



RF Test Report

Standard(s): FCC Part 15 Subpart 15.247,
RSS-247 Issue 3:2023
Unlicensed Intentional Radiators

Issued To: Ecobee Inc
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Toronto, ON M5J 1A7
Canada

Product Name: Smart Thermostat Lite and Smart Thermostat Essential
Model: ECB701
FCC ID: WR9202428847PR
IC: 7981A-202428847PR

Report No. ML301244C-RF01 (DSS – FHSS)
Date of Issue: July 26, 2024

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TRRF_FCC-ICES-247-DTS_v1

Table of Contents

1.	Revision History	3
1.1	Test Verdict	4
1.2	Test Standards.....	5
1.3	Test Facility	6
2.	General Information	9
2.1	Client Information.....	9
2.2	Device Under Test (DUT).....	9
2.3	Test Setup of DUT	10
2.4	Modifications for Compliance.....	10
3.	Test Results	11
3.1	Emission Bandwidth.....	11
3.2	Channel Carrier Frequency Separation.....	15
3.3	Number of Hopping Channels.....	18
3.4	Time of Occupancy (Dwell Time)	20
3.5	Output Power.....	23
3.6	Conducted Spurious Emissions (-20dBc).....	26
3.7	Transmitter Spurious Radiated Emissions	32
3.8	Power Line Conducted Emissions	41

1. Revision History

Project No. & Revision	Report Date	Initials	Description
ML301244C-RF00 (DSS – FHSS)	July 26, 2024	MX	Initial Release
ML301244C-RF01 (DSS – FHSS)	August 9, 2024	MX	Updated product name.

NOTE:

- Latest reports marked as a revision replace any previous report and/or report revision issued under the same project number.

Summary of Test Results

1.1 Test Verdict

Unless otherwise stated, the test data and results in this test report relate only to the sample(s) tested.

Requirement		Test Type	Result	Remark
FCC	ISED			
15.203 15.247(b)(4)	RSS-247 5.4(d)	Antenna Gain and Requirement	Pass	PCB Trace Antenna 2.6 dBi
15.247(a)(1)	RSS-247 5.1	Emission Bandwidth	Pass	$BW_{20dB} \leq 250 \text{ kHz}$
15.247(a)(1)	RSS-247 5.1	Channel Carrier Frequency Separation	Pass	$\Delta f \geq \text{MAX} \{25 \text{ kHz}, BW_{20dB}\}$
15.247(a)(1)	RSS-247 5.1	Number of Hopping Channels	Pass	$N_{ch} \geq 50$
15.247(a)(1)	RSS-247 5.1	Time of Occupancy (Dwell Time)	Pass	$t_{ch} \leq 0.4 \text{ s for } T = 20 \text{ s}$
15.247(b)	RSS-247 5.4	Peak Conducted Output Power	Pass	< 1 Watt
15.247(d)	RSS-247 5.5	Spurious Conducted Out of Band Emissions	Pass	< 20dBc
15.247(d)/ 15.209	RSS-GEN 8.9 (Table 5 & 6)	Transmitter Spurious Radiated Emissions	Pass	---
15.207	RSS-GEN (Table 4)	Power Line Conducted Emissions	N/A	--

1.1.1 Test Verdict Notes and Justifications

The DUT was mounted as in normal usage. See the Test Setup Photos for details.

Antenna details obtained from Manufacturer's Datasheet.

1.2 Test Standards

Standard	Description
47 CFR FCC Part 15 Subpart C	Code of Federal Regulations – Radio Frequency Devices, Intentional Radiators
FCC KDB 558074:2019	Digital Transmission Systems, measurements and procedures
RSS-247 Issue 3:2023	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-GEN Issue 5:2021	General Requirements for Compliance of Radio Apparatus
ANSI C63.4:2014	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10:2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ISO 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories

1.3 Test Facility

All tests were performed at Megalab Group Inc., located at 150 Addison Hall Circle, Aurora, ON, L4G 3X8, Canada.

The 10-meter semi-anechoic chamber for radiated emission and radiated immunity is designed to handle weights of up to 10,000lb and has power capability of over 100A. The turntable is capable of supporting test devices or systems either floor standing or table top of up to 4 meters wide and 3m tall. Conducted emissions, unless otherwise specified, are performed on a 2.44m x 2.48m ground plane and using a 2.44m x 2.48m vertical ground plane if applicable.

1.3.1 Accreditations

This report does not indicate any product endorsement by any government, accreditation agency, or Megalab Group Inc. Megalab Group Inc. shall have no liability for any deductions, interpretations or generalizations drawn by the client or others from the issued reports. If any opinions or interpretations are expressed in this report, they are outside Megalab Group Inc.'s scope of accreditation and do not necessarily reflect the opinions of Megalab Group Inc., unless otherwise specified.



A2LA (Certificate #5179.02)

Megalab Group Inc. is accredited to ISO/IEC 17025:2017 by the American Association for Laboratory Accreditation (A2LA) with Testing Certificate #5179.02. The laboratories current scope of accreditation can be found as listed on A2LA's website.



Innovation, Science and
Economic Development Canada

ISED

Megalab Group Inc. is registered with and recognized by Innovation, Science and Economic Development Canada (ISED) as an accredited testing laboratory.
Company Number: 28697



FCC

Megalab Group Inc. is registered with and recognized by the Federal Communications Commission (FCC) as an accredited testing laboratory.
Registration No. 200040



VCCI

The Semi-anechoic chamber of Megalab Group Inc. is registered with the Regulations for Voluntary Control Council for Interference (VCCI). Registration No.: R-20173, G-20174, C-20132, T-20133.

1.3.2 Measurement Uncertainty

As per ISO/IEC 17025 requirements, an evaluation of the measurement uncertainties associated with the emission test results should be included in the test report.

Where relevant, the following measurement uncertainty levels have been estimated for the tests performed on the DUT as specified in CISPR 16-4-2. The measurement uncertainties given below are based on a coverage factor $k = 2$ which yields approximately a 95% level of confidence for the near-normal distribution typical of most measurement results.

Measurement	Frequency Range	Uncertainty
Conducted Emissions at AC Mains Power Port	150kHz to 30MHz	2.27 dB
Radiated Emissions	30MHz to 1GHz	5.22 dB
	1GHz to 18GHz	4.76 dB

1.3.3 Sample Calculations

Conducted Emissions

$$\begin{aligned}
 \text{Emission Level (dB}\mu\text{V)} &= \text{Read Level (dB}\mu\text{V)} + \text{LISN Factor (dB)} + \text{Attenuation Factor (dB)} + \text{Cable Loss (dB)} \\
 &= 34.8 + 0.1 + 10.0 + 0.2 \\
 &= 45.1
 \end{aligned}$$

$$\begin{aligned}
 \text{Margin (dB)} &= \text{Limit (dB}\mu\text{V)} - \text{Emission Level (dB}\mu\text{V)} \\
 &= 60.0 - 45.1 \\
 &= 14.9
 \end{aligned}$$

Radiated Emissions

$$\begin{aligned}
 \text{Emission Level (dB}\mu\text{V/m)} &= \text{Read Level (dB}\mu\text{V)} + \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} - \text{Pre-Amp Gain (dB)} \\
 &= 52.4 + 9.4 + 1.3 - 29.2 \\
 &= 33.9
 \end{aligned}$$

$$\begin{aligned}
 \text{Margin (dB)} &= \text{Limit (dB}\mu\text{V/m)} - \text{Emission Level (dB}\mu\text{V/m)} \\
 &= 50.0 - 33.9 \\
 &= 16.1
 \end{aligned}$$

1.3.4 Terms, Definitions and Abbreviations

AE	Auxiliary Equipment
DUT	Device Under Test
DTS	Digital Transmission System
EMC	Electro-Magnetic Compatibility
FHSS	Frequency Hopping Spread Spectrum
ISM	Industrial, Scientific and Medical
LISN	Line Impedance Stabilization Network
N/A	Not Applicable
NCR	No Calibration Required
RF	Radio Frequency
RBW	Resolution Bandwidth
VBW	Video Bandwidth

Auxiliary Equipment/Support Equipment

Equipment needed to exercise and/or monitor the operation of the DUT.

Artificial Mains Network

Network that provides a defined impedance to the DUT at radio frequencies, couples the disturbance voltage to the measuring receiver and decouples the test circuit from the supply mains.

Class A Equipment

Equipment suitable for use in all locations other than those allocated in residential environments and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

Class B Equipment

Equipment suitable for use in all locations, including in residential environments and in establishments directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

Device Under Test

Device or system being evaluated for compliance with the requirements of the Test Standards listed in this report.

Electro-Magnetic Compatibility

Ability of equipment or system to function satisfactorily in its EM environment without introducing intolerable electromagnetic disturbances to anything in that environment.

Electromagnetic Disturbance

Any electromagnetic phenomenon which may degrade the performance of a device, equipment or system.

2. General Information

2.1 Client Information

Company	Ecobee Inc
Address	207 Queens Quay Suite 600, Toronto, ON M5J 1A7 Canada
Contact	John Russomanno
Email	john@ecobee.com

2.2 Device Under Test (DUT)

2.2.1 DUT Information

DUT Name	Smart Thermostat Lite and Smart Thermostat Essential
DUT Model(s)	ECB701
Serial Number	Production Sample
Power Source (AC / DC / Battery)	AC
Input Voltage (V) or Range	24Vac
Frequency (Hz) or Range	60Hz
Mode(s) of Operation	Continuous transmission
Connectors Available on DUT	Standard thermostat connections
Transmitter Information	
FCC ID	WR9202428847PR
IC	7981A-202428847PR
Technology Used	FHSS
Operating Frequency	920 MHz – 928 MHz
Modulation Type	FSK
Number of Channels	50
Antenna Manufacturer	Custom – PCB trace
Antenna Model	N/A
Antenna Type	Monopole
Antenna Gain	2.6 dBi

Note: Above antenna information is provided by the client. The characteristics and gain are obtained from the Antenna Manufacturer's Data Sheet.

2.2.2 DUT Description

EUT is a smart thermostat; it contains 2400 – 2483.5 MHz DTS (802.11 b/g/n and BLE) transmitters on one chip, and a 920 – 928 MHz FHSS/Hybrid transmitter on second chip.

This report documents the compliance of the BLE transmitter.

2.3 Test Setup of DUT

2.3.1 Configuration

The DUT was configured in a direct test mode with the following parameters

- For all the tests, the DUT was set to transmit continuously with 100% duty cycle
- Output Power setting: 12 dBm (Peak)
- Channels:
 - o 0 (low, 920 MHz),
 - o 49 (High, 927.35 MHz)
- Packet Type: Random

During all radiated emission measurements, the DUT was mounted in three orthogonal axes. See Test Setup Photos for axis details.

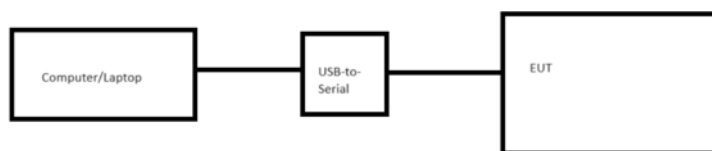


Figure 1 – Configuration Block Diagram

Description of I/O Cables			
Cable Function	Length of Cable (m)	Shielded (Y/N)	Outdoor Use (Y/N)
Thermostat control	>3	N	N

2.3.2 Support Equipment

Device	Manufacturer	Model	S/N
Custom USB Interface	Ecobee	--	---

2.4 Modifications for Compliance

No modifications were made to the device under test to comply with the testing requirements.

3. Test Results

3.1 Emission Bandwidth

Test Date: May 14, 2024
Temperature (°C) 21.8
Relative Humidity (%) 53.6
Barometric Pressure (kPa) 101.0

Initials: MX

During this test, the transmitter's 20 dB and 99% emission bandwidth will be examined and verify that the upper and lower frequency are always kept within the working frequency range band.

3.1.1 Limits

Systems using frequency hopping techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands with maximum allowable 20 dB bandwidth, specified in FCC 15.247 (a)(1) and RSS-247 Section 5.1, summarized below:

Frequency Band	Maximum 20 dB Bandwidth Limit	
	$P_{\text{max-pk}} \leq 1 \text{ W}$	
902–928 MHz	$BW_{20\text{dB}} \leq 250 \text{ kHz}$	$250 \text{ kHz} < BW_{20\text{dB}} \leq 500 \text{ kHz}$ Provide: $P_{\text{max-pk}} \leq 0.25 \text{ W}$ $t_{\text{ch}} \leq 0.4 \text{ s for } T = 10 \text{ s}$
2400–2483.5 MHz	Max. $BW_{20\text{dB}}$ not specified	
5725–5850 MHz	$BW_{20\text{dB}} \leq 1 \text{ MHz}$	

*Note: FCC 15.247 and RSS-247 did not explicitly specify a maximum 20 dB bandwidth for FHSS operating in the 2400–2483.5 MHz band. The maximum 20 dB bandwidth is implicitly limited by the minimum number of hopping channels; i.e., the 20 dB bandwidth multiplied by minimum number of channels shall be within the 2400–2483.5 MHz band.

