



Engineering Test Report No. 2501108-03 Rev. A

Report Date	July 24, 2025	
Manufacturer Name	Badger Meter, Incorporated	
Manufacturer Address	4545 W. Brown Deer Road Milwaukee, WI 53553	
Test Item Name Model No.	ORION Cellular HLG HLG	
Date Received	May 21, 2025	
Test Dates	June 23, 2025 – July 15, 2025	
Specifications	FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 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	<i>Nathaniel Bouchie</i>	
Tested by	Nathaniel Bouchie	
Signature	<i>Raymond J. Klouda</i>	
Approved by	Raymond J. Klouda, Registered Professional Engineer of Illinois – 44894	
PO Number	508151	

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1. Report Revision History

Revision	Date	Description
–	28 JUL 2025	Initial Release of Engineering Test Report No. 2501108-03
A	2 SEP 2025 By NDB	<ul style="list-style-type: none">- Throughout the report: Changed report number to 2501108-03 Rev. A- Sections 20 – 30: Corrected Modes in headers to match data collected

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, Incorporated ORION Cellular HLG (hereinafter referred to as the Equipment Under Test (EUT)). The EUTs were manufactured and submitted for testing by Badger Meter, Incorporated located in Milwaukee, WI.

2.2. Purpose

The test series was performed to determine if the EUTs meet the RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, §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 EUTs meet the RF emission requirements of the 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.

2.3. Identification of the EUT

The EUTs were identified as follows:

EUT Identification	
Product Description	ORION Cellular HLG
Model/Part No.	HLG
Serial No.	180001156 – Radiated Sample 180001134 – Conducted Sample
Size of EUT	5 in x 2.75 in x 2.5 in
Software/Firmware Version	FW Version 2.12.790
Device Type	Frequency Hopping Transmission Device
Band of Operation	902 – 928MHz
Antenna Type	Surface mount, chip antenna
Conducted Output Power	11.29dBm
20dB Bandwidth	324.7kHz
Occupied Bandwidth (99% CBW)	266.5kHz

The EUTs listed above were used throughout the test series.

3. Power Input

The EUTs were powered by 3.6VDC from a twisted wire pair.

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 #	S/N
Support Laptop	Latitude E5570	Badger Meter tag PC10438
Actisys IR Dongle	ACT-IR224UN-L	TA009650

6. Interconnect Leads

The following interconnect cables were submitted with the test item:

Item	Description
USB	Connects laptop to IR Dongle

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 EUTs were programmed to transmit in one of the following modes, using the following steps:

- 1) Point the IR Dongle towards the EUT's communication LED, which protrudes slightly from the potting.
- 2) Plug the EUTs into 3.6VDC. After 10 seconds, a red LED should flash (not the communication LED).
- 3) Open the file name aq_console.exe on the support laptop.
- 4) Type "COM#" where the # is the COM port populated by the IR Dongle. Hit enter.
- 5) Type "deviceid" and hit enter to verify that the EUTs are communicating with the support laptop. The response should read, "deviceid: ____" and the id should correspond to the serial number printed on the EUTs.
- 6) Type the commands provided in the following table to program the EUTs into the corresponding mode. The EUTs will stay in the required mode for 30 minutes.

Mode	Required Command
Tx @ 904.9MHz, Ch1	radiorunbasebandtest 4 0 1 3 1800000
Tx @ 914.1MHz, Ch24	radiorunbasebandtest 4 0 24 3 1800000
Tx @ 923.69MHz, Ch48	radiorunbasebandtest 4 0 48 3 1800000
Hopping	radiorunhoptest 0 1 24000 500

To achieve the required power level, the following command was input between steps (5) and (6) above:

Power Level	Required Command
02	devmemorywrite 0x20002230 02

9. Test Specifications

The tests were performed to selected portions of, and in accordance with, the test specifications.

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

10. Test Plan

No test plan was provided. Instructions were provided by personnel from Badger Meter, Incorporated 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, 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

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

Ambient Parameters	Value
Temperature	24.2°C
Relative Humidity	41%
Atmospheric Pressure	1019mb

13. Summary

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

Test Description	Requirements	Test Method	S/N	Results
20dB Bandwidth	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	180001134	Conforms
Occupied Bandwidth (99%)	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	180001134	Conforms
Carrier Frequency Separation	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	180001134	Conforms
Number of Carrier Channels	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	180001134	Conforms
Average Time of Occupancy	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	180001134	Conforms
Maximum Peak Conducted Output Power	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	180001134	Conforms
Effective Isotropic Radiated Power (EIRP)	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	180001156	Conforms
Duty Cycle Factor Measurements	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	180001156	N/A
Antenna Conducted Spurious Emissions	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	180001134	Conforms
Spurious Radiated Emissions	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	180001156	Conforms
Band-Edge Compliance	FCC 15.247 ISED RSS-247	ANSI C63.10:2013	180001156	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).

$$\text{Formula 1: } VL \text{ (dB}\mu\text{V)} = \text{MTR (dB}\mu\text{V)} + \text{CF (dB)}.$$

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.

$$\text{Formula 1: FS (dB}\mu\text{V/m)} = \text{MTR (dB}\mu\text{V)} + \text{AF (dB/m)} + \text{CF (dB)} + (-\text{PA (dB)}) + \text{DC (dB)}$$

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

$$\text{Formula 2: FS (}\mu\text{V/m)} = \text{AntiLog} [(\text{FS (dB}\mu\text{V/m)})/20]$$

15. Statement of Conformity

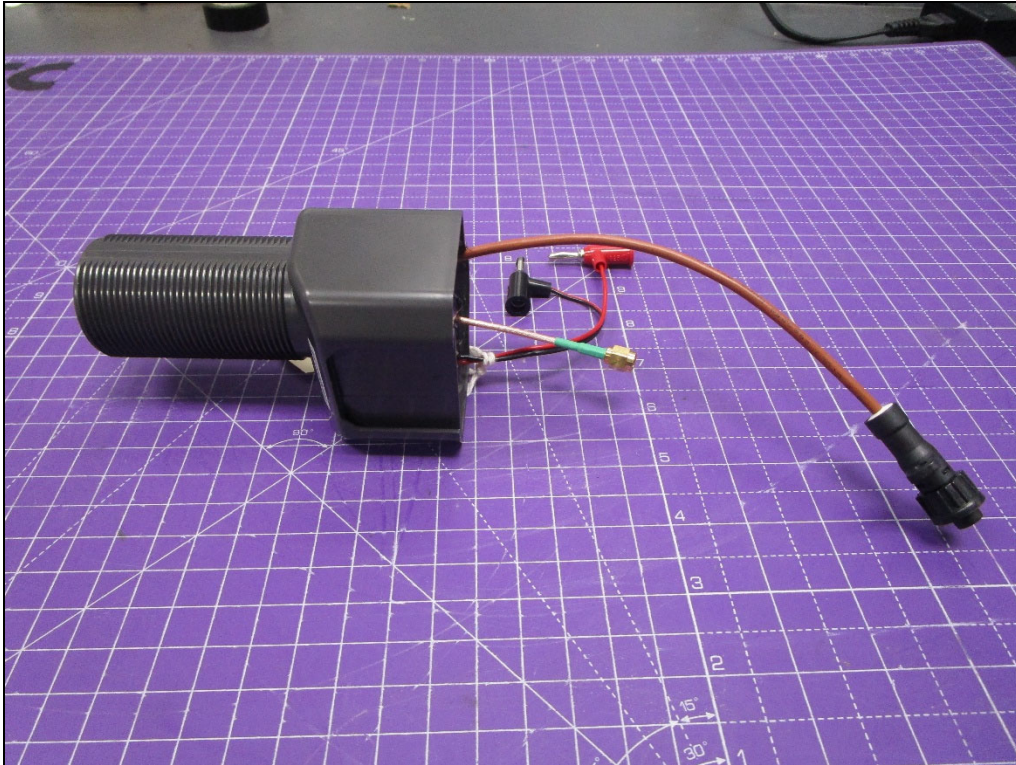
The Badger Meter, Incorporated ORION Cellular HLG did fully conform to the selected requirements of FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.247 and Innovation, Science, and Economic Development Canada, RSS-247:

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 EUTs as received by the customer 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
APW10	Preamplifier	Planar	PE2-35-120-5R0-10-12-SFF	PL11685/1241	1-18GHz	3/18/2025	3/18/2026
APW3	Preamplifier	Planar	PE2-35-120-5R0-10-12	PL2924	1-18GHz	3/24/2025	3/24/2026
CDZ5	LAB WORKSTATION	ELITE	LWS-10		WINDOWS 10	N/A	
NSDS1	UNIVERSAL SPHERICAL DIPOLE SOURCE	AET	USDS-H	AET-1116		NOTE 1	
NTA3	BILOG ANTENNA	TESEQ	6112D	32853	25-2000MHz	10/3/2024	10/3/2026
NWQ1	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS-LINDGREN	3117	66655	1GHZ-18GHZ	7/26/2024	7/26/2026
NWQ2	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66659	1GHZ-18GHZ	4/26/2024	4/26/2026
R21F	3M ANECHOIC CHAMBER NSA	EMC TEST SYSTEMS	3M ANECHOIC		30MHZ-18GHZ	3/1/2025	3/1/2026
R29F	3M ANECHOIC CHAMBER NSA	EMC TEST SYSTEMS	3M ANECHOIC		30MHZ-18GHZ	6/1/2025	6/1/2027
RBF2	WIDEBAND RADIO COMM. TESTER	ROHDE & SCHWARZ	CMW500	121396	---	5/7/2025	5/7/2026
RBG2	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101591	2HZ-44GHZ	6/16/2024	7/16/2025
RBG3	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101592	2HZ-44GHZ	5/4/2025	5/4/2026
RBG4	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	103007	2HZ-44GHZ	4/5/2025	4/5/2026
SES0	24VDC POWER SUPPLY	P-TRANS	FS-32024-1M	001	18-27VDC	NOTE 1	
SHC2	Power Supplies	HENGFU	HF60W-SL-24	A11372702	24V	NOTE 1	
SMAW	DC POWER SUPPLY	VOLTEQ	HY3020EX	02177910	30VDC/20A	NOTE 1	
T1E33	10DB 20W ATTENUATOR	MINI-CIRCUITS	BW-N10W20+	---	DC-18GHZ	12/19/2023	12/19/2025
T2D16	20DB 20W ATTENUATOR	MINI-CIRCUITS	BW-N20W20+	---	DC-18GHZ	2/15/2024	2/15/2026
T2DP	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BS0921	DC-18GHZ	2/4/2025	2/4/2027
VBV2	COMMERCIAL RADIATED EMISSIONS.EXE	ELITE		---	---	N/A	
XPQ3	HIGH PASS FILTER	K&L MICROWAVE	4IH30-1804/T10000-0	4	1.8GHZ-10GHZ	9/14/2023	9/14/2025
XPR0	HIGH PASS FILTER	K&L MICROWAVE	11SH10-4800/X20000	001	4.8-20GHZ	9/14/2023	9/14/2025

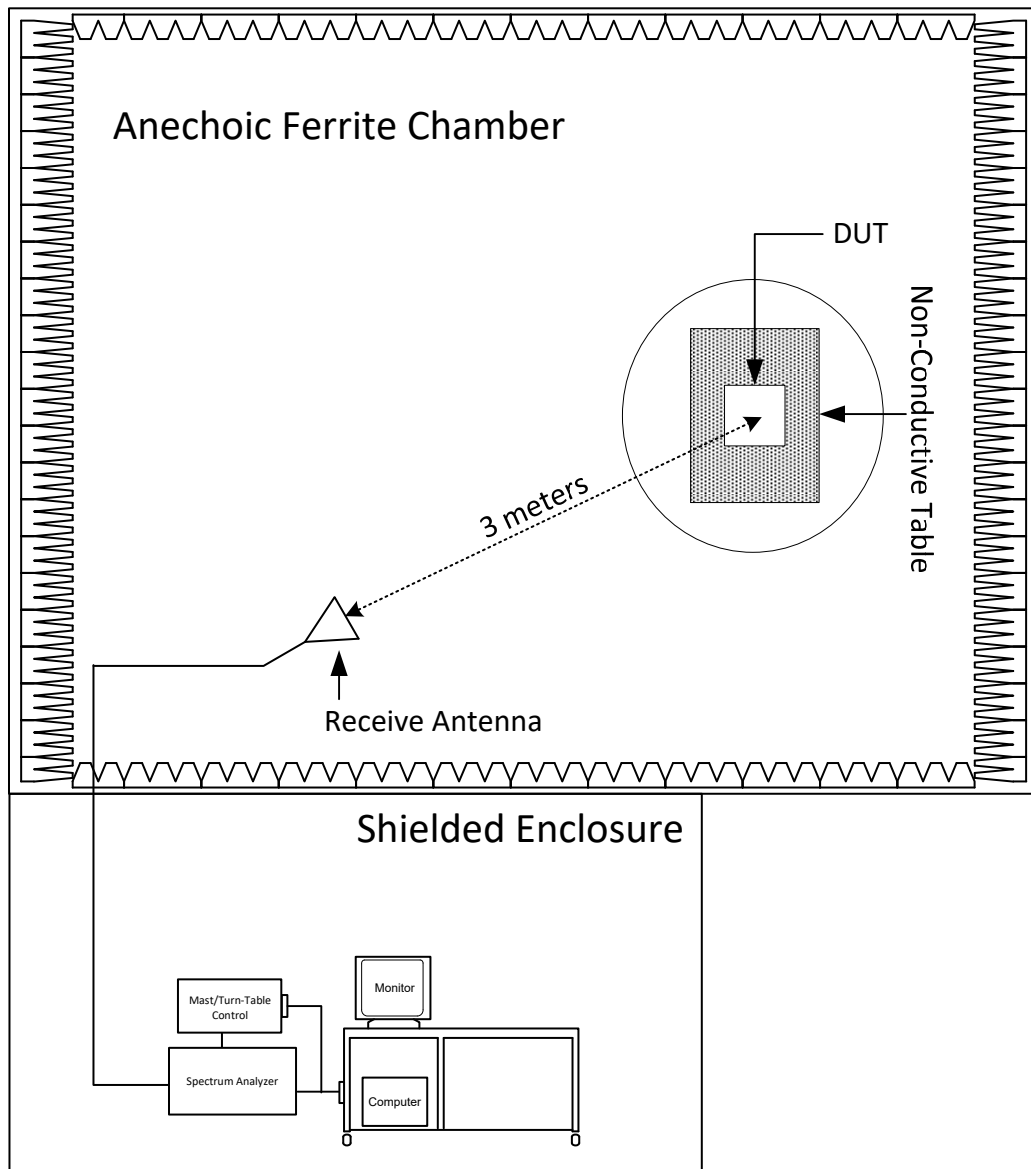
N/A: Not Applicable

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. 20dB Bandwidth

EUT Information	
Manufacturer	Badger Meter, Incorporated
Product	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 904.9MHz, Ch1 Tx @ 914.1MHz, Ch24 Tx @ 923.69MHz, Ch48

