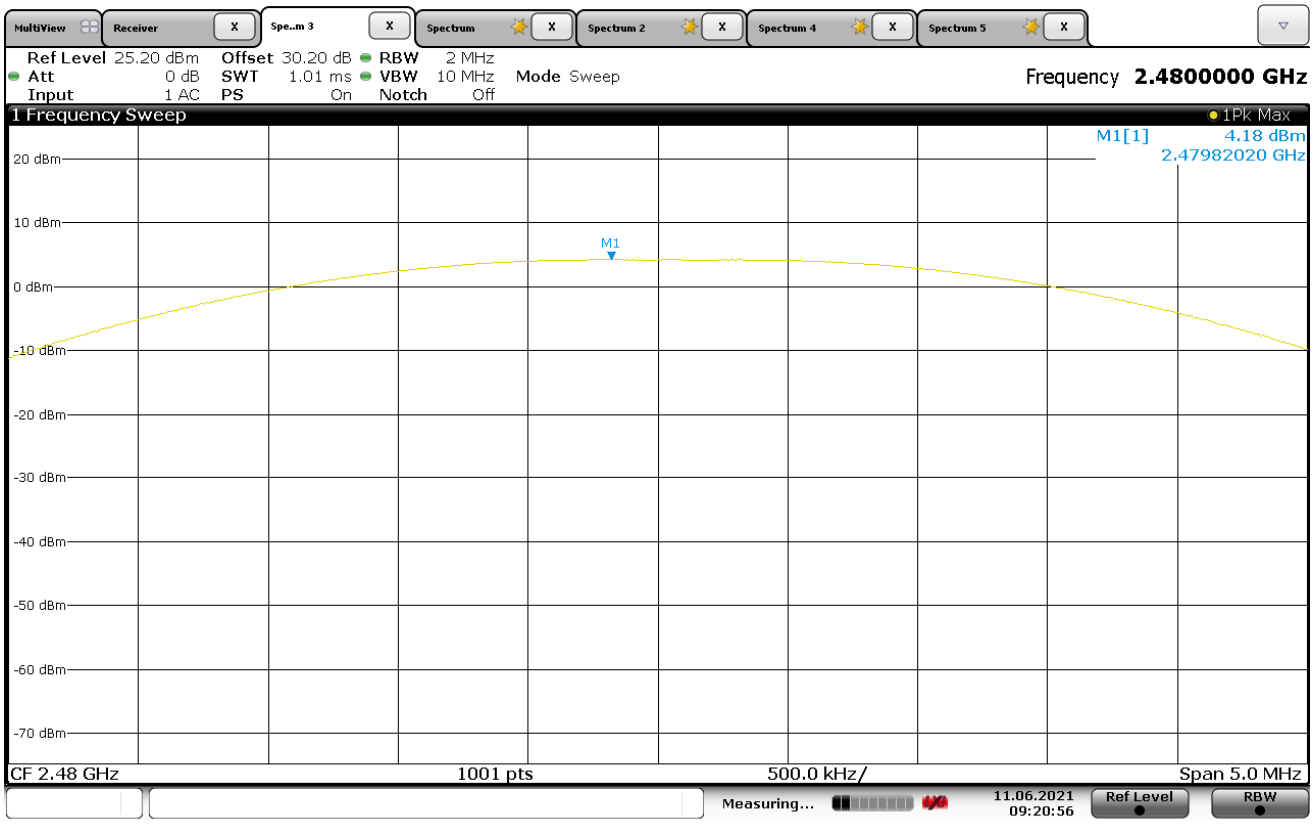
Date: 11.JUN.2021 08:35:17

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	Output Power = 2.73mW (4.37dBm)
Notes	With Nordic nRF52832



Date: 11.JUN.2021 09:11:44

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	Output Power = 2.62mW (4.18dBm)
Notes	With Nordic nRF52832



Date: 11.JUN.2021 09:20:56

23. Effective Isotropic Radiated Power (EIRP)

Test Information	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864 and VER-5869
Serial No	Radiated Sample
Mode	Transmit at 2402MHz, power setting = 4dBm, Transmit at 2440MHz, power setting = 4dBm, and Transmit at 2480MHz, power setting = 4dBm

Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Radiated
Type of Test Site	Semi-Anechoic Chamber
Test site used	Room 29
Type of Antennas Used	Below 1GHz: Bilog (or equivalent) Above 1GHz: Double-ridged waveguide (or equivalent)
Notes	None

Requirements
The output power shall not exceed 4W (36dBm).

Procedures
The EUT was placed on a 1.5 meter high non-conductive stand and set to transmit. A double ridged waveguide was placed at a test distance of 3 meters from the EUT. The resolution bandwidth (RBW) of the spectrum analyzer was set to greater than the 6dB bandwidth. The EUT was maximized for worst case emissions (or maximum output power) at the measuring antenna. The maximum meter reading was recorded. The peak power output was measured for the low, middle and high channels. The equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power, a dipole antenna (double ridged waveguide antenna for all measurements above 1GHz) was then set in place of the EUT and connected to a calibrated signal generator. The output of the signal generator was adjusted to match the received level at the spectrum analyzer. The signal level was recorded. The reading was then corrected to compensate for cable loss (and antenna gain for all measurements above 1GHz), as required. The peak power output was calculated for low, middle, and high hopping frequencies.

