



Radio Test Report

Monitor Audio Ltd

Caspian 4G

Integrated Amplifier

47 CFR Part 15.247 Effective Date 1st October 2024

DSS: Part 15 Spread Spectrum Transmitter

Test Date: 17th September 2025 to 30th September 2025

Report Number: 09-14745-9-25 Issue 01

The testing was carried out by Kiwa Ltd trading as Kiwa Electrical Compliance, an independent test house, at their test facility located at:

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File Name: Monitor Audio Group.14745-9 Issue 01

QMF21J - Issue 05 - KEC Issue 02; 47 CFR Part 15.247 2024



Arnolds Court, Arnolds Farm Lane, Mountnessing, Brentwood Essex, CM13 1UT

Certificate of Test 14745-9

The equipment noted below has been partially tested by Kiwa Electrical Compliance and, where appropriate, conforms to the relevant subpart of 47 CFR Part 15.247. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	Caspian 4G Integrated Amplifier
Model Number:	Integrated Amplifier
Unique Serial Number:	4332426100005
Applicant:	Monitor Audio Ltd Unit 2 24 Brook Road Rayleigh, Essex SS6 7XJ UK
Proposed FCC ID:	O7V-MA102410
Full measurement results are detailed in Report Number:	09-14745-9-25 Issue 01
Test Standards:	47 CFR Part 15.247 Effective Date 1st October 2024 DSS: Part 15 Spread Spectrum Transmitter

NOTE:

With reference to the Rule part detailed, not all tests within the Rule part have been applied at the request of the applicant. The following tests have not been performed at the applicant's request: AC power line conducted emissions, Occupied bandwidth, Maximum Average conducted output power, Maximum Peak conducted output power, Maximum Power Spectral Density, Duty cycle, FHSS carrier frequency separation, Average time of occupancy, Number of Hop Channels. Certain tests were not performed based upon applicant's declarations. Certain other requirements are subject to applicant's declaration only and have not been tested/verified. For details refer to section 3 of this report. This report pertains to the BTC functionality of the Integrated Amplifier. For BTC functionality of the Streaming Amplifier please refer to KEC report number 08-14745-3-24. Contains FCC ID: 2AC7Z-ESPWROOM32UE.

DEVIATIONS: No tests have had deviations applied.

This certificate relates only to the unit tested as identified by a unique serial number and in the condition at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of unit not meeting the intentions of the standard or the requirements of the Federal Regulations, particularly under different conditions to those during testing. Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95%.

Date of Test: 17th September 2025 to 30th September 2025

Test Engineer:
Chee-Wah Yeung

Chee-Wah Yeung
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Radio Approvals Manager


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Date: 2025.12.08 13:46:34 Z



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2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Monitor Audio Ltd Unit 2 24 Brook Road Rayleigh Essex SS6 7XJ UK	
Manufacturer of EUT	Roksan	
Full Name of EUT	Caspian 4G Integrated Amplifier	
Model Number of EUT (HVIN)	Integrated Amplifier	
Serial Number of EUT	4332426100005	
Date Received	17th September 2025	
Date of Test:	17th September 2025 to 30th September 2025	
Date Report Issued	5th December 2025	
Main Function	Stereo Audio Amplifier, featuring digital and analogue inputs, A2DP and BLE control.	
EUT Specification	Height	100 mm
	Width	430 mm
	Depth	345 mm
	Weight	17 kg
	Voltage	100-240 V
	Current	6.3 A

Alternative Model Numbers.

Monitor Audio Ltd have declared the following model numbers to be part of the product family: -

Model	Notes
Streaming Amplifier	Includes 2.4/5GHz WiFi, LAN (Ethernet), USB and HDMI.

For BTC functionality of the Streaming Amplifier please refer to KEC report number 08-14745-3-24.

