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5/23/2025

Amarillo Technologies
4218 Erik Ave
Amarillo, TX, 79106 USA

Dear Jerry Harder,

Enclosed is the EMC Wireless test report for compliance testing of the Amarillo Technologies AT-5 as tested to the requirements of FCC 15.247 for Intentional Radiators. This test report pertains specifically to the Long Range(LoRa) transmitter onboard which operates in the 902MHz to 928MHz band.

Thank you for using the services of Eurofins MET Labs. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
EUROFINS MET LABS

A handwritten signature in blue ink that reads "Nancy LaBrecque".

Nancy LaBrecque
Documentation Department

Reference: WIRA135463-DTS – R1

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**915MHz ISM
Test Report**

for the

Amarillo Technologies
AT-5

Tested under
FCC 15.247 15C
For Intentional Radiators



Veer Patel, Wireless/EMC Engineer
Electromagnetic Compatibility Lab



Nancy LaBrecque
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules Part 15.247 under normal use and maintenance.



Matthew Hinojosa
EMC Manager, Austin Electromagnetic Compatibility Lab

Report Status Sheet

| Revision | Report Date | Reason for Revision |
|----------|-------------|--------------------------------|
| Ø | May 2, 2025 | Initial Issue. |
| 1 | 5/23/2025 | Addressing TCB Review Comments |

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List of Terms and Abbreviations

| | |
|--------------|---|
| AC | Alternating Current |
| ACF | Antenna Correction Factor |
| Cal | Calibration |
| <i>d</i> | Measurement Distance |
| dB | Decibels |
| dB μ A | Decibels above one microamp |
| dB μ V | Decibels above one microvolt |
| dB μ A/m | Decibels above one microamp per meter |
| dB μ V/m | Decibels above one microvolt per meter |
| DC | Direct Current |
| E | Electric Field |
| DSL | Digital Subscriber Line |
| ESD | Electrostatic Discharge |
| EUT | Equipment Under Test |
| <i>f</i> | Frequency |
| FCC | Federal Communications Commission |
| GRP | Ground Reference Plane |
| H | Magnetic Field |
| HCP | Horizontal Coupling Plane |
| Hz | Hertz |
| IEC | International Electrotechnical Commission |
| kHz | kilohertz |
| kPa | kilopascal |
| kV | kilovolt |
| LISN | Line Impedance Stabilization Network |
| MHz | Megahertz |
| μ H | microhenry |
| μ | microfarad |
| μ s | microseconds |
| NEBS | Network Equipment-Building System |
| PRF | Pulse Repetition Frequency |
| RF | Radio Frequency |
| RMS | Root-Mean-Square |
| TWT | Traveling Wave Tube |
| V/m | Volts per meter |
| VCP | Vertical Coupling Plane |

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the AT-5, with the requirements of FCC 15.247. Amarillo Technologies should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the AT-5, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC 15.247, in accordance with Amarillo Technologies purchase order number 21025-A. All tests were conducted using measurement procedures ANSI C63.4-2014 and ANSI C63.10-2013.

| FCC Reference 47 CFR Part 15.247:2005 | IC Reference RSS-247 Issue 3 RSS-GEN Issue 5 | Description | Compliance |
|---|--|--|------------|
| Title 47 of the CFR, Part 15 §15.203 | --- | Antenna Requirement | Compliant |
| Title 47 of the CFR, Part 15 §15.207(a) | RSS-GEN(8.8) | Conducted Emission Limits | Compliant |
| Title 47 of the CFR, Part 15 §15.247(a)(2) | RSS-247 (5.2) | 6dB Occupied Bandwidth | Compliant |
| --- | RSS-GEN(6.7) | 99% Occupied Bandwidth | Compliant |
| Title 47 of the CFR, Part 15 §15.247(b) | RSS-247(5.4) | Peak Power Output | Compliant |
| Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205 | RSS-GEN (6.13), (8.9), & (8.10) | Radiated Spurious Emissions Requirements | Compliant |
| Title 47 of the CFR, Part 15 §15.247(d) | RSS-247(5.5) | RF Conducted Spurious Emissions Requirements | Compliant |
| Title 47 of the CFR, Part 15; §15.247(e) | RSS-247(5.2) | Peak Power Spectral Density | Compliant |

Table 1. Executive Summary

II. Equipment Configuration

A. Overview

Eurofins MET Labs was contracted by Amarillo Technologies to perform testing on the AT-5, under Amarillo Technologies's purchase order number 21025-A.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the AT-5.

The results obtained relate only to the item(s) tested.

| | | |
|---------------------------------------|---|------------------------------------|
| Product Name: | AT-5 Intelligent Lock | |
| Model(s) Tested: | AT-5 | |
| FCCID: | 2BOPUAT5 | |
| Sample Number: | 25382-1 | |
| Equipment Specifications: | Primary Power: | 3VDC Battery Powered |
| | Type of Modulations: | CSS |
| | Equipment Code: | DTS |
| | Peak RF Output Power: | 14 dBm typical (as high as 20 dBm) |
| | EUT Frequency Ranges: | 902MHz to 915MHz |
| | Antenna Gain ¹ : | -1 dBi |
| Analysis: | The results obtained relate only to the item(s) tested. | |
| Environmental Test Conditions: | Temperature: 15-35° C | |
| | Relative Humidity: 30-60% | |
| | Barometric Pressure: 860-1060 mbar | |
| Evaluated by: | Veer Patel | |
| Report Date(s): | 5/23/2025 | |

Table 2. EUT Summary Table

¹ The antenna gain information was provided by Amarillo Technologies and may affect compliance.

B. References

| | |
|--------------------------------------|---|
| CFR 47, Part 15, Subpart C | Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies |
| RSS-247, Issue 3, August 2023 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |
| RSS-GEN, Issue 5, March 2019 | General Requirements and Information for the Certification of Radio Apparatus |
| ANSI C63.4:2014 | Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz |
| ISO/IEC 17025:2017 | General Requirements for the Competence of Testing and Calibration Laboratories |
| ANSI C63.10-2013 | American National Standard for Testing Unlicensed Wireless Devices |

Table 3. References

C. Test Site

All testing was performed at Eurofins MET Labs, 13501 McCallen Pass, Austin, TX 78753. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 10 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

ISED Lab Info:

CAB Identifier: US0004
Company Number: 2043D

FCC Lab Info:

