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# **Test Report**

Prepared for: Inovonics

Address:

397 S. Taylor Ave. Louisville, CO 80027

Product:

**Test Report No:** 

R20210105-20-E2A

EN 1263, EN 1342-60

Approved by:

Nic Schnson, NCE Technical Manager iNARTE Certified EMC Engineer #EMC-003337-NE

DATE:

4 August 2021

Total Pages:

38

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ncee	Report Number:	: R20210105-20-E2A		А
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## REVISION PAGE

Rev. No.	Date	Description
0	26 February 2021	Original – KVepuri
		Prepared by KVepuri, FLane
A	26 May 2021	Updated power, bandedge, and harmonic values



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### 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 2

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, 7.1	Receiver Radiated Emissions	Pass	Meets the requirement of the limit.			
FCC 15.247(a)(1)(i) RSS-247, 5.1(c)	Minimum Bandwidth, Limit: Min. 250kHz	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-Gen, 8.9 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-Gen, 8.9 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	NA	Battery Powered Equipment			



## 2.0 EUT DESCRIPTION

## 2.1 EQUIPMENT UNDER TEST

The Equipment Under Test (EUT) was a wireless FHSS transmitter, EN1242-60, EN 1263.

EUT	EN 1342-60, EN 1263
EUT Received	5/12/2021
EUT Tested	5/19 – 5/26/2021
Serial No.	2640445
Operating Band	902.0 – 928.0 MHz
Device Type	FHSS
Power Supply	3V Lithium Battery (CR123A)

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



### 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.

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on the lowest, highest and one channel in the middle.

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#### 2.3 DESCRIPTION OF SUPPORT UNITS

N/A



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#### 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-1
CAB MRA Recognition Identification No:	US0177

Environmental conditions varied slightly throughout the tests:

Relative humidity of  $35 \pm 4\%$ Temperature of  $22 \pm 3^{\circ}$  Celsius



#### 3.2 TEST PERSONNEL

No.	PERSONNEL	TITLE	ROLE	
1	Karthik Vepuri EMC Test Engineer		Review, Testing and Report	
2	Fox Lane	EMC Test Engineer	Testing and Report	
3	3 James Henry Test Technician		Testing	
4	Samuel Probst	Test Technician	Testing	

#### Notes:

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



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## 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	May 5, 2020	May 5, 2022
SunAR RF Motion	JB1	A091418	March 6, 2020	March 6, 2021
EMCO Horn Antenna	3115	6415	March 16, 2020	March 16, 2022
Rohde & Schwarz Preamplifier**	TS-PR18	3545700803	April 14, 2020	April 14, 2022
Trilithic High Pass Filter*	6HC330	23042	April 14, 2020	April 14, 2022
MiniCircuits High Pass Filter*	VHF-1320+	15542	April 14, 2020	April 14, 2022
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	April 14, 2020	April 14, 2022
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	April 14, 2020	April 14, 2022
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3874	April 14, 2020	April 14, 2022
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	April 14, 2020	April 14, 2022
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	April 14, 2020	April 14, 2022
N connector bulkhead (control room)*	PE9128	NCEEBH2	April 14, 2020	April 14, 2022
TDK Emissions Lab Software	V11.25	700307	NA	NA

\*Internal Characterization

\*\*2 year calibration cycle

## Notes:

All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.



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#### 3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMNTS

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

## Conducted $\Box$

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.

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Figure 1 - Bandwidth Measurements Test Setup

## Radiated $\boxtimes$

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.