2.2 Applicant declarations for testing

General Parameters	
EUT Normal use position	Table top
Choice of model(s) for type tests	Production sample
Antenna details	Applicant designed PIFA antenna 104699 A.5 08/12/2023 fitted into chassis rear panel. Gains 2.4 GHz 2.7 dBi, 2.44 GHz 3.65 dBi, 2.48 GHz 2.77 dBi. Refer to KEC report 10-14745-22-25 Antenna report Issue 01.
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	2480 MHz
Lowest Signal generated in EUT	32.768 kHz
Hardware Version (HVIN)	Integrated Amplifier
Software Version	N/A
Firmware Version (FVIN)	1.14.293
Type of Equipment	Multi-Radio
Technology Type	BTC & BLE + 2.4 GHz WiFi
Geo-location (yes/no)	No
Bluetooth Parameters	
TX Parameters	
Alignment range – transmitter	2402 - 2480 MHz
EUT Declared Modulation Parameters	GFSK, DQPSK & 8-DPSK
EUT Declared Power level	8.439 dBm
EUT Declared Signal Bandwidths	1 MHz
EUT Declared Channel Spacings	1 MHz
EUT declared Duty Cycle	Not Provided
Unmodulated carrier available?	No
Declared frequency stability	Not Provided
RX parameters	
Alignment range – receiver	2402 - 2480 MHz
EUT Declared RX Signal Bandwidth	1 MHz
Receiver Signal Level (RSL)	Not Provided
Method of Monitoring Receiver BER	Not Provided
General BT Parameters	
Specific Technology Type	Bluetooth Classic
Wi-Fi Secondary, Primary or both	N/A
Wi-Fi frame base / load based	N/A
Dynamic frequency selection employed	N/A
TPC	N/A
FHSS / Non-FHSS	FHSS
Number of hopping channels	79
Average dwell time	Not Provided
Adaptivity type	Both (AFA)
Priority class	Not Provided
Energy detection threshold option	Not Provided
Minimum performance criteria for blocking (BER)	Not Provided
Number of antennas and type used	1 x PIFA antenna 104699 A.5 08/12/2023 fitted into chassis rear panel. Gains 2.4 GHz 2.7 dBi, 2.44 GHz 3.65 dBi, 2.48 GHz 2.77 dBi. (Bluetooth classic operation).
Diversity	No
Beamforming	N/A

MIMO	N/A
Supported data rates	DH1, DH3, DH5, 2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3 & 3-DH5
FCC Parameters	
FCC Transmitter Class	DSS: Part 15 Spread Spectrum Transmitter

2.3 Functional description

Stereo audio amplifier with the following:

Inputs - 2x RCA Analogue, 2x RCA for Turntables, 2x Balanced XLR, 2x Digital Coaxial, 2x Digital Optical.

Outputs - 4x RCA Analogue, 2x Balanced XLR, Speaker Outputs.

Networking - 1x A2DP Bluetooth Audio, 1x BLE/Wi-Fi (ESP32).

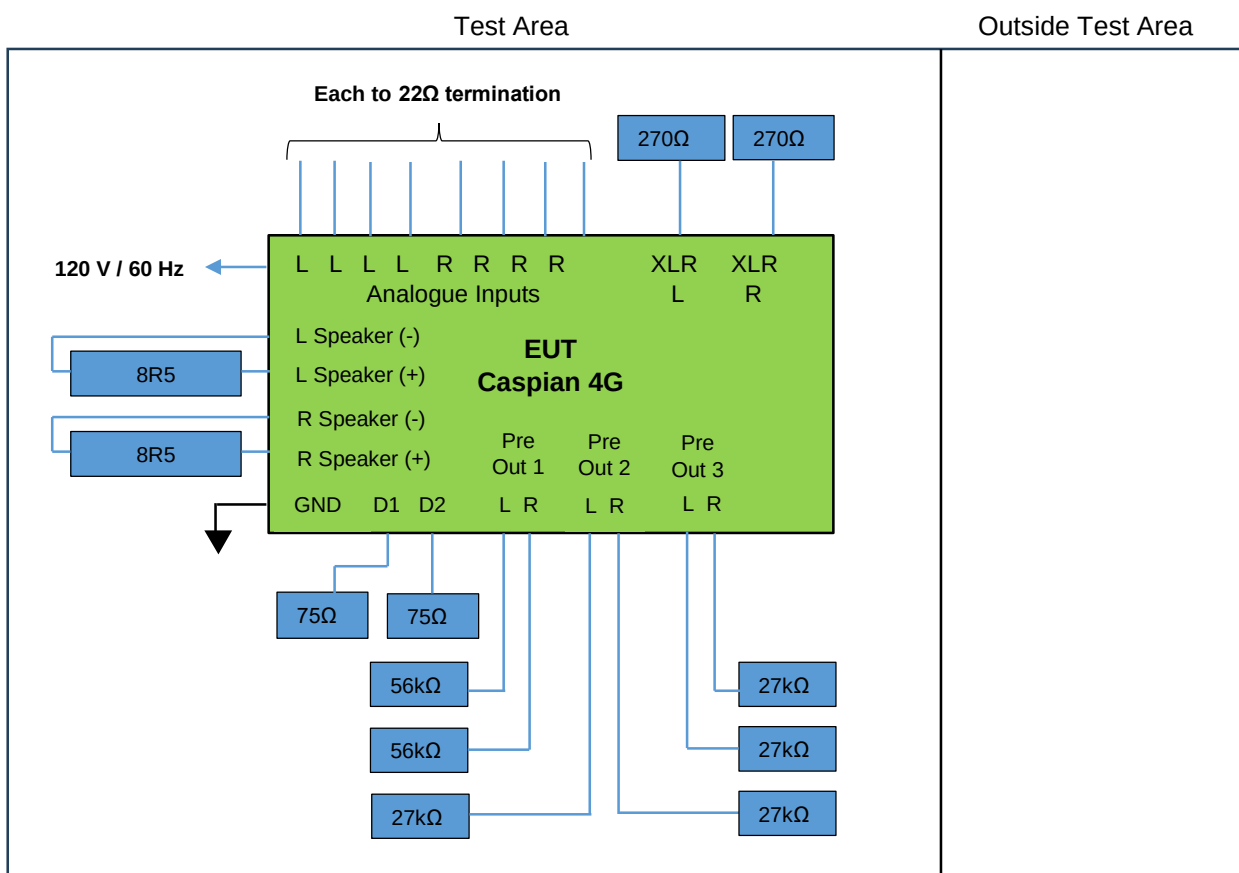
Product allows for control via remote control, physical controls on the front or via one of two mobile applications.