Designation Number: US1127

D. Measurement Uncertainty

| Test Method | Typical Expanded Uncertainty | K | Confidence Level |
|--|------------------------------|---|------------------|
| Occupied Bandwidth Measurements | ±4.52 Hz | 2 | 95% |
| Conducted Power Measurements | ±2.74 dB | 2 | 95% |
| Power Spectral Density Measurements | ±2.74 dB | 2 | 95% |
| Conducted Spurious Emissions | ±2.80 dB | 2 | 95% |
| Conducted Emissions (Mains) | ±2.97 dB | 2 | 95% |
| Radiated Spurious Emissions (9kHz – 1GHz) | ±2.95 dB | 2 | 95% |
| Radiated Spurious Emissions (1GHz - 40GHz) | ±3.54 dB | 2 | 95% |

Table 4. Uncertainty Calculations Summary

E. Description of Test Sample

The AT-5 is a Bluetooth Controlled lock that includes various sensors to detect the occurrence of certain lock events (e.g., battery removed, shackle cut, and so on). Upon the occurrence of a lock event, the event is logged internally, handled, and reported out via a LoRa transmission. The AT-5 is used in connection with a broader software system that automates and enforces rules connected with lockout tagout procedures for industrial facilities.



Figure 1. Block Diagram of Test Configuration

F. Equipment Configuration

The EUT was set up as outlined in Figure 1 above. The laptop computer was used to send test commands to force the transmitters to operate in the appropriate test mode.

G. Support Equipment

| Ref. ID | Name/Description | Manufacturer | Model Number | Customer Supplied Calibration Data |
|-------------|------------------|---------------|--------------|------------------------------------|
| Test Laptop | Dell | Latitude 5411 | BPN66D3 | n/a |

Table 5. Support Equipment

H. Ports and Cabling Information

| Ref. Id | Port Name on EUT | Cable Description or reason for no cable | Qty | Length as tested (m) | Max Length (m) | Shielded? (Y/N) | Termination Box ID & Port Name |
|---------|------------------|---|-----|----------------------|----------------|-----------------|--------------------------------|
| | N/A | Battery Powered EUT and no cable connection required. | | | | | |

Table 6. Ports and Cabling Information

I. Mode of Operation

The AT-5 is connected to computer, it was used to send test commands to the sample in order to force transmission on low, mid, or high channels. Software AT-5 Test Utility v1.1.0.11058 was used to operate the EUT.

| Transmit Band | Modulation | Channel Frequencies Tested | Test Tool Power Setting |
|------------------|------------|----------------------------|-------------------------|
| 902MHz to 928MHz | LoRa | 903MHz/909.4MHz/914.2MHz | 7 |

Table 7. Test Channels Utilized

J. Method of Monitoring EUT Operation

A spectrum analyzer was used to confirm proper transmitter operation.

K. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

L. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Amarillo Technologies upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

Test Requirement: § 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.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

- a.) Antenna must be permanently attached to the unit.
- b.) Antenna must use a unique type of connector to attach to the EUT.
- c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Results: The EUT as tested is compliant the criteria of § 15.203. The TX antenna is permanently attached to the unit and is not accessible by the end user.

Test Engineer(s): Veer Patel

Test Date(s): 03/27/2025

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(2) 6 dB Bandwidth

Test Requirements: § 15.247(a)(2): Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.

Test Procedure: The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately 1% of the total emission bandwidth, and the VBW > RBW. The 6 dB Bandwidth was measured and recorded. The measurements were performed on the low, mid and high channels.

Test Results The EUT was compliant with § 15.247 (a)(2).
The 6 dB Bandwidth was determined from the plots on the following pages.

Test Engineer(s): Veer Patel

Test Date(s): 03/27/2025

Electromagnetic Compatibility Criteria for Intentional Radiators

RSS-GEN (6.7) 99% Bandwidth

Test Requirements: The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

Test Procedure: The transmitter was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1% of the total emission bandwidth, and the VBW > RBW. The 99% Bandwidth was measured and recorded.

Test Results The 99% Bandwidth determined from the plots on the following pages.

Test Engineer(s): Veer Patel

Test Date(s): 03/27/2025 and 04/02/2025

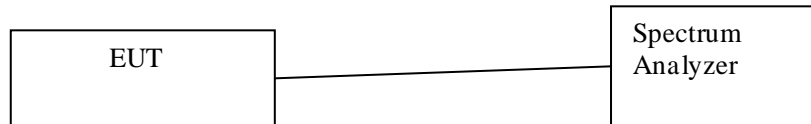


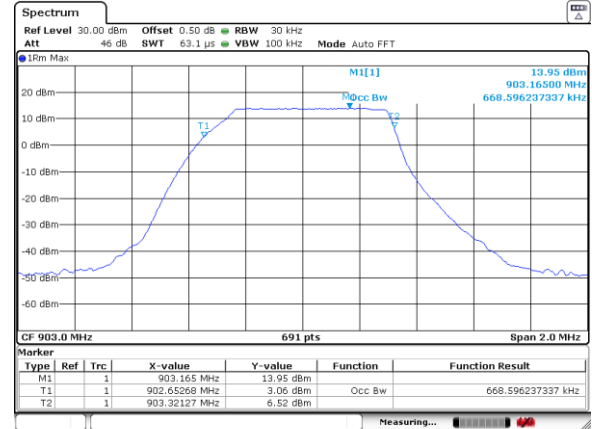
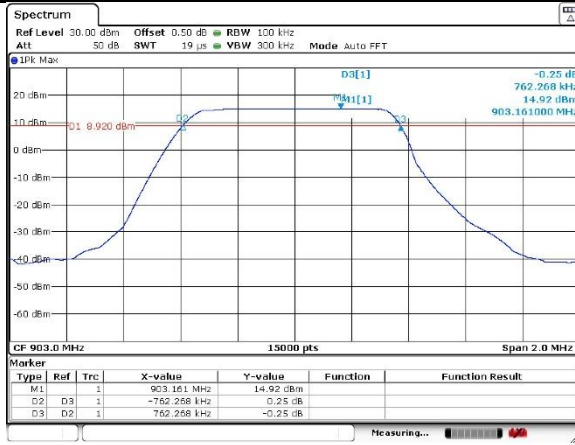
Figure 2. Block Diagram, Occupied Bandwidth Test Setup

| Channel | Frequency (MHz) | 6dB Bandwidth Limit (MHz) | Measured 6dB Bandwidth (MHz) | Measured 99% Bandwidth (MHz) | Result |
|---------|-----------------|---------------------------|------------------------------|------------------------------|--------|
| Low | 903 | 0.5 | 0.762268 | 0.66859 | Pass |
| Middle | 909.4 | 0.5 | 0.747776 | 0.65412 | Pass |
| High | 914.2 | 0.5 | 0.756471 | 0.65991 | Pass |