For 2400–2483.5 MHz band, the minimum number of channels specified is 15 channels. Thus, the maximum 20 dB bandwidth shall be less than 5.5 MHz (83.5 MHz/15).

The DUT operates in the 902 – 928 MHz. The applicable 20 dB BW limit is $BW_{20\text{dB}} \leq 250 \text{ kHz}$.

99% bandwidth limit is not specified but is required for certification application.

3.1.2 Test Procedure

Tested according to ANSI C63.10 Section 6.9.2 for 20 dB bandwidth and Section 6.9.3 for 99% bandwidth.

For 20 dB Emission Bandwidth:

- Set RBW in the range of 1% to 5% of the actual occupied bandwidth.

- b) Set VBW $\geq [3 \times \text{RBW}]$.
- c) Span set to 2 to 5 times the occupied bandwidth.
- d) Detector: Peak
- e) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

For 99% Emission Bandwidth:

- a) Set RBW in the range of 1% to 5% of the actual occupied bandwidth.
- b) Set VBW $\geq [3 \times \text{RBW}]$.
- c) Span set to 1.5 to 5 times the occupied bandwidth.
- d) Detector: Peak
- e) Use the 99% power bandwidth function of the instrument to measure bandwidth.

3.1.3 Test Results

The DUT met the 20 dB requirement; the 20 dB BW of the DUT is ≤ 250 kHz.

Frequency (MHz)	20 dB Bandwidth (kHz)	99% Occupied Bandwidth (kHz)	20 dB Bandwidth Limit (kHz)	Test Result
920.00	86.70	87.29	≤ 250	Pass
927.35	86.70	86.88	≤ 250	Pass

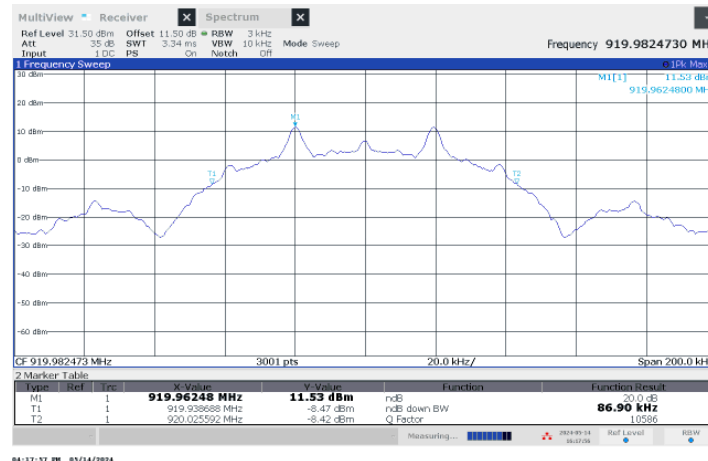


Figure 2 – 20 dB Bandwidth - Low Channel

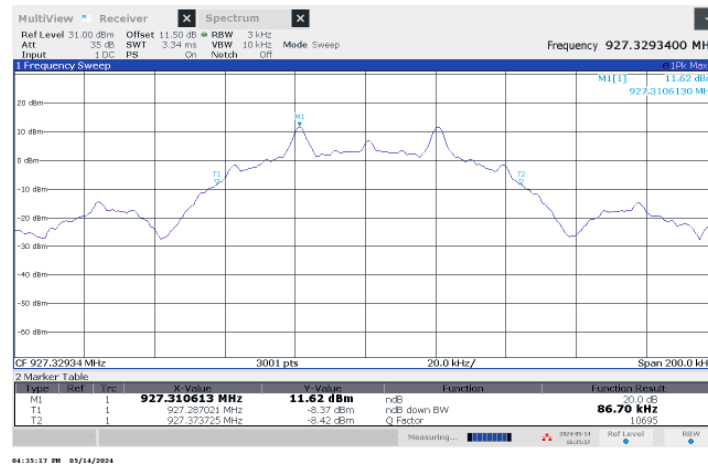


Figure 3 – 20 dB Bandwidth - High Channel

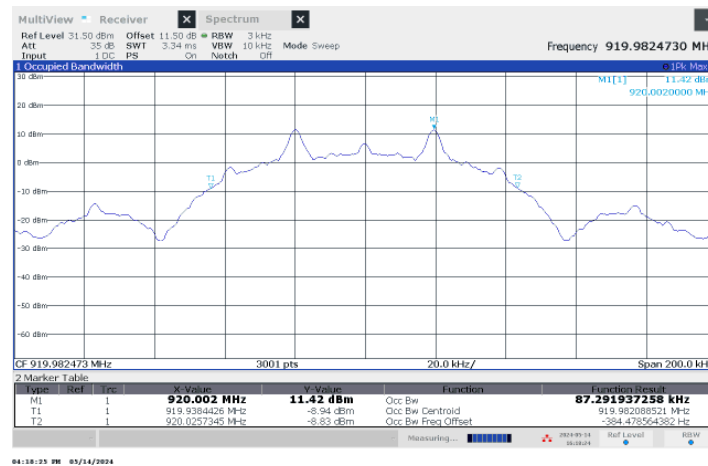


Figure 4 – 99% Bandwidth - Low Channel

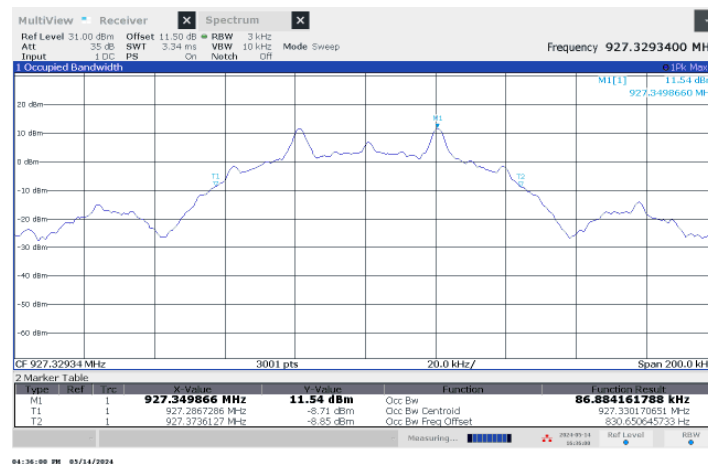


Figure 5 – 99% Bandwidth - High Channel

3.1.4 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_115	10dB Attenuator	Fairview Microwave	SA18E-10	NCR	NCR

3.2 Channel Carrier Frequency Separation

Test Date: May 14, 2024
Temperature (°C) 21.8
Relative Humidity (%) 53.6
Barometric Pressure (kPa) 101.0

Initials: MX

During this test, the channel carrier frequency separation of the transmitter will be examined. This specification facilitates the prevention of data corruption while also indirectly limiting the power density of a transmitter which enable other transmitters to coexist in the same frequency band.

3.2.1 Limits

Systems using frequency hopping techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands with minimum allowable channel carrier frequency separation - Δf , specified in FCC 15.247 (a)(1) and RSS-247 Section 5.1, summarized below:

Frequency Band	Minimum Channel Separation	
	$P_{\text{max-pk}} \leq 1 \text{ W}$	
902–928 MHz	$\Delta f \geq \text{MAX} \{25 \text{ kHz}, BW_{20\text{dB}}\}$	
2400–2483.5 MHz	$\Delta f \geq \text{MAX} \{25 \text{ kHz}, BW_{20\text{dB}}\}$ Provide: $N_{\text{ch}} \geq 75$	$\Delta f \geq [\text{MAX} \{25 \text{ kHz}, \frac{2}{3}BW_{20\text{dB}}\}$ OR $\text{MAX} \{25 \text{ kHz}, BW_{20\text{dB}}\}]$ Provide: $N_{\text{ch}} \geq 15$ $P_{\text{max-pk}} \leq 0.125 \text{ W}$
5725–5850 MHz	$\Delta f \geq \text{MAX} \{25 \text{ kHz}, BW_{20\text{dB}}\}$	

The DUT's operates in the 902 - 928 MHz band. The applicable limit is therefore, the larger of 20 dB BW or 25 kHz. The system's highest 20 dB BW was measured to be 86.70 kHz. The minimum channel separation limit is 86.70 kHz.

3.2.2 Test Procedure

Tested according to ANSI C63.10 Section 7.8.2.

For Channel Carrier Frequency Separation

- Set RBW approximately to 30% of the channel spacing; adjust as necessary to identify the center of each channel.
- Set VBW $\geq$ RBW.
- Detector: Peak
- Span set to wide enough to capture at least two adjacent channels

3.2.3 Test Results

The DUT met the minimum channel separation limit. The channel separation is 150.62 kHz which is larger than 86.70 kHz.

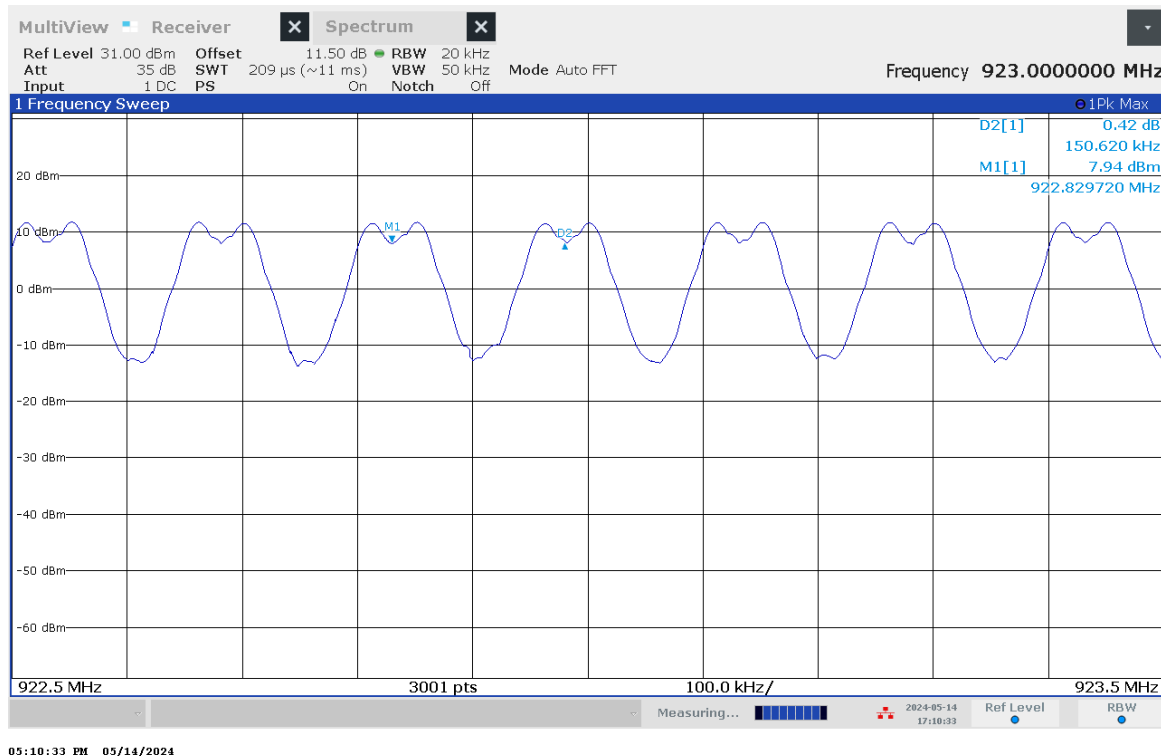


Figure 6 – Channel Separation

3.2.4 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_115	10dB Attenuator	Fairview Microwave	SA18E-10	NCR	NCR

3.3 Number of Hopping Channels

Test Date: May 14, 2024
Temperature (°C) 21.8
Relative Humidity (%) 53.6
Barometric Pressure (kPa) 101.0

Initials: MX

During this test, the Number of Hopping Channels of the transmitter will be examined. This specification limits the power density of a transmitter which enable other transmitters to coexist in the same frequency band.

3.3.1 Limits

Systems using frequency hopping techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands with minimum Number of Hopping Channels - N_{ch} , specified in FCC 15.247 (a)(1) and RSS-247 Section 5.1, summarized below:

Frequency Band	Minimum Number of Hopping Channels	
	$P_{\max\text{-pk}} \leq 1 \text{ W}$	
902–928 MHz	$N_{ch} \geq 50$	$25 \leq N_{ch} < 50$ Provided: $P_{\max\text{-pk}} \leq 0.25 \text{ W}$ $250 \text{ kHz} < BW_{20\text{dB}} \leq 500 \text{ kHz}$
2400–2483.5 MHz	$N_{ch} \geq 75$	$N_{ch} \geq 15$ Provided: $P_{\max\text{-pk}} \leq 0.125 \text{ W}$
5725–5850 MHz	$N_{ch} \geq 75$	

The DUT's operates in the 902–928 MHz band; its maximum power is less than 1 W; and its $BW_{20\text{dB}}$ is $\leq 250 \text{ kHz}$. The applicable limit is therefore, $N_{ch} \geq 50$.

3.3.2 Test Procedure

Tested according to ANSI C63.10 Section 7.8.3.