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site)	3.1

(1 GHz – 6 GHz)	
Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz)	3.2
Radiated disturbance (electric field strength on an open area test site or alternative test site) (18 GHz – 26.5 GHz)	3.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (26.5 GHz – 40 GHz)	3.4

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864 With Nordic nRF52810
S/N	Radiated Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	EIRP = 2.13mW (3.3dBm)
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total dBuV/m at 3m	EIRP (dBm)	Limit (dBm)	Margin (dBm)
2402.00	H	63.0	2.6	32.7	0.0	98.3	3.3	36.0	-32.7
2402.00	V	55.2	2.6	32.7	0.0	90.5	-4.5	36.0	-40.5

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864 With Nordic nRF52810
S/N	Radiated Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	EIRP = 1.9mW (2.9dBm)
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total dBuV/m at 3m	EIRP (dBm)	Limit (dBm)	Margin (dBm)
2440.00	H	62.4	2.6	32.9	0.0	97.9	2.9	36.0	-33.1
2440.00	V	54.3	2.6	32.9	0.0	89.8	-5.2	36.0	-41.2

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864 With Nordic nRF52810
S/N	Radiated Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	EIRP = 1.48mW (1.7dBm)
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total dBuV/m at 3m	EIRP (dBm)	Limit (dBm)	Margin (dBm)
2480.00	H	61.0	2.7	33.1	0.0	96.7	1.7	36.0	-34.3
2480.00	V	50.8	2.7	33.1	0.0	86.5	-8.5	36.0	-44.5

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864 With Nordic nRF52832
S/N	Radiated Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	EIRP = 2.69mW (4.3dBm)
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total dBuV/m at 3m	EIRP (dBm)	Limit (dBm)	Margin (dBm)
2402.00	H	64.0	2.6	32.7	0.0	99.3	4.3	36.0	-31.7
2402.00	V	53.9	2.6	32.7	0.0	89.2	-5.8	36.0	-41.8

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864 With Nordic nRF52832
S/N	Radiated Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	EIRP = 1.78mW (2.5dBm)
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total dBuV/m at 3m	EIRP (dBm)	Limit (dBm)	Margin (dBm)
2440.00	H	62.0	2.6	32.9	0.0	97.5	2.5	36.0	-33.5
2440.00	V	56.8	2.6	32.9	0.0	92.3	-2.7	36.0	-38.7

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864 With Nordic nRF52832
S/N	Radiated Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	EIRP = 1.32mW (1.2dBm)
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total dBuV/m at 3m	EIRP (dBm)	Limit (dBm)	Margin (dBm)
2480.00	H	60.5	2.7	33.1	0.0	96.2	1.2	36.0	-34.8
2480.00	V	53.3	2.7	33.1	0.0	89.0	-6.0	36.0	-42.0

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5869 With Nordic nRF52810
S/N	Radiated Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	EIRP = 2.82mW (4.5dBm)
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total dBuV/m at 3m	EIRP (dBm)	Limit (dBm)	Margin (dBm)
2402.00	H	64.2	2.6	32.7	0.0	99.5	4.5	36.0	-31.5
2402.00	V	48.1	2.6	32.7	0.0	83.4	-11.6	36.0	-47.6

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5869 With Nordic nRF52810
S/N	Radiated Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	EIRP = 1.9mW (2.9dBm)
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total dBuV/m at 3m	EIRP (dBm)	Limit (dBm)	Margin (dBm)
2440.00	H	62.4	2.6	32.9	0.0	97.9	2.9	36.0	-33.1
2440.00	V	57.4	2.6	32.9	0.0	92.9	-2.1	36.0	-38.1

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5869With Nordic nRF52810
S/N	Radiated Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	EIRP = 1.62mW (2.1dBm)
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total dBuV/m at 3m	EIRP (dBm)	Limit (dBm)	Margin (dBm)
2480.00	H	61.4	2.7	33.1	0.0	97.1	2.1	36.0	-33.9
2480.00	V	50.5	2.7	33.1	0.0	86.2	-8.8	36.0	-44.8

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5869 With Nordic nRF52832
S/N	Radiated Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	EIRP = 3.16mW (5.0dBm)
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total dBuV/m at 3m	EIRP (dBm)	Limit (dBm)	Margin (dBm)
2402.00	H	64.7	2.6	32.7	0.0	100.0	5.0	36.0	-31.0
2402.00	V	50.8	2.6	32.7	0.0	86.1	-8.9	36.0	-44.9

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5869 With Nordic nRF52832
S/N	Radiated Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	EIRP = 2.3mW (3.7dBm)
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total dBuV/m at 3m	EIRP (dBm)	Limit (dBm)	Margin (dBm)
2440.00	H	63.2	2.6	32.9	0.0	98.7	3.7	36.0	-32.3
2440.00	V	51.6	2.6	32.9	0.0	87.1	-7.9	36.0	-43.9

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5869With Nordic nRF52832
S/N	Radiated Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	EIRP = 2.0W (3.1dBm)
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total dBuV/m at 3m	EIRP (dBm)	Limit (dBm)	Margin (dBm)
2480.00	H	62.4	2.7	33.1	0.0	98.1	3.1	36.0	-32.9
2480.00	V	50.2	2.7	33.1	0.0	85.9	-9.1	36.0	-45.1

