Engineering Test Report No. 2201829-01		
Report Date	June 30, 2022	
Manufacturer Name	Badger Meter	
Manufacturer Address	4545 W. Brown Deer Road Milwaukee, WI 53223	
Test Item Name Model No.	Water Meter Transceiver Orion Mobile M	
Date Received	June 22, 2022	
Test Dates	June 22, 2022 through June 24, 2022	
Specifications	FCC “Code of Federal Regulations” Title 47, Part 15, Subpart B FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 Innovation, Science, and Economic Development Canada, RSS-GEN Innovation, Science, and Economic Development Canada, RSS-247	
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	435715	

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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 B, FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247, Innovation, Science, and Economic Development Canada, RSS-GEN 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 dates 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.

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1. Report Revision History

Revision	Date	Description
–	30 JUN 2022	Initial Release of Engineering Test Report No. 2201829-01

2. Introduction

2.1. Scope of Tests

This document presents the results of a series of RF emissions tests that were performed on the Badger Meter Water Meter Transceiver (hereinafter referred to as the Equipment Under Test (EUT)). The EUT was manufactured and submitted for testing by Badger Meter located in Milwaukee, WI.

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 Frequency Hopping Spread Spectrum intentional radiator operating within the 902-928MHz 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 Frequency Hopping Spread Spectrum intentional radiator operating within the 902-928MHz band.

Testing was performed in accordance with ANSI C63.10-2013 and ANSI C63-4-2014.

2.3. Identification of the EUT

The EUTs were identified as follows:

EUT Identification	
Test Item #1	
Product Description	Water Meter Transceiver
Model/Part No.	Orion Mobile M
Serial No.	60000112
Size of EUT	12.5cm x 5cm x 4.5cm
Firmware Version	0.1F.32
Device Type	Frequency Hopping Transmission Device
Band of Operation	902 – 928MHz
Conducted Output Power	13.28dBm
Rated Output Power	16dBm
20dB Bandwidth	324.7kHz
Occupied Bandwidth (99% CBW)	270.4kHz
Test Item #2	
Product Description	Water Meter Transceiver
Model/Part No.	Model #2
Serial No.	60000115
Size of EUT	12.5cm x 5cm x 4.5cm
Firmware Version	0.14.32
Device Type	Frequency Hopping Transmission Device
Band of Operation	902 – 928MHz
Antenna Type	Surface mount chip antenna, Lucida model number: SR4L002
Antenna Gain (dBi) [1]	-2dBi
EIRP (Peak)	15.4dBm
Rated Output Power	16dBm

Note 1 – Antenna gain is supplied by the manufacturer and Elite is not responsible for the accuracy of the antenna gain.

Serial No. 60000115 was used for EIRP and spurious radiated emissions tests. Serial No. 60000112 was used for all other tests. For testing purposes, Serial No. 60000112 was modified for testing by adding a coaxial

connector to the antenna port.

3. Power Input

The EUTs normally obtains 3.6VDC from an internal Tadiran Lithium Inorganic battery. For testing purposes, the EUTs were powered with 3.6VDC from an external power supply via two wires.

4. Grounding

The EUTs were not connected to ground.

5. Support Equipment

The EUTs were submitted for testing along with the following support equipment:

Description	Model #
Dell Laptop Computer	Latitude E5550
USB to IR Dongle	ACT-IR224UN-L+

Note: The laptop computer and the USB to IR dongle were used to program the device. For all radiated emissions tests, they were removed from the test chamber prior to test.

6. Interconnect Leads

No interconnect leads were used during the tests.

7. Modifications Made to the EUT

No modifications were made to the EUTs during the testing.

8. Modes of Operation

The EUTs and all peripheral equipment were energized. The units were programmed to transmit in one of the following modes:

Mode	Description
Transmit at 904.94MHz	Power Setting = 16dBm
Transmit at 914.1MHz	Power Setting = 16dBm
Transmit at 923.79MHz	Power Setting = 16dBm
Hopping Enabled	Power Setting = 16dBm
Receive at 904.94MHz	---
Receive at 914.1MHz	---
Receive at 923.79MHz	---

9. Test Specifications

The tests were performed to selected portions of, and in accordance with, these test specifications:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Chapter I, Subchapter A, Part 15, Subpart B

- Federal Communications Commission "Code of Federal Regulations", Title 47, Chapter I, Subchapter A, Part 15, Subpart C

- 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 40GHz”

- 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-Gen Issue 5, February 2020, Amendment 2, Innovation, Science, and Economic Development Canada, “General Requirements for Compliance of Radio Apparatus”

- RSS-247 Issue 2, February 2017, “Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices”

10. Test Plan

No test plan was provided. Instructions were provided by personnel from Badger Meter and used in conjunction with the FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247, Innovation, Science, and Economic Development Canada, RSS-247, ANSI C63.4-2014, and ANSI C63.10-2013 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

The ambient parameters of the laboratory during testing were as follows:

Ambient Parameters	Value
Temperature	24°C
Relative Humidity	28%
Atmospheric Pressure	1018mb

13. Summary

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

Test Description	Requirements	Test Method	S/N	Results
Receiver Radiated Emissions	FCC 15.107 ISED RSS-GEN	ANSI C63.4:2014	60000115	Conforms
20dB Bandwidth	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	60000112	Conforms
Occupied Bandwidth (99%)	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	60000112	Conforms
Carrier Frequency Separation	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	60000112	Conforms
Number of Carrier Channels	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	60000112	Conforms
Average Time of Occupancy	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	60000112	Conforms
Maximum Peak Conducted Output Power	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	60000112	Conforms
Effective Isotropic Radiated Power (EIRP)	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	60000115	Conforms
Duty Cycle Factor Measurements	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	60000112	—

Case Spurious Radiated Emissions	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	60000115	Conforms
Band-Edge Compliance	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	60000112	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 (dBµV) = MTR (dBµV) + 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 (dBµV/m) = MTR (dBµV) + AF (dB/m) + CF (dB) + (- PA (dB)) + DC (dB)

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

Formula 2: FS (µV/m) = AntiLog [(FS (dBµV/m))/20]

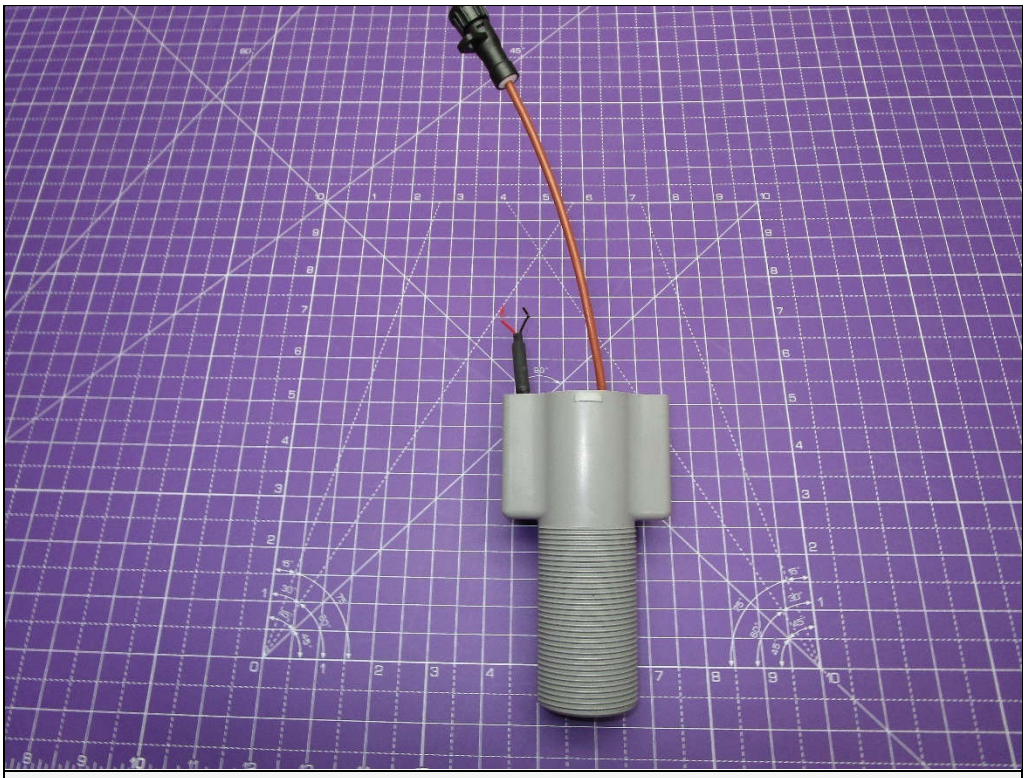
15. Statement of Conformity

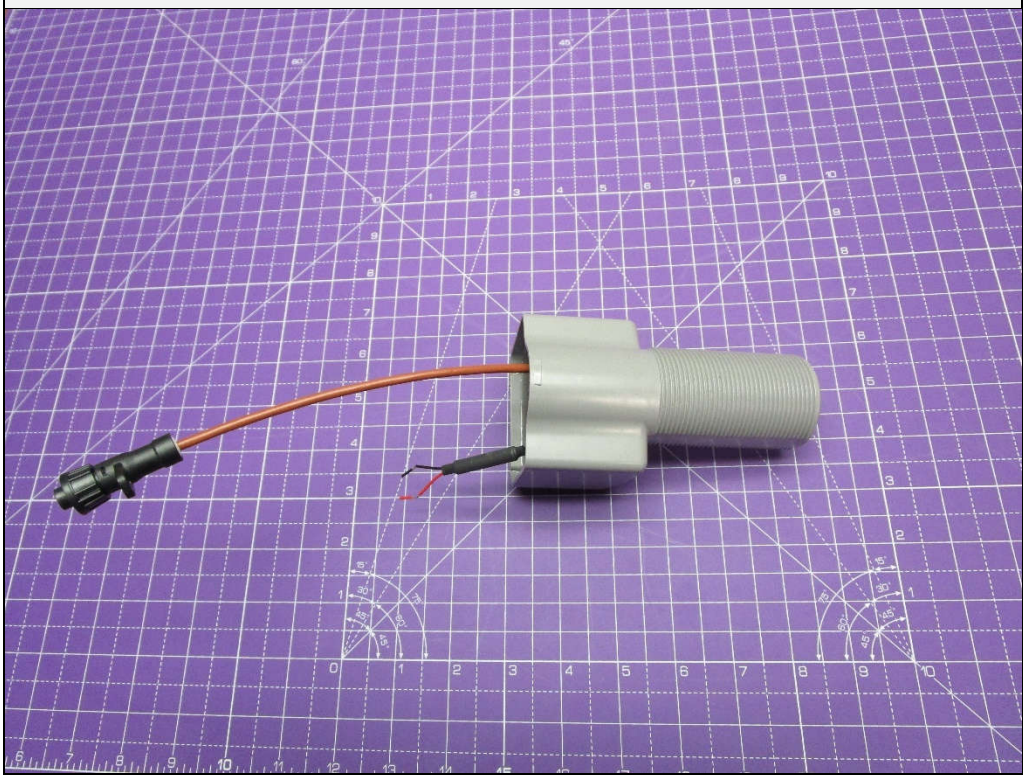
The Badger Meter Water Meter Transceiver, Model No. Orion Mobile M did fully conform to the selected requirements of FCC “Code of Federal Regulations” Title 47, Part 15, Subpart B, FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247, Innovation, Science, and Economic Development Canada, RSS-GEN, and Innovation, Science, and Economic Development Canada, RSS-247.

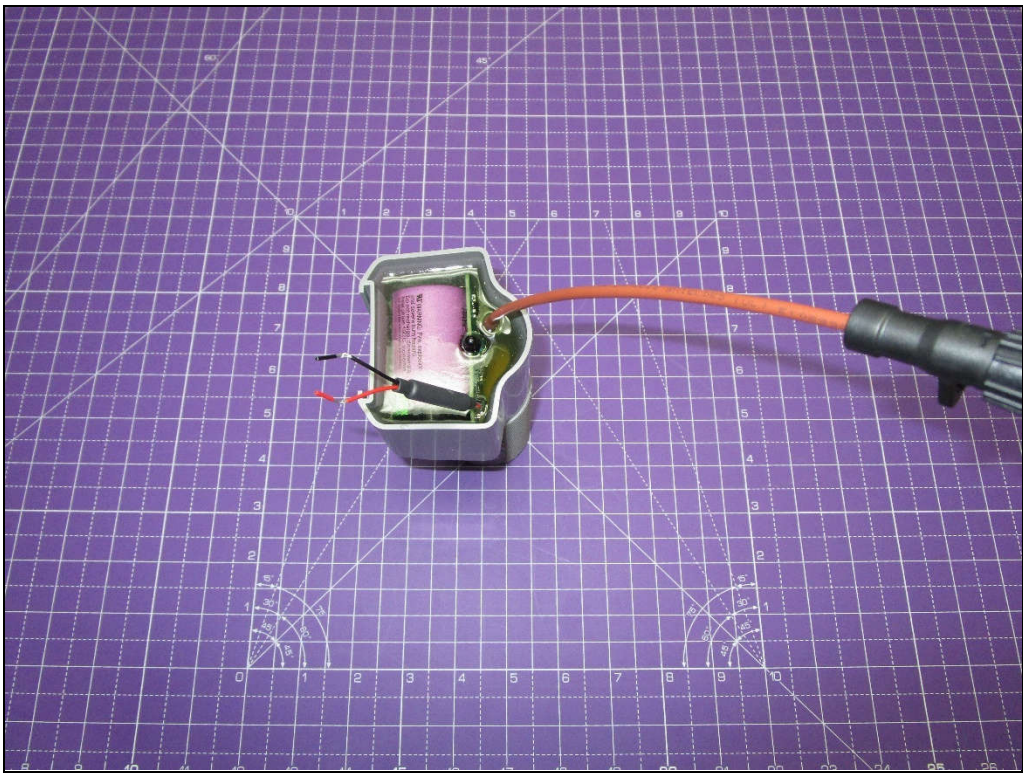
16. Certification

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 B, FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247, Innovation, Science, and Economic Development Canada, RSS-GEN and Innovation, Science, and Economic Development Canada, RSS-247 test specifications. The data presented in this test report pertains to the EUTs on the test date specified. Any electrical or mechanical modifications made to the EUTs subsequent to the specified test date will serve to invalidate the data and void this certification.

17. Photographs of EUT







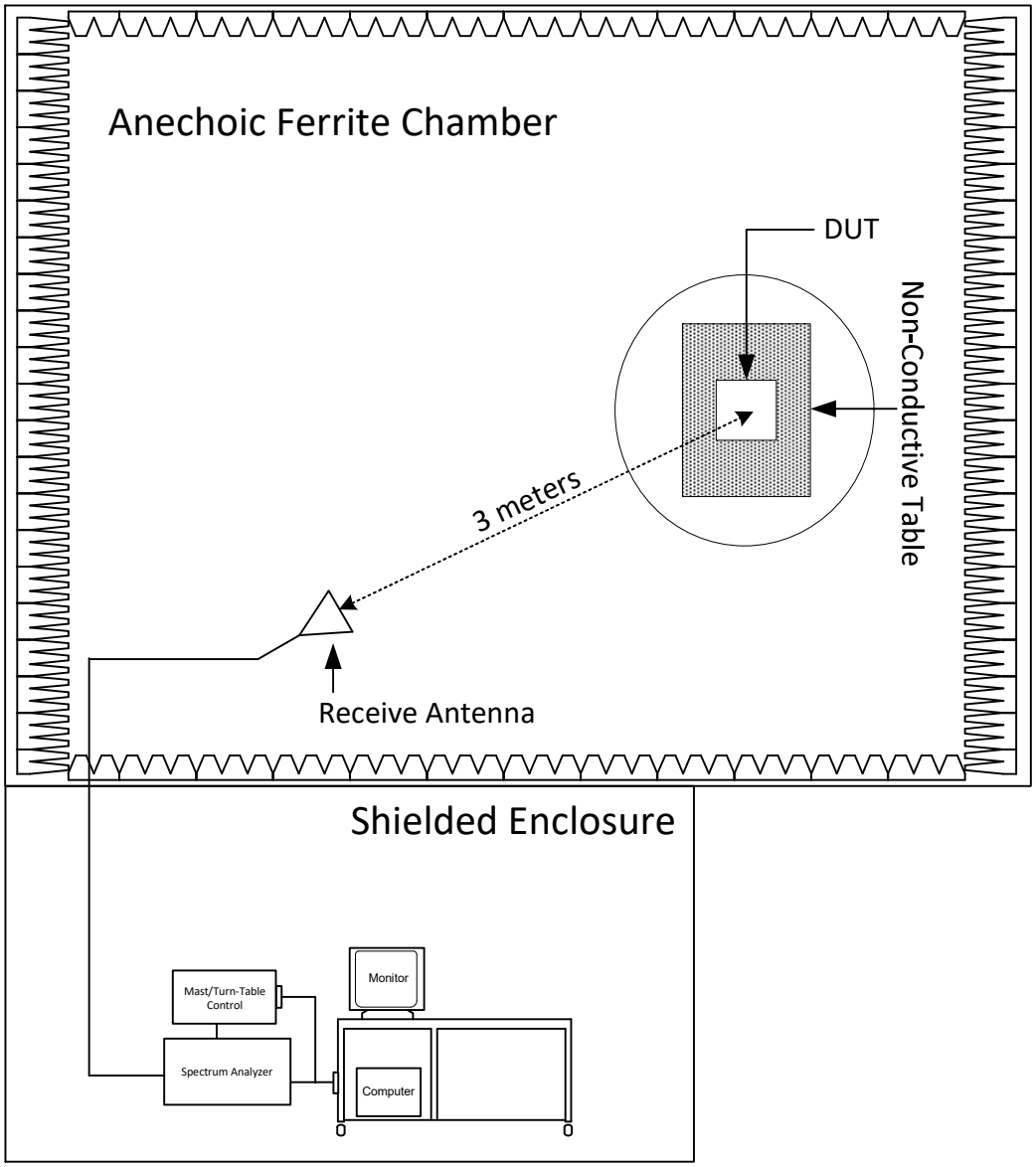
18. Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
APW3	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-35-120-5R0-10-12	PL2924	1GHZ-20GHZ	3/9/2022	3/9/2023
CDZ4	LAB WORKSTATION	ELITE	LWS-10		WINDOWS 10	CNR	
GRE1	SIGNAL GENERATOR	AGILENT	E4438C	MY42081749	250KHZ-6GHZ	3/7/2022	3/7/2023
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	7/28/2020	7/28/2022
NTA4	BILOG ANTENNA	TESEQ	6112D	46660	20-2000GHZ	10/5/2020	10/5/2022
NWQ1	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS-LINDGREN	3117	66655	1GHZ-18GHZ	5/26/2022	5/26/2024
RBG3	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101592	2HZ-44GHZ	4/7/2022	4/7/2023
RBG4	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	103007	2HZ-44GHZ	4/28/2022	4/28/2023
T2DG	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BN1038	DC-18GHZ	1/6/2022	1/6/2024
T2S13	20DB 25W ATTENUATOR	WEINSCHEL	46-20-43	CM5728	DC-18GHZ	5/18/2022	5/18/2024
VBV2	CISPR EN FCC ICES RE.EXE	ELITE	CISPR EN FCC ICES RE.EXE	---	---	N/A	
WKA1	SOFTWARE, UNIVERSAL RCV EMI	ELITE	UNIV_RCV_EMI	1	---	I/O	
XPQ8	HIGH PASS FILTER	K&L MICROWAVE	4IH30-1804/T10000-0	6	1.8-10GHZ	2/3/2021	2/3/2023

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. Receiver Radiated Emissions

EUT Information	
Manufacturer	Badger Meter
Product	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Receive at 904.9MHz Receive at 914.08MHz Receive at 923.7MHz

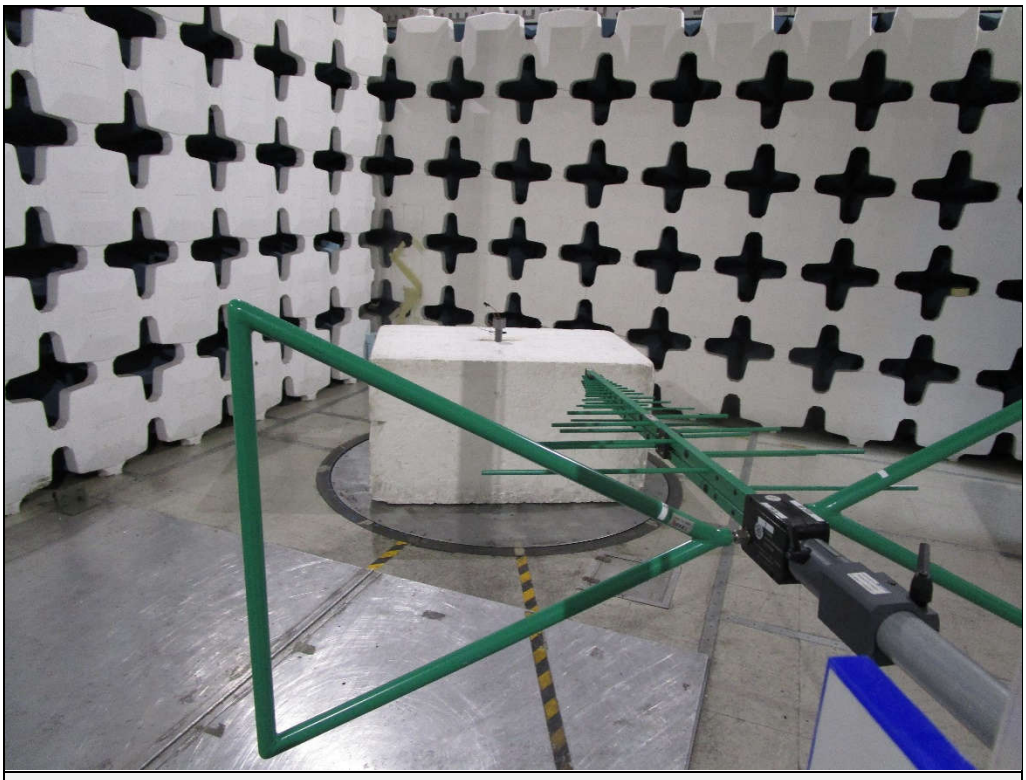
Test Site Information	
Setup Format	Tabletop
Height of Support (For Floor Standing only)	N/A
Type of Test Site	Semi-Anechoic Chamber
Test Site Used	Room 21
Type of Antennas Used	Below 1GHz: Bilog (or equivalent) Above 1GHz: Double-ridged waveguide (or equivalent)
Highest Internal Frequency	923.7MHz
Highest Measurement Frequency	5GHz
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

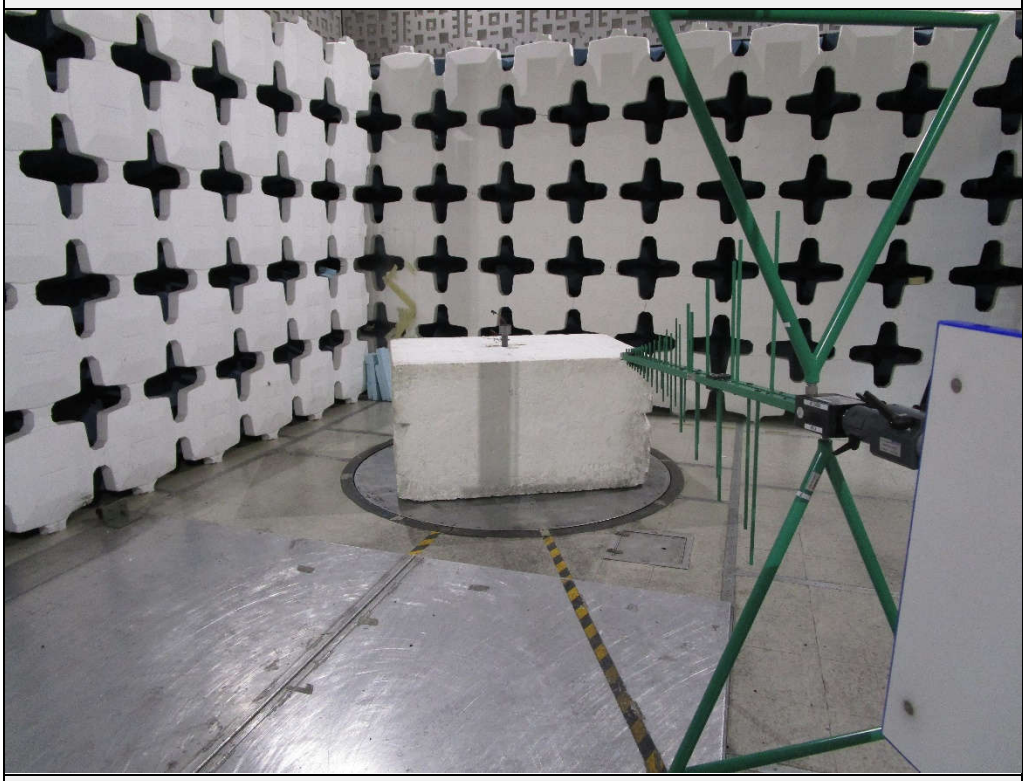
Requirements
The field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the values in the following table.

