

Test Report

Prepared for: Inovonics

Address: 11000 Westmoor Circle
Building 10, Suite 250
Westminster, CO 80021

Product: EN 1941 (OEA)

Test Report No: R20241011-72-E1D

Approved by:


Blake Winter

Blake Winter,
EMC Test Engineer

DATE: 22 July 2025


Total Pages: 35

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	Report Number:	R20241011-72-E1D	Rev	D
	Prepared for:	Inovonics		


REVISION PAGE

Rev. No.	Date	Description
Original	21 April 2025	Issued by BWinter Reviewed by Flane
A	17 May 2025	Revision A – BWinter <ol style="list-style-type: none"> 1. Add statement that band edge measurements are worst-case. 2. Add AC Emissions measurements. 3. Change from Conducted Power to EIRP.
B	2 July 2025	Revision B – B Winter <ol style="list-style-type: none"> 1. Change from EIRP to Conducted Power. 2. Correct reported values in Quasi-Peak Table.
C	17 July 2025	Revision C – B Winter <ol style="list-style-type: none"> 1. Re-measure most parameters after changing antenna matching circuit.
D	22 July 2025	Revision D – B Winter <ol style="list-style-type: none"> 1. Update calibration table.

	Report Number:	R20241011-72-E1D	Rev	D
	Prepared for:	Inovonics		

CONTENTS

Revision Page	2
1.0 Summary of test results.....	4
2.0 EUT Description	5
2.1 Equipment under test	5
2.2 Description of test modes	6
2.3 Description of support units.....	6
3.0 Laboratory description.....	7
3.1 Laboratory description.....	7
3.2 Test personnel.....	7
3.3 Test equipment.....	8
3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMENTS	9
4.0 Detailed results.....	10
4.1 Duty Cycle	11
4.2 Radiated emissions.....	12
4.3 Peak Output Power	19
4.4 Bandwidth.....	20
4.5 Bandedges	21
4.6 Carrier frequency separation, number of hopping channels, time of occupancy	22
4.7 CONDUCTED AC MAINS EMISSIONS.....	23
Appendix A: Sample Calculation	25
Appendix B – Measurement Uncertainty	26
Appendix C – Graphs and Tables	27
REPORT END.....	35


	Report Number:	R20241011-72-E1D	Rev	D
	Prepared for:	Inovonics		

1.0 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

- (1) US Code of Federal Regulations, Title 47, Part 15
- (2) ISED RSS-Gen, Issue 5
- (3) ISED RSS-247, Issue 3

SUMMARY			
Standard Section	Test Type and Limit	Result	Remark
FCC 15.203	Unique Antenna Requirement	Pass	PCB antenna
FCC 15.35 RSS-Gen, 6.10	Duty cycle of pulsed emissions	Pass	Pulsed emissions duty cycle was applied
FCC 15.209 RSS-Gen, 7.3	Receiver Radiated Emissions	Pass	Meets the requirement of the limit.
FCC 15.247(a)(1)(i) RSS-247, 5.1	Minimum Bandwidth, Limit: Min. 250kHz, Frequency Separation	Pass	Meets the requirement of the limit.
FCC 15.247(b)(1) RSS-247, 5.1	Maximum Peak Output Power, Limit: Max. 24 dBm	Pass	Meets the requirement of the limit.
FCC 15.209 RSS-247, 5.5	Transmitter Radiated Emissions	Pass	Meets the requirement of the limit.
FCC 15.247(a) (1) (i) RSS-247, 5.1(c)	Frequency hopping system, Limit: Max. 0.4 Seconds in 10 Second Period	Pass	Meets the requirement of the limit.
FCC 15.209, 15.205, 15.247 RSS-247, 5.5	Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency	Pass	Meets the requirement of the limit.
FCC 15.207 RSS-Gen. 8.8	Conducted AC Emissions	Pass	Meets the requirement of the limit

	Report Number:	R20241011-72-E1D	Rev	D
	Prepared for:	Inovonics		

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

EUT	EN 1941
EUT Received	10/18/2024
EUT Tested	12/12/2024- 7/10/2025
Serial No./ Tx ID	Conducted 200224, 200255, Radiated 200231, 200257 (NCEE assigned serial numbers)
Operating Band	902.0 – 928.0 MHz
Device Type	FHSS
Power Supply	Disposable Battery

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

For Radiated Emissions measurements and peak power, the EUT was set to operate at the selected frequency in Continuous Wave mode with the laptop disconnected.

For Band Edge measurements and Radio Measurements, the EUT was set to operate at the selected frequency with modulation, but the laptop was connected to the EUT.



Report Number:	R20241011-72-E1D	Rev	D
Prepared for:	Inovonics		

2.2 DESCRIPTION OF TEST MODES

The EUT operates on, and was tested at the frequencies below:


Channel	Frequency
Low	902.4
Middle	914.8
High	927.6

These are the only three representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

EUT was modified to transmit at the highest practical duty cycle on the lowest, highest and one channel in the middle that was used for all RF tests.

2.3 DESCRIPTION OF SUPPORT UNITS

N/A

	Report Number:	R20241011-72-E1D	Rev	D
	Prepared for:	Inovonics		

3.0 LABORATORY DESCRIPTION

3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

A2LA Certificate Number: 1953.01
FCC Accredited Test Site Designation No: US1060
Industry Canada Test Site Registration No: 4294A
CAB MRA Recognition Identification No: US0177

Environmental conditions varied slightly throughout the tests.



3.2 TEST PERSONNEL

No.	PERSONNEL	TITLE	ROLE
1	Fox Lane	EMC Test Engineer	Review
2	Blake Winter	EMC Test Engineer	Testing and Report

Notes:

All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.



Report Number: R20241011-72-E1D

Rev

D

Prepared for: Inovonics


3.3 TEST EQUIPMENT

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	July 17, 2024	July 17, 2026
SunAR RF Motion	JB1	A091418	May 16, 2024	May 16, 2026
ETS-Lindgren Horn Antenna	3117	29616	May 16, 2024	May 16, 2026
ETS EMCO Preamp*	3115-PA	00218576	January 22, 2024	January 22, 2026
Trilithic High Pass Filter*	6HC330	23042	June 5, 2023	June 5, 2026
MiniCircuits High Pass Filter*	VHF-1320+	15542	June 5, 2023	June 5, 2026
ETS – Lindgren- VSWR on 10m Chamber	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	May 7, 2024	May 7, 2027
NCEE Labs-NSA on 10m Chamber	10m Semi-anechoic chamber-NSA	NCEE-001	June 18, 2024	June 18, 2026
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	June 5, 2023	June 5, 2026
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	June 5, 2023	June 5, 2026
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3864	June 5, 2023	June 5, 2026
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	June 5, 2023	June 5, 2026
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	June 5, 2023	June 5, 2026
N connector bulkhead (control room)*	PE9128	NCEEBH2	June 5, 2023	June 5, 2026

*Internal Characterization

Notes:

All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities. All equipment were in Cal during testing.

	Report Number:	R20241011-72-E1D	Rev	D
	Prepared for:	Inovonics		

3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMENTS

Measurement type presented in this report (Please see the checked box below):

Conducted ☒

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

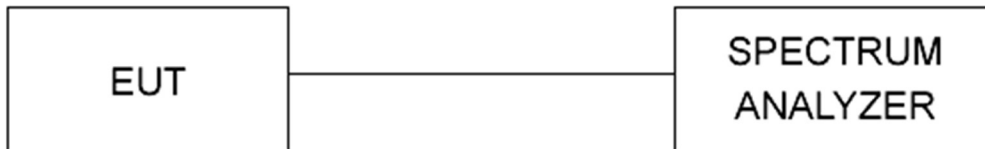



Figure 1 - Bandwidth Measurements Test Setup

Radiated ☒

All the radiated measurements were taken at a distance of 3m from the EUT. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

	Report Number:	R20241011-72-E1D	Rev	D
	Prepared for:	Inovonics		

4.0 DETAILED RESULTS

DSS Radiated Radio Measurements								
CHANNEL	Transmitter	99% Occupied Bandwidth (kHz)	20 dB Bandwidth (kHz)	PEAK Conducted Power (dBm)	PEAK Conducted Power (mW)	RESULT	No. of Hopping Channels	Time of Occupancy*
							25	0.243 S
Low	Continuous*	254.40	258.5	19.64	92.04	PASS	Min	Duty Cycle
Mid	Continuous*	255.53	259.0	19.67	92.68	PASS	Frequency Separation	Correction (Emissions)
High	Continuous*	253.85	258.4	19.61	91.41	PASS	798 kHz	-11.7 dB
Occupied Bandwidth = N/A; 20 dB Bandwidth Limit 250 kHz ≤ BW ≤ 500 kHz; See tables below for Antenna Factor and Cable Corrections *EUT was hopping in low mid and high channel as provided by the manufacturer				Peak Output Power Limit = 24 dBm; corrections can be found in the last table of this section and in the graphs in Appendix C.				
				Time of Occupancy<0.4 S in 10 S				
				*Manufacturer declares that the worst-case average channel occupancy time is 0.088s within any 10 second period.				
Unrestricted Band-Edge**								
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level (dBuV)	Relative Fundamental (dBm)	Delta (dB)	Min Delta (dB)	Result	
Low	Continuous*	902.4	116.88	79.35	37.53	20	PASS	
High	Continuous*	927.6	114.98	78.48	36.50	20	PASS	
*EUT was hopping in low and high channel as provided by the manufacturer								
**Worst-case band edge measurement is shown (non-hopping).								
Peak Restricted Band-Edge**								
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)***	Measurement Type	Limit (dBuV/m @ 3m)*	Margin	Result	
Low	Continuous*	610.59	30.94	Radiated	46.02	15.08	PASS	
High	Continuous*	966.60	37.74	Radiated	53.98	16.24	PASS	
*EUT was hopping in low and high channel as provided by the manufacturer								
**Worst-case band edge measurement is shown (non-hopping).								
***detector used was peak and compared to Quasi-peak limit from FCC Part 15.209 to show compliance								

Frequency (MHz)	Antenna Factor	Cable Loss	Ref Offset
609	22.9	4.49	27.49
902.4	26.5	5.36	32.87
914.8	26.7	5.41	32.11
927.6	26.6	5.54	32.14
980	27.2	5.61	32.81

Declaration from manufacturer: The EchoStream protocol defines 64 channels spaced 400 kHz apart. Manufacturer uses only 25 channels from the set of 64. The minimum spacing between channels is ~800 kHz with some channels space ~1.2 MHz apart. Minimum channel spacing was measured and reported in the tables above. The entire channel map uses a spacing of 400 kHz, but the used channels are either 800 kHz or 1.2 MHz apart.