24. Duty Cycle Factor Measurements

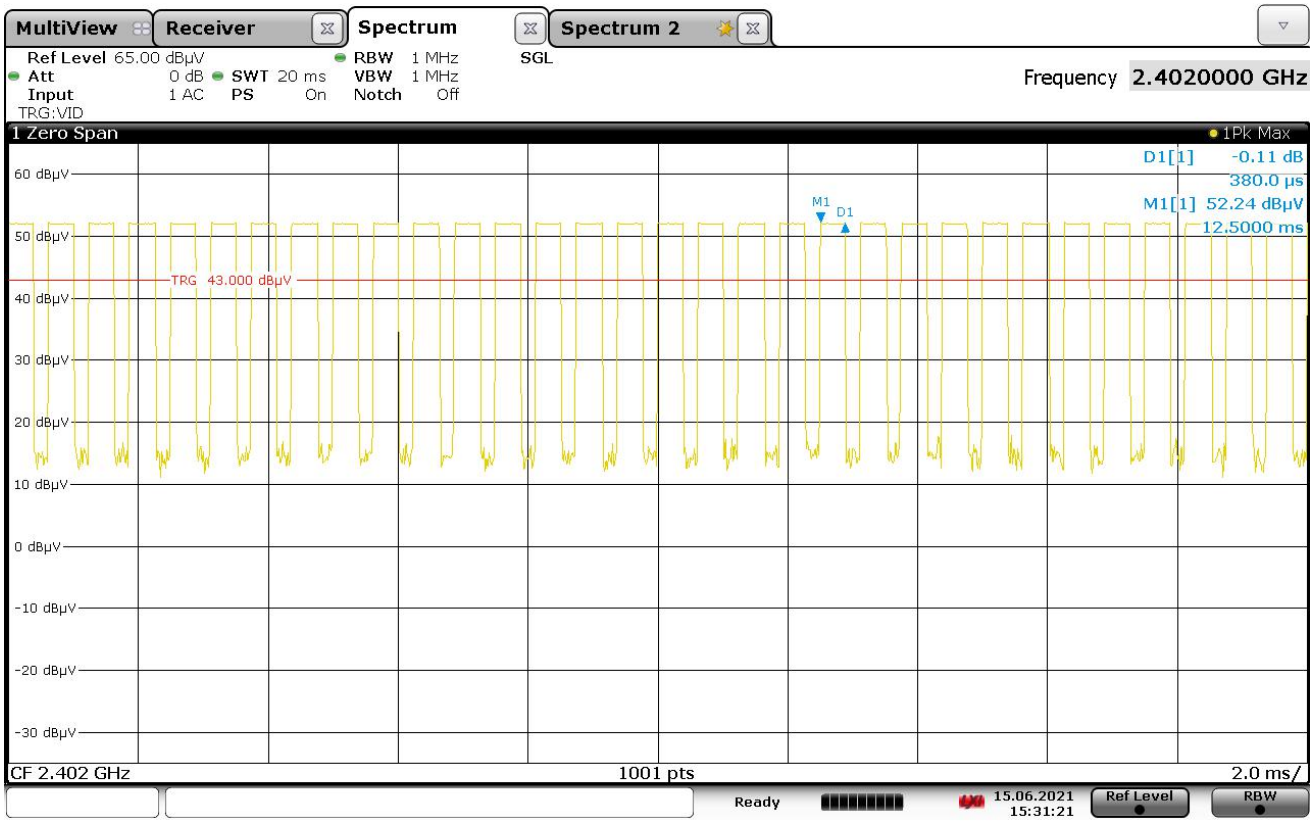
Test Information	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
Serial No	Conducted Sample
Mode	Transmit at 2402MHz, power setting = 4dBm

Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Radiated
Type of Test Site	Semi-Anechoic Chamber
Test site used	Room 29
Notes	None

Procedures
The duty cycle factor is used to convert peak detected readings to average readings when pulsed modulation is employed. This factor is computed from the time domain trace of the pulse modulation signal. With the transmitter set up to transmit for maximum pulse density, the time domain trace is displayed on the spectrum analyzer. This trace is obtained by tuning center frequency to the transmitter frequency and then setting a zero span width with 2 msec/div. The amplitude settings are adjusted so that the on/off transitions clear the 4th division from the bottom of the display. The markers are set at the beginning and end of the “on-time”. The trace is recorded. Next the spectrum analyzer center frequency is set to the transmitter frequency with a zero span width and 10msec/div. This shows if the word is longer than 100msec or shorter than 100msec. If the word period is less than 100msec, the display is set to show at least one word. The on-time and off-time are then measured. The on-time is total time signal level exceeds the 4th division. Off-time is time under for the word period. The duty cycle is then computed as the (On-time/ word period) where the word period = (On-time + Off-time).

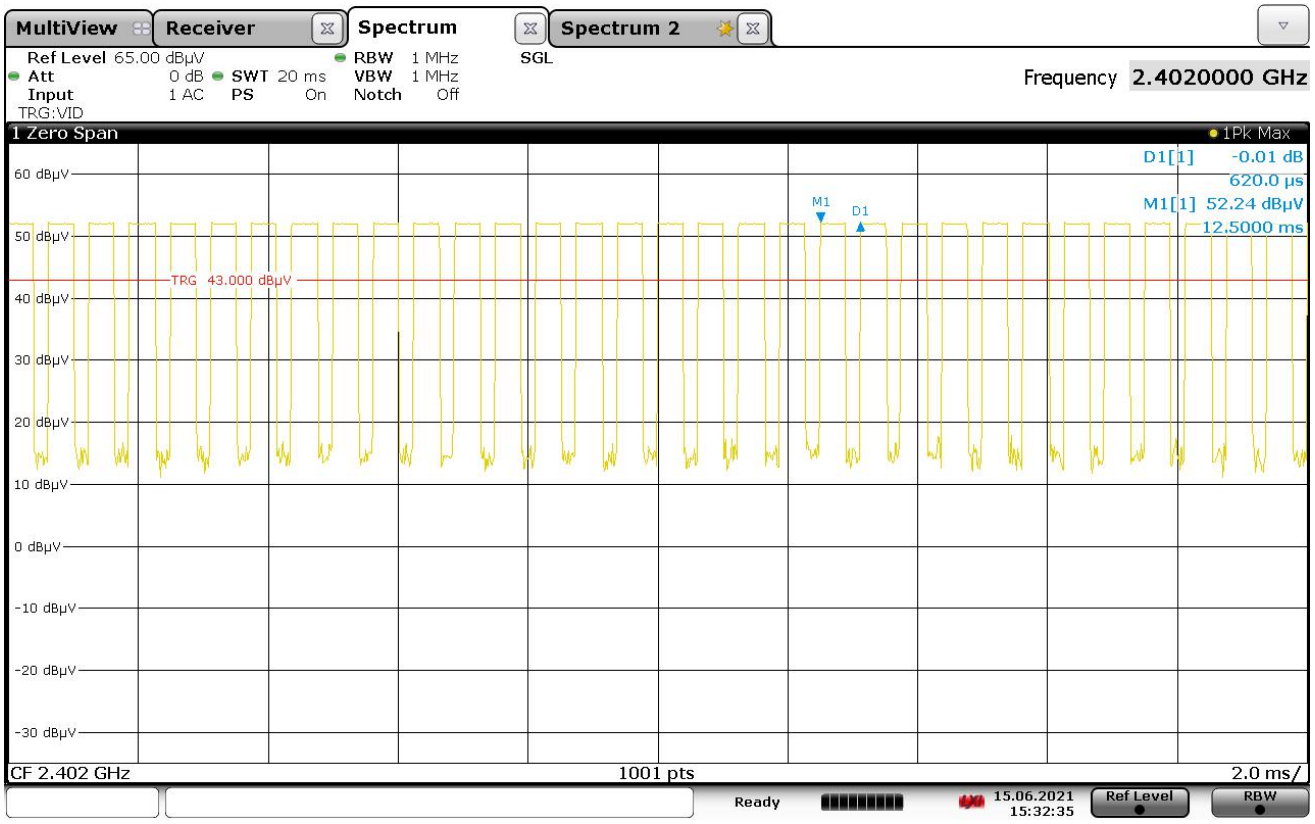
Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz)	3.1
Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz)	3.2
Radiated disturbance (electric field strength on an open area test site or alternative test site) (18 GHz – 26.5 GHz)	3.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (26.5 GHz – 40 GHz)	3.4

