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Intertek
731 Enterprise Drive
Lexington, KY 40510

Tel 859 226 1000
Fax 859 226 1040

www.intertek.com

Powercast Corporation TEST REPORT

SCOPE OF WORK

EMC TESTING – POWERCAST RFID READER MODEL PCR91501

REPORT NUMBER

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EMC TEST REPORT (FULL COMPLIANCE)

Report Number: 105207900LEX-002

Project Number: G105207900

Report Issue Date: 12/12/2022

Model(s) Tested: Powercast RFID Reader model PCR91501

Standards: Title 47 CFR Part 15.247
RSS-247 Issue 2
RSS-Gen Issue 5

Tested by:
Intertek Testing Services NA, Inc.
731 Enterprise Dr.
Lexington, KY 40510
USA

Client:
Powercast Corporation
620 Alpha Drive
Pittsburgh, PA 15238-2912
USA

Report prepared by



Seth Parker, Associate Engineer

Report reviewed by



Brian Lackey, Team Leader

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1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results, and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
6	Occupied Bandwidth (FCC Part 15.215(c), RSS-247 Issue 2 § 5.1(c))	Pass
7	Output Power (FCC Part 15.247(b)(2), RSS-247 Issue 2 § 5.4(a))	Pass
8	Carrier Frequency Separation (FCC Part 15.247(a)(1), RSS-247 Issue 2 § 5.1(b))	Pass
9	Number of Hopping Frequencies (FCC Part 15.247(a)(1)(i), RSS-247 Issue 2 § 5.1(c))	Pass
10	Time of Occupancy (FCC Part 15.247(a)(1)(i), RSS-247 Issue 2 § 5.1(c))	Pass
11	Radiated Spurious Emissions & Band Edge (FCC Part 15.247(d), RSS-247 Issue 2 § 5.5)	Pass
12	Conducted Spurious Emissions (FCC Part 15.247(d), RSS-247 Issue 2 § 5.5)	Pass
13	Antenna Requirement (FCC Part 15.203, RSS-Gen Issue 5 § 6.8)	Pass



3 Client Information

This product was tested at the request of the following:

Client Information	
Client Name:	Powercast Corporation
Address:	620 Alpha Drive Pittsburgh, PA 15238-2912 USA
Contact:	Jason Gill
Email:	jgill@powercastco.com
Manufacturer Information	
Manufacturer Name:	Powercast Corporation
Manufacturer Address:	620 Alpha Drive Pittsburgh, PA 15238-2912 USA



4 Description of Equipment under Test and Variant Models

Equipment Under Test	
Product Name	Powercast RFID Reader
Model Number	PCR91501
Test Start Date	10/14/2022
Test End Date	12/9/2022
Device Received Condition	Good
Test Sample Type	Pre-Production
Transmit Band	902 MHz – 928 MHz
Test Channels	906.36 MHz, 915 MHz, 924 MHz
Equipment Time	Frequency Hopping Spread Spectrum (FHSS)
Antenna Make, Model, and Gain ¹	PCR91501 Integrated Patch Antenna Peak gain 3.8 (5.8 dBi, 3.65 dBd)
Input Rating	5V 1A USB-C
Description of Equipment Under Test (provided by client)	
RFID Reader.	

4.1 Variant Models:

There were no variant models covered by this evaluation.

¹ This information was provided by the client and deviations from these values may affect compliance. Intertek does not make any claim of compliance for other than these values.



5 System Setup and Method

5.1 Method:

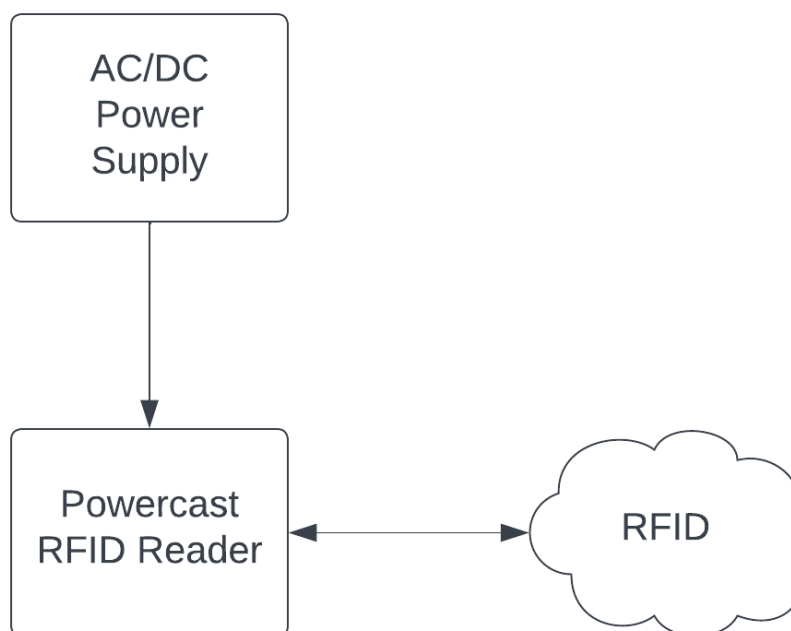
Configuration as required by ANSI C63.10:2013

No.	Descriptions of EUT Exercising
1	The EUT was powered by 120V/60Hz and configured to transmit continuously at a low, mid, or high channel.
2	The EUT was powered by 120V/60Hz and configured to transmit continuously using frequency hopping.

Cables					
Qty	Description	Length (m)	Shielding	Ferrites	Termination
1	USB-C	2	No	No	AC/DC Adapter

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
None	-	-	-

5.2 EUT Block Diagram:





6 Occupied Bandwidth

6.1 Test Limit

FCC Part 15.215(c):

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

RSS-247 Issue 2 § 5.1(c):

For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

6.2 Test Method

Tests are performed in accordance with ANSI C63.10: 2013 clause 6.9.2.

6.3 Test Equipment Used:

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Signal Analyzer	3981	Rohde & Schwarz	FSU	9/16/2022	9/16/2023

6.4 Test Results

The device was found to be **compliant**. The 20dB bandwidth was found to be contained wholly within the authorized frequency band, and less than 500kHz.



6.5 Test Conditions

Test Personnel:	Seth Parker	Test Date:	12/8/2022
Supervising/Reviewing Engineer:	Brian Lackey		
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	25.6C
Input Voltage:	120V/60Hz	Relative Humidity:	52.2%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4mbar

Deviations, Additions, or Exclusions: None

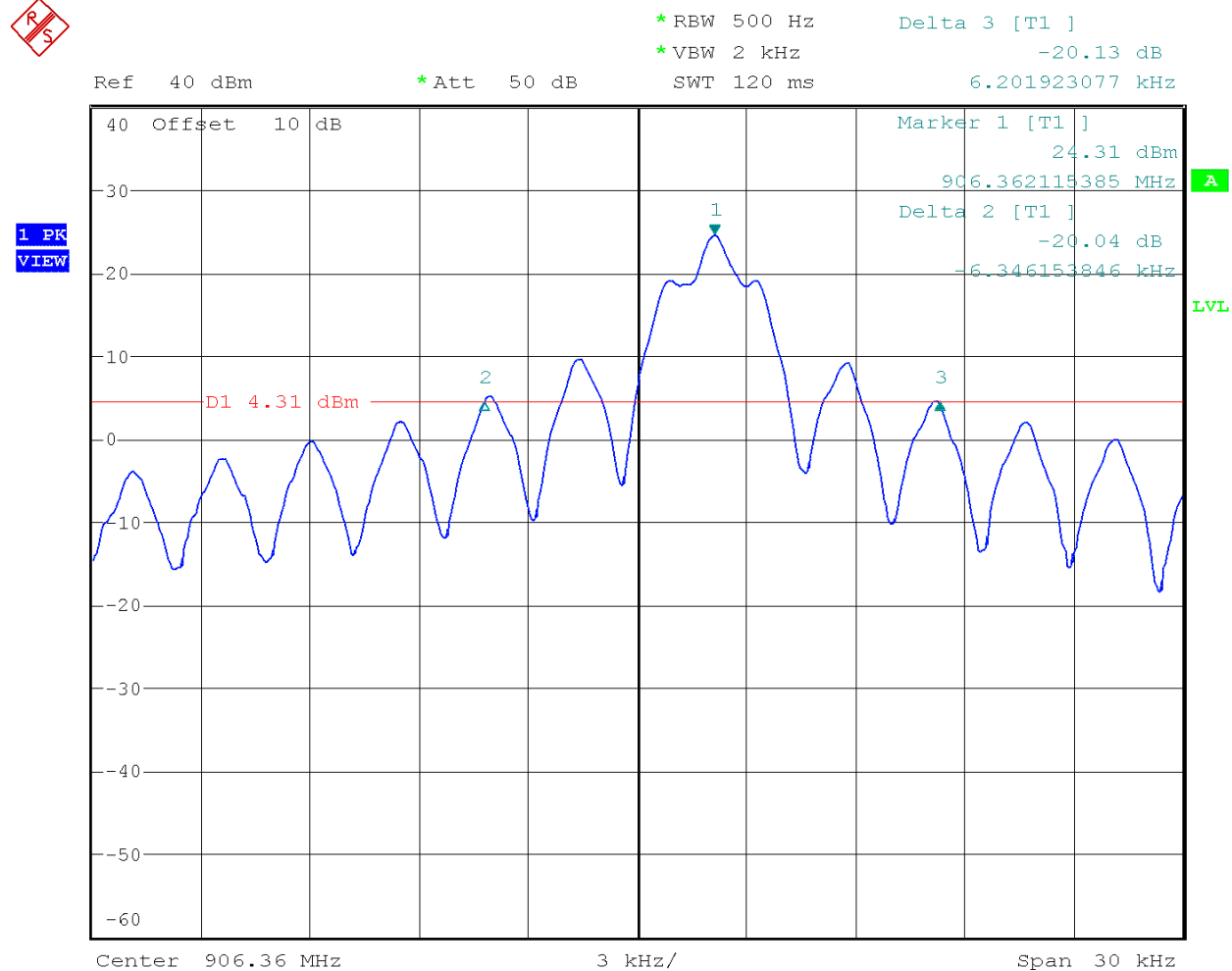
6.6 Test Data

Frequency (MHz)	20dB Bandwidth (kHz)	99% Bandwidth (kHz)	Limit (kHz)
906.36	12.548	21.794	500
915	12.548	22.051	500
924	12.644	21.794	500