For Number of Hopping Channels

- Set RBW less than 30% of the channel spacing or 20 dB bandwidth, whichever is smaller; adjust as necessary to identify each channel.
- Set VBW $\geq$ RBW.
- Detector: Peak
- Span set to wide enough to capture the whole band; maybe necessary to divide the band into multiple spans if individual channels is not clearly seen.

3.3.3 Test Results

The DUT met the minimum number of channels requirement. The number of channels the device occupies is 50 channels.

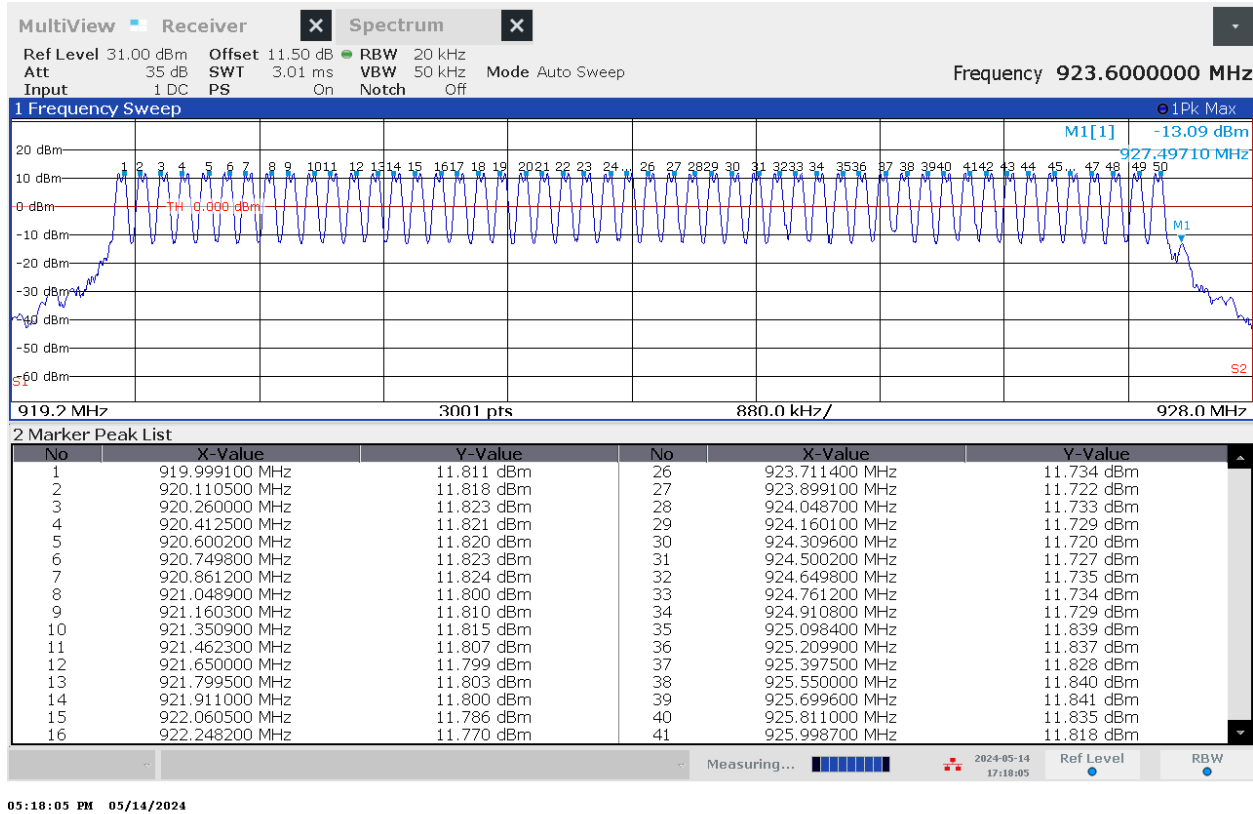


Figure 7 – Number of Hopping Channels

3.3.4 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_115	10dB Attenuator	Fairview Microwave	SA18E-10	NCR	NCR

3.4 Time of Occupancy (Dwell Time)

Test Date: May 14, 2024
Temperature (°C) 21.8
Relative Humidity (%) 53.6
Barometric Pressure (kPa) 101.0

Initials: MX

During this test, the Time of Occupancy for each channel of the transmitter will be examined. This specification limits the time a channel is occupied which enable other transmitter to coexist in the same frequency band.

3.4.1 Limits

Systems using frequency hopping techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands with maximum Time of Occupancy for each channel - t_{ch} , specified in FCC 15.247 (a)(1) and RSS-247 Section 5.1, summarized below:

Frequency Band	Maximum Time of Occupancy	
	$P_{\max\text{-pk}} \leq 1 \text{ W}$	
902–928 MHz	$t_{ch} \leq 0.4 \text{ s for } T = 20 \text{ s}$ Provide: $N_{ch} \geq 50$ $BW_{20\text{dB}} \leq 250 \text{ kHz}$	$t_{ch} \leq 0.4 \text{ s for } T = 10 \text{ s}$ Provided: $P_{\max\text{-pk}} \leq 0.25 \text{ W}$ $250 \text{ kHz} < BW_{20\text{dB}} \leq 500 \text{ kHz}$
2400–2483.5 MHz	$t_{ch} \leq 0.4 \text{ s for } T = 0.4 N_{ch} \text{ s}$	
5725–5850 MHz	$t_{ch} \leq 0.4 \text{ s for } T = 30 \text{ s}$	

The DUT's operates in the 902–928 MHz band and its' maximum power is less than 0.25 W. The applicable limit is therefore, $t_{ch} \leq 0.4 \text{ s for } T = 20 \text{ s}$.

3.4.2 Test Procedure

Tested according to ANSI C63.10 Section 7.8.4.

For Dwell Time per Hop

- Set RBW less than channel spacing
- Detector: Peak
- Span: Zero span, centered on a hopping channel
- Sweep: Single
- Sweep Time: long enough to capture start and end of a transmission

For Number of Hop

- Sweep Time: long enough to capture at least 2 hops
- The number of hops within T is calculated from the number of hops on the channel divided by the Sweep Time multiplied by T

The Time of Occupancy is calculated by multiplying the dwell time per hop by the number of hops in T.

3.4.3 Test Results

Observation time, T, is 20 s. DUT's dwell time per hop is 14.82 ms (0.015 s).

Time between each hop is 2.62 s; number of hops per Observation Time (20 s) = $20/2.62 = 8$ hops.

The DUT has an average occupancy t_{ch} of $8 \times 0.015 \text{ s} = 0.12 \text{ s}$ which is less than 0.4 s.

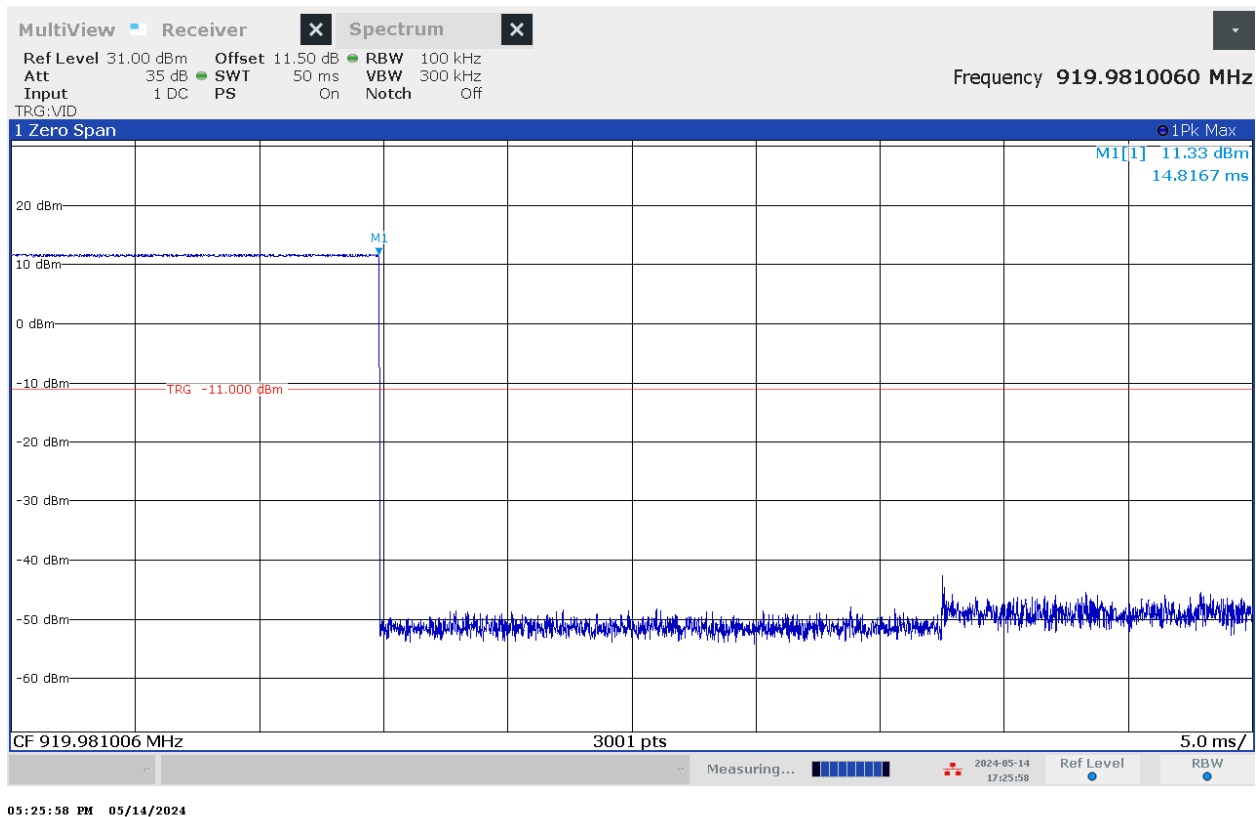


Figure 8 – Dwell Time per Hop

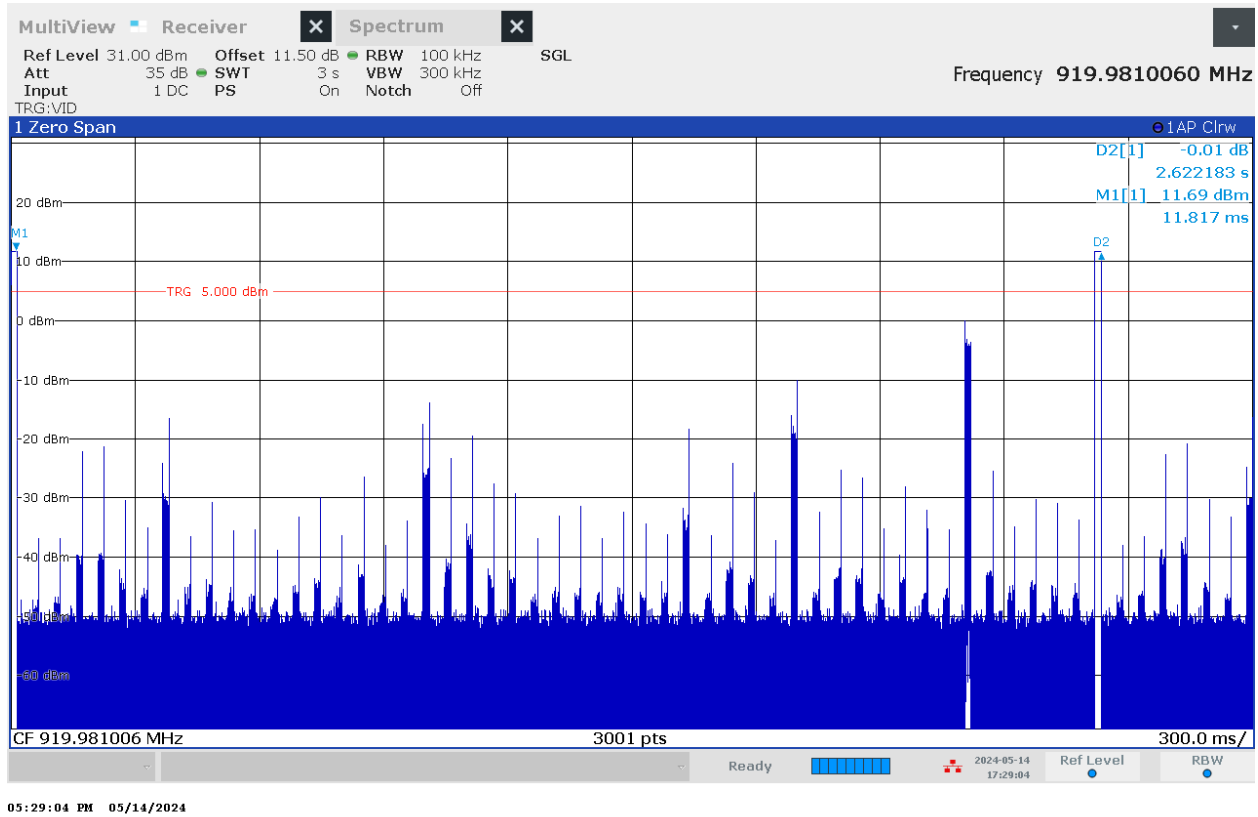


Figure 9 – Number of Hops per Sweep Time

3.4.4 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_115	10dB Attenuator	Fairview Microwave	SA18E-10	NCR	NCR

3.5 Output Power

Test Date: May 14, 2024
Temperature (°C) 21.8
Relative Humidity (%) 53.6
Barometric Pressure (kPa) 101.0

Initials: MX

3.5.1 Limits

Systems using frequency hopping techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands with maximum peak conducted power, specified in FCC 15.247 (b) and RSS-247 Section 5.4, summarized below:

Frequency Band	Maximum Peak Conducted Power	
902–928 MHz	$P_{\text{max-pk}} \leq 1 \text{ W}$	$P_{\text{max-pk}} \leq 0.25 \text{ W}$
	Provided: $N_{\text{ch}} \geq 50$	Provided: $25 \leq N_{\text{ch}} < 50$
2400–2483.5 MHz	$P_{\text{max-pk}} \leq 1 \text{ W}$	$P_{\text{max-pk}} \leq 0.125 \text{ W}$
	Provided: $N_{\text{ch}} \geq 75$	Provided: $N_{\text{ch}} \geq 15$
5725–5850 MHz	$P_{\text{max-pk}} \leq 1 \text{ W}$	
	Provided: $N_{\text{ch}} \geq 75$	

3.5.2 Test Procedure

Tested according to ANSI C63.10 Section 7.8.5.

