Test Report 2023-063

Version B
Issued 11 Jan 2024

Project GCL-0412
Model Identifier GMN-02480
Primary Test Standard

FCC Part 87 D
RSS-141 Issue 2: 2010

Garmin Compliance Lab
Garmin International
1200 E 151st Street
Olathe Kansas 66062 USA

Client-supplied Information

FCC ID: IPH-04074
IC ID: 1312A-04074
Marketing Name: GMN-02480

ACCREDITED
CERTIFICATE #6162.01

See section 6 of this report regarding the presence or absence of accreditation logos or marks on this cover page.

1. Summary

The equipment or product described in section 5 of this report was tested at the Garmin Compliance Lab according to standards listed in section 6. This report focuses on the VHF radio transceivers. The results are as follows.

Parameter	Description	Key Performance Values	Result	Data starts at page
Radio Modulation	Summary of the kinds of communication this radio can achieve, as stated by the client. [RSS-GEN at Annex A item 10b]	A3E Analog voice with amplitude modulation.	Reported	N/A
Transmit Power	The peak transmit power presented to the antenna is no greater that 55 Watts.[FCC 87.131, RSS-141 at 5.1]	The maximum transmit power is 42.58 dBm or 18.1 Watts.	PASS	14
Frequency Stability	The radio tuning must be robust over a range of temperature and supply voltage conditions. [FCC 87.133, RSS-141 at 5.1]	Radio emissions remained within the allowed radio band under all environmental conditions tested.	PASS	16
Occupied Bandwidths	Regulatory agencies also require the reporting 99% of power bandwidths. [FCC 87.135(a)]	The maximum 99% occupied bandwidth observed is 5.504 kHz.	Reported	18
Unwanted Emissions (Conducted Spurious)	The radio should not provide too much radio energy to the antenna at frequencies beyond its intended frequency band. [RSS 141 5.2.2, FCC 87.139(a)]	Emissions outside the band must be reduced from in-band levels according to a mask. The measured reduction was at least 6.6 dB below the mask levels.	PASS with caveat	21
Over Modulation	Modulation Index for A3E and A9W Emissions shall not exceed 100% [FCC 87.141, RSS-141 at 5.1]	The maximum modulation index observed was 90%.	Pass	28
Radiated Emissions	The radiated emissions from the device should be under the limits. [FCC 2.1053, FCC 87.139]	Frequency range tested : 30 MHz-12.5 GHz. Peak emission margin from class B limit : 4.90 dB	Pass	31

NT (Not Tested) means the requirement may or may not be applicable, but the relevant measurement or test was not performed as part of this test project.

N/A (Not Applicable) means the lab judged that the test sample is exempt from the requirement.

Table 1: Summary of results

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Report Organization

For convenience of the reader, this report is organized as follows:

1. Summary
2. Test Background
3. Report History and Approval
4. Test Sample Modifications and Special Conditions
5. Description of Equipment Tested
6. Test Standards Applied
7. Measurement Instrumentation Uncertainty
8. Selected Examples of Calculations
9. Environmental Conditions During Test
10. Immunity Performance Criteria

Annex: Test records are provided for each type of test, following the order and page numbering stated in the summary table. Concluding notes appear on the final page of this report.

Due to confidentiality, certain material (such as test setup photographs) has been removed from this report and placed in GCL Test Report 2023-095. That report is treated as a part of this document by way of this reference.

2. Test Background

The testing reported here was performed at the Garmin Compliance Lab, an organization within Garmin International, located at 1200 E 151st St, Olathe Kansas, USA. The contact telephone number is +1.913.397.8200.

The testing was performed on behalf of the Garmin design group, a separate organization located at 1200 E 151st St, Olathe Kansas, USA. Witnesses from the business group included: None.

Test Sample received: 17 Aug 2023
Test Start Date: 1 Sep 2023
Test End Date: 22 Nov 2023

The data in this test report apply only to the specific samples tested.
Upon receipt all test samples were believed to be properly assembled and ready for testing.

3. Report History and Approval

This report was written by Aditya Prakash and initially issued on 20 Dec 2023 as Version A.
Version B was created on 11 Jan 2024 to mention the presence of intentional emissions in the data which are not subject to the limits, and correct the test record for radiated emissions above 1 GHz.

Report Technical Review: GCL ONLY

David Arnett
Technical Lead EMC Engineer

Report Approval: GCL Only

Shruti Kohli
Manager Test and Measurement (EMC, Reliability and Calibration)

4. Test Sample Modifications and Special Conditions

The following special conditions or usage attributes were judged during test to be necessary to achieve compliance with one or more of the standards listed in section 6 of this report:
None

The following modifications to the test sample(s) were made, and are judged necessary to achieve compliance with one or more of the standards listed in section 6 of this report:
None

5. Description of the Equipment Tested

5.1 Unique Identification

Product Model	GMN-02480
Serial Numbers Tested	70E000120, 70F000108

The product family tested includes both a panel and remote mounted aeronautical VHF transceiver, designed for installation within an aircraft. With the panel mounted variant providing connectivity through a pre-certified 2.4 GHz radio. The authorized transmitter operational frequency band is 118.000 to 136.975 MHz (25 kHz mode). The design provides communication capability in the Aviation VHF Band with channel operational capability for 25 kHz or 8.33 kHz Channel Spacing. In addition to the authorized frequency band the design provides for VHF operation in 8.33 kHz channel spacing for international frequency band services and compatibility. The VHF transmitter supports both 10W and 16W power levels configured during installation.

The client affirmed that the test samples will be representative of production in all relevant aspects.

5.2 Key Parameters

EUT Input Power:	14 V DC, 28 V DC
I/O Ports:	Phantom mic, Speaker, DC-in, Ethernet, Micro-SD card slot, 62-pin DSUB connector.
Radio Transceivers:	Bluetooth, VHF Transceiver
Primary Functions:	VHF Communication
Typical use location:	Aircraft mounted
Highest internal frequency:	2.480 GHz
Firmware Revision	2.00k

5.3 Operating modes

During test, the EUT was operated in one or more of the following modes.

Mode 1: M1 (VHF Rx + BT OFF). VHF radio is in Rx only mode. Bluetooth module is turned off.
Mode 2: M2 (VHF Tx + BT OFF). VHF radio is transmitting and receiving. Bluetooth module is turned off.
Mode 3: M5 (VHF TX ON+BT linked). VHF radio is transmitting and receiving. Bluetooth is linked to companion device.
Mode 4: M6 (VHF TX ON+BT Standby). VHF radio is transmitting and receiving. Bluetooth is powered on but not linked to companion device.

Mode 5: M8 (VHF Rx + BT Standby). VHF radio is in receive only mode. Bluetooth is powered on but not linked to companion device.

Mode 6: M10 (VHF Tx). VHF radio is transmitting and receiving.

5.4 EUT Arrangement

During test, the EUT components and associated support equipment were selected including the following arrangement sets.

Arrangement 1: A1 (Conductive.) RF Com port of the EUT connected to measuring device. Other ports connected to as per depicted in the figure.

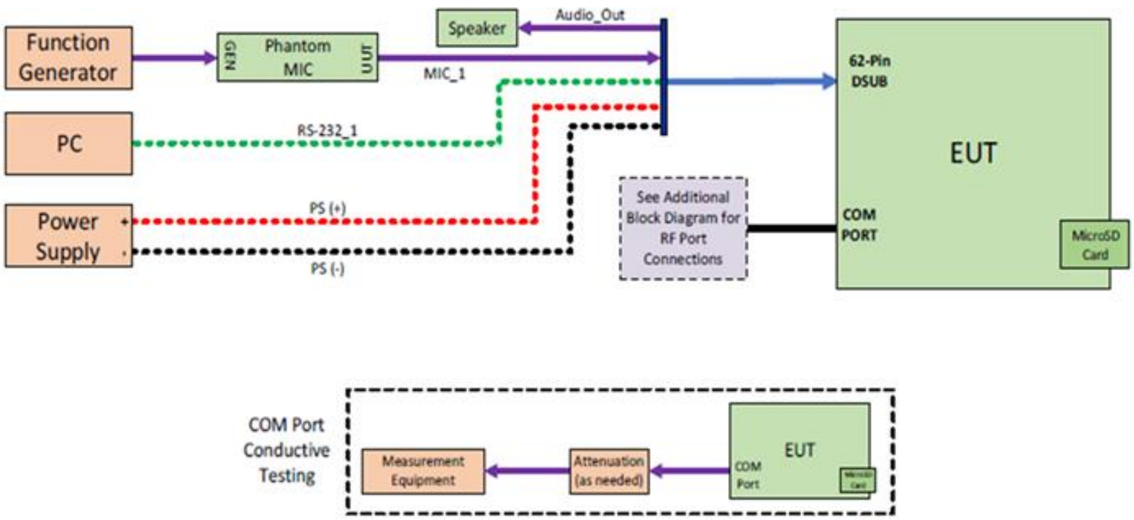

Figure 1: Block diagram of equipment arrangement A1

Arrangement 2: A2 (Non Conductive.) RF Com port of the EUT connected to dummy load. Other ports connected to as per depicted in the figure.

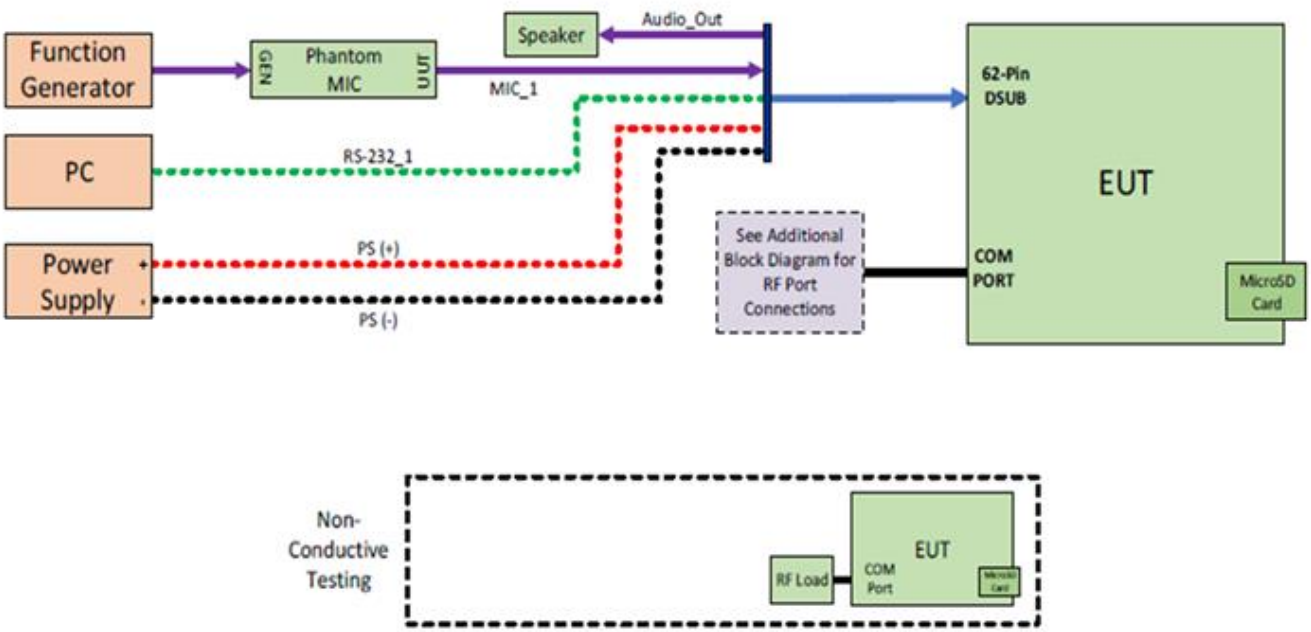

Figure 2: Block diagram of equipment arrangement A2

5.5 Application for Certification (Provided by client)

(5.5.1) The full name and mailing address of the manufacturer of the device and the applicant for certification.

Garmin International, Inc. 1200 East 151st Street Olathe, KS 66062

(5.5.2) FCC identifier.

FCC ID: IPH-04074

(5.5.3) A copy of the installation and operating instructions to be furnished the user. A draft copy of the instructions may be submitted if the actual document is not available. The actual document shall be furnished to the FCC when it becomes available.

Refer to exhibit for Draft Instruction Manual.

(5.5.4) Type or types of emission.

6K00A3E (25 kHz), (5K60A3E for 8.33 kHz operation)

(5.5.5) Frequency range.

118-136.975 MHz (25 kHz channel operation), (118-136.992, 8.33 kHz channels)

(5.5.6) Range of operating power values or specific operating power levels, and description of any means provided for variation of operating power.

Nominal 10 W or 16 W minimum, 40 or 42 dBm.

(5.5.7) Maximum power rating as defined in the applicable part(s) of the rules.

Maximum allowable power output of 55 Watts as defined per CFR47 paragraph 87.131.

(5.5.8) The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range.

Power delivered into final amplifier

16W Operation 19.95 Volts @ 1.349 Amps (26.9 Watts)

10W Operation 16.24 Volts @ 1.141 Amps (18.5 Watts)

(5.5.9) Tune-up procedure over the power range, or at specific operating power levels.

Refer to Exhibit for Transceiver Alignment Procedure.

(5.5.10) A schematic diagram and a description of all circuitry and devices provided for determining and stabilizing frequency, for suppression of spurious radiation, for limiting modulation, and for limiting power.

Refer to Exhibit for Circuit information and theory of operation.

(5.5.11) A photograph or drawing of the equipment identification plate or label showing the information to be placed thereon.

Refer to Exhibit for Photograph or Drawing.

(5.5.12) Photographs (8″ × 10″) of the equipment of sufficient clarity to reveal equipment construction and layout, including meters, if any, and labels for controls and meters and sufficient views of the internal construction to define component placement and chassis assembly. Insofar as these requirements are met by photographs or drawings contained in instruction manuals supplied with the certification request, additional photographs are necessary only to complete the required showing.

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Refer to Exhibit for Drawings of Components Layout and Chassis Drawings.

(5.5.13) For equipment employing digital modulation techniques, a detailed description of the modulation system to be used, including the response characteristics (frequency, phase, and amplitude) of any filters provided, and a description of the modulating wave train, shall be submitted for the maximum rated conditions under which the equipment will be operated.

Not applicable

(5.5.14) The data required by §§2.1046 through 2.1057, inclusive, measured in accordance with the procedures set out in §2.1041.

Data is contained in this application

(5.5.15) The application for certification of an external radio frequency power amplifier under part 97 of this chapter need not be accompanied by the data required by paragraph (b)(14) of this section. In lieu thereof, measurements shall be submitted to show compliance with the technical specifications in subpart C of part 97 of this chapter and such information as required by §2.1060 of this part.

Does not apply to this device or application.

(5.5.16) An application for certification of an AM broadcast stereophonic exciter-generator intended for interfacing with existing certified, or formerly type accepted or notified transmitters must include measurements made on a complete stereophonic transmitter. The instruction book must include complete specifications and circuit requirements for interconnecting with existing transmitters. The instruction book must also provide a full description of the equipment and measurement procedures to monitor modulation and to verify that the combination of stereo exciter-generator and transmitter meet the emission limitations of §73.44.

Does not apply to this device or application.

(5.5.17) Applications for certification required by §25.129 of this chapter shall include any additional equipment test data required by that section.

Does not apply to this device or application.

(5.5.18) An application for certification of a software defined radio must include the information required by §2.944.

Does not apply to this device or application.

(5.5.19) Applications for certification of equipment operating under part 27 of this chapter, that a manufacturer is seeking to certify for operation in the:

(i) 1755-1780 MHz, 2155-2180 MHz, or both bands shall include a statement indicating compliance with the pairing of 1710-1780 and 2110-2180 MHz specified in §§27.5(h) and 27.75 of this chapter.