Table 8. 99% and 6 dB Occupied Bandwidth, Test Results

Occupied Bandwidth Test Results

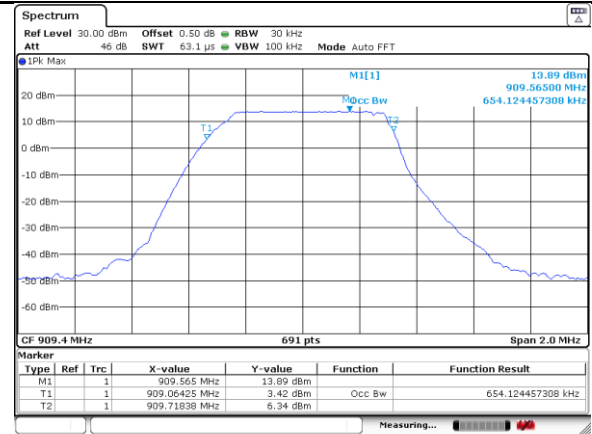
Occupied Bandwidth Plots



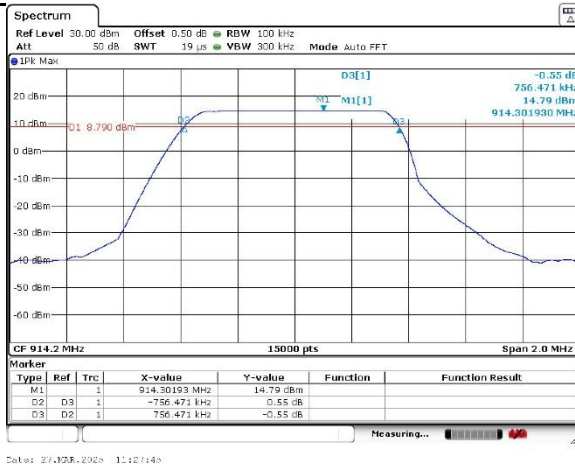
Low Channel 6dB Bandwidth



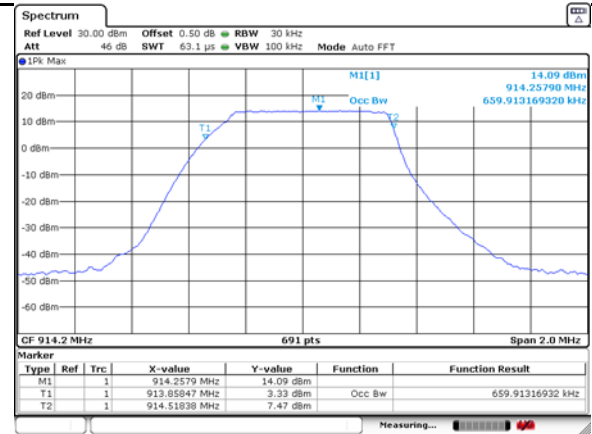
Low Channel 99% Bandwidth



Mid Channel 6dB Bandwidth



Mid Channel 99% Bandwidth



High Channel 6dB Bandwidth

High Channel 99% Bandwidth

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(b) Peak Power Output

Test Requirements: §15.247(b): The maximum peak output power of the intentional radiator shall not exceed the following:

| Digital Transmission Systems (MHz) | Output Limit (Watts) |
|---------------------------------------|-------------------------|
| 902-928 | 1.000 |
| 2400-2483.5 | 1.000 |
| 5725- 5850 | 1.000 |

Table 9. Output Power Requirements from §15.247(b)

§15.247(c): if transmitting antennas of directional gain in greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in the Table 9, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400 – 2483.5 MHz band and using a point to point application may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Fixed, point-to-point operation excludes the use of point-to-multipoint systems, Omni-directional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

RSS-247 EIRP Limit: For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

Test Procedure: The transmitter was connected to a calibrated spectrum analyzer. The analyzer reference level was offset by cable loss connecting to the test sample. The peak power was measured at the low, mid and high channels of each band at the maximum power level. The antenna gain provided by the manufacturer was added to the measured conducted power to arrive at the EIRP.

The analyzer settings are shown in the following table:

| | | | | | |
|------|------|-------------|------|-----------------------|-------|
| RBW: | 1MHz | Detector: | Peak | Reference Level: | 30dBm |
| VBW: | 3MHz | Sweep Time: | Auto | Internal Attenuation: | 50dB |

Figure 3. Analyzer Settings During Measurement

Test Results: The EUT was compliant with the Peak Power Output limits of §15.247(b) and the EIRP limits from RSS-247.

Test Engineer(s): Veer Patel

Test Date(s): 03/27/2025



Figure 4. Peak Power Output Test Setup

Peak Power Output Test Results

| Channel | Frequency (MHz) | Peak Power (dBm) | Peak Power Limit (dBm) | Antenna Gain (dBi) | EIRP (dBm) | EIRP Limit (dBm) | Result |
|---------|-----------------|------------------|------------------------|--------------------|------------|------------------|--------|
| Low | 903MHz | 14.93 | 30 | -1 | 13.93 | 36 | Pass |
| Middle | 909.4MHz | 14.84 | 30 | -1 | 13.84 | 36 | Pass |
| High | 914.2MHz | 14.81 | 30 | -1 | 13.81 | 36 | Pass |

Table 10. Peak Power and EIRP, Test Results

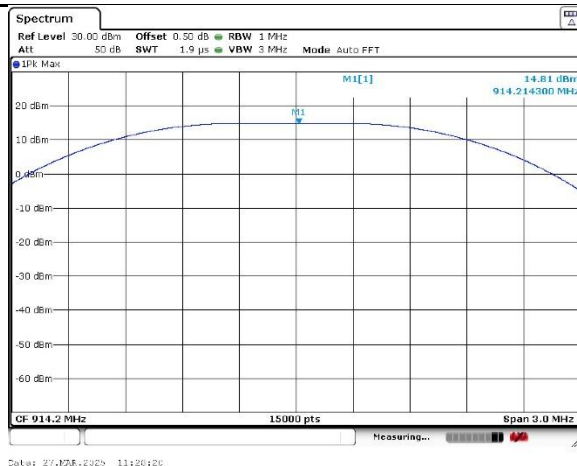
Peak Power Plots



Low Channel



Mid Channel



High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(e) Peak Power Spectral Density

Test Requirements: §15.247(e): For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

Test Procedure: The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level. The RBW was set between 3kHz and 100 kHz. The VBW was set to 3x the RBW. The spectrum analyzer was set to an auto sweep time and a peak detector was used. Measurements were carried out at the low, mid and high channels.