Figure 2 - Radiated Emissions Test Setup



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#### 4.0 DETAILED RESULTS

Radio Measurements								
CHANNEL	Transmitter	Occupied Bandwidth	20 dB Bandwidth	PEAK OUTPUT POWER*	PEAK OUTPUT POWER*	RESULT	No. of Hopping Channels	Time of Occupancy
		(kHz)	(kHz)	(EIRP) (dBm)	(EIRP) (mW)		25	0.088s
Low	Continuous	251.40	302.60	15.287	33.783	PASS	Frequency	Duty Cycle
Mid	Continuous	250.27	302.30	16.269	42.355	PASS	Separatio n	Correction
High	Continuous	249.54	301.60	16.962	49.682	PASS	800.2kHz	-13.15 dB
Occupied Bar 20 dB Bandwi	Occupied Bandwidth = N/A; 20 dB Bandwidth Limit 250 kHz $\leq$ BW $\leq$ 500 kHz.Peak Output Power Limit = 24 dBm; *corrections can be found in the last table of this section and under the graphs in Appendix C. Time of Occupancy<0.4 S in 10 S							
			Radiated Unre	stricted Band-Ed	lge			
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level (dBm)	Relative Fundamental (dBm)	Delta (dB)	Min Delta (dB)	Result	
Low	Hopping	902	-33.803	5.949	39.752	20.00	PA	SS
High	Hopping	928	-30.973	8.154	39.127	20.00	PA	SS
*Measuremer	ts shown in the g	raph were taken in	dBuV and cor	verted to dBm usi	ng: dBm = dl	BuV – 107 B		
воштнорри		Ra	adiated Peak F	Restricted Band-E	Edae	5		
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)	Margin	Re	sult
Low	Hopping	611.156	31.576	Radiated	46.02	14.444	PA	SS
High	Hopping	963.920	39.257	Radiated	53.98	14.723	PA	SS
*Limit shown is the peak limit taken from FCC Part 15.209 **Both Hopping and Continuous modes were investigated and results deviated by less than 1dB								

Corrections for Peak Output Power Measurements						
Channel Uncorrected Output Transducer Cable Loss Out Power (dBm) (dBm)		Output Power (EIRP) (dBm)				
Low	-26.913	26.30	4.13	15.287		
Mid	-26.181	26.60	4.08	16.269		
High	-25.428	26.60	4.02	16.962		

Output Power (EIRP)(dBm) = Cable Loss(dB)+Transducer(dB)+Uncorrected Output Power(dBm)+107(dBm to dBuV)-95.23(3m EIRP conversion)

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### 4.1 DUTY CYCLE

The highest possible duty cycle declared by the manufacturer is 22 ms in a given 100 ms window which is 22%. The Duty Cycle Correction Factor is  $20*\log (22/100) = -13.15$  dB. from C63.10 Sec 7.5



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#### 4.2 RADIATED EMISSIONS

**Test Method**: ANSI C63.10-2013, 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 (µV/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 \* Emission level ( $\mu$ 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.



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#### **Test procedures:**

Prepared for:

a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semianechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements form 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 10dB 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 10 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 3 - Radiated Emissions Test Setup

#### EUT operating conditions

Details can be found in section 2.1 of this report.



Test results:



Figure 4 - Radiated Emissions Plot, Low Channel







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Quasi-Peak Measurements									
Frequency	Frequency Level Limit Margin Height Angle Pol Channel								
MHz	dBµV/m	dBµV/m	dB	cm.	deg.				
30.79584	27.55	40.00	12.45	121	203	Н	Receive/ Idle		
930.96216	34.03	46.02	11.99	260	52	V	Receive/ Idle		

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.

	Peak Measurements										
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation			
MHz	dBµV/m	dBµV/m	dB	cm.	deg.						
2707.432000	41.75	73.98	32.23	300.00	221.00	Н	low	CW			
3609.696000	55.53	73.98	18.45	323.00	188.00	Н	low	CW			
2744.532000	43.33	73.98	30.65	121.00	220.00	Н	Mid	CW			
3659.330000	58.80	73.98	15.18	290.00	161.00	н	Mid	CW			
5488.800000	49.23	73.98	24.75	559.00	351.00	V	Mid	CW			
3710.502000	59.32	73.98	14.66	281.00	143.00	Н	High	CW			
2782.850000	46.24	73.98	27.74	321.00	0.00	Н	High	CW			

Average Measurements										
Frequency	Level* Limit Margin Height Angle Pol Channel M					Modulation				
MHz	dBµV/m	dBµV/m	dB	cm.	deg.					
2707.432	28.60	53.98	25.38	300	221	Н	low	CW		
3609.696	42.38	53.98	11.6	323	188	Н	low	CW		
2744.532	30.18	53.98	23.8	121	220	Н	Mid	CW		
3659.33	45.65	53.98	8.33	290	161	Н	Mid	CW		
5488.8	36.08	53.98	17.9	559	351	V	Mid	CW		
3710.502	46.17	53.98	7.81	281	143	Н	High	CW		
2782.85	33.09	53.98	20.89	321	0	Н	High	CW		

\*Average Measurement Level = Peak Measurement Level - Duty Cycle Correction (see section 4.1 for further details)

#### 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.

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Test Method: ANSI C63.10, Section(s) 7.8.5

#### 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.

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#### Test procedures:

Spectrum analyzer was set with a resolution bandwidth greater than occupied bandwidth and centered on the operating channel.

#### **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 the Appendix C.
- 2. All data is in the table in results section 4.0.
- 3. All the measurements were found to be compliant.