(ii) 1695-1710 MHz, 1755-1780 MHz, or both bands shall include a statement indicating compliance with §27.77 of this chapter.

(iii) 600 MHz band shall include a statement indicating compliance with §27.75 of this chapter.

Does not apply to this device or application.

(5.5.20) Before equipment operating under part 90 of this chapter and capable of operating on the 700 MHz interoperability channels (See §90.531(b)(1) of this chapter) may be marketed or sold, the manufacturer thereof shall have a Compliance Assessment Program Supplier's Declaration of Conformity and Summary Test Report or, alternatively, a document detailing how the manufacturer determined that its equipment complies with §90.548 of this chapter and that the equipment is interoperable across vendors. Submission of a 700 MHz narrowband radio for certification will constitute a representation by the manufacturer that the radio will be shown, by testing, to be interoperable across vendors before it is marketed or sold.

Does not apply to this device or application.

(5.5.21) Contain at least one drawing or photograph showing the test set-up for each of the required types of tests applicable to the device for which certification is requested. These drawings or photographs must show enough detail to confirm other information contained in the test report. Any photographs used must be focused originals without glare or dark spots and must clearly show the test configuration used.

Data is contained in this application or application exhibits

5.6 Associated Equipment (AE) used

Description	Manufacturer	Model	Serial Number
Laptop Computer	Dell	Inspiron	7DCR5R3
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917

Table 2: List of associated equipment that may have been used during test

5.7 Cables used

Description	From	To	Length	EMC Treatment
Phantom MIC connector cable	Signal Generator	EUT	1.2 m	No
Cable Harness	EUT	Laptop	1.5 m	No

Table 3: List of cables that may have been used during test

6 Test Standards Applied

6.1. Accredited Standards

The following test or measurement standards were applied and are within the scope of the lab's accreditation. All results in this report that cite these standards are presented as Accredited results consistent with ISO/IEC 17025.

FCC Part 87 D
RSS-141 Issue 2: 2010;

6.2. Non-accredited Standards

The following test or measurement standards were applied and are either outside the scope of the lab's accreditation, or were performed in such a way that results are not presented as being fully accredited.

(None)

6.3 Variances

The following variances were applied to standards cited in this section.

Where different test standards cover the same test parameter or phenomenon, and the standards have compatible differences, the stricter of the requirements is typically applied. For example, a consolidated limit may be applied to emission tests selecting the strictest of the limits at each frequency. Likewise, if one standard requires a vertical antenna sweep with bore sighting and another does not, swept motion with bore sighting will typically be used as it is the more stringent requirement.

6.4 Laboratory Accreditation

The Garmin Compliance Lab, an organization within Garmin International, is registered with the US Federal Communication Commission as US1311. The lab is recognized by the Canada Department of Innovation, Science, and Economic Development (ISED) under CAB identifier US0233.

The Garmin Compliance Lab, an organization within Garmin International, is accredited by A2LA, Certificate No. 6162.01. The presence of the A2LA logo on the cover of this report indicates this is an accredited ISO/IEC 17025 test report. If the logo is absent, this report is not issued as an accredited report. Other marks and symbols adjacent to the A2LA logo are accreditation co-operations of which A2LA is a member under a mutual recognition agreement, and to which the Garmin Compliance Lab has been sublicensed.

7 Measurement Instrumentation Uncertainty

The lab has analyzed the sources of measurement instrumentation uncertainty. The analysis concludes that the actual measurement values cited in this report are accurate within the U_{LAB} intervals shown below with approximately 95% statistical confidence. Where the report shows a judgment that a test sample passes a test against a published limit based on these measured values, that judgment has a statistical confidence of 97.5% or greater. Measurement Instrumentation Uncertainty is one component of over-all measurement uncertainty, and other uncertainty components are not considered as part of this analysis.

The primary benchmark for measurement instrumentation uncertainty (MIU) in an electromagnetic compatibility (EMC) test lab is the set of U_{CISPR} values published in CISPR 16-4-2. In all cases where a U_{CISPR} value is published by CISPR, the analysis shows that U_{LAB} – this lab's estimated MIU – is better than the U_{CISPR} benchmark.

The secondary benchmark for MIU in an EMC lab performing radio transceiver tests is a set of uncertainty limit values published in various ETSI standards. In this report, U_{ETSI} is the most restrictive of the values found in the ETSI EN standards listed in section 5 of this report. The analysis principles are described in the ETSI TR documents listed there. In most cases U_{LAB} is better than the U_{ETSI} benchmark. Where U_{LAB} exceeds the U_{ETSI} benchmark cited here, that entry is preceded by an asterisk. When required by the ETSI EN standards, excess uncertainty will be added to the measurand before comparison to a limit. In an individual test report, staff may re-evaluate that excess uncertainty based on the uncertainty of the method used and the uncertainty limits of the actual ETSI EN standard being applied, and the revised uncertainty values will be shown in the test report.

Some measurement uncertainties analyzed and reported here are not addressed in CISPR 16-4-2 or the ETSI standards, as indicated by the entry 'None.'

Test Type		**U_{LAB}**	**U_{CISPR}**	**U_{ETSI}**
Conducted DC voltage		0.09% + 2 x LSDPV	None	1%
Conducted AC voltage below 500 Hz		1.0% + 3 x LSDPV	None	2%
Conducted Emissions, Mains Voltage		0.10% + 10 mV	None	None
Conducted Emissions, Mains Current		0.10% + 3 mA	None	None
Conducted Emissions, Mains Power		0.15% + 100 mW	None	None
Conducted Emissions, Power Mains, 9 kHz to 150 kHz		1.49 dB	3.8 dB	None
Conducted Emissions, Power Mains, 150 kHz to 30 MHz		1.40 dB	3.4 dB	None
Conducted Emissions, Cat 6 LCL, 150 kHz to 30 MHz		2.80dB	5 dB	None
Conducted Emissions, Cat 5 LCL, 150 kHz to 30 MHz		3.21 dB	5 dB	None
Conducted Emissions, Cat 3 LCL, 150 kHz to 30 MHz		4.24 dB	5 dB	None
Radiated Emissions, below 30 MHz		0.88 dB	None	6 dB
Radiated Emissions, 30 MHz to 1000 MHz		2.77 dB	6.3 dB	6 dB
Radiated Emissions, 1 GHz to 18 GHz		2.60 dB	5.2 & 5.5 dB	6 dB
Radiated Emissions, 18 GHz to 26.5 GHz		2.73 dB	None	6 dB
*Radio Signal Frequency Accuracy		*1.55 x 10^-7	None	1.0 x 10^-7
Radio Signal Occupied Bandwidth		0.95%	None	5%
Radio Power or Power Spectral Density		0.98 dB	None	1 dB
Temperature		0.38 °C	None	1 °C
Barometric Pressure		0.38 kPA	None	None
Relative Humidity		2.85% RH	None	±5% RH
Signal Timing	The greater of these three...	0.63 usec 0.01% of value 0.5 x LSDPV	None	None

Note: *LSDPV stands for the Least Significant Digit Place Value reported. In the value 1470 msec, the least significant digit is the 7. It has a 10 msec place value. The LSDPV is thus 10 msec and the maximum error due to roundoff would be 5 msec. If the time value were reported as 147<u>0</u> msec, the underscore indicates that the 0 is a significant figure and the error due to roundoff would be 0.5 msec. All digits provided to the right of a decimal point radix are significant.*

8 Selected Example Calculations

Certain regulators require samples of the calculations that lead from the raw measurement to the final result for AC Mains conducted and unintended radiated emissions. The assumption is that the lab performs raw measurements, then adds, subtracts, multiplies, or divides based on transducer factors, amplifier gains, and losses in the signal transmission path. In this lab, our CISPR 16 Receiver does not work that way. The calibration factors and losses and gains are provided to the receiver as detailed data files. These factors are applied in the RF measurement path prior to the detector. But as a step in the lab measurement process, staff frequently verify that these factors are applied correctly. They make a measurement with the factors applied inside the receiver, then they disable the factors and remeasure the result manually adding in the various relevant factors.

The transmission loss is measured including the combined losses and gains of preamplifiers, cables, and any band-selective filters. In many cases above 1 GHz it is a negative value, indicating that the preamplifier gain is greater than these other losses.

Here are examples of these calculations. The data in these examples was not taken as part of this project:

8.1 AC Mains conducted emissions at 22 MHz

(Raw measurement) + (AMN factor) + (transmission loss) = Result

(7.145 dBuV) + (9.812 dB) + (0.216 dB) = 17.173 dBuV

8.2 Radiated Emissions at 630 MHz

(Raw measurement) + (Antenna factor) + (transmission loss) = Result

(2.25 dBuV) + (27.80 dB/m) + (2.89 dB) = 32.94 dBuV/m

8.3 Radiated Emissions at 2.7 GHz

(Raw measurement) + (Antenna factor) + (transmission loss) = Result

(43.72 dBuV) + (32.22 dB/m) + (-36.09 dB) = 39.85 dBuV/m

9 Environmental Conditions During Test

Environmental conditions in the test lab were monitored during the test period. Temperature and humidity are controlled by an air handling system. As information to the reader, the conditions were observed at the values or within the ranges noted below. For any tests where environmental conditions are critical to test results and require further constraints or details, the test records in the annex may provide more specific information.

Temperature:	21.9 to 22.7 °C
Relative Humidity:	43.7% to 53.3% (non-condensing)
Barometric Pressure	98.0 to 98.5 kPa

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
Barometer	Traceable	6453	221702700	3-Aug-2022	1-Aug-2024

Table 4: Environmental monitoring device

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10 Immunity Performance Criteria

If this report includes immunity tests then results have been categorized as Performance Criteria A, B, C, or D. The standards that the lab applied will define the details for A, B, and C, as well as which criterion is required for each type of test. They will also define the electrical stresses that were applied during each test. In a very general sense the observed criteria noted in this report are as follows:

Criterion A. The stress applied did not alter product operation. This criterion is generally used for ‘continuous’ stresses that can be present for a long time in the places the product will be used, or that can appear often, even though they may come and go over time.

Criterion B. The stress applied altered product operation, but the product self-recovered so that the user would not have to try to figure out how to restore it to full operation. This criterion is generally used for ‘transient’ stresses that appear briefly and occasionally, but are usually not present in the places the product will be used.

Criterion C. The stress applied altered product operation, but the user could restore it to full operation, for example by power cycling the product. This criterion is generally used for ‘transient’ stresses that appear briefly and only rarely in the places the product will be used.

Criterion D. This is not an official criterion in the standards, because it would be a failure of the requirements. This indication in a test record means the product was affected in a way that the user might not be able to correct. The effect could include some degree of hardware damage, or it could include loss of program files or data files necessary for operation.

Repeatability is an issue in all EMC immunity work. When the product operation changes unexpectedly during a test, and the change would fail the requirements of the standard, this is an anomaly. The test operator needs to determine whether the anomaly was a result of the applied electrical stress. The investigation is done by repeating the section of the test where the anomaly occurred three times. If the same or a similar anomaly occurs in any of the three repeat trials, it is confirmed as a response to the stress. If not, the anomaly is judged unreproducible and is not considered when judging the A, B, or C observed performance. Since there is usually no ability to confirm a Criterion D anomaly, these are usually treated as Criterion D upon a single occurrence.

Tests that require Criterion B performance will be judged to Pass if criteria A or B is observed. Similarly, tests that require Criterion C performance will be judged to Pass if criteria A, B, or C is observed.

ANNEX

The remainder of this report is an Annex containing individual test data records. These records are the basis for the judgments summarized in section 1 of this report. The Annex ends with a set of concluding notes regarding use of the report.

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Test Record

Transmitter Power
Test IDs TR01
Project GCL-0412

Test Date(s) 01 Sep 2023
Test Personnel Majid Farah

Product Model GMN-02480
Serial Number tested 70E000120

Operating Mode M2 (VHF Tx + BT OFF)
Arrangement A1 (Conductive)
Input Power 14 Vdc

Test Standards: FCC part 87D, RSS-141, ANSI C63.26 (as noted in Section 6 of the report)

Antenna Gain 2.15 dBi, as reported by the client (0 dBd)
Radio Protocol VHF Transceiver, AM DSB (A3E)

Pass/Fail Judgment: PASS

Test record created by: Majid Farah
Date of this record: 15 Sep 2023
Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220139	30-Jan-2023	1-Feb-2024
RF Power Sensor	Rohde&Schwarz	NRP8S	109124	18-Jul-2023	15-Jul-2025
Directional Coupler	Agilent	773D	2839A01849	Calibration	Not Required
Oscilloscope	Rohde&Schwarz	RTE 1102	310012	10-Jul-2023	15-Jul-2024
Power supply	Samlex America	SEC1212	03051-7F03-00426	Calibration	Not Required

Table TR01.1: List of test equipment used

Software used: Rohde & Schwarz Power Viewer V11.3

Test Method

The basic test standards provide options for the time evaluation test method. The following test methods were applied.

ANSI C63.26: 2015 5.2.3.2

The peak output power was measured at the Antenna port of the transceiver using a broadband peak RF power meter. The transmit power limit is 55 Watts.

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Test Data

Each measurement is made conducted from the antenna port with the transmitter on a specified channel and in a selected transmission protocol. Where standards cited here apply harmonized test methods and different limits, the more strict limit is applied. The results are shown below and the highest case highlighted.

Input dc Voltage	Tx Power Setting	Tx Frequency	Measured Tx power
(V)	(W)	(MHz)	(W)
14	16	118.000	17.6
14	16	127.475	17.8
14	16	136.975	17.9
14	16	136.992	18.1
14	10	118.000	12.2
14	10	127.475	12.0
14	10	136.975	11.9
14	10	136.992	11.7

Table TR01.2: Transmit Power measurements

Setup Diagram

The following block diagrams show how the EUT and test equipment is arranged for test.

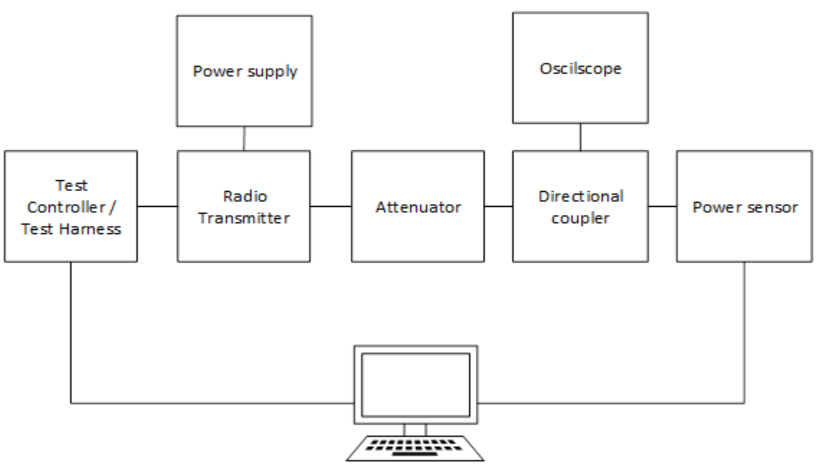

Figure TR01.1: Test equipment setup

This line is the end of the test record.