Report Number:	R20241011-72-E1D	Rev	D
Prepared for:	Inovonics		

4.1 DUTY CYCLE

Manufacturer declared that the maximum on time possible per channel is 26 ms in a given 100 ms period. So, Duty cycle correction factor for spurious emissions related to the transmitter is $20 \log(26/100) = -11.70 \text{ dB}$.



Report Number:	R20241011-72-E1D	Rev	D
Prepared for:	Inovonics		

4.2 RADIATED EMISSIONS

Test Method: ANSI C63.10-2020, Section 6.5, 6.6

Limits for radiated emissions measurements:

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH (μ V/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = $20 * \log * \text{Emission level } (\mu\text{V/m})$.
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.



Report Number:	R20241011-72-E1D	Rev	D
Prepared for:	Inovonics		

Test procedures:

- a. The EUT was placed on the top of a rotating table above the ground plane in a 10-meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements from 30MHz-1GHz and 1.5m for measurements from 1GHz to 10 GHz.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.
- d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.
- e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.
- f. If the emission level of the EUT in peak mode was 6dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise, the emissions that did not have 6 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- g. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.
2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

Deviations from test standard:

No deviation.

Test setup:

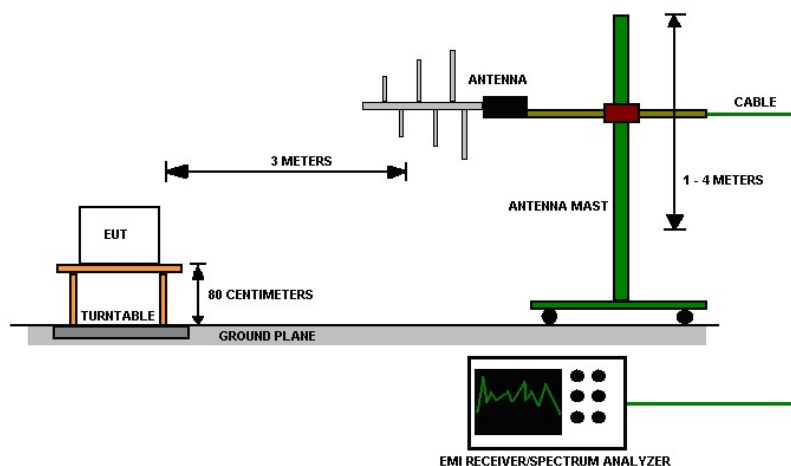


Figure 2 - Radiated Emissions Test Setup, 30MHz to 1GHz

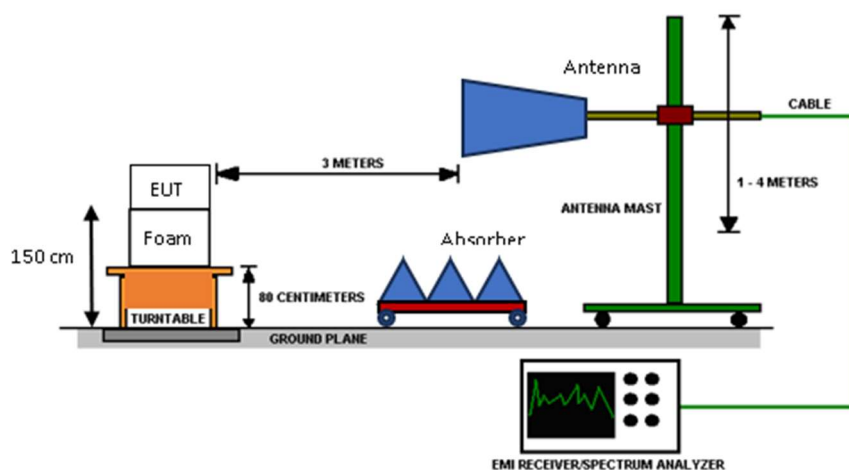


Figure 3 - Radiated Emissions Test Setup, 1GHz – 18GHz



Report Number:	R20241011-72-E1D	Rev	D
Prepared for:	Inovonics		

Test results:

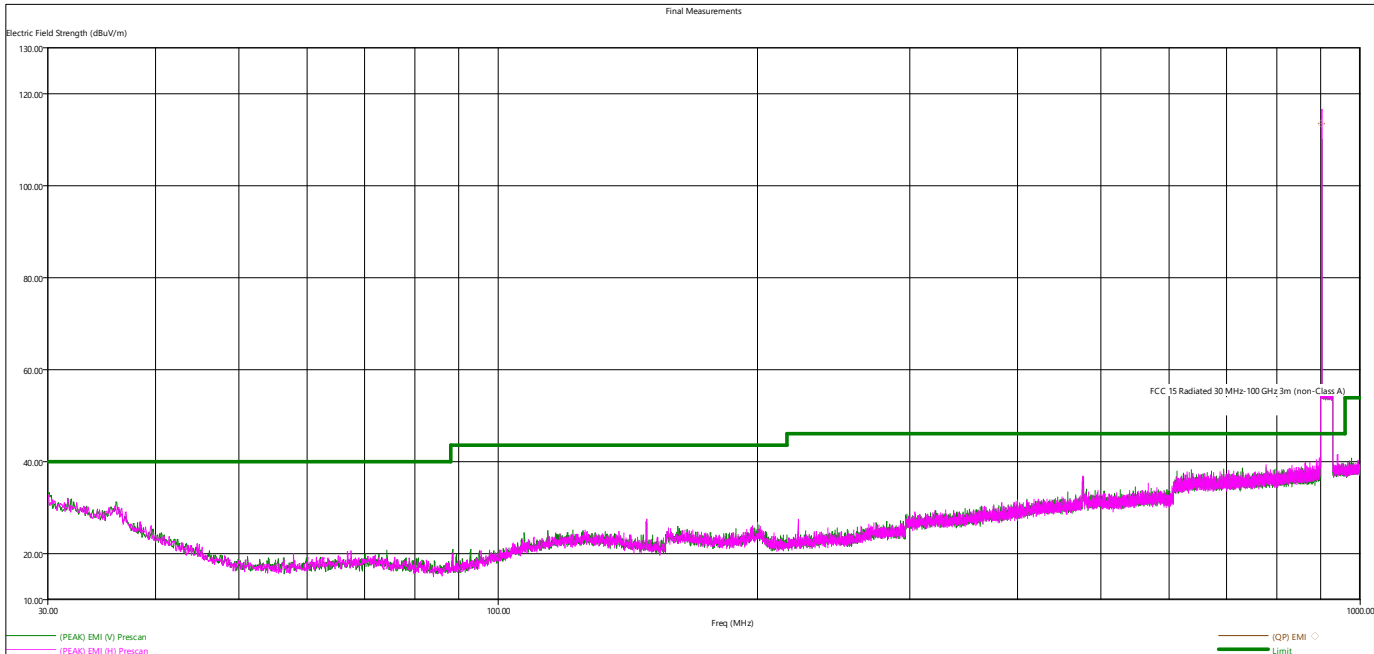


Figure 4 - Radiated Emissions Plot, Low Channel, 30 MHz-1GHz

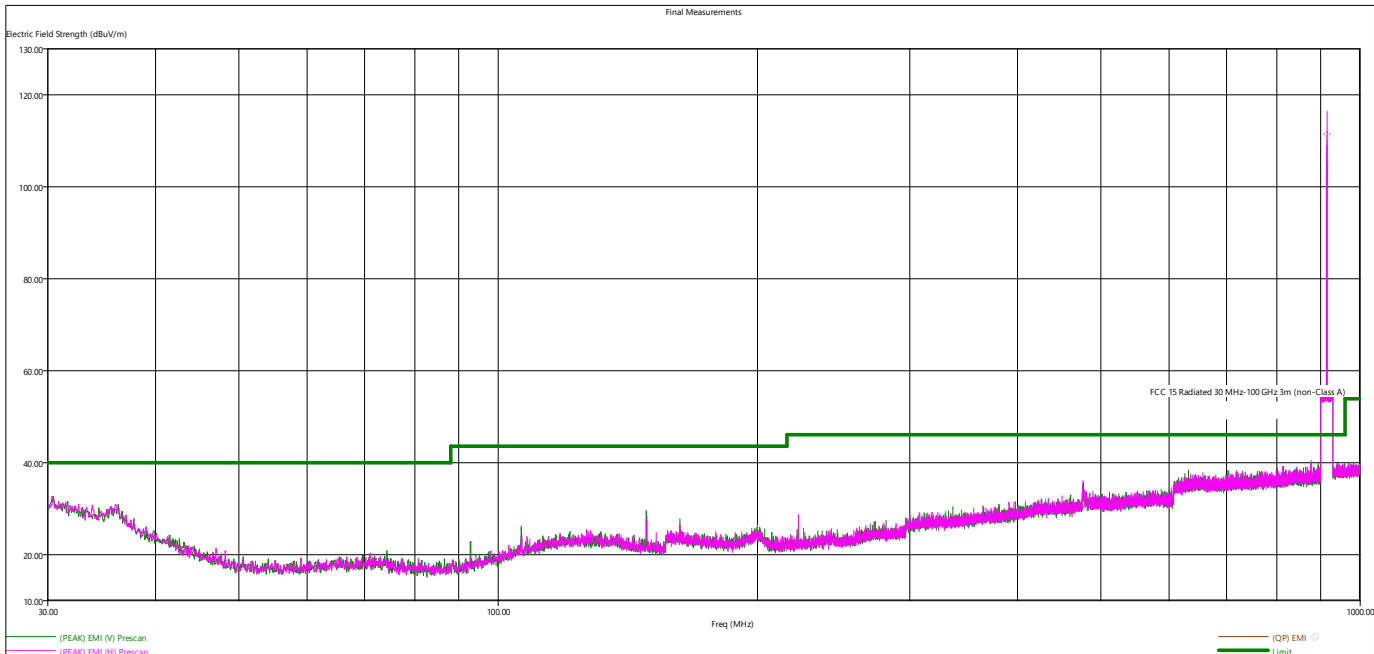


Figure 5 - Radiated Emissions Plot, Mid Channel, 30 MHz-1GHz

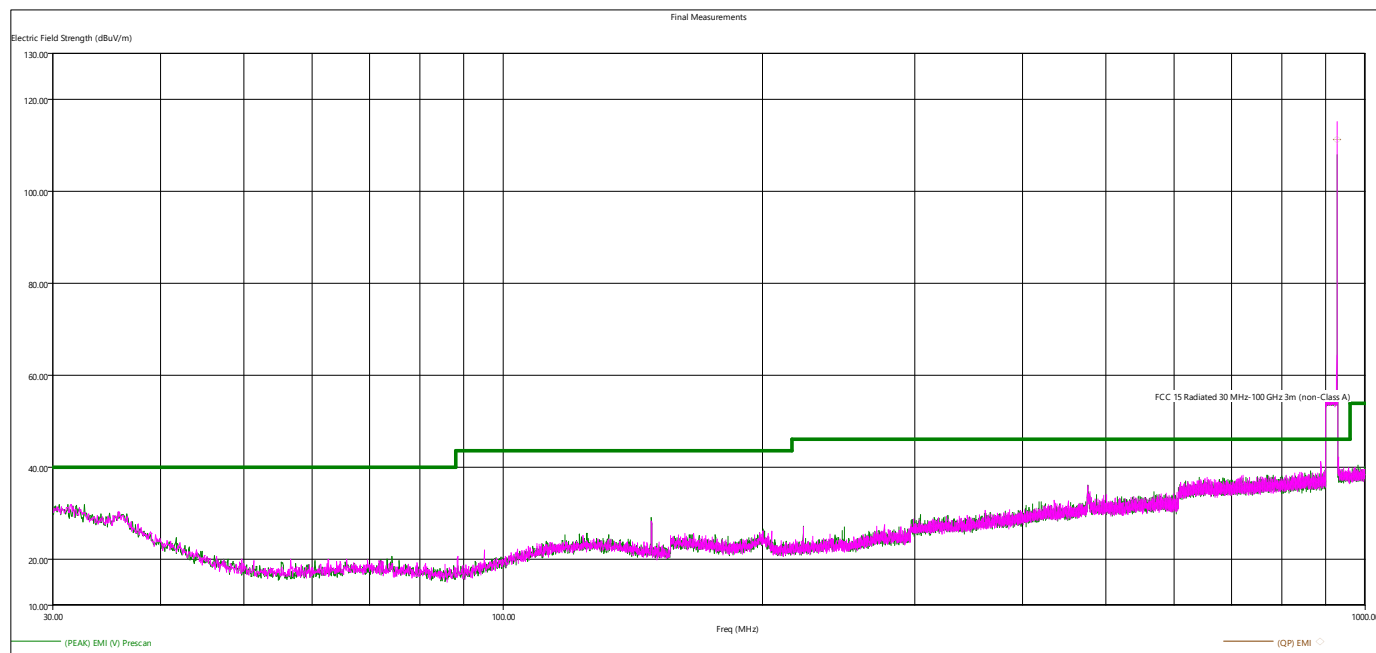


Figure 6 - Radiated Emissions Plot, High Channel, 30 MHz-1GHz

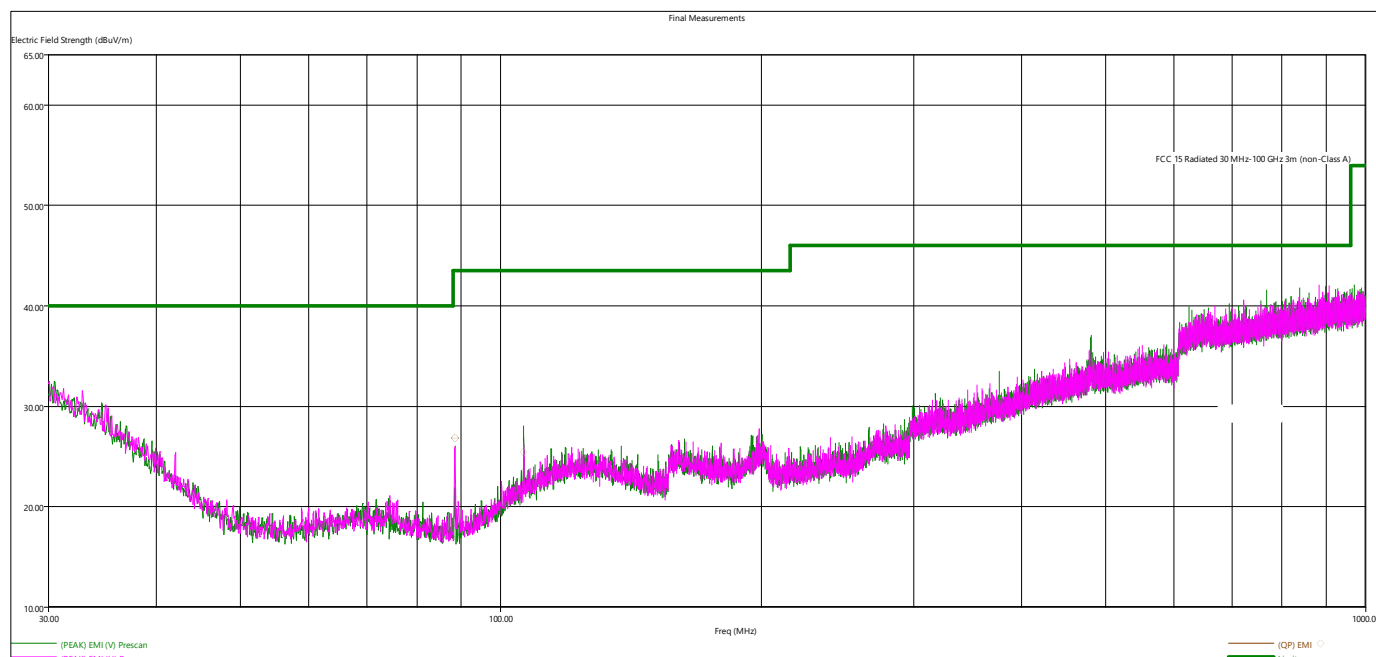


Figure 7 - Radiated Emissions Plot, Transmitter Off, 30 MHz-1GHz

The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions. The worst-case emissions are reported.

No other Quasi-peak measurements were attributable to the EUT in the 30MHz – 1GHz frequencies.

Tabulated 30MHz – 1GHz results were obtained using SN 200231; SN 200257 was used to confirm that Radiated Emissions did not increase after changing the EIRP in figures 4-7.



Report Number:

R20241011-72-E1D

Rev

D

Prepared for:

Inovonics

Quasi-Peak Measurements, 900 MHz Radio,

Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Radio Band
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.			MHz
863.348400	38.06	46.02	7.96	112.92	3.25	H	Low	900 -928
899.754720	37.20	46.02	8.82	107.97	4.75	H	Low	900 -928
949.252320	35.64	46.02	10.38	274.05	66.25	V	Low	900 -928
875.807760	35.08	46.02	10.94	289.82	268.25	H	Mid	900 -928
882.478800	35.06	46.02	10.96	123.13	187.75	V	Mid	900 -928
934.775520	35.51	46.02	10.51	224.80	326.75	H	Mid	900 -928
823.416960	34.72	46.02	11.30	360.92	224.50	V	High	900 -928
949.547280	35.63	46.02	10.39	115.61	155.75	H	High	900 -928
953.232000	35.56	46.02	10.46	108.38	58.50	V	High	900 -928
88.490640	26.91	43.52	16.61	174.89	90.75	H	Rx Mode	
106.305840	25.50	43.52	18.02	104.08	358.75	V	Rx Mode	

All other measurements were found to be at least 6dB below the limit line.