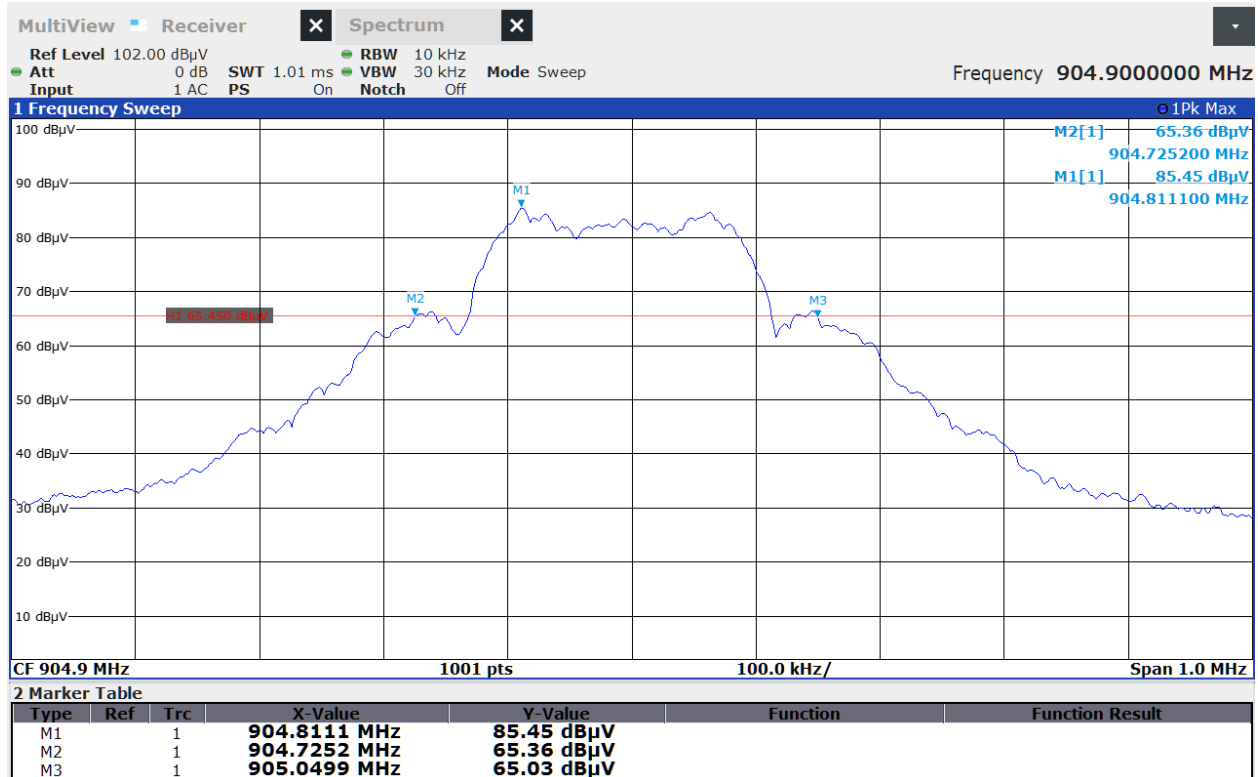
Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop

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
<p>The antenna port of the EUT was connected to the spectrum analyzer through 30dB of attenuation. With the hopping function disabled, the EUT was allowed to transmit continuously.</p> <p>The frequency hopping channel was set separately to low, middle, and high hopping channels. The resolution bandwidth (RBW) was set to $\geq 1\%$ of the 20dB BW. The span was set to approximately 2 to 3 times the 20dB bandwidth.</p> <p>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.</p>

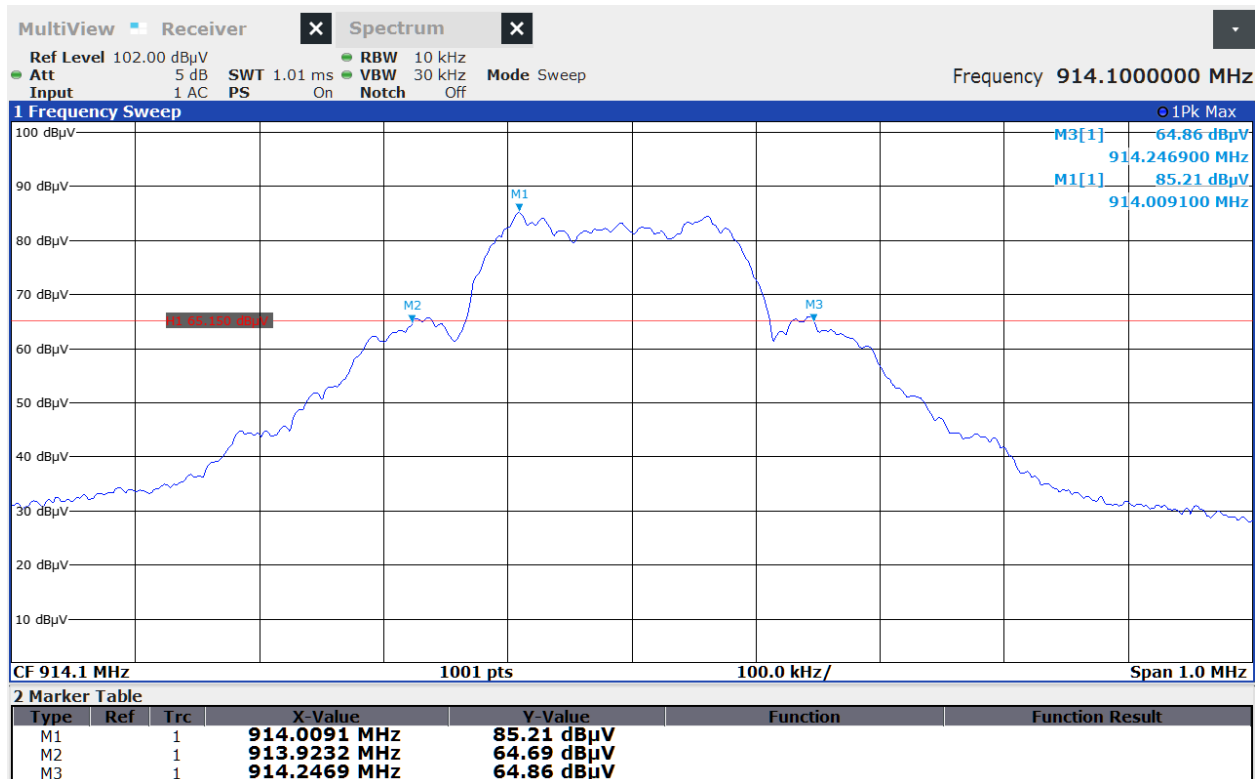
Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 904.9MHz, Ch1
Result	20dB BW = 905.0499 – 904.7252 = 324.7kHz



Manufacturer : Badger Meter Incorporated
Model Number : HLG
Serial Number : 180001134
Mode : Tx @ 904.9MHz
Parameters : 20dB BW > 250kHz
Date : 7/24/2025 1:49:21 PM
Notes :

TRACE1 : Function plot of Max Hold Peak

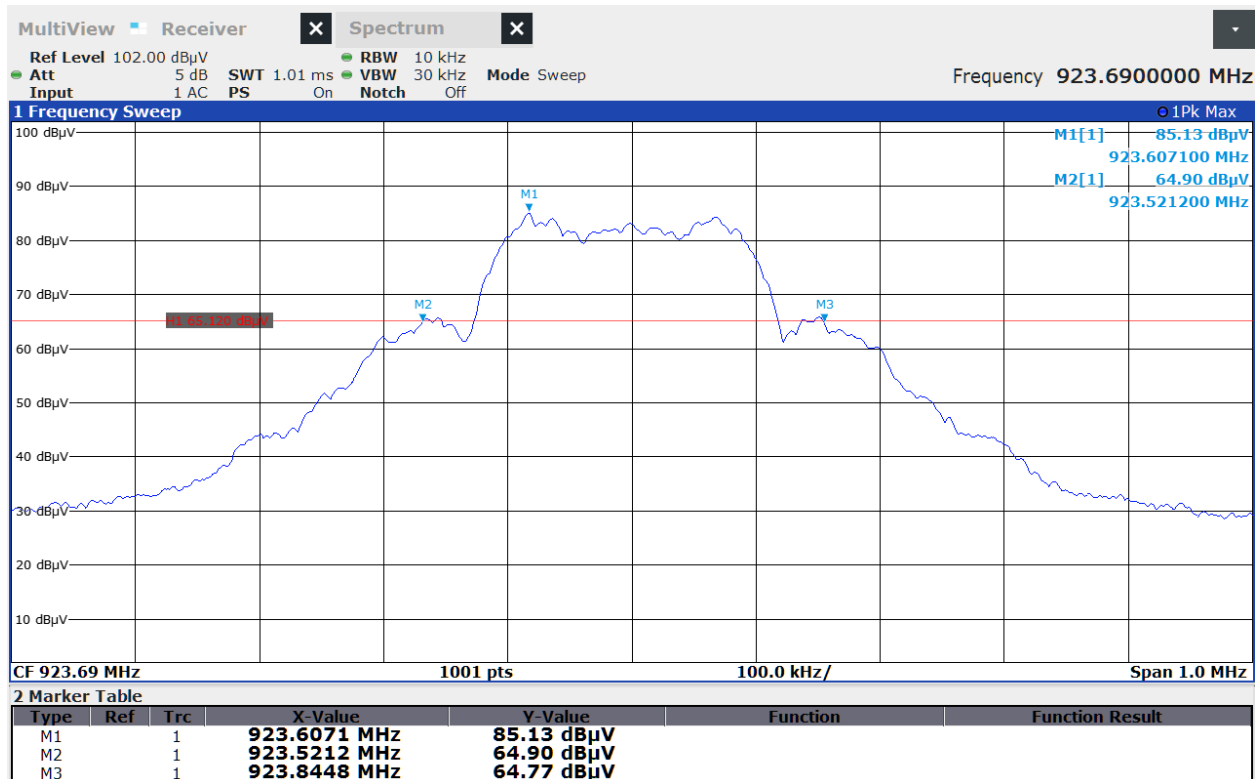
Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 914.1MHz, Ch24
Result	20dB BW = 914.2469 – 913.9232 = 323.7kHz



Manufacturer : Badger Meter Incorporated
 Model Number : HLG
 Serial Number : 180001134
 Mode : Tx @ 914.1MHz
 Parameters : 20dB BW > 250kHz
 Date : 7/24/2025 1:53:28 PM
 Notes :

TRACE1 : Function plot of Max Hold Peak

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 923.69MHz, Ch48
Result	20dB BW = 923.8448 – 923.5212 = 323.6kHz



Manufacturer : Badger Meter Incorporated
Model Number : HLG
Serial Number : 180001134
Mode : Tx @ 923.65MHz
Parameters : 20dB BW > 250kHz
Date : 7/24/2025 1:56:40 PM
Notes :

TRACE1 : Function plot of Max Hold Peak

21. Occupied Bandwidth (99%)

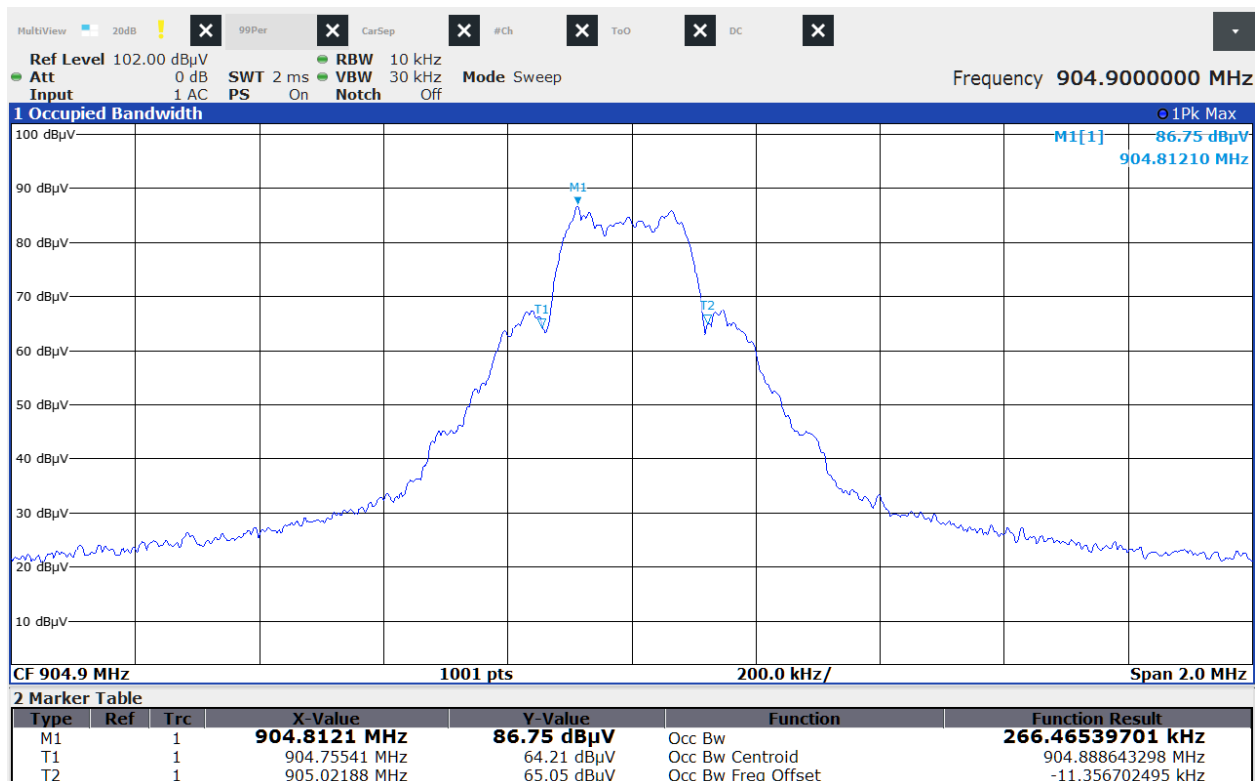
EUT Information	
Manufacturer	Badger Meter, Incorporated
Product	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 904.9MHz, Ch1 Tx @ 914.1MHz, Ch24 Tx @ 923.69MHz, Ch48

Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop

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
<p>The antenna port of the EUT was connected to the spectrum analyzer through 30dB of attenuation.</p> <p>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 / x dB 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.</p> <p>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.</p>

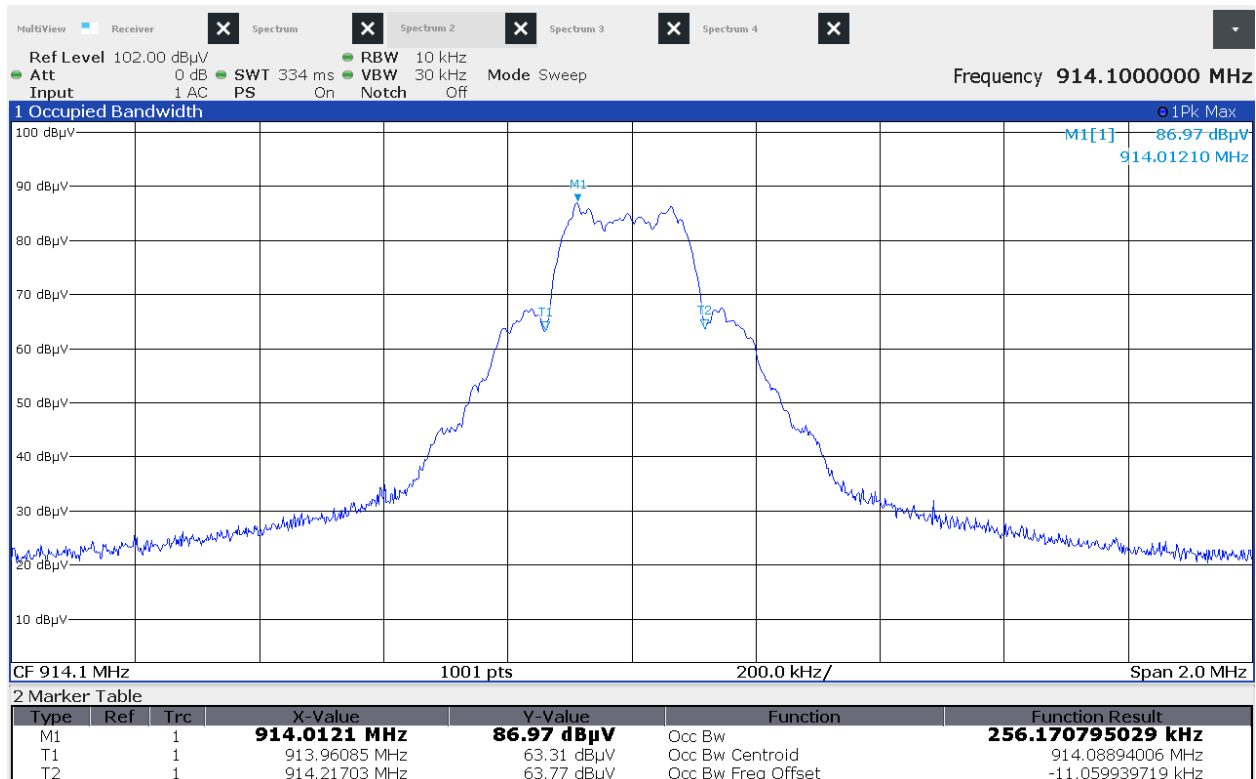
Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 904.9MHz, Ch1
Result	OBW = 266.46kHz



Manufacturer : Badger Meter Incorporated
 Model Number : HLG
 Serial Number : 180001156
 Mode : Tx @ 904.9MHz
 Parameters :
 Date : 6/26/2025 8:04:27 AM
 Notes :

TRACE1 : Function plot of Max Hold Peak

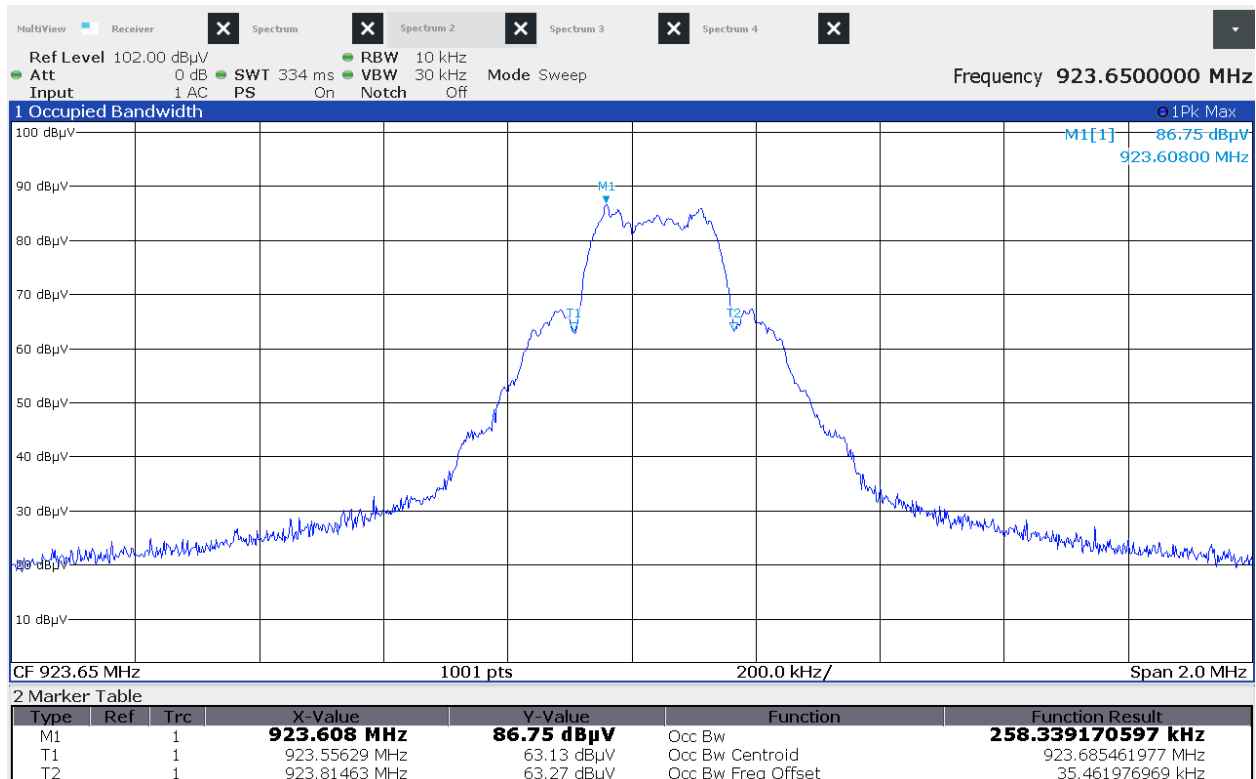
Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 914.1MHz, Ch24
Result	OBW = 256.17kHz



Manufacturer : Badger Meter Incorporated
 Model Number : HLG
 Serial Number : 180001156
 Mode : Tx @ 914.1MHz
 Parameters :
 Date : 6/26/2025 9:37:46 AM
 Notes :

TRACE1 : Function plot of Max Hold Peak

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 923.69MHz, Ch48
Result	OBW = 258.34kHz



Manufacturer : Badger Meter Incorporated
 Model Number : HLG
 Serial Number : 180001156
 Mode : Tx @ 923.65MHz
 Parameters :
 Date : 6/26/2025 9:43:26 AM
 Notes :

TRACE1 : Function plot of Max Hold Peak

22. Carrier Frequency Separation

EUT Information	
Manufacturer	Badger Meter, Incorporated
Product	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Hopping

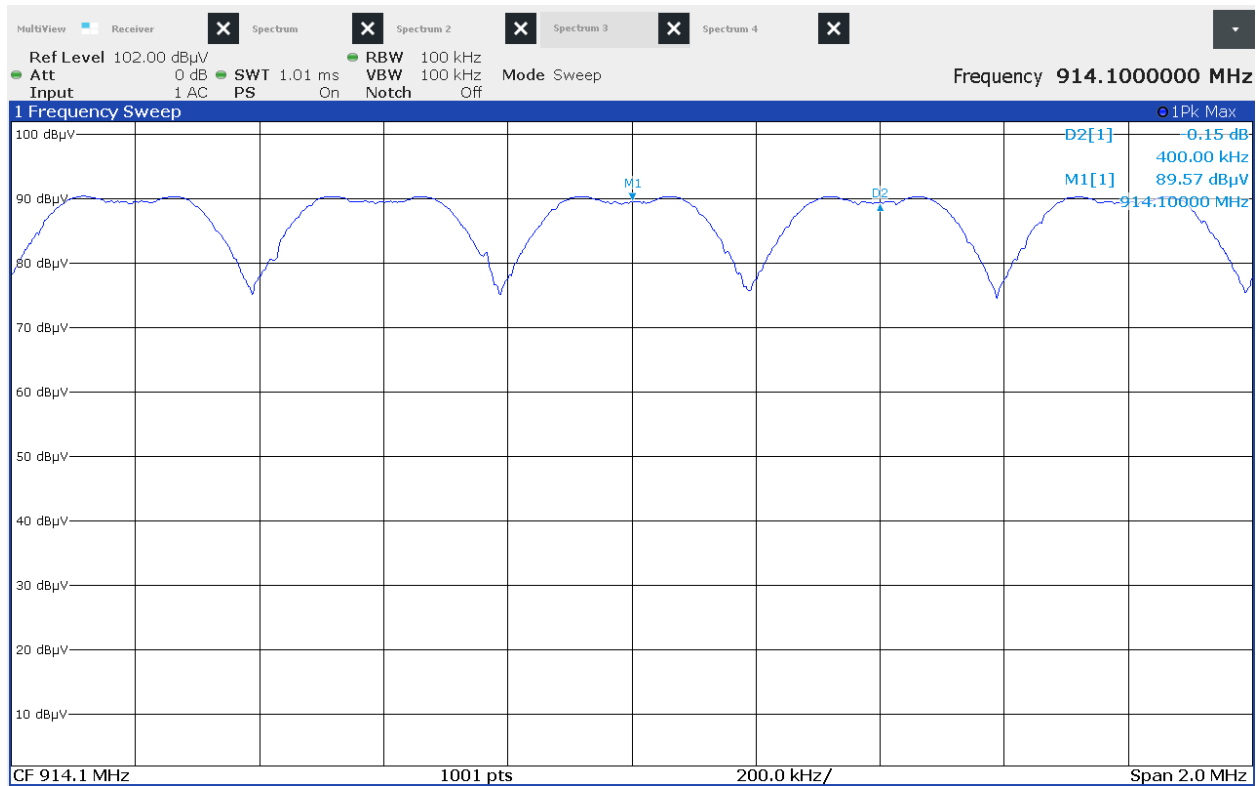
Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop

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.

Procedure
<p>The antenna port of the EUT was connected to the spectrum analyzer through 30dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously.</p> <p>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.</p>

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Hopping
Result	Frequency Separation = 400kHz



Manufacturer : Badger Meter Incorporated
 Model Number : HLG
 Serial Number : 180001134
 Mode : Hopping
 Parameters :
 Date : 6/26/2025 10:24:09 AM
 Notes :

TRACE1 : Function plot of Max Hold Peak

23. Number of Carrier Channels

EUT Information	
Manufacturer	Badger Meter, Incorporated
Product	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Hopping

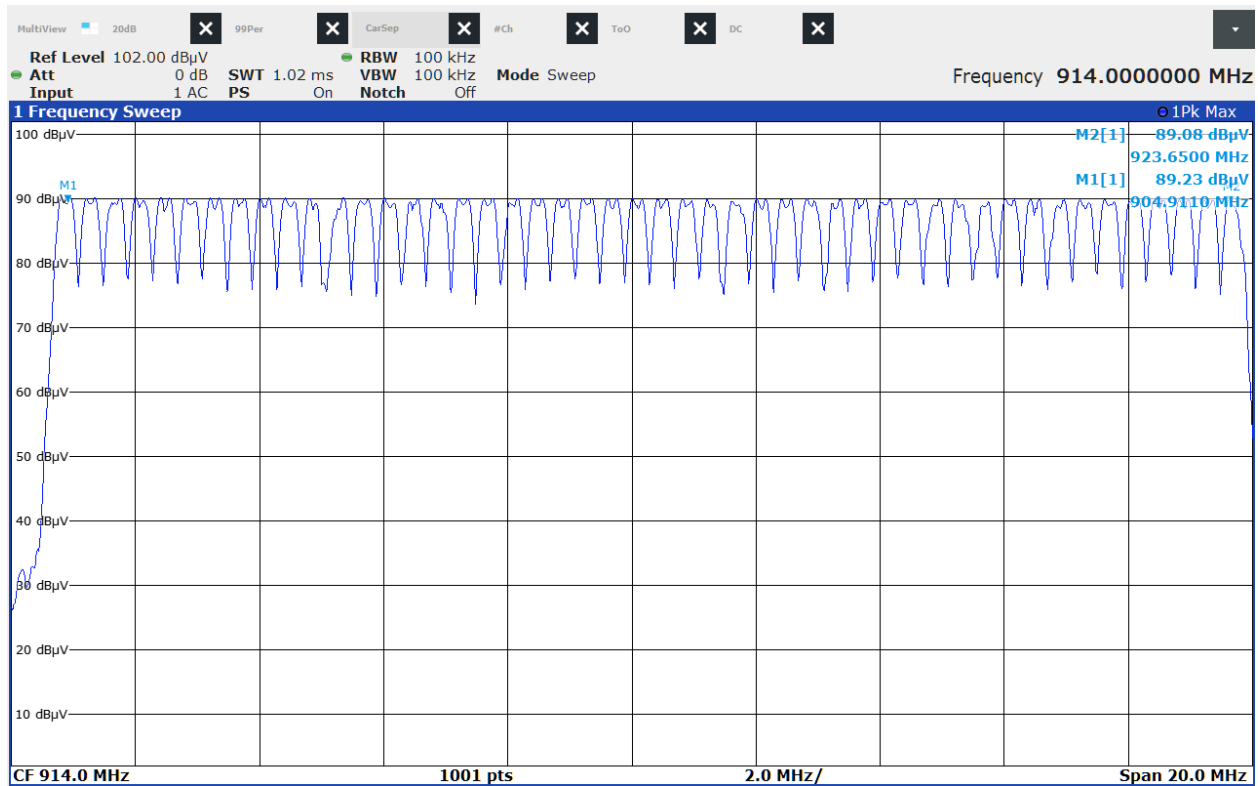
Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop

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
The system shall use at least 25 hopping frequencies.