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Test Record

Transmitter Stability in Extreme Conditions
Test IDs TR02
Project GCL-0412

Test Date(s)	14 Sep 2023
Test Personnel	Majid Farah
Product Model	GMN-02480
Serial Number tested	70E000120
Operating Mode	M2 (VHF Tx + BT OFF)
Arrangement	A1 (Conductive)
Nominal Input Power	14 Vdc and 28 Vdc
Test Standards:	FCC Part 87D, RSS-141, ANSI C63.26 (as noted in Section 6 of the report)
Radio Protocol	VHF Transceiver, AM DSB (A3E)
Pass/Fail Judgment:	**PASS**
Test record created by:	**Majid Farah**
Date this record:	**18 Sep 2023**

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	21-Sep-2022	15-Sep-2023
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	15-Apr-2024
Thermometer	Thermco	ACCD370P	220608121	26-Aug-2022	1-Sep-2024
Thermal Chamber	Tenney	T2RC	31244	Calibration	Not Required
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024

Table TR02.1: List of test equipment used

Test Software Used: Keysight PXE firmware A.32.06

Test Method

The various standards require observation of the stability for transmission frequency and/or power at certain environmental extremes. The reference is performance on nominal input voltage and a temperature of 20 °C. Where the standards cited here apply to different limits or conditions, the most stringent limits and conditions have been applied. The standards cited allow 30 ppm maximum carrier frequency drift for Aircraft stations.

The EUT accepts 14 Vdc and 28 Vdc as nominal input voltage. For the voltage variation test, the extreme conditions applied were 11.9 Vdc (85% of 14 Vdc) and 32.2 Vdc (115% of 28 Vdc).

The PXE receiver was used to measure the carrier frequency of the VHF transmitter.

Test Data

The test sample was set for maximum output power (16 W) with an unmodulated 127.475 MHz carrier frequency. Observed data is presented in the table below and the highest value highlighted.

Temperature	Input voltage	Measured Frequency	Difference
°C	Volt	MHz	ppm
50	14	127.474925	0.09
40	14	127.474916	0.02
30	14	127.474910	0.02
20	14	127.474913	0.00
10	14	127.474925	0.09
0	14	127.474883	0.24
-10	14	127.474881	0.25
-20	14	127.474873	0.31
-30	14	127.474904	0.07
85% of Nominal voltage	11.9	127.474916	0.02
115% of Nominal voltage	32.2	127.474925	0.09

Table TR02.2: Carrier frequency changes under extreme conditions

Setup Block Diagram

The following block diagram shows the EUT configured and arranged in the manner in which it was measured.

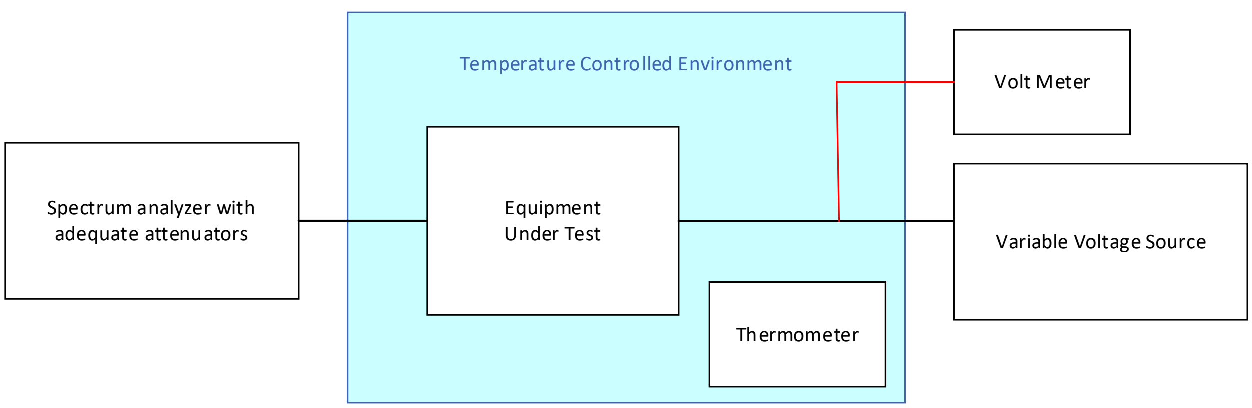

Figure TR02.1: Test setup

This line is the end of the test record.

Test Record

Transmitter Occupied Bandwidth Tests
Test IDs TR03
Project GCL-412

Test Date(s)	13 Sep 2023
Test Personnel	Majid Farah
Product Model	GMN-02480
Serial Number tested	70F000108
Operating Mode	M10 (VHF Tx)
Arrangement	A1 (Conductive)
Input Power	14 Vdc
Test Standards:	FCC Part 87 D, RSS-141, ANSI C63.26 (as noted in Section 6 of the report)
Radio Protocol	VHF Transceiver, AM DSB (A3E)
Radio Band	118 to 137 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**Majid Farah**
Date of this record:	**15 Sep 2023**

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220146	3-Jun-2023	3-Jun-2024
Power supply	Samlex America	SEC1212	03051-7F03-00426	Calibration	Not Required
PSG Analog Signal Generator	Keysight	E8257D	SG59140055	7-Jul-2023	1-Jul-2024

Table TR03.1: List of test equipment used

Test Software Used: Keysight PXE firmware A.35.06

Test Method

The following test methods was applied.
ANSI C63.26: 2015 5.4.4

During this test the transmitter output is fed directly, or through RF attenuators, to the spectrum analyzer. The analyzer has a built-in capability to identify the minimum bandwidth that contains a specified portion of the total power observed, and also identify parameters such as the edge frequencies for that bandwidth and the center frequency error. The spectrum is scanned many times so that the varied effects of modulation are appropriately assessed. Since the focus is on the relative distribution of energy across a range of frequencies, the absolute amplitudes recorded during this test are not relevant and may not include cable losses or attenuation factors.

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Test Data

The data for each test is summarized below, followed by the spectral data for each case highlighted in yellow.

The analysis threshold for the Occupied Bandwidth test was the bandwidth containing 99% of the observed power. The standards cited the Occupied Bandwidth (OBW) for all operating modes that will result in transmission in a different OBW. In such cases different channel spacing and different power level tested when modulating a 2500 Hz audio signal at maximum available modulation level.

Power (W)	Transmit freq (MHz)	OBW %99 (Hz)
16	118.000	5502
16	127.475	5496
16	136.975	5501
16	136.992	5504
10	118.000	5497
10	127.475	5491
10	136.975	5493
10	136.992	5494

Table TR03.2: Summary of 99% occupied bandwidth data

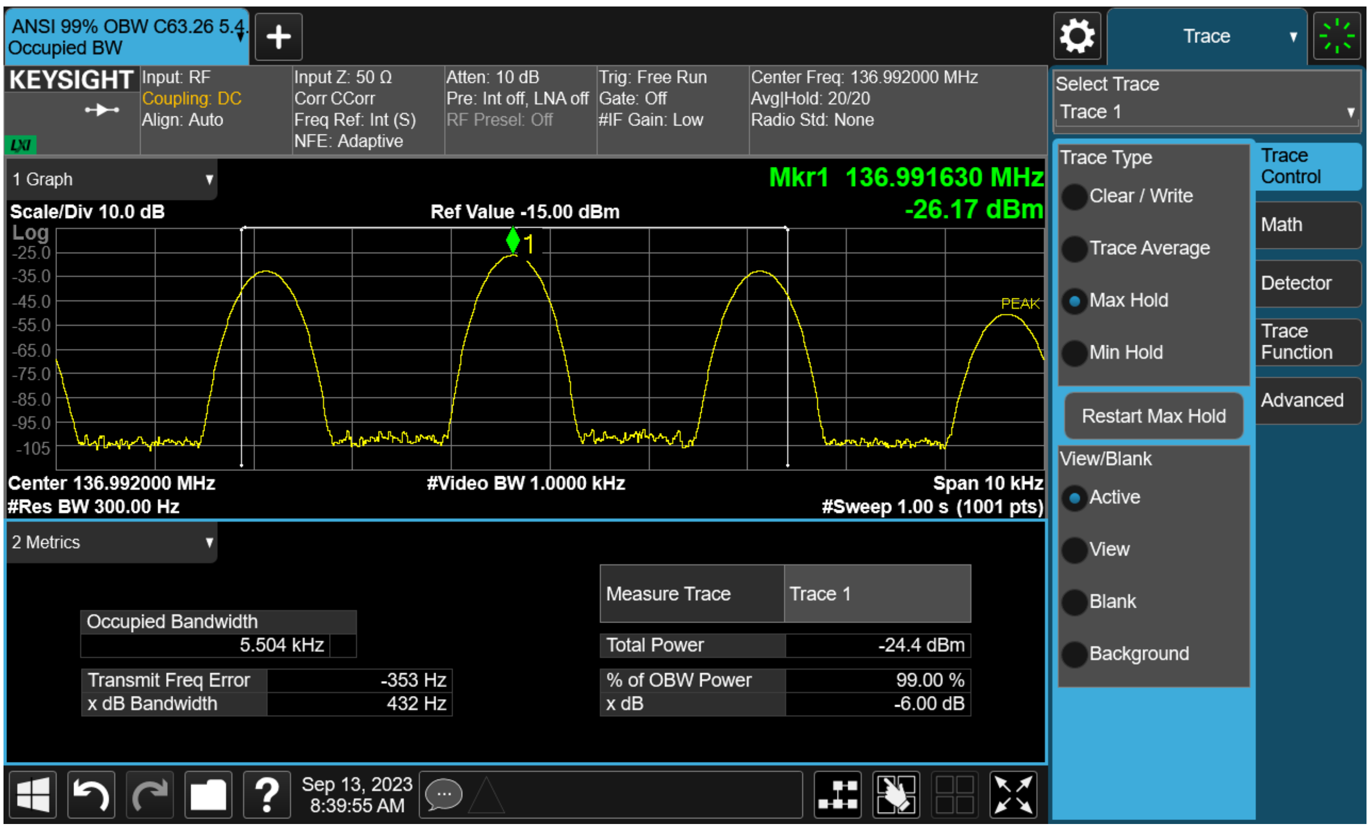

Figure TR03.1: 99% occupied bandwidth data for 16 Watt power at 136.992 MHz

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Test Setup

This block diagram shows the test equipment setup.

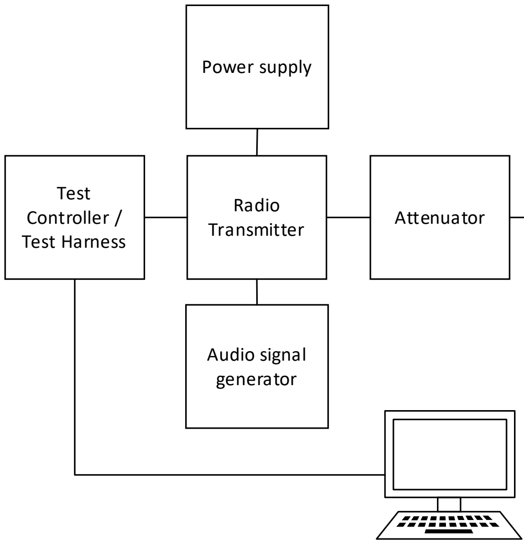

Figure TR03.2: Test setup

This line is the end of the test record.

Test Record

Transmitter Channel Edge and Spurious Emission Tests
Test IDs TR4
Project GCL-0412

Test Date(s)	15 Sep 2023
Test Personnel	David Arnett
Product Model	GMN-02480
Serial Number tested	70E000120
Operating Mode	M2 (VHF Tx + BT OFF)
Arrangement	A1 (Conductive)
Input Power	14 Vdc
Test Standards:	FCC Part 87D, RSS-141, ANSI C63.26 (as noted in Section 6 of the report).
Radio Protocol	VHF Transceiver, AM DSB (A3E)
Pass/Fail Judgment:	**PASS with Caveat**
Test record created by:	**David Arnett**
Date of this record:	**21 Sep 2023**
Original record, Version A.	

Caveat
The caveat for the PASS judgment is related only to the channel edge test data, and only for the FCC Part 87 rules. There is no caveat whatsoever related to the RSS-141 rules. The area of consideration is the width of the mask which establishes the test limit.

The US and Canadian radio rules tend to be very well aligned. RSS-141 at 5.1 states that the Channel Bandwidth is 25 kHz. The text and figure at 5.2.2 provide a mask based on this 25 kHz channel bandwidth.

FCC Part 87.137 agrees that the channel spacing is 25 kHz. See note 17 under the table. Note 17 is connected to an oddly placed snippet of text 'kHz' associated with two table entries for A3E communication. The second A3E entry in the table applies to airborne equipment such as the device being reported here. This second A3E line sets an authorized bandwidth of 8.33 kHz for this type of radio, but note 17 suggests the 8.33 kHz entry is tied to a particular use case. The two A3E entries in the table seem so focused on the authorized bandwidth for special cases (notes 2, 3, and 17) that it is less clear what authorized bandwidth the Commission applies to the usual cases.

The text at Part 87.139(a) builds the near-channel emission mask using the same structure as RSS-141. However under 87.139(a) the frequency parameter used to structure the mask seems to be based on the unusual authorized bandwidth of 8.33 kHz rather than the 25 kHz channel spacing as Canada has done.

Given the oddities in CFR47 discussed above, the client has requested that the Garmin Compliance Lab apply the mask based on setting the parameter to 25 kHz. That has been done. Anyone reviewing this data ought to be aware of the relevant details.

The data of Tables TR4.2 and TR4.3 below include pairs of sideband emissions offset above and below the carrier by approximately 5 kHz. The levels measured were 23.597 dBc to 24.751 dBc (decibel relative to carrier level). If the mask is based on the 25 kHz parameter, the limit at a 5 kHz carrier offset is 0 dBc and these emissions comply. If the mask is based on 8.33 kHz the signals have to be reduced at least 25 dB below carrier level. These emissions do not satisfy a mask based on the 8.33 kHz parameter.

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Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220146	3-Jun-2023	3-Jun-2024
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	15-Apr-2024
PSG Analog Signal Generator	Keysight	E8257D	SG59140055	7-Jul-2023	1-Jul-2024

Table TR4.1: Test equipment used

Test Software Used: Keysight PXE firmware A.35.06

Test Method

Each measurement is made conducted from the antenna port with the transmitter on a specified channel or hopping (for FHSS devices) and in a selected transmission protocol. Measurements are power spectral density values over a specific measurement bandwidth. The results include the effects of any measurement cable losses as well as antenna gain. Resulting values are compared against a limit. Where the test standards listed have different limit definitions, a composite limit is typically applied that is the most stringent of the defined masks in all regulated respects. Compliance with this composite limit therefore demonstrates compliance with the limits in each listed standard.

All data in this test record was performed with continuous transmission. The carrier was modulated using a 2.5 kHz sinusoidal tone from a signal generator. The tone level from the generator was set at a level 16 dB above the tone level that produced a 50% AM modulation.

Channel Edge Test Data

The standards allow a certain amount of power to be emitted in an Out-of-Channel region just beyond the tuned radio frequency. The limit for this test is a mask, which defines specific amplitude limits over specific frequency ranges. For these standards, the generation of the mask is based on a set parameter as discussed in the Caveat above.

The data below include a graph of the measured energy showing an approximation of the applied mask for visual reference, as well as a table summarizing the test results. Markers were set for the strongest sideband emission within each mask range. The table shows, for each emission, its actual offset from the carrier in both frequency and amplitude.