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	On time = 380usec
Notes	None



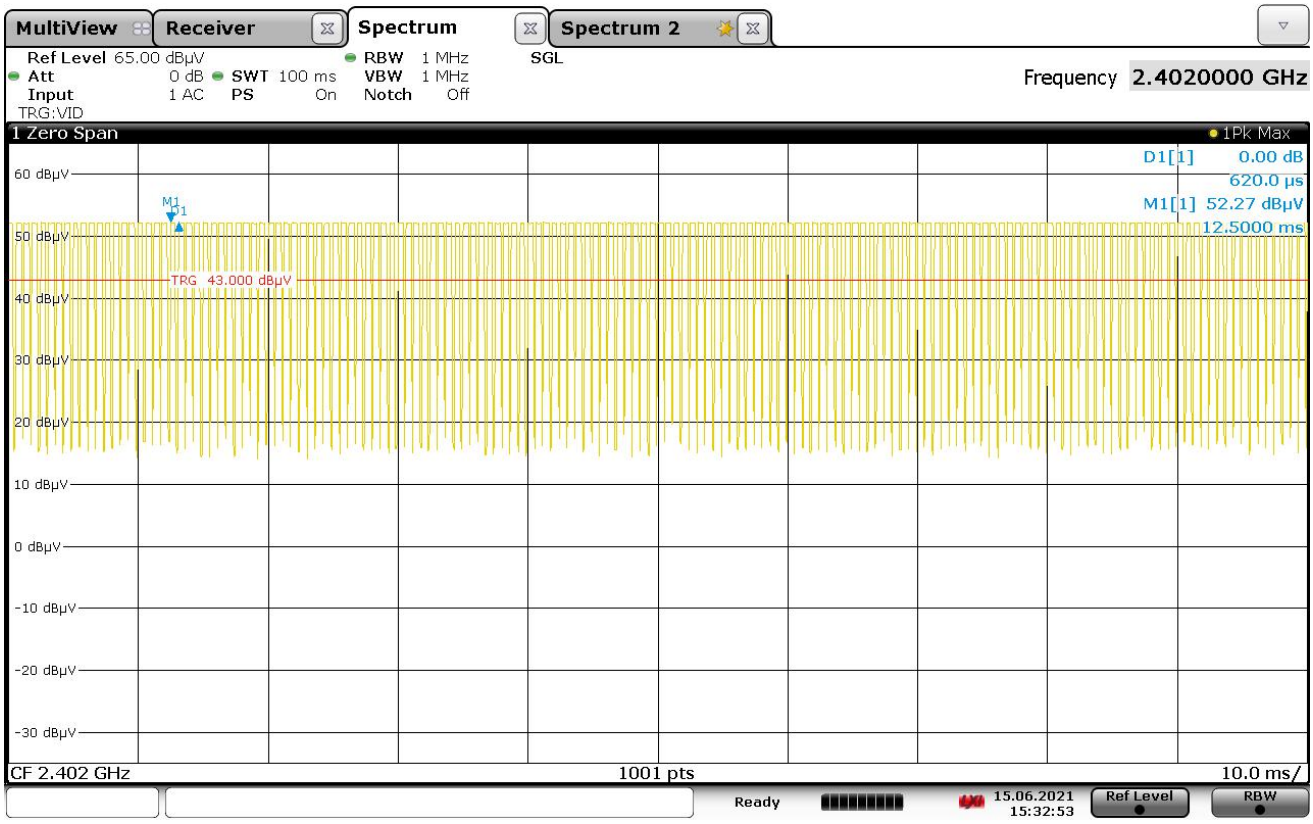
15:31:22 15.06.2021

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	Total time = 620usec
Notes	None



15:32:35 15.06.2021

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2402MHz, power setting = 4dBm
Parameters	100msec observation period shows the duty cycle is constant
Notes	None