For Peak Conducted Output Power

- Set RBW > 20 dB emission bandwidth
- Set VBW ≥ RBW
- Detector: Peak
- Span: Approximately 5 times 20 dB emission bandwidth
- Trace: Max-hold

The RF output of the DUT was connected to the spectrum analyzer with sufficient attenuation in front and the total path loss was set as reference offset to correct the final reading.

3.5.3 Test Results

The EUT meets power limits of 1 W. The EUT meets N_{ch} (50) ≥ 15 condition.

Channel	Frequency (MHz)	Peak Power (dBm)	Peak Power (mW)	Peak Power (W)	Limit (W)	Test Result
Low	920.0	11.81	15.17	0.015	1	Pass
High	927.35	11.84	15.28	0.015	1	Pass

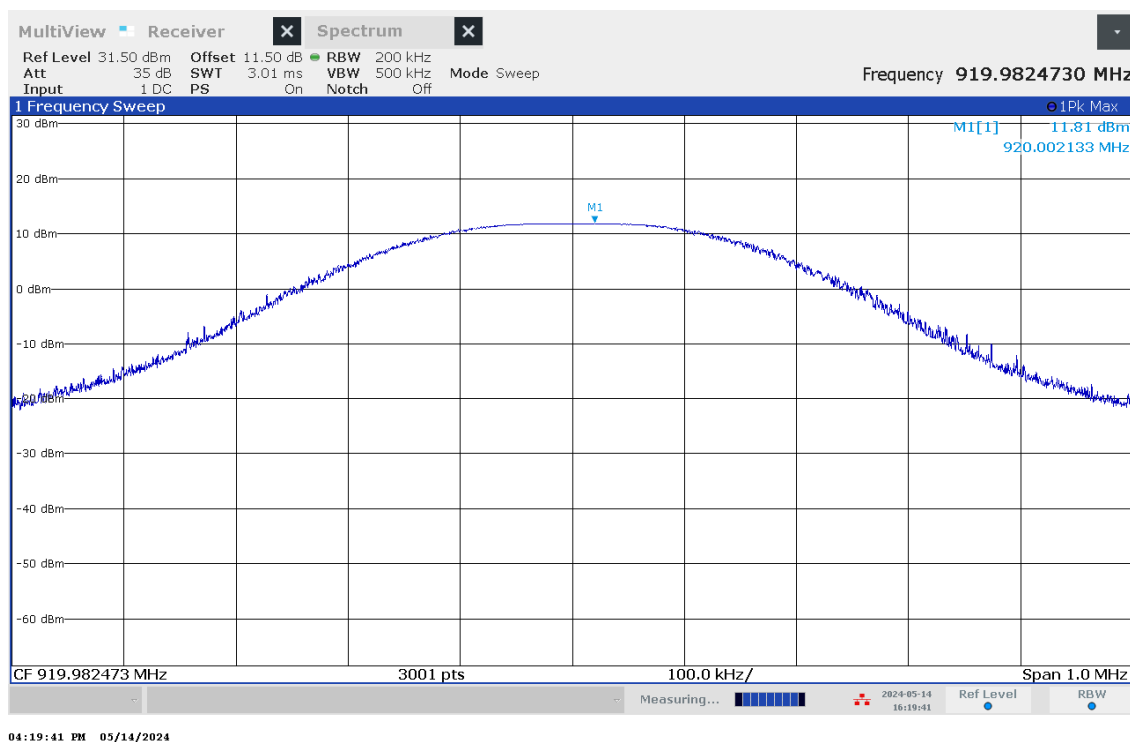


Figure 10 – Peak Power - Low Channel

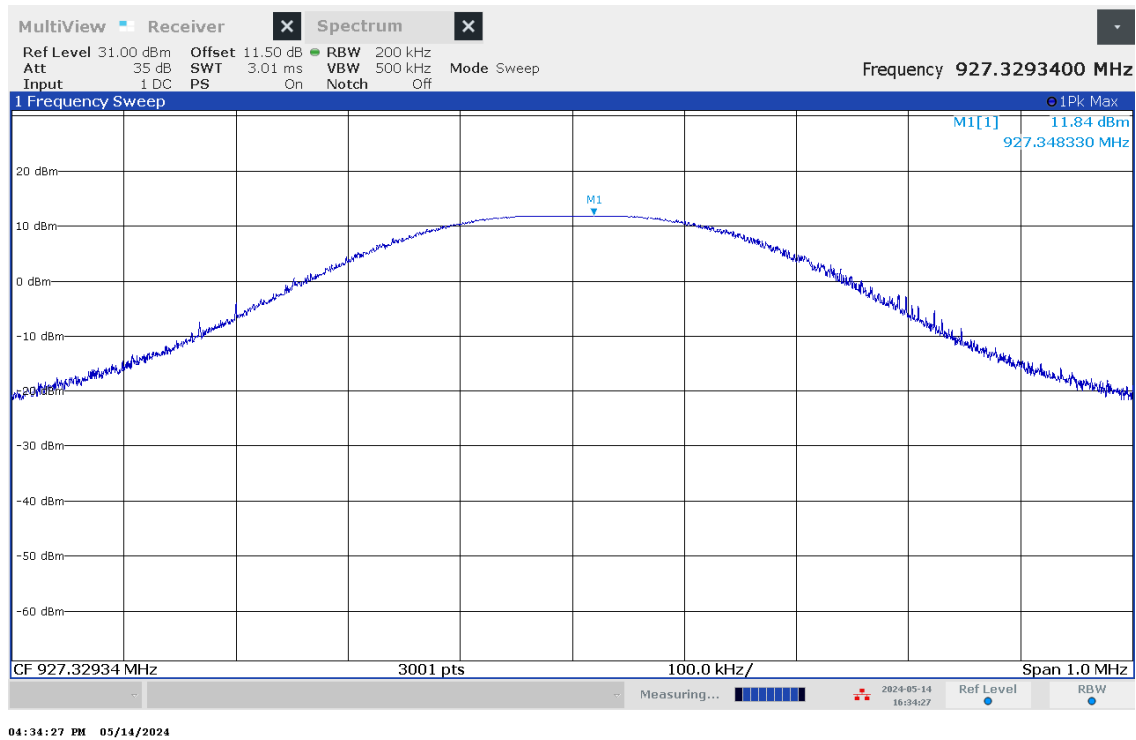


Figure 11 – Peak Power - High Channel

3.5.4 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_115	10dB Attenuator	Fairview Microwave	SA18E-10	NCR	NCR

3.6 Conducted Spurious Emissions (-20dBc)

Test Date:	May 14, 2024
Temperature (°C)	21.8
Relative Humidity (%)	53.6
Barometric Pressure (kPa)	101.0

Initials: MX

3.6.1 Limits

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 20dB below that in the 100kHz 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, the attenuation required shall be 30dB instead of 20dB.

3.6.2 Test Procedure

Tested according to ANSI C63.10 Section 7.8.7

Conducted Band-edge testing is performed with hopping disabled and enabled.

For the reference level measurement:

- Set RBW = 100kHz and VBW $\geq [3 \times \text{RBW}]$.
- Detector = Peak and Trace Mode = Max Hold.
- Sweep = Auto Couple.
- Span set to ≥ 1.5 20 dB emission bandwidth.
- Use the peak marker function to determine the maximum level.

For the out of band emission measurement

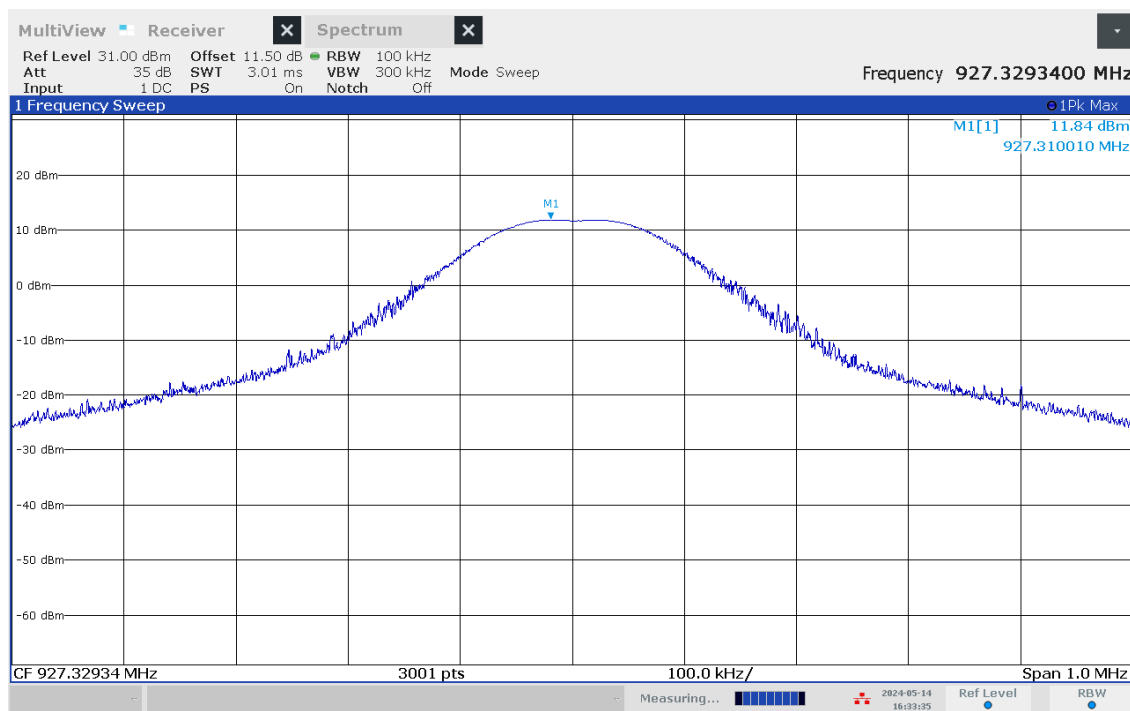
- Set the start and stop frequency to encompass the frequency range to be measured.
- Set RBW = 100kHz and VBW $\geq [3 \times \text{RBW}]$.
- Detector = Peak and Trace Mode = Max Hold.
- Sweep = Auto Couple.
- Use the peak marker function to determine the maximum level.

The RF output of the DUT was connected to the spectrum analyzer with sufficient attenuation in front and the total path loss was set as reference offset to correct the final reading.

3.6.3 Test Results

The DUT met the 20dB below carrier requirement for out of band emissions.