Carrier Offset		Limit
(kHz)	(dBc)	(dBc)
-27.48	-65.744	-35
-12.52	-50.228	-25
-5.01	-24.183	0
-2.52	-6.643	0
2.48	-6.668	0
4.98	-24.751	0
14.96	-53.869	-25
25.04	-67.789	-35

Table TR4.2: Channel edge data summary for 10W transmit power

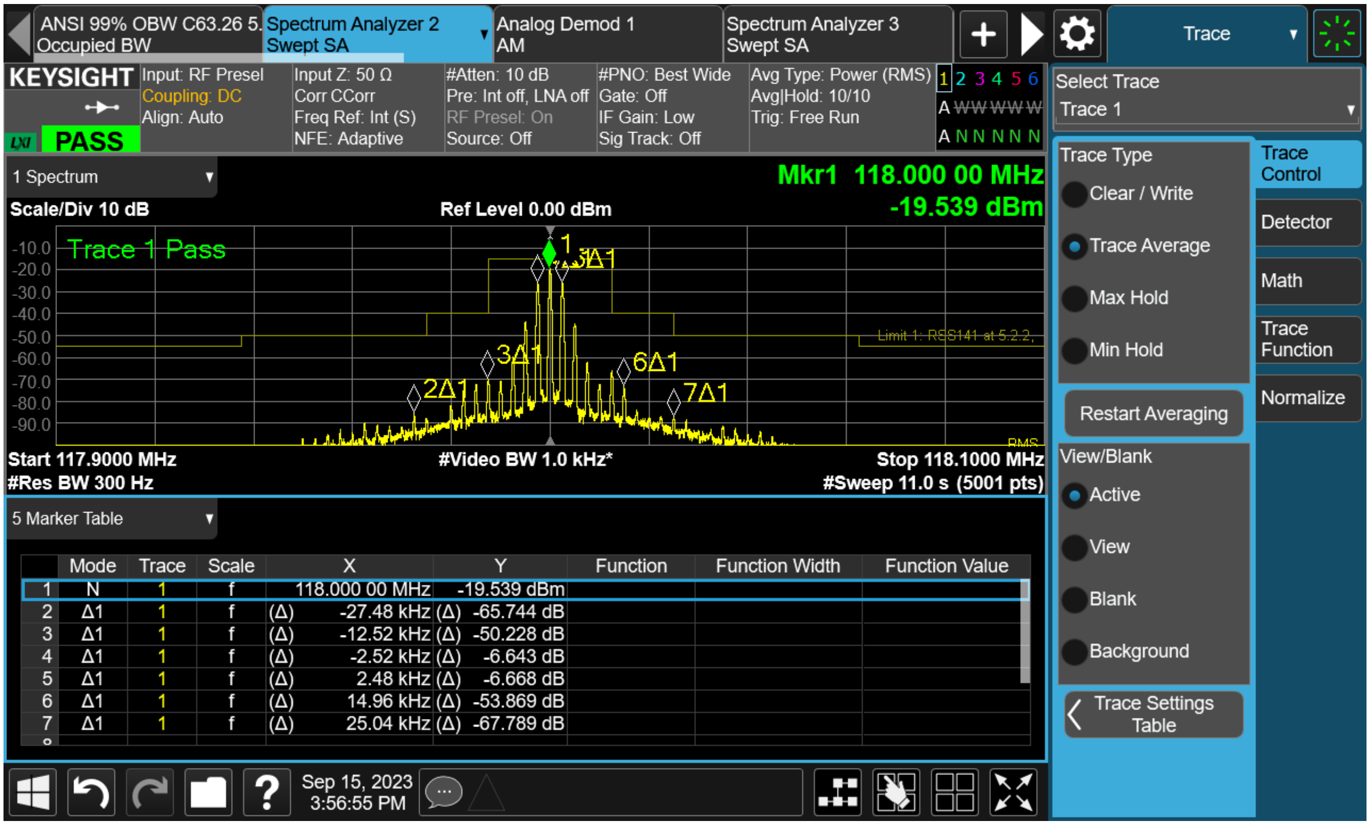

Figure TR4.1: Channel edge data for 10W transmit power

Carrier Offset		Limit
(kHz)	(dBc)	(dBc)
-30.04	-67.466	-35
-12.52	-50.995	-25
-5.01	-23.597	0
-2.52	-6.579	0
2.48	-6.611	0
5.00	-24.067	0
15.00	-48.991	-25
27.44	-68.774	-35

Table TR4.3: Channel edge data summary for 16W transmit power

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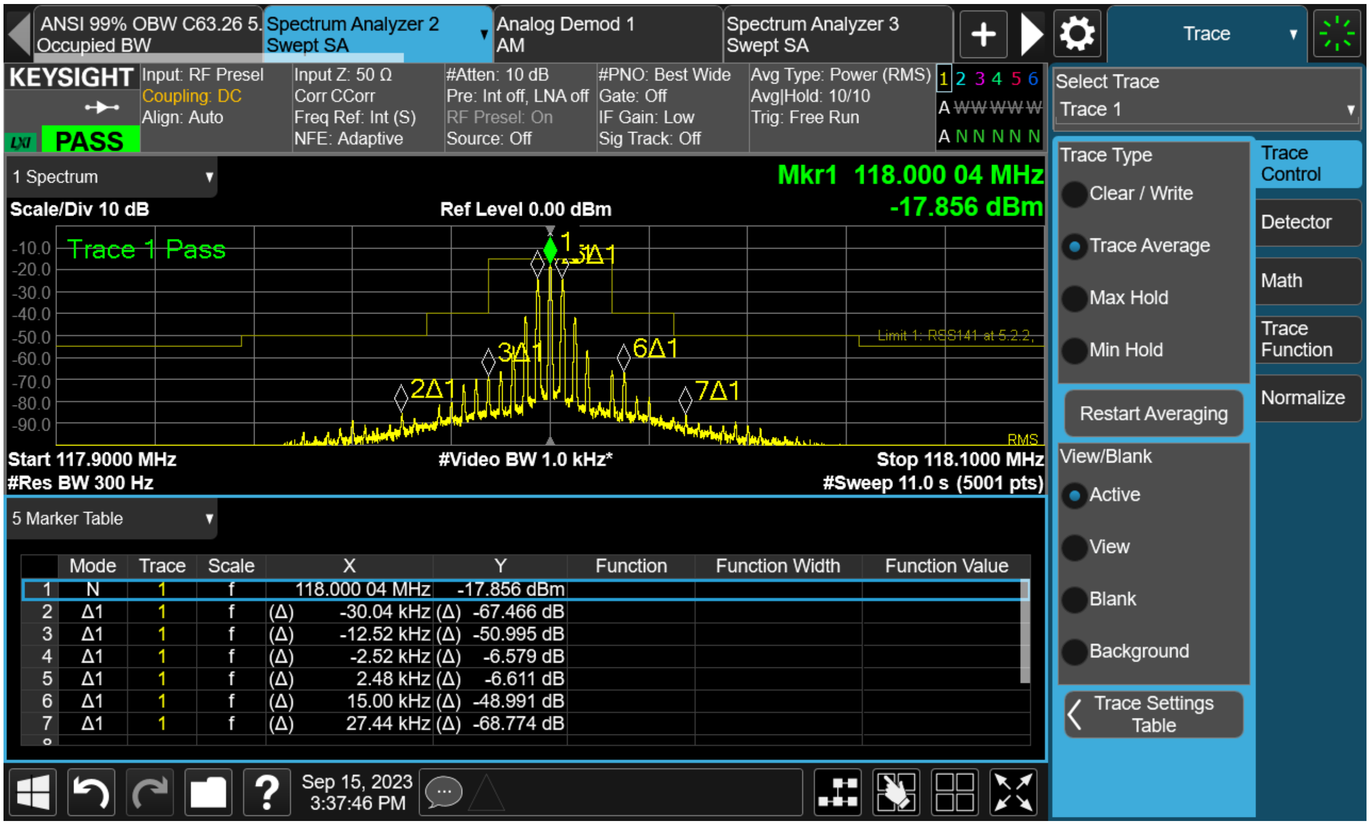

Figure TR4.2: Channel edge data for 16W transmit power

Conducted Spurious Emission Test Data

The spurious emission limits apply to emissions that are generated but are not required for radio communication. The standards require spectra for the lowest and highest transmit frequencies. Two upper end transmit frequencies are represented based on whether the transmit frequencies are selected on 25 kHz centers or 8.33 kHz centers. All emissions beyond the channel edge spectrum mask discussed above must be reduced at least 40 dB below the carrier level. Note that this test method uses a wider resolution bandwidth than the channel edge data above, so the measured carrier level is affected. The table shows the strongest emission observed that is subject to the -40 dBc limit. The graphical data for each tuned frequency follows.

Carrier (MHz)	Tx Power (W)	Max Spur (dBc)	Limit (dBc)
118.000	10	-72.470	-40
118.000	16	-74.916	-40
136.975	10	-70.653	-40
136.975	16	-72.680	-40
136.992	10	-78.250	-40
136.992	16	-75.168	-40