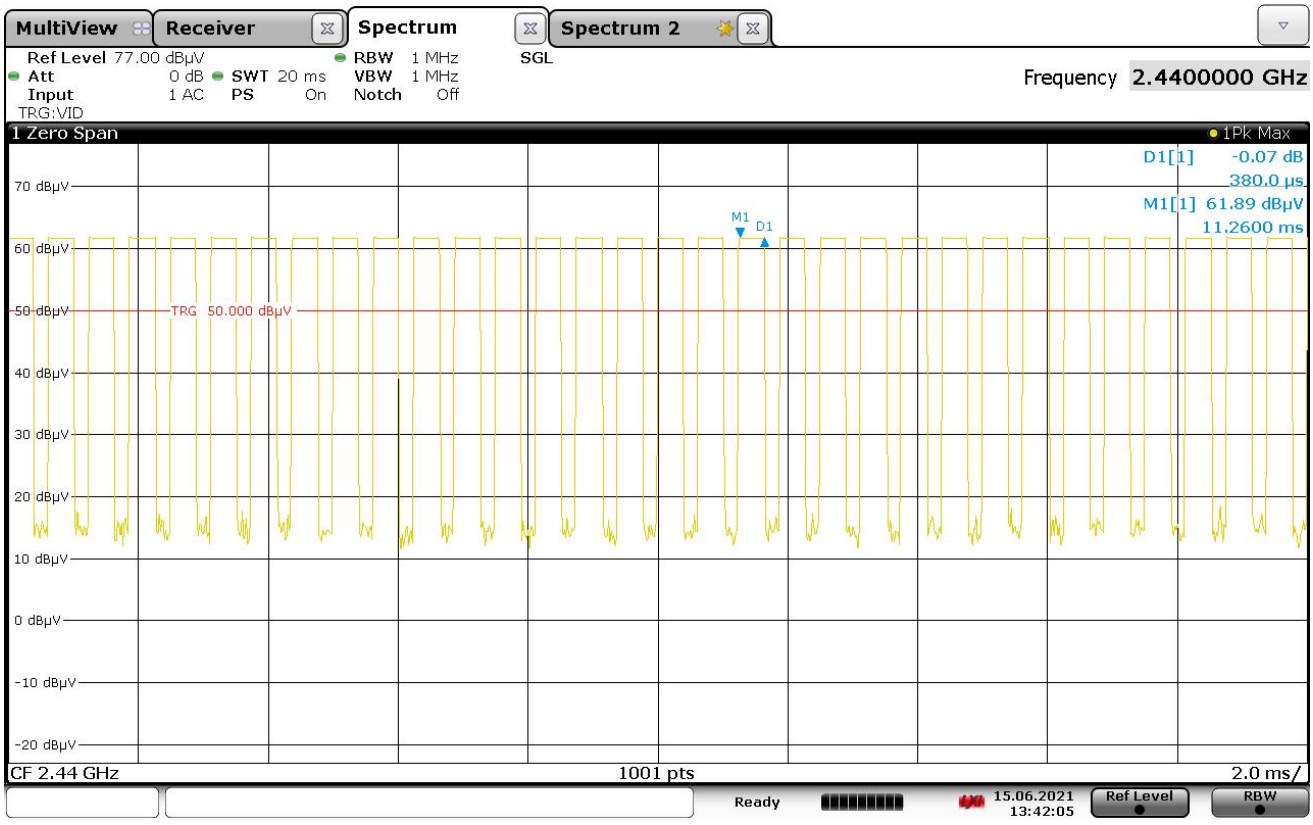


15:32:53 15.06.2021

$$\text{Duty Cycle} = 20\log\left(\frac{380usec}{620usec}\right) = 0.6129$$

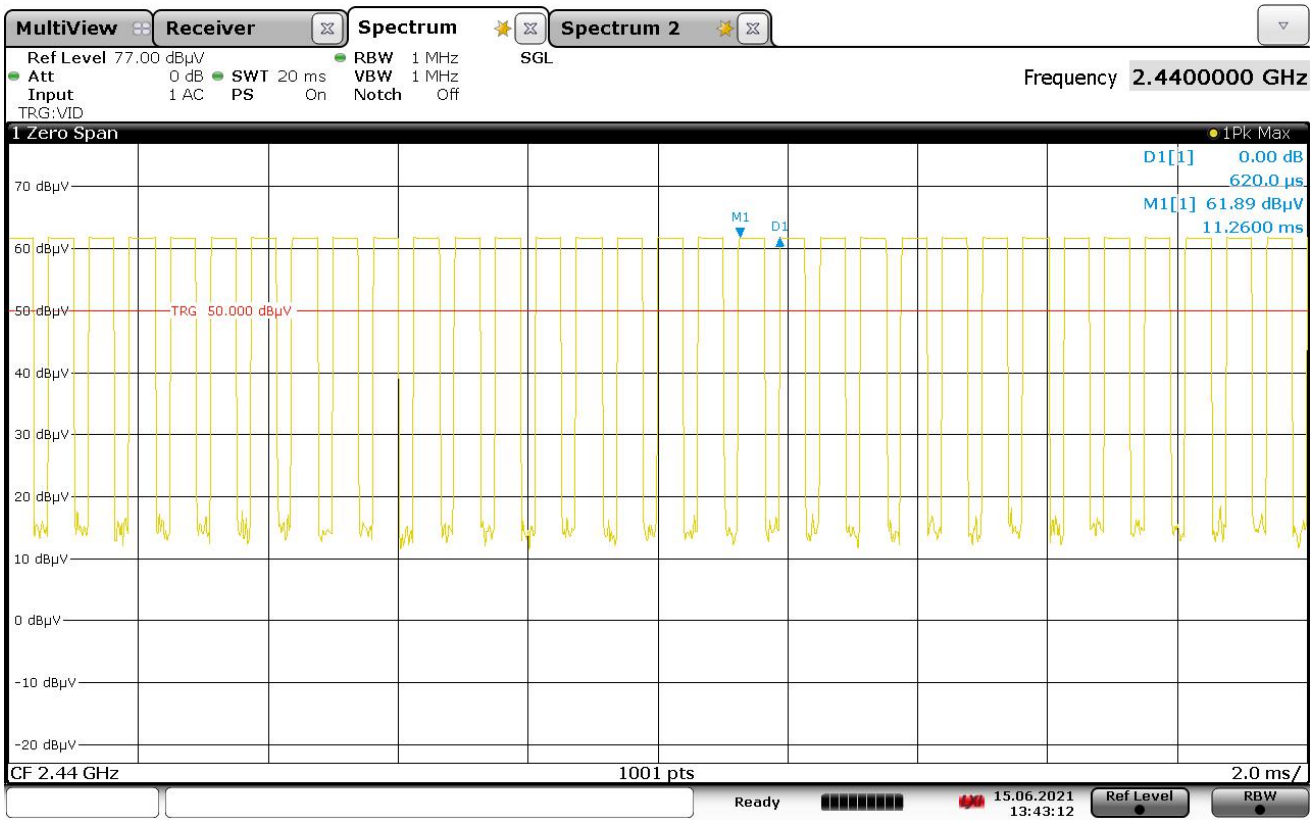
Duty Cycle Correction Factor = 20 log (1/DC) = 20 log (1/0.6129) = 4.25dB

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	On time = 380usec
Notes	None



13:42:05 15.06.2021

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	Total time = 620usec
Notes	None