Channel	Frequency (MHz)	Peak PSD w/ RBW=100 kHz (dBm)	20 dBc Limit (dBm)
Low	920.0	11.80	-8.20
High	927.35	11.84	-8.16



04:33:35 PM 05/14/2024

Figure 12 – -20dBc Reference Level - High Channel

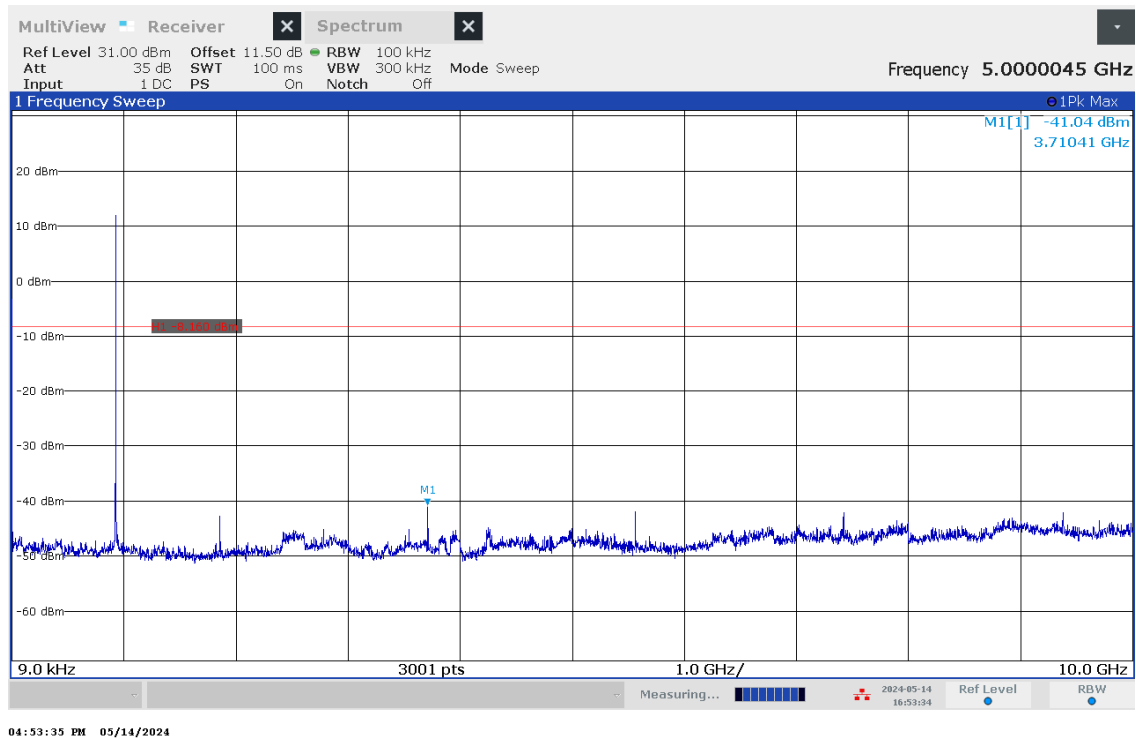


Figure 13 – -20dBc with High Channel

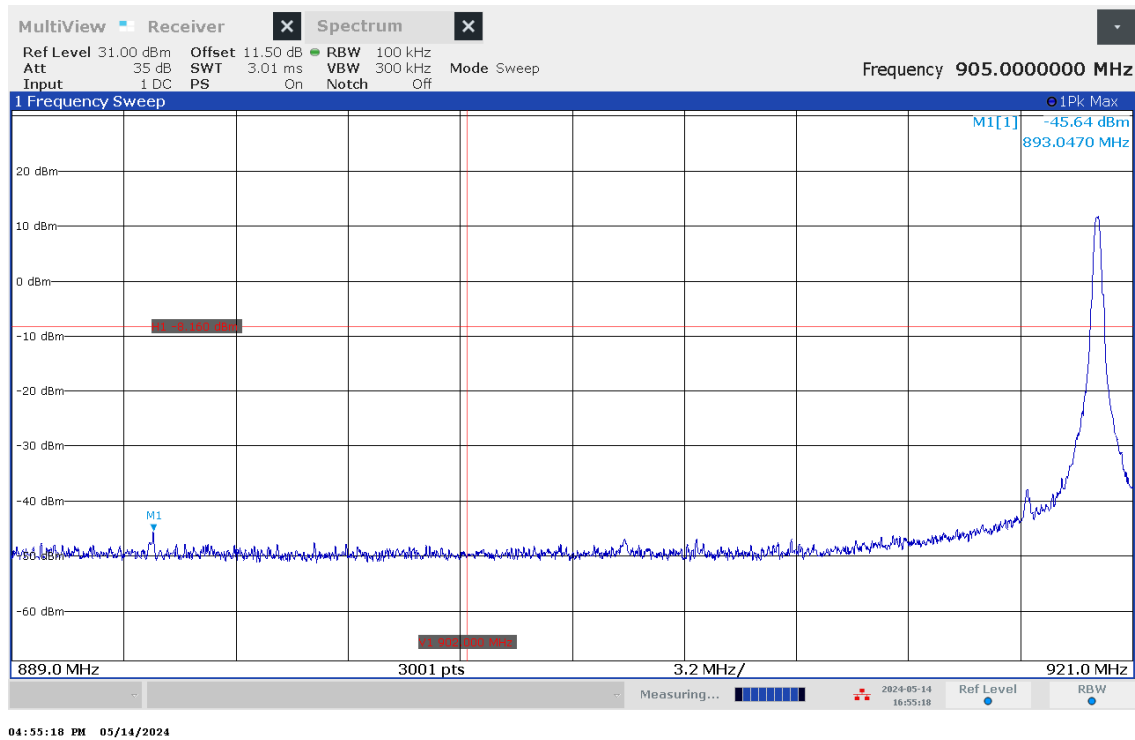


Figure 14 – -20dBc Band Edge - Low Channel (Hoping Disabled)

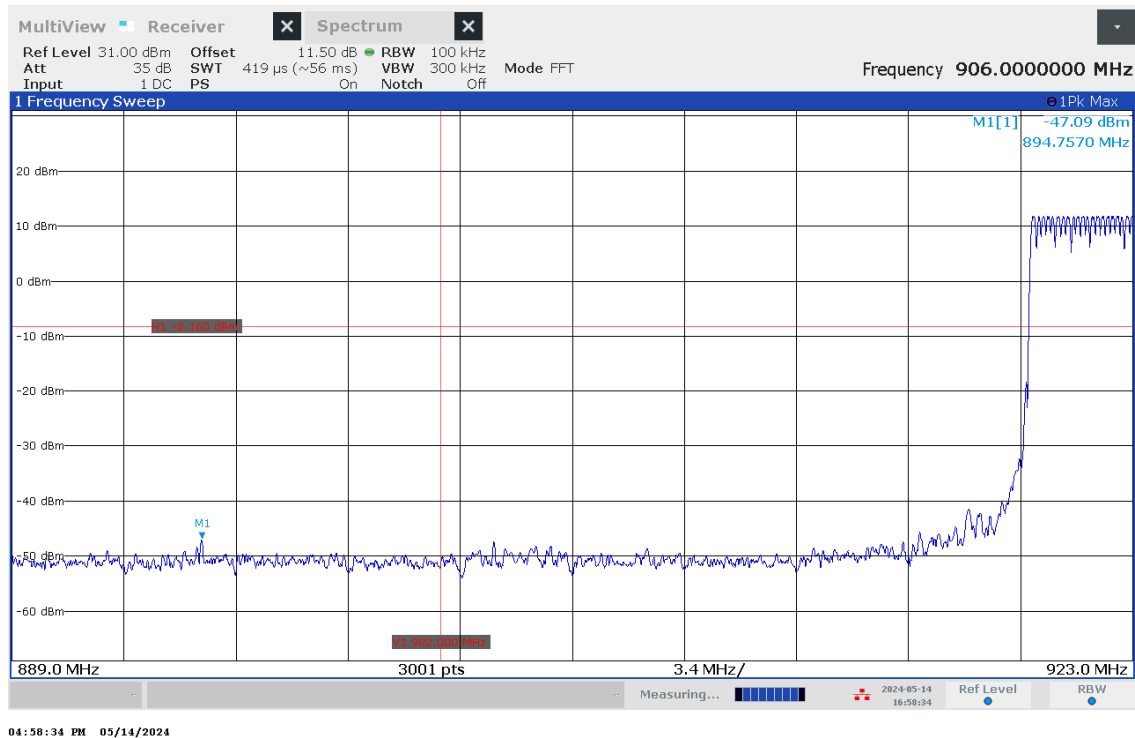


Figure 15 – -20dBc Band Edge - Low Channel (Hoping Enabled)

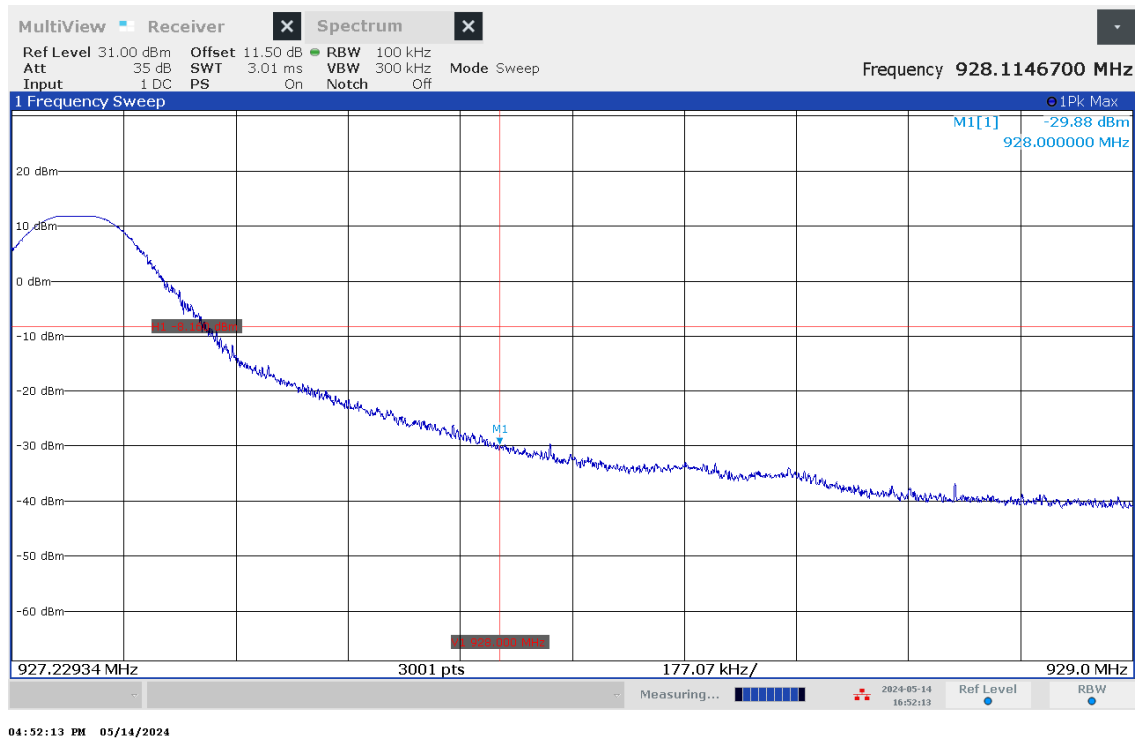


Figure 16 – -20dBc Band Edge - High Channel (Hoping Disabled)

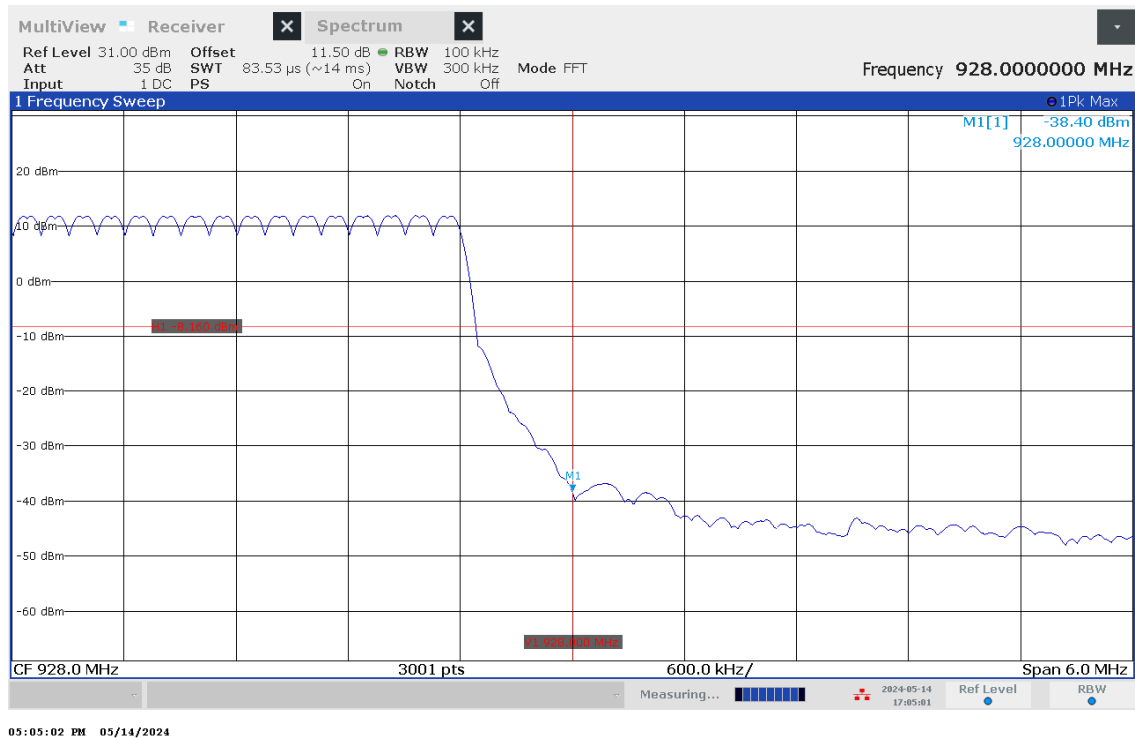


Figure 17 – -20dBc Band Edge - High Channel (Hoping Enabled)

3.6.4 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_115	10dB Attenuator	Fairview Microwave	SA18E-10	NCR	NCR

3.7 Transmitter Spurious Radiated Emissions

Test Date: May 6 – 13, 2024
Temperature (°C) 20.8 – 21.7
Relative Humidity (%) 42.8 – 54.7
Barometric Pressure (kPa) 100.4 – 101.5

Initials: MX

3.7.1 Limits

Any radiated emissions which fall in the restricted bands, as defined in FCC 15.205(a), must comply with the general radiated emission limits specified in FCC 15.209(a). Other emissions shall be at least 20dB below the highest level of the intentional transmitter.