Table TR4.4: Spurious emission data summary for all three transmit frequencies

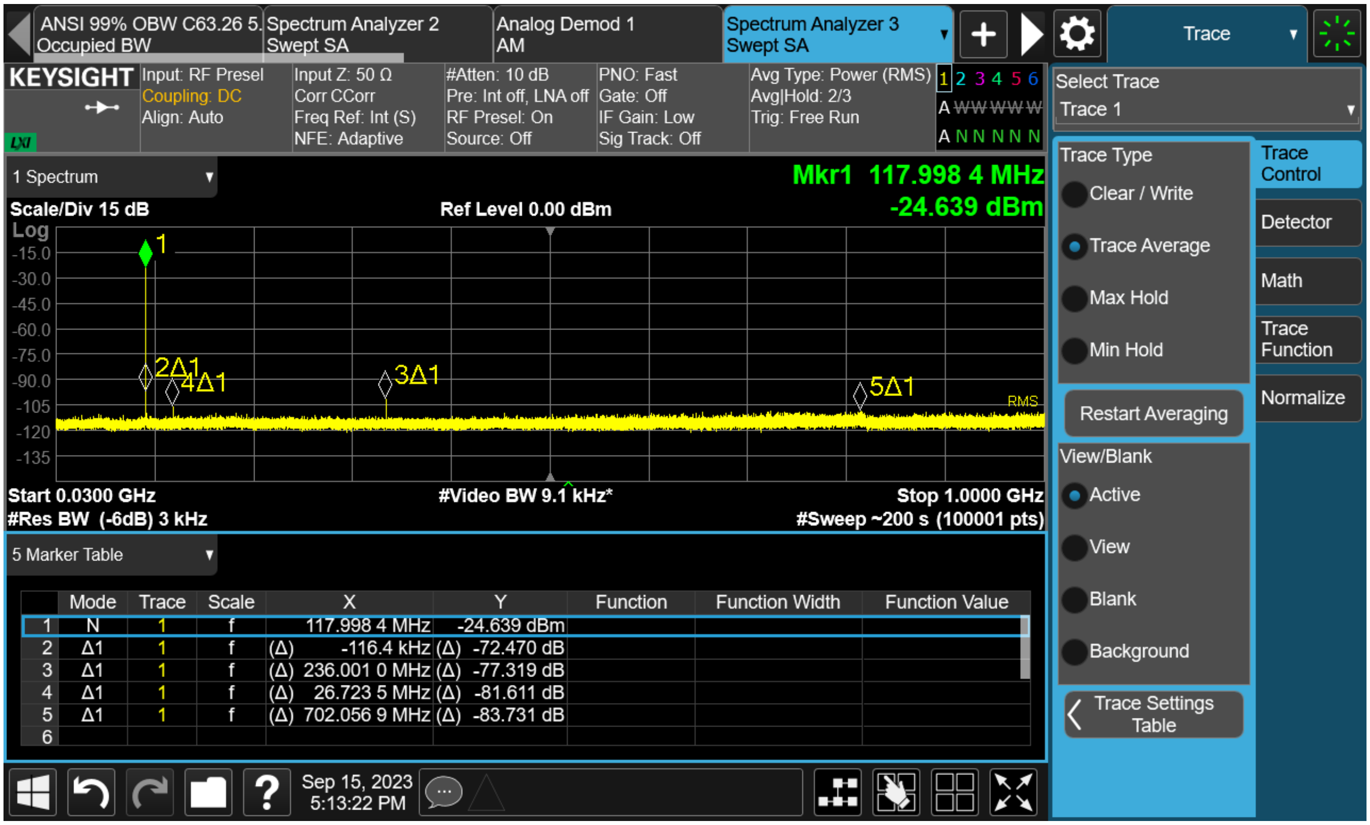

Figure TR4.3: Spurious emission graphical data for 118.000 MHz, 10W

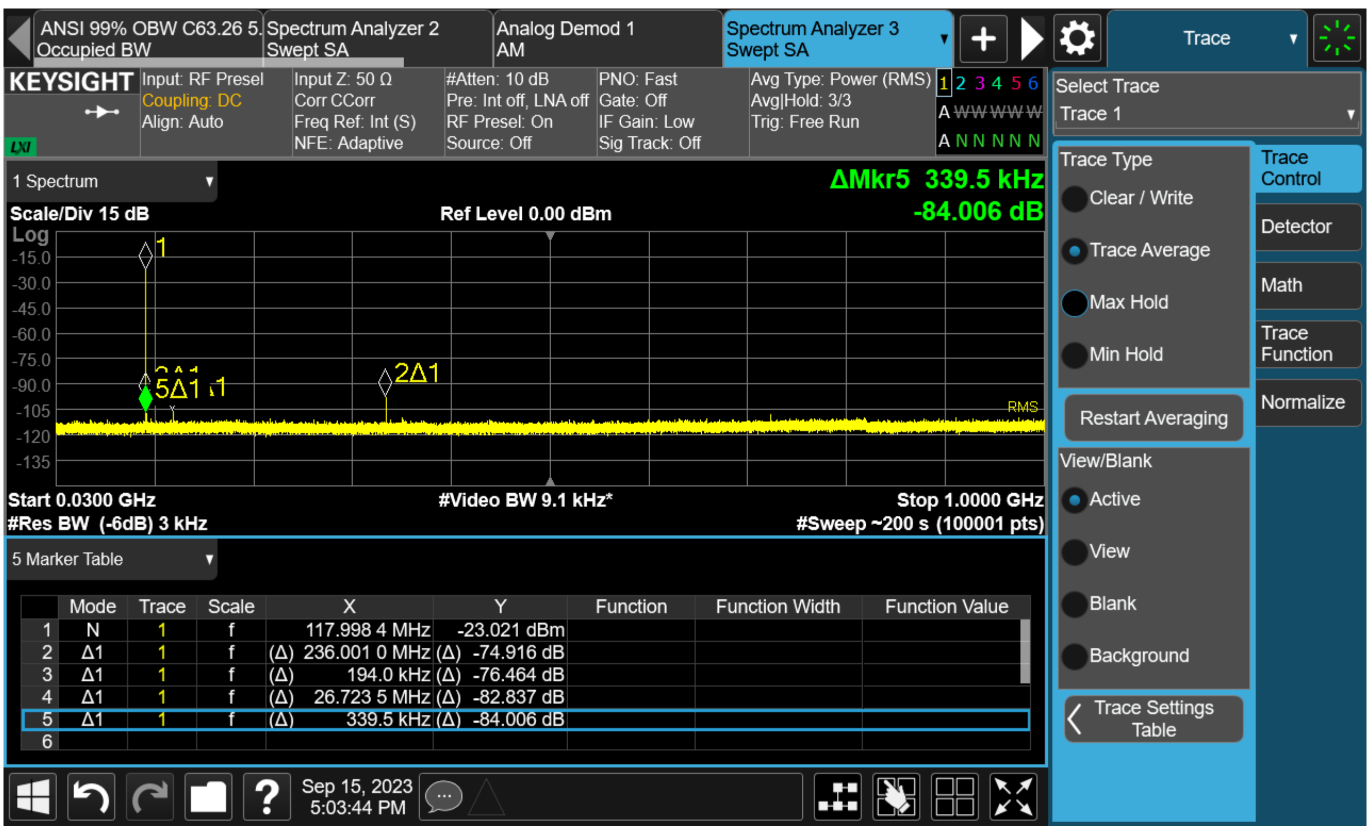

Figure TR4.4: Spurious emission graphical data for 118.000 MHz, 16W

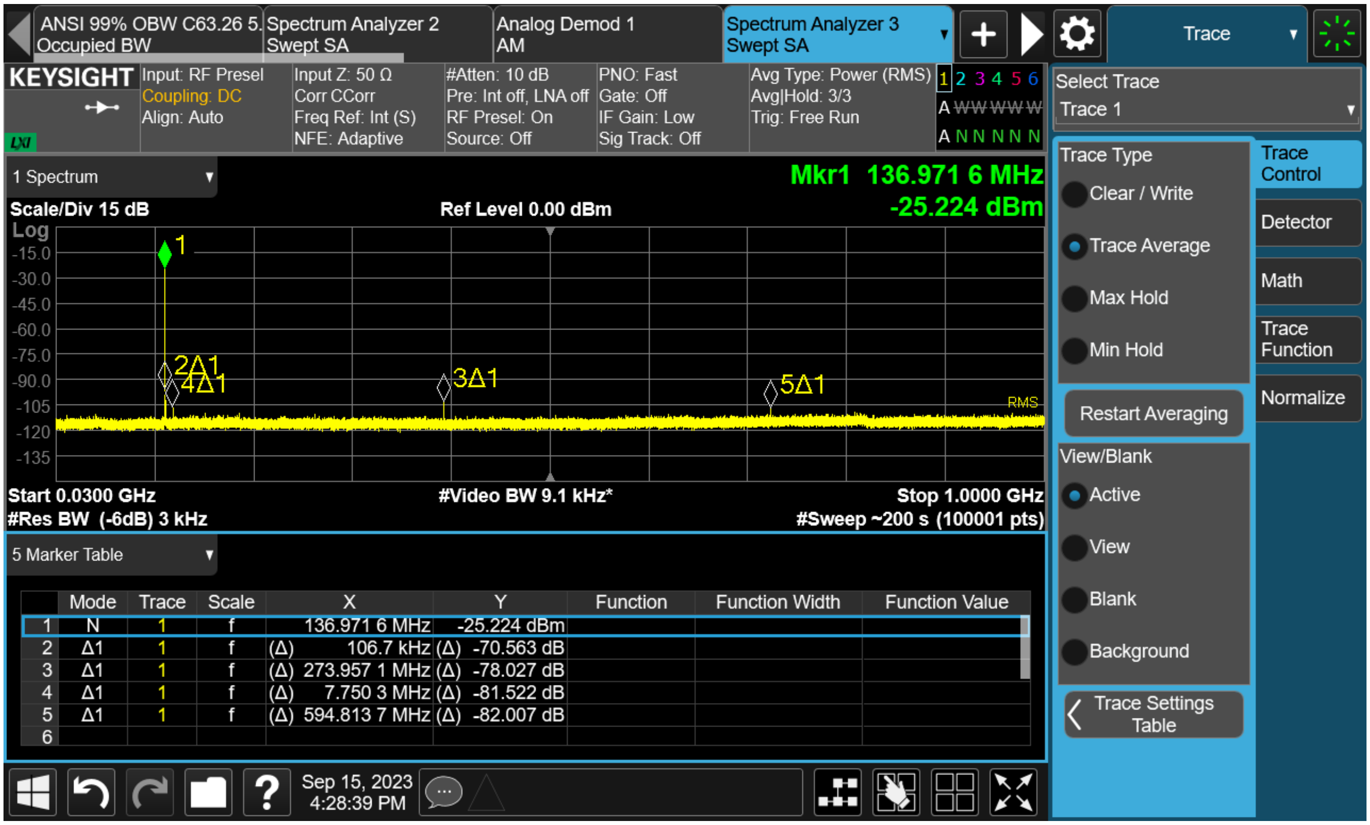

Figure TR4.5: Spurious emission graphical data for 136.975 MHz, 10W

Figure TR4.6: Spurious emission graphical data for 136.975 MHz, 16W

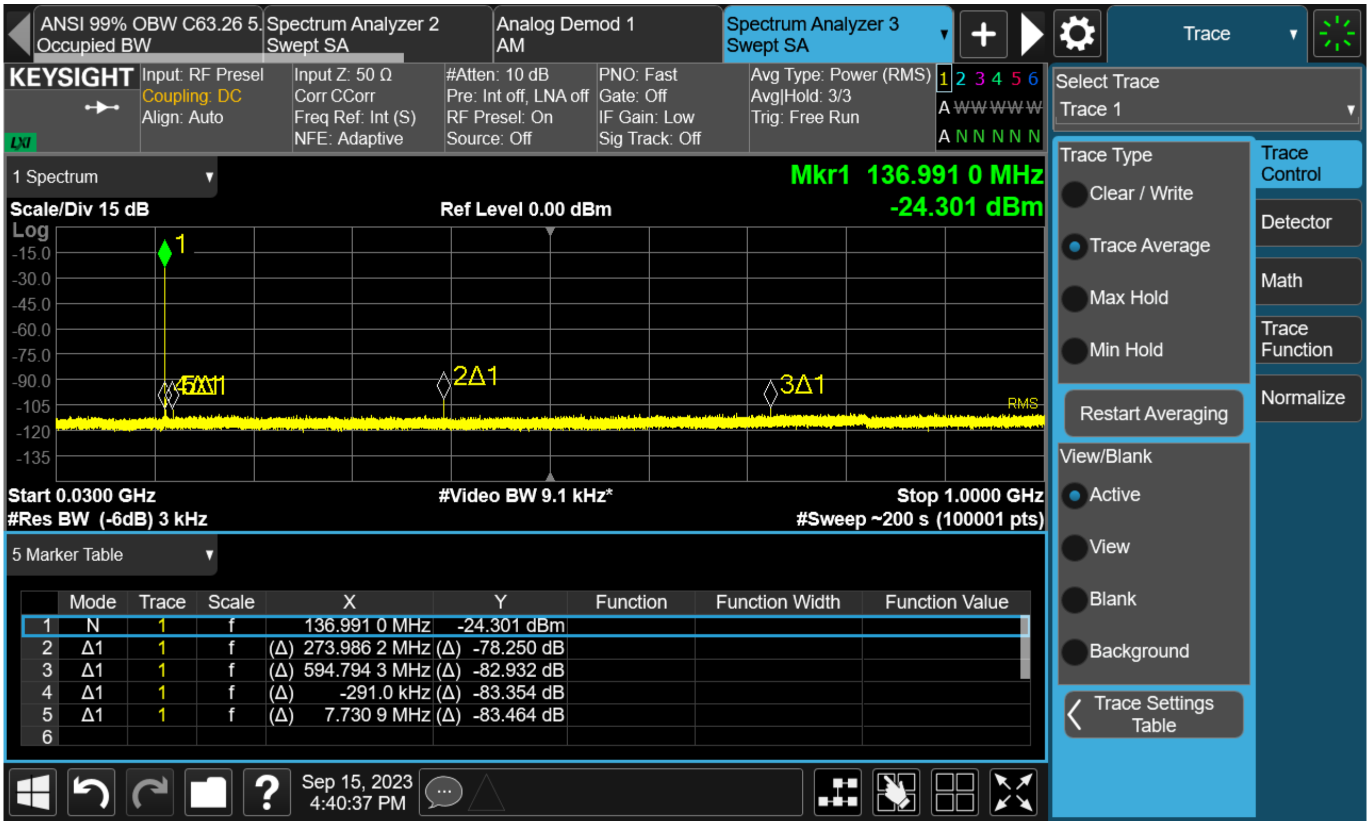

Figure TR4.7: Spurious emission graphical data for 136.992 MHz, 10W

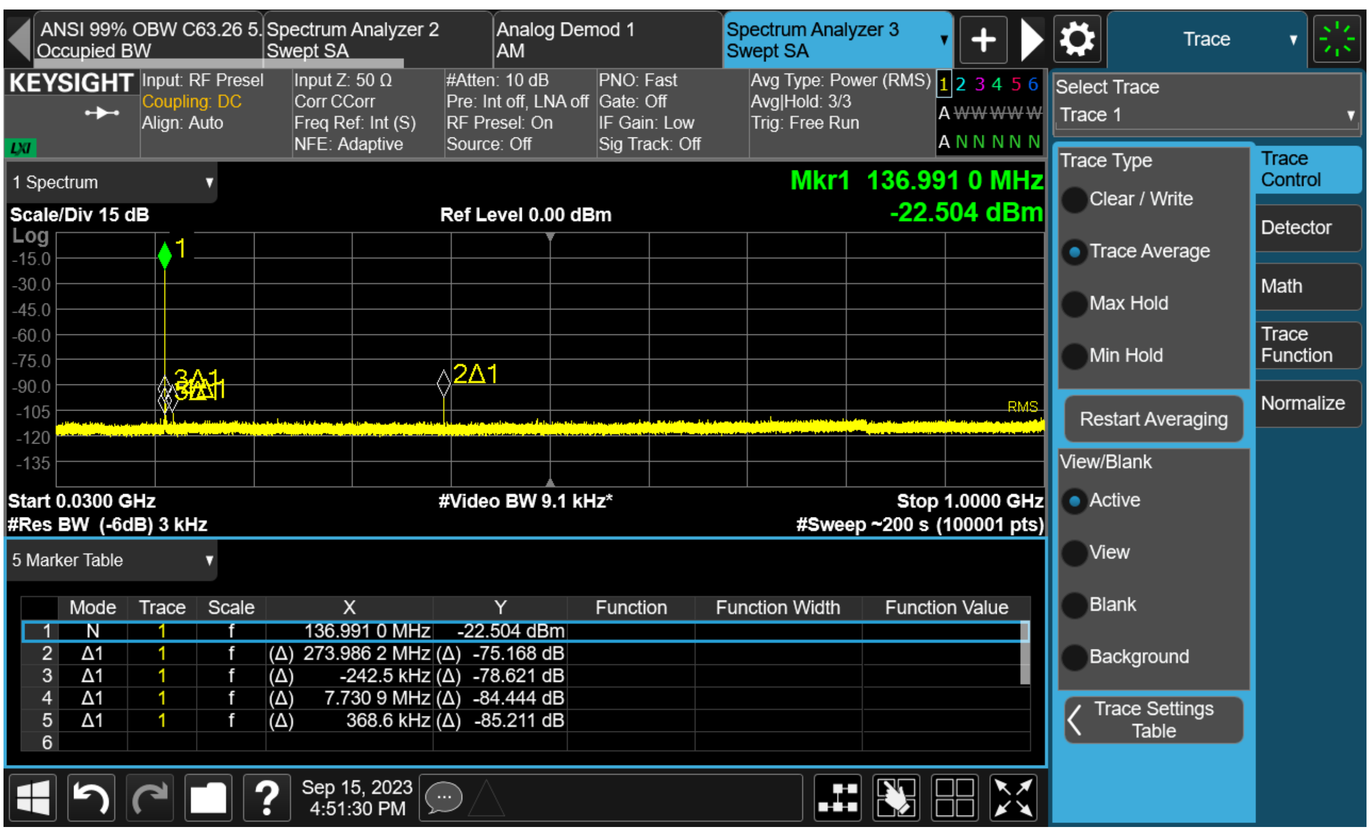

Figure TR4.8: Spurious emission graphical data for 136.992 MHz, 16W

This line is the end of the test record.

Test Record

Modulation Characteristics Tests
Test IDs TR05
Project GCL-0412

Test Date(s)	12 Sep 2023
Test Personnel	Majid Farah
Product Model	GMN-02480
Serial Number tested	70F000108
Operating Mode	M10 (VHF Tx)
Arrangement	A1 (Conductive)
Input Power	14 Vdc
Test Standards:	FCC Part 87D, FCC Part 2.1047, RSS-141, ANSI C63.26 (as noted in Section 6 of the report)
Radio Protocol	VHF Transceiver, AM DSB (A3E)
Radio Band	118 to 137 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**Majid Farah**
Date of this record:	**18 Sep 2023**

Original record, Version A.

Test Equipment Used

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 44GHz	Keysight	N9048B	MY62220146	3-Jun-2023	3-Jun-2024
Power supply	Samlex America	SEC1212	03051-7F03-00426	Calibration	Not Required
PSG Analog Signal Generator	Keysight	E8257D	SG59140055	7-Jul-2023	1-Jul-2024

Table TR05.1: List of test equipment used

Test Software Used: Keysight PXE firmware A.35.06

Test Method

The basic test standards provide options for the time evaluation test method. The following test methods were applied. ANSI C63.26: 2015 5.3.2 and 5.3.3

During these tests the transmitter output was fed directly, or through RF attenuators, to the PXE spectrum analyzer. The analyzer has a built-in capability to characterize AM modulation and provide details such as modulation depth for positive/negative peaks and demodulated signal frequency. The analyzer was tuned to the carrier frequency. The PSG signal generator provided various sinusoidal input tones at controlled amplitudes and frequencies to the audio input of the transmitter.

Modulation limiting response

This test ensures that the EUT will not provide overmodulation of the AM carrier for an input tone of 300 Hz, 1 kHz, 2.5 kHz, or 3 kHz. For each tone frequency, the signal generator output level was adjusted to obtain 60% modulation depth. This PSG signal drive level was the ‘0 dB’ reference level for that tone frequency. The modulating signal level was increased in 5 dB steps to 20 dB above the reference level. The modulation depth was recorded at each step. This process was repeated at each tone frequency. The limit is no more than 100% AM modulation.

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Audio frequency response

This test looks at frequency response across a set of tone frequencies from 100 Hz to 5 kHz. The analysis compares the drive strength levels from the PSG signal generator that resulted in 20% modulation. The drive strength for the 1 kHz tone is taken as the '0 dB' reference level. This data is required but there is no pass/fail limit.

Test Data

For both tests the VHF transmitter was set to 16 Watts output power transmitting at 127.475 MHz. The data for each test are shown in below.

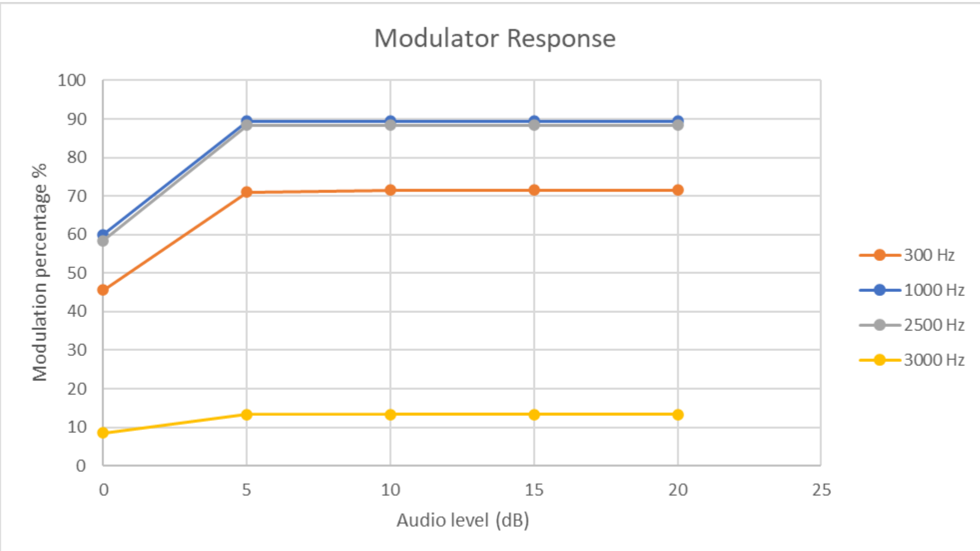

Figure TR05.1: Modulation limiting response

Audio frequency response data from 3 kHz to 5 kHz are not shown in the picture below. No signal generator drive level was able to produce 20% modulation at these frequencies.