13:43:13 15.06.2021

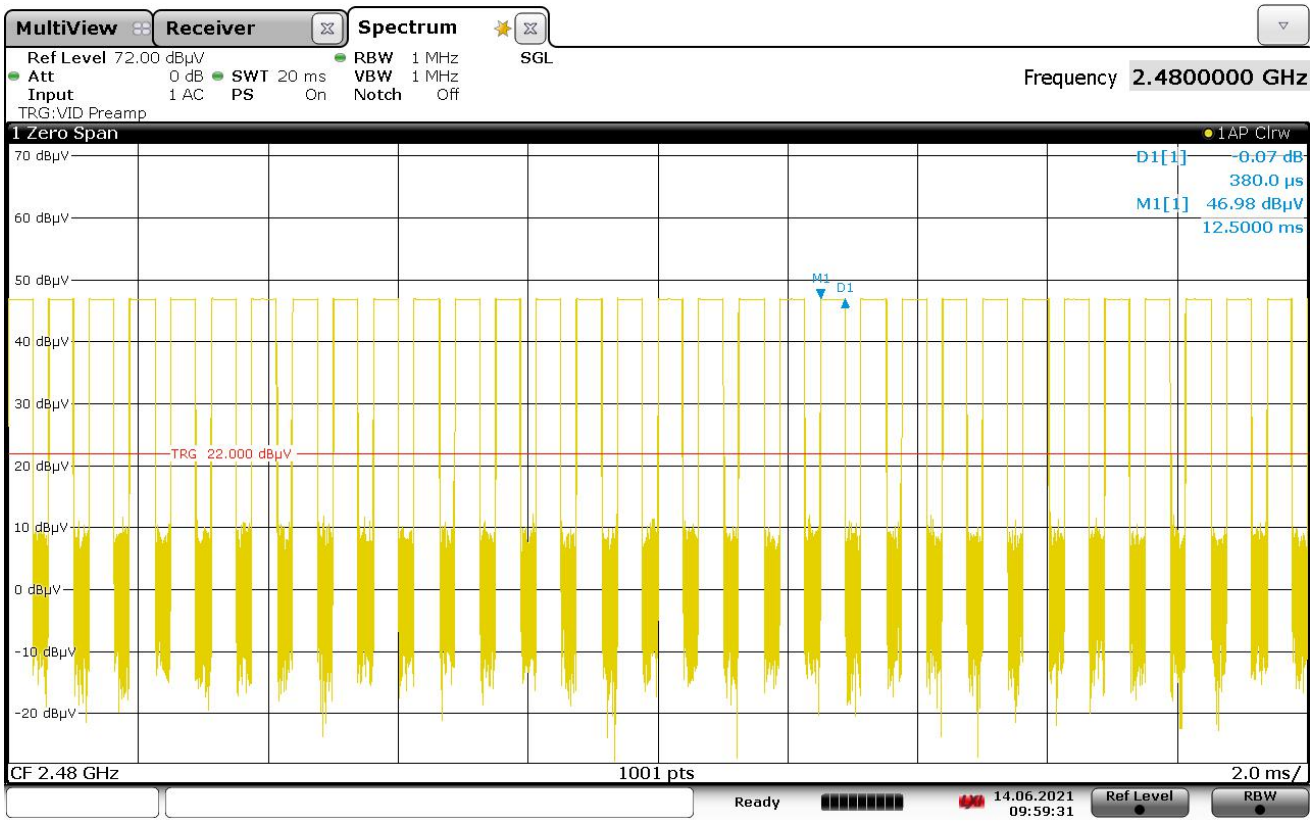
Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2440MHz, power setting = 4dBm
Parameters	100msec observation period shows the duty cycle is constant
Notes	None

13:43:46 15.06.2021

$$\text{Duty Cycle} = 20\log\left(\frac{380usec}{620usec}\right) = 0.6129$$

Duty Cycle Correction Factor = 20 log (1/DC) = 20 log (1/0.6129) = 4.25dB

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	On time = 380usec
Notes	None



09:59:31 14.06.2021

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	Total time = 620usec
Notes	None

10:00:52 14.06.2021

Test Details	
Manufacturer	Midmark, RTLS Solutions Inc.
Model	VER-5864
S/N	Conducted Sample
Mode	Transmit at 2480MHz, power setting = 4dBm
Parameters	100msec observation period shows the duty cycle is constant
Notes	None

10:01:28 14.06.2021

$$\text{Duty Cycle} = 20\log\left(\frac{380usec}{620usec}\right) = 0.6129$$

Duty Cycle Correction Factor = 20 log (1/DC) = 20 log (1/0.6129) = 4.25dB

25. Case Spurious Radiated Emissions

Test Information	
Manufacturer	Midmark, RTLS Solutions Inc.
Product	Asset Tag
Model	VER-5864
Serial No	Radiated Sample
Mode	Transmit at 2402MHz, power setting = 4dBm, Transmit at 2440MHz, power setting = 4dBm, Transmit at 2480MHz, power setting = 4dBm

Test Setup Details	
Setup Format	Tabletop
Height of Support	N/A
Measurement Method	Radiated
Type of Test Site	Semi-Anechoic Chamber
Test site used	Room 29
Type of Antennas Used	Below 1GHz: Bilog (or equivalent) Above 1GHz: Double-ridged waveguide (or equivalent)
Notes	The cables were manually maximized during the preliminary emissions sweeps. The cable arrangement which resulted in the worst-case emissions was utilized.

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz)	3.1
Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz)	3.2
Radiated disturbance (electric field strength on an open area test site or alternative test site) (18 GHz – 26.5 GHz)	3.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (26.5 GHz – 40 GHz)	3.4

Procedures
Radiated measurements were performed in a 32ft. x 20ft. x 14ft. high shielded enclosure. The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads. Preliminary radiated emissions tests were performed to determine the emission characteristics of the EUT. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the EUT. The entire frequency range from 30MHz to 25GHz was investigated using a peak detector function. The final open field emission tests were then manually performed over the frequency range of 30MHz to 25GHz. 1) For all harmonics not in the restricted bands, the following procedure was used:

a) The field strength of the fundamental was measured using a double ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on a 1.5m high non-conductive stand. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.

b) The field strengths of all the harmonics not in the restricted band were then measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on a 1.5m high non-conductive stand. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.

c) To ensure that maximum or worst case emission levels at the fundamental and harmonics were measured, the following steps were taken when measuring the fundamental emissions and the spurious emissions:

i) The EUT was rotated so that all of its sides were exposed to the receiving antenna.

ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.

iii) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.

iv) In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer, the measuring antenna was not raised or lowered to ensure maximized readings. Instead the EUT was rotated through all axis to ensure the maximum readings were recorded for the EUT.

d) All harmonics not in the restricted bands must be at least 20 dB below levels measured at the fundamental. However, attenuation below the general limits specified in §15.209(a) is not required.