Radiated Emissions Limits (30MHz to 1GHz)		
Frequency of Emission (MHz)	Field Strength (µV/m)	Field Strength (dBµV/m)
30 – 88	100	40
88 – 216	150	43.5
216 – 960	200	46
Above 960	500	54
Radiated Emissions Limits (Above 1GHz)		
Frequency of Emission (MHz)	Peak Limit (dBµV/m)	Average Limit (dBµV/m)
Above 1000	74	54

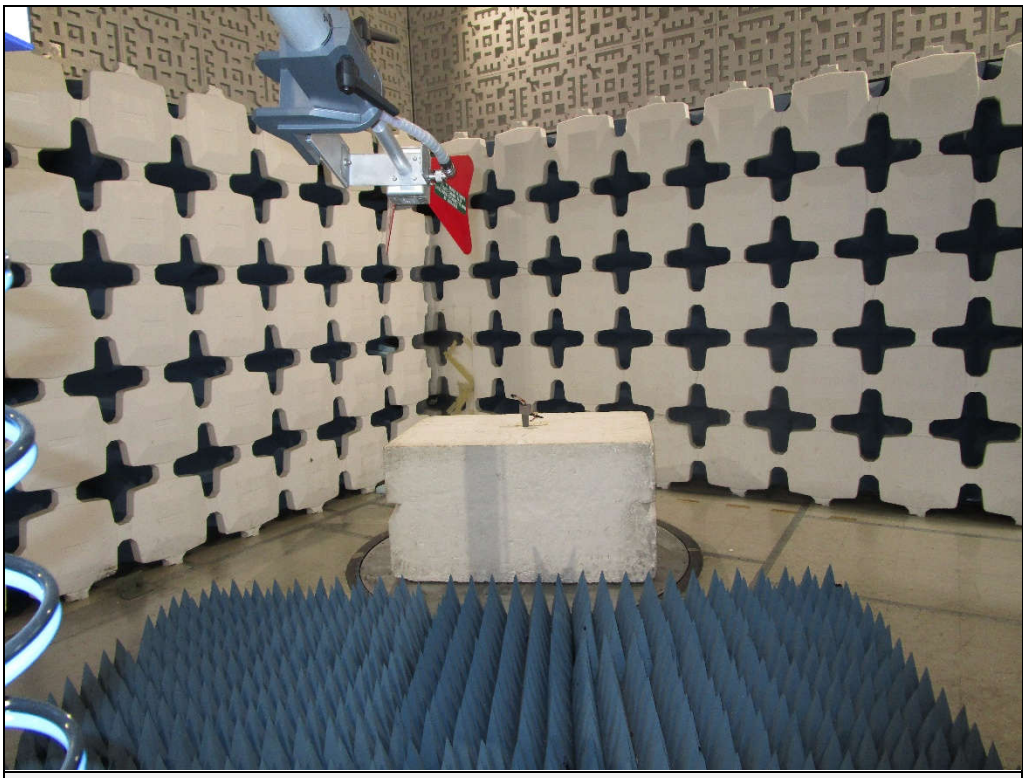
Procedure
Since a quasi-peak detector and an average detector require long integration times, it is not practical to automatically sweep through the quasi-peak and average levels. Therefore, radiated emissions from the EUT were first scanned using a peak detector and automatically plotted. The frequencies where significant emission levels were noted were then remeasured using the quasi-peak detector or average detector. The EUT and all peripheral equipment were placed on an 80cm high non-conductive stand. The broadband measuring antenna was positioned at a 3-meter distance from the EUT. The frequency range from 30MHz to 1GHz was investigated using a peak detector function with the bilog antenna at several heights, horizontal and vertical polarization, and with several different orientations of the EUT with respect to the antenna. The frequency range from 1GHz to 5GHz was investigated using a peak detector function with the double ridged waveguide antenna at several heights, horizontal and vertical polarization, and with several different orientations of the EUT with respect to the antenna. The maximum levels for each antenna polarization were plotted. Final radiated emissions were performed on all significant broadband and narrowband emissions found in the exploratory sweeps using the following methods: 1) Measurements from 30MHz to 1GHz were made using a quasi-peak detector and a broadband bilog antenna. Measurements above 1GHz were made using an average detector and a broadband double ridged waveguide antenna. 2) To ensure that maximum or worst case, emission levels were measured, the following steps were taken: a) The EUT was rotated so that all sides were exposed to the receiving antenna. b) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured. c) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.



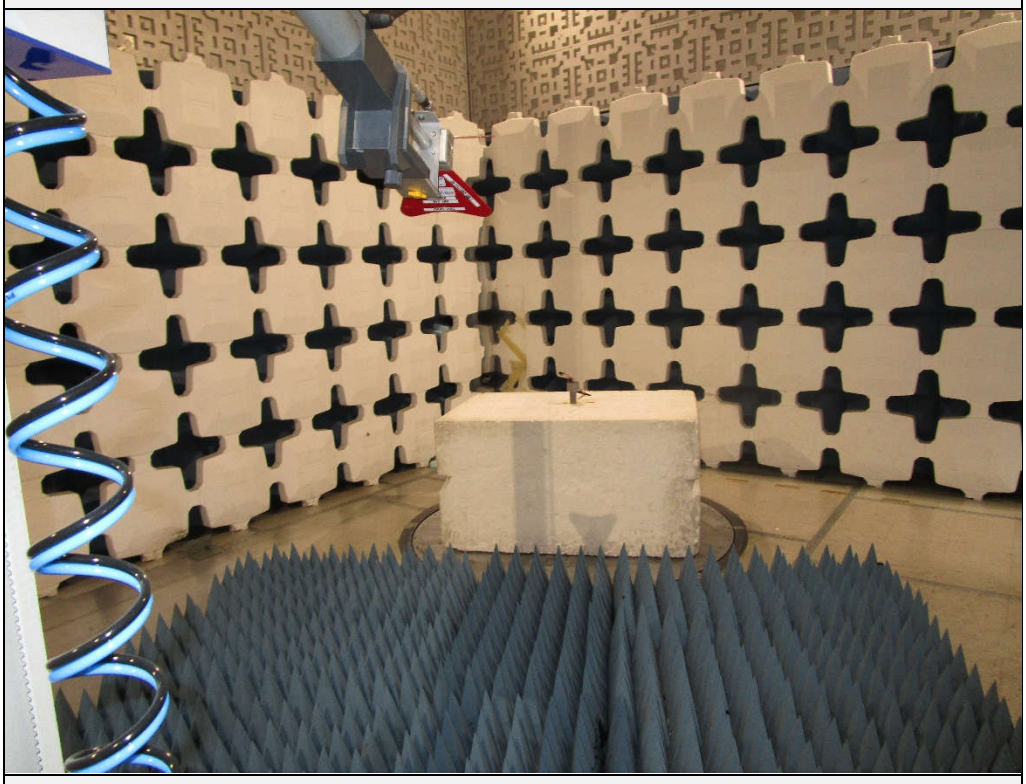
Test Setup for Radiated Emissions: 30MHz to 1GHz, Horizontal Polarization



Test Setup for Radiated Emissions: 30MHz to 1GHz, Vertical Polarization



Test Setup for Radiated Emissions: Above 1GHz, Horizontal Polarization



Test Setup for Radiated Emissions: Above 1GHz, Vertical Polarization

FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

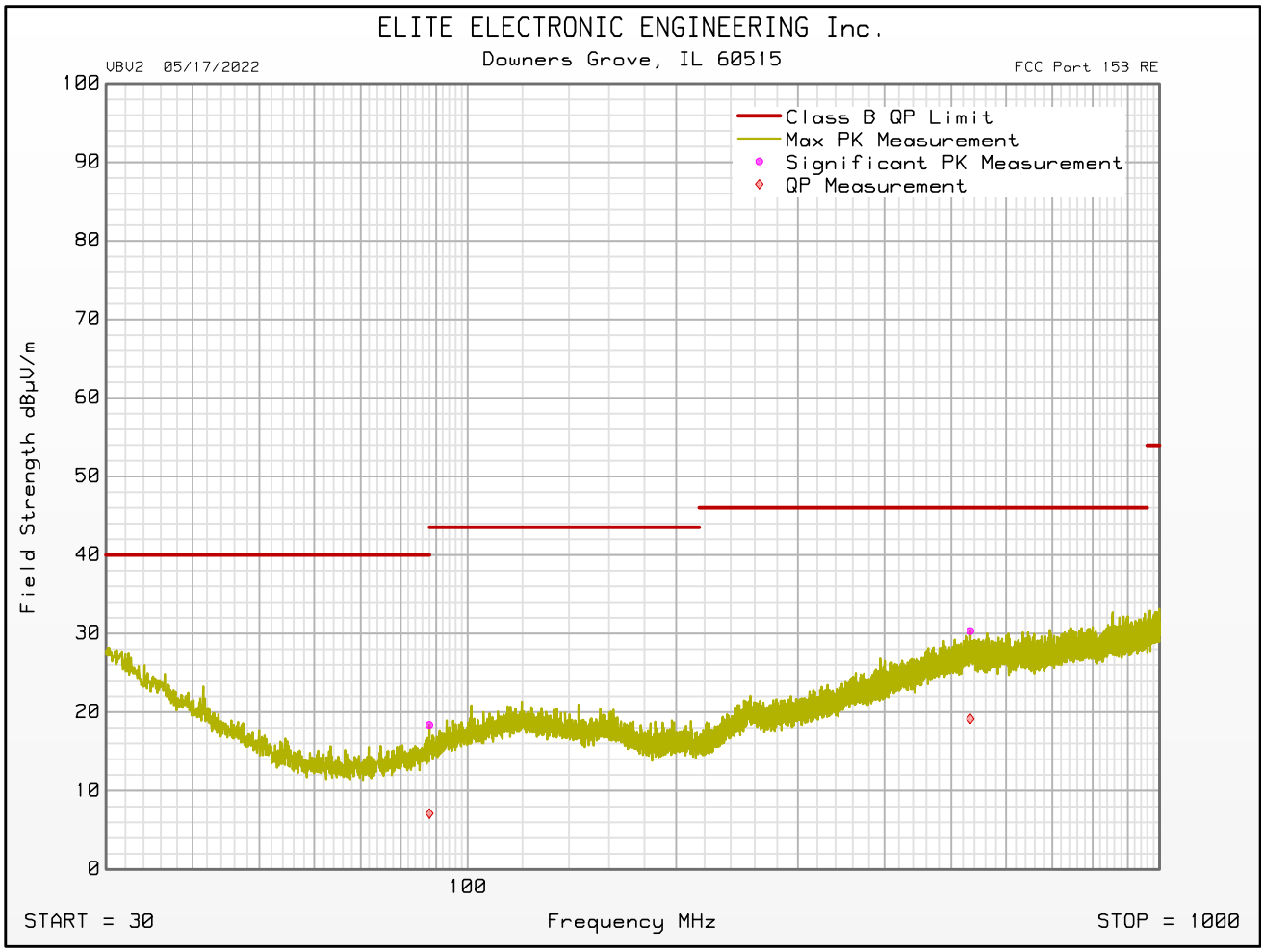
Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 904.9MHz
Scan Type	:	Stepped Scan
Test RBW	:	120 kHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 11:50:37 AM

Freq MHz	Peak Mtr Rdg dBuV	QP Mtr Rdg dBuV	Ant Fac dB/m	Amp Fac dB	Cbl Fac dB	Dist Corr dB	Peak Total dBµV/m	QP Total dBµV/m	QP Limit dBµV/m	QP Lim Mrg dB	Ant Pol	Mast Ht cm	Azim °	Excessive QP Level
31.320	5.6	-5.2	24.2	0.0	0.5	0.0	30.2	19.5	40.0	-20.5	Vertical	200	0	
88.000	3.3	-8.0	14.6	0.0	0.5	0.0	18.4	7.1	40.0	-32.9	Horizontal	340	315	
120.040	3.3	-7.6	18.2	0.0	0.6	0.0	22.1	11.2	43.5	-32.3	Vertical	340	90	
286.020	4.3	-7.3	18.8	0.0	1.0	0.0	24.1	12.5	46.0	-33.5	Vertical	120	270	
532.560	4.0	-7.2	24.8	0.0	1.5	0.0	30.3	19.2	46.0	-26.8	Horizontal	120	180	
926.520	4.0	-6.8	26.8	0.0	2.0	0.0	32.8	21.9	46.0	-24.1	Vertical	340	0	

FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

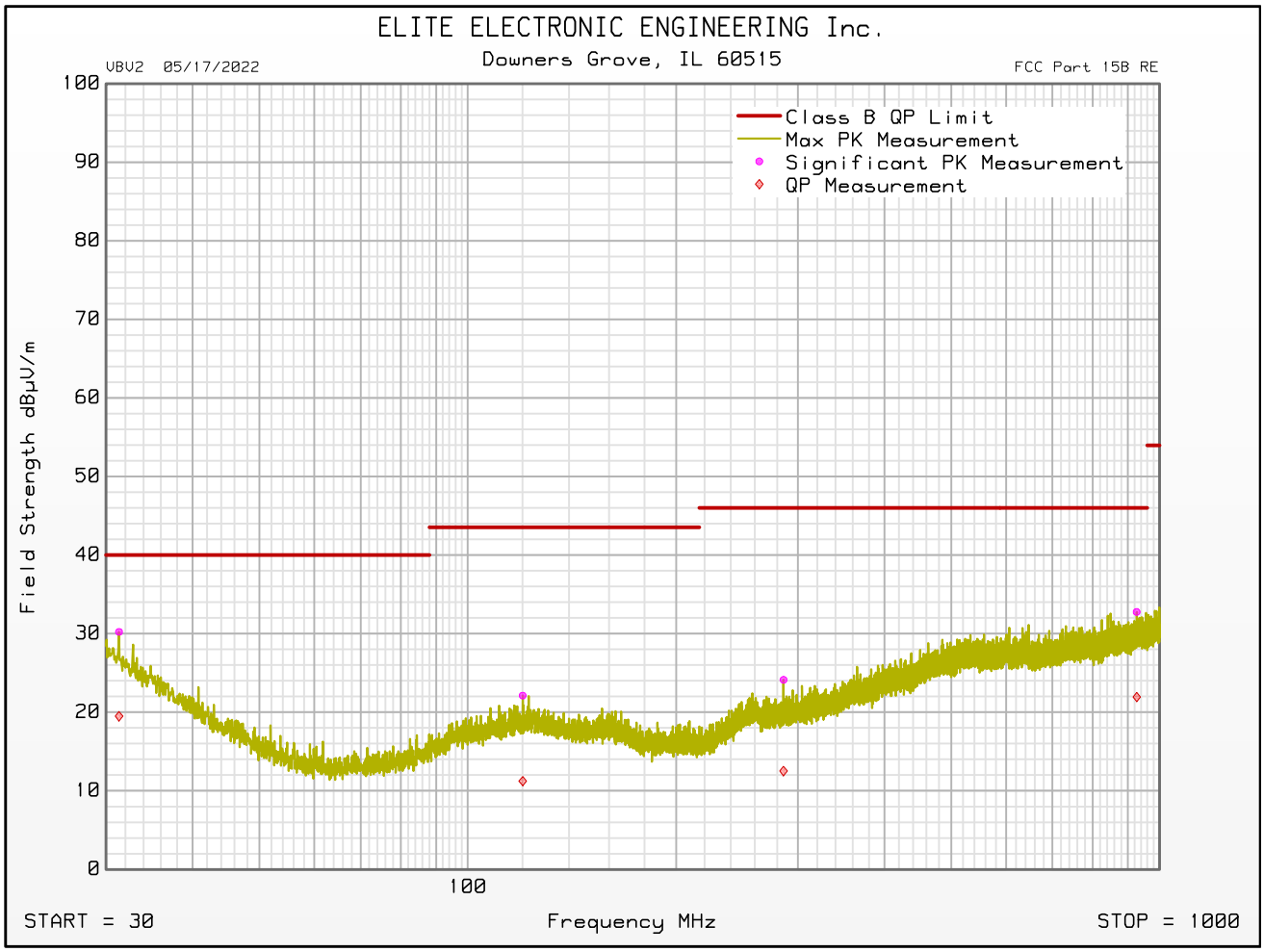
Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 904.9MHz
Antenna Polarization	:	Horizontal
Scan Type	:	Stepped Scan
Test RBW	:	120 kHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 11:50:37 AM



FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 904.9MHz
Antenna Polarization	:	Vertical
Scan Type	:	Stepped Scan
Test RBW	:	120 kHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 11:50:37 AM



FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 904.9MHz
Scan Type	:	Stepped Scan
Test RBW	:	1 MHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 09:13:22 AM

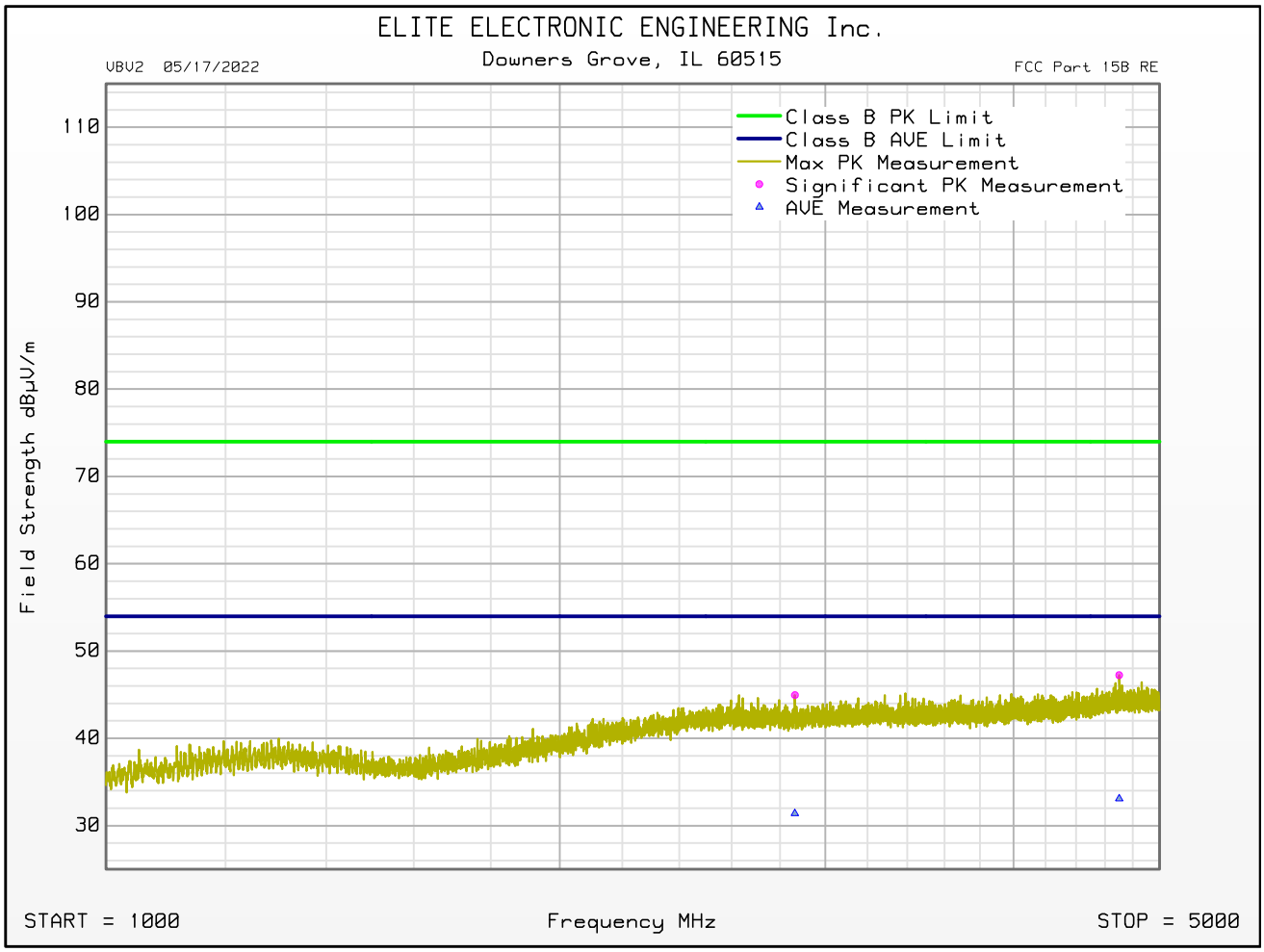
Freq MHz	Peak Mtr Rdg dBuV	Ant Fac dB/m	Amp Fac dB	Cbl Fac dB	Dist Corr dB	Peak Total dBµV/m	Peak Limit dBµV/m	Peak Lim Mrg dB	Ant Pol	Mast Ht cm	Azim °	Excessive Peak Level
1262.500	51.2	29.7	-41.9	2.3	0.0	41.3	74.0	-32.7	Vertical	120	270	
1312.000	50.6	29.7	-41.7	2.4	0.0	41.0	74.0	-33.0	Vertical	120	135	
2213.500	48.8	31.5	-40.7	3.2	0.0	42.8	74.0	-31.2	Vertical	120	225	
2864.000	49.5	32.8	-41.2	3.8	0.0	45.0	74.0	-29.0	Horizontal	120	45	
3092.500	49.1	33.0	-40.9	4.0	0.0	45.2	74.0	-28.8	Vertical	120	180	
4700.500	48.3	34.8	-40.7	4.9	0.0	47.2	74.0	-26.7	Horizontal	200	315	

Freq MHz	Average Mtr Rdg dBuV	Ant Fac dB/m	Amp Fac dB	Cbl Fac dB	Dist Corr dB	Average Total dBµV/m	Average Limit dBµV/m	Average Lim Mrg dB	Ant Pol	Mast Ht cm	Azim °	Excessive Average Level
1262.500	37.4	29.7	-41.9	2.3	0.0	27.5	54.0	-26.5	Vertical	120	270	
1312.000	37.3	29.7	-41.7	2.4	0.0	27.7	54.0	-26.3	Vertical	120	135	
2213.500	35.7	31.5	-40.7	3.2	0.0	29.7	54.0	-24.2	Vertical	120	225	
2864.000	35.9	32.8	-41.2	3.8	0.0	31.4	54.0	-22.6	Horizontal	120	45	
3092.500	35.3	33.0	-40.9	4.0	0.0	31.3	54.0	-22.6	Vertical	120	180	
4700.500	34.2	34.8	-40.7	4.9	0.0	33.1	54.0	-20.9	Horizontal	200	315	

FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

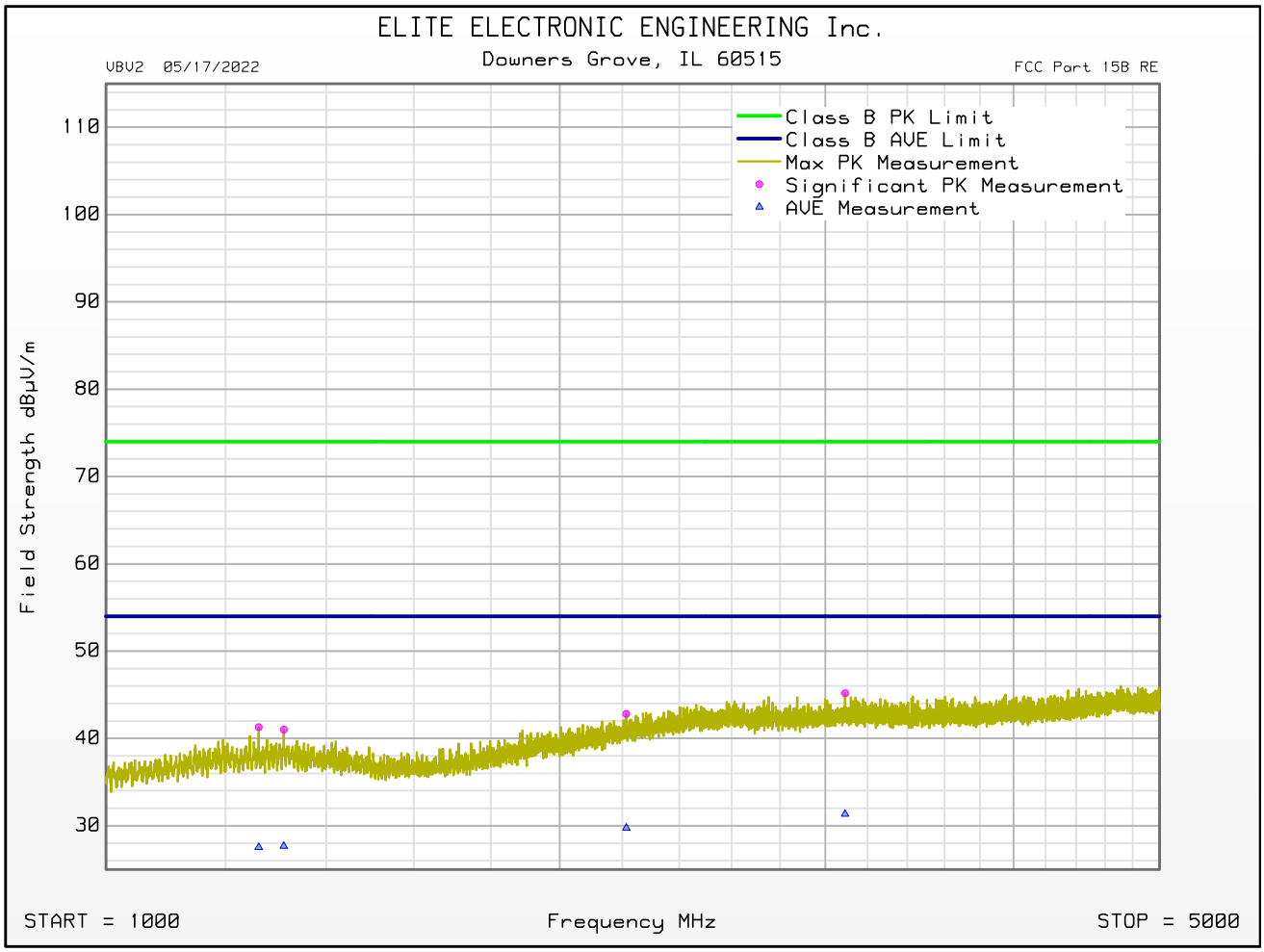
Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 904.9MHz
Antenna Polarization	:	Horizontal
Scan Type	:	Stepped Scan
Test RBW	:	1 MHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 09:13:22 AM



FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 904.9MHz
Antenna Polarization	:	Vertical
Scan Type	:	Stepped Scan
Test RBW	:	1 MHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 09:13:22 AM



FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

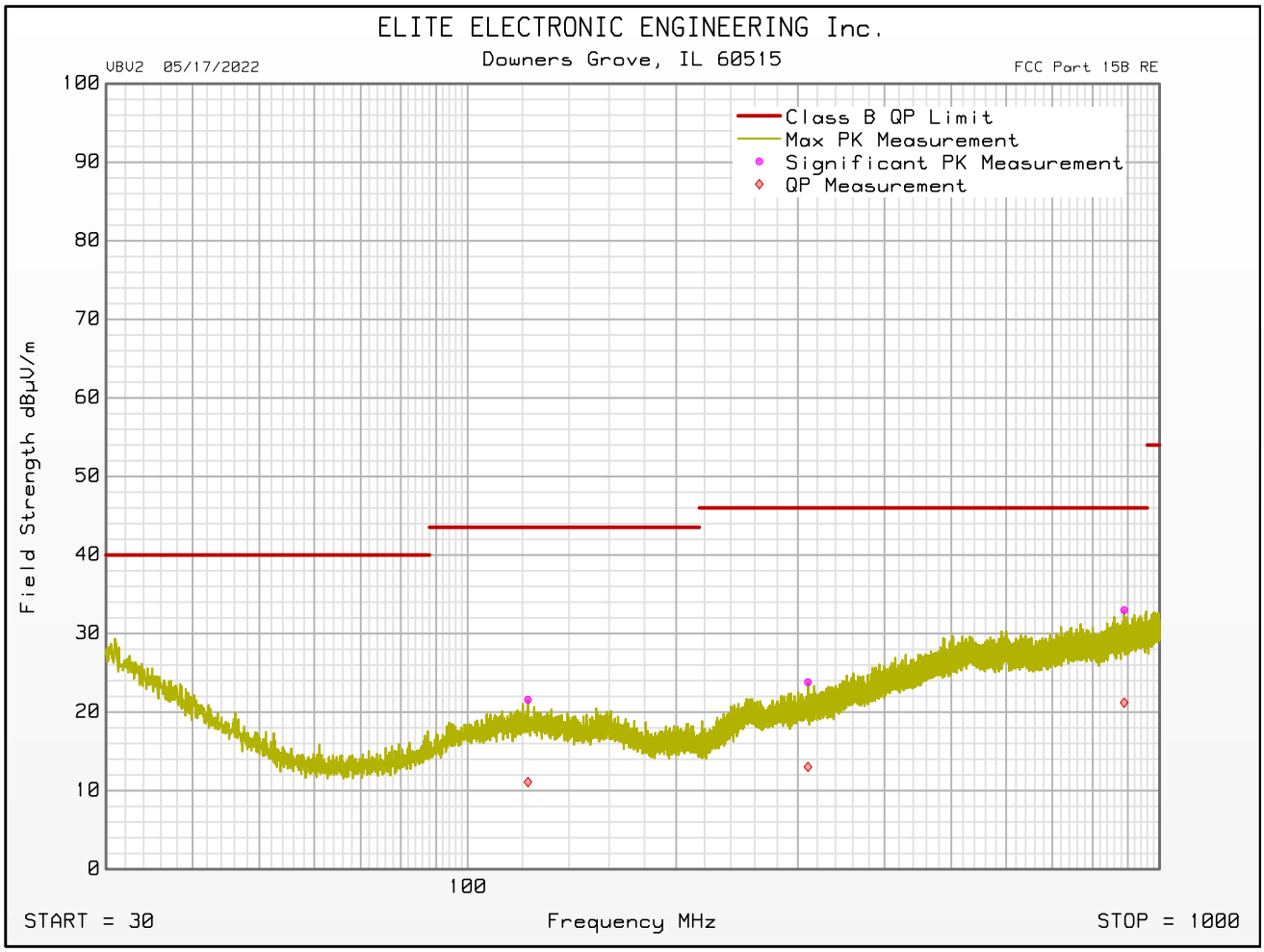
Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 914.08MHz
Scan Type	:	Stepped Scan
Test RBW	:	120 kHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 12:50:48 PM

Freq MHz	Peak Mtr Rdg dBuV	QP Mtr Rdg dBuV	Ant Fac dB/m	Amp Fac dB	Cbl Fac dB	Dist Corr dB	Peak Total dBµV/m	QP Total dBµV/m	QP Limit dBµV/m	QP Lim Mrg dB	Ant Pol	Mast Ht cm	Azim °	Excessive QP Level
31.260	4.9	-5.3	24.2	0.0	0.5	0.0	29.6	19.4	40.0	-20.6	Vertical	120	0	
87.060	3.7	-7.8	14.4	0.0	0.5	0.0	18.5	7.1	40.0	-32.9	Vertical	120	0	
122.140	2.7	-7.8	18.3	0.0	0.6	0.0	21.6	11.1	43.5	-32.4	Horizontal	200	180	
310.260	3.4	-7.4	19.3	0.0	1.1	0.0	23.8	13.0	46.0	-33.0	Horizontal	120	135	
527.460	4.3	-7.0	24.8	0.0	1.5	0.0	30.5	19.2	46.0	-26.8	Vertical	120	270	
888.840	4.4	-7.4	26.6	0.0	2.0	0.0	33.0	21.2	46.0	-24.8	Horizontal	340	45	

FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

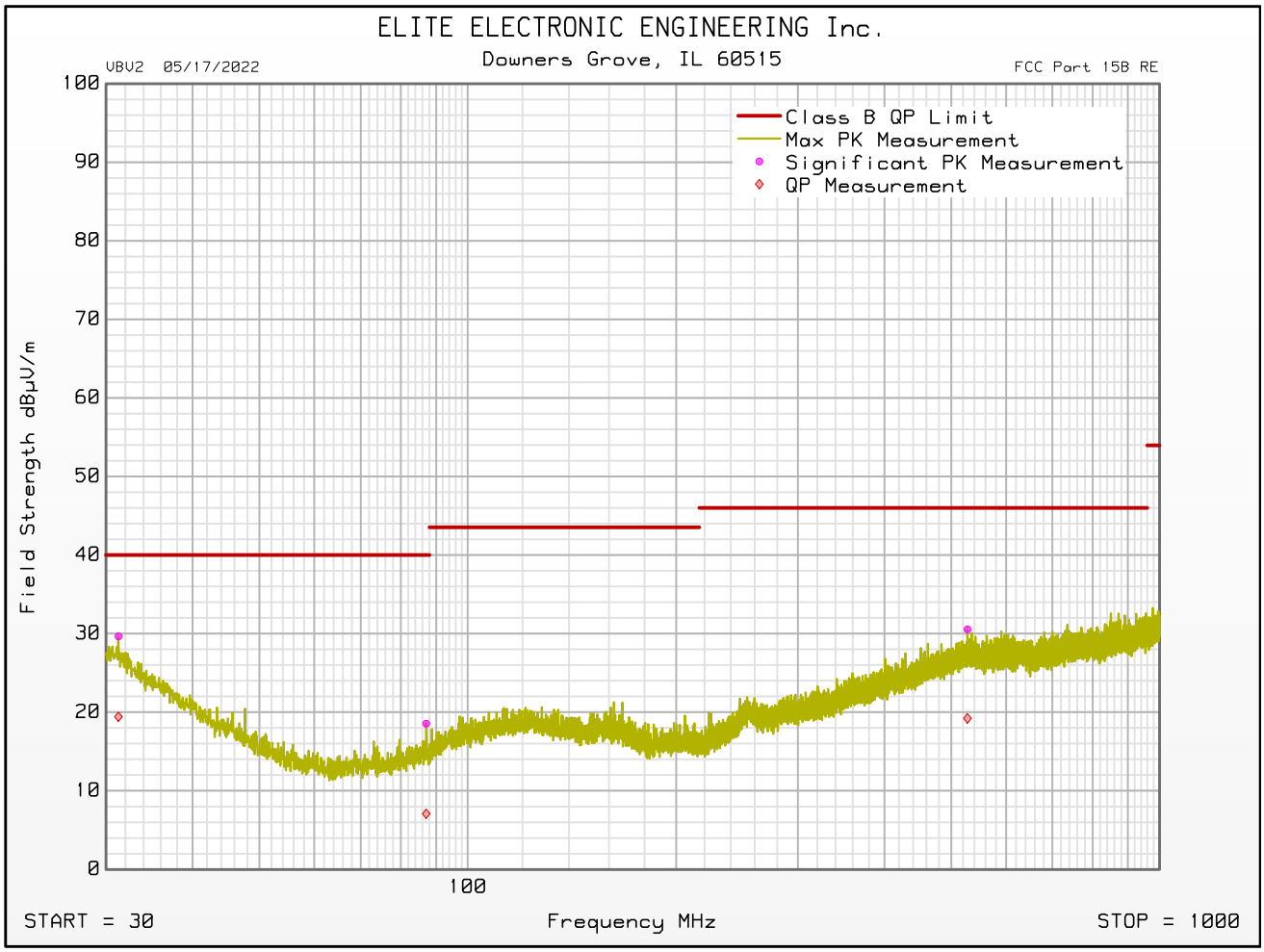
Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 914.08MHz
Antenna Polarization	:	Horizontal
Scan Type	:	Stepped Scan
Test RBW	:	120 kHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 12:50:48 PM



FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 914.08MHz
Antenna Polarization	:	Vertical
Scan Type	:	Stepped Scan
Test RBW	:	120 kHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 12:50:48 PM



FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 914.08MHz
Scan Type	:	Stepped Scan
Test RBW	:	1 MHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 09:34:03 AM

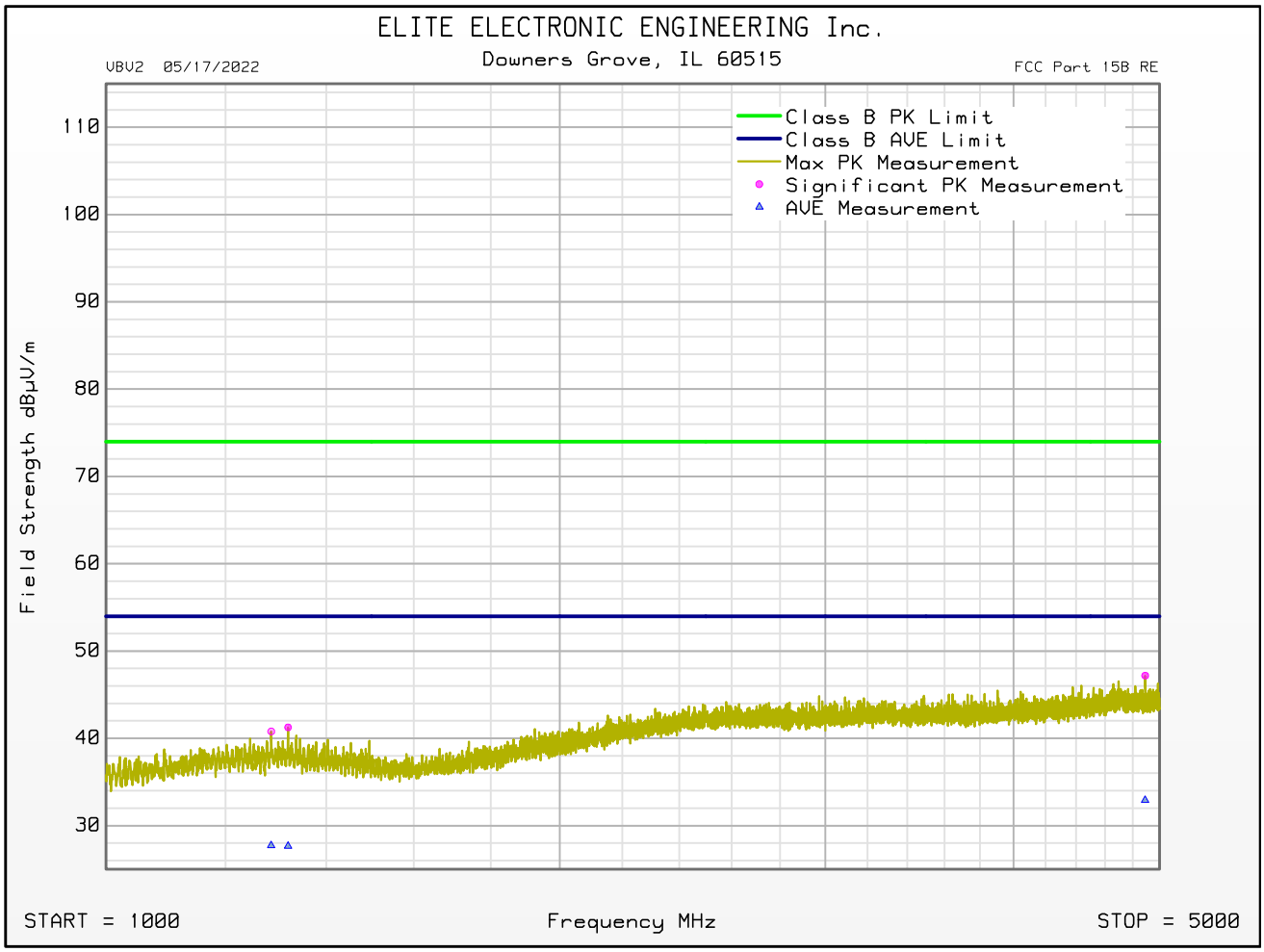
Freq MHz	Peak Mtr Rdg dBuV	Ant Fac dB/m	Amp Fac dB	Cbl Fac dB	Dist Corr dB	Peak Total dBµV/m	Peak Limit dBµV/m	Peak Lim Mrg dB	Ant Pol	Mast Ht cm	Azim °	Excessive Peak Level
1287.000	50.5	29.7	-41.8	2.4	0.0	40.8	74.0	-33.2	Horizontal	120	225	
1320.500	50.9	29.6	-41.7	2.4	0.0	41.3	74.0	-32.7	Horizontal	200	180	
2203.500	50.2	31.4	-40.6	3.2	0.0	44.2	74.0	-29.8	Vertical	120	0	
2544.000	49.7	33.1	-41.3	3.5	0.0	45.1	74.0	-28.9	Vertical	120	180	
3236.500	49.8	33.0	-40.7	4.1	0.0	46.2	74.0	-27.8	Vertical	200	270	
4891.000	48.3	34.6	-40.6	5.0	0.0	47.2	74.0	-26.8	Horizontal	200	315	

Freq MHz	Average Mtr Rdg dBuV	Ant Fac dB/m	Amp Fac dB	Cbl Fac dB	Dist Corr dB	Average Total dBµV/m	Average Limit dBµV/m	Average Lim Mrg dB	Ant Pol	Mast Ht cm	Azim °	Excessive Average Level
1287.000	37.4	29.7	-41.8	2.4	0.0	27.7	54.0	-26.2	Horizontal	120	225	
1320.500	37.3	29.6	-41.7	2.4	0.0	27.7	54.0	-26.3	Horizontal	200	180	
2203.500	35.7	31.4	-40.6	3.2	0.0	29.7	54.0	-24.3	Vertical	120	0	
2544.000	35.4	33.1	-41.3	3.5	0.0	30.8	54.0	-23.2	Vertical	120	180	
3236.500	35.1	33.0	-40.7	4.1	0.0	31.5	54.0	-22.5	Vertical	200	270	
4891.000	34.0	34.6	-40.6	5.0	0.0	32.9	54.0	-21.1	Horizontal	200	315	

FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

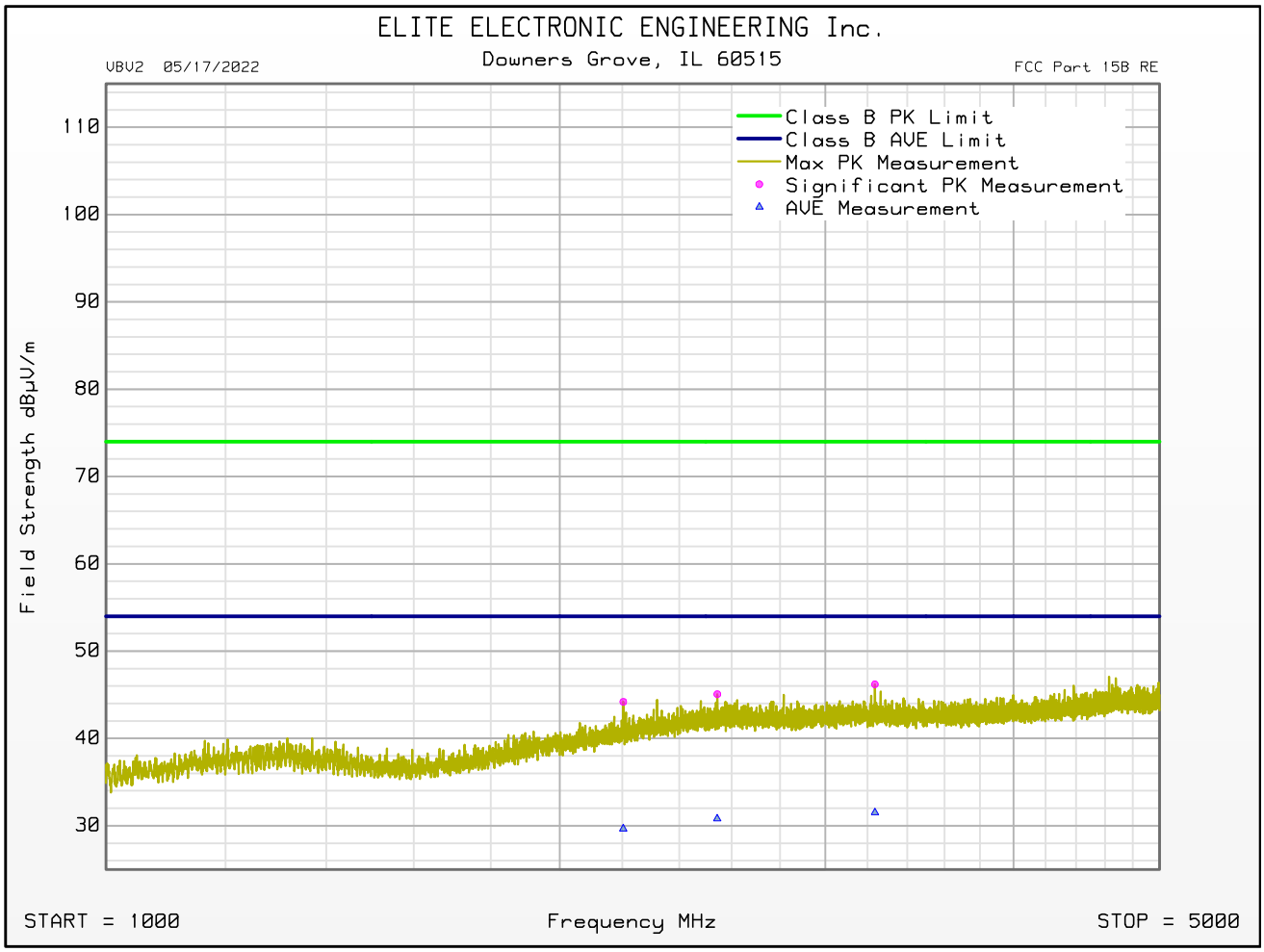
Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 914.08MHz
Antenna Polarization	:	Horizontal
Scan Type	:	Stepped Scan
Test RBW	:	1 MHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 09:34:03 AM



FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 914.08MHz
Antenna Polarization	:	Vertical
Scan Type	:	Stepped Scan
Test RBW	:	1 MHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 09:34:03 AM



FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

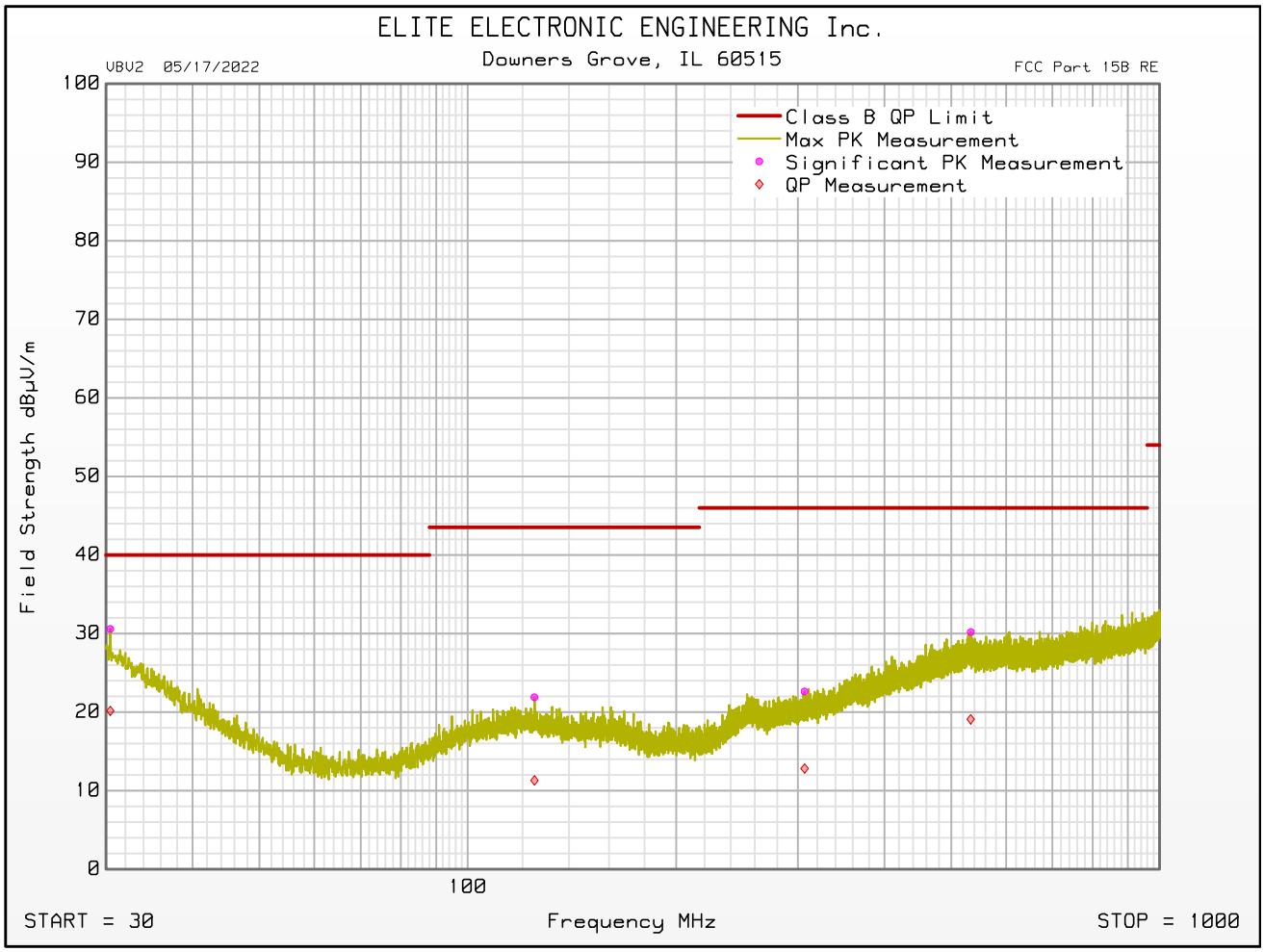
Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 923.7MHz
Scan Type	:	Stepped Scan
Test RBW	:	120 kHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 02:00:49 PM

Freq MHz	Peak Mtr Rdg dBuV	QP Mtr Rdg dBuV	Ant Fac dB/m	Amp Fac dB	Cbl Fac dB	Dist Corr dB	Peak Total dBµV/m	QP Total dBµV/m	QP Limit dBµV/m	QP Lim Mrg dB	Ant Pol	Mast Ht cm	Azim °	Excessive QP Level
30.420	5.4	-5.1	24.7	0.0	0.5	0.0	30.6	20.2	40.0	-19.8	Horizontal	340	90	
86.160	3.0	-7.8	14.2	0.0	0.5	0.0	17.7	6.9	40.0	-33.1	Vertical	120	135	
124.840	3.1	-7.5	18.2	0.0	0.7	0.0	21.9	11.3	43.5	-32.2	Horizontal	120	270	
306.720	2.3	-7.5	19.3	0.0	1.0	0.0	22.6	12.8	46.0	-33.2	Horizontal	200	315	
533.340	3.9	-7.2	24.8	0.0	1.5	0.0	30.2	19.1	46.0	-26.9	Horizontal	200	180	
940.320	4.5	-6.9	27.0	0.0	2.0	0.0	33.5	22.0	46.0	-24.0	Vertical	200	135	

FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

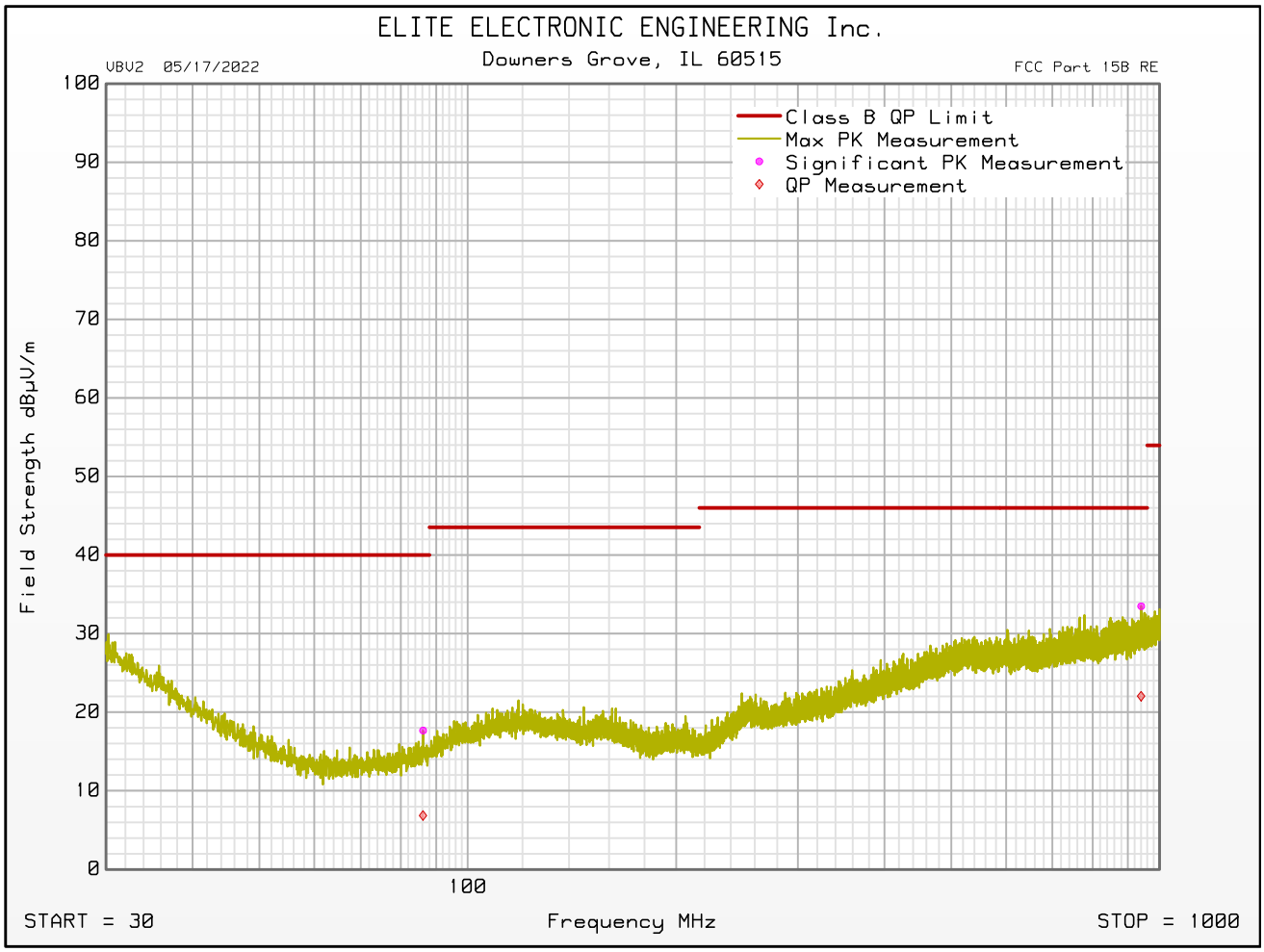
Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 923.7MHz
Antenna Polarization	:	Horizontal
Scan Type	:	Stepped Scan
Test RBW	:	120 kHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 02:00:49 PM



FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 923.7MHz
Antenna Polarization	:	Vertical
Scan Type	:	Stepped Scan
Test RBW	:	120 kHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 02:00:49 PM



FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 923.7MHz
Scan Type	:	Stepped Scan
Test RBW	:	1 MHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 10:42:50 AM

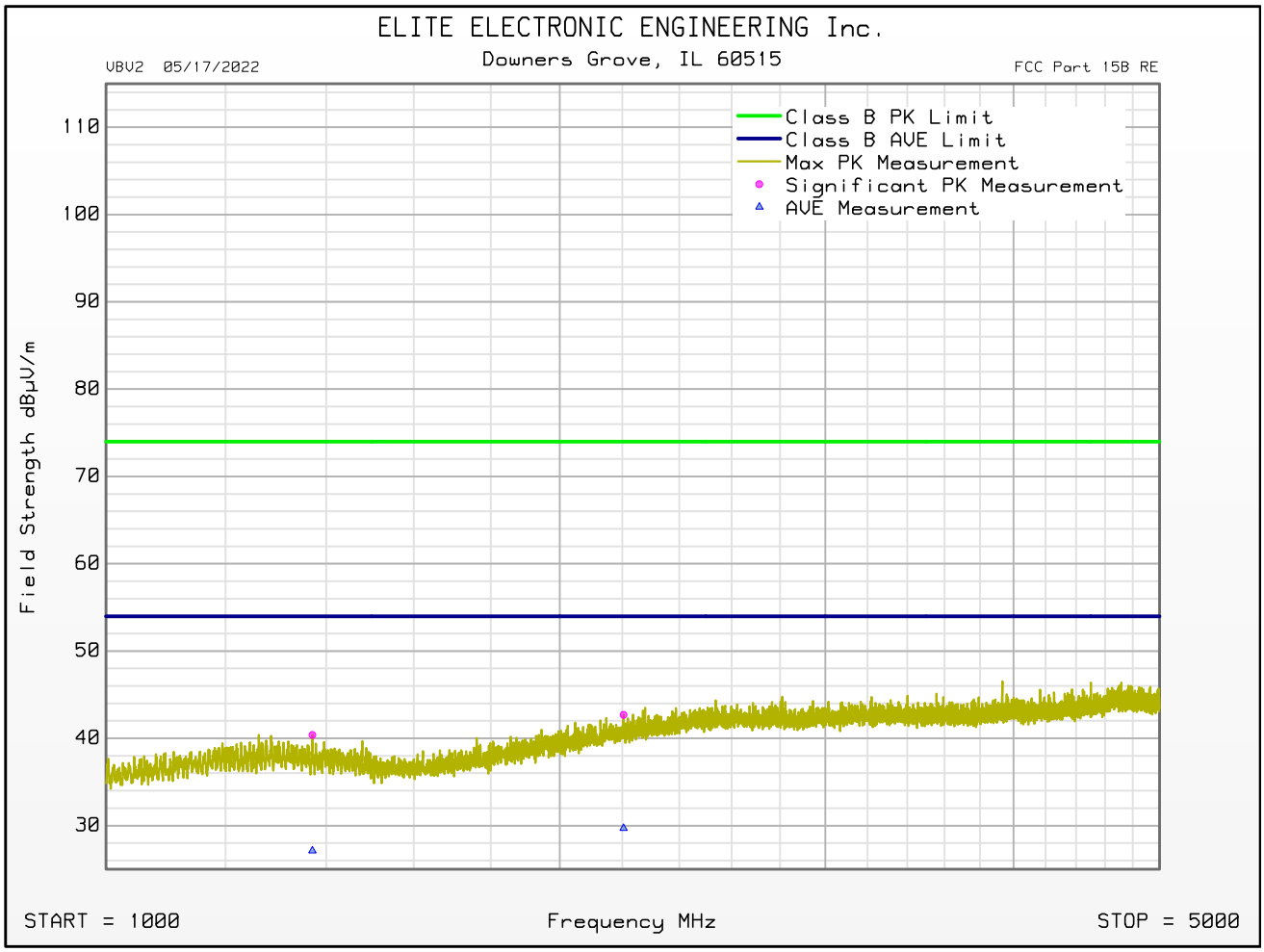
Freq MHz	Peak Mtr Rdg dBuV	Ant Fac dB/m	Amp Fac dB	Cbl Fac dB	Dist Corr dB	Peak Total dBµV/m	Peak Limit dBµV/m	Peak Lim Mrg dB	Ant Pol	Mast Ht cm	Azim °	Excessive Peak Level
1211.500	50.9	29.5	-42.1	2.3	0.0	40.6	74.0	-33.4	Vertical	120	225	
1370.500	50.1	29.3	-41.5	2.5	0.0	40.4	74.0	-33.6	Horizontal	340	90	
2204.500	48.7	31.4	-40.6	3.2	0.0	42.7	74.0	-31.3	Horizontal	340	270	
2687.000	49.7	33.1	-41.4	3.6	0.0	45.0	74.0	-28.9	Vertical	120	0	
3636.500	48.6	33.2	-40.4	4.3	0.0	45.7	74.0	-28.3	Vertical	340	270	
4547.500	48.1	34.3	-40.5	4.8	0.0	46.8	74.0	-27.2	Vertical	200	135	

Freq MHz	Average Mtr Rdg dBuV	Ant Fac dB/m	Amp Fac dB	Cbl Fac dB	Dist Corr dB	Average Total dBµV/m	Average Limit dBµV/m	Average Lim Mrg dB	Ant Pol	Mast Ht cm	Azim °	Excessive Average Level
1211.500	37.4	29.5	-42.1	2.3	0.0	27.1	54.0	-26.9	Vertical	120	225	
1370.500	36.8	29.3	-41.5	2.5	0.0	27.1	54.0	-26.9	Horizontal	340	90	
2204.500	35.7	31.4	-40.6	3.2	0.0	29.7	54.0	-24.3	Horizontal	340	270	
2687.000	35.7	33.1	-41.4	3.6	0.0	31.1	54.0	-22.9	Vertical	120	0	
3636.500	34.2	33.2	-40.4	4.3	0.0	31.3	54.0	-22.7	Vertical	340	270	
4547.500	34.1	34.3	-40.5	4.8	0.0	32.8	54.0	-21.2	Vertical	200	135	

FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

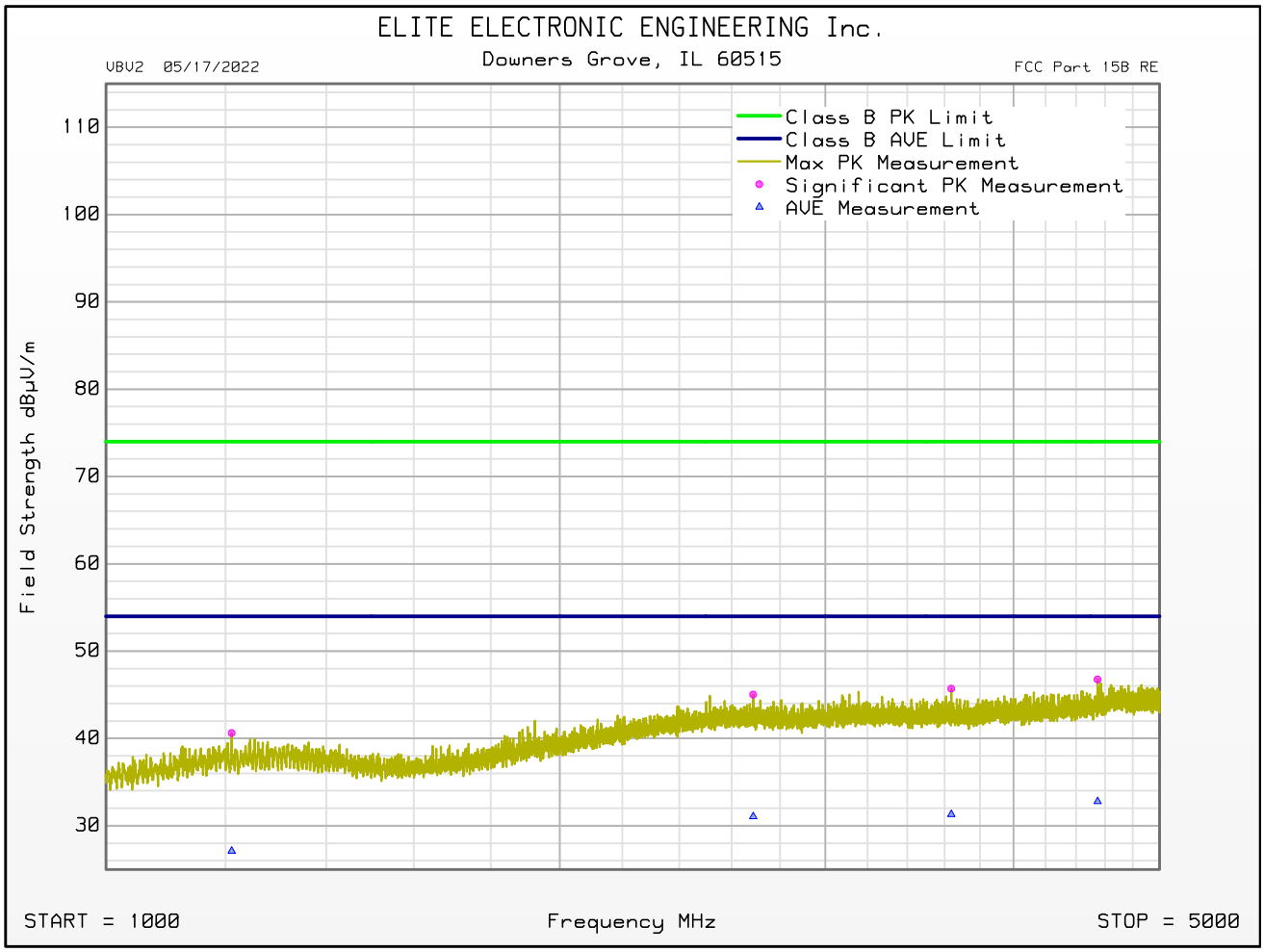
Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 923.7MHz
Antenna Polarization	:	Horizontal
Scan Type	:	Stepped Scan
Test RBW	:	1 MHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 10:42:50 AM



FCC Part 15B
Radiated RF Emissions Test

SW ID/Rev: VBV2 05/17/2022

Manufacturer	:	Badger Meter
Model	:	Orion Mobile M
Serial Number	:	60000115
DUT Mode	:	Receive at 923.7MHz
Antenna Polarization	:	Vertical
Scan Type	:	Stepped Scan
Test RBW	:	1 MHz
Prelim Dwell Time (s)	:	0.0001
Notes	:	
Test Engineer	:	M. Longinotti
Test Date	:	Jun 23, 2022 10:42:50 AM



21. 20dB Bandwidth

EUT Information	
Manufacturer	Badger Meter
Product	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 904.9MHz Transmit at 914.08MHz Transmit at 923.7MHz

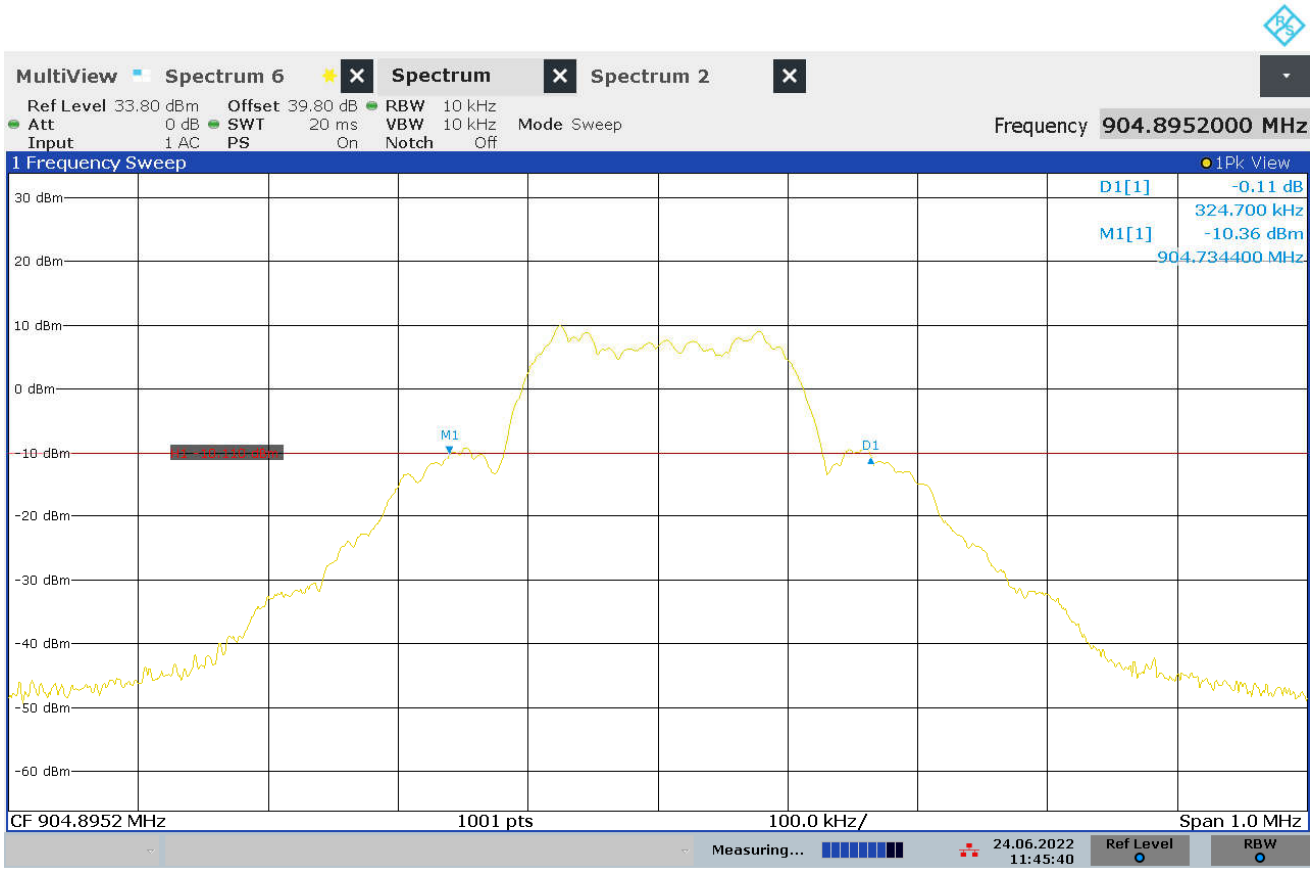
Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop
Test Site Used	N/A
Notes	

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

Requirements
Systems using frequency hopping techniques operating in the 902 – 928MHz band are allowed a maximum 20dB bandwidth of 500kHz.

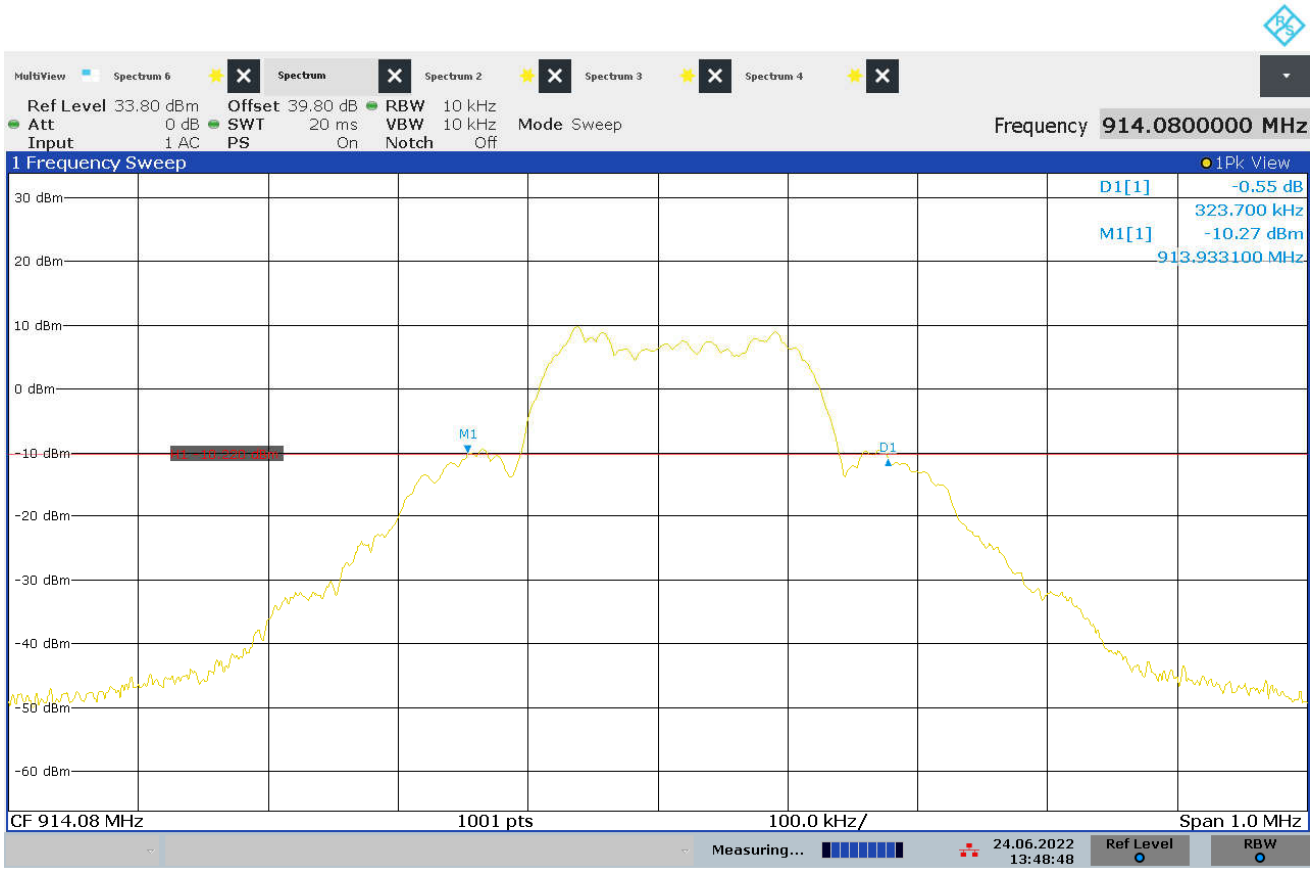
Procedure
The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function disabled, the EUT was allowed to transmit continuously. The frequency hopping channel was set separately to low, middle, and high hopping channels. The resolution bandwidth (RBW) was set to ≥ 1% of the 20dB BW. The span was set to approximately 2 to 3 times the 20dB bandwidth. 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 then screenshot and saved.