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

#### Limits of bandwidth measurements:

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

#### Test procedures:

The bandwidth of the fundamental frequency was measured by spectrum analyzer with 9 kHz RBW and 30 kHz VBW.

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



Test Method: ANSI C63.10, 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 EUT was tested in the same method as described in section *4.4* - *Bandwidth*. 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 quasi-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 the 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.

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## 4.6 CARRIER FREQUENCY SEPERATION, NUMBER OF HOPPING CHANNELS, TIME OF OCCUPANCY

Test Method: ANSI C63.10, 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 the Appendix C.
- 2. All the measurements were found to be compliant.
- 3. The measurements are reported on the graph.



#### APPENDIX A: SAMPLE CALCULATION

#### **Field Strength Calculation**

The field strength is calculated 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 = RA + AF - (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude AF = Antenna Factor CF = Cable Attenuation Factor AG = Amplifier Gain AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dB $\mu$ V is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dB $\mu$ V/m.

 $FS = 55 + 12 - (-1.1 + 20) + 0 = 48.1 \text{ dB}\mu\text{V/m}$ 

The 48.1 dB $\mu$ V/m value can be mathematically converted to its corresponding level in  $\mu$ V/m.

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

AV is calculated by the taking the  $20^{100}(T_{on}/100)$  where  $T_{on}$  is the maximum transmission time in any 100ms window.

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### **EIRP Calculations**

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]<sup>2</sup> / 30

Power (watts) = 10^[Power (dBm)/10] / 1000

Voltage  $(dB\mu V) = Power (dBm) + 107$  (for 50 $\Omega$  measurement systems)

Field Strength (V/m) =  $10^{Field}$  Strength (dB $\mu$ V/m) / 20] /  $10^{6}$ 

Gain = 1 (numeric gain for isotropic radiator)

Conversion from 3m field strength to EIRP (d=3):

 $EIRP = [FS(V/m) \times d^2]/30 = FS[0.3]$  for d = 3

 $EIRP(dBm) = FS(dB\mu V/m) - 10(log 10^9) + 10log[0.3] = FS(dB\mu V/m) - 95.23$ 

10log( 10^9) is the conversion from micro to milli



## APPENDIX B - MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	3.82
Radiated Emissions, 3m	1GHz - 18GHz	4.44
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB

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

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#### APPENDIX C – GRAPHS AND TABLES

Keysight S Marker	pectrum A RF PRES 1 901.	analyzer - Swept SA SEL 50 Ω AC 39500000	0 MHz NFE F	PNO: Fast	SENSE:IN Trig: #Atte	Free Run en: 10 dB	<u> </u>	LIGN OFF Avg Type: Avg Hold:>	Voltage 100/100	08:52:05 TF	AM May 20, 2021   AACE 1 2 3 4 5 6   TYPE M WM WWW   DET P P P N N
8 dB/div	Ref	-5.00 dBm								/lkr1 901. -26.	395 MHz 913 dBm
-13.0					<u>^</u> 1.						
-29.0 -37.0								- <u> </u>			
-45.0											
-61.0 -69.0											utranalouteratologie
-77.0 Center 9	02.40	0 MHz								Span	15.00 MHz
#Res BV	V (-6dE	3) 10 MHz		#VB	W 50 M	ИНz			Sweep	o 1.000 ms	: (1001 pts)
MKR MODE 1 N 2 3 4 5 6	TRC SCL		× 901.395 MHz	Y -26.913	dBm	FUNCTION	FUNCT	FION WIDTH	FI	UNCTION VALUE	^
7 8 9 10 11 <											×
MSG								STATUS			

01 Peak Output Power, Low Channel

Corrections and losses are not included in the graph.

Channel	Uncorrected Output Power (dBm)	Transducer (dBm)	Cable Loss (dBm)	Output Power (EIRP) (dBm)
Low	-26.913	26.30	4.13	15.287

Output Power (EIRP)(dBm) =Cable Loss(dB)+Transducer(dB)+Uncorrected Output Power(dBm)+107(dBm to dBuV)-95.23(3m EIRP conversion)

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YPE MWMWWW DET PPPNN
715 MHz 81 dBm
<sup>1</sup> WALLANDON
15.00 MHz
(1001 pts)
^
>

02 Peak Output Power, Mid Channel

Corrections and losses are not included in the graph.