2) For all emissions in the restricted bands, the following procedure was used:

a) The field strengths of all emissions below 1 GHz were measured using a bi-log antenna. The bi-log antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on an 80cm high non-conductive stand. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.

b) The field strengths of all emissions above 1 GHz were measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. The EUT was placed on a 1.5m high non-conductive stand. A peak detector with a resolution bandwidth of 1 MHz was used on the spectrum analyzer.

c) To ensure that maximum or worst case emission levels were measured, the following steps were taken when taking all measurements:

i) The EUT was rotated so that all of its sides were exposed to the receiving antenna.

ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.

iii) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.

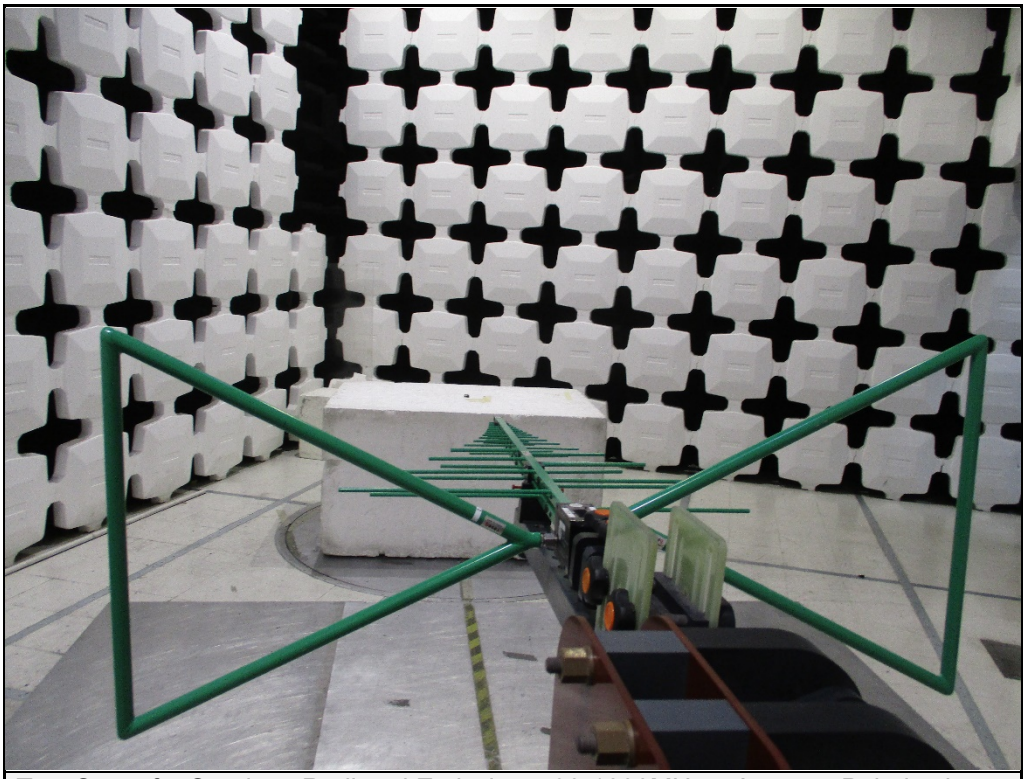
iv) In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer, the measuring antenna was not raised or lowered to ensure maximized readings. Instead, the EUT was rotated through all axis to ensure the maximum readings were recorded for the EUT.

d) For all radiated emissions measurements below 1 GHz, if the peak reading is below the limits listed in 15.209(a), no further measurements are required. If however, the peak readings exceed the limits listed in 15.209(a), then the emissions are remeasured using a quasi-peak detector.

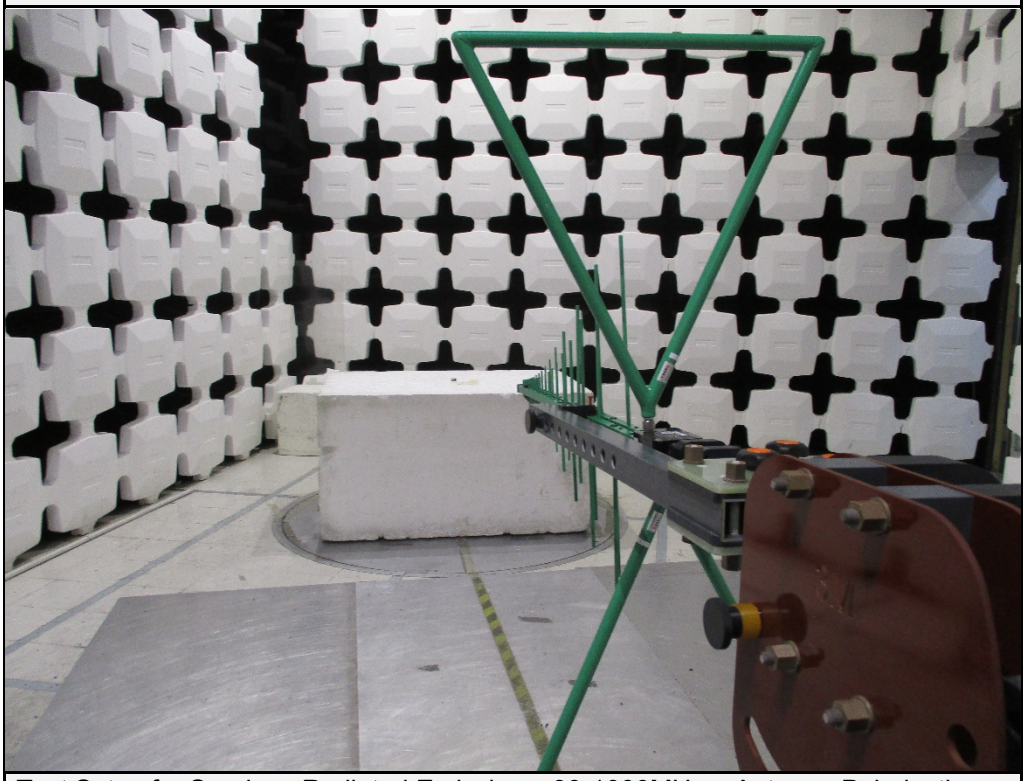
e) For all radiated emissions measurements above 1 GHz, the peak readings must comply with the 15.35(b) limits. 15.35(b) states that when average radiated emissions measurements are specified,

there also is a limit on the peak level of the radiated emissions. The limit on the peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. Therefore, all peak readings above 1 GHz must be no greater than 20 dB above the limits specified in 15.209(a).