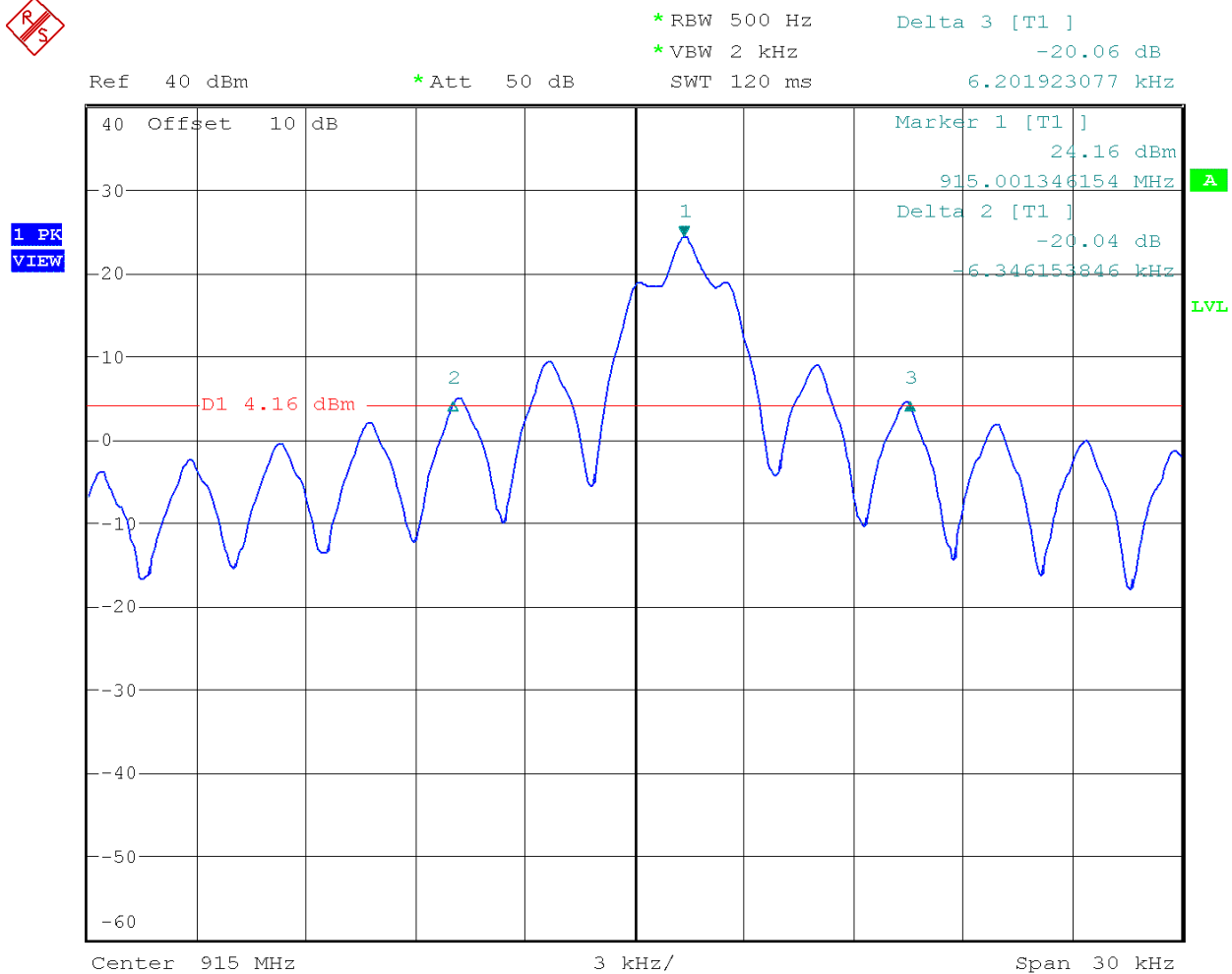
6.7 Spectrum Plots

6.7.1 906.36 MHz, 20dB Bandwidth



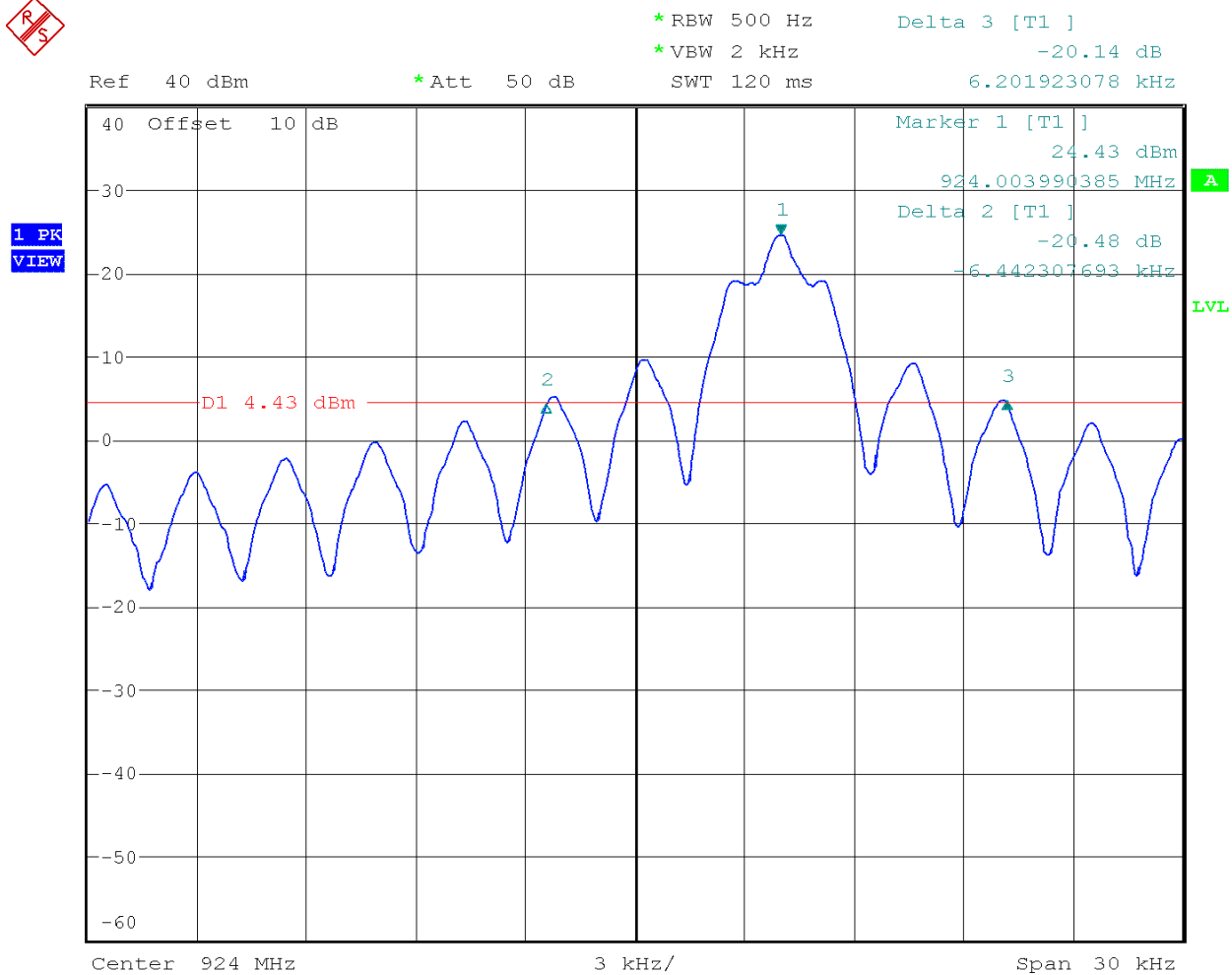


6.7.2 915 MHz, 20dB Bandwidth



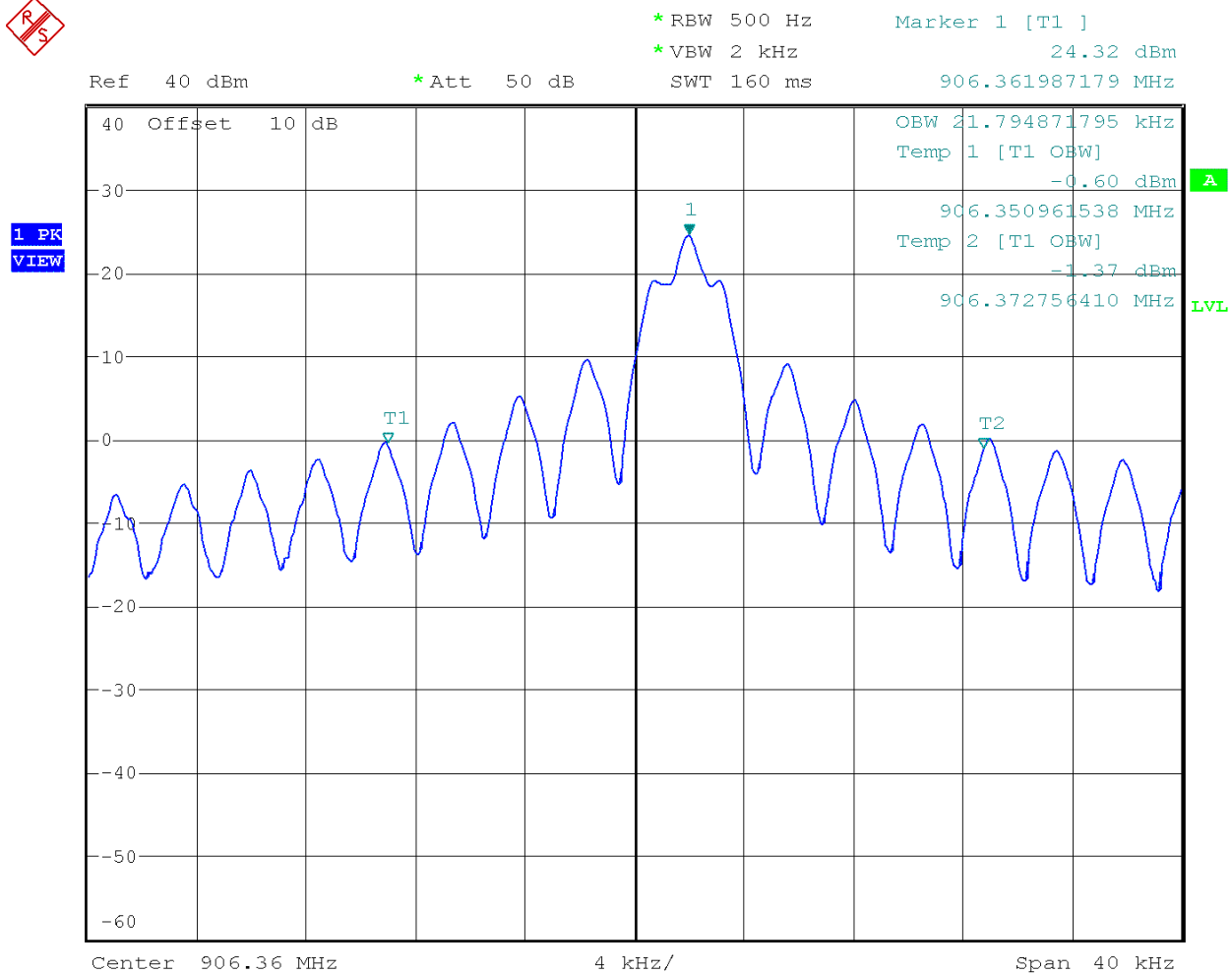


6.7.3 924 MHz, 20dB Bandwidth



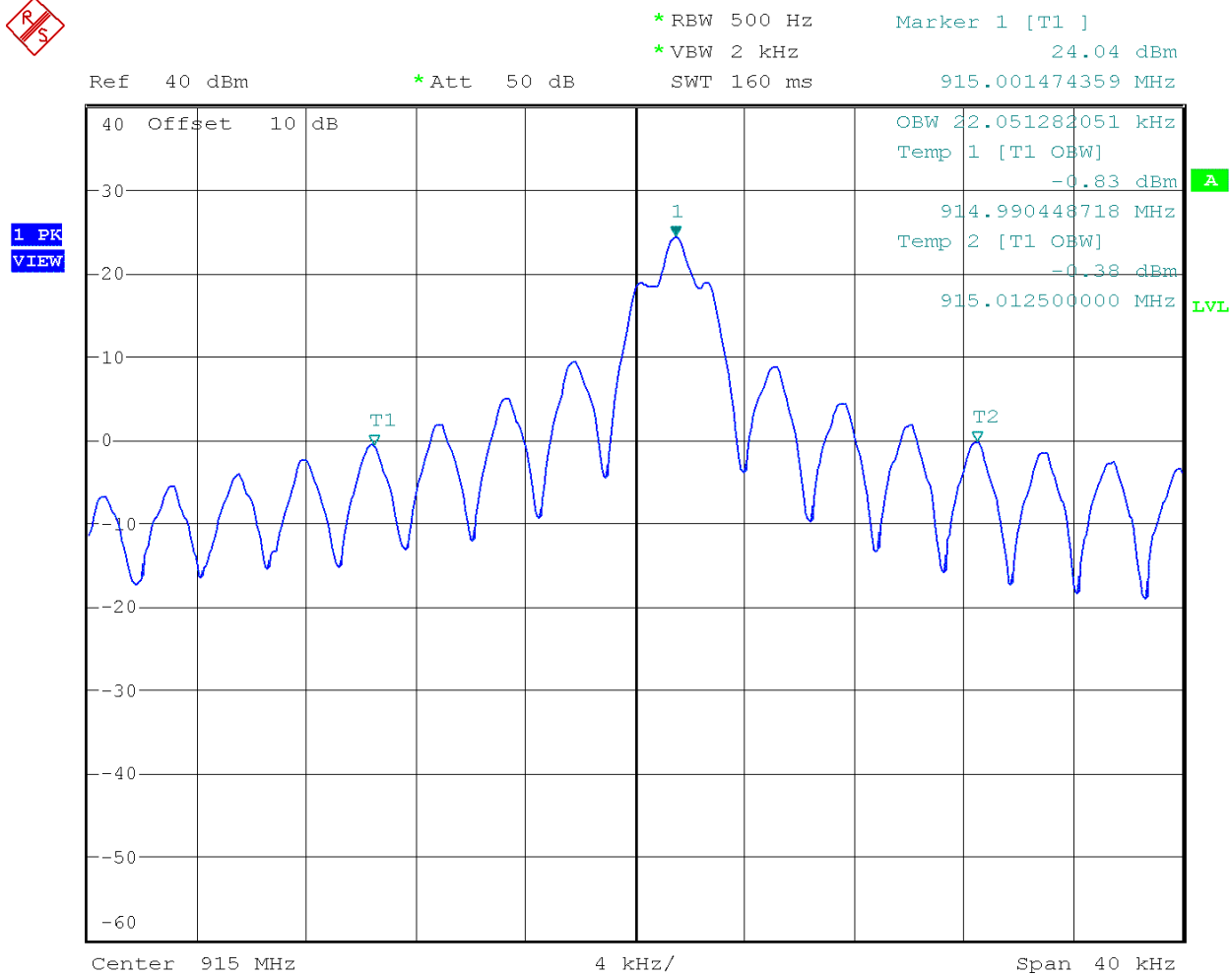


6.7.4 906.36 MHz, 99% Bandwidth



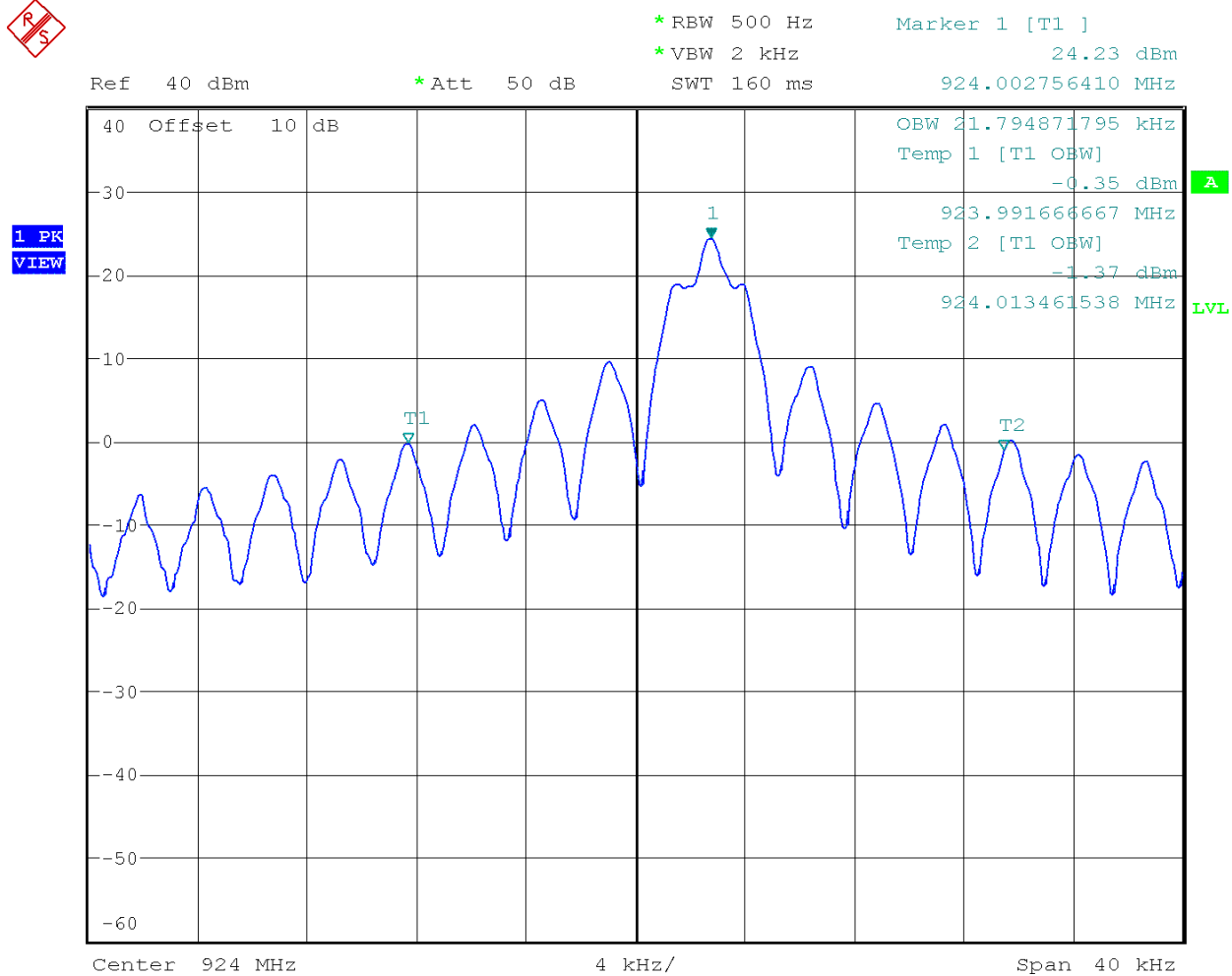


6.7.5 915 MHz, 99% Bandwidth





6.7.6 924 MHz, 99% Bandwidth





7 Maximum Peak Output Power

7.1 Test Limits

FCC Part 15.247(b)(2):

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

RSS-247 Issue 2 § 5.4(a):

For FHSs operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

7.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013 § 7.8.5.

7.3 Test Equipment Used:

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	10/5/2022	10/5/2023

7.4 Test Results

The device was found to be **compliant**. The peak output power was less than 1W. The maximum EIRP was less than 4W.

7.5 Test Conditions

Test Personnel:	Seth Parker	Test Date:	12/9/2022
Supervising/Reviewing Engineer:	Brian Lackey	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	25.6C
Input Voltage:	120V/60Hz	Relative Humidity:	52.2%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4mbar

Deviations, Additions, or Exclusions: None

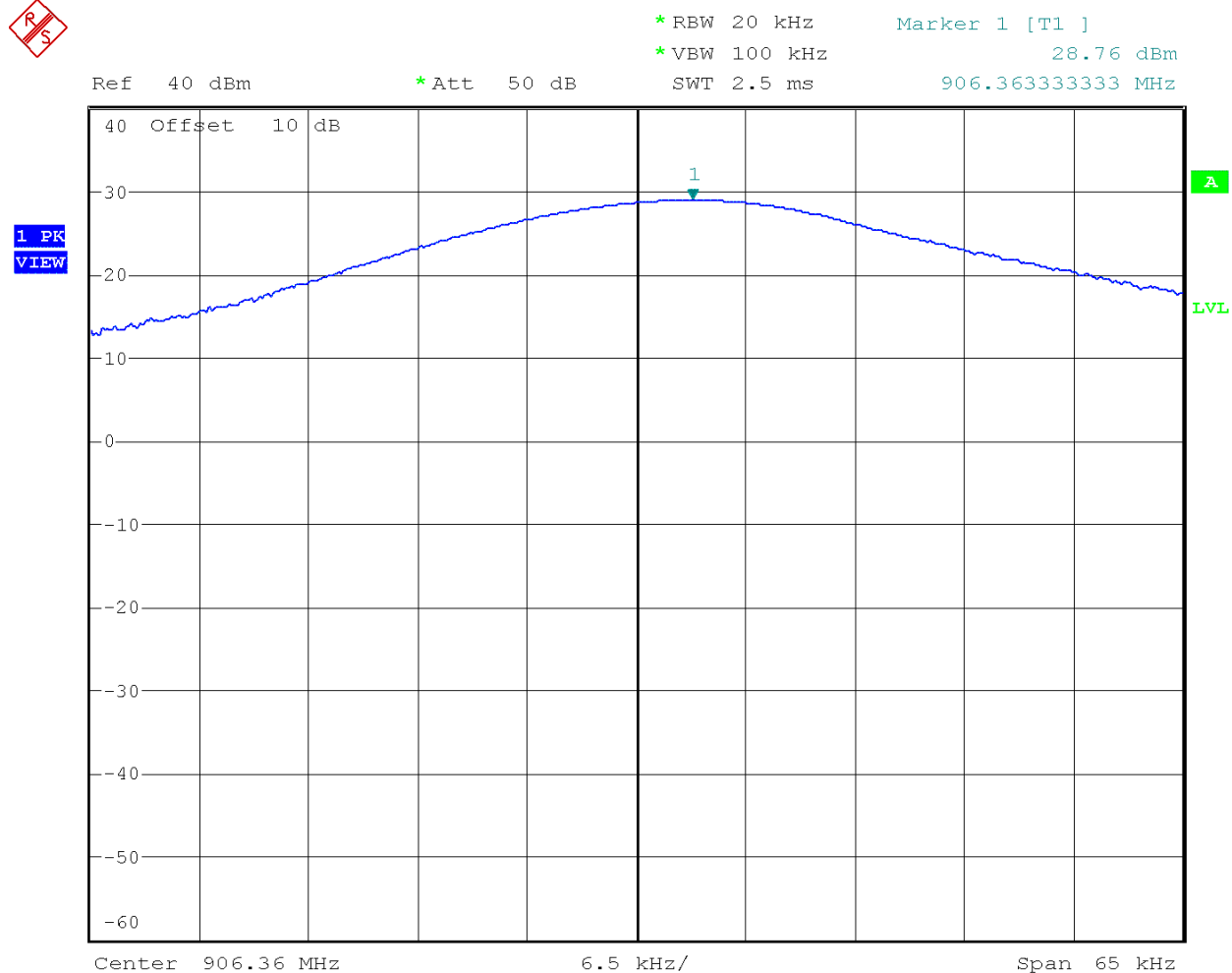


7.6 Test Data

Frequency (MHz)	Conducted Power (dBm)	Gain (dBd)	ERP (dBm)	Conducted Power Limit (dBm)	EIRP Limit (dBm)
906.36	28.76	3.65	32.41	30	36.02
915	28.57	3.65	32.22	30	36.02
924	28.67	3.65	32.32	30	36.02