The analyzer settings are shown in the following table:

| | | | | | |
|------|-------|-------------|------|-----------------------|-------|
| RBW: | 3kHz | Detector: | Peak | Reference Level: | 30dBm |
| VBW: | 10kHz | Sweep Time: | Auto | Internal Attenuation: | 50dB |

Figure 5. Analyzer Settings During Measurement

Test Results: The EUT was compliant with the peak power spectral density limits of § 15.247 (e).

Test Engineer: Veer Patel

Test Date: 04/02/2025

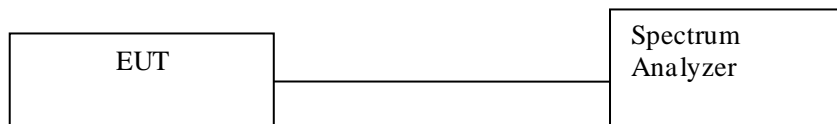
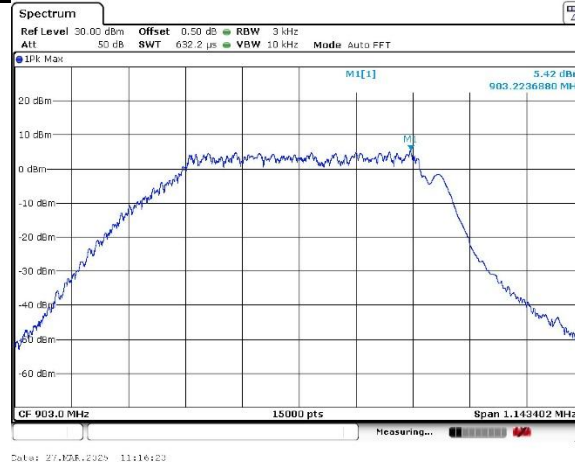


Figure 6. Block Diagram, Peak Power Spectral Density Test Setup

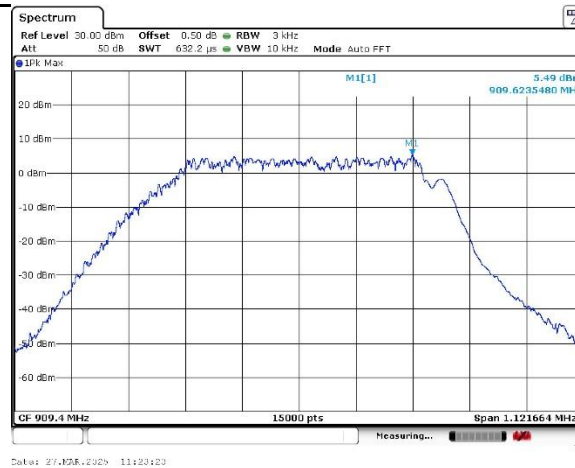
| Data Rate | Channel | Frequency (MHz) | Peak Power Spectral Density (dBm / 3kHz) | Peak Power Spectral Density Limit (dBm / 3kHz) | Result |
|-----------|---------|-----------------|--|--|--------|
| 1Mbps | Low | 903 | 5.42 | 8 | Pass |
| | Middle | 909.4 | 5.49 | 8 | Pass |
| | High | 914.2 | 5.38 | 8 | Pass |

Table 11. Peak Power Spectral Density, Test Results

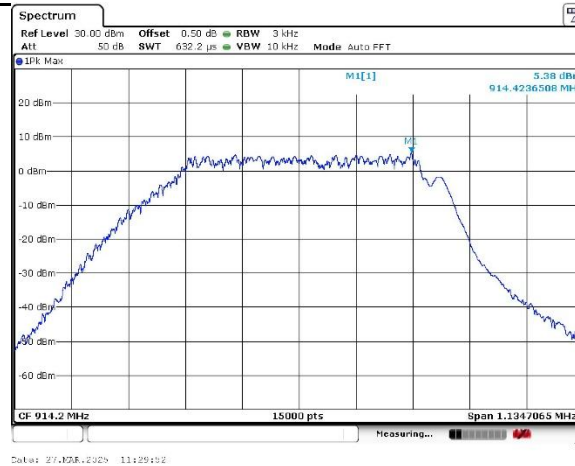
Peak Power Spectral Density Plots



Low Channel



Mid Channel



High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) RF Conducted Spurious Emissions Requirements

Test Requirement: **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.

Test Procedure: For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per § 15.33(a)(1) and § 15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

The transmitter was connected directly to a Spectrum Analyzer through an attenuator. The power level was set to the maximum level. The RBW was set to 100 kHz. The VBW was set to 3x the RBW. The spectrum analyzer was set to an auto sweep time and a peak detector was used. Measurements were carried out at the low, mid and high channels.

See following pages for detailed test results with RF Conducted Spurious Emissions.

The analyzer settings are shown in the following table:

| | | | | | |
|------|--------|-------------|------|-----------------------|-------|
| RBW: | 100kHz | Detector: | Peak | Reference Level: | 30dBm |
| VBW: | 300kHz | Sweep Time: | Auto | Internal Attenuation: | 50dB |

Figure 7. Analyzer Settings During Measurement

Test Results: The EUT was compliant with the Conducted Spurious Emission limits of §15.247(d).

Test Engineer(s): Veer Patel

Test Date(s): 04/02/2025

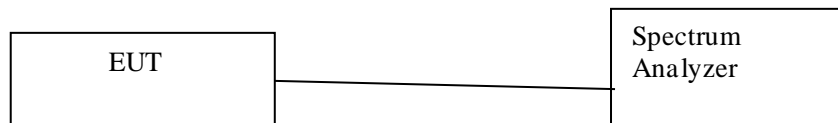
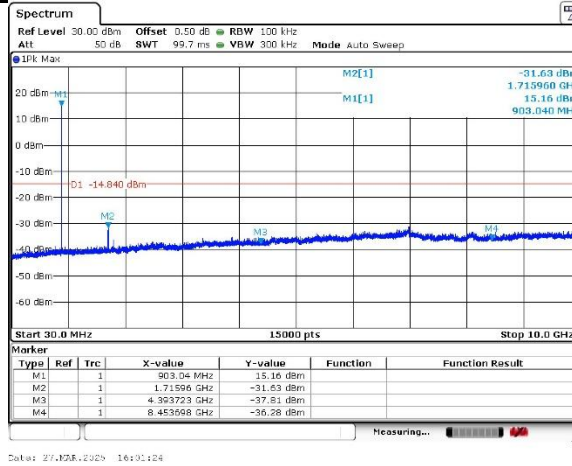
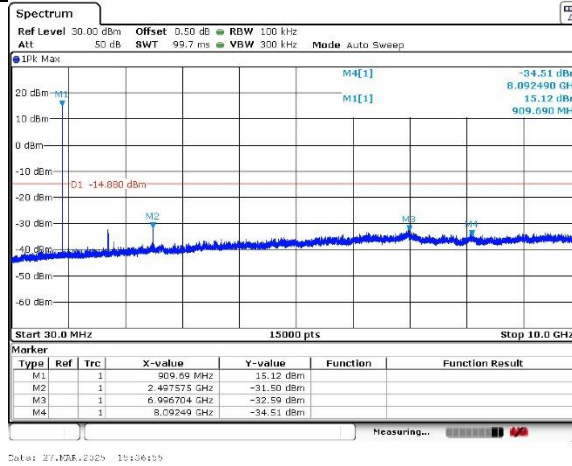