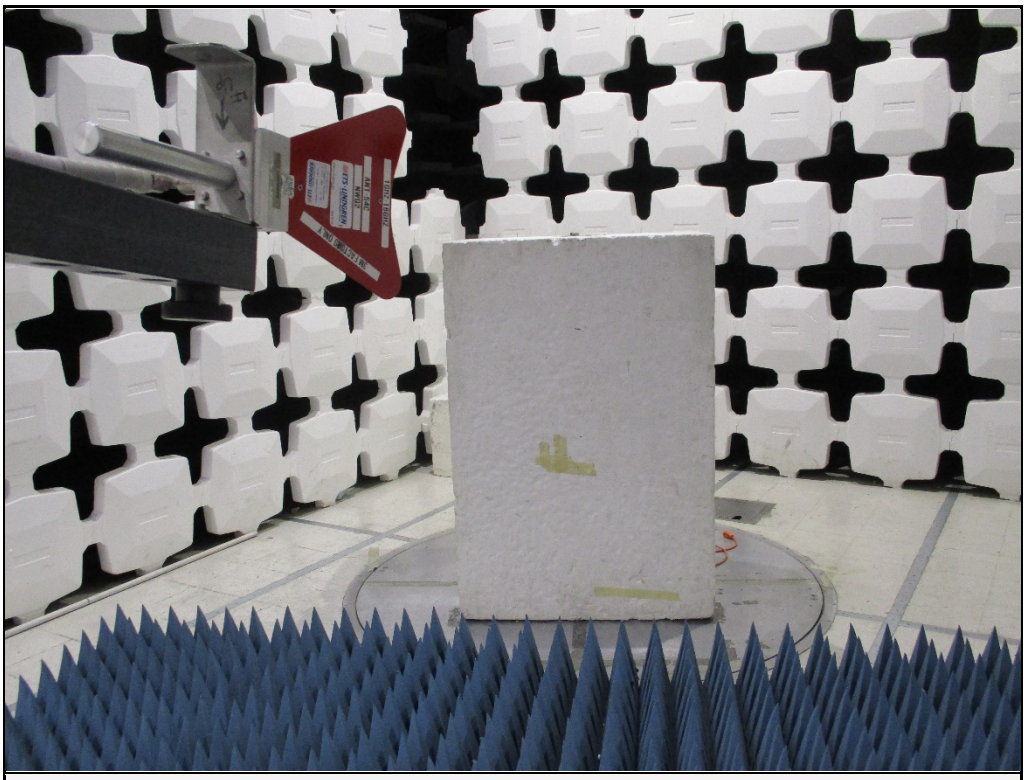
f) Next, for all radiated emissions measurements above 1GHz, the resolution bandwidth was set to 1MHz. The analyzer was set to linear mode with a 10Hz video bandwidth in order to simulate an average detector. An average reading was taken.



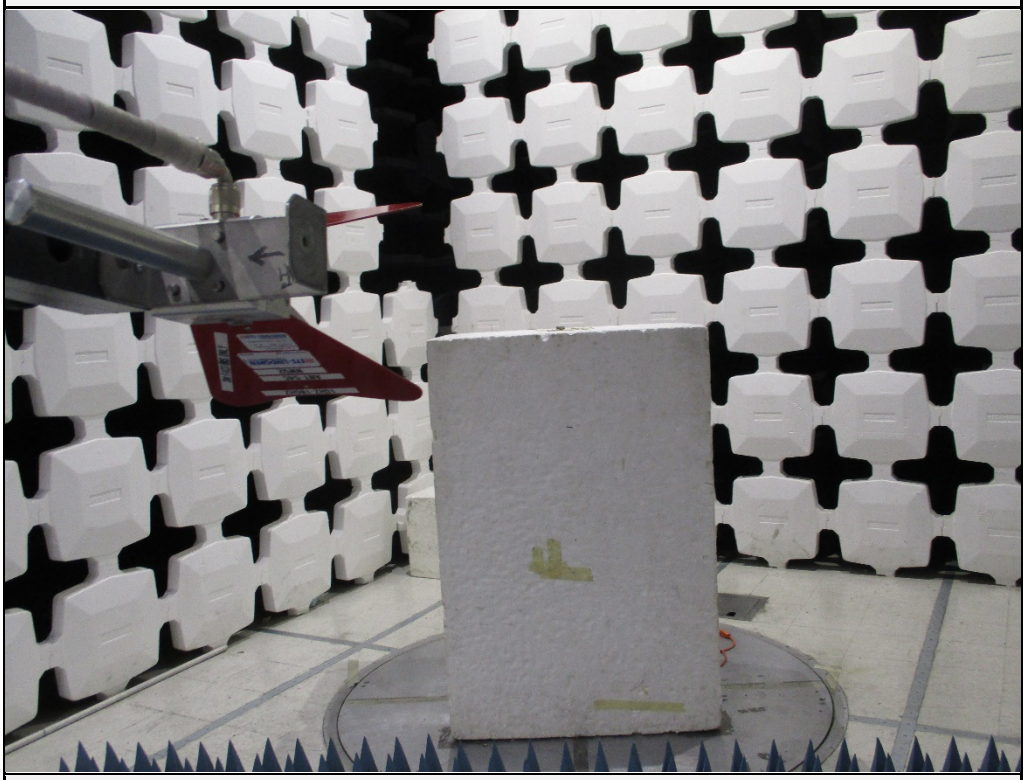
Test Setup for Spurious Radiated Emissions, 30-1000MHz – Antenna Polarization Horizontal



Test Setup for Spurious Radiated Emissions, 30-1000MHz – Antenna Polarization Vertical



Test Setup for Spurious Radiated Emissions, 1GHz to 18GHz – Antenna Polarization Horizontal



Test Setup for Spurious Radiated Emissions, 1GHz to 18GHz – Antenna Polarization Vertical