MaestroUnite connects via Bluetooth Low Energy to provision Wi-Fi and allows playback, audio and basic operation control. Streaming Amplifier models also include a BluOS streaming PCB, which enables music streaming over Wi-Fi or Ethernet and system control over IP networks.

2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 1	Constant Transmit, BTC, Low Channel (2402 MHz), GFSK, DH5, Default Power setting + BLE 2.4GHz Advertising	Yes
Mode 2	Constant Transmit, BTC, Mid Channel (2441 MHz), GFSK, DH5, Default Power setting + BLE 2.4GHz Advertising	Yes
Mode 3	Constant Transmit, BTC, High Channel (2480 MHz), GFSK, DH5, Default Power setting + BLE 2.4GHz Advertising	Yes

2.5 Emissions configuration



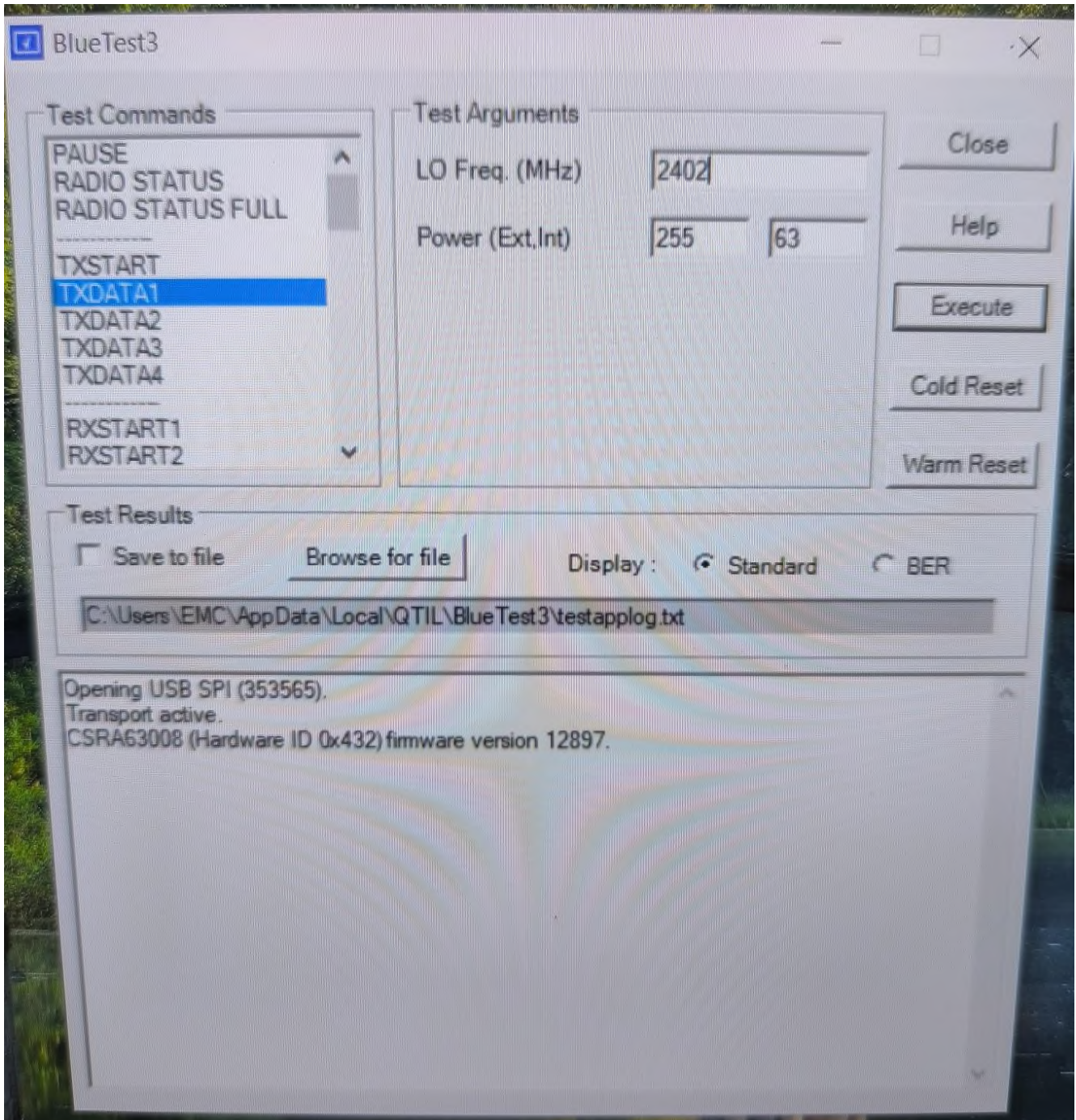
The unit was powered from 120 V AC mains. For conducted tests the internal antenna was disconnected and a UFL to SMA cable was connected in its place. The unit was configured using engineering software called “Blue test 3” provided by the Manufacturer to allow permanent transmit modes of device on the top, middle and bottom channels with modulation and with TX hopping sequence on and TX hopping sequence off, as stated within section 2.4 of this report. The ‘GND’ port was connect to the test chamber safety earth. Bluetooth classic Transmit modes were also set transmitting simultaneously with the BLE advertising mode from the BLE pre-approved module to check for any intermodulation emissions.