Procedure
<p>The antenna port of the EUT was connected to the spectrum analyzer through 30dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously.</p> <p>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.</p> <p>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.</p>

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Hopping
Result	48 hopping frequencies



Manufacturer : Badger Meter Incorporated
 Model Number : HLG
 Serial Number : 180001156
 Mode : Hopping
 Parameters :
 Date : 6/26/2025 8:14:47 AM
 Notes :

TRACE1 : Function plot of Max Hold Peak

24. Average Time of Occupancy

EUT Information	
Manufacturer	Badger Meter, Incorporated
Product	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Hopping

Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop

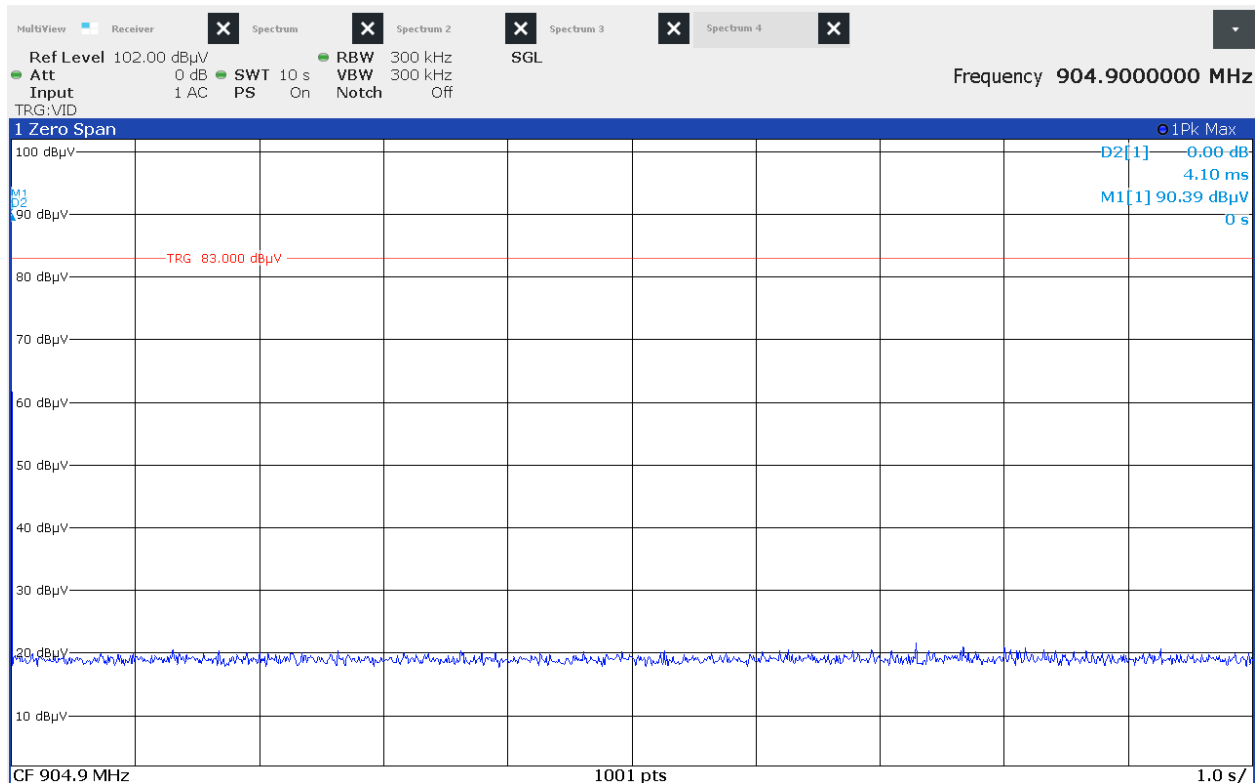
Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz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

Requirements
The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

Procedure
<p>The antenna port of the EUT was connected to the spectrum analyzer through 30dB of attenuation. With the hopping function enabled, the EUT was allowed to transmit continuously.</p> <p>The spectrum analyzer was set to zero span centered on a hopping channel. The resolution bandwidth (RBW) was set \geq 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.</p>



Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Hopping
Result	Ave. Time of Occupancy = 4.1ms per 20 seconds



Manufacturer : Badger Meter Incorporated
Model Number : HLG
Serial Number : 180001134
Mode : Hopping
Parameters :
Date : 6/26/2025 10:32:09 AM
Notes :

TRACE1 : Function plot of Max Hold Peak

25. Maximum Peak Conducted Output Power

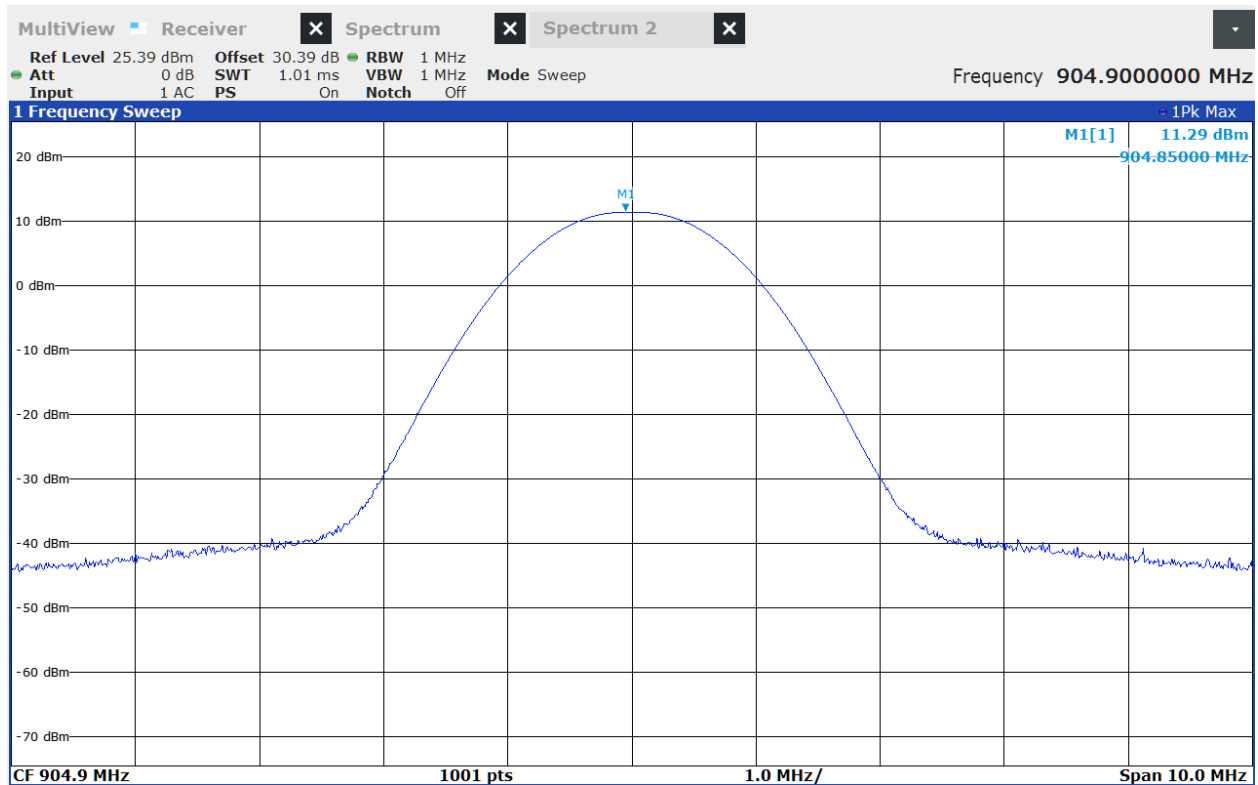
EUT Information	
Manufacturer	Badger Meter, Incorporated
Product	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 904.9MHz, Ch1 Tx @ 914.1MHz, Ch24 Tx @ 923.69MHz, Ch48

Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop

Requirements
The output power shall not exceed 125mW (21dBm).

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 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.

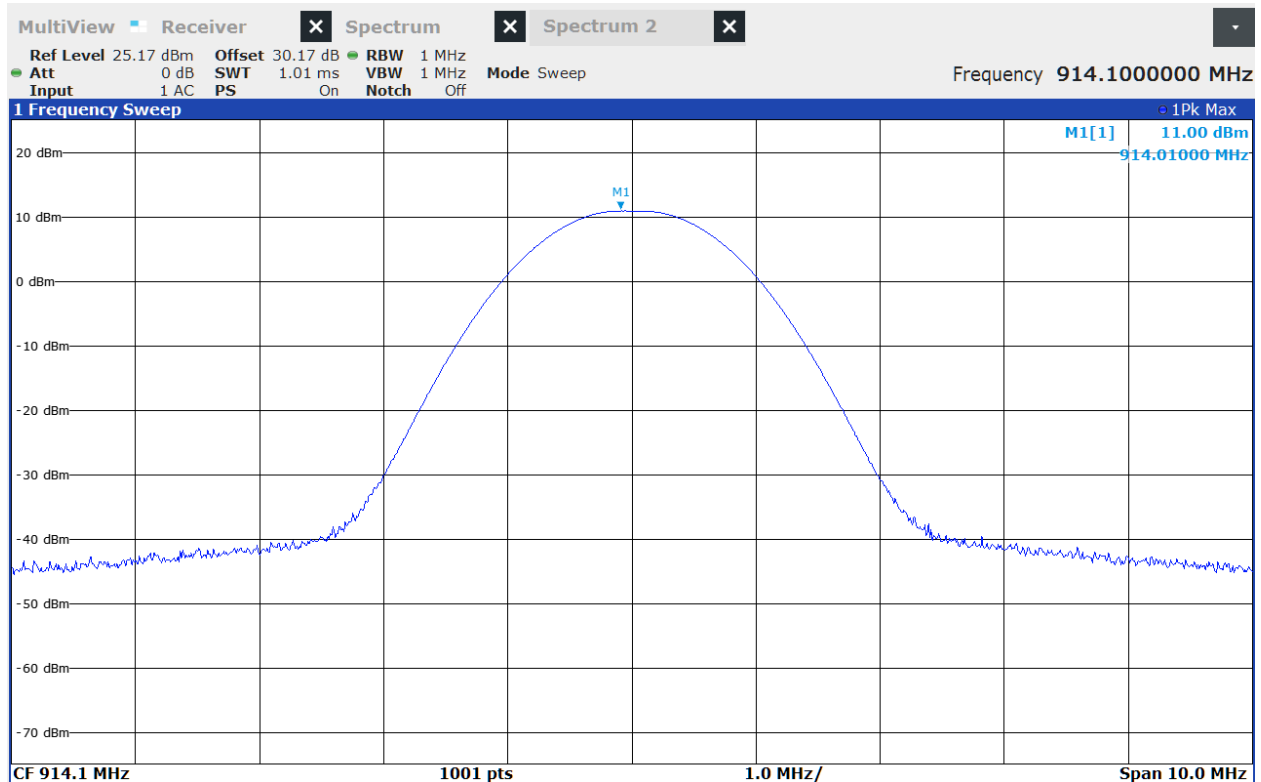
Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 904.9MHz, Ch1
Result	Output Power = 13.5mW (11.29dBm)
Notes	Power Setting "02" was used.



Manufacturer : Badger Meter, Incorporated
Model Number : HLG
Serial Number : 180001134
Mode : Tx @ 904.9MHz, Ch1
Parameters :
Date : 7/15/2025 8:03:17 AM
Notes :

TRACE1 : Function plot of Max Hold Peak

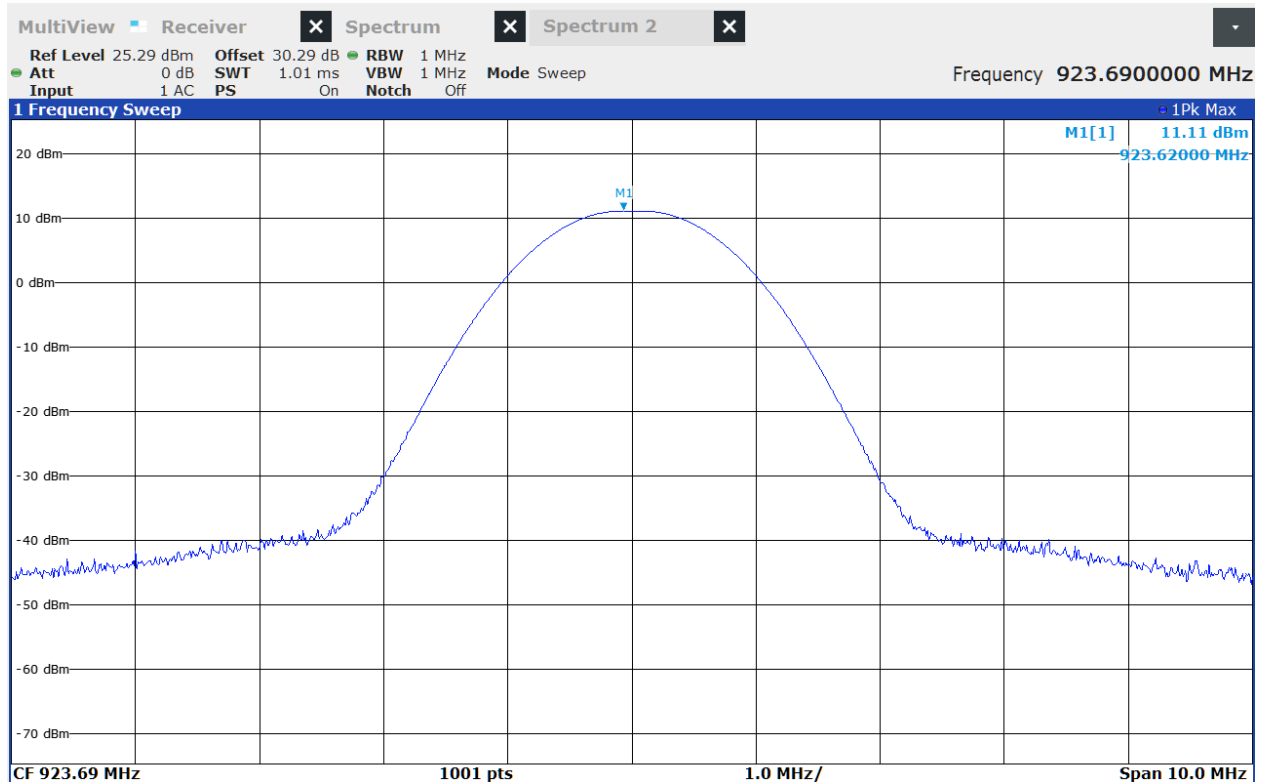
Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 914.1MHz, Ch24
Result	Output Power = 12.6mW (11dBm)
Notes	Power Setting "02" was used.