Base Standard(s): FCC Subpart C 15.209 and RSS-Gen Section 8.9.

Frequency Range (MHz)	Field Strength Limit		Field Strength at 3m (dBμV/m)	Detector Type / Measurement Bandwidth
	μV/m	Distance		
0.009 – 0.150	2400/F(kHz)	300	128.5 – 104.1	Quasi-Peak‡ / 200Hz
0.150 – 0.490	2400/F(kHz)	300	104.1 – 93.8	Quasi-Peak‡ / 9kHz
0.490 – 1.705	24000/F(kHz)	30	73.8 – 63.0	Quasi-Peak / 9kHz
1.705 – 30	30	30	69.5	Quasi-Peak / 9kHz
30 – 88	100	3	40.0	Quasi-Peak / 120kHz
88 – 216	150	3	43.5	Quasi-Peak / 120kHz
216 – 960	200	3	46.0	Quasi-Peak / 120kHz
960 – 1000	500	3	54.0	Quasi-Peak / 120kHz
Above 1000	500	3	54.0	Average / 1MHz
Above 1000	5000	3	74.0	Peak / 1MHz

‡The emission limits below 1GHz shown in the above table are based on measurements employing a CISPR Quasi-Peak detector except for the frequency bands 9-90 kHz and 110-490 kHz. Radiated emission limits in these two bands are based on measurements employing an average detector.

As per ANSI C63.4 Section 4.2, if the Peak detector measurements do not exceed the Quasi-Peak limits, or Average limits where defined, then the DUT is considered to have passed the requirements.

3.7.2 Test Procedure

Tested according to ANSI C63.10 Section 6.3.

The device under test was setup inside a semi-anechoic chamber with remotely controlled turntable and antenna positioner at a 3m test distance. The DUT was placed on top of a 0.8m high non-conductive table above the reference ground plane for frequencies below 1GHz and 1.5m high for frequencies above 1GHz.

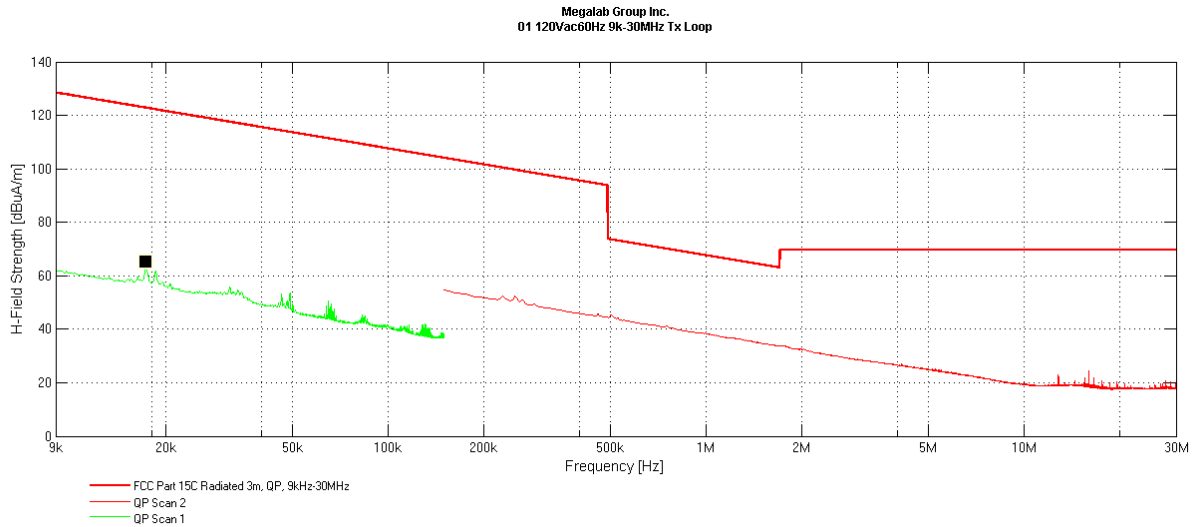
To determine the emission characteristics of the DUT, exploratory radiated emission scans were made while rotating the turntable 0° to 360° and using a Peak detector. The results were recorded in graphical form.

For each suspected emission, final measurements of the DUT radiated emissions with the Quasi-Peak, Average or Peak detector, as defined in the limit tables above, were made with the turntable azimuth rotated 0° to 360° and antenna height varied from 1m to 4m. The antenna was positioned to receive emissions in the vertical and horizontal polarizations such that the maximum radiated emission levels were detected.

As per FCC Part 15.33(a), the DUT was scanned to the 10th harmonic of the highest fundamental frequency.

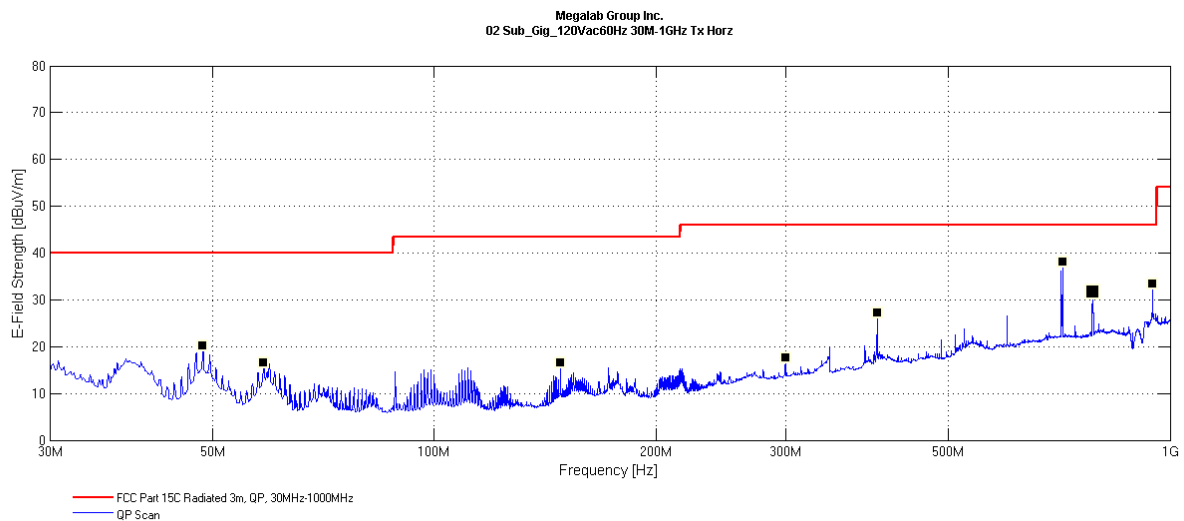
3.7.3 Test Results

Range:	9kHz to 30 MHz	Tx Frequency	927.35 MHz
Test Voltage:	24Vac 60Hz	Antenna Polarization	XZ-Plane



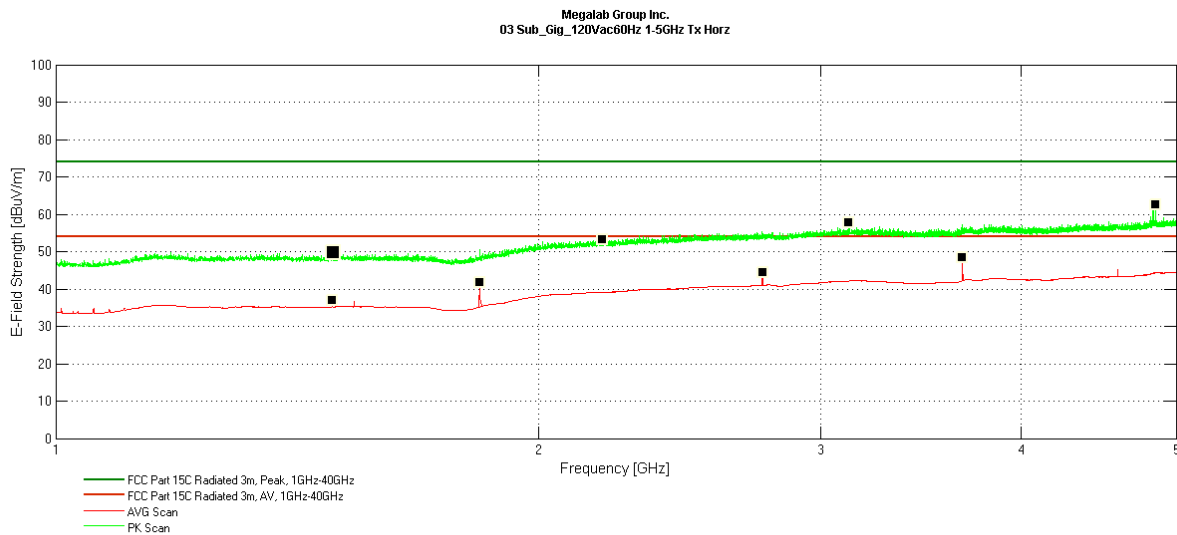
Remark: Quasi-Peak Emission Plot

Range:	30MHz to 1GHz	Tx Frequency	927.35 MHz
Test Voltage:	24Vac 60Hz	Antenna Polarization	Horizontal



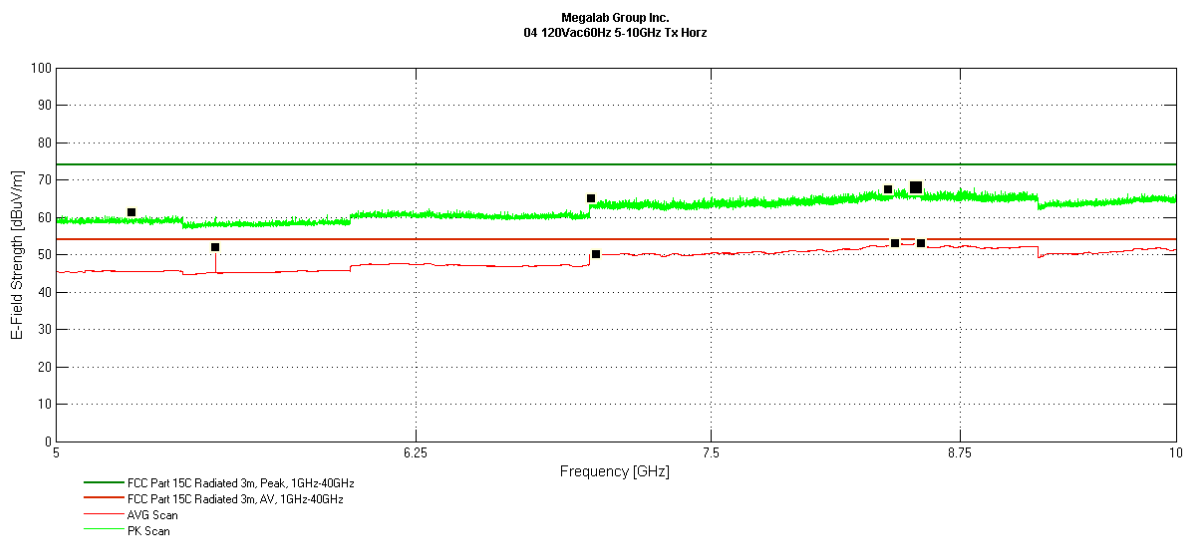
Remark: - Quasi-Peak Emission Plot
- A notch filter was used to filter out the fundamental

Range:	1GHz to 5GHz	Tx Frequency	927.35 MHz
Test Voltage:	24Vac 60Hz	Antenna Polarization	Horizontal



Remark: - **Peak** and **Average** Emission Plot
- A high pass filter was used to filter out the fundamental

Range:	5 GHz to 10GHz	Tx Frequency	927.35 MHz
Test Voltage:	24Vac 60Hz	Antenna Polarization	Horizontal

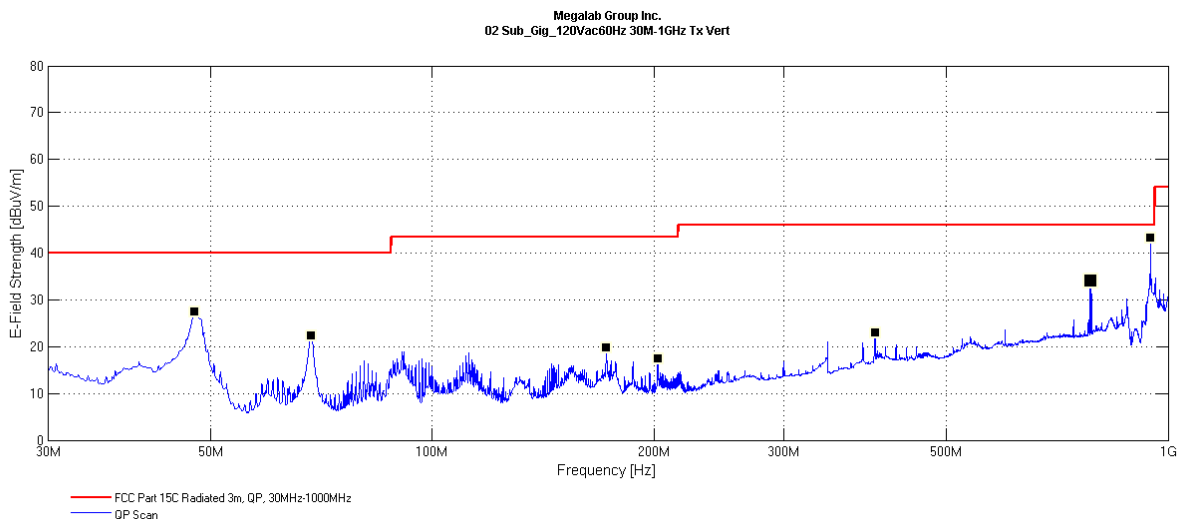


Remark: - **Peak** and **Average** Emission Plot
- A high pass filter was used to filter out the fundamental