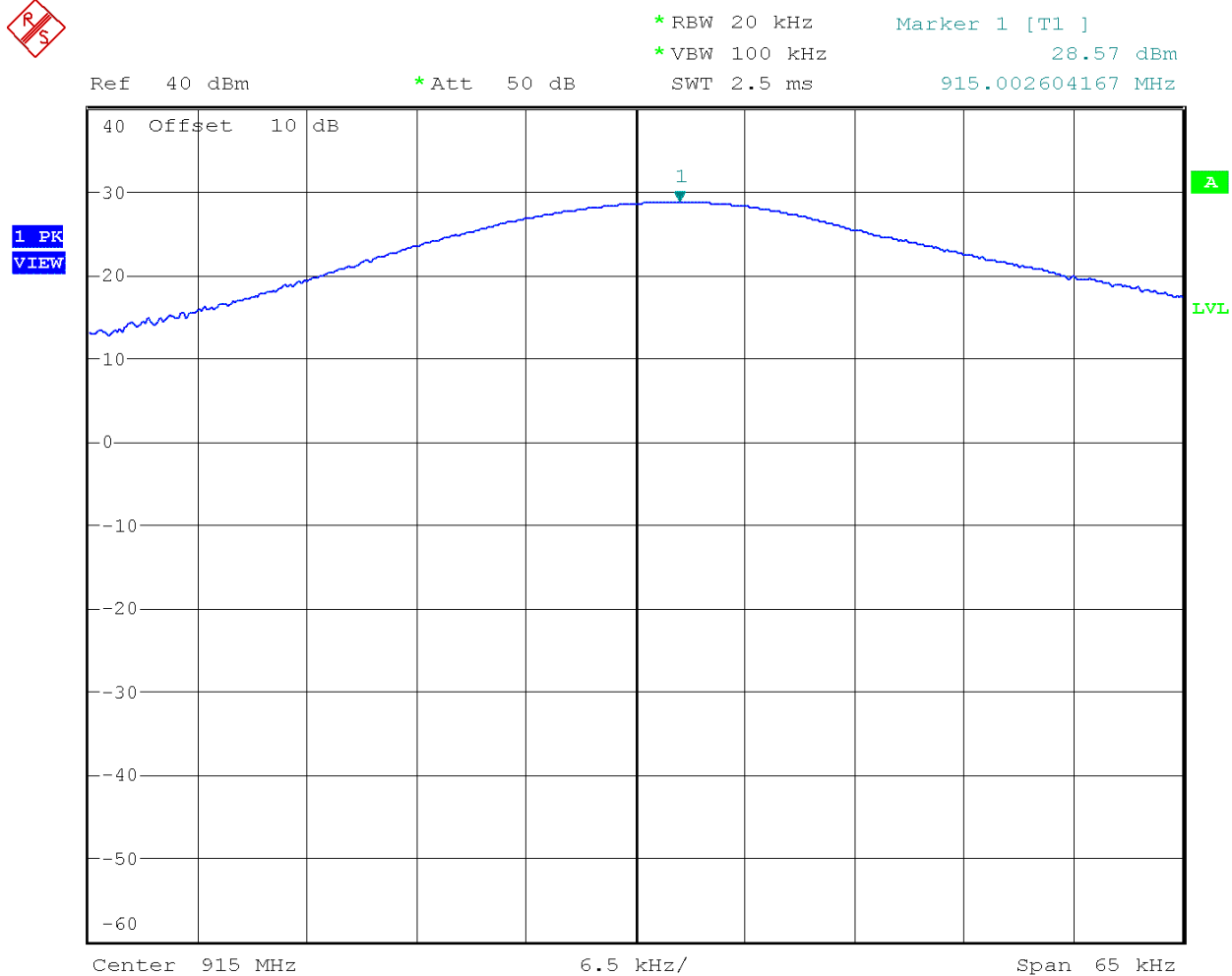
7.7 Spectrum Plots

7.7.1 906.36 MHz



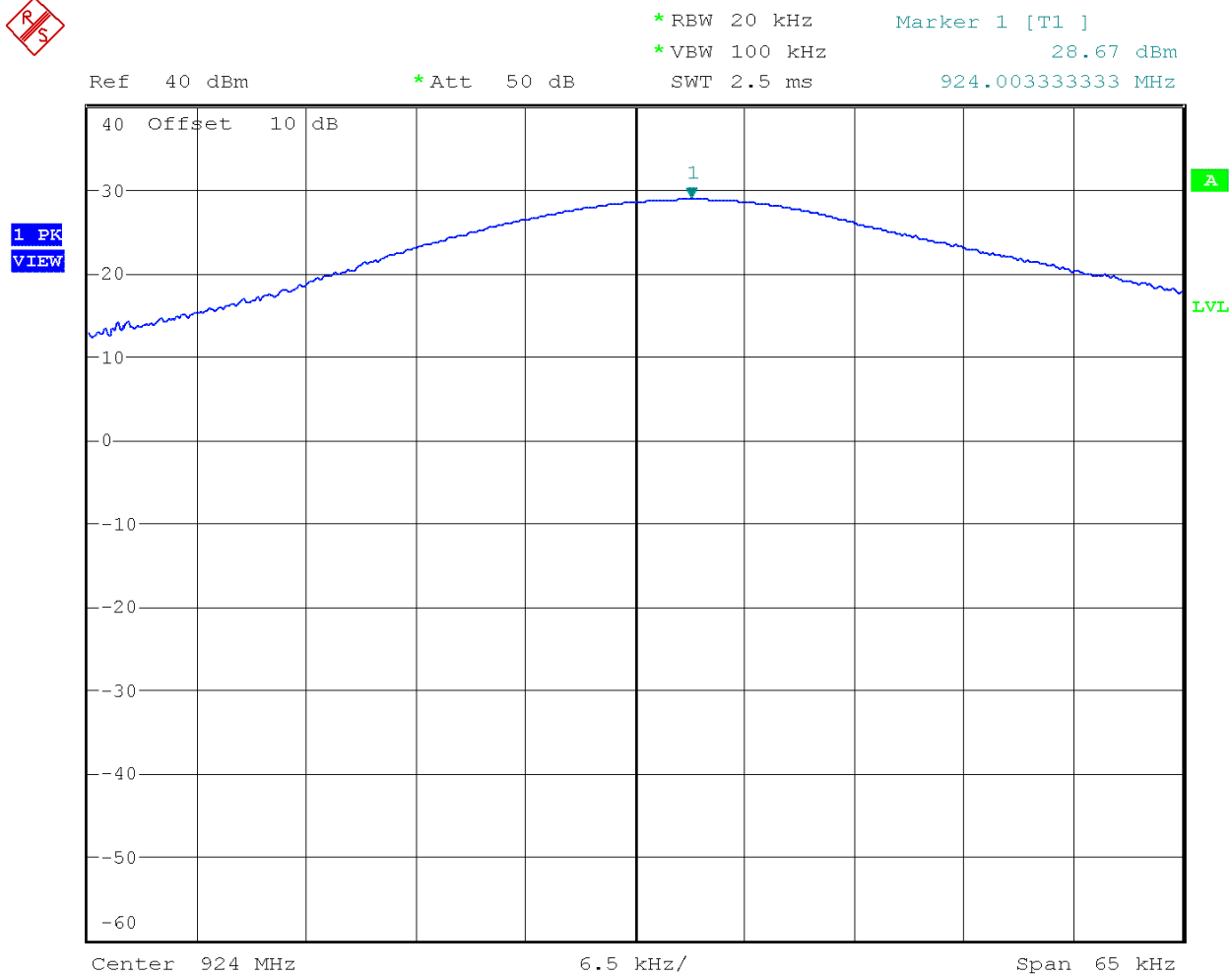


7.7.2 915 MHz





7.7.3 924 MHz





8 Carrier Frequency Separation

8.1 Test Limit

FCC Title 47 CFR Part 15.247(a)(1):

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

RSS-247 Issue 2 § 5.1(b):

FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

8.2 Test Method

Tests are performed in accordance with ANSI C63.10: 2013 clause 7.8.2.

8.3 Test Equipment Used:

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Spectrum Analyzer	3981	Rohde & Schwarz	FSU	9/16/2022	9/16/2023

8.4 Test Results

The device was found to be **compliant**. The carrier frequency separation was at least 25 kHz.

8.5 Test Conditions

Test Personnel:	Seth Parker	Test Date:	12/8/2022
Supervising/Reviewing Engineer:	Brian Lackey	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	25.6C
Input Voltage:	120V/60Hz	Relative Humidity:	52.2%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4mbar

Deviations, Additions, or Exclusions: Limits were applied to the 20dB bandwidth as reported in section 6.6.

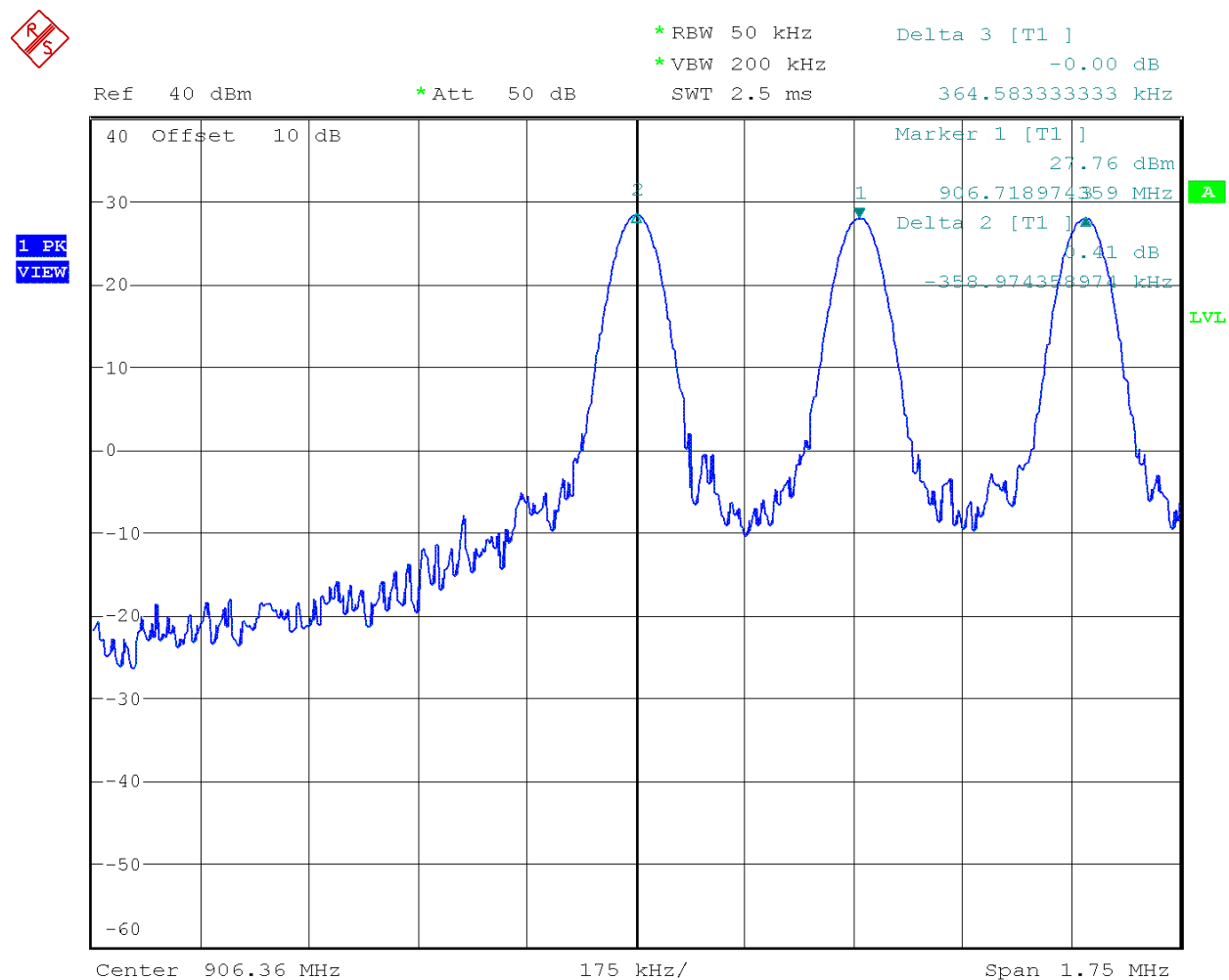


8.6 Test Data

Frequency (kHz)	Measured Value (kHz)	Limit (kHz)
906.36	361.77	≥ 25
915	360.37	≥ 25
924	360.37	≥ 25