Report Number: R20241011-72-E1D

Rev

D

Prepared for: Inovonics

Peak Measurements, 900 MHz Radio, SN 200257

Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Radio Band
MHz	dBμV/m	dBμV/m	dB	cm.	deg.			MHz
4511.536000	44.35	73.98	29.63	147.25	155.50	V	Low	900 - 928
5413.958000	50.23	73.98	23.75	474.77	309.50	V	Low	900 -928
2744.32	47.48	70.00	22.52	462.47	94.00	H	Mid	900 -928
4574.762000	44.59	73.98	29.39	195.73	168.50	V	Mid	900 -928
7319.060000	50.76	73.98	23.22	492.62	350.75	V	Mid	900 -928
2782.54	48.88	70.00	21.12	449.22	260.25	H	High	900-928
4638.096000	48.49	73.98	25.49	484.86	149.75	V	High	900-928
7419.892000	49.54	73.98	24.44	516.56	325.75	V	High	900-928

All other measurements were found to be at least 6dB below the limit line.

Average Measurements, 900 MHz Radio, SN 200257

Frequency	Level (Peak + DCCF)	DCCF	Limit	Margin	Height	Angle	Pol	Channel	Radio Band
MHz	dBμV/m	dB	dBμV/m	dB	cm.	deg.			MHz
4511.536000	32.65	-11.7	53.98	21.33	147.25	155.50	V	Low	900 - 928
5413.958000	38.53	-11.7	53.98	15.45	474.77	309.50	V	Low	900 -928
2744.32	35.78	-11.7	50.00	14.22	462.47	94.00	H	Mid	900 -928
4574.762000	32.89	-11.7	53.98	21.09	195.73	168.50	V	Mid	900 -928
7319.060000	39.06	-11.7	53.98	14.92	492.62	350.75	V	Mid	900 -928
2782.54	37.18	-11.7	50.00	12.82	449.22	260.25	H	High	900-928
4638.096000	36.79	-11.7	53.98	17.19	484.86	149.75	V	Mid	900-928
7419.892000	37.84	-11.7	53.98	16.14	516.56	325.75	V	High	900-928

Average Level is obtained by adding the duty cycle correction factor found in section 4.1 to the peak level. All the measurements were compared to general limits from FCC part 15.209 to show compliance.

All other measurements were found to be at least 6dB below the limit line.

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Limit Value – Emission Level.
5. The EUT was measured in all 3 orthogonal axes. See the test setup photo exhibit for details on the orientations.



Report Number:	R20241011-72-E1D	Rev	D
Prepared for:	Inovonics		

4.3 PEAK OUTPUT POWER

Test Method: ANSI C63.10-2020, Section(s) 11.9.1.1

Limits of bandwidth measurements:

Per FCC Part 15

For an FHSS system with 25 channels, the output power is required to be less than 250 mW or 24 dBm.

Test procedures:

Spectrum analyzer was set with a resolution bandwidth greater than occupied bandwidth and centered on the operating channel. Output Power was measured by the conducted method.

Deviations from test standard:

No deviation.

Test setup:

Details can be found in section 3.4 of this report.

EUT operating conditions:


Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the output power plots can be found in Appendix C.
2. All data is in the table in results section 4.0.
3. All the measurements were found to be compliant.

	Report Number:	R20241011-72-E1D	Rev	D
	Prepared for:	Inovonics		

4.4 BANDWIDTH

Test Method: ANSI C63.10-2020, Section(s) 6.9.2

Limits of bandwidth measurements:

The allowed 20 dB bandwidth of the hopping channel is $250 \text{ kHz} \leq \text{BW} \leq 500 \text{ kHz}$.

Test procedures:

The bandwidth of the fundamental frequency was measured by spectrum analyzer with 3 kHz RBW and 30 kHz VBW.

The 20 dB bandwidth is defined as the bandwidth of which is higher than peak power minus 20dB. The 99% bandwidth is defined as the bandwidth that contains 99% of the power.

Deviations from test standard:

No deviation.

Test setup:

Details can be found in section 3.4 of this report.

EUT operating conditions:


Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the bandwidth plots can be found in Appendix C.
2. All data is in the table in results section 4.0.
3. All the measurements were found to be compliant.

	Report Number:	R20241011-72-E1D	Rev	D
	Prepared for:	Inovonics		

4.5 BANDEDGES

Test Method: ANSI C63.10-2020, Section(s) 6.10.6

Limits of band edge measurements:

For emissions outside of the allowed band of operation (902 – 928MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

Test procedures:

The resolution bandwidth was set to 100kHz and the EMI receiver was used to scan from the band edge to the fundamental frequency with a Peak detector. The highest emissions level beyond the band edge was measured and recorded. For restricted band edge measurements, the unit was tested to the same method as section 4.2 of this report.

Deviations from test standard:

No deviation.

Test setup:

Details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the band edge plots can be found in Appendix C.
2. All data is in the table in results section 4.0.
3. If the device falls under FCC Part 15.247 (Details can be found in summary of test results), compliance is shown in the unrestricted band edges by showing minimum delta of 20 dB between peak and the band edge.
4. The restricted band edge compliance is shown by comparing to the general limit defined in Part 15.209. The limit shown in the graph accounts for the antenna gain of the device.

Report Number:	R20241011-72-E1D	Rev	D
Prepared for:	Inovonics		

4.6 CARRIER FREQUENCY SEPARATION, NUMBER OF HOPPING CHANNELS, TIME OF OCCUPANCY

Test Method: ANSI C63.10-2020, Section 7.8.2, 7.8.3, 7.8.4

Limits for Time of Occupancy

Average time of occupancy on any frequency, not to exceed 0.4 seconds within a 10 second period.

Test procedures:

The method from KDB 558074 D01 v05;

Test setup:

Details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the plots can be found in Appendix C.
2. All the measurements were found to be compliant.
3. The measurements are reported on the graph.
4. **Declaration from manufacturer:** The EchoStream protocol defines 64 channels spaced 400 kHz apart. Manufacturer uses only 25 channels from the set of 64. The minimum spacing between channels is ~ 800 kHz with some channels space ~1.2 MHz apart. The entire channel map uses a spacing of 400 kHz, but the used channels are either 800 kHz or 1.2 MHz apart.

4.7 CONDUCTED AC MAINS EMISSIONS

Test Method: ANSI C63.10-2013, Section(s) 6.2

Limits for conducted emissions measurements:

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

Notes:

1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

Test Procedures:

- a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
- b. Both line and neutral of the power mains connected to the EUT were checked for maximum conducted interference.
- c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits are not reported.
- d. Results were compared to the 15.207 limits.

Deviation from the test standard:

No deviation

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test Results:

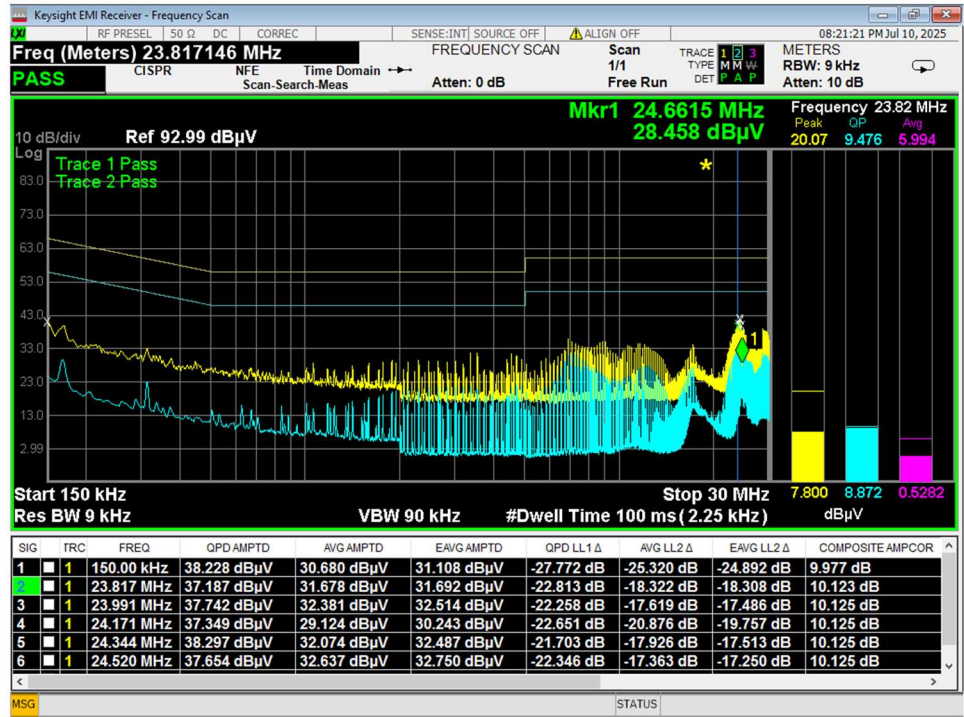


Figure 8 - Conducted Emissions, Line

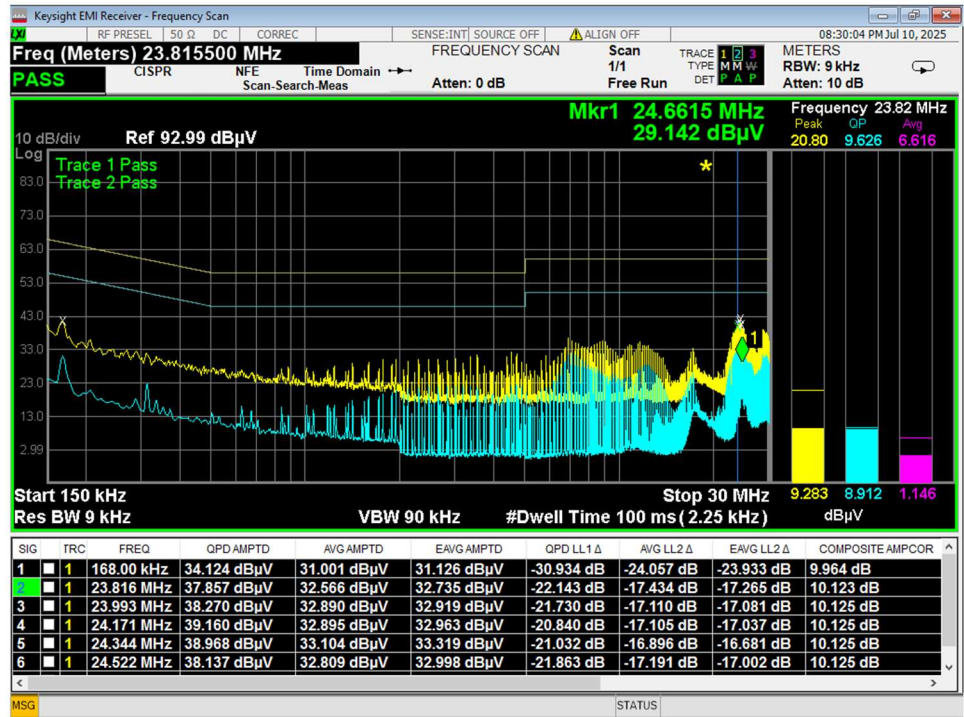



Figure 9 - Conducted Emissions, Neutral

	Report Number:	R20241011-72-E1D	Rev	D
	Prepared for:	Inovonics		

APPENDIX A: SAMPLE CALCULATION

Radiated Emissions

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

$$FS = R + AF - (-CF + AG)$$

where FS = Field Strength
R = Receiver Amplitude Receiver reading in dBμV
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Preamplifier Amplifier Gain

Assume a receiver reading of 55.00 dBμV is obtained. The Antenna Factor of 12.00 and a Cable Factor of 1.10 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.10 dBμV/m.

$$FS = 55.00 + 12.00 - (-1.10 + 20.00) = 48.1 \text{ dB}\mu\text{V/m}$$

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(48.1 \text{ dB}\mu\text{V/m})/20] = 254.1 \text{ } \mu\text{V/m}$$

Conducted Emissions

Receiver readings are compared directly to the conducted emissions limits in decibels (dB) by adding the cable loss and LISN insertion loss to the receiver reading. The basic equations with a sample calculation is as follows;

$$FS = R + IL - (-CF)$$

where V = Conducted Emissions Voltage Measurement
R = Receiver reading in dBμV
IL = LISN Insertion Loss
CF = Cable Attenuation Factor



Report Number: R20241011-72-E1D

Rev

D

Prepared for: Inovonics

APPENDIX B – MEASUREMENT UNCERTAINTY

NCEE Labs does not add uncertainty to the levels present in this report.

Where relevant, the following measurement uncertainty levels apply to tests performed in this test report:

Test	Frequency Range	NCEE Labs Uncertainty Value (dB)	Maximum Uncertainty Values per CISPR 16-4-2:2011/A1:2018
Radiated Emissions, 3m	30MHz - 1GHz	4.28	5.3
Radiated Emissions, 3m	1GHz – 18GHz	5.14	5.2

Expanded uncertainty values are calculated to a confidence level of 95%.

NCEE Labs meets the maximum uncertainty requirements per CISPR 16-4-2:2011/A1:2018, and therefore does not require a minimum passing margin to state that an EUT is less than the field strength limits of the applicable CISPR, IEC or EN limit per CISPR 16-4-2:2011/A1:2018, Section 4.1.

NCEE Labs employs tilting when testing at 3m test distance and >1GHz. The maximum uncertainty associated with this method is used.

Maximum uncertainty values show the worst-case of all test distances used.