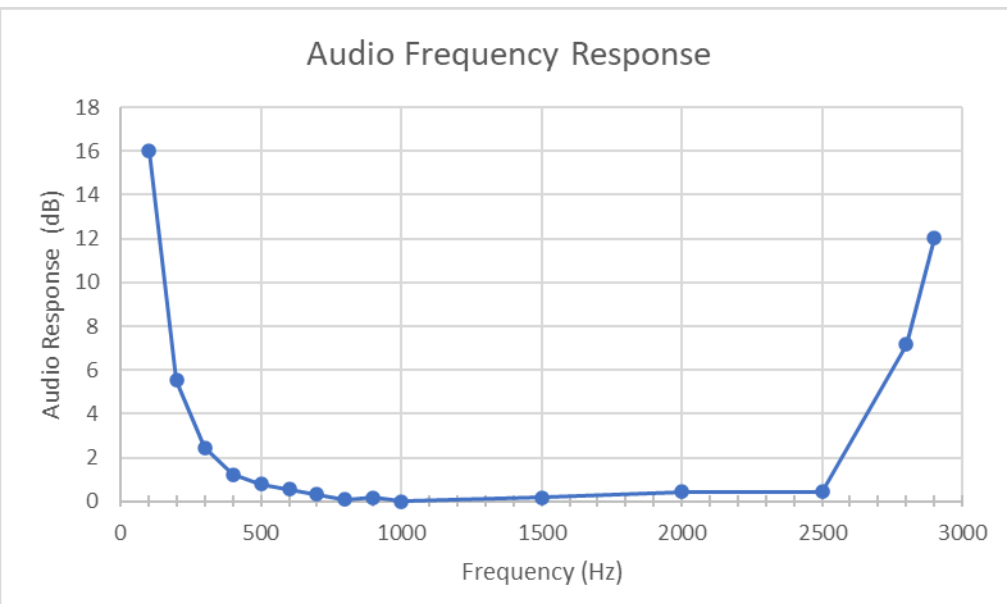

Figure TR05.2: Audio frequency response

Test Setup

This block diagram shows the test equipment setup.

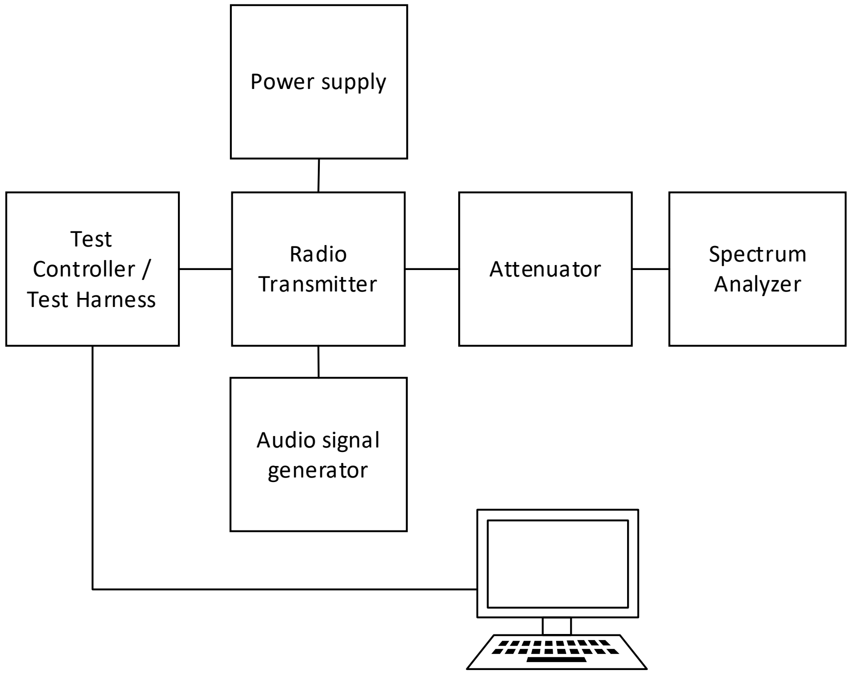

Figure TR05.3: Test setup
This line is the end of the test record.

Test Record
Radiated Emission Test RE01
Project GCL-0412

Test Date(s) 30 Aug 2023
Test Personnel David Kerr

Product Model GMN-02480
Serial Number tested 70E000120

Operating Mode M5 (VHF TX ON+BT linked)
Arrangement A2 (Non Conductive)
Input Power 14 Vdc

Test Standards: CISPR 32, FCC 87 D (as noted in Section 6 of the report).

Frequency Range: 30 MHz to 1000 MHz
Pass/Fail Judgment: PASS

Test record created by: Aditya Prakash
Date of this record: 10 Jan 2024

Original record, Version A was created on 1 Sep 2023 by Aditya Prakash. Version B was created on 10 Jan 2024 by Aditya Prakash to mention the presence of Intentional radiator in the data which are not subject to the QP limits.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	21-Sep-2022	15-Sep-2023
Antenna, Biconilog, 30M-6 GHz	ETS Lindgren	3142E	00233201	19-Jul-2022	15-Jul-2024
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	7-Nov-2022	7-Nov-2025
Tape measure, 1" x 33'	Lufkin	PHV1410C	10720	16-Jan-2023	15-Jan-2026
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
Programmable DC power source	Keithley	2260B-30-	1411917	21-Apr-2023	15-Apr-2024

Table RE01.1: Test Equipment Used

Software Used: Keysight PXE software A.32.06, RE Signal Maximization Tool v2022May10.xlsx.

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Test Data

The radiated emission test process began with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Where the test standard requires cable manipulation, this was done at one of more likely worst case frequencies selected by the test personnel while observing the receiver display. At each of the frequencies selected for final measurements, the turntable angle, antenna height, and antenna polarization were explored to find the worst-case settings. Final field strength measurements were taken in that set of positions. Full maximization was not performed at frequencies that are noise floor measurements included per the test standard requirements.

At azimuth angle 0° the ‘front’ reference mark of the turntable is pointed Southward. At 90° the reference mark points West. At -90° it points East. At -7° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 30 MHz and 1 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the Composite FCC/CISPR Class B Limit at 3m.

The measurement was taken for High, Medium, and Low frequency channels (25 kHz spacing).

Frequency	Limit	Measured	Margin	Azimuth	Height	Antenna
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	(degree)	(mm)	Polarity
33.000	40.00	29.90	10.10	62.00	1078.00	VERT
216.000	40.00	28.60	11.40	99.00	1301.00	HORZ
255.000	46.00	33.50	12.50	58.00	1838.00	HORZ
504.000	46.00	29.80	16.20	53.00	1124.00	HORZ
566.670	46.00	29.60	16.40	15.00	1211.00	HORZ
864.000	46.00	31.80	14.20	-89.00	3120.00	HORZ

Table RE01.2: Emission summary (Low channel, 118.000 MHz)

Frequency	Limit	Measured	Margin	Azimuth	Height	Antenna
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	(degree)	(mm)	Polarity
33.000	40.00	32.30	7.70	-193.00	1028.00	VERT
75.000	40.00	30.00	10.00	151.00	2487.00	HORZ
144.000	40.00	25.90	14.10	36.00	2421.00	HORZ
249.000	46.00	35.70	10.30	57.00	1838.00	HORZ
480.000	46.00	31.40	14.60	98.00	1047.00	HORZ
864.000	46.00	31.90	14.10	-55.00	2977.00	HORZ

Table RE01.3: Emission summary (Medium channel, 127.475 MHz)

Frequency (MHz)	Limit (dBuV/m)	Measured (dBuV/m)	Margin (dB)	Azimuth (degree)	Height (mm)	Antenna Polarity
33.000	40.00	32.20	7.80	116.00	1037.00	VERT
75.000	40.00	30.20	9.80	161.00	2334.00	HORZ
231.000	46.00	30.40	15.60	93.00	2102.00	HORZ
249.000	46.00	35.00	11.00	75.00	1903.00	HORZ
492.000	46.00	30.50	15.50	83.00	1034.00	HORZ
864.000	46.00	31.90	14.10	-30.00	1034.00	VERT

Table RE01.4: Emission summary (High channel, 136.975 MHz)

The graph below shows the background spectrum observed during pre-scan, as well as the final data points from the table above. The carrier for the VHF radio is shown in the chart, and identified in the caption. This intentional transmission is not subject to the QP Limit.

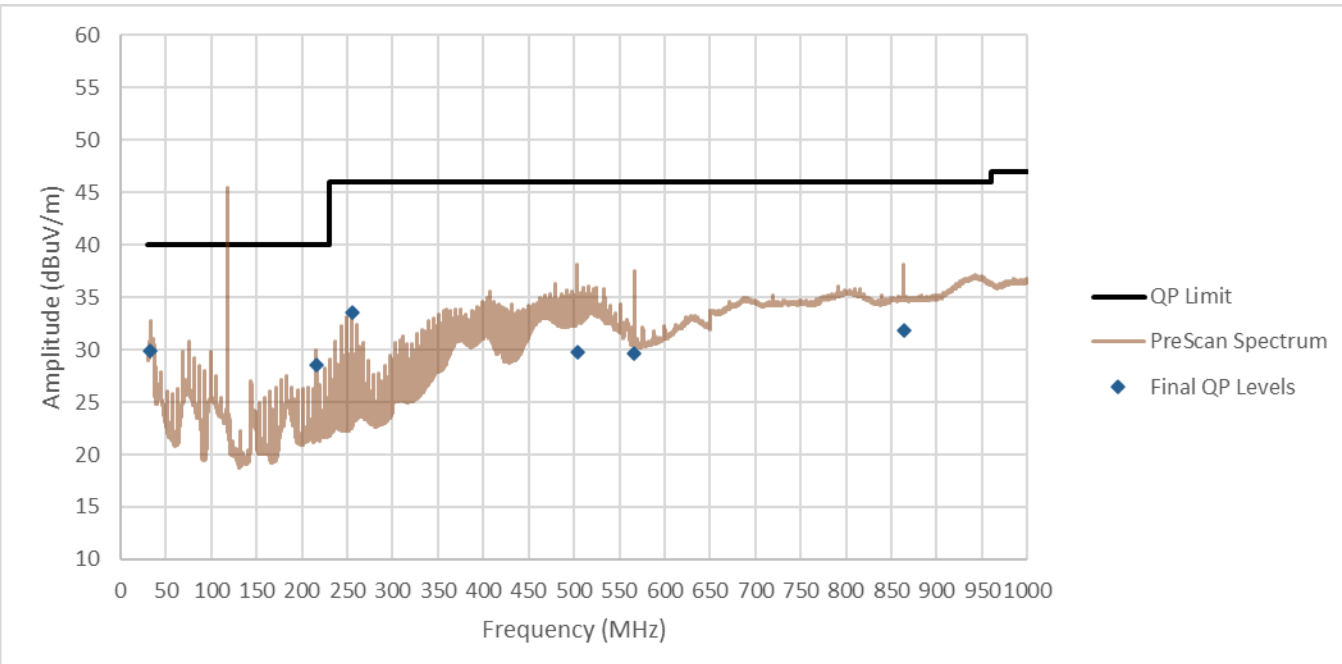

Figure RE01.1: Spectral data (Low channel, 118.000 MHz)

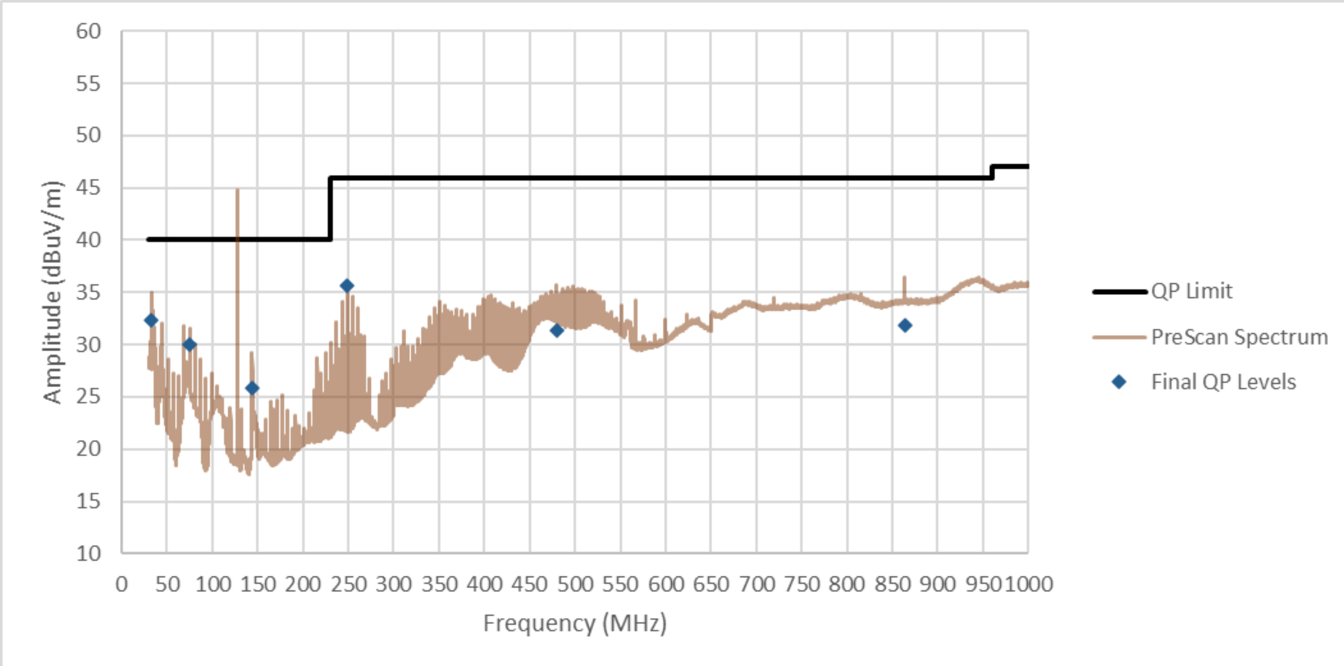

Figure RE01.2: Spectral data (Medium channel, 127.475 MHz)

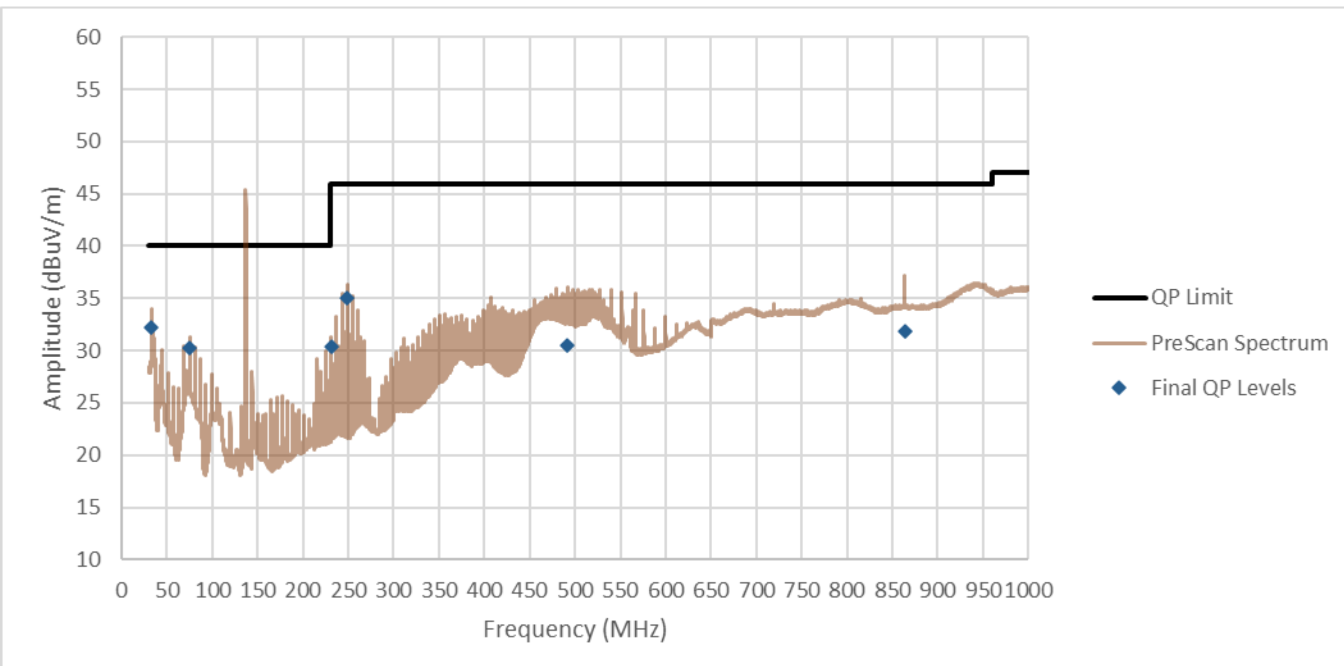

Figure RE01.3: Spectral data (High channel, 136.975 MHz)

Setup Photographs

The following photographs show the EUT configured and arranged in the manner in which it was measured.