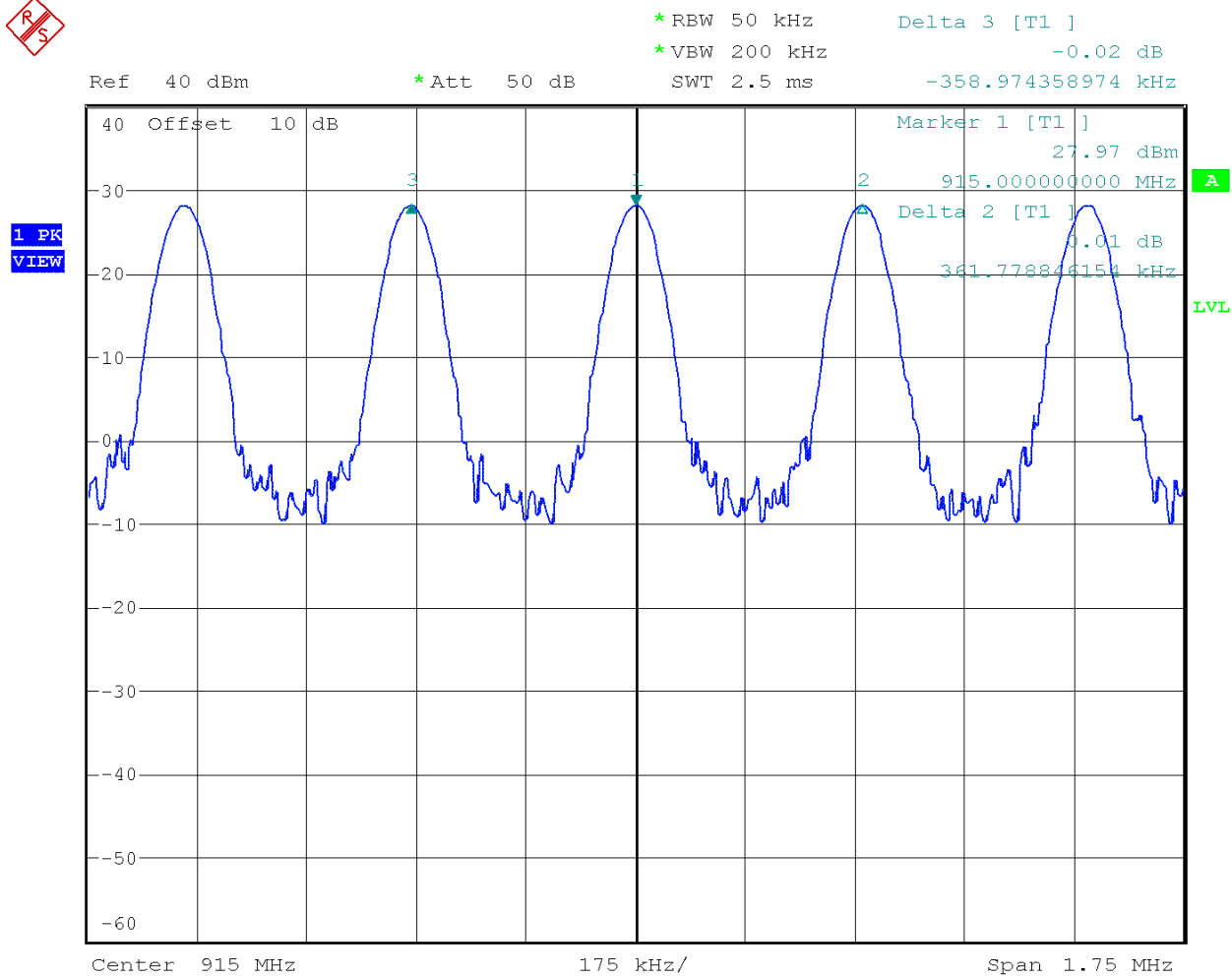
8.7 Spectrum Plots

8.7.1 906.36 MHz



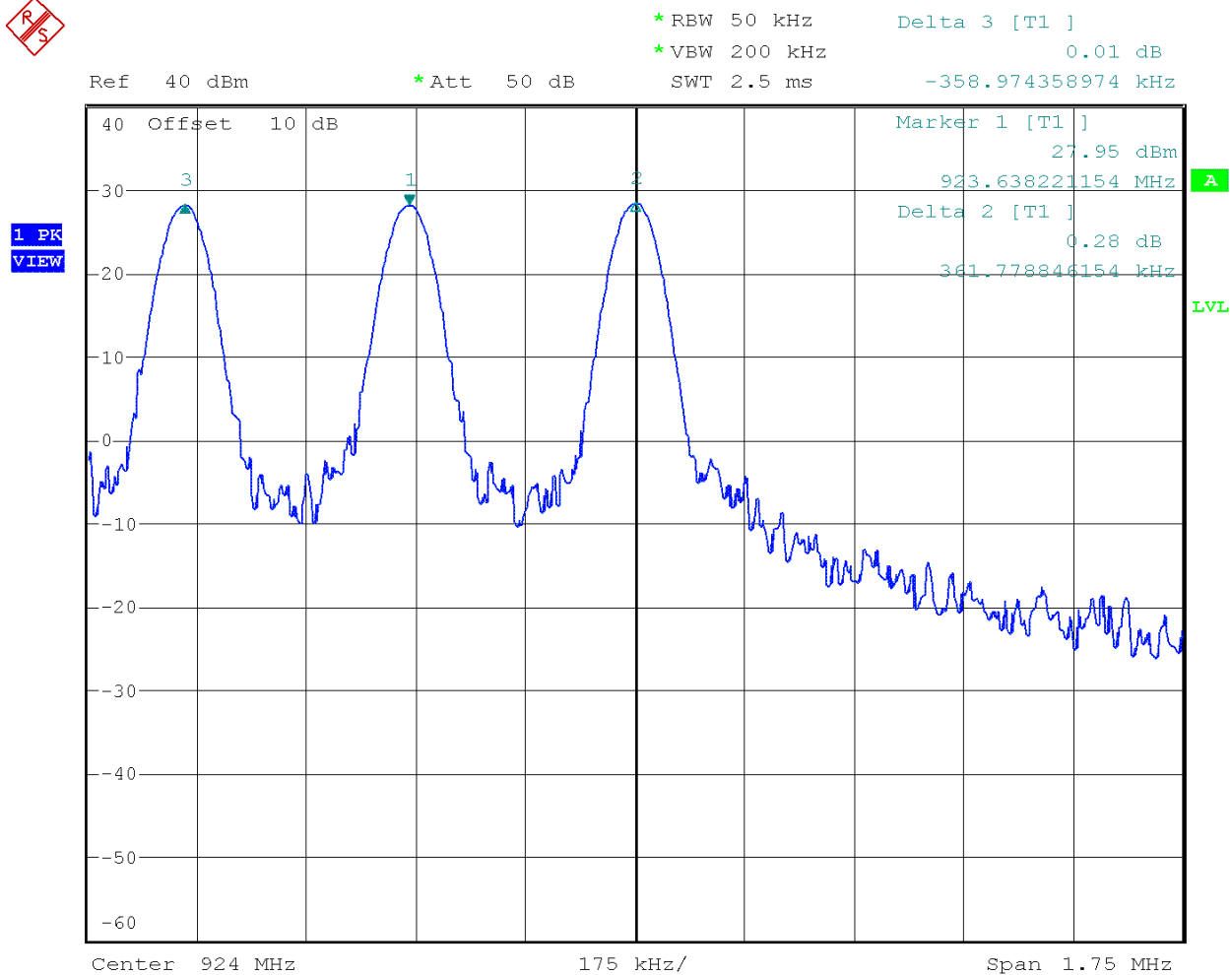


8.7.2 915 MHz





8.7.3 924 MHz





9 Number of Hopping Frequencies

9.1 Test Limits

FCC Part 15.247(a)(1)(i):

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

RSS-247 Issue 2 § 5.1(c):

For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

9.2 Test Method

Tests are performed in accordance with ANSI C63.10: 2013 clause 7.8.3.

9.3 Test Results

The device was found to be **compliant**. There were 50 measured hopping channels.

9.4 Test Equipment Used:

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Spectrum Analyzer	3981	Rohde & Schwarz	FSU	9/16/2022	9/16/2023

9.5 Test Conditions

Test Personnel:	Seth Parker	Test Date:	12/8/2022
Supervising/Reviewing Engineer:	Brian Lackey	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	25.6C
Input Voltage:	120V/60Hz	Relative Humidity:	52.2%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4mbar

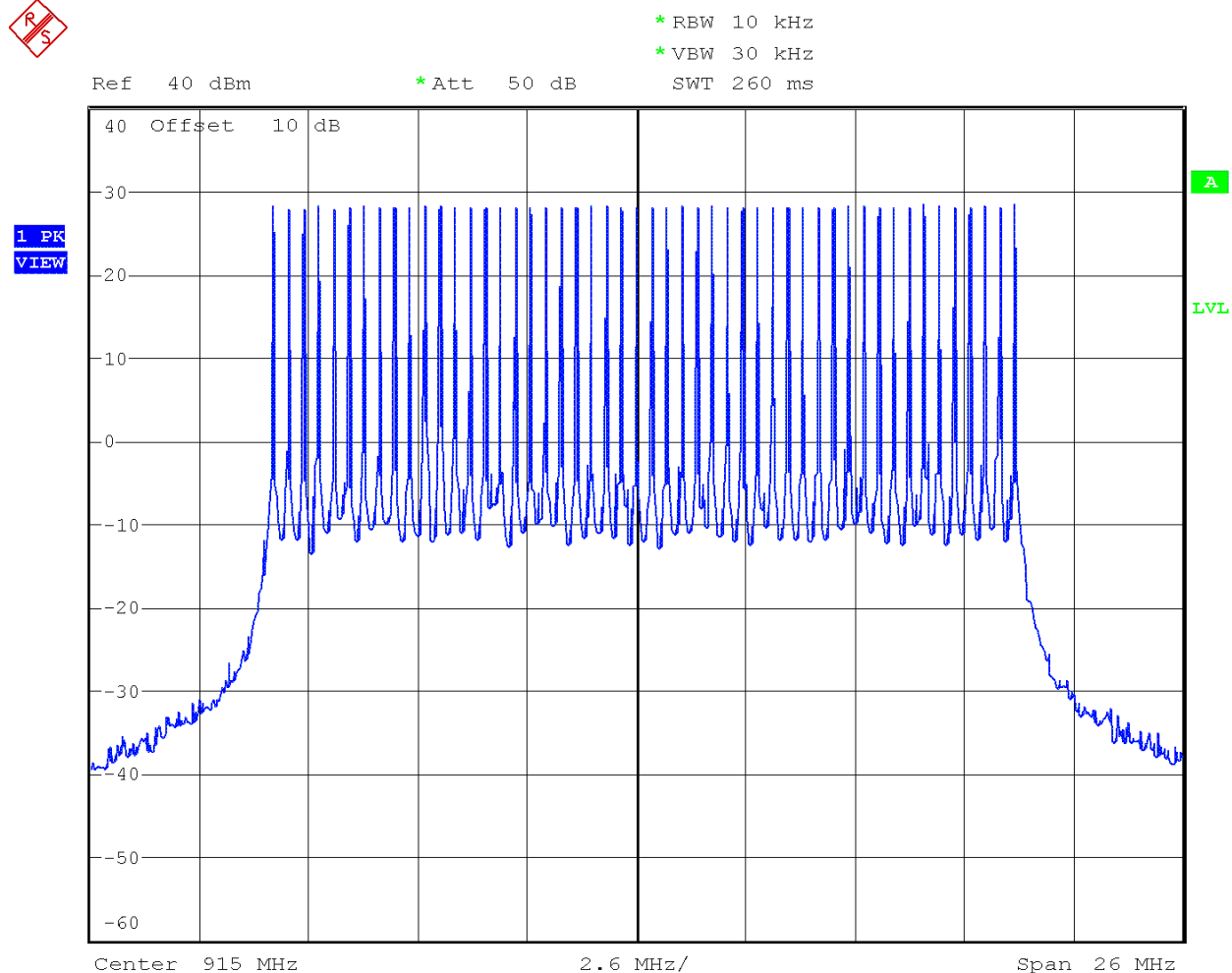
Deviations, Additions, or Exclusions: None



9.6 Test Data

Operating Mode	Measured Value (Count)	Limit
FHSS	50	≥ 50

9.7 Spectrum Plots





10 Time of Occupancy

10.1 Test Limits

FCC Part 15.247(a)(1)(i):

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

RSS-247 Issue 2 § 5.1(c):

For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

10.2 Test Method

Tests are performed in accordance with ANSI C63.10: 2013 clause 7.8.4.

10.3 Test Equipment Used:

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
Spectrum Analyzer	3981	Rohde & Schwarz	FSU	9/16/2022	9/16/2023

10.4 Test Results

The device was found to be **compliant**. The maximum accumulated transmit time on any single channel was less than 0.4 seconds.

10.5 Test Conditions

Test Personnel:	Seth Parker	Test Date:	12/8/2022
Supervising/Reviewing Engineer:	Brian Lackey	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	25.6C
Input Voltage:	120V/60Hz	Relative Humidity:	52.2%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	985.4mbar