Horizontal Antenna Polarization							
Frequency (MHz)	Detector	Reading (dBμV)	Correction Factor (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Test Result
48.50	QP	35.8	-15.8	20.1	40.0	19.9	Pass
58.60	QP	32.5	-15.9	16.6	40.0	23.4	Pass
148.50	QP	29.8	-13.2	16.6	43.5	26.9	Pass
300.00	QP	26.8	-9.1	17.7	46.0	28.3	Pass
399.90	QP	31.4	-4.2	27.2	46.0	18.9	Pass
714.70	QP	36.6	1.5	38.1	46.0	7.9	Pass
947.00	QP	28.7	4.8	33.5	12.5	12.5	Pass
785.15	QP	29.8	2.0	31.8	14.2	14.2	Pass

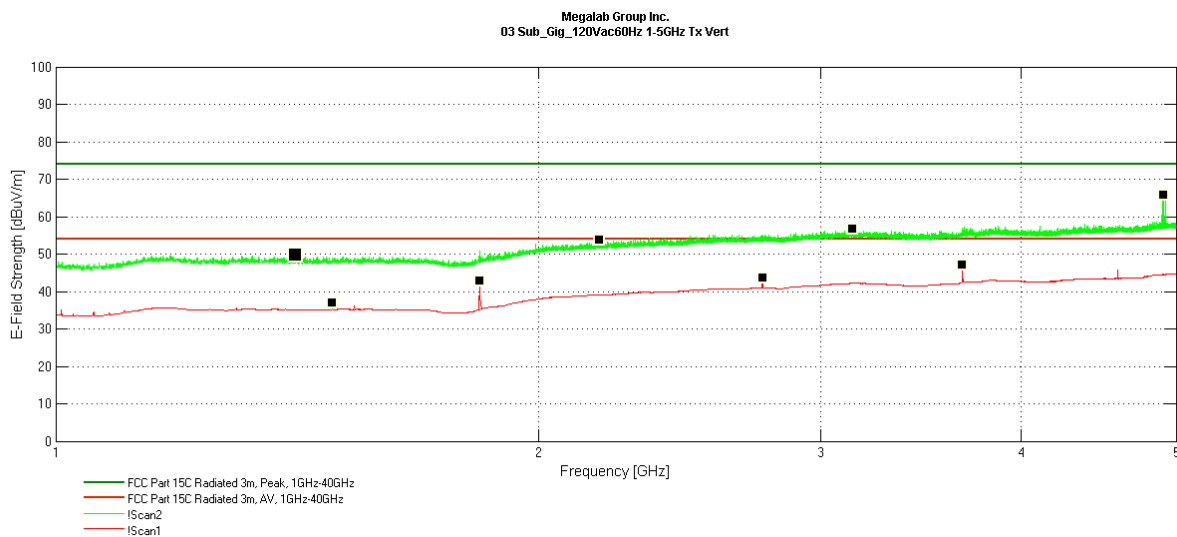
Frequency (MHz)	Detector	Antenna Polarity	Reading (dBμV)	Antenna Factor (dB/m)	Cable Factor (dB)	Attenuator (dB)	Pre-Amp Gain (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Test Result
Low Channel											
1840	PEAK	Horz	54.1	30.9	6.7	0.0	-41.0	50.7	74.0	23.3	Pass
1840	AVG	Horz	51.1	30.9	6.7	0.0	-41.0	47.7	54.0	6.3	Pass
2760	PEAK	Horz	51.6	32.7	6.8	0.0	-41.7	49.4	74.0	24.6	Pass
2760	AVG	Horz	45.7	32.7	6.8	0.0	-41.7	43.5	54.0	10.5	Pass
3680	PEAK	Horz	53.0	33.4	6.8	0.0	-42.3	51.0	74.0	23.0	Pass
3680	AVG	Horz	47.0	33.4	6.8	0.0	-42.3	45.0	54.0	9.0	Pass
4600	PEAK	Horz	45.8	34.4	7.6	0.0	-42.0	45.9	74.0	28.1	Pass
4600	AVG	Horz	31.4	34.4	7.6	0.0	-42.0	31.5	54.0	22.5	Pass
5520	PEAK	Horz	50.1	35.1	8.5	0.0	-41.0	52.7	74.0	21.3	Pass
5520	AVG	Horz	45.8	35.1	8.5	0.0	-41.0	48.4	54.0	5.6	Pass
High Channel											
1854.7	PEAK	Horz	51.8	31.0	6.7	0.0	-41.0	48.5	74.0	25.5	Pass
1854.7	AVG	Horz	46.5	31.0	6.7	0.0	-41.0	43.1	54.0	10.9	Pass
2782.05	PEAK	Horz	50.5	32.8	6.5	0.0	-41.7	48.0	74.0	26.0	Pass
2782.05	AVG	Horz	43.3	32.8	6.5	0.0	-41.7	40.8	54.0	13.2	Pass
3709.4	PEAK	Horz	51.3	33.5	6.8	0.0	-42.3	49.3	74.0	24.7	Pass
3709.4	AVG	Horz	44.7	33.5	6.8	0.0	-42.3	42.7	54.0	11.3	Pass
4636.75	PEAK	Horz	49.2	34.4	7.6	0.0	-41.9	49.3	74.0	24.7	Pass
4636.75	AVG	Horz	40.3	34.4	7.6	0.0	-41.9	40.5	54.0	13.5	Pass
5564.1	PEAK	Horz	48.1	35.1	8.6	0.0	-41.0	50.8	74.0	23.2	Pass
5564.1	AVG	Horz	39.5	35.1	8.6	0.0	-41.0	42.1	54.0	11.9	Pass

Range:	30MHz to 1GHz	Tx Frequency	927.35 MHz
Test Voltage:	24Vac 60Hz	Antenna Polarization	Vertical



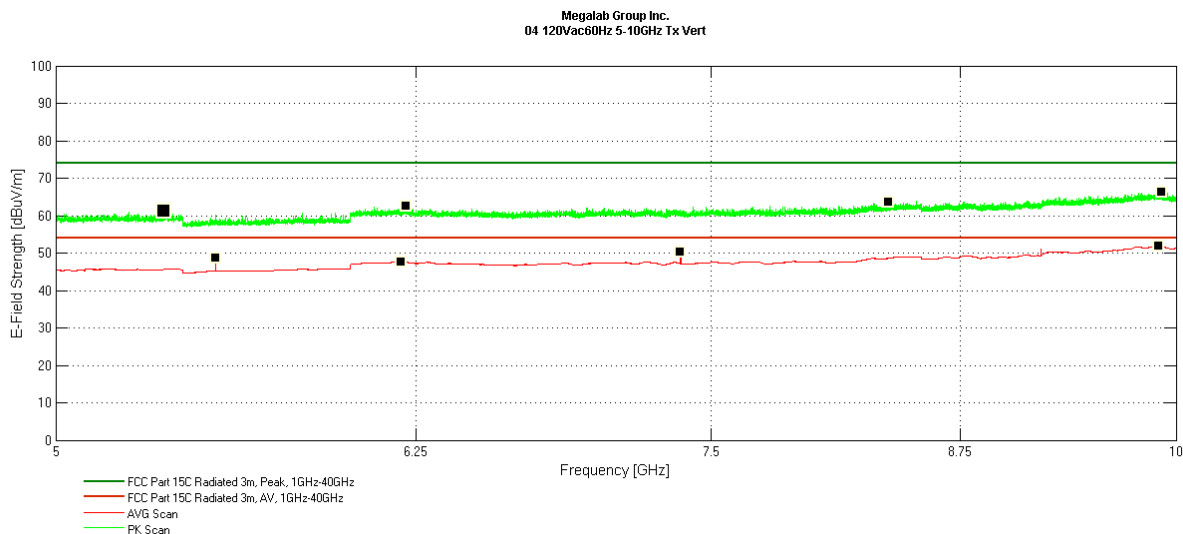
Remark: - Quasi-Peak Emission Plot
- A Notch filter was used to filter out the fundamental

Range:	1GHz to 5GHz	Tx Frequency	2403.5 MHz
Test Voltage:	24Vac 60Hz	Antenna Polarization	Vertical



Remark: - **Peak** and **Average** Emission Plot
- A high pass filter was used to filter out the fundamental

Range:	5GHz to 10GHz	Tx Frequency	927.35 MHz
Test Voltage:	24Vac 60Hz	Antenna Polarization	Vertical



Operator: admin
Last Data Update: 2024-05-07 12:21:52

Project: Ecobee_301244_SmartThermo_Light_SubGig.S64

Remark: - **Peak** and **Average** Emission Plot

- A high pass filter was used to filter out the fundamental

Vertical Antenna Polarization							
Frequency (MHz)	Detector	Reading (dBμV)	Correction Factor (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Test Result
47.50	QP	43.0	-15.4	27.5	40.0	12.5	Pass
68.50	QP	37.7	-15.4	22.3	40.0	17.7	Pass
172.40	QP	32.3	-12.6	19.7	43.5	23.8	Pass
202.50	QP	29.2	-11.8	17.3	43.5	26.2	Pass
399.90	QP	27.1	-4.2	22.9	46.0	23.1	Pass
947.00	QP	38.4	4.8	43.3	46.0	2.8	Pass
784.05	QP	32.0	1.9	33.9	12.1	12.1	Pass

Frequency (MHz)	Detector	Antenna Polarity	Reading (dBμV)	Antenna Factor (dB/m)	Cable Factor (dB)	Attenuator (dB)	Pre-Amp Gain (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Test Result
Low Channel											
1840	PEAK	Vert	54.1	30.9	6.7	0.0	-41.0	50.6	74.0	23.4	Pass
1840	AVG	Vert	49.8	30.9	6.7	0.0	-41.0	46.4	54.0	7.6	Pass
2760	PEAK	Vert	51.4	32.7	6.8	0.0	-41.7	49.2	74.0	24.8	Pass
2760	AVG	Vert	45.8	32.7	6.8	0.0	-41.7	43.6	54.0	10.4	Pass
3680	PEAK	Vert	51.9	33.4	6.8	0.0	-42.3	49.9	74.0	24.1	Pass
3680	AVG	Vert	45.9	33.4	6.8	0.0	-42.3	43.9	54.0	10.1	Pass
4600	PEAK	Vert	45.9	34.4	7.6	0.0	-42.0	46.0	74.0	28.0	Pass
4600	AVG	Vert	31.5	34.4	7.6	0.0	-42.0	31.6	54.0	22.4	Pass
5520	PEAK	Vert	52.6	35.1	8.5	0.0	-41.0	55.1	74.0	18.9	Pass
5520	AVG	Vert	47.9	35.1	8.5	0.0	-41.0	50.4	54.0	3.6	Pass
High Channel											
1854.7	PEAK	Vert	52.3	31.0	6.7	0.0	-41.0	49.0	74.0	25.0	Pass
1854.7	AVG	Vert	47.4	31.0	6.7	0.0	-41.0	44.1	54.0	9.9	Pass
2782.05	PEAK	Vert	50.7	32.8	6.5	0.0	-41.7	48.2	74.0	25.8	Pass
2782.05	AVG	Vert	44.5	32.8	6.5	0.0	-41.7	42.0	54.0	12.0	Pass
3709.4	PEAK	Vert	52.0	33.5	6.8	0.0	-42.3	50.0	74.0	24.0	Pass
3709.4	AVG	Vert	46.7	33.5	6.8	0.0	-42.3	44.7	54.0	9.3	Pass
4636.75	PEAK	Vert	49.6	34.4	7.6	0.0	-41.9	49.7	74.0	24.3	Pass
4636.75	AVG	Vert	42.5	34.4	7.6	0.0	-41.9	42.7	54.0	11.3	Pass
5564.1	PEAK	Vert	49.0	35.1	8.6	0.0	-41.0	51.6	74.0	22.4	Pass
5564.1	AVG	Vert	42.6	35.1	8.6	0.0	-41.0	45.3	54.0	8.7	Pass

Worst case position: Angle: 0 Deg
Height: 151 cm

3.7.4 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_132	EMI Test Receiver (v6.91.2)	Gauss Instruments	TDEMI X40	Nov 29, 2023	Nov 29, 2025
EQ_EMC_48	Loop Antenna	Com-Power	AL-130R	Apr 9, 2024	Apr 9, 2026
EQ_EMC_59	BiLog Antenna	ETS Lindgren	3142E	Apr 19, 2024	Apr 19, 2026
EQ_EMC_60	Horn Antenna	ETS Lindgren	3117	Apr 9, 2024	Apr 9, 2026
EQ_EMC_68	6dB Attenuator	Fairview Microwave	SA3NS-06	Apr 19, 2024	Apr 19, 2026
EQ_EMC_85	RF Cable <1GHz	Times Microwave	LMR-400	NCR	NCR
EQ_EMC_75	RF Cable >1GHz	MegaPhase	EMC2	NCR	NCR
EQ_EMC_123	Preamplifier 30MHz-9GHz	RF Bay	EPA-250T	Jan 23, 2024	Jan 23, 2026
EQ_EMC_42	Preamplifier 1GHz-18GHz	Com-Power	PAM-118A	Jan 17, 2024	Jan 17, 2026
EQ_EMC_107	902MHz-928MHz Notch Filter	Micro-Tronics	BRC50722	NCR	NCR
EQ_EMC_110	1 GHz HPF Filter	Micro-Tronics	HPM50108	NCR	NCR
EQ_EMC_149	Emission Software RE/CE	Gauss Instruments	EMI64k v6.31.2	NCR	NCR

3.8 Power Line Conducted Emissions

Test Date: May 13, 2024
Temperature (°C) 21.1
Relative Humidity (%) 54.7
Barometric Pressure (kPa) 100.8

Initials: MX

The conducted emission test is to measure radio-frequency (RF) signals and noise emitted from electrical and electronic devices in the frequency range of 150kHz to 30MHz.