Manufacturer : Badger Meter, Incorporated
Model Number : HLG
Serial Number : 180001134
Mode : Tx @ 914.1MHz, Ch24
Parameters :
Date : 7/15/2025 8:05:04 AM
Notes :

TRACE1 : Function plot of Max Hold Peak

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 923.69MHz, Ch48
Result	Output Power = 12.9mW (11.11dBm)
Notes	Power Setting "02" was used.



Manufacturer : Badger Meter, Incorporated
Model Number : HLG
Serial Number : 180001134
Mode : Tx @ 923.69MHz, Ch48
Parameters :
Date : 7/15/2025 8:06:48 AM
Notes :

TRACE1 : Function plot of Max Hold Peak

26. Effective Isotropic Radiated Power (EIRP)

EUT Information	
Manufacturer	Badger Meter, Incorporated
Product	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 904.9MHz, Ch1 Tx @ 914.1MHz, Ch24 Tx @ 923.69MHz, Ch48

Test Setup Details	
Setup Format	Tabletop
Measurement Method	Radiated
Type of Test Site	Semi-Anechoic Chamber
Test Site Used	R29F
Type of Antennas Used	Bilog (or equivalent)

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
The output power shall not exceed 250mW (24dBm). EIRP shall not exceed (24+6 or 30dBm)

Procedure
<p>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.</p> <p>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.</p>

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 904.9MHz, Ch1 Tx @ 914.1MHz, Ch24 Tx @ 923.69MHz, Ch48
Result	Max EIRP = 32.4mW (15.1dBm)

Freq (MHz)	Ant Pol	Wide BW Meter Reading (dBμV)	Cable Factor (dB)	Antenna Factor (dB/m)	Pre Amp (dB)	Peak Total (dBμV/m)	EIRP (dBm)	Limit (dBm)	Margin (dB)
904.90	H	71.7	1.6	26.8	0.0	100.0	4.7	30.0	-25.3
	V	82.1	1.6	26.8	0.0	110.4	15.1	30.0	-14.9
914.10	H	72.5	1.6	26.7	0.0	100.7	5.4	30.0	-24.6
	V	81.1	1.6	26.7	0.0	109.3	14.0	30.0	-16.0
923.69	H	72.0	1.6	26.8	0.0	100.4	5.1	30.0	-24.9
	V	80.8	1.6	26.8	0.0	109.1	13.8	30.0	-16.2

27. Duty Cycle Factor Measurements

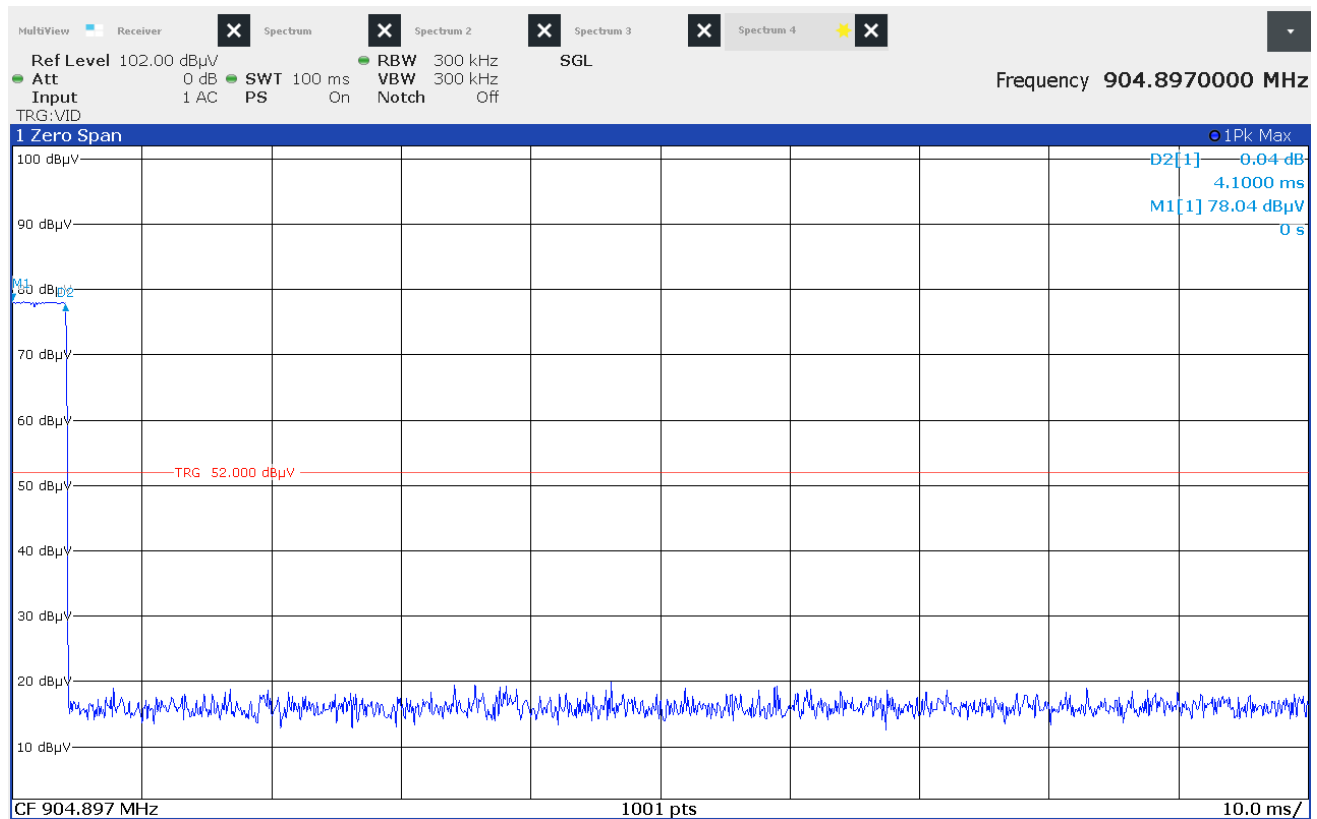
EUT Information	
Manufacturer	Badger Meter, Incorporated
Product	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 904.9MHz, Ch1

Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop

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
<p>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.</p> <p>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.</p> <p>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.</p> <p>The duty cycle is then computed as $\left(\frac{On\ Time}{Word\ Period}\right)$, where $Word\ Period = (On\ Time + Off\ Time)$.</p>

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 904.9MHz, Ch1
Result	Duty Cycle = - 27.74dB
Notes	Duty Cycle Factor Calculation: $1 \times 4.1\text{ms} = 4.1\text{ms}$ Duty Cycle Factor = $20 \log \left(\frac{4.1\text{ms}}{100\text{ms}} \right) = -27.74\text{dB}$



28. Antenna Conducted Spurious Emissions

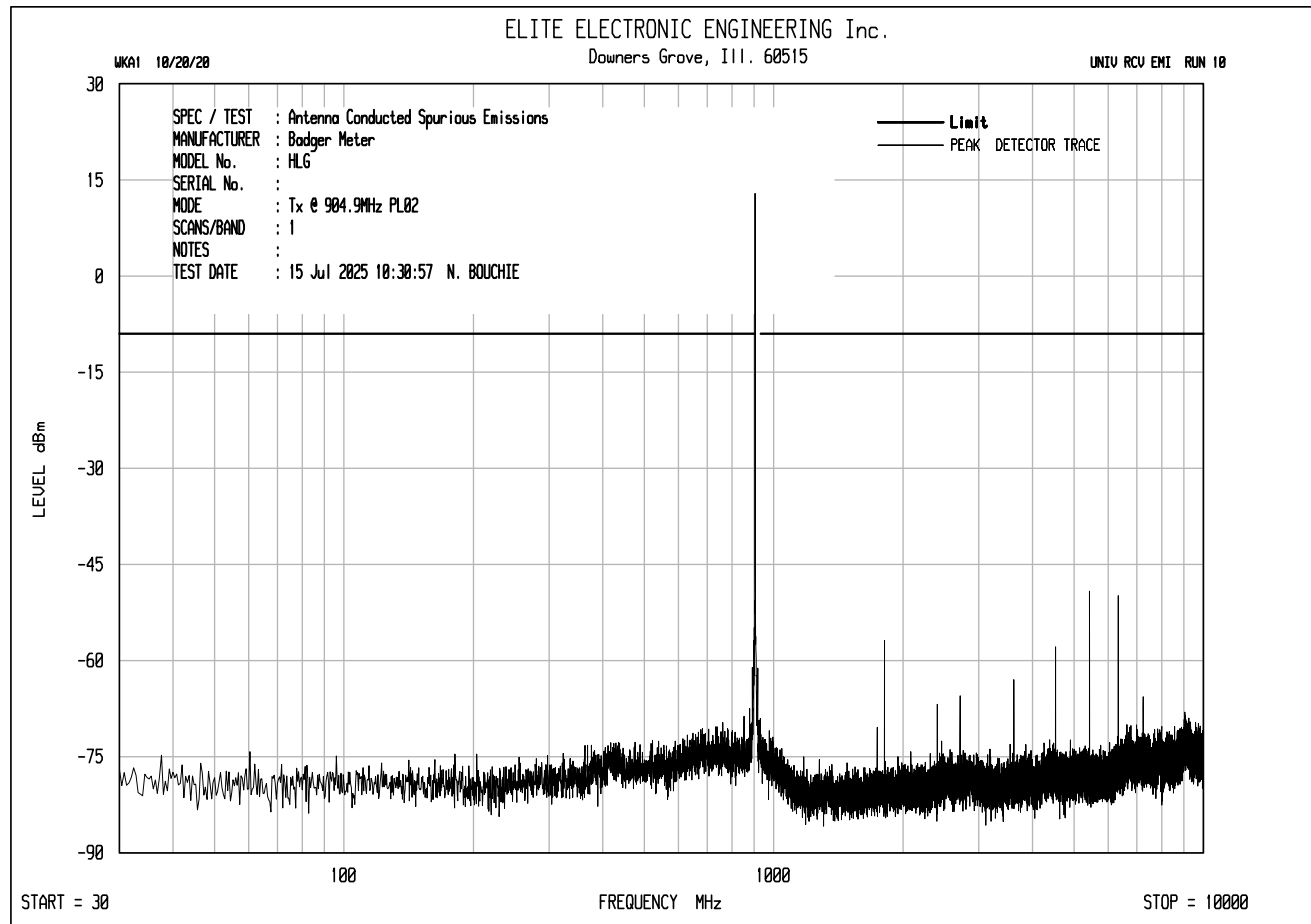
EUT Information	
Manufacturer	Badger Meter, Incorporated
Product	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 904.9MHz, Ch1 Tx @ 914.1MHz, Ch24 Tx @ 923.69MHz, Ch48

Test Setup Details	
Setup Format	Tabletop
Measurement Method	Antenna Conducted
Type of Test Site	Tabletop

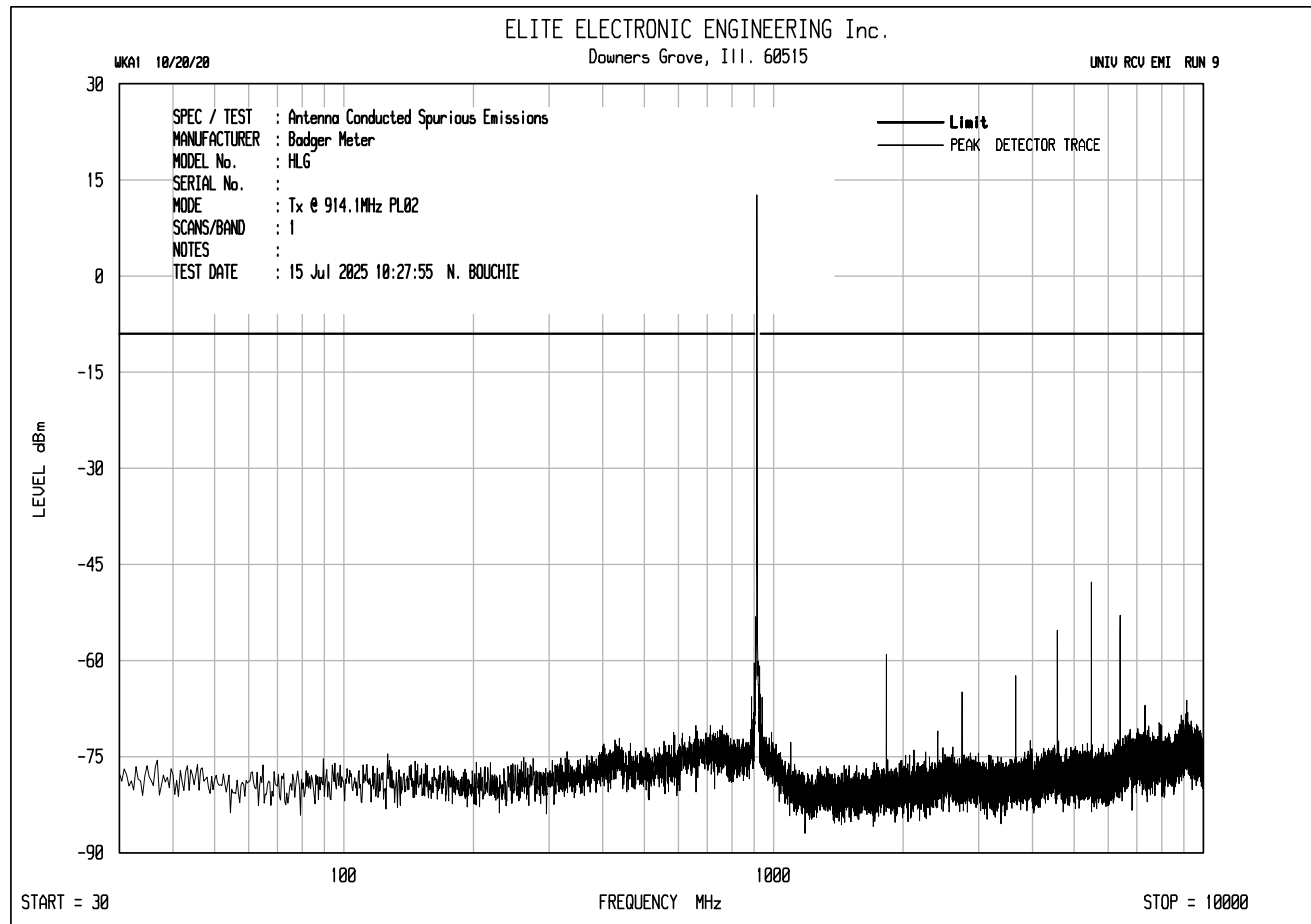
Requirements
Any emissions in a 100kHz bandwidth outside the frequency band must be 20dB below the 100kHz bandwidth of the fundamental emission.