APPENDIX C – GRAPHS AND TABLES

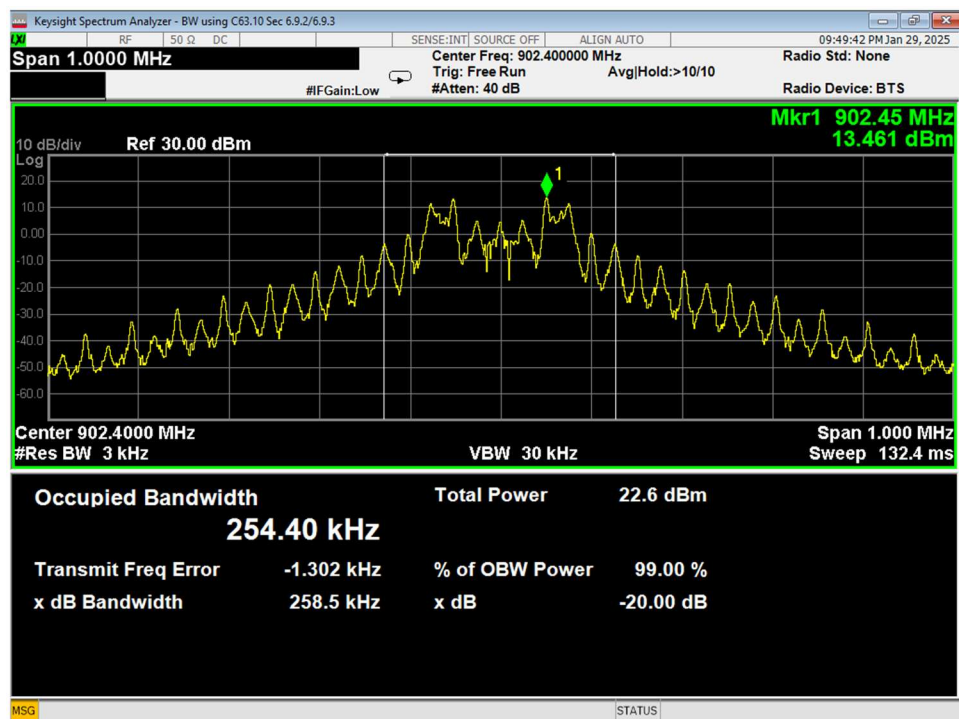


Figure 10. Bandwidth Low Channel

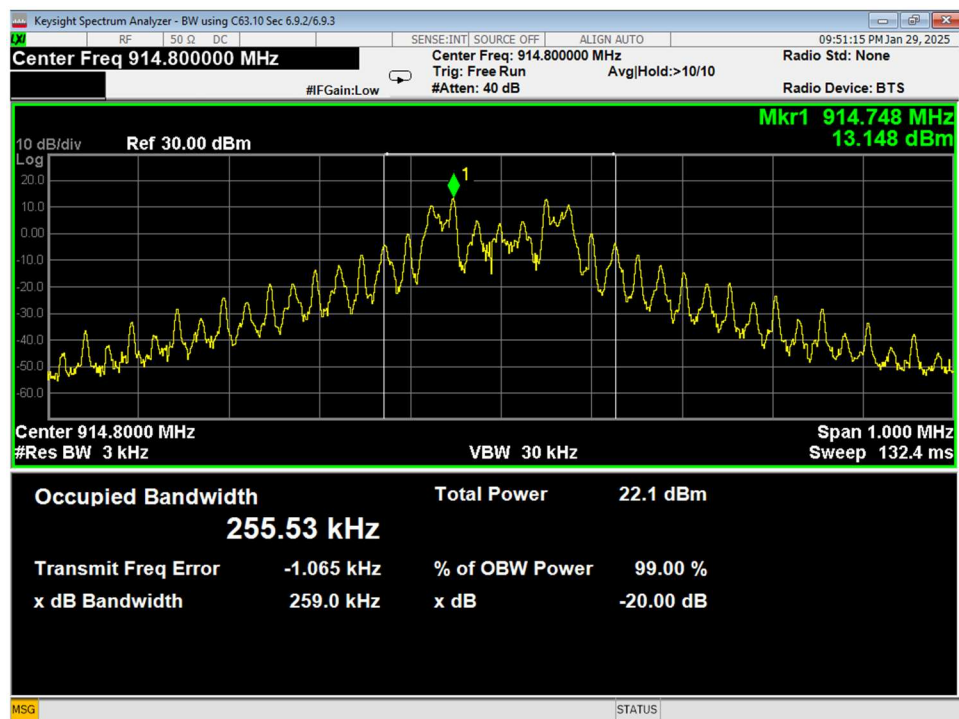


Figure 11. Bandwidth Mid Channel

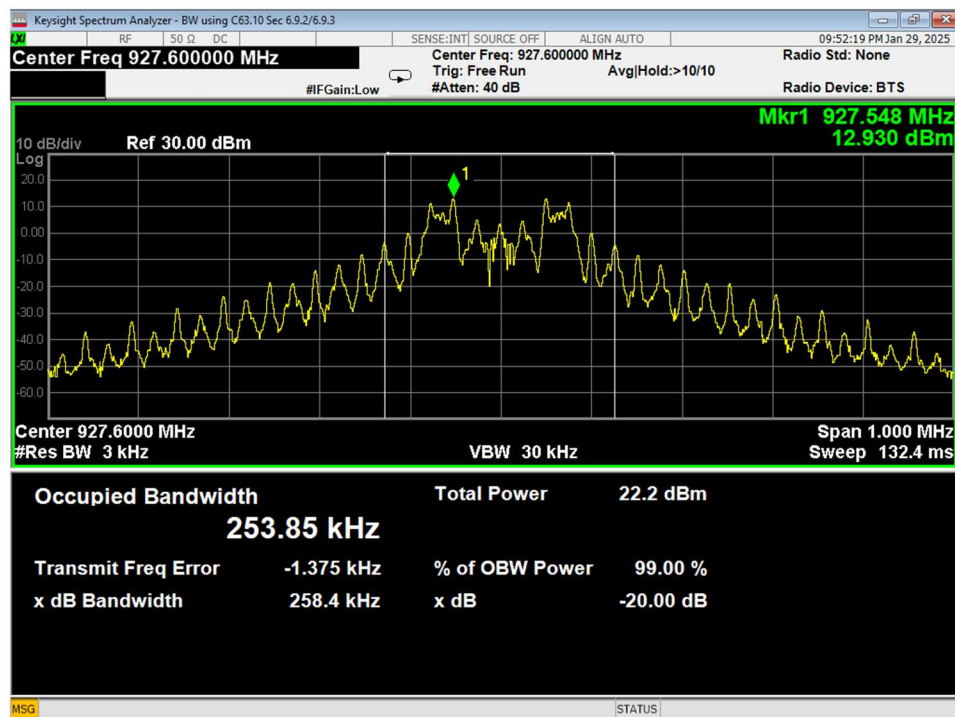


Figure 12. Bandwidth High Channel

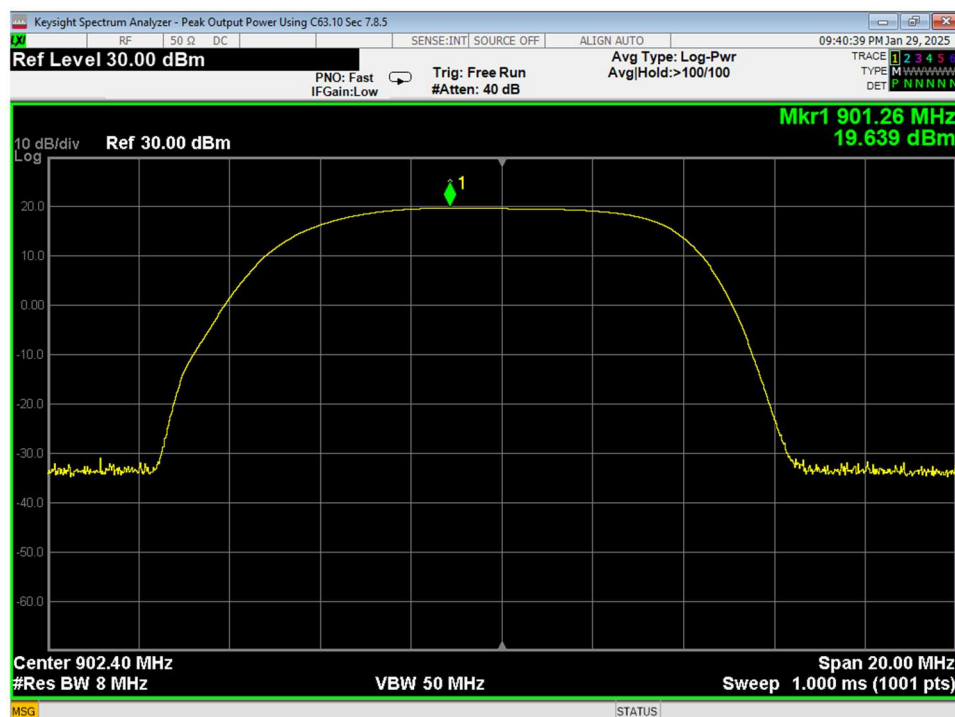


Figure 13. Peak Conducted Power, Low Channel

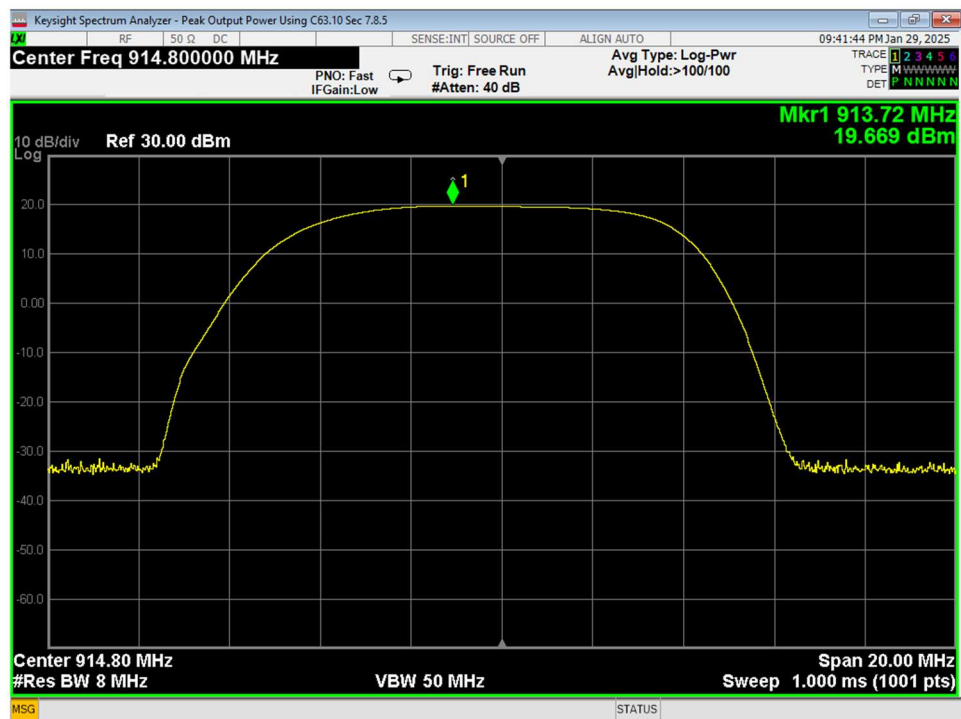


Figure 14. Peak Conducted Power, Mid Channel