Channel	Uncorrected Output Power (dBm)	Transducer (dBm)	Cable Loss (dBm)	Output Power (EIRP) (dBm)
Mid	-26.181	26.60	4.08	16.269

Output Power (EIRP)(dBm) = Cable Loss(dB)+Transducer(dB)+Uncorrected Output Power(dBm)+107(dBm to dBuV)-95.23(3m EIRP conversion)

ncee	Report Number:	R20210105-20-E2A	Rev	А
	Prepared for:	Inovonics		

🔤 Ke	/sight S	pectr	um A	nalyzer - Swept SA										
(X) Cen	tor l	RF	PRES	EL 50 Ω AC	0 MHz		SENSE	INT		🛕 ALIO	Ava Type	: Voltage	08:58:4 T	IS AM May 20, 2021
Cen			ЧЭ	21.00000	NFE I	PNO: Fast FGain:Low	Tr #A	ig: Free Atten: 10	Run dB		Avg Hold:	>100/100		
													Mkr1 926	.595 MHz
8 dB	/div		Ref	-5.00 dBm									-25	.428 dBm
-13.0									Ĭ					
-21.0								<u>^</u> 1						
-29.0														
-37.0														
-45.0	<u> </u>													
-53.0	<u> </u>		J											
-61.0	http://	w.												~~~~~
-69.0														
-77.0														
Cen	L ter 9	27	.000	) MHz		<u> </u>			<u> </u>				Spar	15.00 MHz
#Re	s BV	V (-	ôdE	3) 10 MHz		#	VBW 50	) MHz				Swe	ep 1.000 m	s (1001 pts)
MKR	MODE	TRC	SCL		Х		Y	FUN	CTION	FUNCTIO	N WIDTH		FUNCTION VALUE	^
2	N	1	î		926.595 MHZ	-25.4	428 dBm							
3														
5														
7														
9														
10														~
<														>

03 Peak Output Power, High Channel

Corrections and losses are not included in the graph.

Channel	Uncorrected Output Power (dBm)	Transducer (dBm)	Cable Loss (dBm)	Output Power (EIRP) (dBm)
High	-25.428	26.60	4.02	16.962

Output Power (EIRP)(dBm) = Cable Loss(dB)+Transducer(dB)+Uncorrected Output Power(dBm)+107(dBm to dBuV)-95.23(3m EIRP conversion)





04 Bandwidth, Low Channel

Note: the vertical lines in the plot show the occupied bandwidth. The 20 dB bandwidth measurement is displayed, but the lines are not shown.





05 Bandwidth, Mid Channel

Note: the vertical lines in the plot show the occupied bandwidth. The 20 dB bandwidth measurement is displayed, but the lines are not shown.





06 Bandwidth, High Channel

Note: the vertical lines in the plot show the occupied bandwidth. The 20 dB bandwidth measurement is displayed, but the lines are not shown.

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	Prepared for:	Inovonics		

nn Kej	ysight Spe	ctrum A	nalyzer - Band Edg	ge C 63.10 Sec 6.1	0.6							ŀ	- 6 ×
<mark>LXI</mark>		RF	50 Ω AC	CORREC		SENS	E:INT		ALIGN OFF			12:32:13 P	M May 25, 2021
Rer	Leve	64. Р	99 авµv REAMP		PNO: Wide IFGain:High	⊊ <b>⊺</b>	rig: Free Atten: 0 (	Run dB	Avg F	loid:>100/100		TY	
											Mkr	1 611.1	156 MHz
10 dl	B/div	Ref	<sup>°</sup> 84.99 dBµ	V								31.57	76 dBµV
Log 75.0													
75.0 65.0													
55.0													
99.U													
45.0								<u> </u>					
35.0	ᢉ᠇ᠬᢇᠬ	᠆᠕᠊᠕	$\sim$	n-mannan		mm	᠊ᠧᡊᡰ᠆ᠰᠰᠧᠼᡣᢍ	walnu	Man	-	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	hard	nan
25.U													
15.0													
4.99													
-5.01													
Star	t 608.	000 I	MHz								S	itop 614	.000 MHz
#Re	s BW	120	kHz		1	/BW 1.	2 MHz			S	weep 1.0	000 ms (	(1001 pts)
MKR		C SCL		X GAA AEC MIL	- 24	Y FZC JDu	FUN	ICTION	FUNCTION WIDT	H	FUNCTIO	N VALUE	^
2	N 1	ľ		011.150 MH	z 31.	<u>576 aBh</u>	V						
3													
5													
7													
8													
10													
<													>
		<u></u>					-						

MSG DEFile <State 900 MHz FHSS Restricted Lower Bandedge Corrrected.state>...