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 904.9MHz
Date Tested	June 24, 2022
Result	20dB BW = 324.7kHz
Notes	



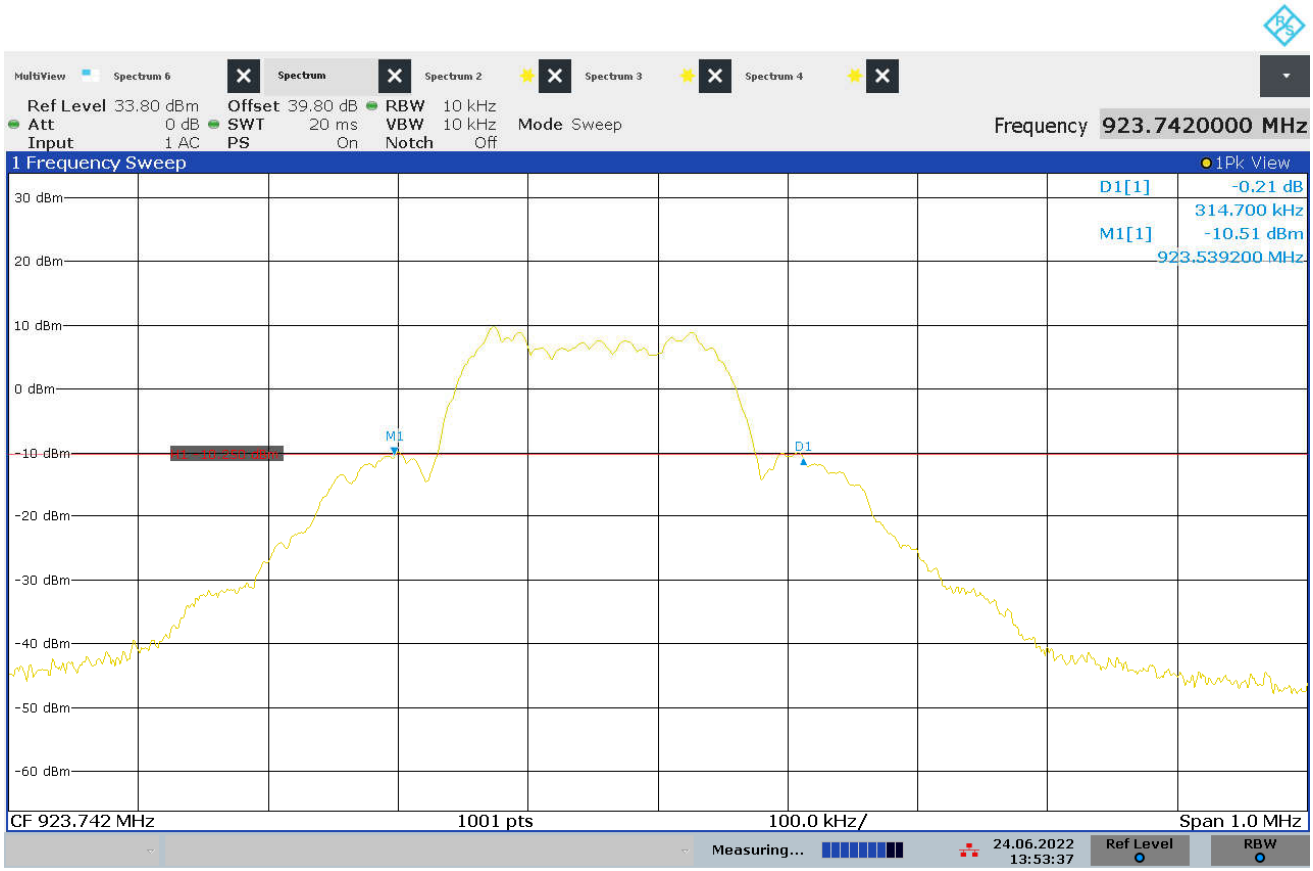
11:45:40 24.06.2022

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 914.08MHz
Date Tested	June 24, 2022
Result	20dB BW = 323.7kHz
Notes	



13:48:49 24.06.2022

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 923.7MHz
Date Tested	June 24, 2022
Result	20dB BW = 314.7kHz
Notes	



13:53:38 24.06.2022

22. Occupied Bandwidth (99%)

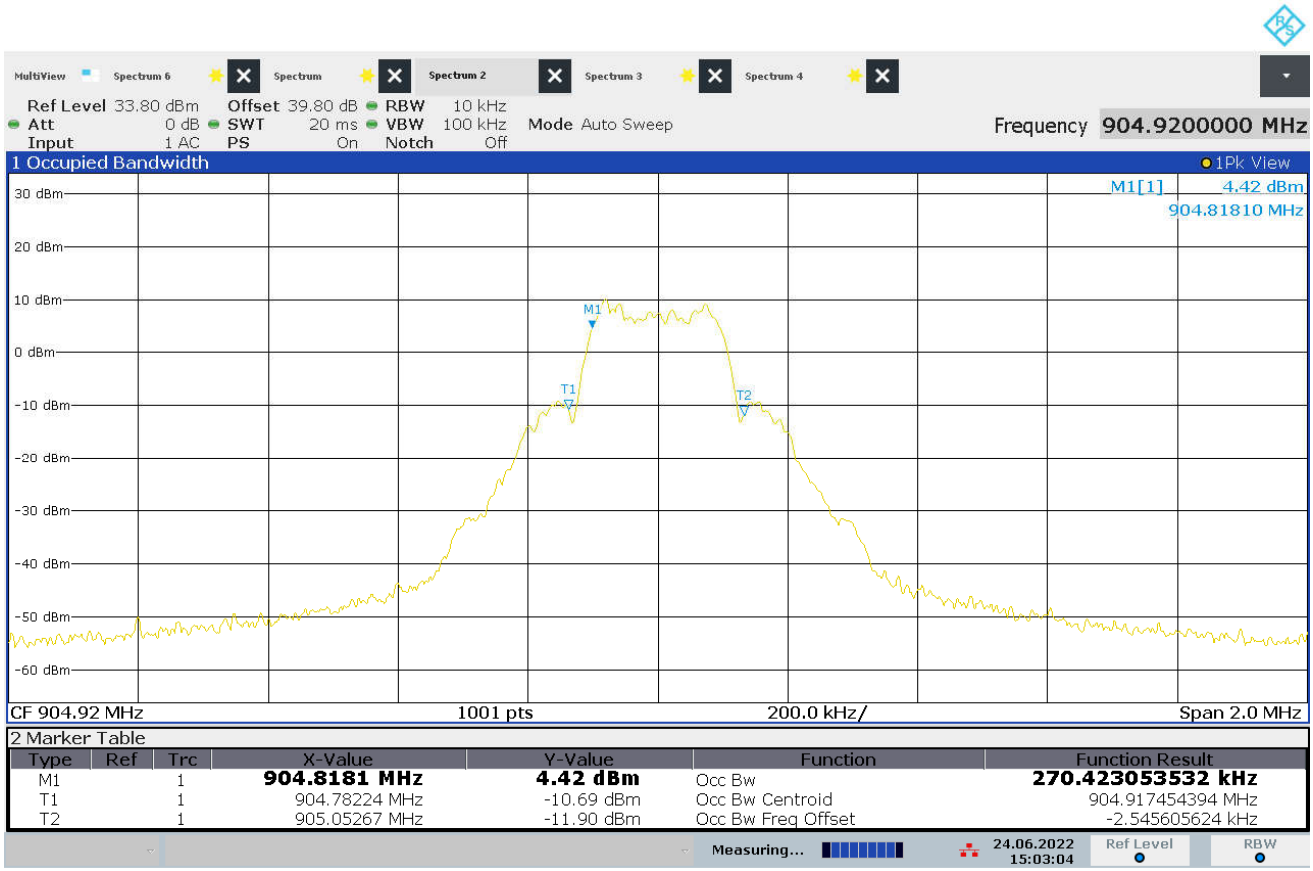
EUT Information	
Manufacturer	Badger Meter
Product	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 904.9MHz Transmit at 914.08MHz Transmit at 923.7MHz

Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop
Test Site Used	N/A
Notes	

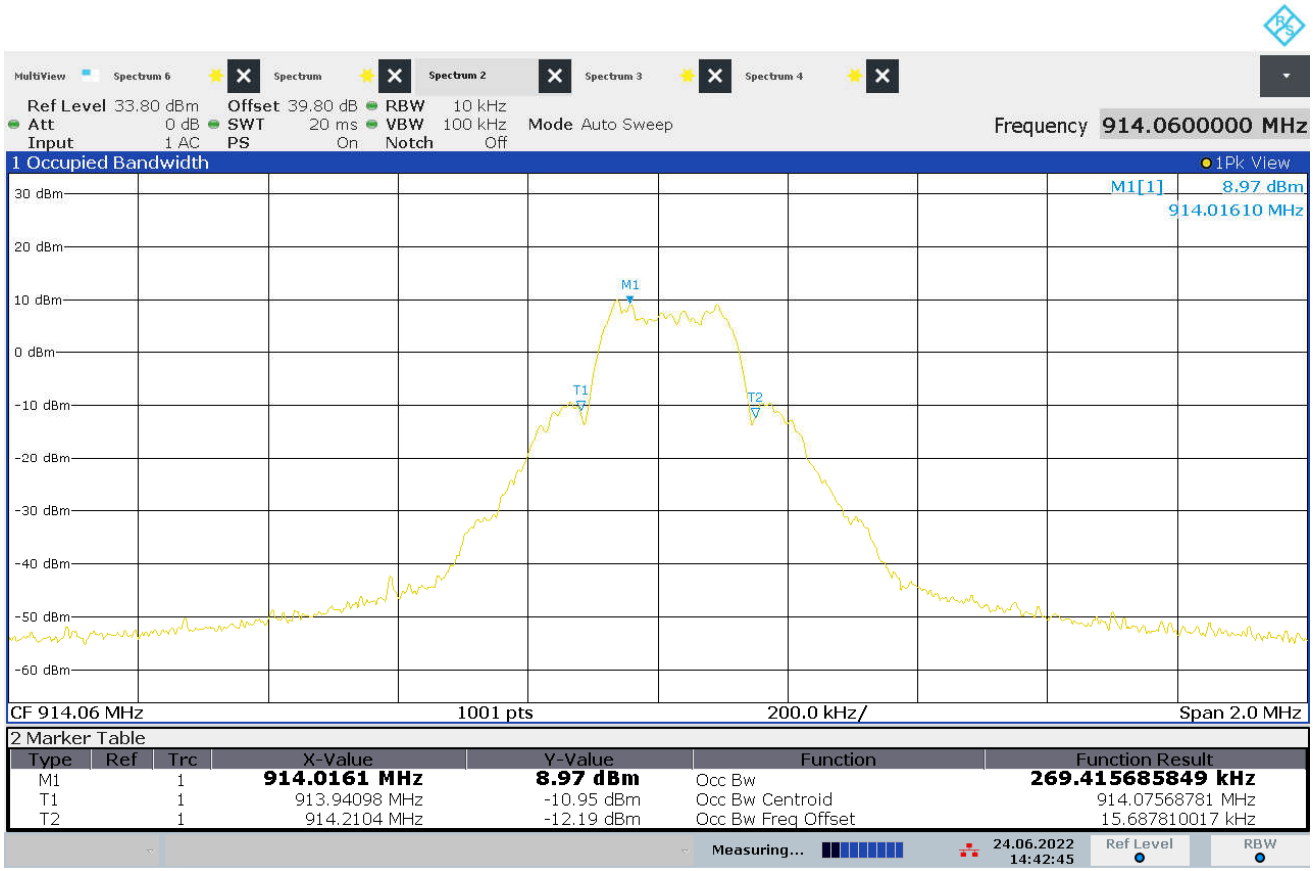
Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz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

Procedure
The antenna port of the EUT was connected to the spectrum analyzer through 40dB 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.

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 904.9MHz
Date Tested	June 24, 2022
Result	OBW = 270.4kHz
Notes	

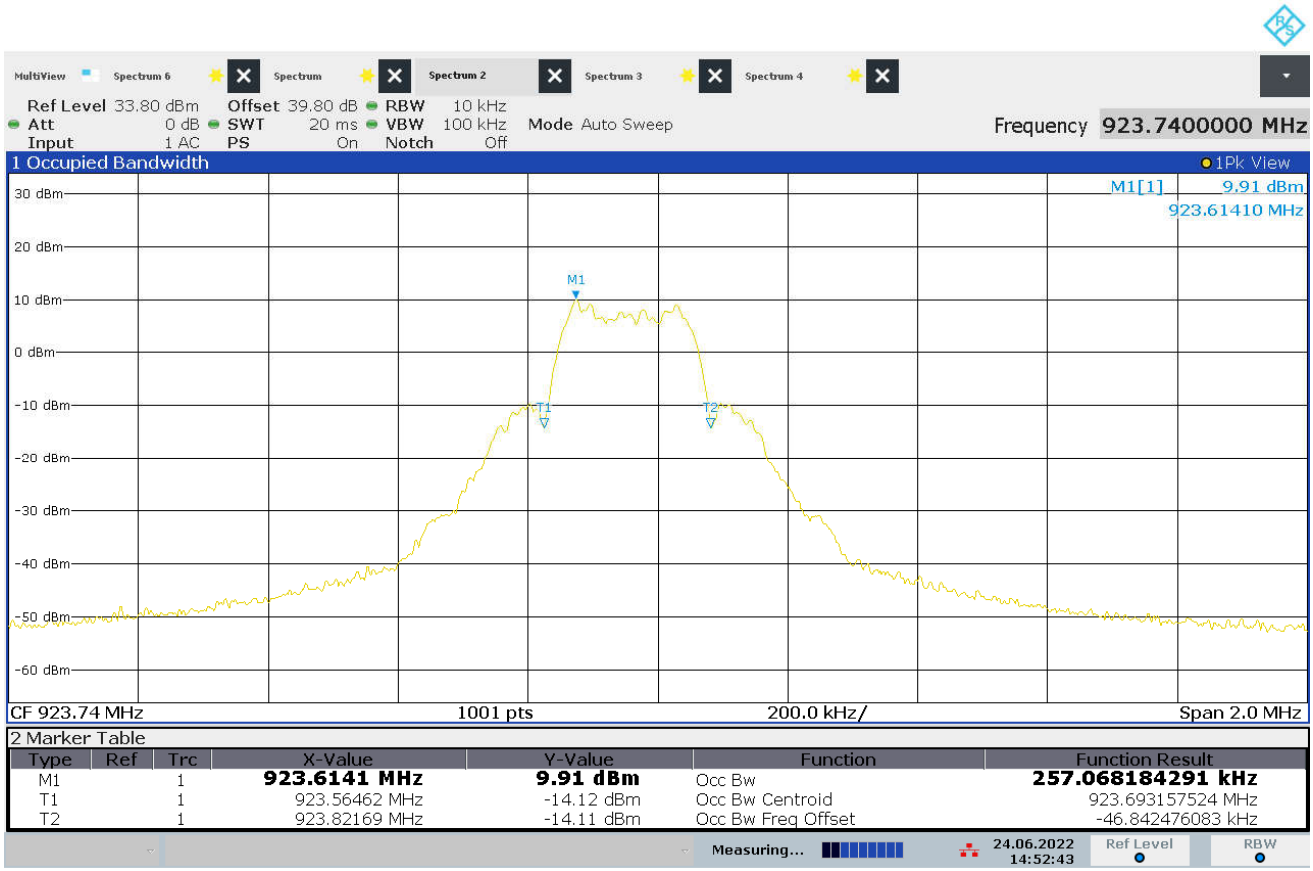


Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 914.08MHz
Date Tested	June 24, 2022
Result	OBW = 269.4kHz
Notes	



14:42:46 24.06.2022

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 923.7MHz
Date Tested	June 24, 2022
Result	OBW = 257.1kHz
Notes	



14:52:44 24.06.2022

23. Carrier Frequency Separation

EUT Information	
Manufacturer	Badger Meter
Product	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Hopping Enabled

Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop
Test Site Used	N/A
Notes	

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

Requirement
Channel carrier frequencies shall be separated by a minimum of 25kHz or the 20dB bandwidth, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5MHz band may have hopping channel carrier frequencies that are separated by 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW.

Procedure
The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously. Span was set wide enough to capture the peaks of two adjacent channels. The resolution bandwidth was set to approximately 30% of the channel spacing. The peak detector and 'Max-Hold' function were engaged. The span was set wide enough to capture the peaks of at least two adjacent channels. When the trace had stabilized after multiple scans, the marker-delta function was used to determine the separation between the peaks of the adjacent channels. The analyzer's display was plotted using a 'screen dump' utility.

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Hopping Enabled
Date Tested	June 24, 2022
Result	Separation = 400.6kHz
Notes	

13:33:47 24.06.2022

24. Number of Carrier Channels

EUT Information	
Manufacturer	Badger Meter
Product	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Hopping Enabled

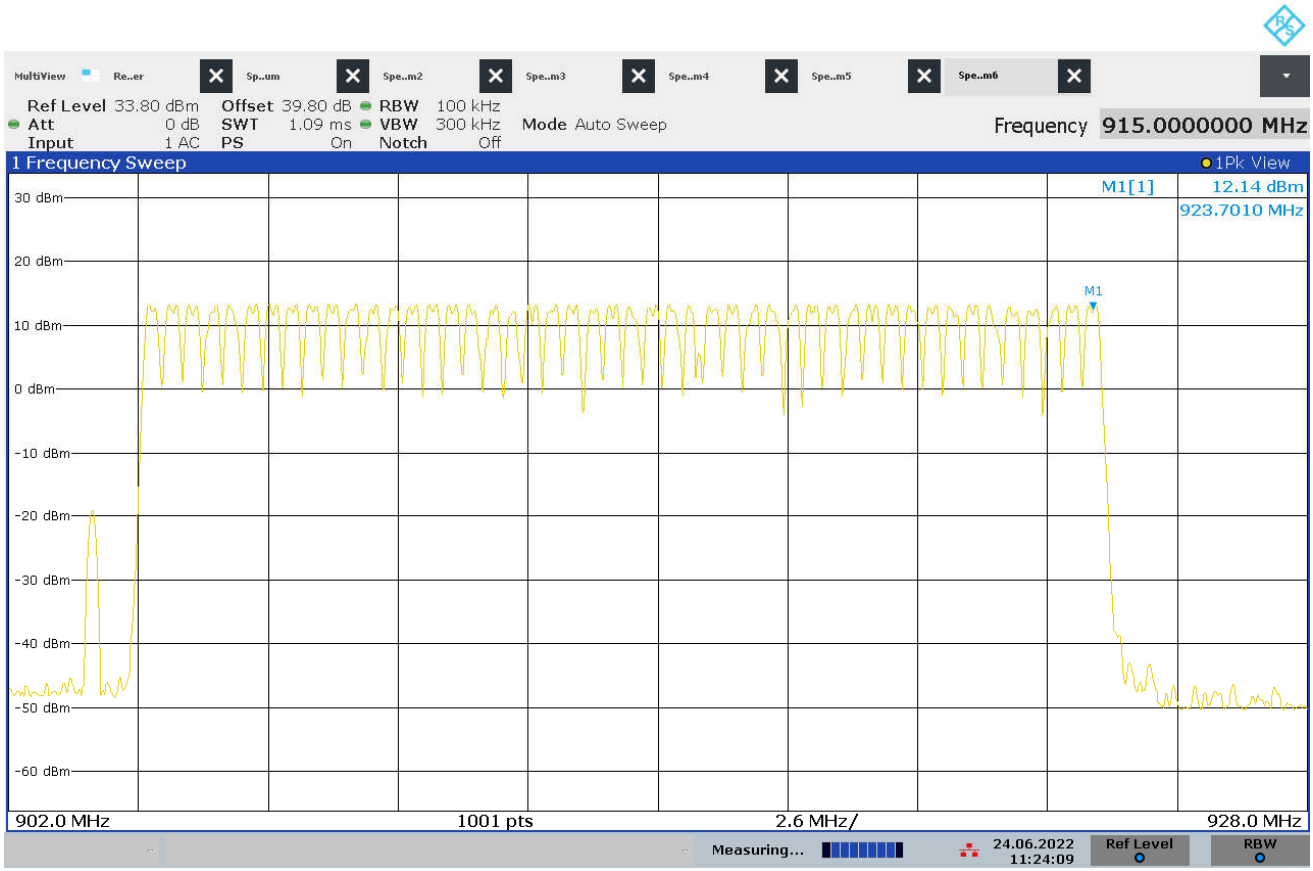
Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop
Test Site Used	N/A
Notes	

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

Requirements
FOR 902-928 MHz, 20dB BW ≥ 250kHz The system shall use at least 25 hopping frequencies.

Procedure
The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously. The resolution bandwidth (RBW) was set to less than 30% of the channel spacing or the 20dB bandwidth, whichever is smaller. The peak detector and 'Max-Hold' function were engaged. The span was set wide enough to capture the entire frequency band of operation. The EUT's signal was allowed to stabilize after multiple scans. The number of hopping frequencies was counted. The analyzer's display was plotted using a 'screen dump' utility.

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Hopping Enabled
Date Tested	June 24, 2022
Result	48 hopping frequencies
Notes	



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25. Average Time of Occupancy

EUT Information	
Manufacturer	Badger Meter
Product	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Hopping Enabled

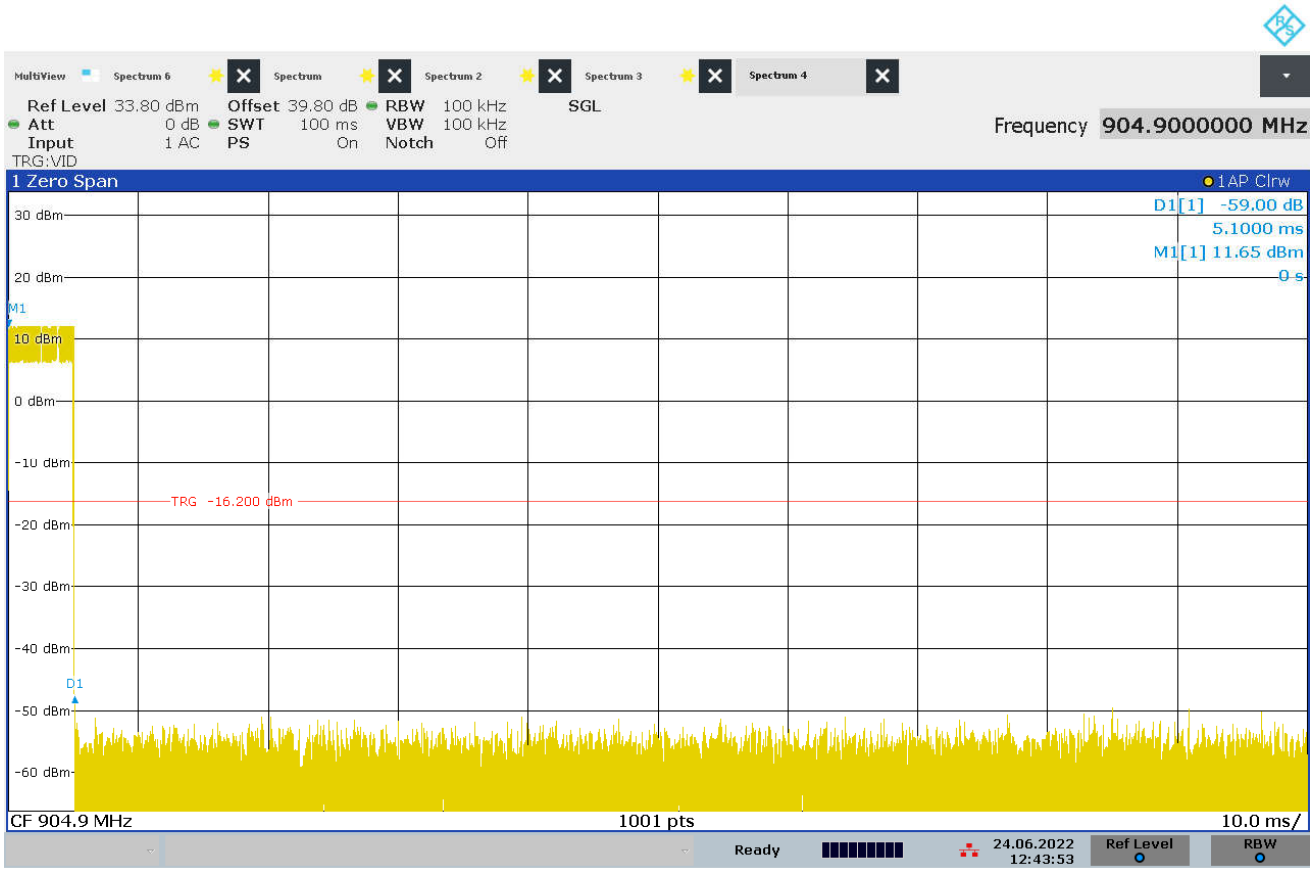
Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop
Test Site Used	N/A
Notes	

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

Requirements
For 902-928 MHz, 20dB BW ≥ 250kHz The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

Procedure
The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously. The spectrum analyzer was set to zero span centered on a hopping channel. The resolution bandwidth (RBW) was set ≥ to the channel spacing. The sweep was set to capture the entire dwell time per hopping channel. The peak detector and 'Max-Hold' function were engaged. The analyzer's display was plotted using a 'screen dump' utility.