Deviations, Additions, or Exclusions: None

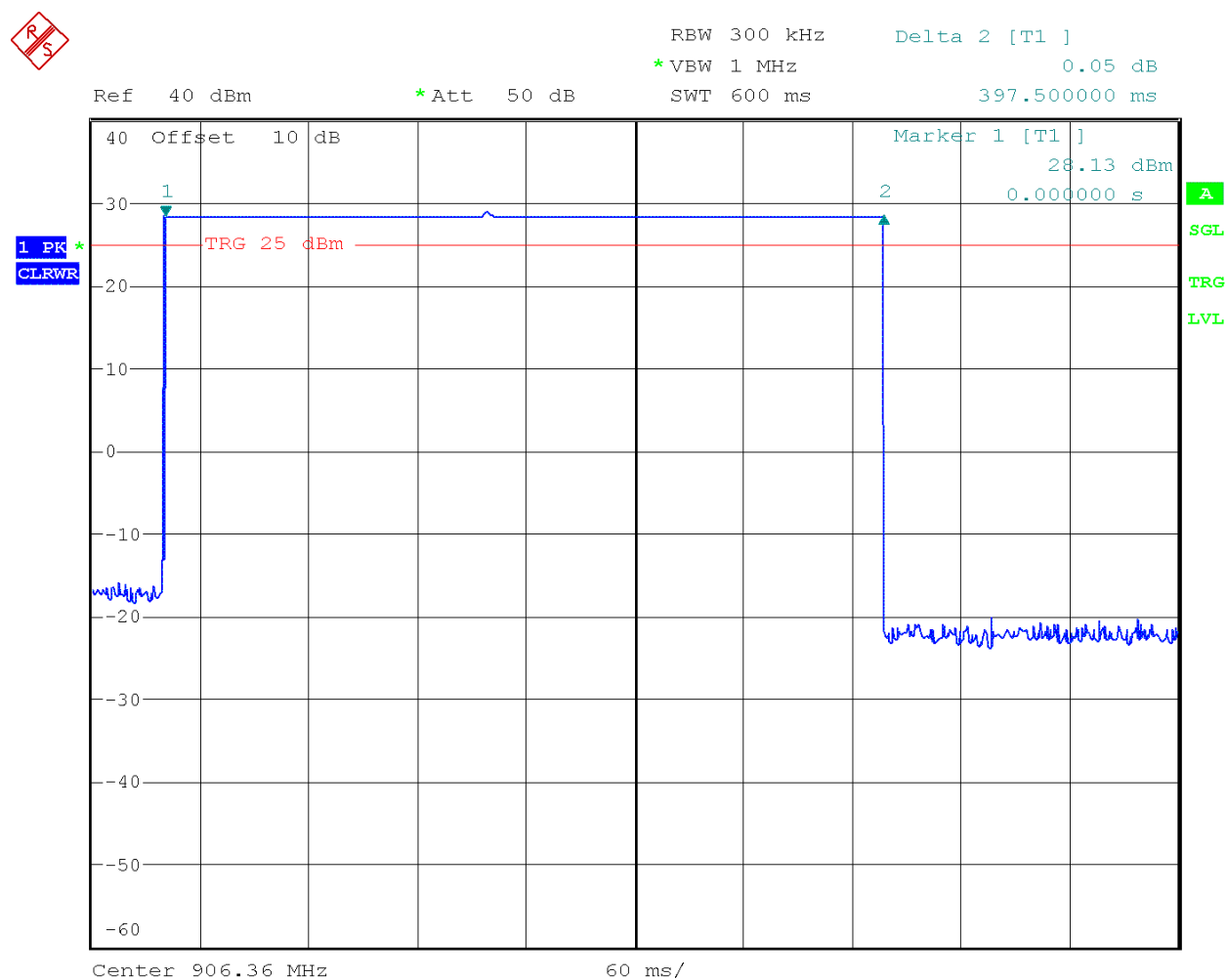


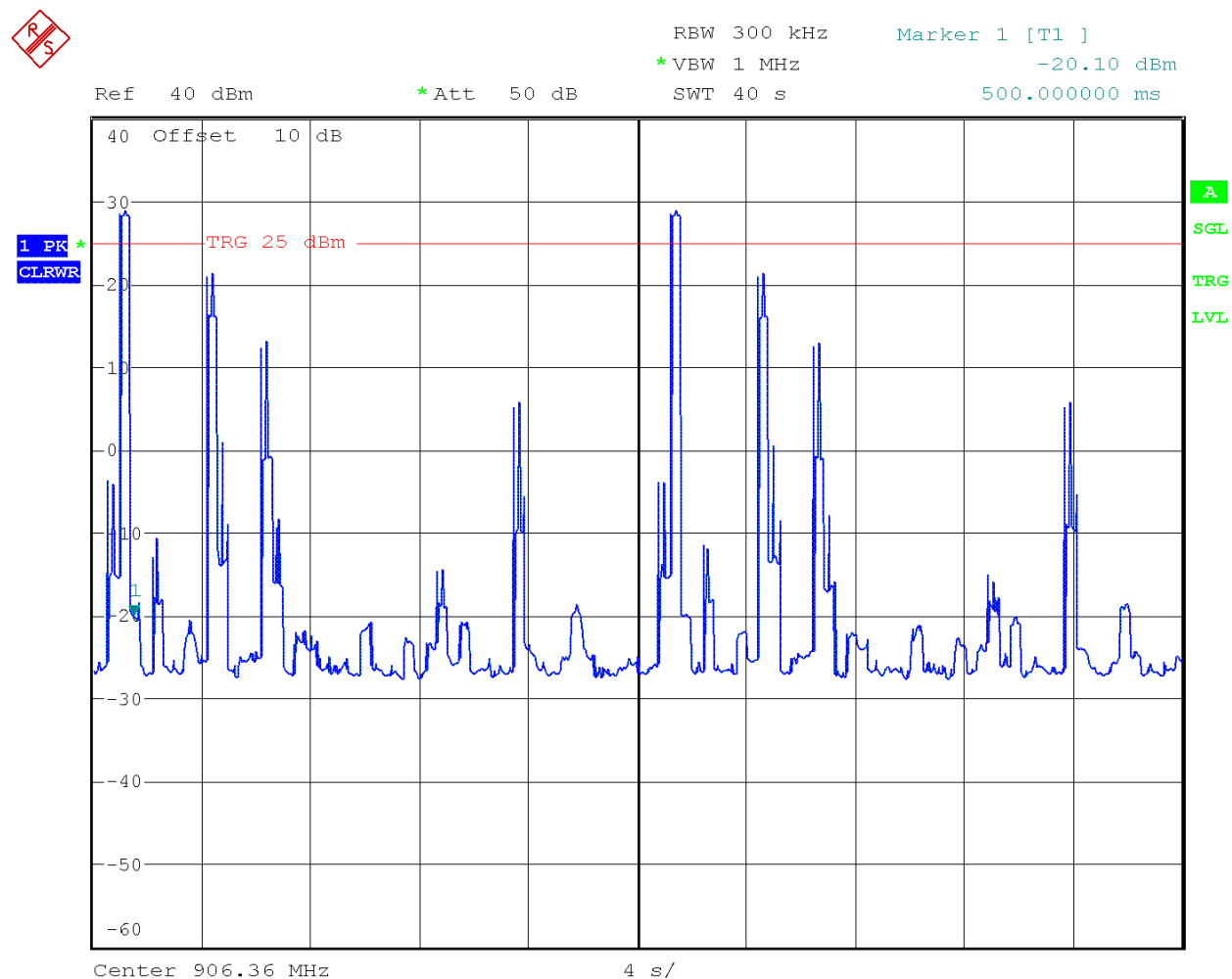
10.6 Test Data

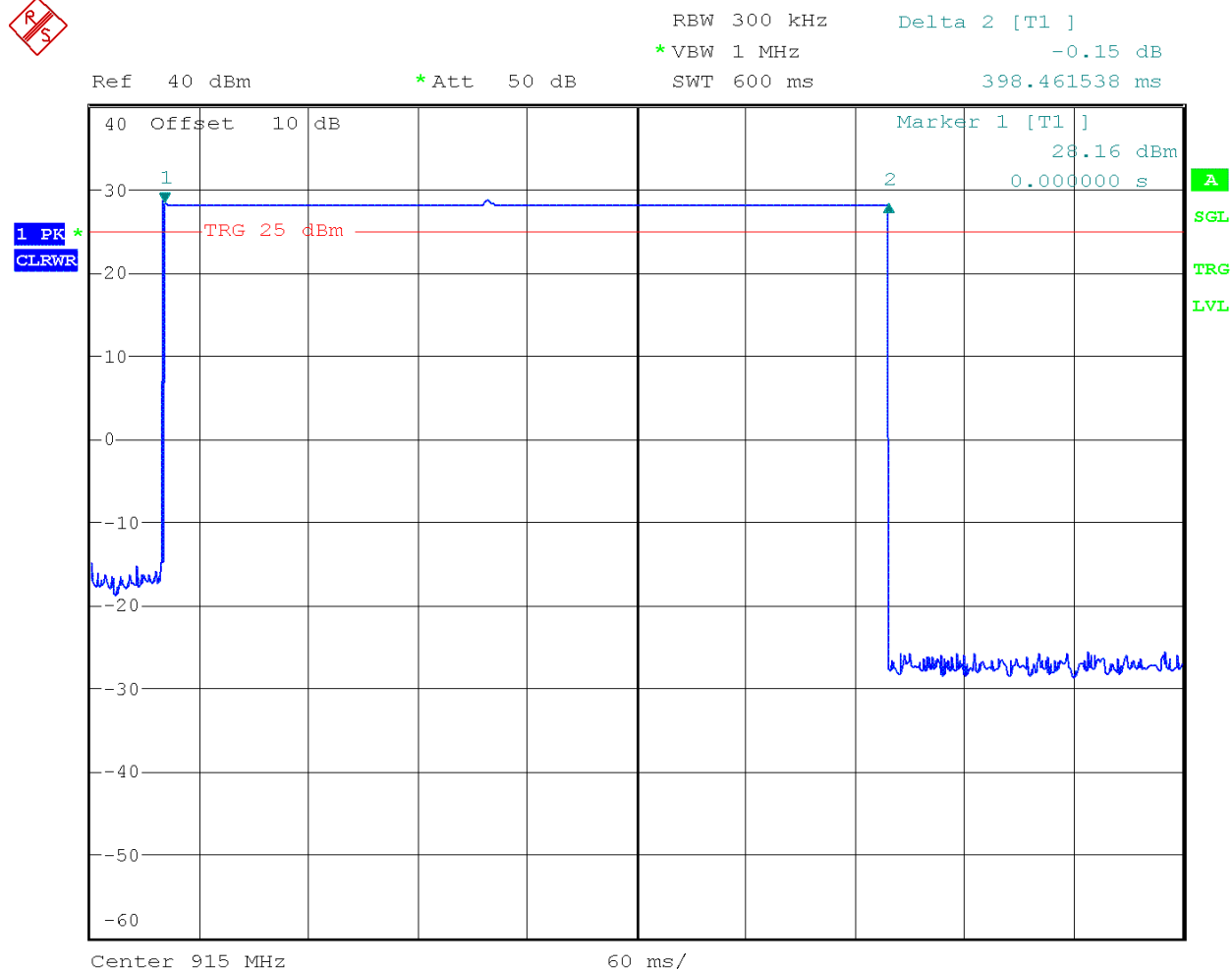
Frequency (MHz)	Pulse Width (ms)	Number of hops per channel in specified period	Time of Occupancy (ms)	Limit (ms)
906.36	397.500	1	397.500	≤ 400
915	398.461	1	398.461	≤ 400
924	397.500	1	397.115	≤ 400

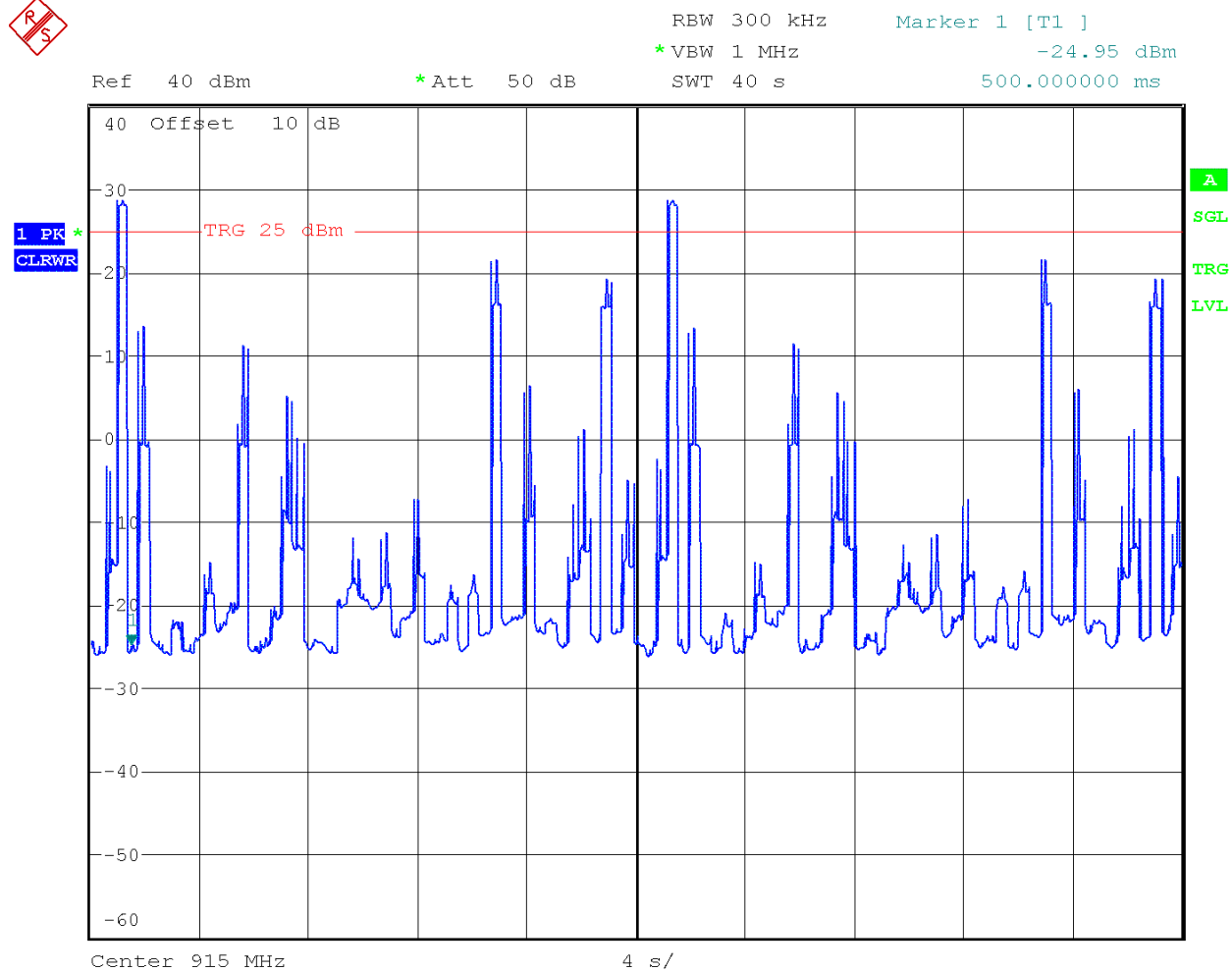
10.7 Spectrum Plots

10.7.1 906.36 MHz, Pulse Width



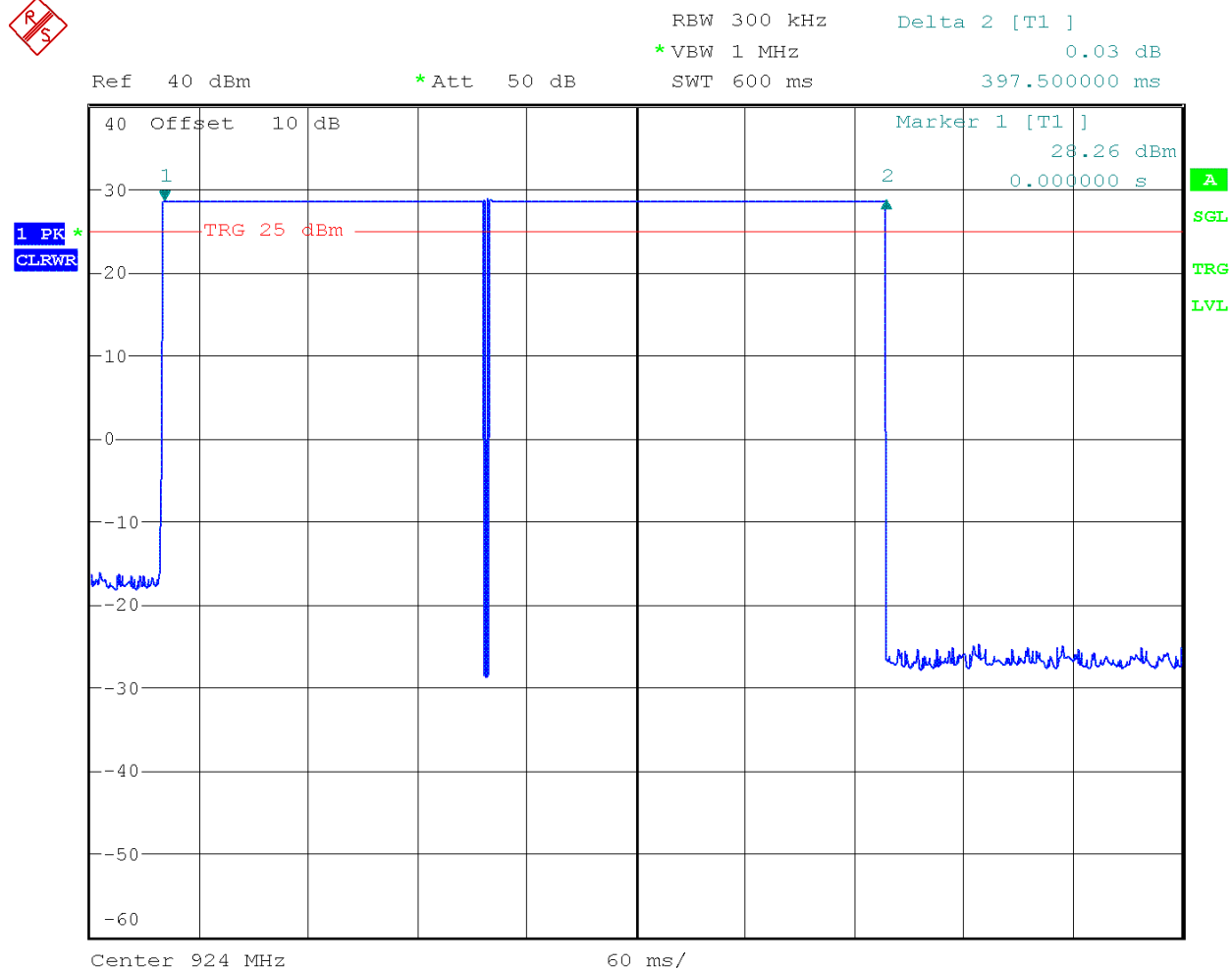
**10.7.2 906.36 MHz, Number of Hops in 20s**

**10.7.3 915 MHz, Pulse Width**

**10.7.4 915 MHz, Number of Hops in 20s**

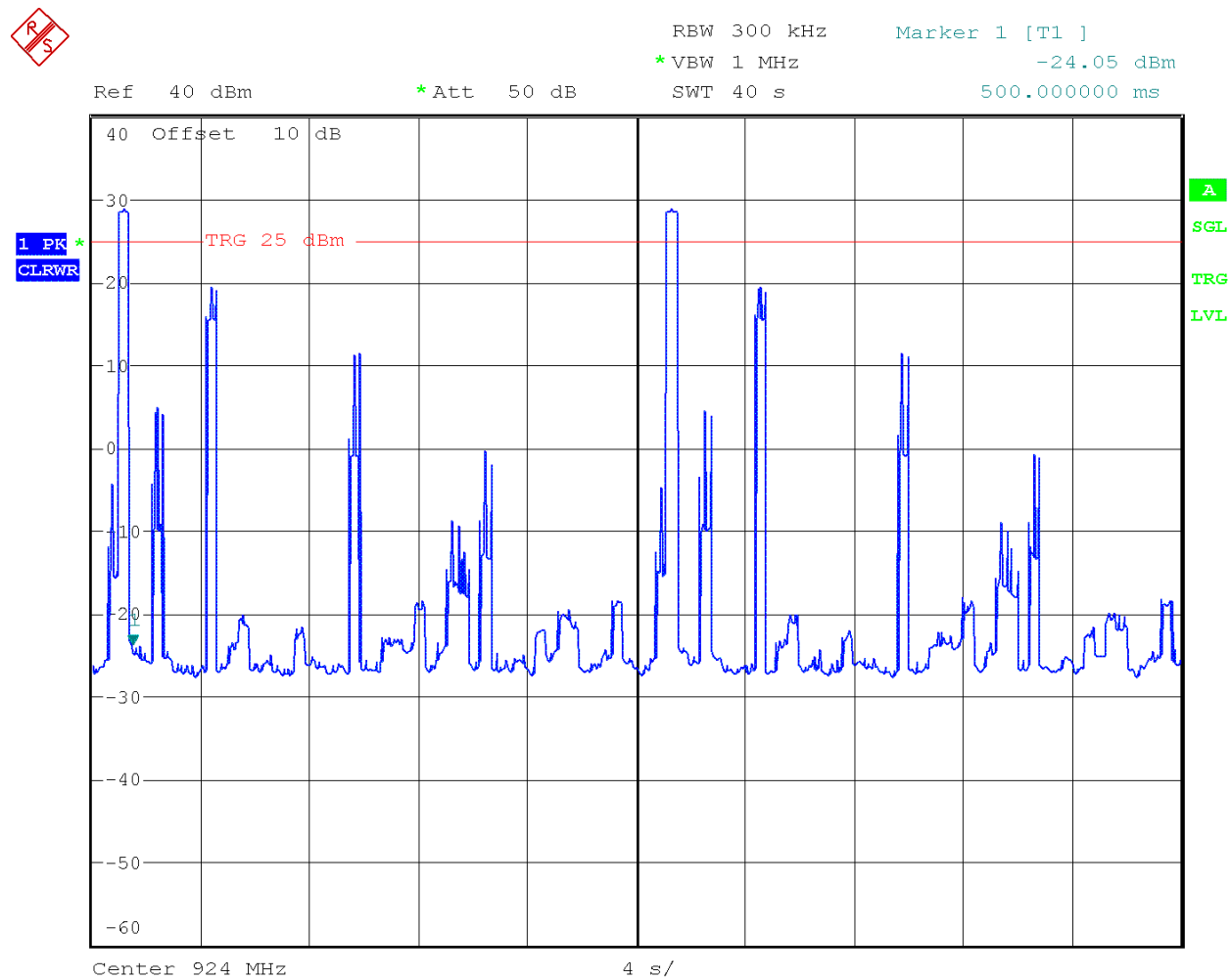


10.7.5 924 MHz, Pulse Width





10.7.6 924 MHz, Number of Hops in 20s





11 Radiated Spurious Emissions & Band Edge

11.1 Test Limits

FCC Part 15.247(d):

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

RSS-247 Issue 2 § 5.5:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

11.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013 § 11.12.1 Radiated emission measurements.