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE01.4: EUT test setup, front view

Image removed for client confidentiality.
See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE01.5: EUT test setup, reverse view

This line is the end of the test record.

Test Record
Radiated Emission Test RE02
Project GCL-0412

Test Date(s) 31 Aug 2023
Test Personnel David Kerr

Product Model GMN-02480
Serial Number tested 70E000120

Operating Mode M5 (VHF TX ON+BT linked)
Arrangement A2 (Non Conductive)
Input Power 28 Vdc

Test Standards: CISPR 32, FCC 87 D (as noted in Section 6 of the report).

Frequency Range: 30 MHz to 1000 MHz
Pass/Fail Judgment: PASS

Test record created by: Aditya Prakash
Date of this record: 10 Jan 2024

Original record, Version A was created on 1 Sep 2023 by Aditya Prakash. Version B was created on 10 Jan 2024 by Aditya Prakash to mention the presence of Intentional radiator in the data which are not subject to the QP limits.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	21-Sep-2022	15-Sep-2023
Antenna, Biconilog, 30M-6 GHz	ETS Lindgren	3142E	00233201	19-Jul-2022	15-Jul-2024
SAC 3m, below 1 GHz	Frankonia	SAC3	F199004	7-Nov-2022	7-Nov-2025
Tape measure, 1” x 33’	Lufkin	PHV1410C	10720	16-Jan-2023	15-Jan-2026
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
Programmable DC power source	Keithley	2260B-30-	1411917	21-Apr-2023	15-Apr-2024

Table RE02.1: Test Equipment Used

Software Used: Keysight PXE software A.32.06, RE Signal Maximization Tool v2022May10.xlsx.

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Test Data

The radiated emission test process began with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Where the test standard requires cable manipulation, this was done at one of more likely worst case frequencies selected by the test personnel while observing the receiver display. At each of the frequencies selected for final measurements, the turntable angle, antenna height, and antenna polarization were explored to find the worst-case settings. Final field strength measurements were taken in that set of positions. Full maximization was not performed at frequencies that are noise floor measurements included per the test standard requirements.

At azimuth angle 0° the 'front' reference mark of the turntable is pointed Southward. At 90° the reference mark points West. At -90° it points East. At -7° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 30 MHz and 1 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the Composite FCC/CISPR Class B Limit at 3m.

The measurement was taken for High, Medium, and Low frequency channels (25 kHz spacing).

Frequency (MHz)	Limit (dBuV/m)	Measured (dBuV/m)	Margin (dB)	Azimuth (degree)	Height (mm)	Antenna Polarity
33.000	40.00	29.40	10.60	-198.00	1065.00	VERT
69.000	40.00	30.00	10.00	-87.00	3076.00	VERT
144.000	40.00	29.10	10.90	40.00	2223.00	HORZ
255.000	46.00	32.90	13.10	88.00	1934.00	HORZ
492.000	46.00	29.90	16.10	94.00	1304.00	HORZ
566.670	46.00	31.10	14.90	31.00	1109.00	HORZ

Table RE02.2: Emission summary (Low channel, 118.005 MHz)

Frequency (MHz)	Limit (dBuV/m)	Measured (dBuV/m)	Margin (dB)	Azimuth (degree)	Height (mm)	Antenna Polarity
33.000	40.00	29.90	10.10	30.00	1000.00	VERT
69.000	40.00	33.90	6.10	109.00	2164.00	VERT
255.000	46.00	35.20	10.80	90.00	1776.00	HORZ
525.000	46.00	30.90	15.10	69.00	1124.00	HORZ
566.670	46.00	32.50	13.50	-3.00	1186.00	HORZ
864.000	46.00	32.00	14.00	-173.00	2226.00	HORZ

Table RE02.3: Emission summary (Medium channel, 127.490 MHz)

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Frequency (MHz)	Limit (dBuV/m)	Measured (dBuV/m)	Margin (dB)	Azimuth (degree)	Height (mm)	Antenna Polarity
69.000	40.00	32.30	7.70	92.00	2334.00	VERT
75.000	40.00	32.10	7.90	-197.00	2288.00	HORZ
255.000	46.00	35.50	10.50	63.00	1878.00	HORZ
408.000	46.00	30.20	15.80	53.00	1043.00	HORZ
525.000	46.00	31.40	14.60	58.00	1040.00	HORZ
566.670	46.00	33.30	12.70	1.00	1208.00	HORZ

Table RE02.4: Emission summary (High channel, 136.992 MHz)

The graph below shows the background spectrum observed during pre-scan, as well as the final data points from the table above. The carrier for the VHF radio is shown in the chart, and identified in the caption. This intentional transmission is not subject to the QP Limit.

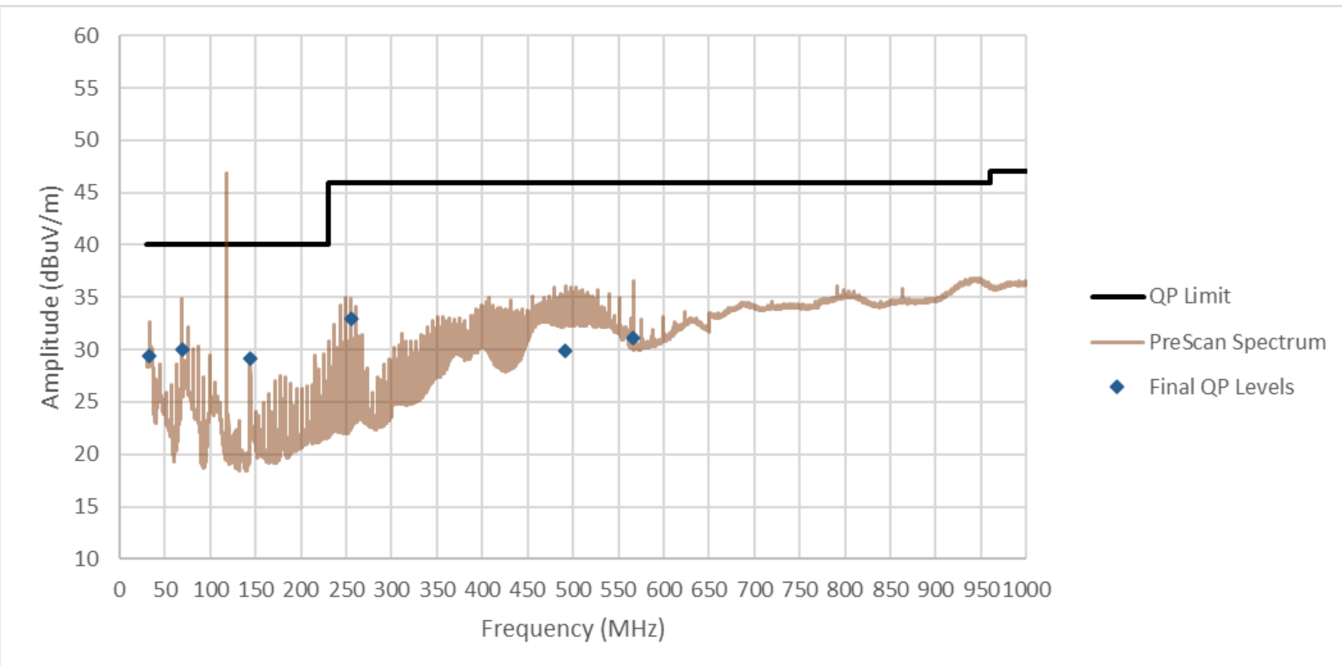

Figure RE02.1: Spectral data (Low channel, 118.005 MHz)

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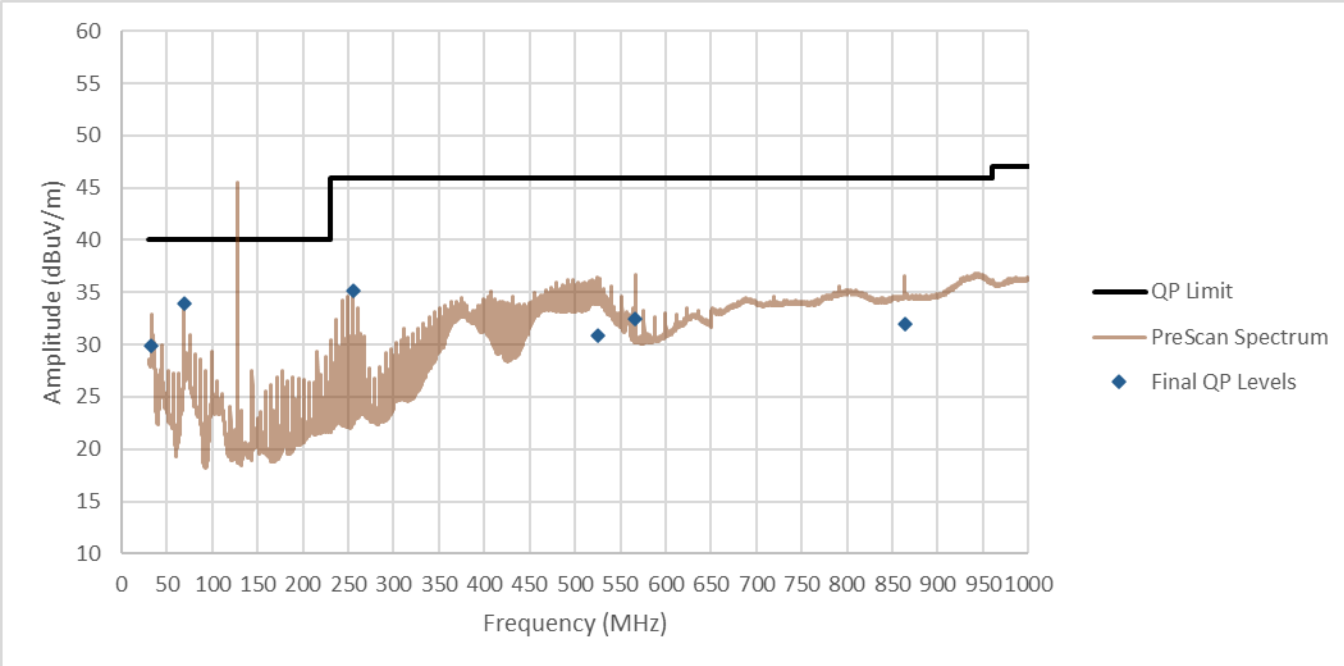

Figure RE02.2: Spectral data (Medium channel, 127.490 MHz)

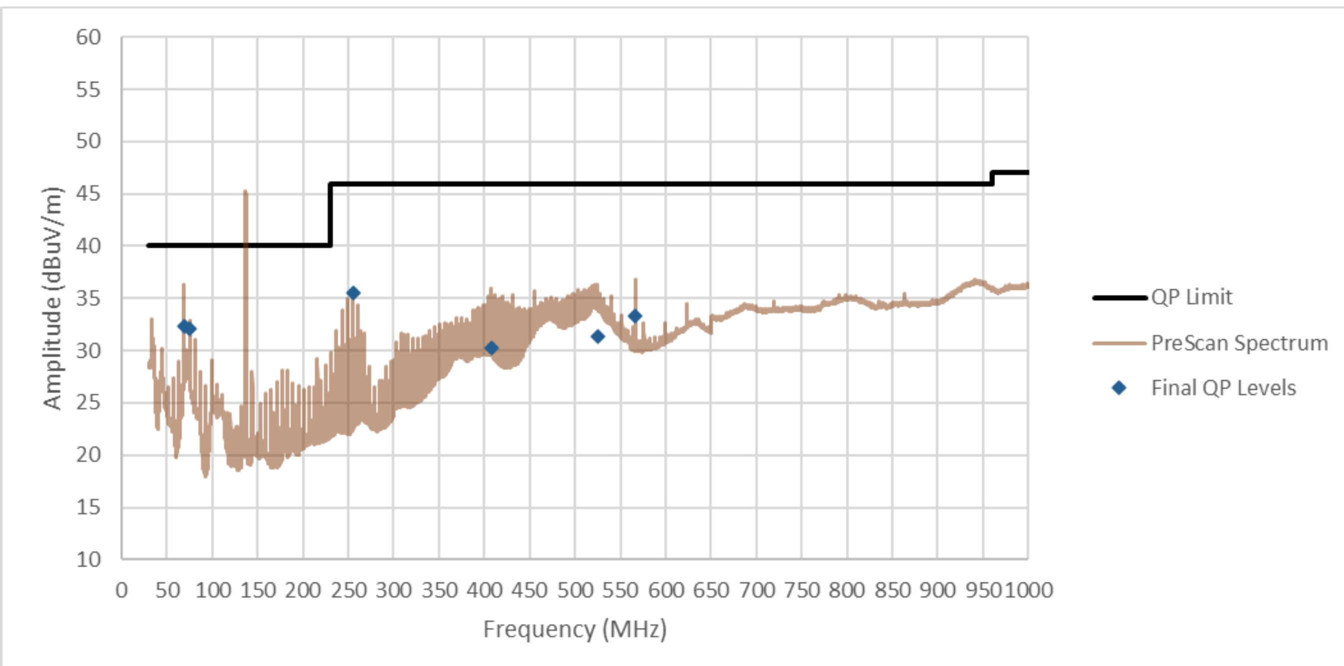

Figure RE02.3: Spectral data (High channel, 136.992 MHz)

Setup Photographs

The following photographs show the EUT configured and arranged in the manner in which it was measured.

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See section 1 of this report
to identify the report where
the photos may be viewed.

Figure RE02.4: EUT test setup, front view

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to identify the report where
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Figure RE02.5: EUT test setup, reverse view

This line is the end of the test record.

Test Record
Radiated Emission Test RE06
Project GCL0412

Test Date(s)	9 Sep 2023
Test Personnel	David Kerr
Product Model	4074
Serial Number tested	70E000120
Operating Mode	M5 (VHF Tx ON + BT Linked)
Arrangement	A2 (Non Conductive)
Input Power	14 Vdc
Test Standards:	FCC 15 B, RSS-Gen (as noted in Section 6 of the report).
Frequency Range:	1000 MHz to 12500 MHz
Pass/Fail Judgment:	**PASS**
Test record created by:	**Aditya Prakash**
Date of this record:	**10 Jan 2024**

Original record, Version A.