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Hopping Enabled
Date Tested	June 24, 2022
Result	Pulse Length = 5.1msec
Notes	



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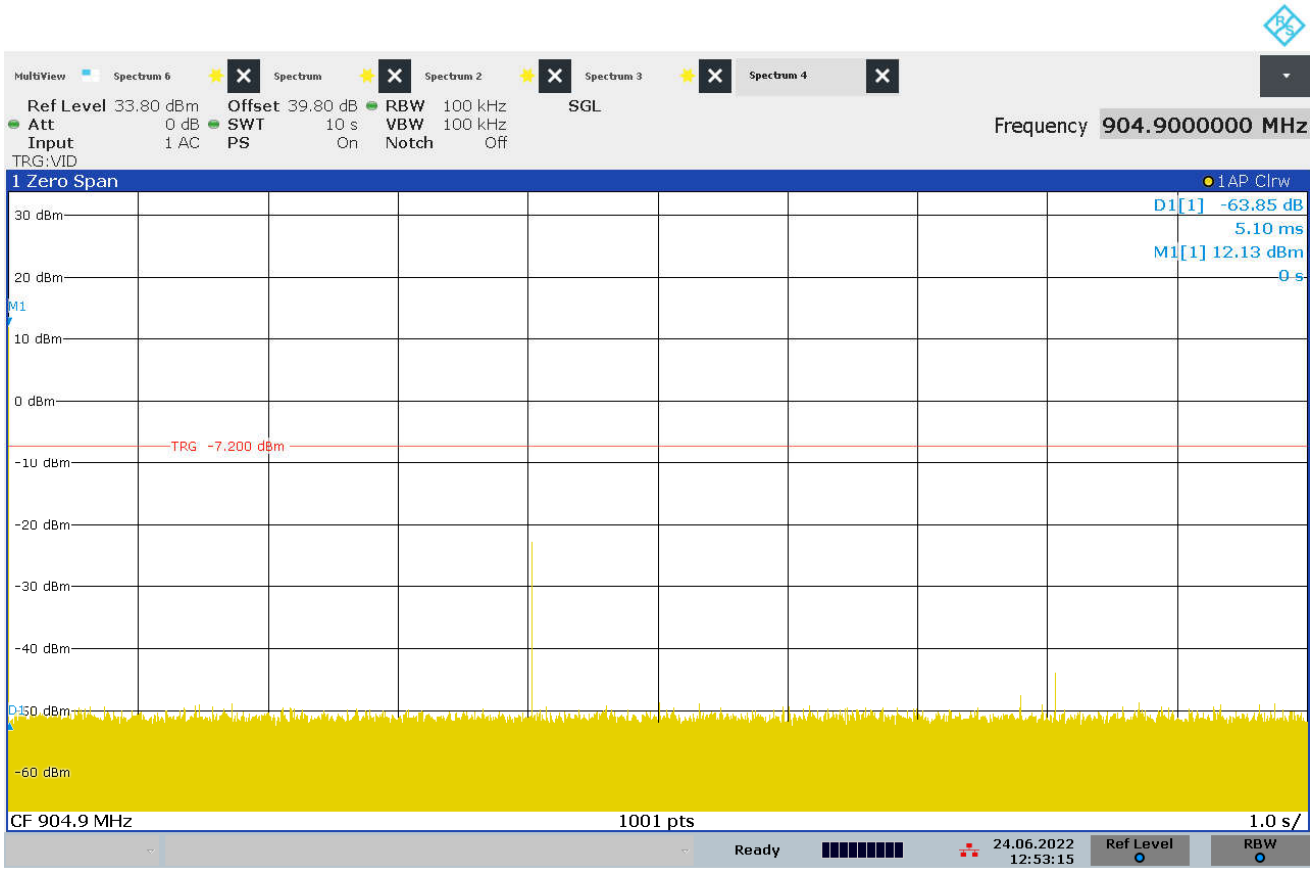
Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Hopping Enabled
Date Tested	June 24, 2022
Result	Time of Occupancy in 10 seconds = 5.1msec x 1 = 5.1msec
Notes	



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26. Maximum Peak Conducted Output Power

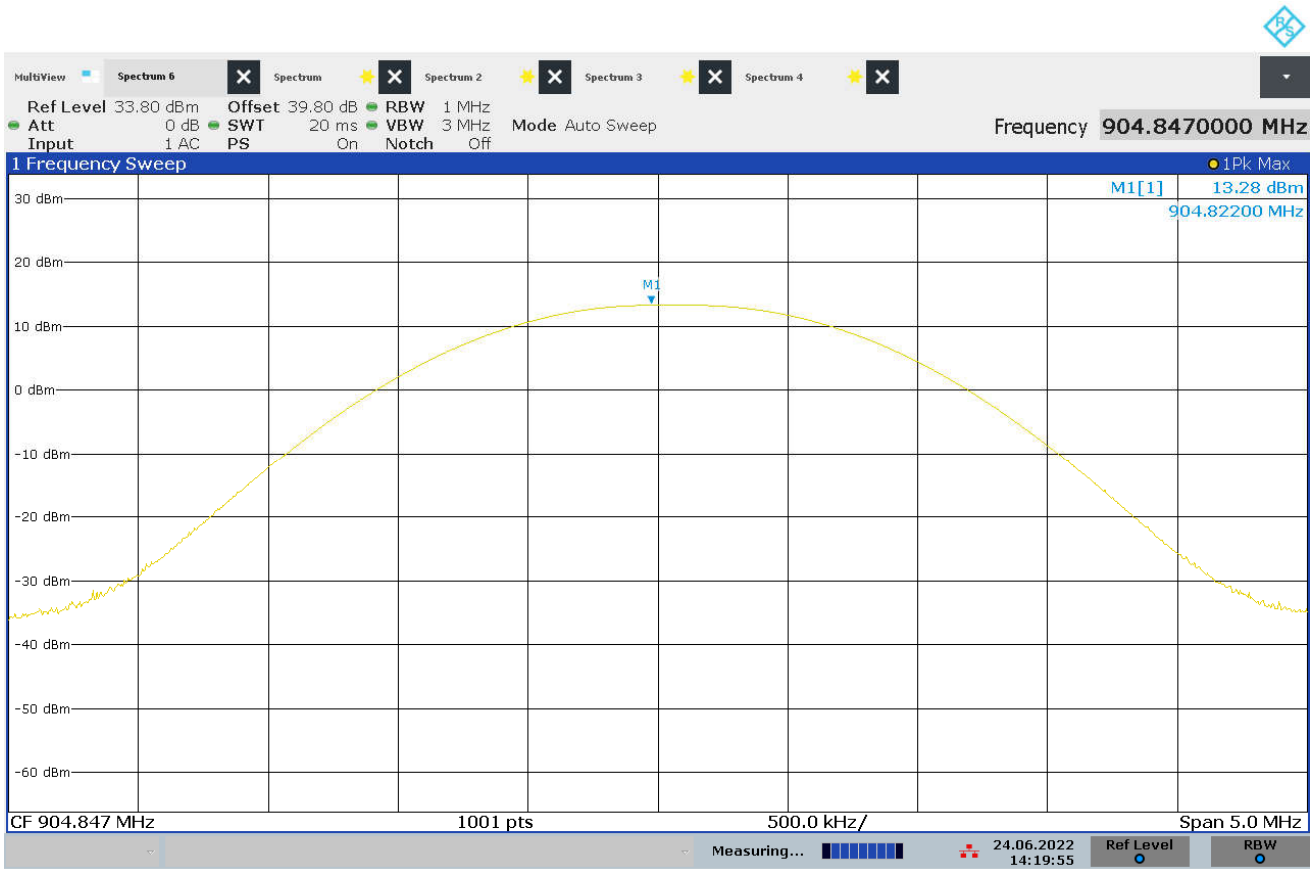
EUT Information	
Manufacturer	Badger Meter
Product	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 904.9MHz Transmit at 914.08MHz Transmit at 923.7MHz

Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop
Test Site Used	N/A
Notes	

Requirements
FOR FREQUENCY HOPPING SYSTEMS IN THE 902-928 MHz, CHANNELS < 50 The output power shall not exceed 250mW (24dBm).

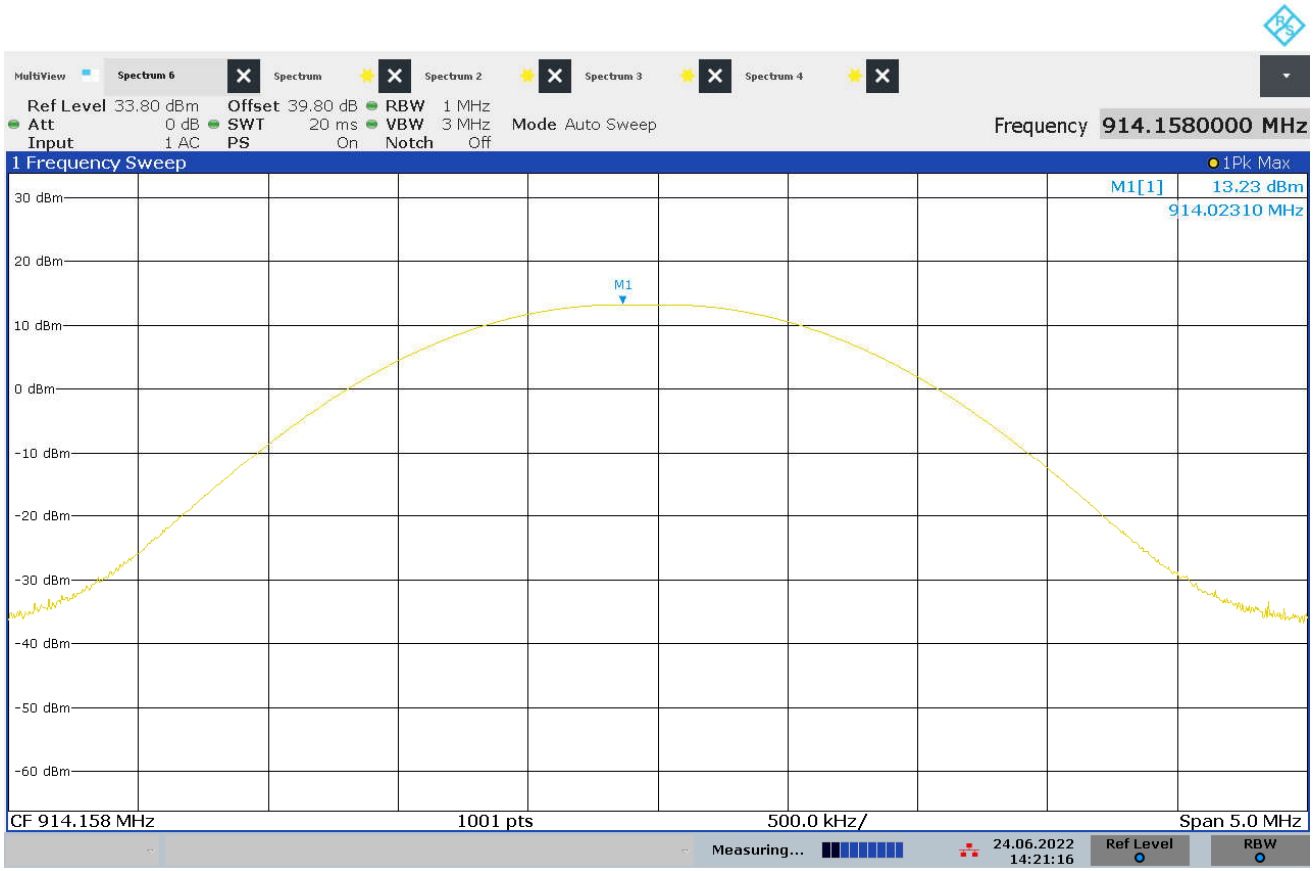
Procedure
FOR FREQUENCY HOPPING SYSTEMS The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation. With the hopping function disabled, the EUT was allowed to transmit continuously. The frequency hopping channel was set separately to low, middle, and high hopping channels. The resolution bandwidth (RBW) was set to greater than the 20dB bandwidth. The span was set to approximately 5 times the 20dB bandwidth. The 'Max-Hold' function was engaged. The maximum meter reading was recorded. The peak power output was calculated for the low, middle, and high hopping frequencies.

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 904.9MHz
Date Tested	June 24, 2022
Result	Output Power = 21.3mW (13.28dBm)
Notes	



14:19:56 24.06.2022

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 914.08MHz
Date Tested	June 24, 2022
Result	Output Power = 21.03mW (13.23dBm)
Notes	



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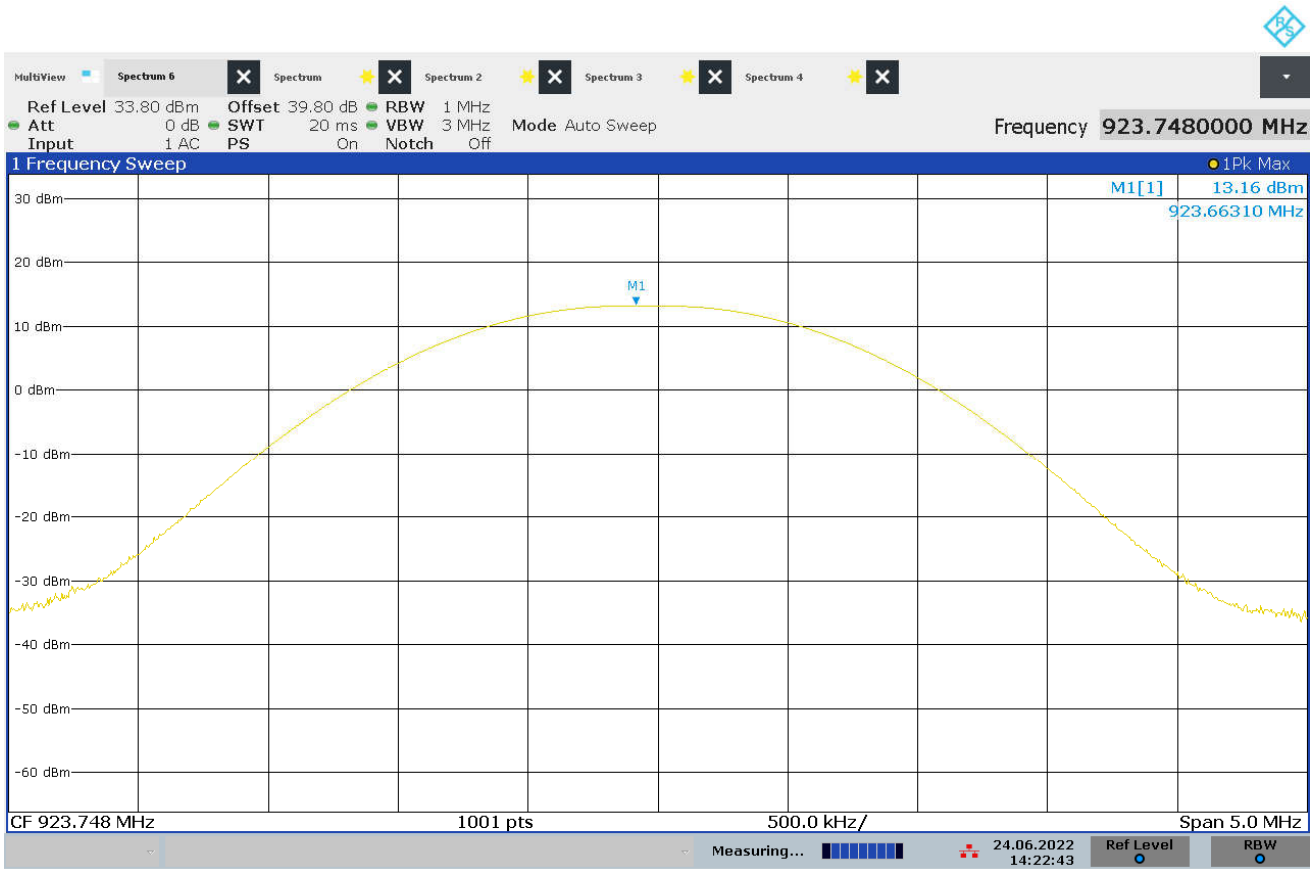
Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 923.7MHz
Date Tested	June 24, 2022
Result	Output Power = 20.7mW (13.16dBm)
Notes	



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27. Effective Isotropic Radiated Power (EIRP)

EUT Information	
Manufacturer	Badger Meter
Product	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Transmit at 904.9MHz Transmit at 914.08MHz Transmit at 923.7MHz

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 21
Type of Antennas Used	Below 1GHz: Bilog (or equivalent)
Notes	

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

Requirements
FOR FREQUENCY HOPPING SYSTEMS IN THE 902-928 MHz, CHANNELS < 50 The output power shall not exceed 500mW (30dBm).

Procedure
The EUT was placed on the non-conductive stand and set to transmit. A bilog antenna 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 20dB bandwidth. The span was set to approximately 5 times the 20 dB 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 hopping frequencies. 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 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, as required. The peak power output was calculated for low, middle, and high hopping frequencies.

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Transmit at 904.9MHz Transmit at 914.08MHz Transmit at 923.7MHz
Date Tested	June 24, 2022
Result	Max EIRP = 34.7mW (15.4dBm)
Notes	

Freq (MHz)	Ant Pol	Wide BW Meter Reading (dBµV)	Matched Sig Gen Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
904.90	H	78.5	8.9	2.2	1.6	9.4	30.0	-20.6
	V	83.8	14.6	2.2	1.6	15.1	30.0	-14.9
914.08	H	76.6	6.4	2.2	1.6	6.9	30.0	-23.1
	V	84.2	14.9	2.2	1.6	15.4	30.0	-14.6
923.70	H	78.2	8.0	2.2	1.7	8.5	30.0	-21.5
	V	83.2	13.8	2.2	1.7	14.3	30.0	-15.7

28. Duty Cycle Factor Measurements

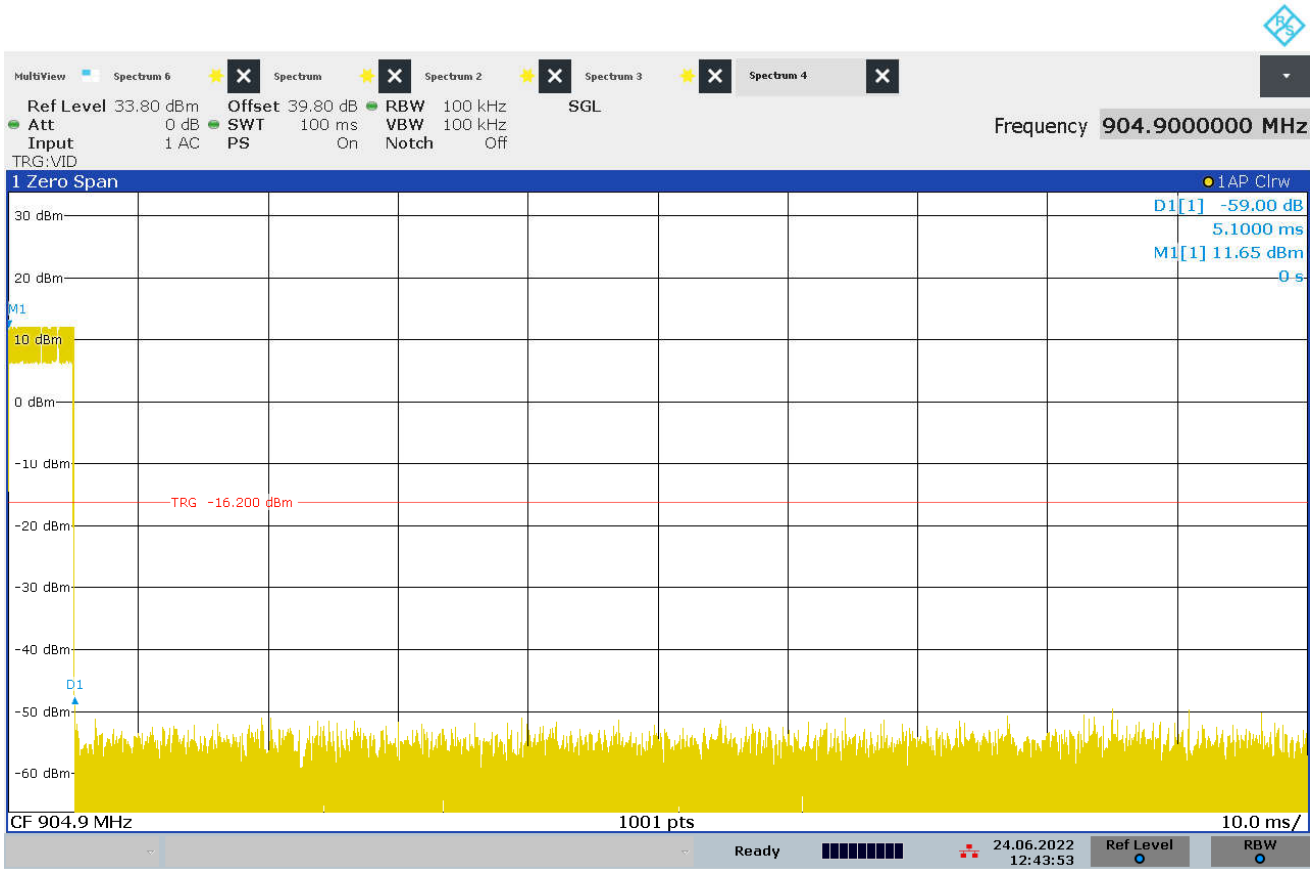
EUT Information	
Manufacturer	Badger Meter
Product	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 904.9MHz

Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop
Test Site Used	N/A
Notes	

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

Procedure
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 10msec/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. 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 $\left(\frac{On\ Time}{Word\ Period}\right)$, where $Word\ Period\ =\ (On\ Time + Off\ Time)$.

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 904.9MHz
Date Tested	June 24, 2022
Result	Duty Cycle = -25.9dB
Notes	Duty Cycle Factor Calculation: 1 pulse × 5.1ms = 5.1ms $\text{Duty Cycle Factor} = 20\log\left(\frac{5.1\text{ms}}{100\text{ms}}\right) = -25.85dB$



29. Case Spurious Radiated Emissions

EUT Information	
Manufacturer	Badger Meter
Product	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Transmit at 904.9MHz Transmit at 914.08MHz Transmit at 923.7MHz

Test Setup Details	
Setup Format	Tabletop
Height of Support (For Floor Standing only)	N/A
Type of Test Site	Semi-Anechoic Chamber
Test Site Used	Room 21
Type of Antennas Used	Below 1GHz: Bilog (or equivalent) Above 1GHz: Double-Ridged Waveguide (or equivalent)
Notes	N/A

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

Procedure
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 10.0GHz was investigated using a peak detector function. The final open field emission tests were then manually performed over the frequency range of 30MHz to 10.0GHz. 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 bilog antenna. The bilog 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 of 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 1.5-meter-high non-conductive stand. A peak detector with a resolution bandwidth of 100kHz 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 20dB 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 1GHz 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 1GHz 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 1.5-meter-high non-conductive stand. A peak detector with a resolution bandwidth of 1MHz 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.

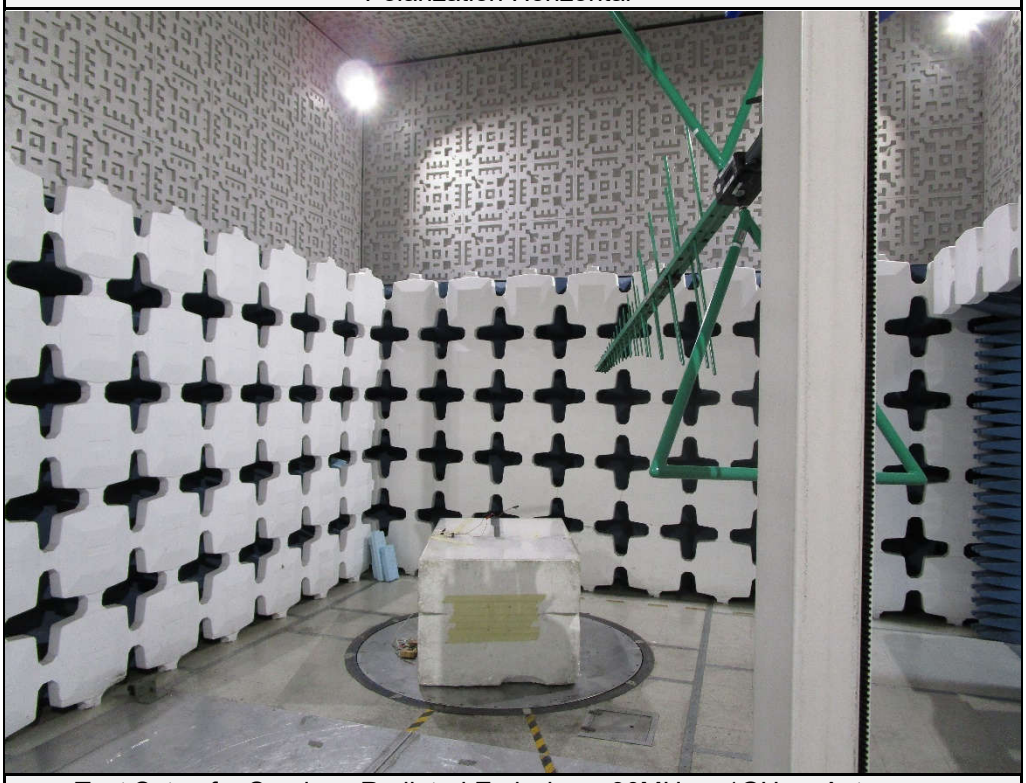
iv) In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer, the measuring antenna was not raised or lowered to ensure maximized readings. Instead, the EUT was rotated through all axis to ensure the maximum readings were recorded for the EUT.

d) For all radiated emissions measurements below 1GHz, 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.