TEST SITE: 10m ALSE

Site Designation: 10m Chamber

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	U _{CISPR}
Radiated Emissions, 10m	30-1000 MHz	3.9dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	4.0dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.7dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	4.7dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.7dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.7dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required.



11.3 Sample 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:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB μ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

$$RA = 52.0 \text{ dB}\mu\text{V}$$

$$AF = 7.4 \text{ dB/m}$$

$$CF = 1.6 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$FS = 32 \text{ dB}\mu\text{V/m}$$

To convert from dB μ V to μ V or mV the following was used:

$$UF = 10^{(NF / 20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$
$$NF = \text{Net Reading in dB}\mu\text{V}$$

Example:

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10^{(32 \text{ dB}\mu\text{V} / 20)} = 39.8 \mu\text{V/m}$$



11.4 Test Equipment Used

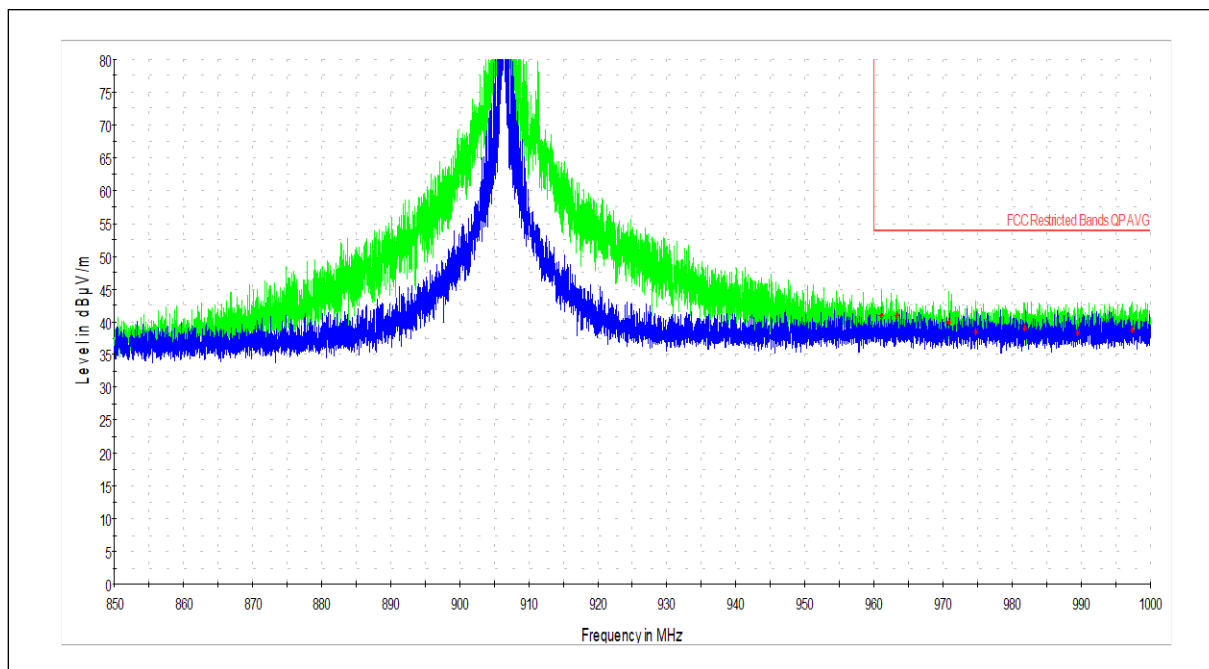
Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	10/5/2022	10/5/2023
Bilog Antenna	3133	ETS	3142C	8/10/2022	8/10/2023
Horn Antenna	4001	ETS	3117	2/23/2022	2/23/2023
System Controller	4096	ETS Lindgren	2090	Verify at Time of Use	Verify at Time of Use
System Controller	3957	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
Preamplifier	3918	Rohde & Schwarz	TS-PR18	1/13/2022	1/13/2023
Coaxial Cable	3074			1/13/2022	1/13/2023
Coaxial Cable	2588			1/13/2022	1/13/2023
Coaxial Cable	2593			1/13/2022	1/13/2023
Coaxial Cable	8185			1/13/2022	1/13/2023
Coaxial Cable	8188			1/13/2022	1/13/2023
Coaxial Cable	3339			1/13/2022	1/13/2023
Preamplifier	3919	Rohde & Schwarz	TS-PR3	1/13/2022	1/13/2023
Coaxial Cable	3172			1/13/2022	1/13/2023
Coaxial Cable	2590			1/13/2022	1/13/2023
Coaxial Cable	8186			1/13/2022	1/13/2023
Coaxial Cable	8187			1/13/2022	1/13/2023
Coaxial Cable	7020			1/13/2022	1/13/2023
Coaxial Cable	7021			1/13/2022	1/13/2023
Preamplifier (18-40GHz)	3921	Rohde & Schwarz	TS-PR40	1/13/2022	1/13/2023
Horn Antenna (18-40GHz)	3779	ETS	3116c	8/29/2022	8/29/2023
Magnetic Loop Antenna	2366	ETS	6502	8/22/2022	8/22/2023

11.5 Software Utilized

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	Version 10.60.20

11.6 Test Results

The sample tested was found to be **compliant**. The data presented represents the worst-case emissions with the device positioned in three orthogonal positions. All observed emissions outside of the band of operation were attenuated by at least 20dB.

**11.7 Test Data: Radiated Band Edge****11.7.1 906.36 MHz**

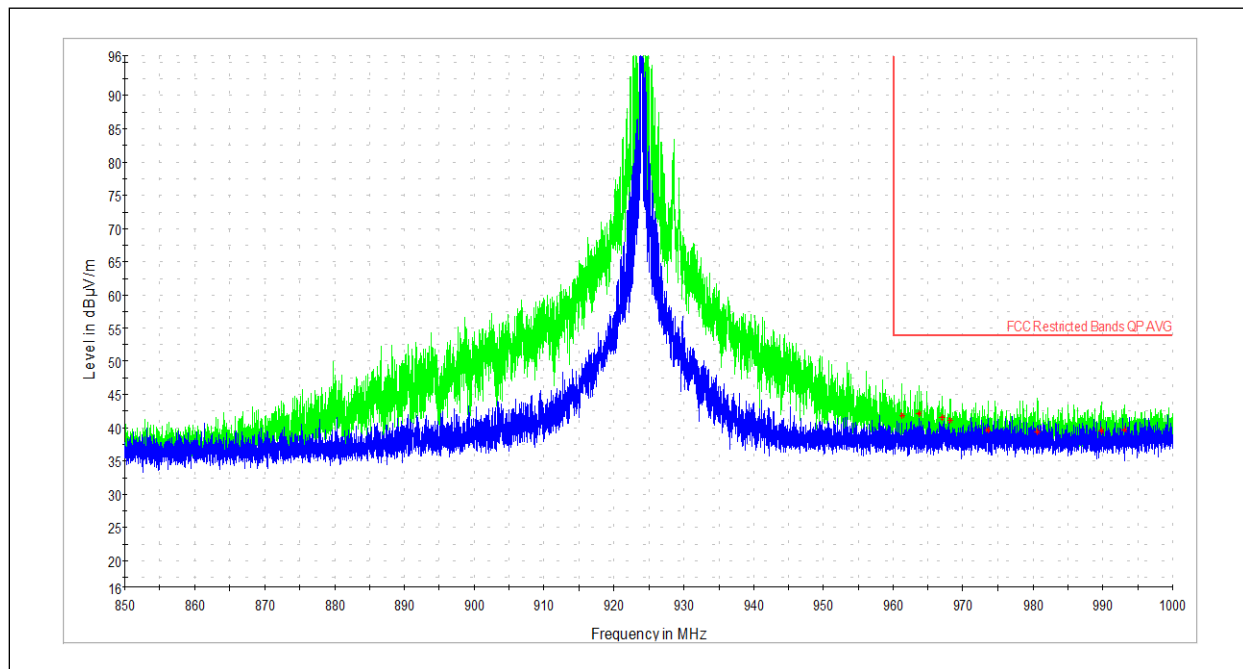
Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
961.058333	40.91	53.98	13.07	120.000	100.0	H	8.0	37.3
963.333333	40.93	53.98	13.05	120.000	100.0	H	16.0	37.3
970.858333	39.96	53.98	14.02	120.000	100.0	H	16.0	37.3
974.825000	38.53	53.98	15.45	120.000	125.0	H	16.0	37.3
981.866667	39.09	53.98	14.89	120.000	96.0	H	17.0	37.3
989.491667	38.37	53.98	15.61	120.000	159.0	H	17.0	37.4
997.441667	38.80	53.98	15.18	120.000	161.0	H	16.0	37.7

Test Personnel:	Jeremiah Andrade	Test Date:	12/9/2022
Supervising/Reviewing Engineer:	Brian Lackey	Limit Applied:	Limits from 15.209 in restricted bands from 15.205.
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	120V/60Hz	Relative Humidity:	62.8%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	987.4mbar

Deviations, Additions, or Exclusions: None



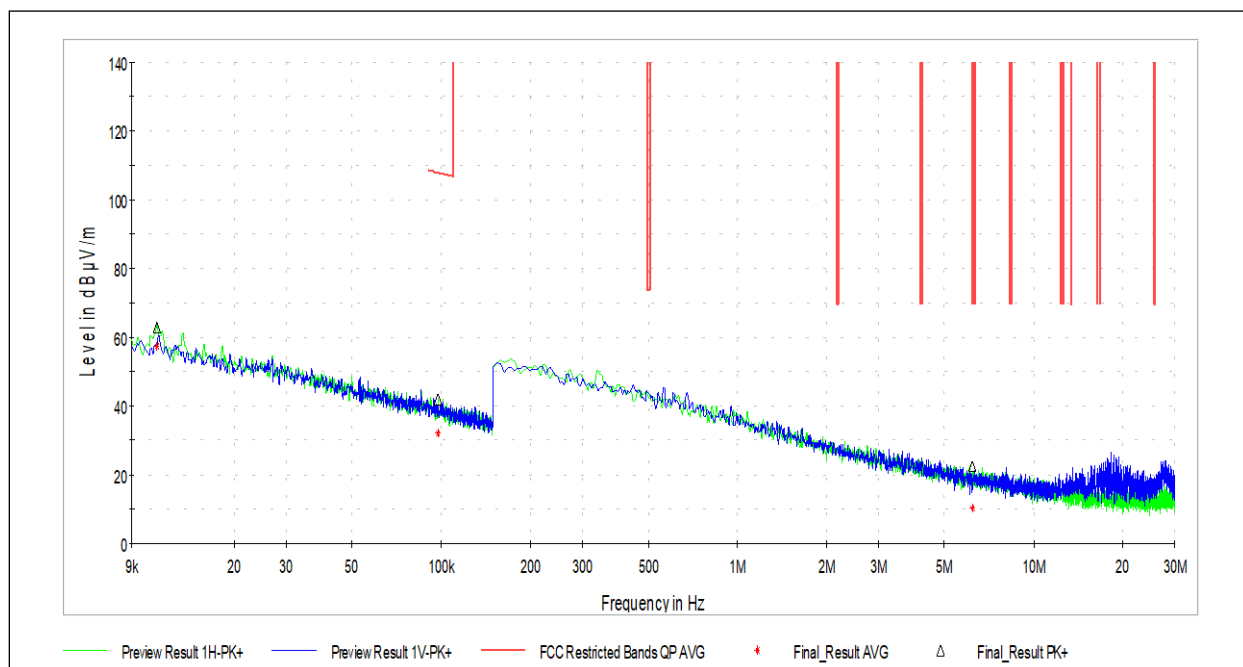
11.7.2 924 MHz



Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
961.316667	41.94	53.98	12.04	120.000	132.0	H	6.0	37.3
963.675000	42.12	53.98	11.86	120.000	100.0	H	6.0	37.3
967.041667	41.44	53.98	12.54	120.000	100.0	H	14.0	37.3
968.208333	41.17	53.98	12.80	120.000	101.0	H	7.0	37.3
973.591667	39.73	53.98	14.25	120.000	128.0	H	14.0	37.3
980.666667	39.47	53.98	14.51	120.000	129.0	H	6.0	37.3
989.875000	39.54	53.98	14.44	120.000	96.0	H	13.0	37.4
993.166667	39.75	53.98	14.23	120.000	130.0	H	16.0	37.5

Test Personnel:	Jordan Coughenour	Test Date:	12/8/2022
Supervising/Reviewing Engineer:	Brian Lackey	Limit Applied:	Limits from 15.209 in restricted bands from 15.205.
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	120V/60Hz	Relative Humidity:	62.8%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	987.4mbar

Deviations, Additions, or Exclusions: None

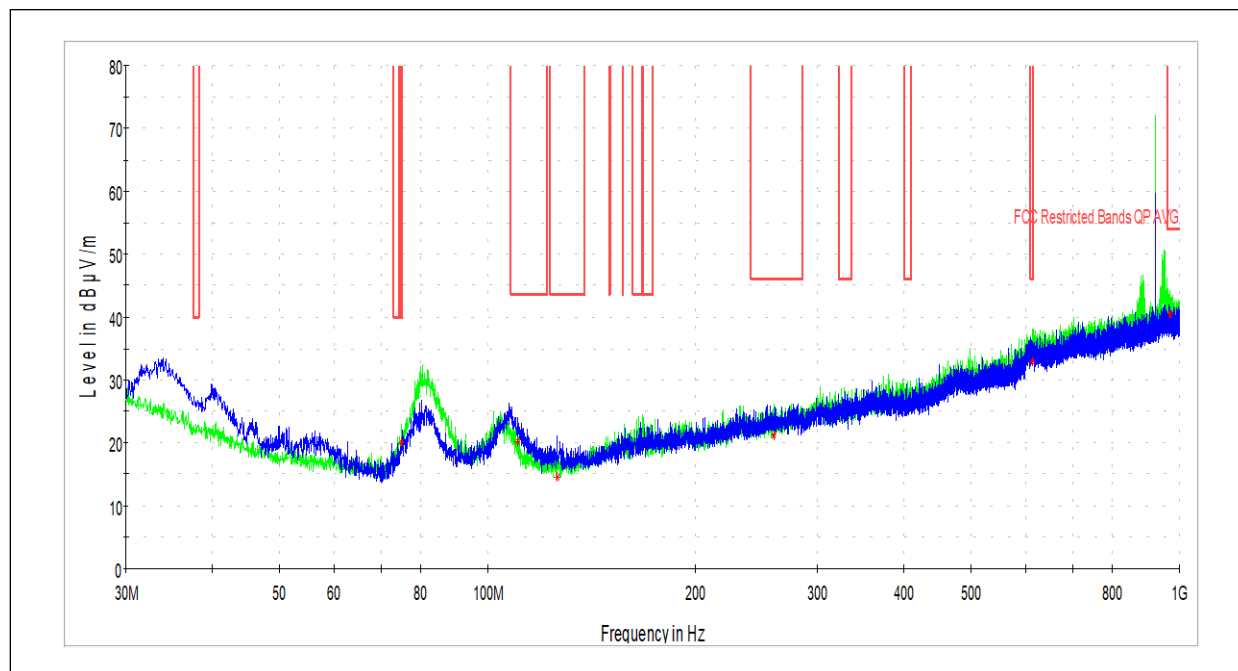
**11.8 Test Data: 9 kHz – 30 MHz**

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Azimuth (deg)	Corr. (dB/m)
0.010914	62.92	126.844	63.924	0.200	170.0	18.61
0.097125	41.96	127.898	85.938	0.200	35.0	12.14
6.216574	22.55	89.542	66.992	9.000	232.0	11.36