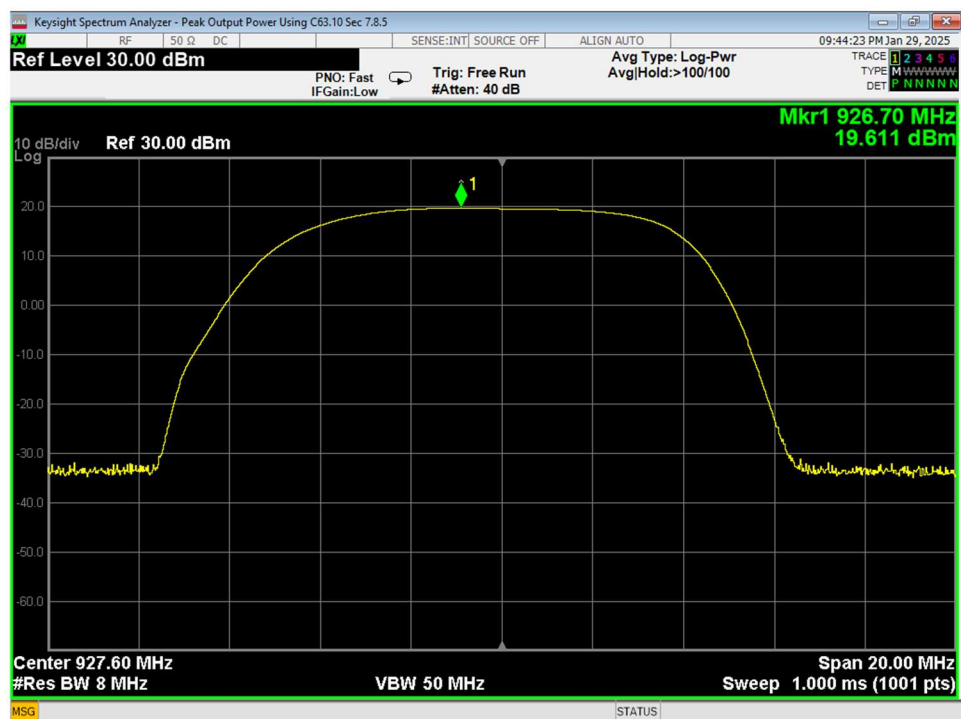


Figure 15. Peak Conducted Power, High Channel

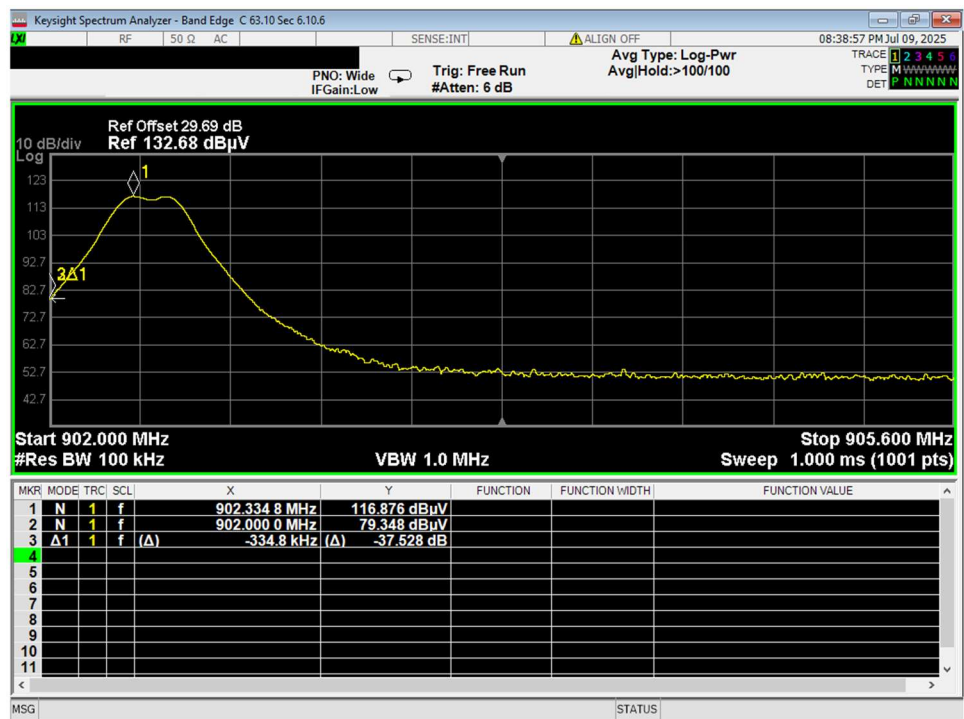


Figure 16. Bandedge Unrestricted Low Channel

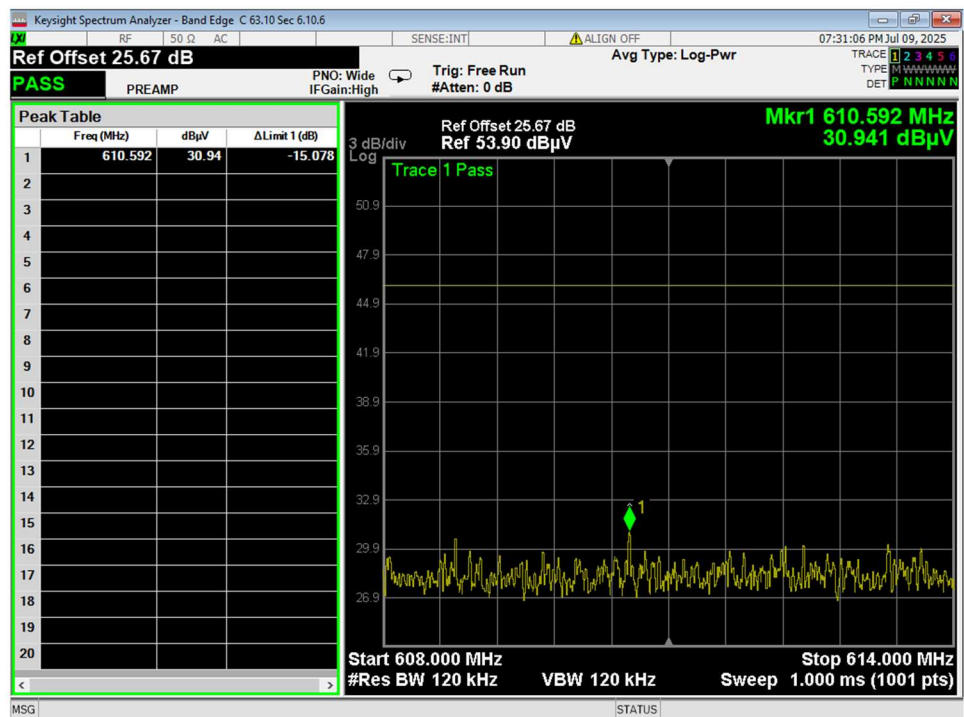


Figure 17. Bandedge Restricted Low Channel

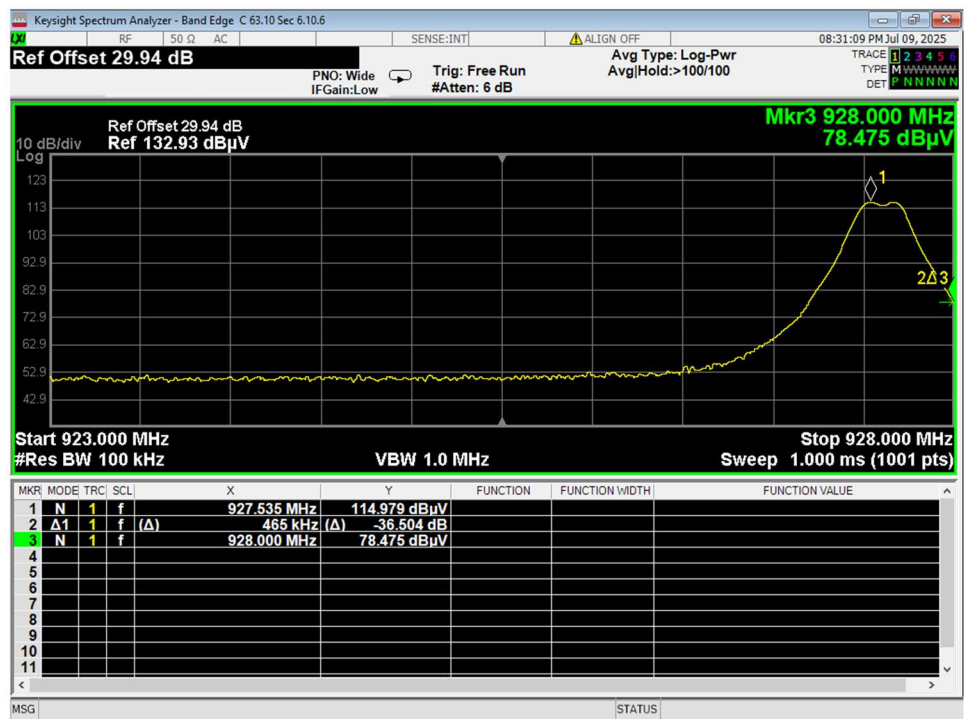


Figure 18. Bandedge Unrestricted High Channel

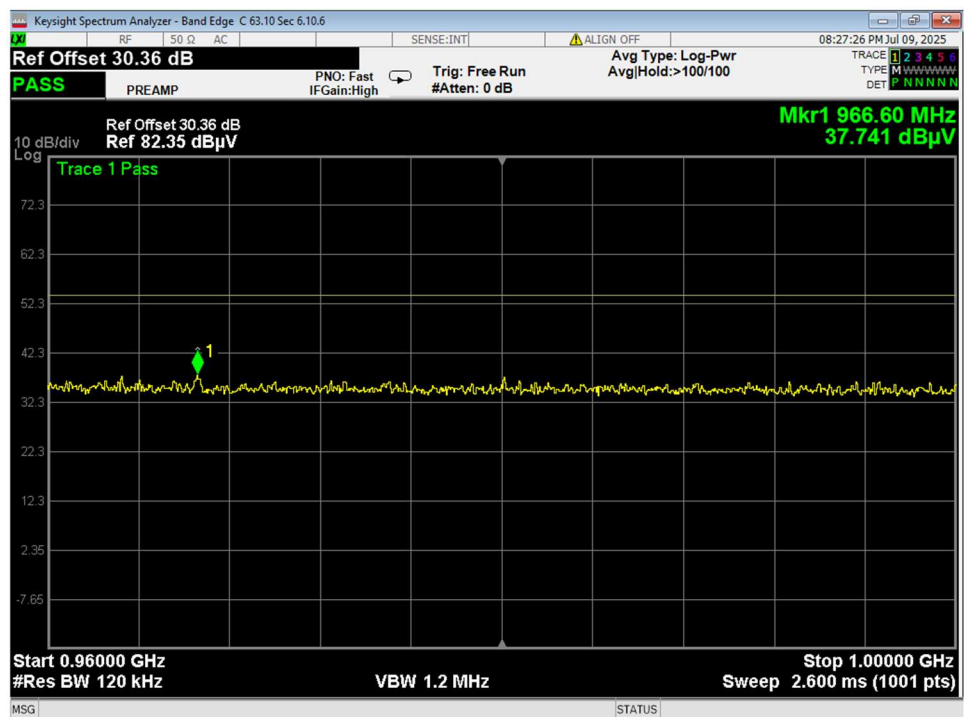


Figure 19. Bandedge Restricted High Channel.