Figure 8. Block Diagram, Conducted Spurious Emissions Test Setup

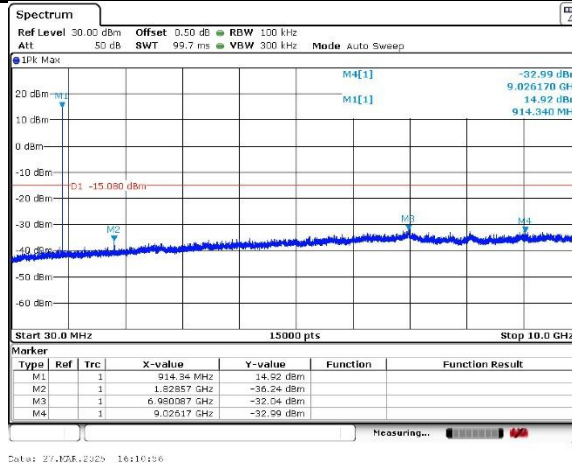
Conducted Spurious Plots



Low Channel

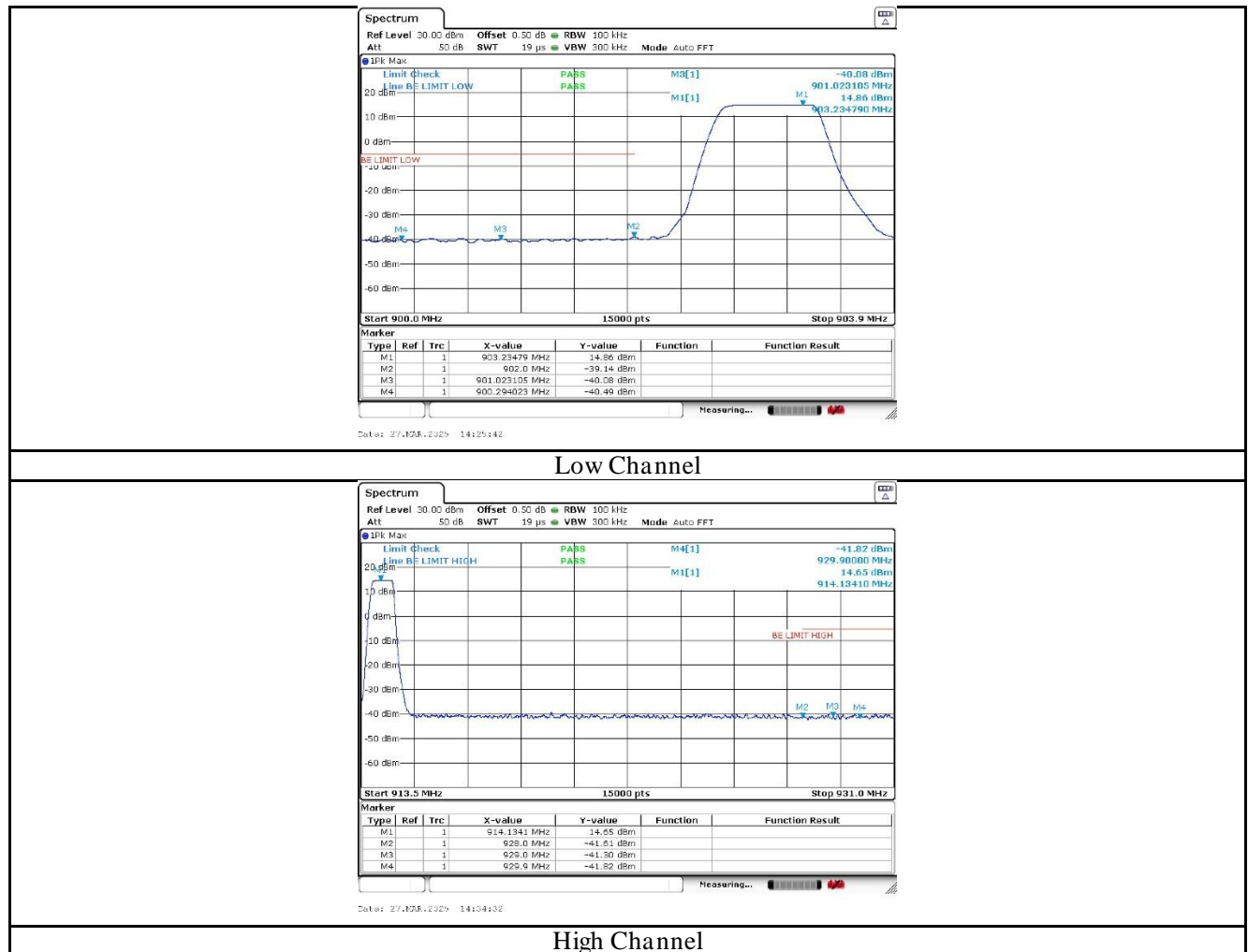


Mid Channel



High Channel

Band Edge



Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Radiated Spurious Emissions Requirements and Band Edge

Test Requirements: §15.247(d); §15.205: Emissions outside the frequency band.

§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. 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).