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Azimuth (deg)	Corr. (dB/m)
0.010914	57.42	146.844	89.424	0.200	170.0	18.61
0.097125	32.14	107.898	75.758	0.200	35.0	12.14
6.216574	10.39	69.542	59.152	9.000	232.0	11.36

Test Personnel:	Seth Parker	Test Date:	10/14/2022
Supervising/Reviewing Engineer:	Brian Lackey	Limit Applied:	Limits from 15.209 in restricted bands from 15.205.
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	19.7C
Input Voltage:	120V/60Hz	Relative Humidity:	39.2%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	978.1mbar

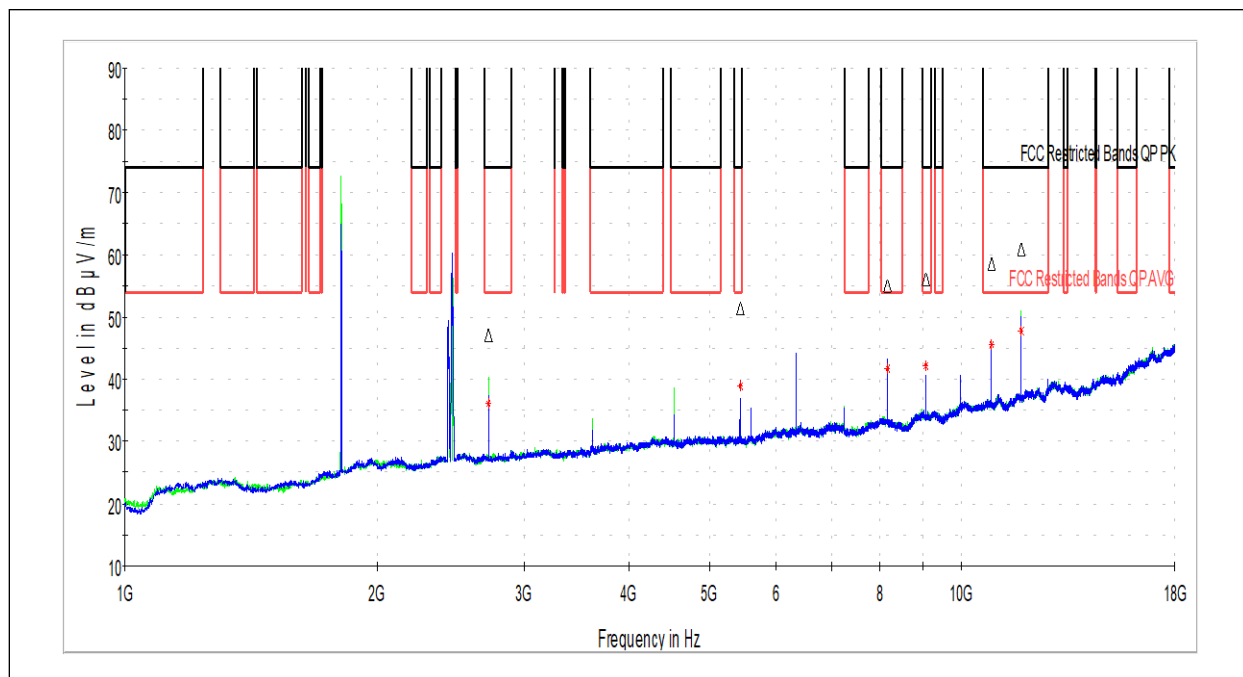
Deviations, Additions, or Exclusions: Testing represents the worst case of low, middle, and high channels.

**11.9 Test Data: 30 MHz – 1 GHz****11.9.1 915 MHz**

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
75.105000	20.09	40.00	19.91	120.000	218.0	H	25.0	14.2
110.456111	20.31	43.52	23.21	120.000	100.0	V	148.0	16.4
126.191667	14.54	43.52	28.98	120.000	100.0	V	99.0	16.0
259.027778	21.11	46.02	24.91	120.000	203.0	H	88.0	22.1
613.293333	32.89	46.02	13.13	120.000	131.0	H	177.0	32.8
967.990000	40.43	53.98	13.54	120.000	100.0	H	6.0	37.3

Test Personnel:	Jordan Coughenour	Test Date:	12/8/2022
Supervising/Reviewing Engineer:	Brian Lackey	Limit Applied:	Limits from 15.209 in restricted bands from 15.205.
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	120V/60Hz	Relative Humidity:	62.8%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	987.4mbar

Deviations, Additions, or Exclusions: Testing represents the worst case of low, middle, and high channels.

**11.10 Test Data: 1 GHz – 18 GHz****11.10.1 906.36 MHz**

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2719.000000	47.00	73.98	26.98	1000.000	142.0	H	32.0	4.9
5438.000000	51.37	73.98	22.61	1000.000	262.0	V	135.0	9.7
8157.500000	55.04	73.98	18.94	1000.000	100.0	V	53.0	13.8
9064.000000	56.06	73.98	17.92	1000.000	100.0	V	164.0	15.4
10876.000000	58.43	73.98	15.55	1000.000	100.0	V	190.0	18.4
11782.500000	60.84	73.98	13.14	1000.000	217.0	H	326.0	19.5

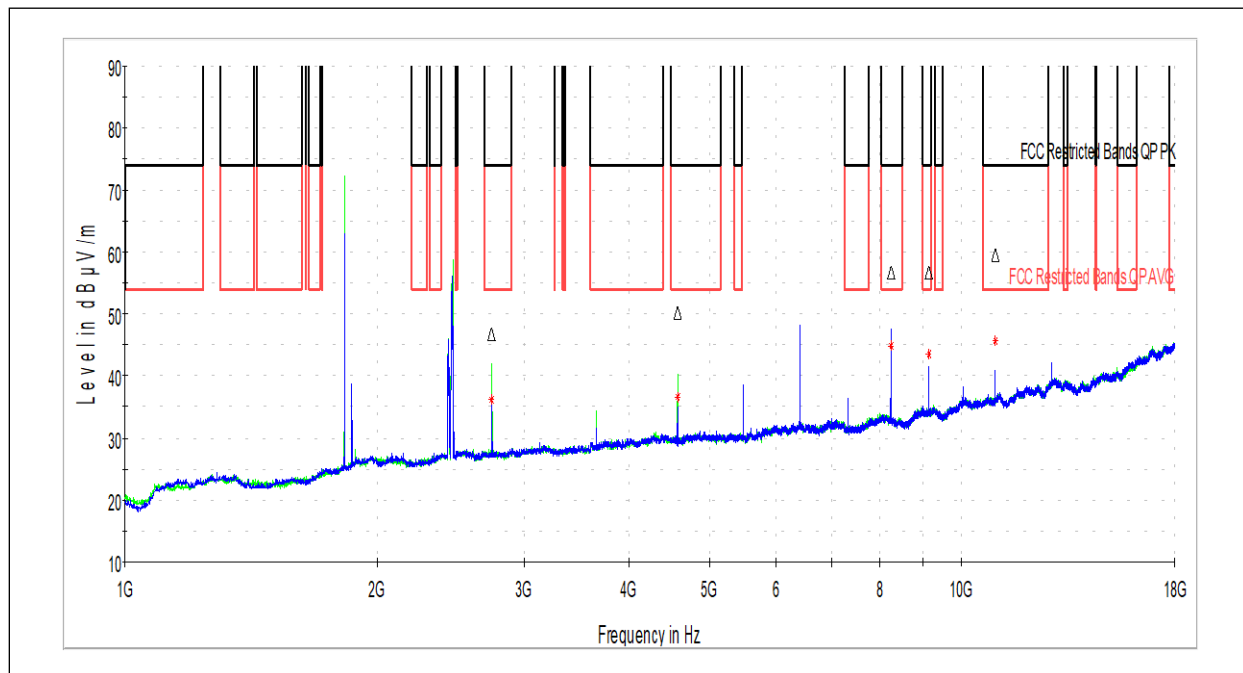
Frequency (MHz)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2719.000000	36.19	53.98	17.79	1000.000	142.0	H	32.0	4.9
5438.000000	38.87	53.98	15.11	1000.000	262.0	V	135.0	9.7
8157.500000	41.76	53.98	12.22	1000.000	100.0	V	53.0	13.8
9064.000000	42.11	53.98	11.87	1000.000	100.0	V	164.0	15.4
10876.000000	45.61	53.98	8.37	1000.000	100.0	V	190.0	18.4
11782.500000	47.78	53.98	6.20	1000.000	217.0	H	326.0	19.5

Test Personnel:	Jordan Coughenour	Test Date:	12/8/2022
Supervising/Reviewing Engineer:	Brian Lackey	Limit Applied:	Limits from 15.209 in restricted bands from 15.205.
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	120V/60Hz	Relative Humidity:	62.8%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	987.4mbar

Deviations, Additions, or Exclusions: None



11.10.2 915 MHz

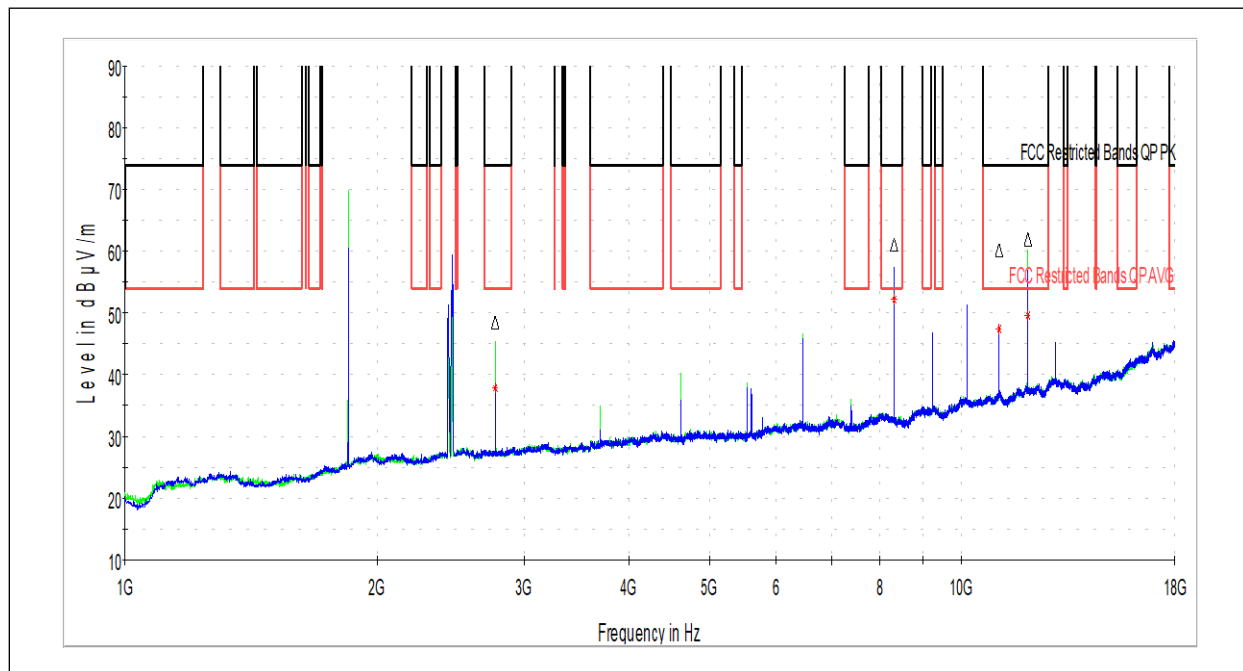


Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2745.000000	46.69	73.98	27.29	1000.000	180.0	H	348.0	4.9
4575.000000	50.14	73.98	23.84	1000.000	184.0	H	324.0	9.2
8235.000000	56.60	73.98	17.38	1000.000	194.0	V	212.0	13.9
9150.000000	56.66	73.98	17.32	1000.000	199.0	V	158.0	15.5
10980.000000	59.46	73.98	14.52	1000.000	100.0	V	200.0	18.5

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2745.000000	36.06	53.98	17.92	1000.000	180.0	H	348.0	4.9
4575.000000	36.63	53.98	17.35	1000.000	184.0	H	324.0	9.2
8235.000000	44.91	53.98	9.07	1000.000	194.0	V	212.0	13.9
9150.000000	43.56	53.98	10.42	1000.000	199.0	V	158.0	15.5
10980.000000	45.78	53.98	8.20	1000.000	100.0	V	200.0	18.5

Test Personnel:	Jordan Coughenour	Test Date:	12/8/2022
Supervising/Reviewing Engineer:	Brian Lackey	Limit Applied:	Limits from 15.209 in restricted bands from 15.205.
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	120V/60Hz	Relative Humidity:	62.8%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	987.4mbar

Deviations, Additions, or Exclusions: None

**11.10.3 924 MHz**

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2772.000000	48.40	73.98	25.58	1000.000	182.0	H	346.0	4.8
8316.000000	61.04	73.98	12.94	1000.000	192.0	V	212.0	14.0
11088.000000	60.16	73.98	13.82	1000.000	202.0	H	232.0	18.5
12012.000000	61.96	73.98	12.02	1000.000	218.0	H	324.0	19.8

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2772.000000	37.85	53.98	16.13	1000.000	182.0	H	346.0	4.8
8316.000000	52.09	53.98	1.89	1000.000	192.0	V	212.0	14.0
11088.000000	47.29	53.98	6.69	1000.000	202.0	H	232.0	18.5
12012.000000	49.60	53.98	4.38	1000.000	218.0	H	324.0	19.8

Test Personnel:	Jordan Coughenour	Test Date:	12/8/2022
Supervising/Reviewing Engineer:	Brian Lackey	Limit Applied:	Limits from 15.209 in restricted bands from 15.205.
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	120V/60Hz	Relative Humidity:	62.8%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	987.4mbar

Deviations, Additions, or Exclusions: None



12 Conducted Spurious Emissions

12.1 Test Limits

FCC Part 15.247(d):

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

RSS-247 Issue 2 § 5.5:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

12.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013 § 11.11 Emissions in nonrestricted frequency bands.

12.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	10/5/2022	10/5/2023

12.4 Test Results

The device was found to be **compliant**. All spurious emissions were found to be attenuated more than 20dB below the level of the fundamental.