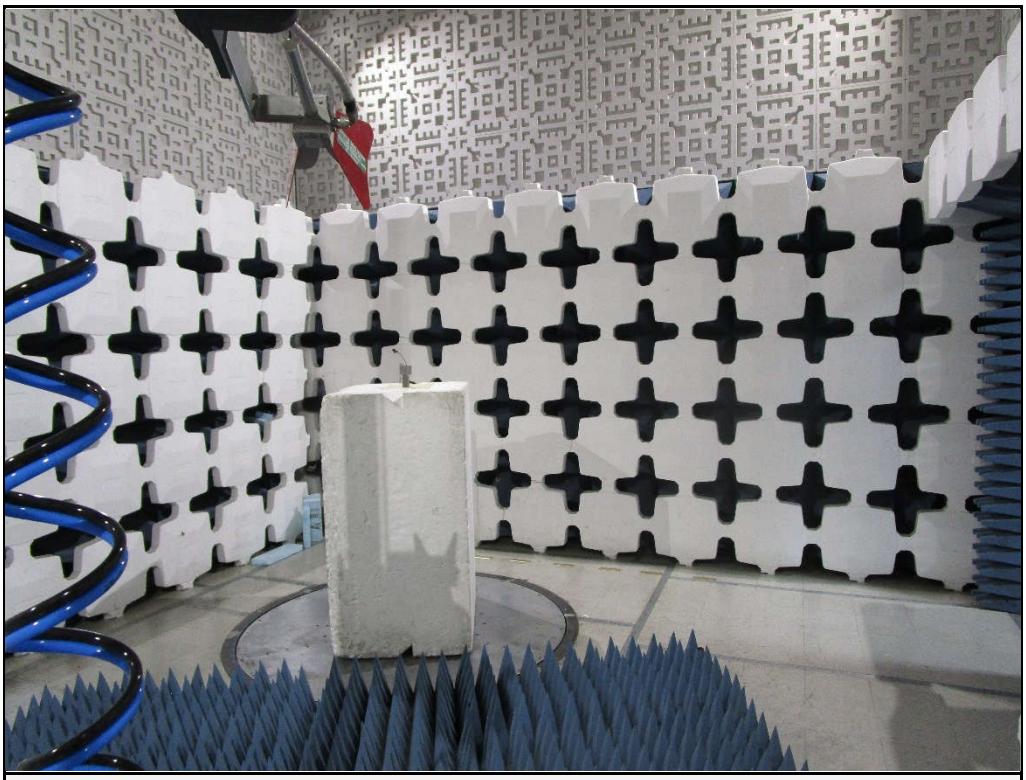
e) For all radiated emissions measurements above 1GHz, the peak readings must comply with the §15.35(b) limits. §15.35(b) states that when average radiated emissions measurements are specified, there also is a limit on the peak level of the radiated emissions. The limit on the peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. Therefore, all peak readings above 1GHz must be no greater than 20dB above the limits specified in §15.209(a).

f) Next, for all radiated emissions measurements above 1GHz, the peak readings are converted to average readings by adding the duty cycle correction factor to the peak reading. For all radiated emissions measurements above 1GHz, the average radiated emissions measurements must be no greater than the limits specified in §15.209(a).

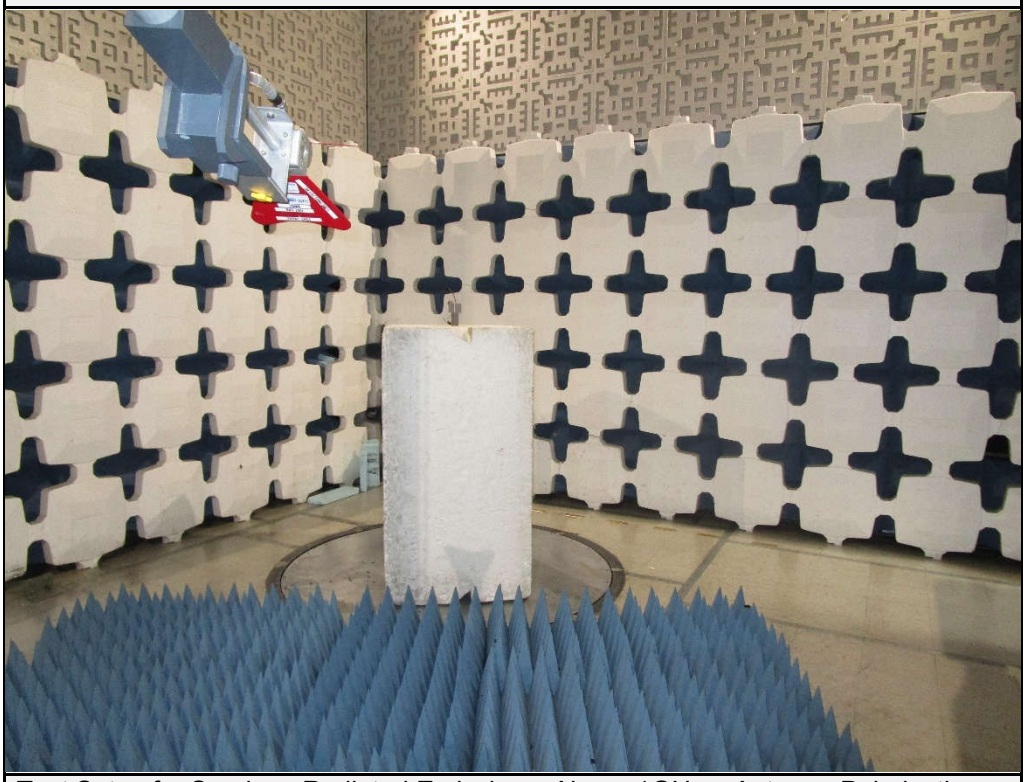
Test Setup for Spurious Radiated Emissions, 30MHz – 1GHz – Antenna Polarization Horizontal



Test Setup for Spurious Radiated Emissions, 30MHz – 1GHz – Antenna Polarization Vertical



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



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

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Transmit at 904.9MHz
Date Tested	June 22, 2022
Notes	Peak Measurements in the Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dBm)
2714.70	H	56.5		3.7	33.1	-39.5	53.7	486.6	5000.0	-20.2
	V	56.2		3.7	33.1	-39.5	53.4	470.1	5000.0	-20.5
3619.60	H	60.1		4.3	33.2	-38.9	58.7	862.6	5000.0	-15.3
	V	62.1		4.3	33.2	-38.9	60.7	1085.9	5000.0	-13.3
4524.50	H	65.4		4.7	34.3	-38.9	65.5	1877.4	5000.0	-8.5
	V	63.0		4.7	34.3	-38.9	63.1	1424.1	5000.0	-10.9
5429.40	H	72.9		5.2	34.8	-39.0	73.9	4934.2	5000.0	-0.1
	V	68.8		5.2	34.8	-39.0	69.8	3077.7	5000.0	-4.2
8144.10	H	55.3		6.5	35.8	-39.0	58.6	851.5	5000.0	-15.4
	V	55.5		6.5	35.8	-39.0	58.8	871.3	5000.0	-15.2
9049.00	H	56.0		6.5	36.2	-38.9	59.9	983.7	5000.0	-14.1
	V	54.2		6.5	36.2	-38.9	58.1	799.6	5000.0	-15.9

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Transmit at 904.9MHz
Date Tested	June 22, 2022
Notes	Average Measurements in the Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Duty Cycle Factor (dB)	Average Total at 3m (dBµV/m)	Average Total at 3m (µV/m)	Average Limit at 3m (µV/m)	Margin (dB)
2714.70	H	56.50		3.7	33.1	-39.5	-25.9	27.9	24.8	500.0	-26.1
	V	56.20		3.7	33.1	-39.5	-25.9	27.6	24.0	500.0	-26.4
3619.60	H	60.10		4.3	33.2	-38.9	-25.9	32.9	44.0	500.0	-21.1
	V	62.10		4.3	33.2	-38.9	-25.9	34.9	55.4	500.0	-19.1
4524.50	H	65.40		4.7	34.3	-38.9	-25.9	39.6	95.7	500.0	-14.4
	V	0.00		4.7	34.3	-38.9	-25.9	-25.8	0.1	500.0	-79.8
5429.40	H	72.90		5.2	34.8	-39.0	-25.9	48.0	251.6	500.0	-6.0
	V	68.80		5.2	34.8	-39.0	-25.9	43.9	156.9	500.0	-10.1
8144.10	H	55.30		6.5	35.8	-39.0	-25.9	32.8	43.4	500.0	-21.2
	V	55.50		6.5	35.8	-39.0	-25.9	33.0	44.4	500.0	-21.0
9049.00	H	56.00		6.5	36.2	-38.9	-25.9	34.0	50.2	500.0	-20.0
	V	54.20		6.5	36.2	-38.9	-25.9	32.2	40.8	500.0	-21.8

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Transmit at 904.9MHz
Date Tested	June 22, 2022
Notes	Peak Measurements in Non-Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dBm)
904.90	H	78.50		2.0	26.5	0.0	107.0	223684.6	NA	NA
	V	83.80		2.0	26.5	0.0	112.3	411752.3	NA	NA
1809.80	H	61.20		2.9	29.4	-39.8	53.7	486.0	41175.2	-38.6
	V	64.40		2.9	29.4	-39.8	56.9	702.4	41175.2	-35.4
6334.30	H	45.70		5.6	35.5	-39.0	47.8	246.4	41175.2	-44.5
	V	47.00		5.6	35.5	-39.0	49.1	286.2	41175.2	-43.2
7239.20	H	64.10		6.1	35.7	-39.0	67.0	2229.3	41175.2	-25.3
	V	61.60		6.1	35.7	-39.0	64.5	1671.7	41175.2	-27.8

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Transmit at 914.08MHz
Date Tested	June 22, 2022
Notes	Peak Measurements in the Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dBm)
2742.24	H	55.7		3.7	33.0	-39.5	52.9	442.6	5000.0	-21.1
	V	56.2		3.7	33.0	-39.5	53.4	468.9	5000.0	-20.6
3656.32	H	60.3		4.3	33.2	-38.9	59.0	887.2	5000.0	-15.0
	V	59.7		4.3	33.2	-38.9	58.4	828.0	5000.0	-15.6
4570.40	H	65.5		4.7	34.4	-38.9	65.7	1935.4	5000.0	-8.2
	V	62.1		4.7	34.4	-38.9	62.3	1308.5	5000.0	-11.6
7312.64	H	63.4		6.2	35.7	-39.0	66.3	2065.0	5000.0	-7.7
	V	62.4		6.2	35.7	-39.0	65.3	1840.4	5000.0	-8.7
8226.72	H	52.3		6.5	35.8	-39.0	55.6	604.2	5000.0	-18.4
	V	55.3		6.5	35.8	-39.0	58.6	853.5	5000.0	-15.4
9140.80	H	54.1		6.6	36.3	-38.9	58.1	800.5	5000.0	-15.9
	V	55.1		6.6	36.3	-38.9	59.1	898.2	5000.0	-14.9

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Transmit at 914.08MHz
Date Tested	June 22, 2022
Notes	Average Measurements in the Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Duty Cycle Factor (dB)	Average Total at 3m (dBµV/m)	Average Total at 3m (µV/m)	Average Limit at 3m (µV/m)	Margin (dB)
2742.24	H	55.70		3.7	33.0	-39.5	-25.9	27.1	22.6	500.0	-26.9
	V	56.20		3.7	33.0	-39.5	-25.9	27.6	23.9	500.0	-26.4
3656.32	H	60.30		4.3	33.2	-38.9	-25.9	33.1	45.2	500.0	-20.9
	V	59.70		4.3	33.2	-38.9	-25.9	32.5	42.2	500.0	-21.5
4570.40	H	65.50		4.7	34.4	-38.9	-25.9	39.9	98.7	500.0	-14.1
	V	62.10		4.7	34.4	-38.9	-25.9	36.5	66.7	500.0	-17.5
7312.64	H	63.40		6.2	35.7	-39.0	-25.9	40.4	105.3	500.0	-13.5
	V	62.40		6.2	35.7	-39.0	-25.9	39.4	93.8	500.0	-14.5
8226.72	H	52.30		6.5	35.8	-39.0	-25.9	29.8	30.8	500.0	-24.2
	V	55.30		6.5	35.8	-39.0	-25.9	32.8	43.5	500.0	-21.2
9140.80	H	54.10		6.6	36.3	-38.9	-25.9	32.2	40.8	500.0	-21.8
	V	55.10		6.6	36.3	-38.9	-25.9	33.2	45.8	500.0	-20.8

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Transmit at 914.08MHz
Date Tested	June 22, 2022
Notes	Peak Measurements in Non-Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dBm)
914.08	H	76.60		2.1	26.4	0.0	105.0	178441.2	NA	NA
	V	84.20		2.1	26.4	0.0	112.6	428050.6	NA	NA
1828.16	H	62.10		2.9	29.5	-39.7	54.8	550.2	42805.1	-37.8
	V	64.10		2.9	29.5	-39.7	56.8	692.6	42805.1	-35.8
5484.48	H	74.20		5.2	34.9	-39.0	75.2	5754.2	42805.1	-17.4
	V	71.20		5.2	34.9	-39.0	72.2	4073.6	42805.1	-20.4
6398.56	H	55.80		5.7	35.6	-39.0	58.0	797.3	42805.1	-34.6
	V	53.70		5.7	35.6	-39.0	55.9	626.1	42805.1	-36.7

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Transmit at 923.7MHz
Date Tested	June 22, 2022
Notes	Peak Measurements in the Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dBm)
2771.10	H	56.6		3.7	32.9	-39.5	53.8	489.6	5000.0	-20.2
	V	56.1		3.7	32.9	-39.5	53.3	462.2	5000.0	-20.7
3694.80	H	60.8		4.3	33.3	-38.9	59.5	944.8	5000.0	-14.5
	V	62.1		4.3	33.3	-38.9	60.8	1097.3	5000.0	-13.2
4618.50	H	66.0		4.8	34.6	-38.9	66.4	2087.1	5000.0	-7.6
	V	63.0		4.8	34.6	-38.9	63.4	1477.5	5000.0	-10.6
7389.60	H	63.1		6.2	35.7	-39.0	66.0	2003.2	5000.0	-7.9
	V	61.6		6.2	35.7	-39.0	64.5	1685.5	5000.0	-9.4
8313.30	H	56.1		6.5	35.8	-39.0	59.4	935.3	5000.0	-14.6
	V	55.5		6.5	35.8	-39.0	58.8	872.8	5000.0	-15.2

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Transmit at 923.7MHz
Date Tested	June 22, 2022
Notes	Average Measurements in the Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Duty Cycle Factor (dB)	Average Total at 3m (dBµV/m)	Average Total at 3m (µV/m)	Average Limit at 3m (µV/m)	Margin (dB)
2771.10	H	56.60		3.7	32.9	-39.5	-25.9	27.9	25.0	500.0	-26.0
	V	56.10		3.7	32.9	-39.5	-25.9	27.4	23.6	500.0	-26.5
3694.80	H	60.80		4.3	33.3	-38.9	-25.9	33.7	48.2	500.0	-20.3
	V	62.10		4.3	33.3	-38.9	-25.9	35.0	56.0	500.0	-19.0
4618.50	H	66.00		4.8	34.6	-38.9	-25.9	40.5	106.4	500.0	-13.4
	V	63.00		4.8	34.6	-38.9	-25.9	37.5	75.3	500.0	-16.4
7389.60	H	63.10		6.2	35.7	-39.0	-25.9	40.2	102.1	500.0	-13.8
	V	61.60		6.2	35.7	-39.0	-25.9	38.7	85.9	500.0	-15.3
8313.30	H	56.10		6.5	35.8	-39.0	-25.9	33.6	47.7	500.0	-20.4
	V	55.50		6.5	35.8	-39.0	-25.9	33.0	44.5	500.0	-21.0

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000115
Mode	Transmit at 923.7MHz
Date Tested	June 22, 2022
Notes	Peak Measurements in Non-Restricted Bands

Freq (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total at 3m (dBµV/m)	Peak Total at 3m (µV/m)	Peak Limit at 3m (µV/m)	Margin (dBm)
923.70	H	78.20		2.1	26.7	0.0	106.9	221902.5	NA	NA
	V	83.20		2.1	26.7	0.0	111.9	394604.6	NA	NA
1847.40	H	63.40		3.0	29.7	-39.7	56.3	652.7	39460.5	-35.6
	V	64.80		3.0	29.7	-39.7	57.7	766.8	39460.5	-34.2
5542.20	H	71.10		5.2	34.9	-39.0	72.2	4070.5	39460.5	-19.7
	V	69.00		5.2	34.9	-39.0	70.1	3196.3	39460.5	-21.8
6465.90	H	60.60		5.7	35.7	-39.0	63.0	1405.0	39460.5	-29.0
	V	58.70		5.7	35.7	-39.0	61.1	1129.0	39460.5	-30.9
9237.00	H	50.50		6.6	36.3	-38.9	54.6	536.2	39460.5	-37.3
	V	49.40		6.6	36.3	-38.9	53.5	472.5	39460.5	-38.4

30. Band-Edge Compliance

EUT Information	
Manufacturer	Badger Meter
Product	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 904.9MHz

Test Setup Details	
Setup Format	Tabletop
Height of Support (For Floor Standing only)	N/A
Measurement Method	Antenna Conducted
Type of Test Site	Elite Test Bench
Type of Antennas Used	Below 1GHz: Bilog (or equivalent) Above 1GHz: Double-Ridged Waveguide (or equivalent) N/A
Notes	None

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

Procedure

1) Low Band Edge:
   a) The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation.
   b) The EUT was set to transmit continuously at the channel closest to the low band-edge, hopping function disabled.
   c) To determine the band edge compliance, the following spectrum analyzer settings were used:
      - Center Frequency = 902MHz (low band-edge frequency).
      - Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
      - Resolution Bandwidth (RBW) = ≥ 1% of the span.
      - 'Max-Hold' function was engaged.
   d) The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.
   e) The marker was set on the peak of the in-band emissions. A display line was placed 20dB down from the peak of the in-band emissions. All emissions which fall outside of the authorized band of operation must be below the 20dB. (All emissions to the left of the center frequency (band-edge) must be below the display line.)
   f) The analyzer's display was then screenshot and saved.
   g) Steps (d) through (f) were repeated with the frequency hopping function enabled.

2) High Band Edge:

a) The antenna port of the EUT was connected to the spectrum analyzer through 40dB of attenuation.

b) The EUT was set to transmit continuously at the channel closest to the high band-edge, hopping function disabled.

c) To determine the band edge compliance, the following spectrum analyzer settings were used:

- Center Frequency = 928MHz (high band-edge frequency).
- Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
- Resolution Bandwidth (RBW) = ≥ 1% of the span.
- ‘Max-Hold' function was engaged.

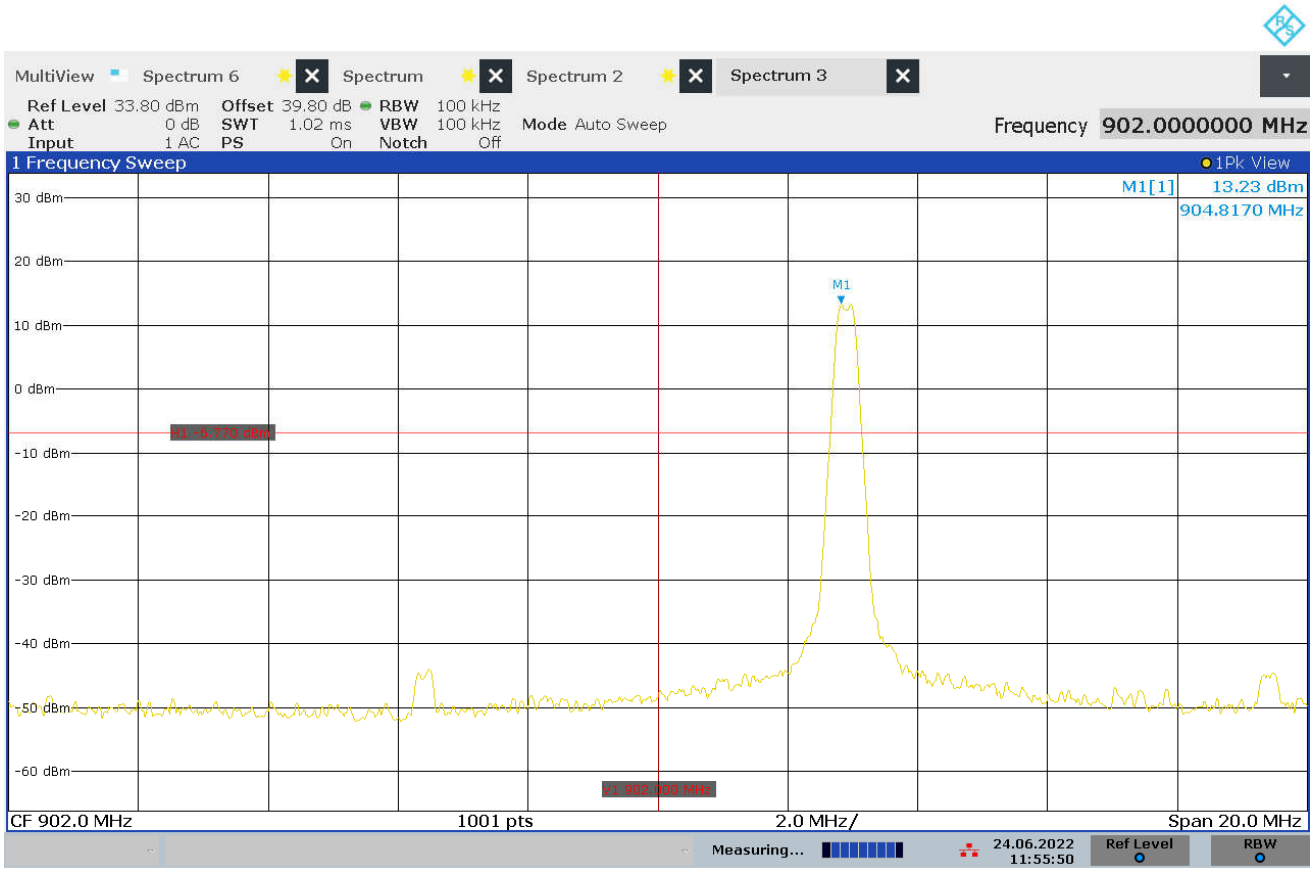
d) The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.

e) The marker was set on the peak of the in-band emissions. A display line was placed 20dB down from the peak of the in-band emissions. All emissions which fall outside of the authorized band of operation must be below the 20dBdown display line. (All emissions to the left of the center frequency (band-edge) must be below the display line.)

f) The analyzer's display was then screenshot and saved.

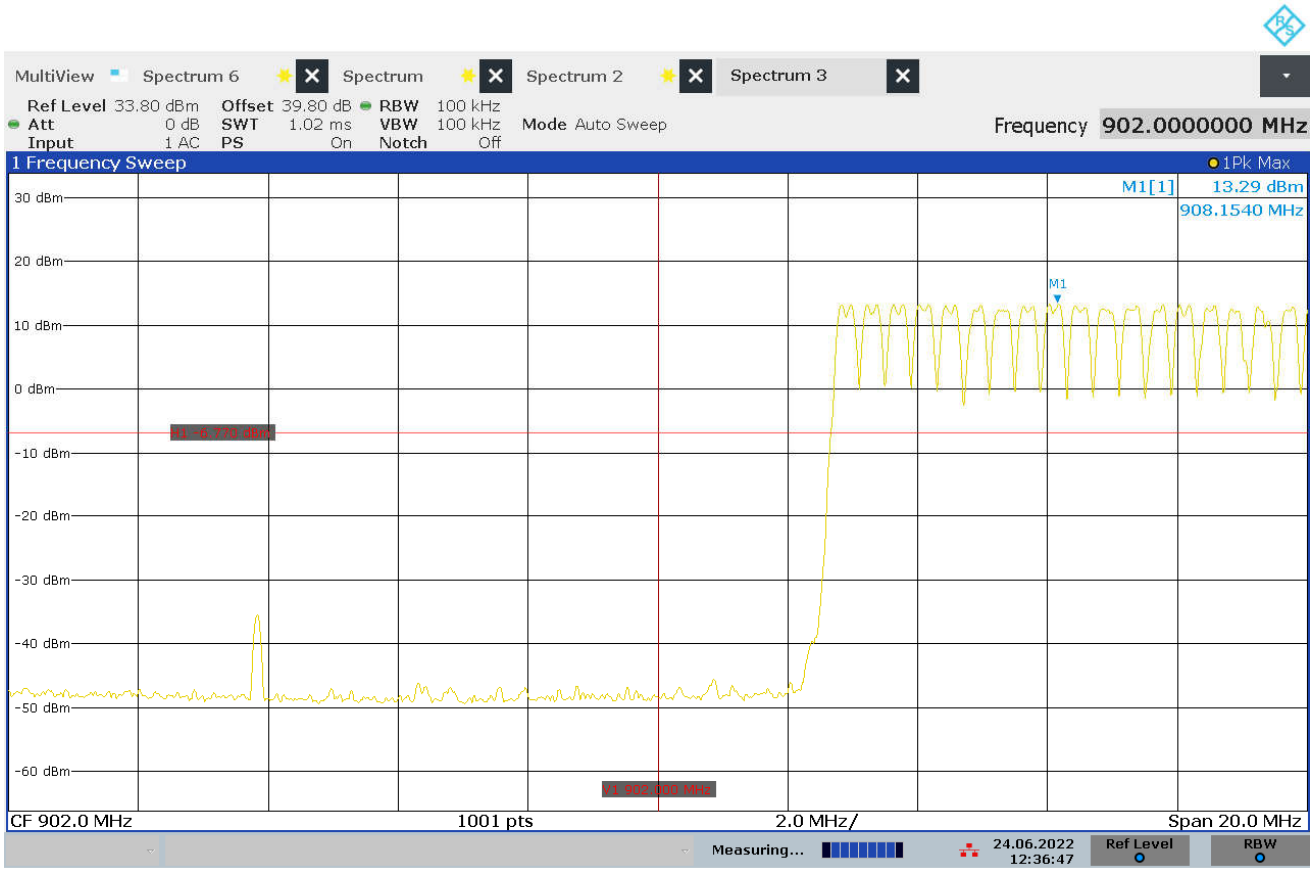
g) Steps (d) through (f) were repeated with the frequency hopping function enabled.