§15.205(a): Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|-------------------------------|---------------------|-----------------|------------------|
| 0.090–0.110----- | 16.42–16.423 | 399.9–410 | 4.5–5.15 |
| ¹ 0.495–0.505----- | 16.69475–16.69525 | 608–614 | 5.35–5.46 |
| 2.1735–2.1905----- | 16.80425–16.80475 | 960–1240 | 7.25–7.75 |
| 4.125–4.128----- | 25.5–25.67 | 1300–1427 | 8.025–8.5 |
| 4.17725–4.17775----- | 37.5–38.25 | 1435–1626.5 | 9.0–9.2 |
| 4.20725–4.20775----- | 73–74.6 | 1645.5–1646.5 | 9.3–9.5 |
| 6.215–6.218----- | 74.8–75.2 | 1660–1710 | 10.6–12.7 |
| 6.26775–6.26825----- | 108–121.94 | 1718.8–1722.2 | 13.25–13.4 |
| 6.31175–6.31225----- | 123–138 | 2200–2300 | 14.47–14.5 |
| 8.291–8.294----- | 149.9–150.05 | 2310–2390 | 15.35–16.2 |
| 8.362–8.366----- | 156.52475–156.52525 | 2483.5–2500 | 17.7–21.4 |
| 8.37625–8.38675----- | 156.7–156.9 | 2655–2900 | 22.01–23.12 |
| 8.41425–8.41475----- | 162.0125–167.17 | 3260–3267 | 23.6–24.0 |
| 12.29–12.293----- | 167.72–173.2 | 3332–3339 | 31.2–31.8 |
| 12.51975–12.52025----- | 240–285 | 3345.8–3358 36. | 43–36.5 |
| 12.57675–12.57725----- | 322–335.4 | 3600–4400 | (²) |

Table 12. Restricted Bands of Operation

¹ Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.

² Above 38.6

Test Requirement(s): § 15.209 (a): Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 13.

| Frequency (MHz) | § 15.209(a), Radiated Emission Limits (dBµV) @ 3m |
|-----------------|--|
| 30 - 88 | 40.00 |
| 88 - 216 | 43.50 |
| 216 - 960 | 46.00 |
| Above 960 | 54.00 |

Table 13. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

Test Procedures: The radiated methodology referenced in ANSI C63.10: 2013 Section 11.12.1 was utilized in order to assess the unwanted emissions in the restricted bands.

A radiated scan was performed with the antenna of proper impedance installed. The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes if multiple mounting orientations are supported. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.

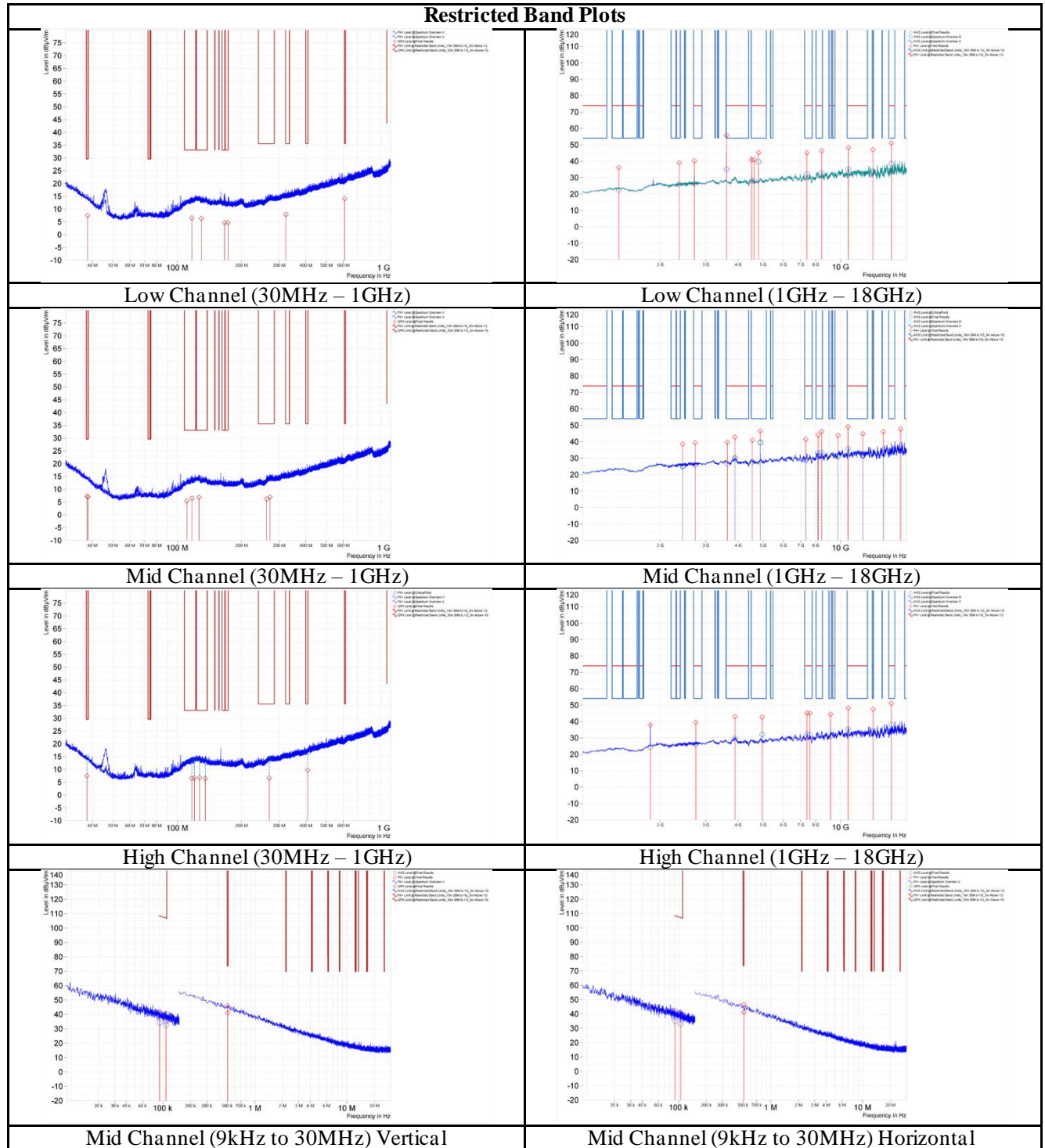
Radiated measurements below 30MHz were performed in a semi-anechoic chamber that has been correlated to an open area site.

Test Software: TILE Version 7.4.2.5 (Manufactured by ETS Lindgren) and ELEKTRA Version 4.61 (Manufactured by Rohde&Schwarz) was utilized to perform these measurements.

Test Results: The EUT was compliant with the Radiated Spurious Emission limits of § 15.247(d).