3.8.1 Limits

Base Standard(s): FCC Subpart B 15.207 and RSS-GEN Section 8.8.

Frequency Range (MHz)	Coupling Device	Detector Type / Bandwidth	Limit (dBμV)
0.15 to 0.50	LISN	Quasi-Peak / 9kHz	66 to 56*
0.50 to 5			56
5 to 30			60
0.15 to 0.50	LISN	Average / 9kHz	56 to 46*
0.50 to 5			46
5 to 30			50

* Decreases linearly with the logarithm of the frequency

As per ANSI C63.4 Section 4.2, if the Peak or Quasi-Peak detector measurements do not exceed the Average limits, then the DUT is considered to have passed the requirements.

3.8.2 Test Procedure

Tested according to ANSI C63.10 Section 6.2.

Conducted emissions were measured on the DUT's power port via an Artificial Mains Network (AMN), also known as Line Impedance Stabilization Network (LISN), and maximum conducted emissions are checked on all the DUT's AC lines in the frequency range of 150kHz to 30MHz. The LISNs provide 50Ω/50μH of coupling impedance for the measuring receiver.

To determine the emission characteristics of the DUT, the conducted emission scans were made using a Peak detector and the results were recorded in graphical form.

For each suspected emission, final measurements of the DUT conducted emissions were made with the Quasi-Peak or Average detector as defined in the limits table above.

For Table-Top Equipment, the device under test is configured on a 0.8m high non-conductive table above the reference ground plane and 0.4m away from the vertical reference ground plane.

3.8.3 Setup Diagram

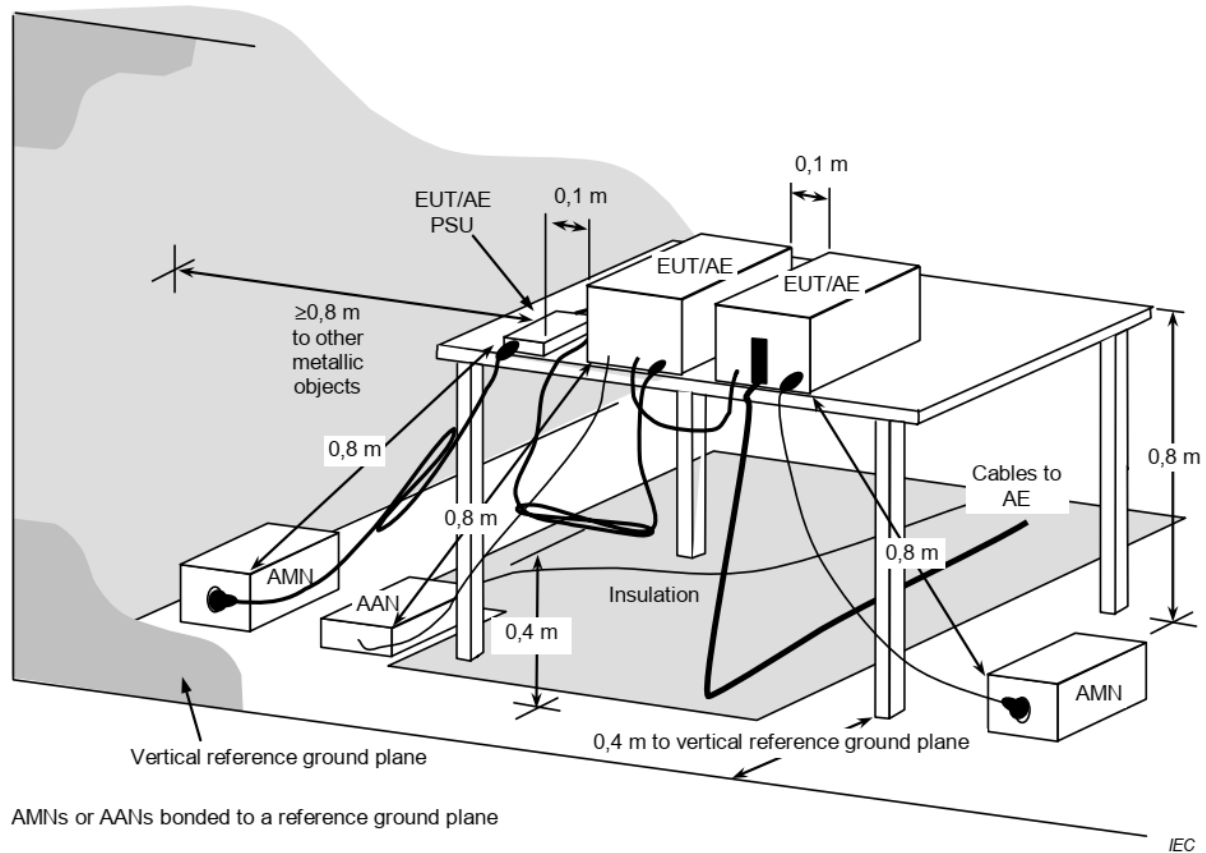
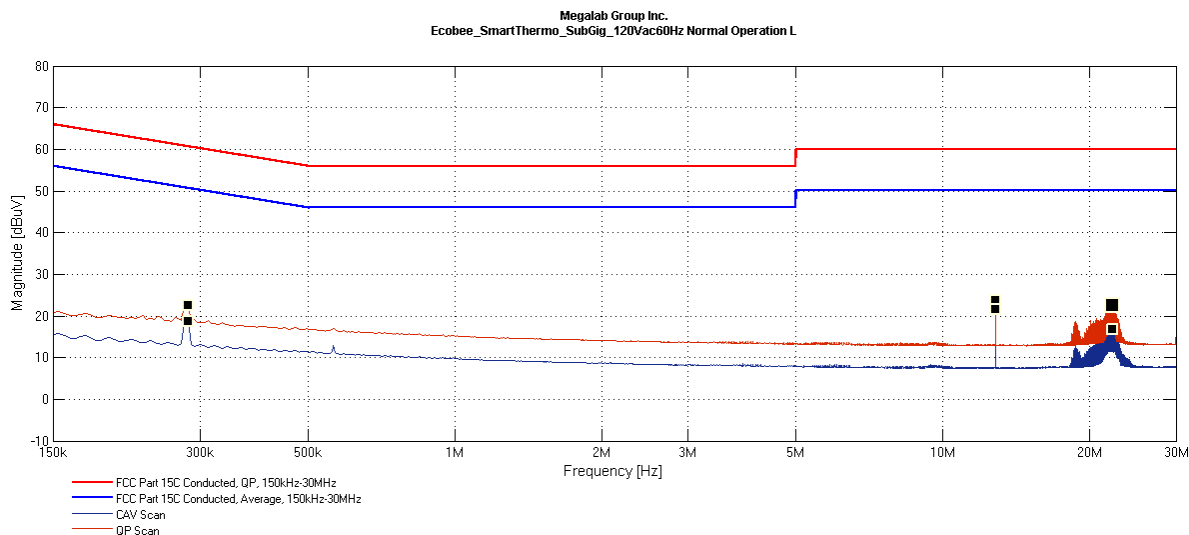


Figure 18 – Sample Measurement Arrangement for DUT

3.8.4 Test Results

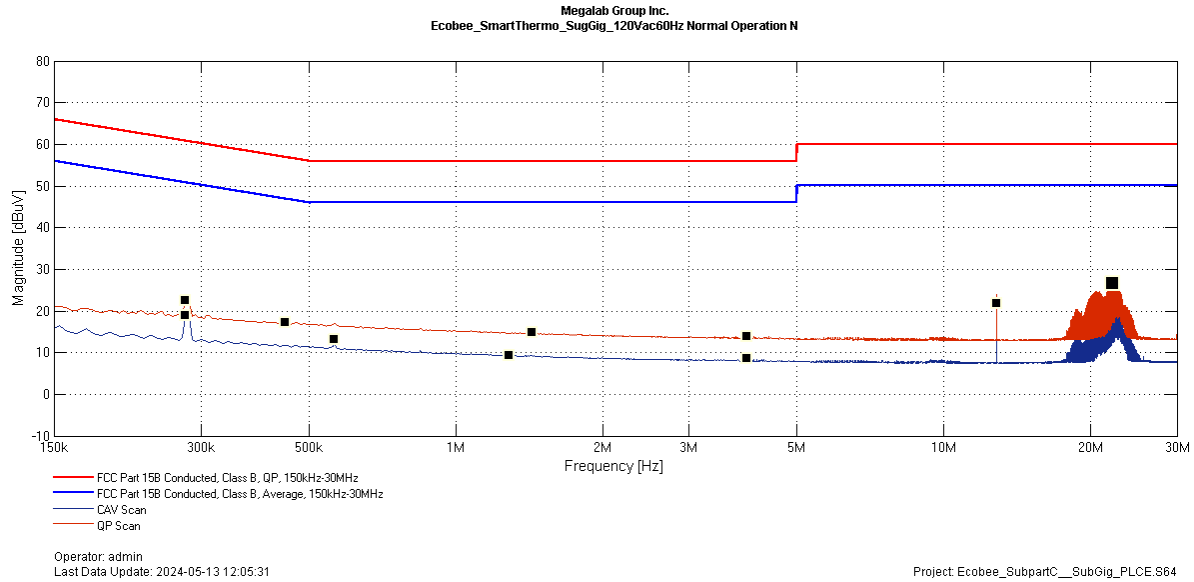
Range:	150kHz to 30MHz	DUT	ECB701
Test Voltage:	120Vac 60Hz	Phase	Line



Remark: Quasi-Peak and Average Emission Plot

Line										
Freq (MHz)	QP Reading (dBμV)	AVG Reading (dBμV)	Corr Factor (dB)	QP Emission Level (dBμV)	AVG Emission Level (dBμV)	QP Limit (dBμV)	QP Margin (dB)	AVG Limit (dBμV)	AVG Margin (dB)	Test Result
12.799	13.7	11.4	10.1	23.8	21.6	60.0	36.2	50.0	28.5	Pass
0.284	12.6	8.8	9.9	22.4	18.7	60.7	38.3	50.7	32.0	Pass
22.228	12.2	6.5	10.3	22.5	16.8	37.6	37.6	33.2	33.2	Pass

Range:	150kHz to 30MHz	DUT	ECB701
Test Voltage:	120Vac 60Hz	Phase	Neutral



Remark: Quasi-Peak and Average Emission Plot

Line										
Freq (MHz)	QP Reading (dBμV)	AVG Reading (dBμV)	Corr Factor (dB)	QP Emission Level (dBμV)	AVG Emission Level (dBμV)	QP Limit (dBμV)	QP Margin (dB)	AVG Limit (dBμV)	AVG Margin (dB)	Test Result
22.182	16.3	--	10.3	26.6	--	60.0	33.4	--	--	Pass
0.279	12.5	8.9	9.9	22.4	18.8	60.8	38.4	50.8	32.0	Pass
12.799	--	11.6	10.1	--	21.7	--	--	50.0	28.3	Pass

3.8.5 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_132	EMI Test Receiver (v6.91.2)	Gauss Instruments	TDEMI X40	Nov 29, 2023	Nov 29, 2025
EQ_EMC_61	LISN	FCC	50/250-16-2-01	Jan 16, 2024	Jan 16, 2026
EQ_EMC_44	Transient Limiter (10dB)	Com-Power	LIT-930A	NCR	NCR
EQ_EMC_84	RF Cable	Times Microwave	LMR-400	NCR	NCR
EQ_EMC_149	Emission Software RE/CE	Gauss Instruments	EMI64k v6.31.2	NCR	NCR

----- End of Test Report -----