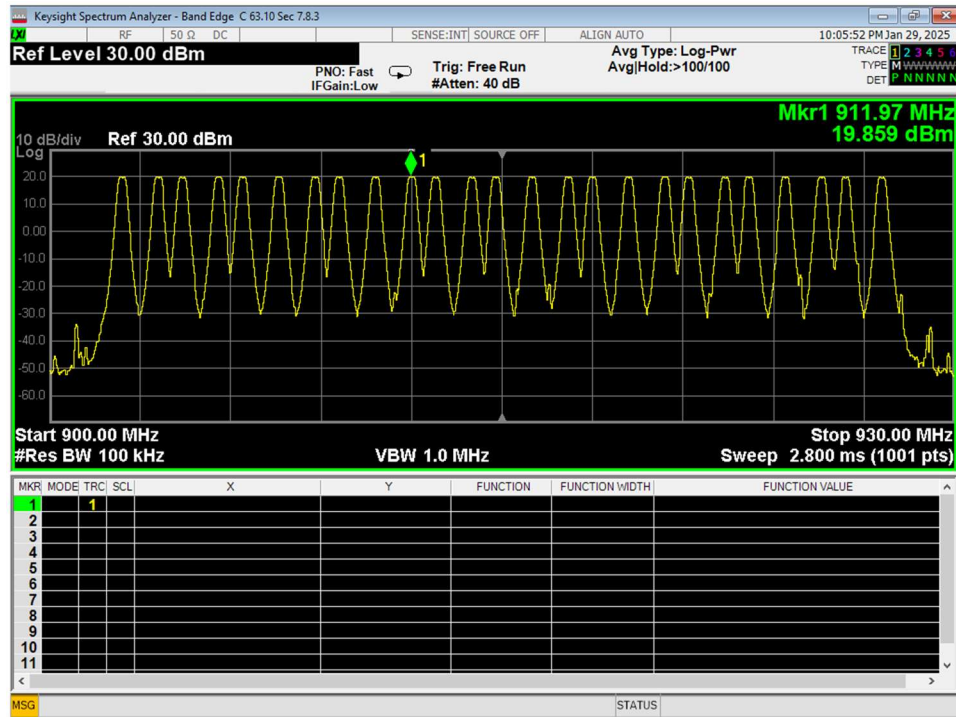


Figure 20. Hop Count, 25 Hops

Declaration from manufacturer: The EchoStream protocol defines 64 channels spaced 400 kHz apart. Manufacturer uses only 25 channels from the set of 64. The minimum spacing between channels is ~ 800 kHz with some channels space ~1.2 MHz apart. The entire channel map uses a spacing of 400 kHz, but the used channels are either 800 kHz or 1.2 MHz apart.

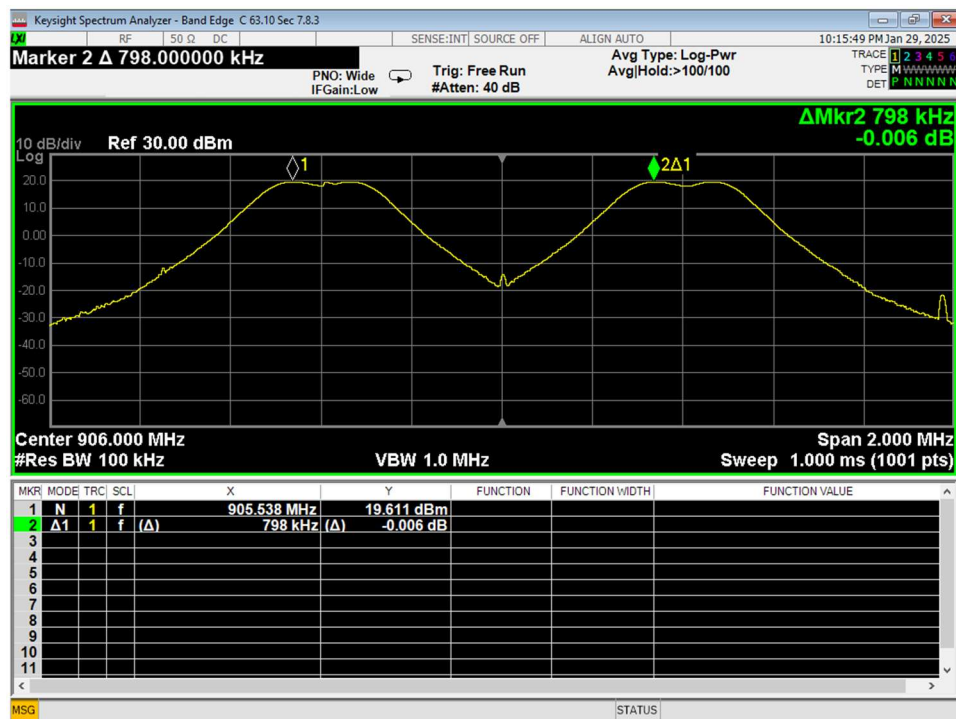



Figure 21. Minimum Frequency Separation

	Report Number:	R20241011-72-E1D	Rev	D
	Prepared for:	Inovonics		

Declaration from manufacturer: The EchoStream protocol defines 64 channels spaced 400 kHz apart. Manufacturer uses only 25 channels from the set of 64. The minimum spacing between channels is ~ 800 kHz with some channels space ~1.2 MHz apart. The entire channel map uses a spacing of 400 kHz, but the used channels are either 800 kHz or 1.2 MHz apart.

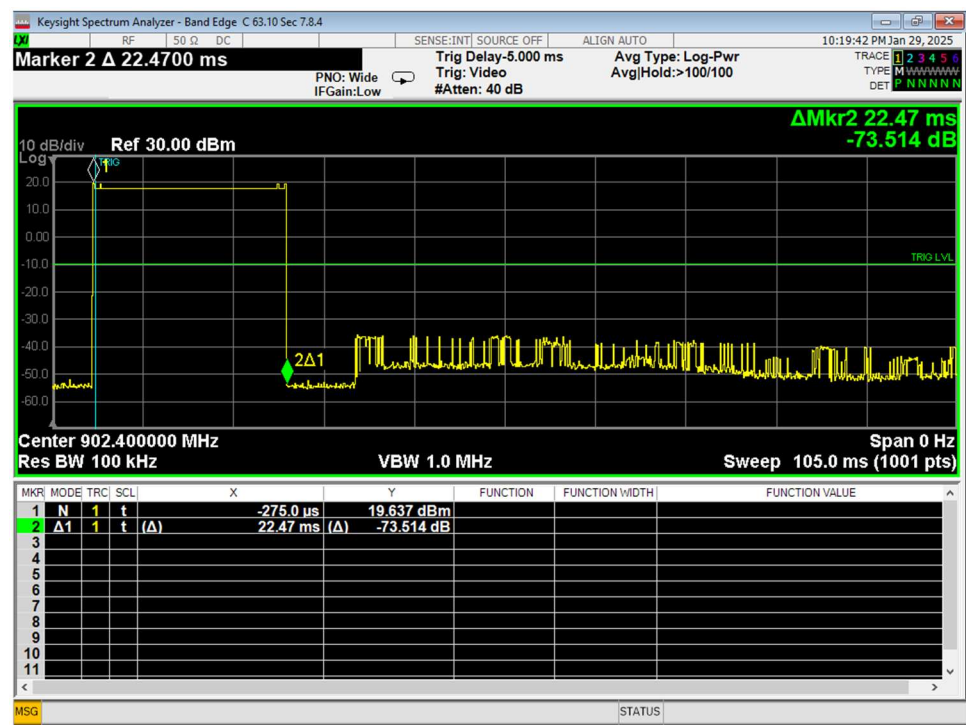


Figure 22. Channel Occupancy, On time*
 *Measured in hopping mode provided by the manufacturer.

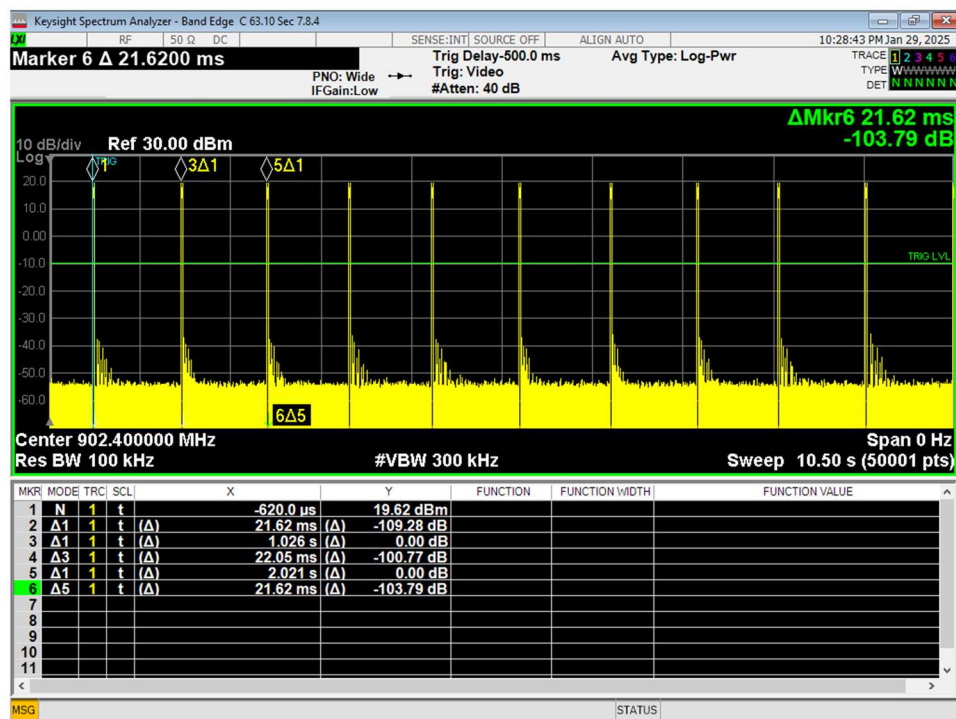



Figure 23. Channel Occupancy/ Period, Maximum of 11 Hops possible*
*Measured in hopping mode provided by the manufacturer.

$$22.05 \text{ ms} \times 11 = 0.243 \text{ s}$$

	Report Number:	R20241011-72-E1D	Rev	D
	Prepared for:	Inovonics		

REPORT END