07 Band-Edge Measurement, Low Channel, Restricted Frequency, Hopping

Corrections and losses are included in the graph.

ncee	Report Number:	R20210105-20-E2A	Rev	А
	Prepared for:	Inovonics		

2:30:34 PM May 25, 2021
TYPE MWWWW
DET P NNNN
902.460 MHz
12.949 dBµV
BA D D-
Mar
003 0000 MHz
0 ms (1001 pts)
ALUE
~
>

08 Band-Edge Measurement, Low Channel, Unrestricted Frequency, Hopping

**Relative Measurement** 

\*Measurements shown in the graph were taken in dBuV and converted to dBm using: dBm = dBuV-107 to report in section 4.0

ncee	Report Number:	R20210105-20-E2A	Rev	А
	Prepared for:	Inovonics		

🔤 Key	/sight Spec	trum Ana	lyzer - Band Edg	e C 63.10 Sec 6.10	).6				•		1			
<mark>.x</mark> Mar	ker 1 s	RF 963.9	50 Ω DC 2000000	0 MHz		SENSE:	INT		<u>A</u> A	LIGN OFF Avg Typ	e: Log-Pwr		12:37:18 TF	3 PM May 25, 2021 RACE <b>1 2 3 4 5 6</b>
		PRE	AMP	I	PNO: Fast 🔾 FGain:High	⊃ Tri #A	g: Free tten: 0 d	Run IB		Avg Hole	d:>100/100			
													Mkr1 96	3.92 MHz
10 dE	3/div	Ref 7	′9.59 dBµ	v									39.2	57 dBμV
69 6								[						
59.6														
49.6														
39.6														
0.00 29 s	๛๛	᠕᠂᠕᠕	-markanna	᠇ᢐᠾ᠆᠋᠋ᠺᠯ᠆᠈᠋ᡘ᠆᠈ᠺᡯ᠆ᡘᡘᡧ	and all all all all all all all all all al	mar have	᠕ᠰᡅᠴᠬᢧᢇ	www.rutu	ՠՠՠՠ	harphan	monnohm	الريمي	ᠳ᠕ᠳ᠕ᡧ᠋ᡗᡗᢩᢛᡗ᠂᠕ᠬᠬᡟᢑᠥ	Marthant Lynn-under
10.6														
0.50														
9.59														
-0.41														
-10.4														
Star	t 0.960	)00 GI	lz	,							'		Stop 1.	00000 GHz
#Re	s BW ′	120 kH	lz		VB	₩ 1.2	MHz				Sw	/eep	2.600 ms	; (1001 pts)
MKR I		C SCL	:	X	Y		FUN	CTION	FUNCT	TION WIDTH		FU	NCTION VALUE	^
2	N 1	<u>t</u>		963.92 MHz	39.257	dBµV								
3														
5														
6														
8														
10														
11														>
MSG										STATUS				

09 Band-Edge Measurement, High Channel, Restricted Frequency, Hopping

Corrections and losses are included in the graph.

ncee	Report Number:	R20210105-20-E2A	Rev	А
labs	Prepared for:	Inovonics		

🔤 Ke	ysight	Spect	rum A	Analyzer - Bar	nd Edge	C 63.10 Sec 6.1	0.6									- 6 💌
<mark>LXI</mark>			RF	<u>50 Ω</u>	DC	CORREC			SENSE:	NT		ΔA	LIGN OFF		12:36:0	6 PM May 25, 2021
Mar	ker	19	27	.536000	0000	MHz		Wide (	Tri	g: Free	Run		Avg Type: Avg Hold:	Log-Pwr >100/100		TYPE MWWWWW
							IFGair	:Low	#A	tten: 6 d	B		<b>.</b>			DETPNNNN
															Mkr1 927	.536 MHz
<u>10 d</u>	B/div	1	Rei	f 130.59	dΒμ	V									115. <sup>-</sup>	l54 dBµV
Log											Â					
121																
111	$\vdash$									مستقم ممسم				- month		
101	$\vdash$							~~~	v <sup>r</sup> v						$\mathcal{V}_{\mathcal{D}_{\mathcal{D}_{\mathcal{D}_{\mathcal{D}}}}}$	
90.6	$\vdash$														1 Marin	° 2∆2
80.6	$\vdash$					when he have	<u> </u>									- A Martin 200
70.6		. <u>~</u> //	~~~~~	ᡎᢇᠧᢧᢇᡗᡟᢇᠬ	1 12-1											
60.6	~~	Ψ· 1				Y										
50.6																
40.6																
Star	t 92	27.0	000	) MHz											Stop 92	8.0000 MHz
#Re	s Bì	N 1	00	kHz				VBV	V 1.0	MHz				Swee	p 1.000 ms	s (1001 pts)
MKR	MODE	TRC	SCL		Х			Y		FUN	CTION	FUNC	TION WIDTH	F	UNCTION VALUE	^
1	Ν Λ1	1	f f	(A)	9	27.536 MH 464 kH	z z (Λ)	<u>115.154</u> -39.1	<u>dBµV</u> 27 dB							
3	N	1	f		9	28.000 MH	z	76.027	dBµV							
45																
6																
8																
9																
11																~
<																>
MSG													STATUS			