Test Engineer(s): Veer Patel/An Dang

Test Date(s): 03/24/2025 - 03/27/2025



Worst Case Cabinet Spurious Emissions

| Frequency [MHz] | PK+ Level [dBμV/m] | PK+ Limit [dBμV/m] | PK+ Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|-----------------|--------------------|--------------------|-----------------|-----------------|--------------|---------------|--------------------|----------------|--------|
| 0.091 | 42.51 | 108.41 | 65.90 | 11.70 | V | 92.7 | 1 | 0.200 | Pass |
| 0.092 | 41.83 | 108.31 | 66.48 | 11.64 | H | 240.7 | 1 | 0.200 | Pass |
| 0.105 | 41.18 | 107.22 | 66.04 | 11.32 | V | 150.8 | 1 | 0.200 | Pass |
| 0.108 | 40.67 | 106.95 | 66.28 | 11.36 | H | 89.2 | 1 | 0.200 | Pass |
| 0.506 | 46.04 | 73.62 | 27.57 | 11.31 | H | 277 | 1 | 9.000 | Pass |
| 0.510 | 46.59 | 73.54 | 26.95 | 11.35 | V | 327.8 | 1 | 9.000 | Pass |

Figure 9. Worst Case Cabinet Radiation, 9kHz - 30MHz Mid Channel

| Frequency [MHz] | QPK Level [dBμV/m] | QPK Limit [dBμV/m] | QPK Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|-----------------|--------------------|--------------------|-----------------|-----------------|--------------|---------------|--------------------|----------------|--------|
| 37.980 | 7.47 | 29.55 | 22.08 | -6.33 | V | 316.1 | 1.16 | 120.000 | Pass |
| 116.940 | 6.57 | 33.07 | 26.50 | -6.60 | H | 218.2 | 3.99 | 120.000 | Pass |
| 129.450 | 6.35 | 33.07 | 26.72 | -6.39 | H | 315.1 | 1.27 | 120.000 | Pass |
| 166.500 | 4.71 | 33.07 | 28.36 | -8.26 | V | 286.3 | 1.27 | 120.000 | Pass |
| 172.950 | 4.82 | 33.07 | 28.25 | -8.33 | V | 342.3 | 1.5 | 120.000 | Pass |
| 322.770 | 7.94 | 35.57 | 27.63 | -4.78 | V | 117.7 | 3.64 | 120.000 | Pass |

Figure 10. Radiated Spurious, 30MHz - 1GHz Low Channel

| Frequency [MHz] | QPK Level [dBμV/m] | QPK Limit [dBμV/m] | QPK Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|-----------------|--------------------|--------------------|-----------------|-----------------|--------------|---------------|--------------------|----------------|--------|
| 37.800 | 7.28 | 29.55 | 22.27 | -5.89 | H | 320.4 | 2.38 | 120.000 | Pass |
| 38.130 | 7.04 | 29.55 | 22.51 | -6.14 | H | 202.2 | 3.11 | 120.000 | Pass |
| 110.850 | 5.42 | 33.07 | 27.65 | -7.56 | H | 90 | 1.23 | 120.000 | Pass |
| 117.210 | 6.51 | 33.07 | 26.56 | -6.59 | H | 175.8 | 3.67 | 120.000 | Pass |
| 126.540 | 6.88 | 33.07 | 26.19 | -6.25 | H | 352.3 | 1.42 | 120.000 | Pass |
| 262.140 | 6.20 | 35.57 | 29.37 | -6.55 | V | 234.9 | 2.88 | 120.000 | Pass |

Figure 11. Radiated Spurious, 30MHz - 1GHz Mid Channel

| Frequency [MHz] | QPK Level [dBμV/m] | QPK Limit [dBμV/m] | QPK Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Meas. BW [kHz] | Result |
|-----------------|--------------------|--------------------|-----------------|-----------------|--------------|---------------|--------------------|----------------|--------|
| 37.740 | 7.52 | 29.55 | 22.03 | -6.18 | V | 94 | 1.15 | 120.000 | Pass |
| 116.970 | 6.52 | 33.07 | 26.55 | -6.60 | H | 4.5 | 1.6 | 120.000 | Pass |
| 120.300 | 6.54 | 33.07 | 26.53 | -6.34 | H | 301.1 | 3.76 | 120.000 | Pass |
| 127.110 | 6.87 | 33.07 | 26.20 | -6.26 | H | 53.6 | 1.48 | 120.000 | Pass |
| 135.420 | 6.34 | 33.07 | 26.73 | -6.64 | V | 164.9 | 3.7 | 120.000 | Pass |
| 269.850 | 6.65 | 35.57 | 28.92 | -5.97 | H | 356.8 | 1.34 | 120.000 | Pass |

Figure 12. Radiated Spurious, 30MHz - 1GHz High Channel

| Frequency [MHz] | PK+ Level [dBμV/m] | PK+ Limit [dBμV/m] | PK+ Margin [dB] | AVG Level [dBμV/m] | AVG Limit [dBμV/m] | AVG Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Result |
|-----------------|--------------------|--------------------|-----------------|--------------------|--------------------|-----------------|-----------------|--------------|---------------|--------------------|--------|
| 1,380.000 | 36.12 | 74.00 | 37.88 | 22.50 | 54.00 | 31.50 | 0.05 | H | 60.9 | 3.15 | Pass |
| 2,367.000 | 39.01 | 74.00 | 34.99 | 26.06 | 54.00 | 27.94 | -2.43 | H | 230.7 | 3.43 | Pass |
| 2,709.000 | 40.21 | 74.00 | 33.79 | 26.39 | 54.00 | 27.61 | -2.70 | V | 147 | 3.16 | Pass |
| 3,612.500 | 55.72 | 74.00 | 18.28 | 35.18 | 54.00 | 18.82 | -2.50 | V | 100.6 | 2.96 | Pass |
| 4,514.500 | 40.85 | 74.00 | 33.15 | 28.03 | 54.00 | 25.97 | -3.15 | V | 178.4 | 3.09 | Pass |
| 4,618.500 | 40.90 | 74.00 | 33.10 | 27.92 | 54.00 | 26.08 | -4.20 | V | 332.2 | 1.19 | Pass |
| 4,804.000 | 45.18 | 74.00 | 28.82 | 39.63 | 54.00 | 14.37 | -4.60 | V | 40.6 | 1.22 | Pass |
| 7,397.000 | 45.12 | 74.00 | 28.88 | 32.22 | 54.00 | 21.78 | -2.48 | H | 243 | 1.56 | Pass |
| 8,440.500 | 46.40 | 74.00 | 27.60 | 32.87 | 54.00 | 21.13 | -3.70 | H | 124.6 | 2.23 | Pass |
| 10,712.500 | 48.24 | 74.00 | 25.76 | 35.20 | 54.00 | 18.80 | -0.95 | V | 245.7 | 1.13 | Pass |
| 13,340.000 | 47.12 | 74.00 | 26.88 | 33.98 | 54.00 | 20.02 | -2.93 | H | 157.1 | 1.08 | Pass |
| 15,707.500 | 51.17 | 74.00 | 22.83 | 38.38 | 54.00 | 15.62 | 1.02 | H | 313.6 | 2.57 | Pass |