Procedure
The antenna port of the EUT was connected to the spectrum analyzer through 13dB of attenuation. The frequency hopping function was disabled. The resolution bandwidth (RBW) was set to 100kHz. The peak detector and 'Max-Hold' function were engaged. The emissions in the frequency range from 30MHz to 10GHz were observed and plotted separately with the EUT transmitting at low, middle, and high hopping frequencies.

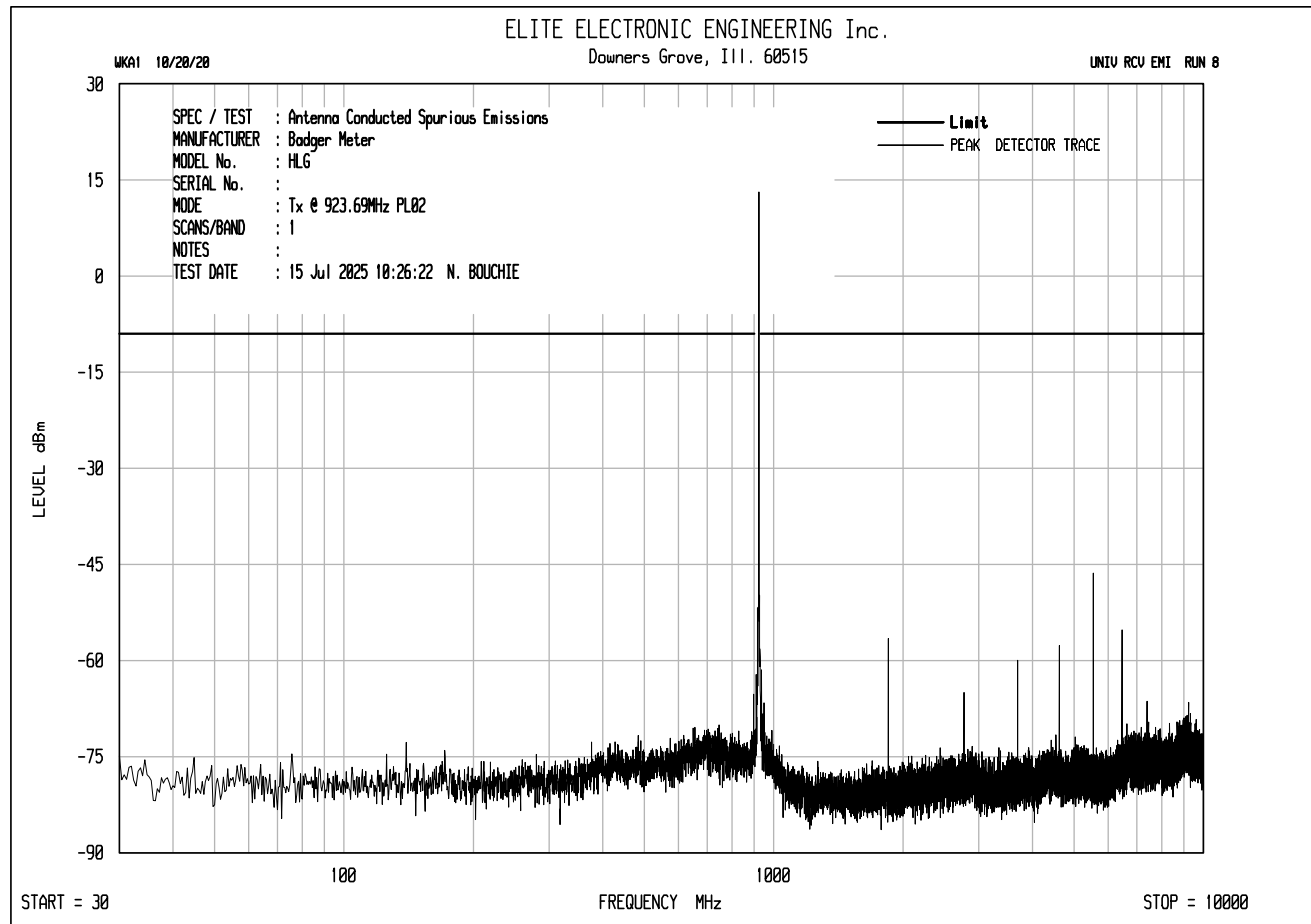
Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 904.9MHz, Ch1
Notes	Conducted Spurious Emissions



Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 914.1MHz, Ch24
Notes	Conducted Spurious Emissions



Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001134
Mode	Tx @ 923.69MHz, Ch48
Notes	Conducted Spurious Emissions



29. Spurious Radiated Emissions

EUT Information	
Manufacturer	Badger Meter, Incorporated
Product	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 904.9MHz, Ch1 Tx @ 914.1MHz, Ch24 Tx @ 923.69MHz, Ch48

Test Setup Details	
Setup Format	Tabletop
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)

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

Requirements
Any emissions in a 100kHz bandwidth inside an unrestricted band must be 20dB below the 100kHz bandwidth of the fundamental emission.
Any average emissions in a 1MHz bandwidth inside a restricted band must not exceed 500 μ V/m.
Any peak emissions in a 1MHz bandwidth inside a restricted band must not exceed the average emissions limit by 20dB.

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 power lines 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

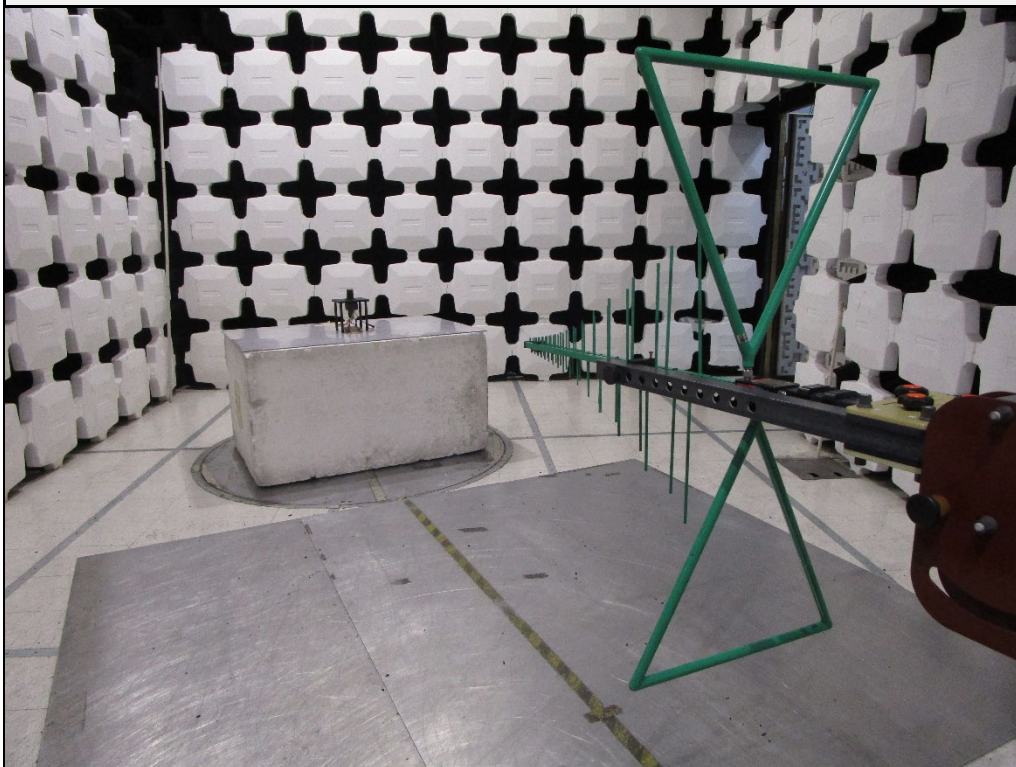
were measured.

- 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 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.

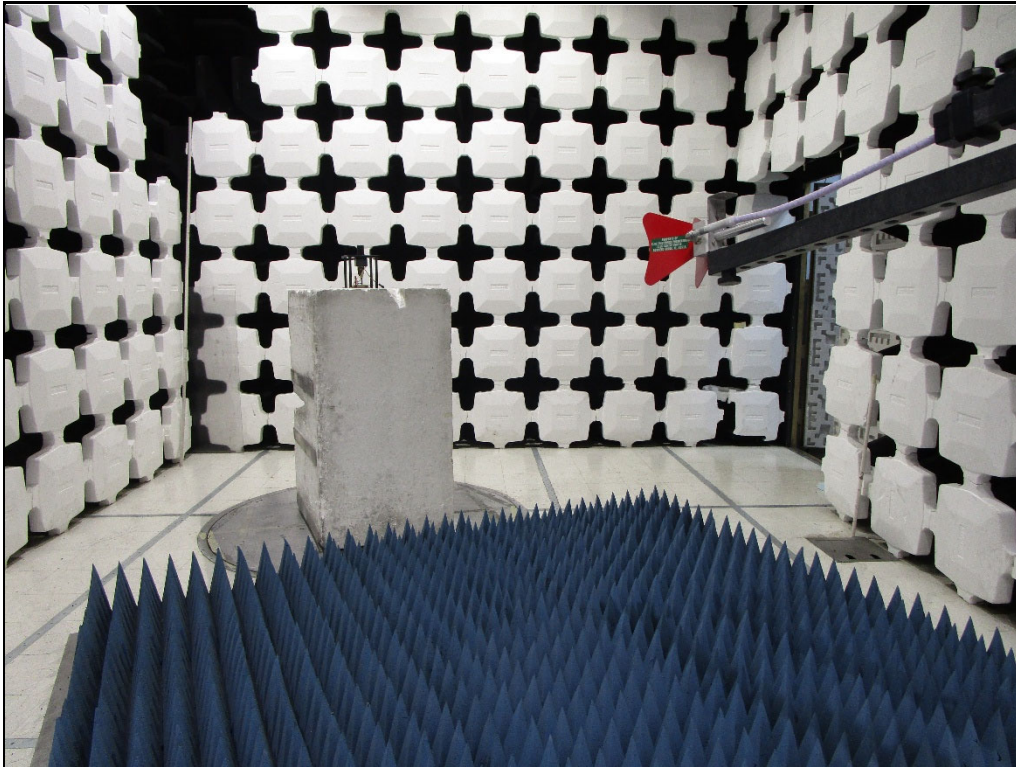
If the dwell time per channel of the hopping signal is less than 100msec, then the reading obtained with the 10Hz video bandwidth may be further adjusted by a duty cycle correction factor derived from $20 \cdot \log(\text{dwell time}/100\text{msec})$. These readings must be no greater than the limits specified in §15.209(a).