10 Band-Edge Measurement, High Channel, Unrestricted Frequency, Hopping

**Relative Measurement** 

Corrections and losses are included in the graph.

\*Measurements shown in the graph were taken in dBuV and converted to dBm using: dBm = dBuV-107 to report in section 4.0





15 Frequency Separation Minimum





16 Hop Count, 25 Hops

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labs	Prepared for:	Inovonics		

Keysight Spectrum Analyzer - Swept SA							- 2 🐱
RF PRESEL 50 Ω AC			SENSE:INT		ALIGN AUTO	Voltage	09:51:00 AM Feb 04, 2021
Marker 1 480.000 ms	NFE PNO: V	Nide 😱	Trig: Free I	Run	Avg type	. voitage	TYPE WWWWWWW DET P P N N N N
	IFGain	LOW	writeri. To				Mkr1 480.0 ms
10 dB/div Ref 0.00 dBm							-21.55 dBm
-10.0		. 9					*
-20.0		¢°			<b>\</b>		Q'
-30.0							
-40.0							
-50.0							
-60.0							
-70.0							
-90.0 4 1 2 1	www.controlland.d	4∆3 州湖小人	heloperadiate	Hidrocas	hand the 605	retro-attacherente	807
Center 902.400000 MHz Res BW (CISPR) 120 kHz		#VB	W 1.0 MHz			Sweep	Span 0 Hz 10.00 s (1001 pts)
MKR MODE TRC SCL X		Y	FUNC	TION	FUNCTION WIDTH	FUNCT	TION VALUE
1 N 1 t 2 Δ1 1 t (Δ)	480.0 ms 30.00 ms (Δ)	-21.55	dBm 17 dB				
3 N 1 t 4 Δ3 1 t (Δ)	3.400 s 30.00 ms (Δ)	-21.65	dBm 24 dB				
5 N 1 t 6 Δ5 1 t (Δ)	6.360 s 30.00 ms (Δ)	-21.18 -72.1	dBm 0 dB				
7 N 1 t 8 Δ7 1 t (Δ)	9.510 s 30.00 ms (Δ)	-21.94	dBm 2 dB				
9							
11							v
MSG					STATUS		,

17 Period over 10s

Maximum of 4 transmissions are possible

Incee labs	Report Number:	R20210105-20-E2A	Rev	А
	Prepared for:	Inovonics		

Keysight Sp	ectrum A	nalyzer - Swept SA			SENSE-INT		ALTON ALL	πο		02-02-02	DM Eeb 25, 2021
Marker 2	Δ 22 Pl	.2000 ms	NFE P	PNO: Wide 🖵 FGain:High	Trig: Free #Atten: 0	Run dB	Av	g Type:	Voltage	TR	ACE 1 2 3 4 5 6 TYPE MUSERNEY DET P P N N N N
10 dB/div Loa√	Ref	-40.00 dBr	n							ΔMkr2	22.20 ms 48.19 dB
-50.0			Ŷ <sup>1</sup>								
-70.0 -80.0											
-90.0 -100 -110	<sub>v</sub> latht		prij	2Δ1	myyely, canyelydd	hadalaan.	ntanu	hadayu	, alway later to a start of the	dritheathath	www.whitewallo
-120											
Center 902.400000 MHz Span 0 H Res BW (CISPR) 120 kHz VBW 91 kHz Sweep 200.0 ms (1001 pt									Span 0 Hz (1001 pts)		
MKR MODE T 1 N 2 A1 3 4 5 6 7 8 9 9 10 11 <		(Δ)	44.40 ms 22.20 ms	γ -61.25 (Δ) -48.	dBm 19 dB	ICTION	FUNCTION W		FU	NCTION VALUE	
MSG							ST	ATUS			

18 On Time, 0.022s



REPORT END