Figure 13. Radiated Spurious, Above 1GHz Low Channel

| Frequency [MHz] | PK+ Level [dBμV/m] | PK+ Limit [dBμV/m] | PK+ Margin [dB] | AVG Level [dBμV/m] | AVG Limit [dBμV/m] | AVG Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Result |
|-----------------|--------------------|--------------------|-----------------|--------------------|--------------------|-----------------|-----------------|--------------|---------------|--------------------|--------|
| 2,440.000 | 38.56 | 1,000.00 | 961.44 | 24.91 | 1,000.00 | 975.09 | -2.43 | H | 211.9 | 2.54 | Pass |
| 2,728.200 | 39.37 | 74.00 | 34.63 | 25.82 | 54.00 | 28.18 | -2.73 | V | 312.4 | 1.15 | Pass |
| 3,637.600 | 39.72 | 74.00 | 34.28 | 26.75 | 54.00 | 27.25 | -3.20 | V | 16.7 | 2.93 | Pass |
| 3,890.000 | 42.85 | 74.00 | 31.15 | 29.81 | 54.00 | 24.19 | -1.61 | V | 45.4 | 1.5 | Pass |
| 4,547.000 | 40.90 | 74.00 | 33.10 | 27.84 | 54.00 | 26.16 | -3.48 | V | 272 | 2.78 | Pass |
| 4,880.000 | 46.55 | 74.00 | 27.45 | 39.49 | 54.00 | 14.51 | -3.35 | V | 23.7 | 2.49 | Pass |
| 7,320.000 | 41.54 | 74.00 | 32.46 | 28.84 | 54.00 | 25.16 | -2.79 | H | 12.8 | 1.42 | Pass |
| 8,184.600 | 44.07 | 74.00 | 29.93 | 30.90 | 54.00 | 23.10 | -3.03 | V | 31.1 | 3.5 | Pass |
| 8,435.000 | 46.18 | 74.00 | 27.82 | 33.41 | 54.00 | 20.59 | -3.62 | V | 236.5 | 2.5 | Pass |
| 10,685.000 | 49.20 | 74.00 | 24.80 | 35.65 | 54.00 | 18.35 | -0.85 | V | 215.4 | 2.71 | Pass |
| 12,200.000 | 44.88 | 74.00 | 29.12 | 31.36 | 54.00 | 22.64 | -1.91 | V | 150.7 | 3.03 | Pass |

Figure 14. Radiated Spurious, Above 1GHz Mid Channel

| Frequency [MHz] | PK+ Level [dBμV/m] | PK+ Limit [dBμV/m] | PK+ Margin [dB] | AVG Level [dBμV/m] | AVG Limit [dBμV/m] | AVG Margin [dB] | Correction [dB] | Polarization | Azimuth [deg] | Antenna Height [m] | Result |
|-----------------|--------------------|--------------------|-----------------|--------------------|--------------------|-----------------|-----------------|--------------|---------------|--------------------|--------|
| 2,742.500 | 39.50 | 74.00 | 34.50 | 26.08 | 54.00 | 27.92 | -2.74 | H | 54.2 | 1.29 | Pass |
| 3,890.500 | 42.94 | 74.00 | 31.06 | 29.84 | 54.00 | 24.16 | -1.62 | V | 208.4 | 1.8 | Pass |
| 4,960.000 | 42.76 | 74.00 | 31.24 | 32.05 | 54.00 | 21.95 | -3.98 | V | 149.1 | 2.71 | Pass |
| 7,399.000 | 45.12 | 74.00 | 28.88 | 32.53 | 54.00 | 21.47 | -2.47 | V | 84.2 | 1.93 | Pass |
| 7,593.500 | 45.08 | 74.00 | 28.92 | 31.81 | 54.00 | 22.19 | -2.39 | V | 240.8 | 2.74 | Pass |
| 9,140.500 | 44.45 | 74.00 | 29.55 | 31.05 | 54.00 | 22.95 | -3.99 | V | 44.3 | 2.67 | Pass |
| 10,686.000 | 48.27 | 74.00 | 25.73 | 35.30 | 54.00 | 18.70 | -0.85 | V | 311.5 | 1.98 | Pass |
| 13,381.000 | 47.46 | 74.00 | 26.54 | 34.39 | 54.00 | 19.61 | -3.02 | V | 206.5 | 3 | Pass |
| 15,704.500 | 50.99 | 74.00 | 23.01 | 38.08 | 54.00 | 15.92 | 1.04 | V | 69.1 | 3.5 | Pass |
| 2,742.500 | 39.50 | 74.00 | 34.50 | 26.08 | 54.00 | 27.92 | -2.74 | H | 54.2 | 1.29 | Pass |

Figure 15. Radiated Spurious, Above 1GHz High Channel

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2017.

| MET Asset # | Nomenclature | Manufacturer | Model | Last Cal Date | Cal Due Date |
|-------------|---------------------------------|--------------------|------------------------|---------------|--------------|
| 1A1250 | EMI Test Receiver | Rohde & Schwarz | ESW44 | 04/08/2024 | 04/08/2025 |
| 100984 | Spectrum Analyzer | Rohde & Schwarz | FSV40 | 03/13/2025 | 03/13/2027 |
| 1A1147 | Bi-Log Antenna | Suno Sciences Corp | JB3 | 04/06/2023 | 04/06/2025 |
| 1A1259 | Thermohygrometer with barometer | Traceable | 6453 | 04/25/2024 | 04/25/2025 |
| 1A1176 | Loop Antenna | ETS Lindgren | 6502 | 08/22/2024 | 08/22/2026 |
| 1A1183 | Double Ridged Waveguide Antenna | ETS Lindgren | 3117 | 02/20/2024 | 02/20/2026 |
| 1A1161 | 18G – 40G Horn Antenna | ETS Lindgren | 3116C-PA | 08/01/2024 | 01/01/2026 |
| 1A1099 | Generator | COM-Power Corp | CGO 51000 | See Note | |
| 1A1080 | Multi Device Controller | ETS EMCO | 2090 | See Note | |
| 1A1088 | Preamplifier | Rohde & Schwarz | TS-PR1 | See Note | |
| 1A1044 | Generator | COM-Power Corp | CG- 520 | See Note | |
| 1A1073 | Multi Device Controller | ETS EMCO | 2090 | See Note | |
| 1A1180 | Amplifier | Miteq | AMF-7D-01001800-22-10P | See Note | |

Table 14. Test Equipment List

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

End of Report