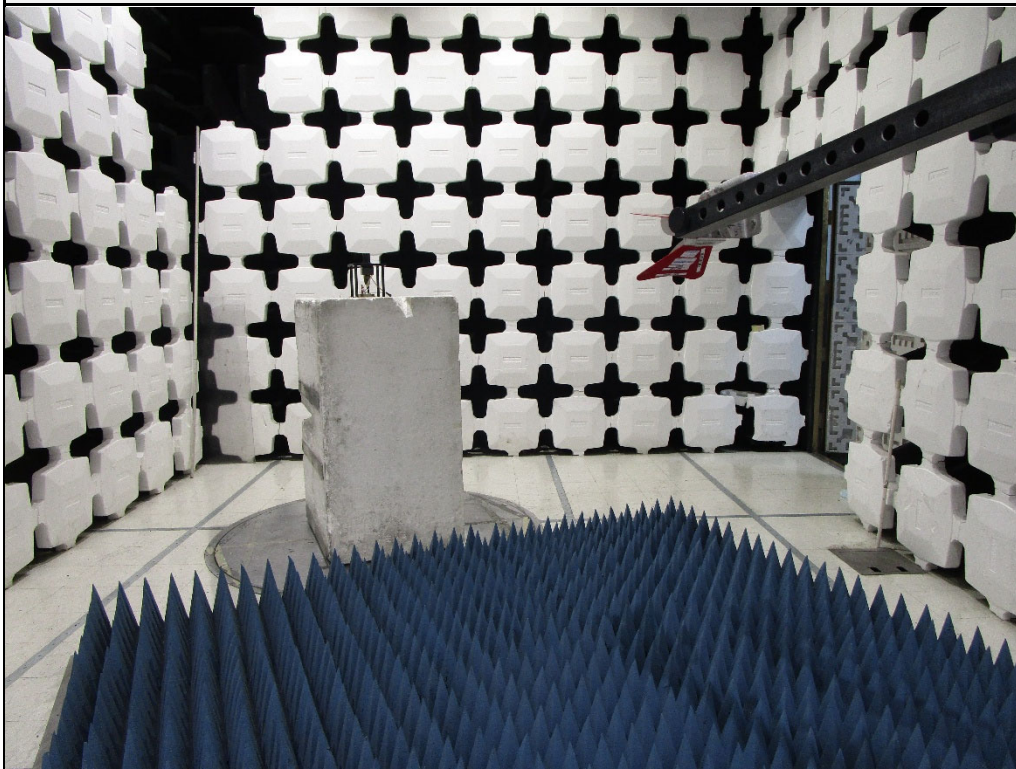
Test Setup for Spurious Radiated Emissions, 30MHz – 1GHz – Antenna Polarization Horizontal



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, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 904.9MHz, Ch1
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 (dB)
2714.70	H	53.0		2.8	33.1	-39.8	49.1	286.2	5000.0	-24.8
	V	51.6		2.8	33.1	-39.8	47.7	243.9	5000.0	-26.2
3619.60	H	60.3		3.2	33.2	-39.2	57.6	756.2	5000.0	-16.4
	V	61.9		3.2	33.2	-39.2	59.1	900.8	5000.0	-14.9
4524.50	H	63.1		3.6	34.3	-39.2	61.7	1212.3	5000.0	-12.3
	V	59.5		3.6	34.3	-39.2	58.1	803.8	5000.0	-15.9
5429.40	H	74.3		3.9	34.8	-39.4	73.7	4834.3	5000.0	-0.3
	V	67.6		3.9	34.8	-39.4	66.9	2225.0	5000.0	-7.0
8144.10	H	53.5		4.9	35.8	-39.4	54.8	551.0	5000.0	-19.2
	V	51.4		4.9	35.8	-39.4	52.7	429.2	5000.0	-21.3
9049.00	H	52.2		5.0	36.2	-39.3	54.0	503.8	5000.0	-19.9
	V	49.9		5.0	36.2	-39.3	51.7	386.1	5000.0	-22.2

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 904.9MHz, Ch1
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	53.03		2.8	33.1	-39.8	-27.7	21.4	11.7	500.0	-32.6
	V	51.64		2.8	33.1	-39.8	-27.7	20.0	10.0	500.0	-34.0
3619.60	H	60.33		3.2	33.2	-39.2	-27.7	29.8	31.0	500.0	-24.2
	V	61.85		3.2	33.2	-39.2	-27.7	31.3	36.9	500.0	-22.6
4524.50	H	63.06		3.6	34.3	-39.2	-27.7	33.9	49.7	500.0	-20.1
	V	59.49		3.6	34.3	-39.2	-27.7	30.4	33.0	500.0	-23.6
5429.40	H	74.30		3.9	34.8	-39.4	-27.7	45.9	198.2	500.0	-8.0
	V	67.56		3.9	34.8	-39.4	-27.7	39.2	91.2	500.0	-14.8
8144.10	H	53.52		4.9	35.8	-39.4	-27.7	27.1	22.6	500.0	-26.9
	V	51.35		4.9	35.8	-39.4	-27.7	24.9	17.6	500.0	-29.1
9049.00	H	52.20		5.0	36.2	-39.3	-27.7	26.3	20.7	500.0	-27.7
	V	49.89		5.0	36.2	-39.3	-27.7	24.0	15.8	500.0	-30.0

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 904.9MHz, Ch1
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 (dB)
904.90	H	72.03		1.6	26.8	0.0	100.4	104447.1	NA	NA
	V	82.35		1.6	26.8	0.0	110.7	342686.1	NA	NA
1809.80	H	61.96		2.2	29.4	-40.0	53.5	474.6	34268.6	-37.2
	V	62.42		2.2	29.4	-40.0	54.0	500.4	34268.6	-36.7
6334.30	H	58.40		4.3	35.5	-39.4	58.8	871.0	34268.6	-31.9
	V	49.83		4.3	35.5	-39.4	50.2	324.7	34268.6	-40.5
7239.20	H	61.41		4.7	35.7	-39.4	62.4	1316.5	34268.6	-28.3
	V	57.43		4.7	35.7	-39.4	58.4	832.6	34268.6	-32.3

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 914.1MHz, Ch24
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 (dB)
2742.30	H	52.1		2.8	33.0	-39.7	48.2	255.7	5000.0	-25.8
	V	51.7		2.8	33.0	-39.7	47.8	244.5	5000.0	-26.2
3656.40	H	59.7		3.3	33.2	-39.2	57.0	705.7	5000.0	-17.0
	V	62.6		3.3	33.2	-39.2	59.9	991.2	5000.0	-14.1
4570.50	H	64.9		3.6	34.4	-39.2	63.7	1529.9	5000.0	-10.3
	V	59.9		3.6	34.4	-39.2	58.7	857.3	5000.0	-15.3
7312.80	H	58.4		4.7	35.7	-39.4	59.4	931.3	5000.0	-14.6
	V	56.3		4.7	35.7	-39.4	57.3	736.4	5000.0	-16.6
8226.90	H	57.1		4.9	35.8	-39.4	58.4	834.9	5000.0	-15.5
	V	54.6		4.9	35.8	-39.4	55.9	621.8	5000.0	-18.1
9141.00	H	52.9		5.0	36.3	-39.3	54.8	551.6	5000.0	-19.1
	V	49.2		5.0	36.3	-39.3	51.2	362.4	5000.0	-22.8

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 914.1MHz, Ch24
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)
2742.30	H	52.08		2.8	33.0	-39.7	-27.7	20.4	10.5	500.0	-33.6
	V	51.69		2.8	33.0	-39.7	-27.7	20.0	10.0	500.0	-34.0
3656.40	H	59.69		3.3	33.2	-39.2	-27.7	29.2	28.9	500.0	-24.8
	V	62.64		3.3	33.2	-39.2	-27.7	32.2	40.6	500.0	-21.8
4570.50	H	64.92		3.6	34.4	-39.2	-27.7	35.9	62.7	500.0	-18.0
	V	59.89		3.6	34.4	-39.2	-27.7	30.9	35.2	500.0	-23.1
7312.80	H	58.38		4.7	35.7	-39.4	-27.7	31.6	38.2	500.0	-22.3
	V	56.34		4.7	35.7	-39.4	-27.7	29.6	30.2	500.0	-24.4
8226.90	H	57.11		4.9	35.8	-39.4	-27.7	30.7	34.2	500.0	-23.3
	V	54.55		4.9	35.8	-39.4	-27.7	28.1	25.5	500.0	-25.9
9141.00	H	52.89		5.0	36.3	-39.3	-27.7	27.1	22.6	500.0	-26.9
	V	49.24		5.0	36.3	-39.3	-27.7	23.4	14.9	500.0	-30.5

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 914.1MHz, Ch24
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 (dB)
914.10	H	72.77		1.6	26.7	0.0	101.0	112588.0	NA	NA
	V	81.45		1.6	26.7	0.0	109.7	305838.5	NA	NA
1828.20	H	59.68		2.2	29.5	-40.0	51.4	372.4	30583.8	-38.3
	V	61.64		2.2	29.5	-40.0	53.4	466.7	30583.8	-36.3
5484.60	H	73.63		3.9	34.9	-39.4	73.0	4488.8	30583.8	-16.7
	V	66.53		3.9	34.9	-39.4	65.9	1982.1	30583.8	-23.8
6398.70	H	66.46		4.3	35.6	-39.4	66.9	2225.5	30583.8	-22.8
	V	63.58		4.3	35.6	-39.4	64.1	1597.5	30583.8	-25.6

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 923.69MHz, Ch48
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 (dB)
2771.07	H	56.9		2.8	32.9	-39.7	53.0	445.8	5000.0	-21.0
	V	55.0		2.8	32.9	-39.7	51.0	356.6	5000.0	-22.9
3694.76	H	61.5		3.3	33.3	-39.2	58.8	869.5	5000.0	-15.2
	V	62.8		3.3	33.3	-39.2	60.2	1019.2	5000.0	-13.8
4618.45	H	65.5		3.6	34.6	-39.3	64.5	1671.7	5000.0	-9.5
	V	61.3		3.6	34.6	-39.3	60.2	1028.4	5000.0	-13.7
7389.52	H	58.7		4.7	35.7	-39.4	59.7	968.9	5000.0	-14.3
	V	56.3		4.7	35.7	-39.4	57.3	733.3	5000.0	-16.7
8313.21	H	53.5		4.9	35.8	-39.4	54.8	550.6	5000.0	-19.2
	V	52.1		4.9	35.8	-39.4	53.4	465.9	5000.0	-20.6

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 923.69MHz, Ch48
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)
2771.07	H	56.94		2.8	32.9	-39.7	-27.7	25.2	18.3	500.0	-28.7
	V	55.00		2.8	32.9	-39.7	-27.7	23.3	14.6	500.0	-30.7
3694.76	H	61.46		3.3	33.3	-39.2	-27.7	31.0	35.6	500.0	-22.9
	V	62.84		3.3	33.3	-39.2	-27.7	32.4	41.8	500.0	-21.6
4618.45	H	65.54		3.6	34.6	-39.3	-27.7	36.7	68.5	500.0	-17.3
	V	61.32		3.6	34.6	-39.3	-27.7	32.5	42.2	500.0	-21.5
7389.52	H	58.70		4.7	35.7	-39.4	-27.7	32.0	39.7	500.0	-22.0
	V	56.28		4.7	35.7	-39.4	-27.7	29.6	30.1	500.0	-24.4
8313.21	H	53.50		4.9	35.8	-39.4	-27.7	27.1	22.6	500.0	-26.9
	V	52.05		4.9	35.8	-39.4	-27.7	25.6	19.1	500.0	-28.4

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 923.69MHz, Ch48
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 (dB)
923.69	H	71.65		1.6	26.8	0.0	100.0	99906.5	NA	NA
	V	80.70		1.6	26.8	0.0	109.0	283200.2	NA	NA
1847.38	H	62.01		2.2	29.7	-40.0	53.9	497.1	28320.0	-35.1
	V	61.84		2.2	29.7	-40.0	53.8	487.5	28320.0	-35.3
5542.14	H	61.08		4.0	34.9	-39.4	60.6	1068.6	28320.0	-28.5
	V	64.08		4.0	34.9	-39.4	63.6	1509.4	28320.0	-25.5
6465.83	H	59.08		4.3	35.7	-39.4	59.7	963.6	28320.0	-29.4
	V	56.54		4.3	35.7	-39.4	57.1	719.3	28320.0	-31.9
9236.90	H	46.31		5.0	36.3	-39.3	48.4	261.8	28320.0	-40.7
	V	42.76		5.0	36.3	-39.3	44.8	174.0	28320.0	-44.2

30. Band-Edge Compliance

EUT Information	
Manufacturer	Badger Meter, Incorporated
Product	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 904.9MHz, Ch1 Tx @ 923.69MHz, Ch48 Hopping

Test Setup Details	
Setup Format	Tabletop
Measurement Method	Radiated
Type of Test Site	Semi-Anechoic Chamber
Type of Antennas Used	Bilog (or equivalent)
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

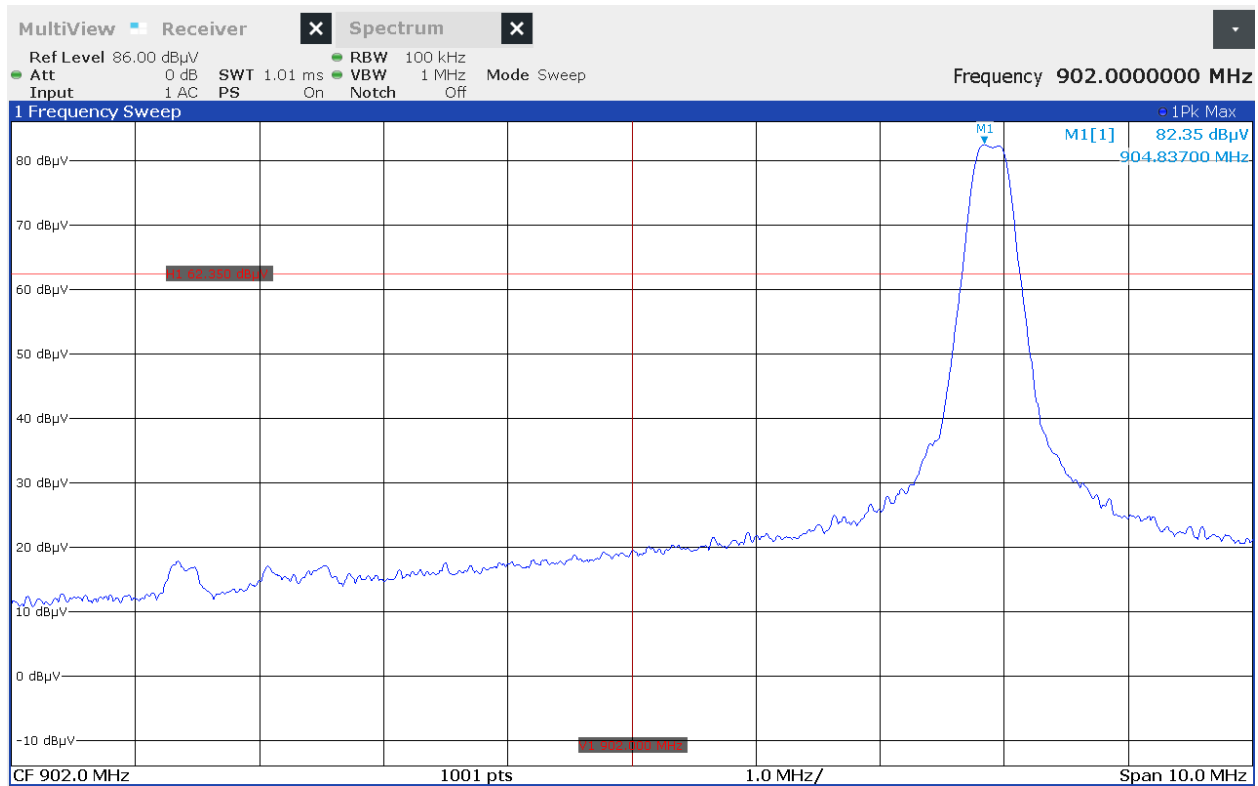
Requirements
Any emissions in a 100kHz bandwidth outside the 902 – 928MHz frequency band must be 20dB below the 100kHz bandwidth of the fundamental emission.