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 904.9MHz
Date Tested	June 24, 2022
Notes	Low Band Edge



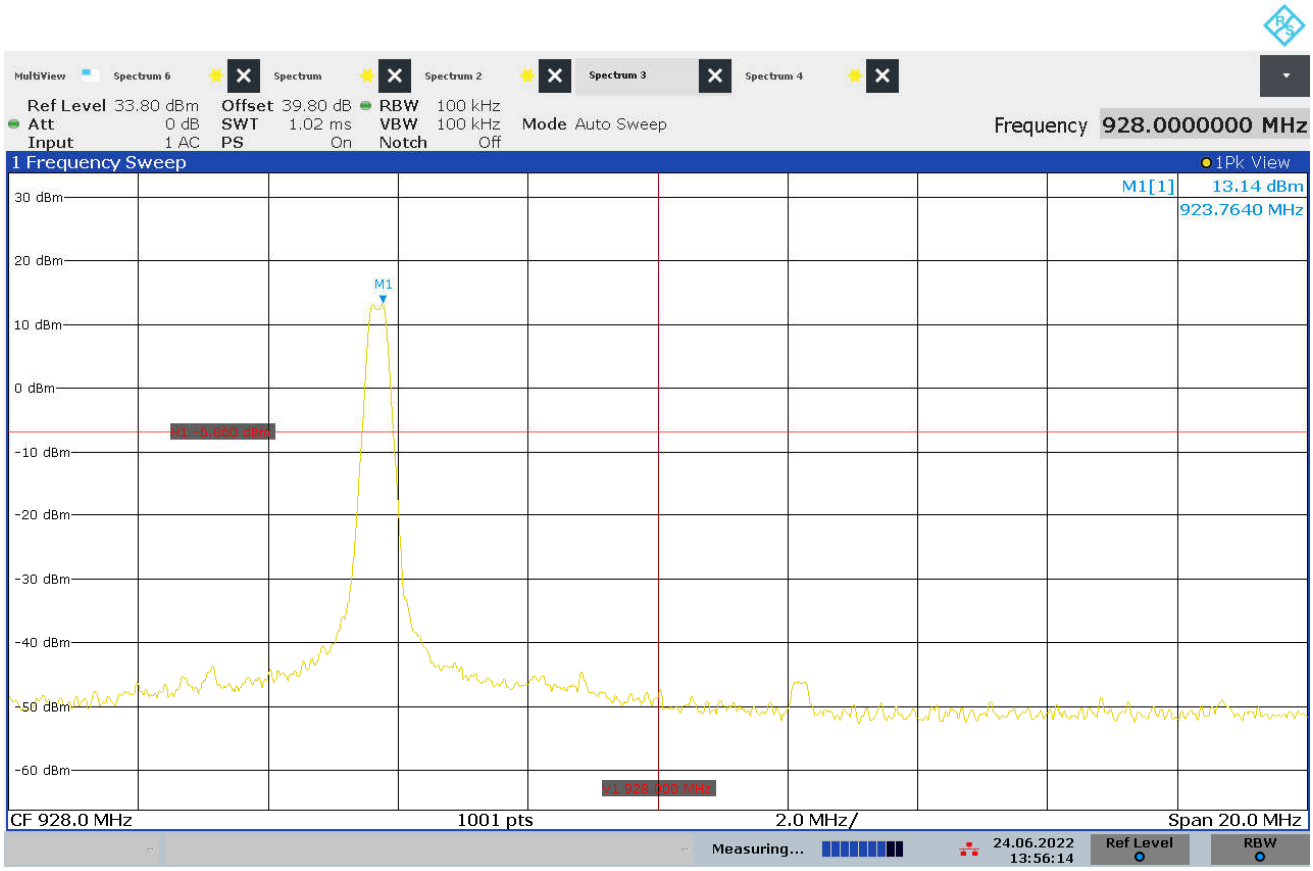
11:55:50 24.06.2022

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 904.9MHz
Date Tested	June 24, 2022
Notes	Low Band Edge



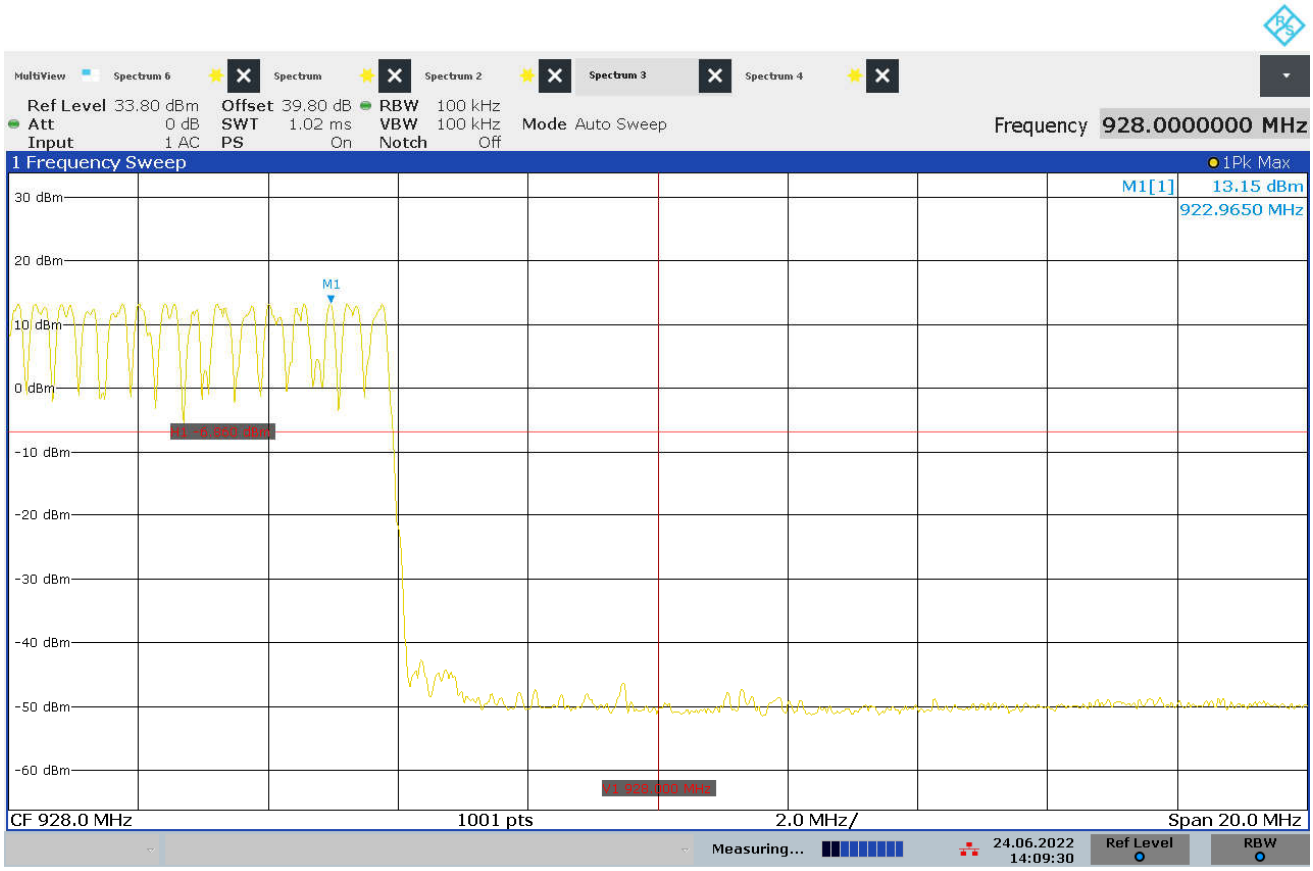
12:36:47 24.06.2022

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 923.7MHz
Date Tested	June 24, 2022
Notes	High Band Edge



13:56:15 24.06.2022

Test Details	
Manufacturer	Badger Meter
EUT	Water Meter Transceiver
Model No.	Orion Mobile M
Serial No.	60000112
Mode	Transmit at 923.7MHz
Date Tested	June 24, 2022
Notes	High Band Edge



14:09:30 24.06.2022

31. Scope of Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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ELECTRICAL

Valid To: June 30, 2023 Certificate Number: 1786.01

In recognition of the successful completion of the A2LA Accreditation Program evaluation process, accreditation is granted to this laboratory to perform the following automotive electromagnetic compatibility and other electrical tests:

Test Technology:	Test Method(s) [1]:
Transient Immunity	ISO 7637-2 (including emissions); ISO 7637-3; ISO 16750-2:2012, Sections 4.6.3 and 4.6.4; CS-11979, Section 6.4; CS.00054, Section 5.9; EMC-CS-2009.1 (CI220); FMC1278 (CI220, CI221, CI222); GMW 3097, Section 3.5; SAE J1113-11; SAE J1113-12; ECE Regulation 10.06 Annex 10
Electrostatic Discharge (ESD)	ISO 10605 (2001, 2008); CS-11979 Section 7.0; CS.00054, Section 5.10; EMC-CS-2009.1 (CI 280); FMC1278 (CI280); SAE J1113-13; GMW 3097 Section 3.6
Conducted Emissions	CISPR 25 (2002, 2008), Sections 6.2 and 6.3; CISPR 25 (2016), Sections 6.3 and 6.4; CS-11979, Section 5.1; CS.00054, Sections 5.6.1 and 5.6.2; GMW 3097, Section 3.3.2; EMC-CS-2009.1 (CE 420); FMC1278 (CE420, CE421)
Radiated Emissions Anechoic	CISPR 25 (2002, 2008), Section 6.4; CISPR 25 (2016), Section 6.5; CS-11979, Section 5.3; CS.00054, Section 5.6.3; GMW 3097, Section 3.3.1; EMC-CS-2009.1 (RE 310); FMC1278 (RE310); ECE Regulation 10.06 Annex 7 (Broadband) ECE Regulation 10.06 Annex 8 (Narrowband)

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Test Technology:	Test Method(s) [1]:
Vehicle Radiated Emissions	CISPR 12; CISPR 36; ICES-002; ECE Regulation 10.06 Annex 5
Bulk Current Injection (BCI)	ISO 11452-4; CS-11979, Section 6.1; CS.00054, Section 5.8.1; GMW 3097, Section 3.4.1; SAE J1113-4; EMC-CS-2009.1 (RI112); FMC1278 (RI112); ECE Regulation 10.06 Annex 9
Radiated Immunity Anechoic *(Including Radar Pulse)*	ISO 11452-2; ISO 11452-5; CS-11979, Section 6.2; CS.00054, Section 5.8.2; GMW 3097, Section 3.4.2; EMC-CS-2009.1 (RI114); FMC1278 (RI114); SAE J1113-21; ECE Regulation 10.06 Annex 9
Radiated Immunity Magnetic Field	ISO 11452-8
Radiated Immunity Reverb	ISO/IEC 61000-4-21; GMW 3097, Section 3.4.3; EMC-CS-2009.1 (RI114); FMC1278 (RI114); ISO 11452-11
Radiated Immunity *(Portable Transmitters)*	ISO 11452-9; EMC-CS-2009.1 (RI115); FMC1278 (RI115)
Vehicle Radiated Immunity (ALSE)	ISO 11451-2; ECE Regulation 10.06 Annex 6
Vehicle Product Specific EMC Standards	EN 14982; EN ISO 13309, ISO 13766; EN 50498; EC Regulation No. 2015/208; EN 55012
Electrical Loads	ISO 16750-2
Emissions Radiated and Conducted (3m Semi-anechoic chamber, up to 40 GHz)	47 CFR, FCC Part 15 B (using ANSI C63.4:2014); 47 CFR, FCC Part 18 (using FCC MP-5:1986); ICES-001; ICES-003; ICES-005; IEC/CISPR 11, Ed. 4.1 (2004-06); AS/NZS CISPR 11 (2004); IEC/CISPR 11 Ed 5 (2009-05) + A1 (2010); KN 11 (2008-5) with RRL Notice No. 2008-3 (May 20, 2008); CISPR 11; EN 55011; KS C 9811; CNS 13803 (1997, 2003); CISPR 14-1; EN 55014-1; AS/NZS CISPR 14.1; KS C 9814-1; KN 14-1; IEC/CISPR 22 (1997); EN 55022 (1998) + A1(2000); EN 55022 (1998) + A1(2000) + A2(2003); EN 55022 (2006); IEC/CISPR 22 (2008-09); AS/NZS CISPR 22 (2004); AS/NZS CISPR 22, 3rd Edition (2006); KN 22 (up to 6 GHz); CNS 13438 (up to 6 GHz); VCCI V-3 (up to 6 GHz); CISPR 32; EN 55032; KS C 9832; KN 32; ECE Regulation 10.06 Annex 14
Cellular Radiated Spurious Emissions	ETSI TS 151 010-1 GSM; 3GPP TS 51.010-1, Sec 12; ETSI TS 134 124 UMTS; 3GPP TS 34.124; ETSI TS 136 124 LTE; E-UTRA; 3GPP TS 36.124

Test Technology:	Test Method(s) [1]:
Emissions (cont'd)	
Current Harmonics	IEC 61000-3-2; EN 61000-3-2; KN 61000-3-2; KS C 9610-3-2; ECE Regulation 10.06 Annex 11
Flicker and Fluctuations	IEC 61000-3-3; EN 61000-3-3; KN 61000-3-3; KS C 9610-3-3; ECE Regulation 10.06 Annex 12
Immunity	
Electrostatic Discharge	IEC 61000-4-2, Ed. 1.2 (2001); IEC 61000-4-2 (1995) + A1(1998) + A2(2000); EN 61000-4-2 (1995); EN 61000-4-2 (2009-05); KN 61000-4-2 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-2; EN 61000-4-2; KN 61000-4-2; KS C 9610-4-2; IEEE C37.90.3 2001
Radiated Immunity	IEC 61000-4-3 (1995) + A1(1998) + A2(2000); IEC 61000-4-3, Ed. 3.0 (2006-02); IEC 61000-4-3, Ed. 3.2 (2010); KN 61000-4-3 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-3; EN 61000-4-3; KN 61000-4-3; KS C 9610-4-3; IEEE C37.90.2 2004
Electrical Fast Transient/Burst	IEC 61000-4-4, Ed. 2.0 (2004-07); IEC 61000-4-4, Ed. 2.1 (2011); IEC 61000-4-4 (1995) + A1(2000) + A2(2001); KN 61000-4-4 (2008-5); RRL Notice No. 2008-5 (May 20, 2008); IEC 61000-4-4; EN 61000-4-4; KN 61000-4-4; KS C 9610-4-4; ECE Regulation 10.06 Annex 15
Surge	IEC 61000-4-5 (1995) + A1(2000); IEC 61000-4-5, Ed 1.1 (2005-11); EN 61000-4-5 (1995) + A1(2001); KN 61000-4-5 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-5; EN 61000-4-5; KN 61000-4-5; KS C 9610-4-5; IEEE C37.90.1 2012; IEEE STD C62.41.2 2002; ECE Regulation 10.06 Annex 16
Conducted Immunity	IEC 61000-4-6 (1996) + A1(2000); IEC 61000-4-6, Ed 2.0 (2006-05); IEC 61000-4-6 Ed. 3.0 (2008); KN 61000-4-6 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); EN 61000-4-6 (1996) + A1(2001); IEC 61000-4-6; EN 61000-4-6; KN 61000-4-6; KS C 9610-4-6

Test Technology:	Test Method(s) [1]:
Immunity (cont'd)	
Power Frequency Magnetic Field Immunity (*Down to 3 A/m*)	IEC 61000-4-8 (1993) + A1(2000); IEC 61000-4-8 (2009); EN 61000-4-8 (1994) + A1(2000); KN 61000-4-8 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-8; EN 61000-4-8; KN 61000-4-8; KS C 9610-4-8
Voltage Dips, Short Interrupts, and Line Voltage Variations	IEC 61000-4-11, Ed. 2 (2004-03); KN 61000-4-11 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-11; EN 61000-4-11; KN 61000-4-11; KS C 9610-4-11
Ring Wave	IEC 61000-4-12, Ed. 2 (2006-09); EN 61000-4-12:2006; IEC 61000-4-12; EN 61000-4-12; KN 61000-4-12; IEEE STD C62.41.2 2002
Generic and Product Specific EMC Standards	IEC/EN 61000-6-1; AS/NZS 61000-6-1; KN 61000-6-1; KS C 9610-6-1; IEC/EN 61000-6-2; AS/NZS 61000-6-2; KN 61000-6-2; KS C 9610-6-2; IEC/EN 61000-6-3; AS/NZS 61000-6-3; KN 61000-6-3; KS C 9610-6-3; IEC/EN 61000-6-4; AS/NZS 61000-6-4; KN 61000-6-4; KS C 9610-6-4; EN 50130-4; EN 61326-1; EN 50121-3-2; EN 12895; EN 50270; EN 50491-1; EN 50491-2; EN 50491-3; EN 55015; EN 60730-1; EN 60945; IEC 60533; EN 61326-2-6; EN 61800-3; IEC/CISPR 14-2; EN 55014-2; AS/NZS CISPR 14.2; KN 14-2; KS C 9814-2; IEC/CISPR 24; AS/NZS CISPR 24; EN 55024; KN 24; IEC/CISPR 35; AS/NZS CISPR 35; EN 55035; KN 35; KS C 9835; IEC 60601-1-2; JIS T0601-1-2
TxRx EMC Requirements	EN 301 489-1; EN 301 489-3; EN 301 489-9; EN 301 489-17; EN 301 489-19; EN 301 489-20
European Radio Test Standards	ETSI EN 300 086-1; ETSI EN 300 086-2; ETSI EN 300 113-1; ETSI EN 300 113-2; ETSI EN 300 220-1; ETSI EN 300 220-2; ETSI EN 300 220-3-1; ETSI EN 300 220-3-2; ETSI EN 300 330-1; ETSI EN 300 330-2; ETSI EN 300 440-1; ETSI EN 300 440-2; ETSI EN 300 422-1; ETSI EN 300 422-2; ETSI EN 300 328; ETSI EN 301 893; ETSI EN 301 511; ETSI EN 301 908-1; ETSI EN 908-2; ETSI EN 908-13; ETSI EN 303 413; ETSI EN 302 502; EN 303 340; EN 303 345-2; EN 303 345-3; EN 303 345-4

Test Technology:	Test Method(s) [1]:
Canadian Radio Tests	RSS-102 (RF Exposure Evaluation only); RSS-111; RSS-112; RSS-117; RSS-119; RSS-123; RSS-125; RSS-127; RSS-130; RSS-131; RSS-132; RSS-133; RSS-134; RSS-135; RSS-137; RSS-139; RSS-140; RSS-141; RSS-142; RSS-170; RSS-181; RSS-182; RSS-191; RSS-192; RSS-194; RSS-195; RSS-196; RSS-197; RSS-199; RSS-210; RSS-211; RSS-213; RSS-215; RSS-216; RSS-220; RSS-222; RSS-236; RSS-238; RSS-243; RSS-244; RSS-247; RSS-248; RSS-251; RSS-252; RSS-287; RSS-288; RSS-310; RSS-GEN
Mexico Radio Tests	IFT-008-2015; NOM-208-SCFI-2016
Japan Radio Tests	Radio Law No. 131, Ordinance of MPT No. 37, 1981, MIC Notification No. 88:2004, Table No. 22-11; ARIB STD-T66, Regulation 18
Taiwan Radio Tests	LP-0002 (July 15, 2020)
Australia/New Zealand Radio Tests	AS/NZS 4268; Radiocommunications (Short Range Devices) Standard (2014)
Hong Kong Radio Tests	HKCA 1039 Issue 6; HKCA 1042; HKCA 1033 Issue 7; HKCA 1061; HKCA 1008; HKCA 1043; HKCA 1057; HKCA 1073
Korean Radio Test Standards	KN 301 489-1; KN 301 489-3; KN 301 489-9; KN 301 489-17; KN 301 489-52; KS X 3124; KS X 3125; KS X 3130; KS X 3126; KS X 3129
Vietnam Radio Test Standards	QCVN 47:2015/BTTTT; QCVN 54:2020/BTTTT; QCVN 55:2011/BTTTT; QCVN 65:2013/BTTTT; QCVN 73:2013/BTTTT; QCVN 74:2020/BTTTT; QCVN 112:2017/BTTTT; QCVN 117:2020//BTTTT
Vietnam EMC Test Standards	QCVN 18:2014/BTTTT; QCVN 86:2019/BTTTT; QCVN 96:2015/BTTTT; QCVN 118:2018/BTTTT
Unlicensed Radio Frequency Devices *(3 Meter Semi-Anechoic Room)*	47 CFR FCC Part 15C, 15D, 15E, 15F, 15G, 15H (using ANSI C63.10:2013, ANSI C63.17:2013 and FCC KDB 905462 D02 (v02))
Licensed Radio Service Equipment	47 CFR FCC Parts 20, 22, 24, 25, 27, 30, 73, 74, 80, 87, 90, 95, 96, 97, 101 (using ANSI/TIA-603-E, TIA-102.CAAA-E, ANSI C63.26:2015)

Test Technology:	Test Method(s) [1]:
OTA (Over the Air) Performance GSM, GPRS, EGPRS UMTS (W-CDMA) LTE including CAT M1 A-GPS for UMTS/GSM LTS A-GPS, A-GLONASS, STB8/STB16 Large Device/Laptop/Tablet Testing Integrated Device Testing WiFi 802.11 a/b/g/n/a	CTIA Test Plan for Wireless Device Over-the-Air Performance (Method for Measurement for Radiated Power and Receiver Performance) V3.8.2; CTIA Test Plan for RF Performance Evaluation of WiFi Mobile Converged Devices V2.1.0
Electrical Measurements and Simulation AC Voltage / Current	
(1mV to 5kV) 60 Hz	FAA AC 150/5345-10H
(0.1V to 250V) up to 500 MHz	FAA AC 150/5345-43J
(1µA to 150A) 60 Hz	FAA AC 150/5345-44K
DC Voltage / Current	FAA AC 150/5345-46E
(1mV to 15-kV) / (1µA to 10A)	FAA AC 150/5345-47C
Power Factor / Efficiency / Crest Factor (Power to 30kW)	FAA EB 67D
Resistance (1mΩ to 4000MΩ)	
Surge (Up to 10 kV / 5 kA) (Combination Wave and Ring Wave)	

On the following products and materials:
Telecommunications Terminal Equipment (TTE), Radio Equipment, Network Equipment, Information Technology Equipment (ITE), Automotive Electronic Equipment, Automotive Hybrid Electronic Devices, Maritime Navigation and Radio Communication Equipment and Systems, Vehicles, Boats and Internal Combustion Engine Driven Devices, Automotive, Aviation, and General Lighting Products, Medical Electrical Equipment, Motors, Industrial, Scientific and Medical (ISM) Radio-Frequency Equipment, Household Appliances, Electric Tools, Low-voltage Switchgear and Control gear, Programmable Controllers, Electrical Equipment for Measurement, Control and Laboratory Use, Base Materials, Power and Data Transmission Cables and Connectors

[1] When the date, edition, version, etc. is not identified in the scope of accreditation, laboratories may use the version that immediately precedes the current version for a period of one year from the date of publication of the standard measurement method, per part C., Section 1 of A2LA *R101 - General Requirements - Accreditation of ISO-IEC 17025 Laboratories*.

Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1 [2]

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
Unintentional Radiators Part 15B	ANSI C63.4:2014	40000

Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1[2]

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
Industrial, Scientific, and Medical Equipment Part 18	FCC MP-5 (February 1986)	40000
Intentional Radiators Part 15C	ANSI C63.10:2013	40000
Unlicensed Personal Communication Systems Devices Part 15D	ANSI C63.17:2013	40000
U-NII without DFS Intentional Radiators Part 15E	ANSI C63.10:2013	40000
U-NII with DFS Intentional Radiators Part 15E	FCC KDB 905462 D02 (v02)	40000
UWB Intentional Radiators Part 15F	ANSI C63.10:2013	40000
BPL Intentional Radiators Part 15G	ANSI C63.10:2013	40000
White Space Device Intentional Radiators Part 15H	ANSI C63.10:2013	40000
Commercial Mobile Services (FCC Licensed Radio Service Equipment) Parts 22 (cellular), 24, 25 (below 3 GHz), and 27	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
General Mobile Radio Services (FCC Licensed Radio Service Equipment) Parts 22 (non-cellular), 90 (below 3 GHz), 95, 97, and 101 (below 3 GHz)	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
Citizens Broadband Radio Services (FCC Licensed Radio Service Equipment) Part 96	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000

Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1[2]

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
Maritime and Aviation Radio Services		
Parts 80 and 87	ANSI/TIA-603-E; ANSI C63.26:2015	40000
Microwave and Millimeter Bands Radio Services		
Parts 25, 30, 74, 90 (above 3 GHz), 97 (above 3 GHz), and 101	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
Broadcast Radio Services		
Parts 73 and 74 (below 3 GHz)	ANSI/TIA-603-E; TIA-102.CAAA-E; ANSI C63.26:2015	40000
Signal Boosters		
Part 20 (Wideband Consumer Signal Boosters, Provider-specific signal boosters, and Industrial Signal Boosters) Section 90.219	ANSI C63.26:2015	40000

[2] Accreditation does not imply acceptance to the FCC equipment authorization program. Please see the FCC website (https://apps.fcc.gov/oetcf/eas/) for a listing of FCC approved laboratories.

Accredited Laboratory

A2LA has accredited

ELITE ELECTRONIC ENGINEERING INC.

Downers Grove, IL

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories.* This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 19th day of May 2021.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 1786.01
Valid to June 30, 2023

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.