Test Equipment

Description	Make	Model #	Serial #	Last Cal/Ver	Next Due
PXE Receiver 26 GHz	Keysight	N9048B	MY59290135	21-Sep-2022	15-Sep-2023
Antenna, Horn, 1-18 GHz	ETS Lindgren	3117	00259208	7-Jun-2023	1-Jun-2024
FSOATS 3m, above 1 GHz	Frankonia	SAC3	F199004	16-Nov-2022	16-Nov-2025
Tape measure, 1" x 33'	Lufkin	PHV1410CMEN	10720	16-Jan-2023	15-Jan-2026
DMM Multimeter	FLUKE	79 III	71740743	5-Apr-2023	1-Apr-2024
Preamplifier, 500 MHz 18 GHz	Com-Power	PAM-118A	18040133	Calibration	Not Required
Wifi Filter	K&L	8NSL26-2437/E82.2-0/0	1	Calibration	Not Required
3 GHz High Pass filter	Anatech Electronics	0K0R2	01	Calibration	Not Required
Programmable DC power source	Keithley	2260B-30-72 720 W	1411917	21-Apr-2023	15-Apr-2024

Table RE06.1: Test Equipment Used

Software Used: Keysight PXE software A.32.06, RE Signal Maximization Tool v2023Jul14.xlsx.

Test Data

The radiated emission test process began with a preliminary scan at multiple turntable angles, antenna heights, and both antenna polarizations. For test standards that require reorienting the test sample, further preliminary scans were taken in those alternate orientations typically described as X, Y, and Z. Subsequent testing was done using on the orientation(s) producing the highest result relative to the test limit. Where the test standard requires cable manipulation, this was done at one of more likely worst case frequencies selected by the test personnel while observing the receiver display. At each of the frequencies selected for final measurements, the turntable angle, antenna height, and antenna polarization were explored to find the worst-case settings. Final field strength measurements were taken in that set of positions. Full maximization was not performed at frequencies that are noise floor measurements included per the test standard requirements.

In the 3.2 GHz to 12.5 GHz frequency range, pre-scan spectral data was taken at 1 meter and extrapolated to a 3 meter distance. Final measurements were made at 3 meters.

At azimuth angle 0° the 'front' reference mark of the turntable is pointed Southward. At 90° the reference mark points West. At -90° it points East. At -7° the turntable reference mark is pointed directly at the antenna. The designation of the X, Y, and Z orientations of the test sample are sample dependent, so these are reported by use of photographs.

The table shows the selected final measurement data between 1 GHz and 12.5 GHz. It includes at least the six strongest emissions observed relative to the test limit, along with other data points of interest. Where a data point is highlighted is yellow, this is an aid to indicate the data point(s) with the least margin to the test limit. A positive margin value indicates that the emission was below the test limit. The test limit is the Composite FCC/CISPR Class B Limit at 3m.

The measurement was taken with VHF transceiver of the EUT in Receive + Transmit mode, tuned to frequencies 118.05 MHz (Low channel), 127.49 MHz (Mid channel), 136.99 MHz (High channel) frequencies respectively. The transmitter was configured in accordance with 8.33 kHz spacing, and it was transmitting at 16 W power output.

Frequency (MHz)	Avg Limit (dBuV/m)	Pk Limit (dBuV/m)	Avg Level (dBuV/m)	Pk Level (dBuV/m)	Av Margin (dB)	Pk Margin (dB)	Azimuth (degree)	Height (mm)	Antenna Polarity
2228.250	54.00	74.00	31.80	46.30	22.20	27.70	-81	1183	HORZ
2355.250	54.00	74.00	31.90	46.10	22.10	27.90	180	1053	VERT
2383.000	54.00	74.00	32.30	46.10	21.70	27.90	-62	1906	VERT

Table RE06.2: Emission (Low channel)

Frequency (MHz)	Avg Limit (dBuV/m)	Pk Limit (dBuV/m)	Avg Level (dBuV/m)	Pk Level (dBuV/m)	Av Margin (dB)	Pk Margin (dB)	Azimuth (degree)	Height (mm)	Antenna Polarity
1329.000	54.00	74.00	30.20	51.60	23.80	22.40	-94	2133	VERT
3091.000	54.00	74.00	33.70	47.20	20.30	26.80	90	3104	HORZ
3163.750	54.00	74.00	34.40	48.60	19.60	25.40	103	1022	VERT
10135.750	54.00	74.00	46.80	61.40	7.20	12.60	-193	3691	VERT
12107.750	54.00	74.00	46.30	59.90	7.70	14.10	-133	1472	VERT
12459.500	54.00	74.00	47.20	60.40	6.80	13.60	-144	2701	VERT

Table RE06.3: Emission (Mid channel)

Frequency (MHz)	Avg Limit (dBuV/m)	Pk Limit (dBuV/m)	Avg Level (dBuV/m)	Pk Level (dBuV/m)	Av Margin (dB)	Pk Margin (dB)	Azimuth (degree)	Height (mm)	Antenna Polarity
1327.500	54.00	74.00	30.00	50.60	24.00	23.40	-100	2378	VERT
2375.000	54.00	74.00	31.90	46.40	22.10	27.60	-157	1971	VERT
3187.750	54.00	74.00	33.90	47.60	20.10	26.40	80	3594	HORZ
10120.500	54.00	74.00	46.60	60.60	7.40	13.40	-23	1211	HORZ
11114.750	54.00	74.00	45.20	58.90	8.80	15.10	2	3290	HORZ
12401.750	54.00	74.00	46.40	60.20	7.60	13.80	-38	1863	VERT

Table RE06.4: Emission (High channel)

The graphs below show the background spectrum observed during pre-scan, as well as the final data points from the tables above. The carrier for the 2.4 GHz band Bluetooth radio is shown in the charts. This intentional transmission is not subject to the QP Limit.

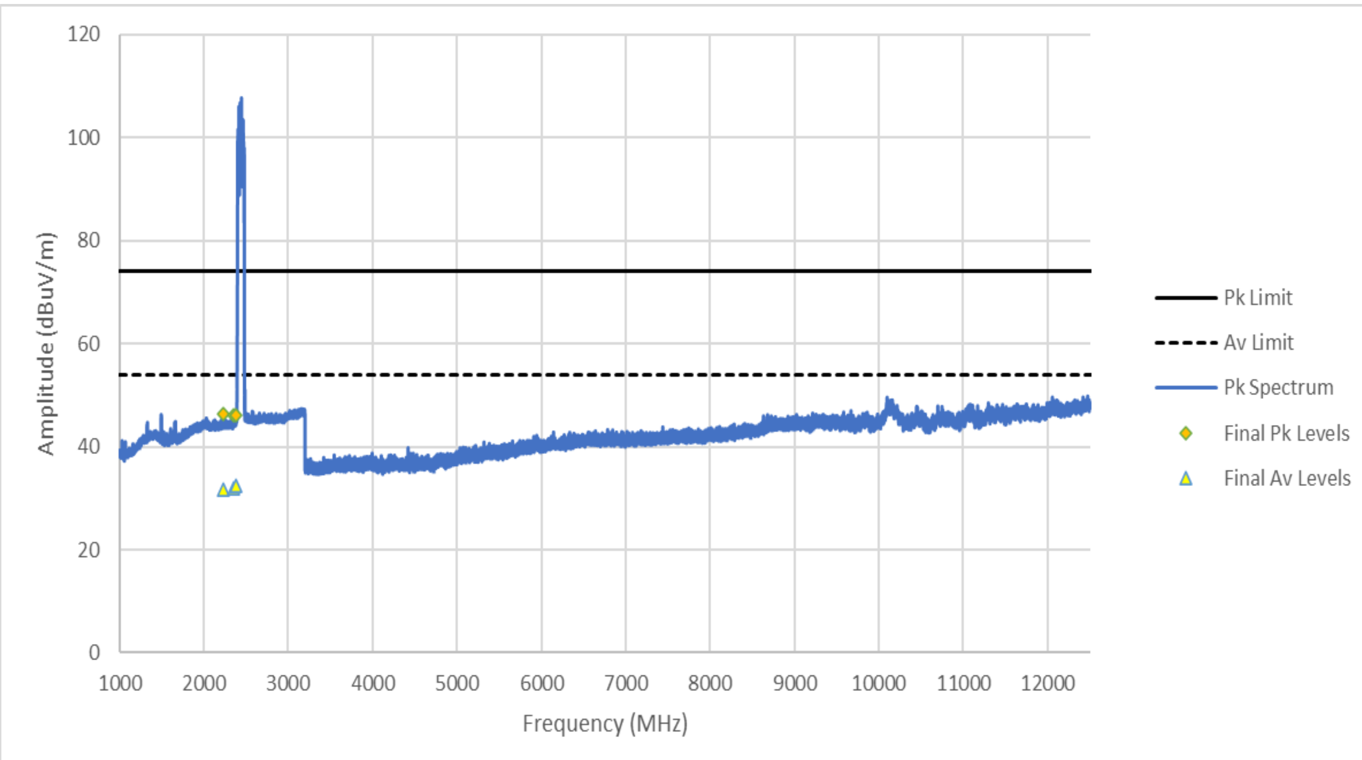

Figure RE06.1: Spectral data (Low channel)

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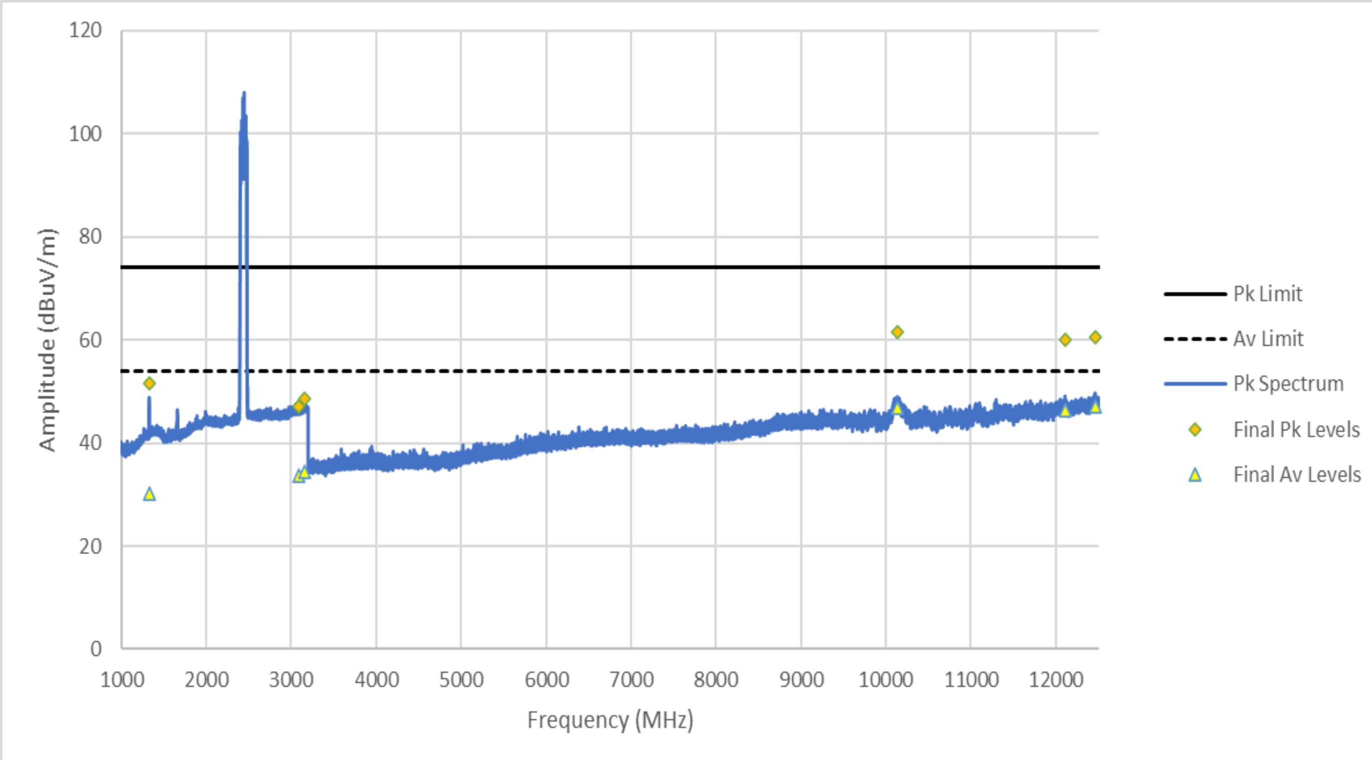

Figure RE06.2: Spectral data (Mid channel)

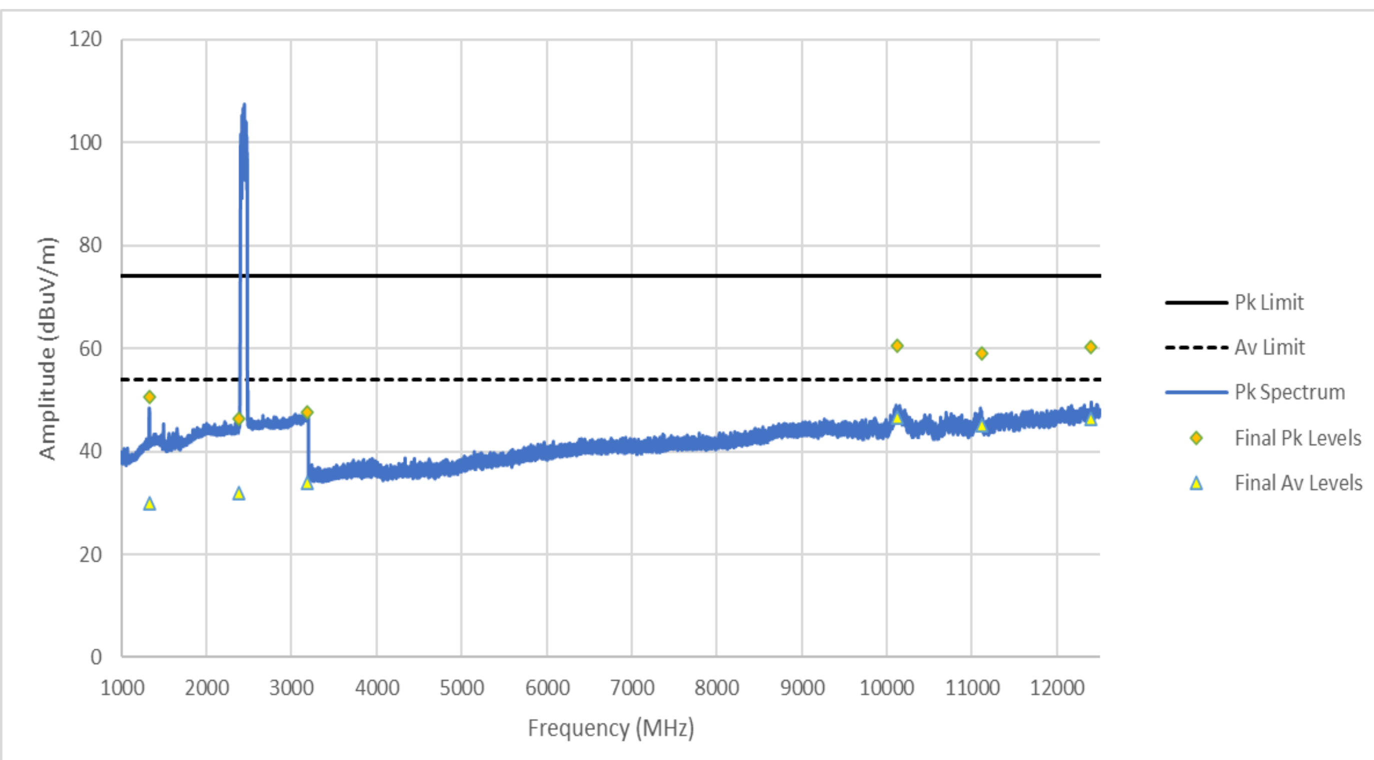

Figure RE06.3: Spectral data (High channel)

Setup Photographs

The following photographs show the EUT configured and arranged in the manner in which it was measured.

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to identify the report where
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Figure RE06.4: EUT test setup, front view

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Figure RE06.5: EUT test setup, reverse view

This line is the end of the test record.

Concluding Notes

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