Procedure
<ol style="list-style-type: none"> The EUT was set up inside the test chamber on a non-conductive stand and set to transmit continuously at the channel closest to the high band-edge. A broadband measuring antenna was placed at a test distance of 3 meters from the EUT. The antenna was connected to the input of a spectrum analyzer. The center frequency of the analyzer was set to the low band edge (902MHz). The Resolution Bandwidth was set to 100kHz. To ensure that the maximum or worst case emission level was measured, the following steps were taken: <ol style="list-style-type: none"> The EUT was rotated so that all of its sides were exposed to the receiving antenna. Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured. The EUT was rotated so that all of its sides were exposed to the receiving antenna. The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings. The highest measured peak reading and the highest measured average reading were

recorded.

- f) The test was repeated to with the center frequency of the analyzer was set to the high band edge (928MHz).

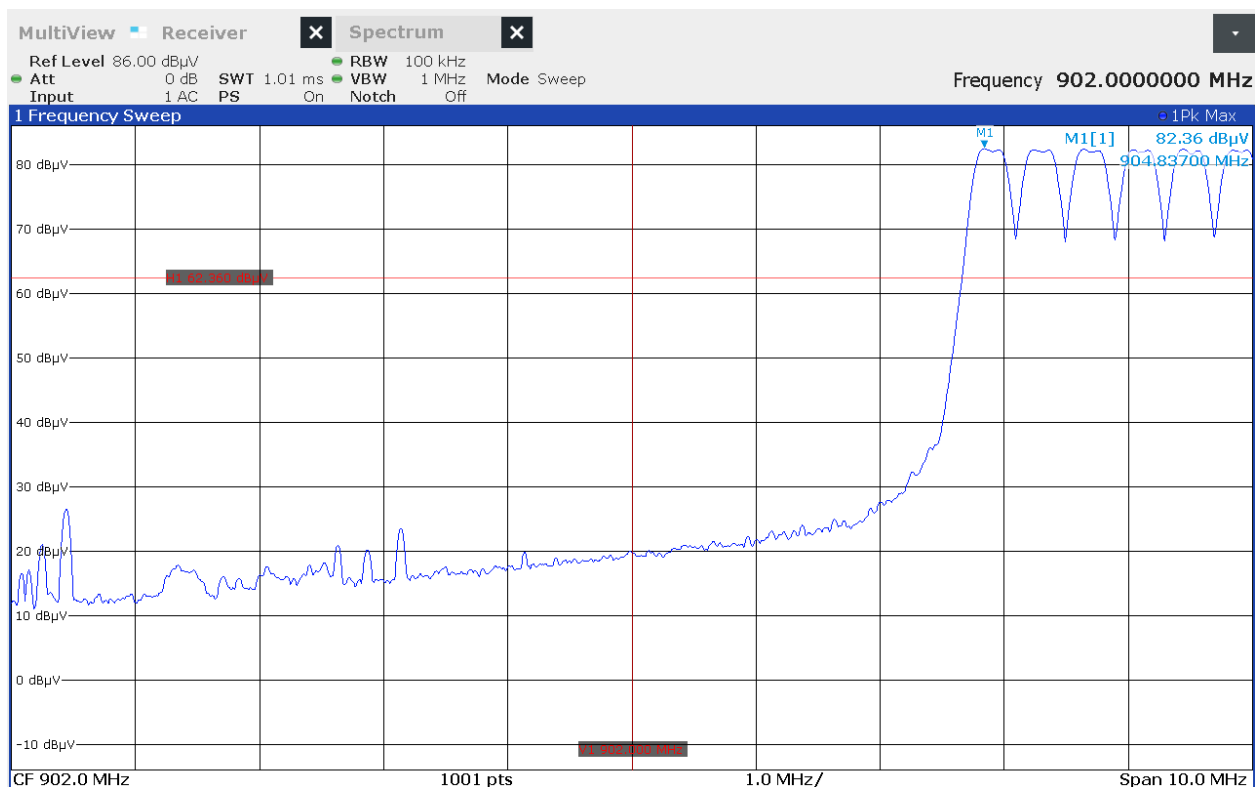
Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 904.9MHz, Ch1
Notes	Low Band Edge



Manufacturer : Badger Meter Incorporated
 Model Number : HLG
 Serial Number : 180001134
 Mode : Tx @ 904.9MHz, Ch1
 Parameters :
 Date : 7/14/2025 11:14:23 AM
 Notes :

TRACE1 : Function plot of Max Hold Peak

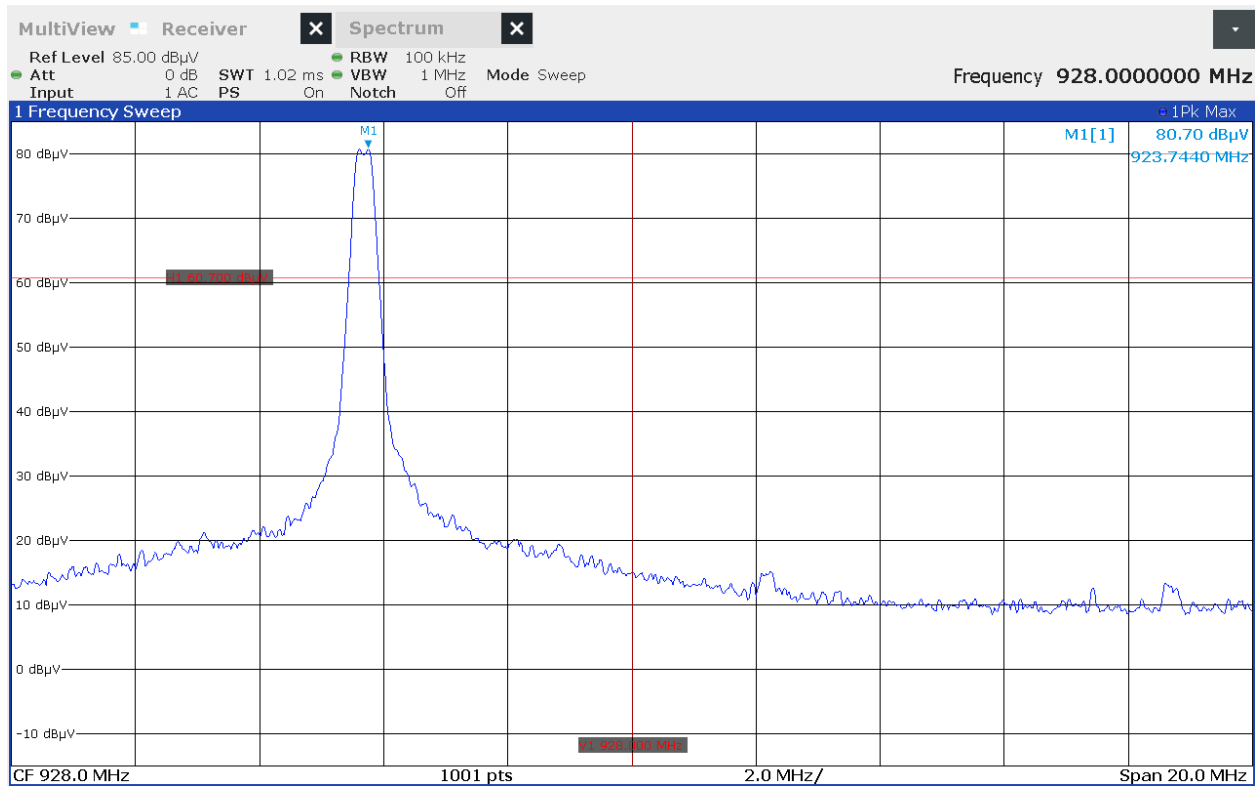
Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Hopping
Notes	Low Band Edge



Manufacturer : Badger Meter Incorporated
 Model Number : HLG
 Serial Number : 180001134
 Mode : Hopping
 Parameters :
 Date : 7/14/2025 11:24:31 AM
 Notes :

TRACE1 : Function plot of Max Hold Peak

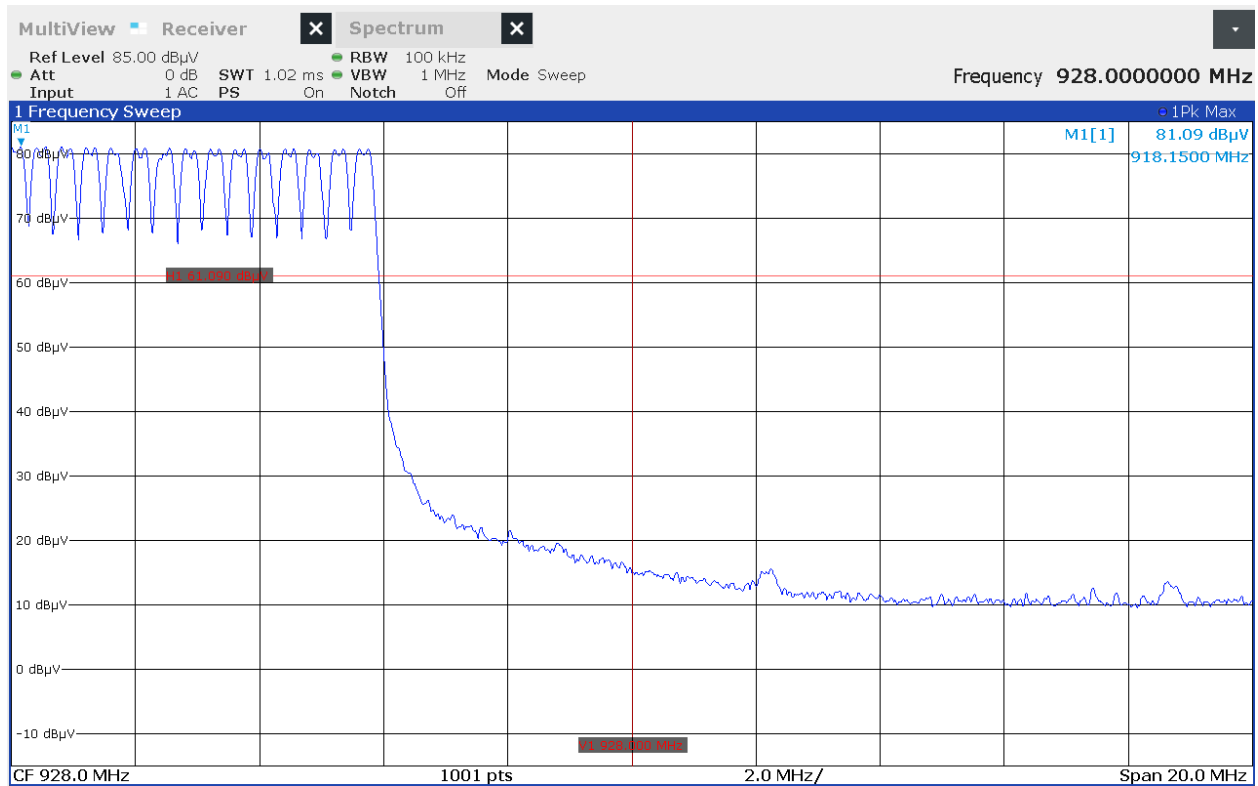
Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Tx @ 923.69MHz, Ch48
Notes	High Band Edge



Manufacturer : Badger Meter Incorporated
Model Number : HLG
Serial Number : 180001134
Mode : Tx @ 923.69MHz, Ch48
Parameters :
Date : 7/14/2025 10:38:00 AM
Notes :

TRACE1 : Function plot of Max Hold Peak

Test Details	
Manufacturer	Badger Meter, Incorporated
EUT	ORION Cellular HLG
Model No.	HLG
Serial No.	180001156
Mode	Hopping
Notes	High Band Edge



Manufacturer : Badger Meter Incorporated
 Model Number : HLG
 Serial Number : 180001134
 Mode : Hopping
 Parameters :
 Date : 7/14/2025 10:43:17 AM
 Notes :

TRACE1 : Function plot of Max Hold Peak

31. Scope of Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

ELITE ELECTRONIC ENGINEERING, INC.
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Downers Grove, IL 60515
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ELECTRICAL

Valid To: August 31, 2025

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
(Max Voltage 60V/Max current 100A)

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)
(Up to +/-25kV)

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,
CE 430, CE440)

(A2LA Cert. No. 1786.01) Revised 05/08/2025



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5202 Presidents Court, Suite 220 | Frederick, MD 21703-8515 | Phone: 301 644 3248 | Fax: 240 454 9449 | www.A2LA.org

Test Technology:
Test Method(s)¹:

Radiated Emissions Anechoic
(Up to 6GHz)

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, RE320);

Vehicle Radiated Emissions

CISPR 12; CISPR 36; ICES-002;
ECE Regulation 10.06 Annex 4;
ECE Regulation 10.06 Annex 5

Bulk Current Injection (BCI)
(1 to 400MHz 500mA)

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
(Up to 6GHz and 200V/m)
(Including Radar Pulse 600V/m)

ISO 11452-2;
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; FMC 1278 (RI140)

Radiated Immunity Reverb
(360MHz to 6GHz and 100V/m)

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)
(Up to 6GHz and 20W)

ISO 11452-9;
EMC-CS-2009.1 (RI115); FMC1278 (RI115);
GMW 3097, Sec 3.4.4

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

Stripline

ISO 11452-5

Transverse Electromagnetic (TEM) Cell

ISO 11452-3

Test Technology:
Test Method(s)¹:
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;
CISPR 16-2-1 (2008); CISPR 16-2-1; 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 7 (Broadband);
ECE Regulation 10.06 Annex 8 (Narrowband);
ECE Regulation 10.06 Annex 13 (Conducted);
ECE Regulation 10.06 Annex 14 (Conducted)

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

Current Harmonics

IEC 61000-3-2; IEC 61000-3-12;
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; IEC 61000-3-11;
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