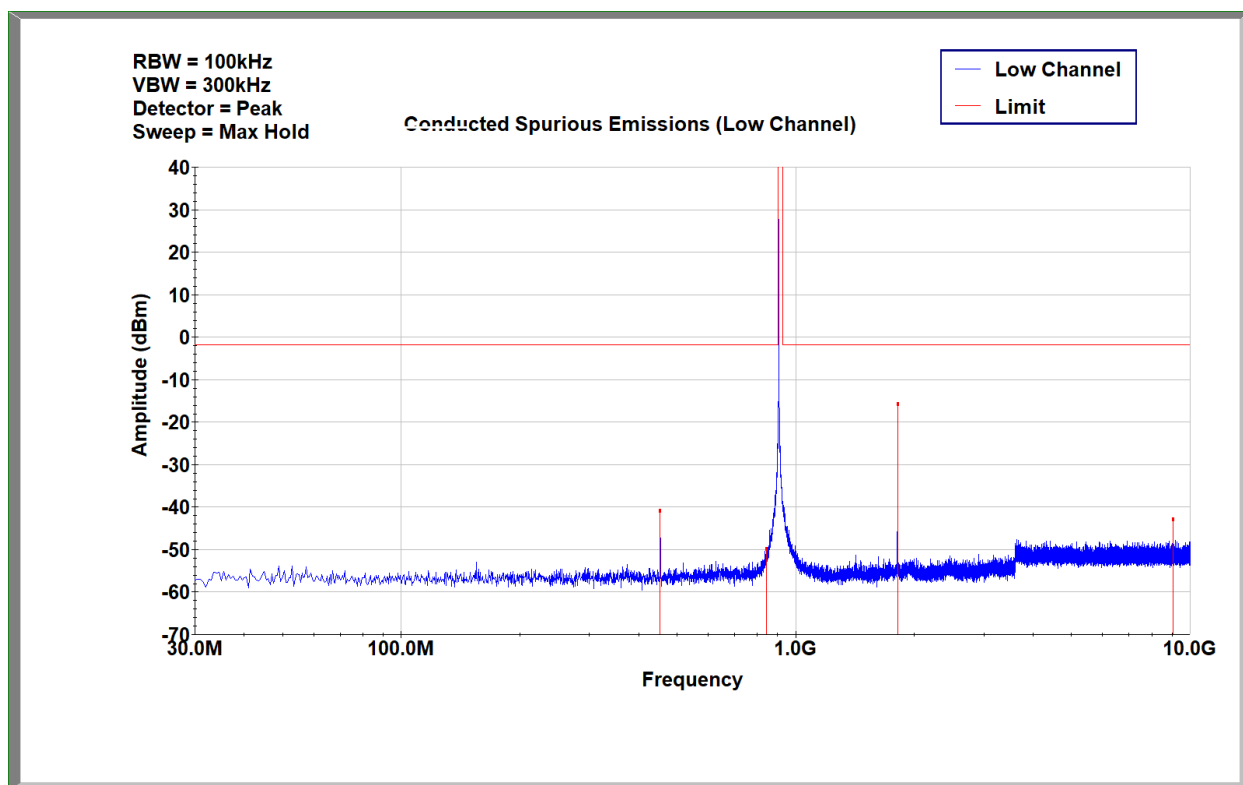
12.5 Test Conditions

Test Personnel:	Seth Parker	Test Date:	12/8/2022
Supervising/Reviewing Engineer:	Brian Lackey	Limit Applied:	See Above
Product Standard:	FCC Part 15.247 & RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	120V/60Hz	Relative Humidity:	62.8%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	987.4mbar

Deviations, additions, or exclusions: None

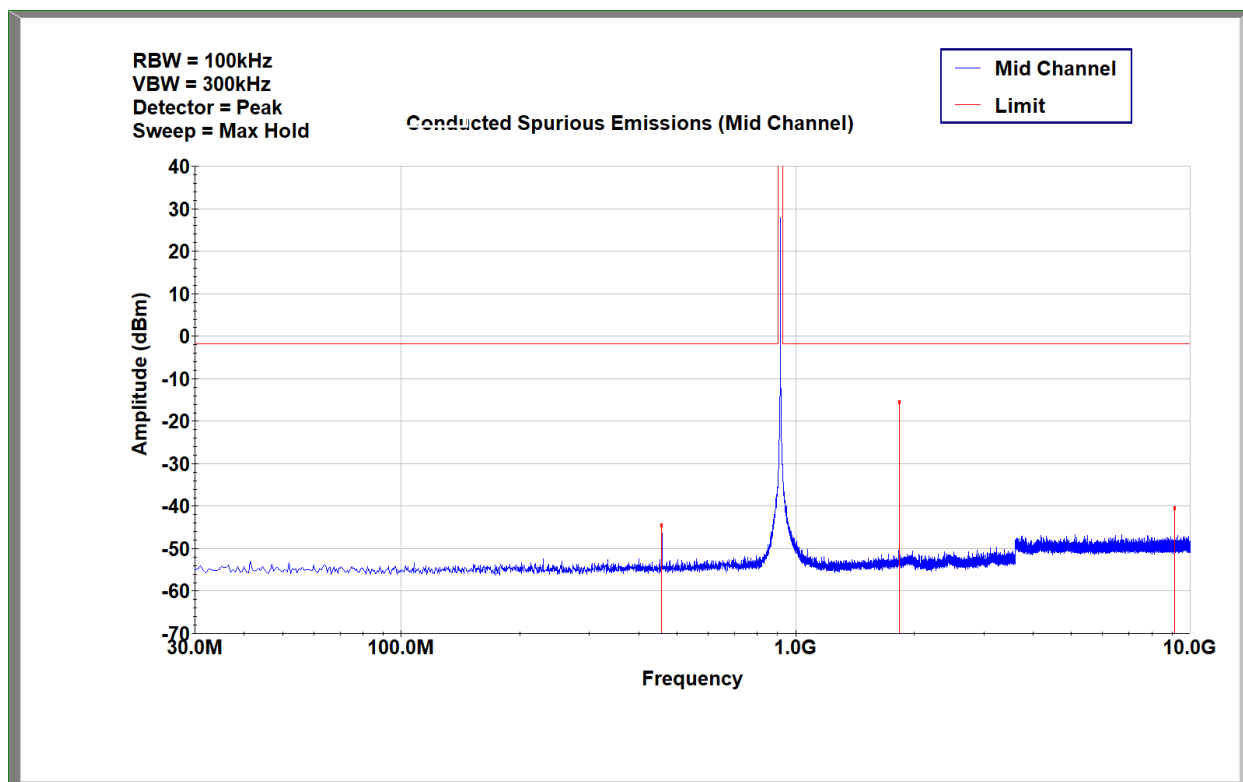
12.6 Test Data

12.6.1 906.36 MHz



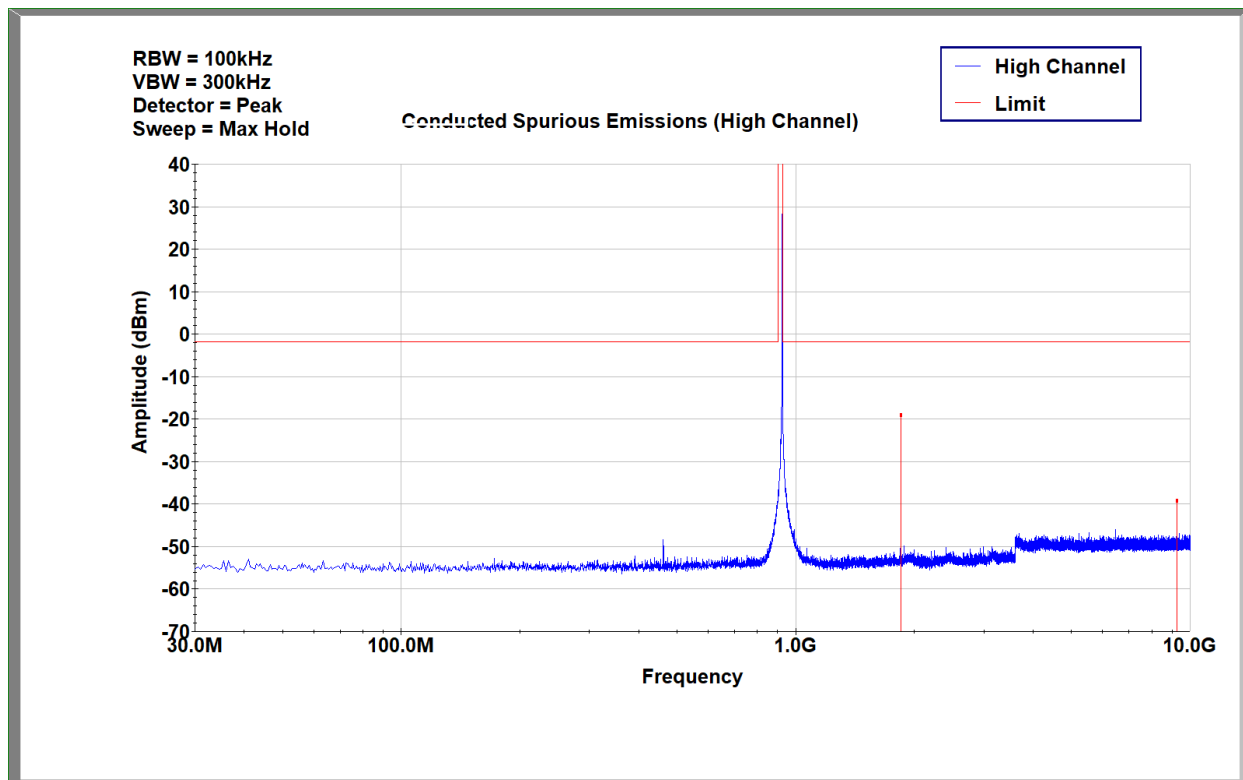


12.6.2 915 MHz



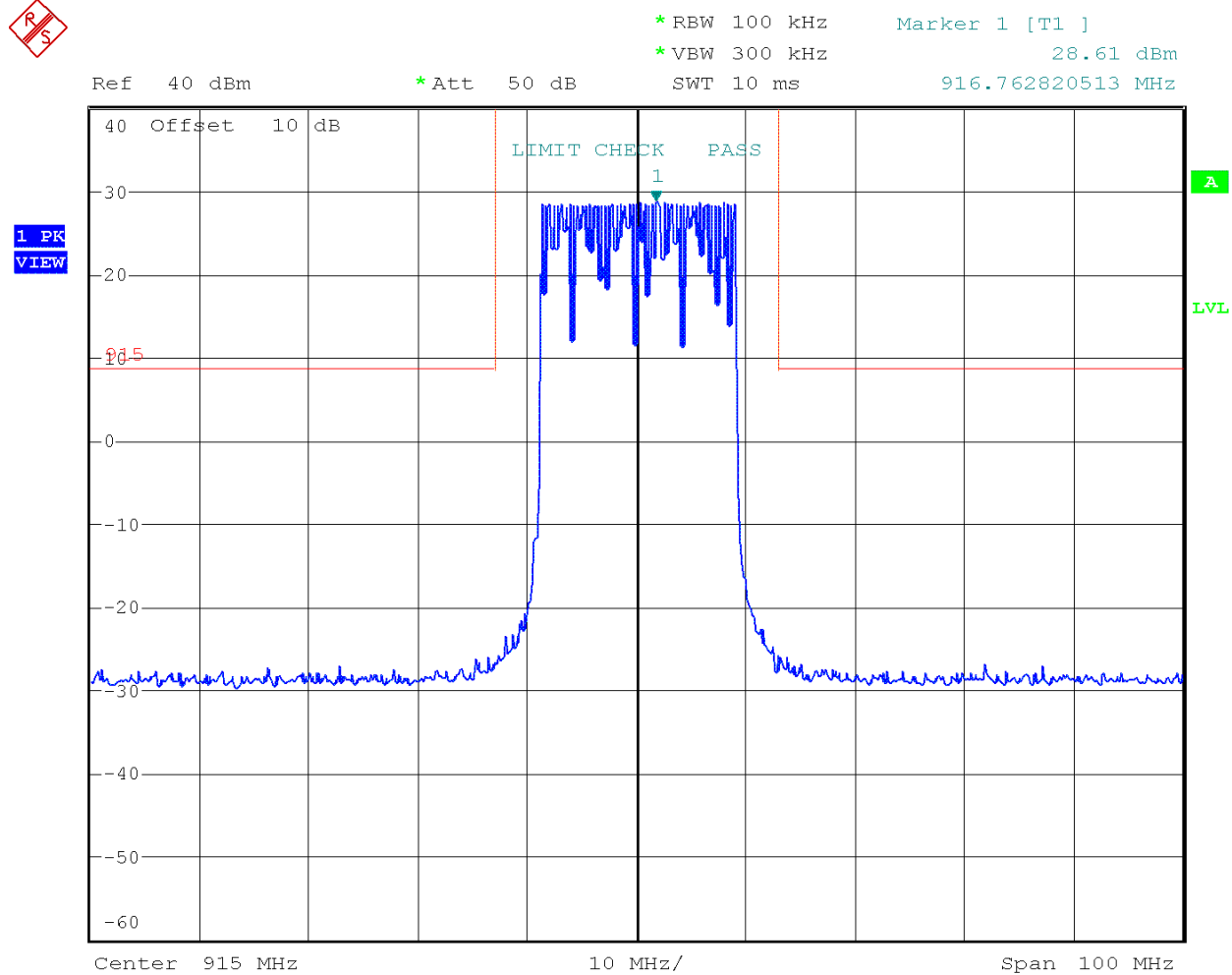


12.6.3 924 MHz



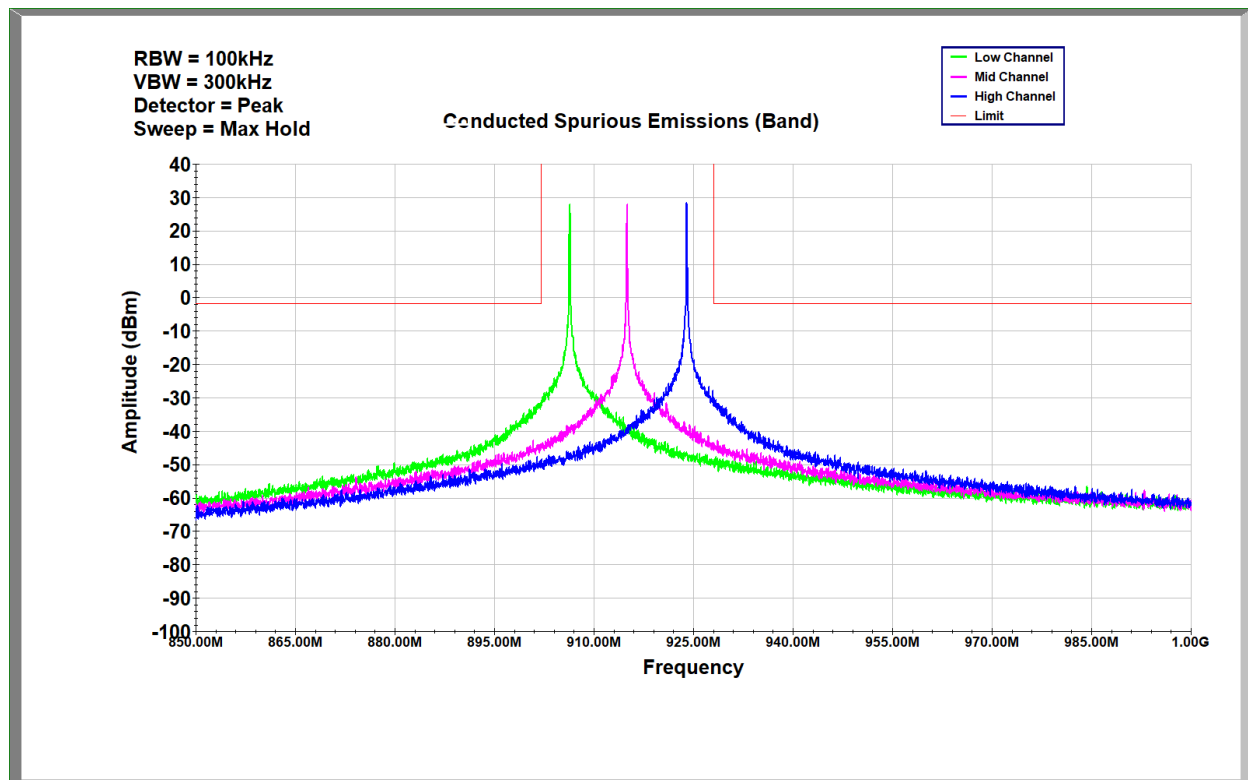


12.6.4 FHSS On





12.6.5 Band Edge





13 Antenna Requirement

13.1 Test Limits

FCC Part 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

RSS-Gen Issue 5 § 6.8:

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the license-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

License-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotopically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the license-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of license-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

13.2 Test Results

The device was found to be **compliant**. The device uses a permanently installed internal antenna.

**14 Revision History**

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	12/12/2022	105207900LEX-002	<i>SP</i>	<i>BZ</i>	Original Issue