The Bluetooth Classic power setting was set to its default power setting as requested by the applicant – this was using (255, 63) command setting in the Bluetest 3 software (+8dBm).

Low Channel: 2402 MHz
Mid Channel: 2441 MHz
High Channel: 2480 MHz

Note: This physical unit was the same unit and therefore the same Bluetooth Classic radio tested under Kiwa report 08-14745-3-24. The serial number is different as the serial number is associated with the rear panel, which gets changed, along with the removal of the BluOs WLAN board, to make the “Streaming Amplifier” model into the “Integrated Amplifier” model.

Screen shot of GUI/software used to set Bluetooth Classic test modes:



2.5.1 Signal leads

Port Name	Cable Type	Connected
Mains	3 Core	Yes
A1 L	Analogue RCA Input	Yes
A1 R	Analogue RCA Input	Yes
A2 L	Analogue RCA Input	Yes
A2 R	Analogue RCA Input	Yes
A3 L	Balanced XLR Input	Yes
A3 R	Analogue RCA Input	Yes
MC L	Analogue RCA Input	Yes
MC R	Analogue RCA Input	Yes
MM L	Analogue RCA Input	Yes
MM R	Analogue RCA Input	Yes
D1	Digital Coaxial Input	Yes
D2	Digital Coaxial Input	Yes
D3	Digital Optical Input	No
D4	Digital Optical Input	No
Pre Out 1	Balanced XLR Output	Yes
Pre Out 2	Analogue RCA Output	Yes
Pre Out 3	Analogue RCA Output	Yes
Speaker L 1	4mm Banana Output	Yes
Speaker L 2	4mm Banana Output	Yes
Speaker R 1	4mm Banana Output	Yes
Speaker R 2	4mm Banana Output	Yes
IR Input	3.5mm Jack Input	No
12V Trigger 1	3.5mm Jack Input	No
12V Trigger 2	3.5mm Jack Input	No
GND	1 Core	Yes

3 Summary of test results

The Caspian 4G Integrated Amplifier was tested for compliance to the following standard(s):

47 CFR Part 15.247 Effective Date 1st October 2024
DSS: Part 15 Spread Spectrum Transmitter

Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard or the essential requirements of the directive, particularly under different conditions to those during testing. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Title	References	Results
Transmitter Tests		
1. AC power line conducted emissions	47 CFR Part 15.247 Part 15.207	NOT TESTED ¹
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15.247 Part 15.209	PASSED ⁴
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15.247 Part 15.209	PASSED ⁴
4. Radiated emissions 30 MHz -1 GHz	47 CFR Part 15.247 Part 15.247(d) & 15.209	PASSED
5. Radiated emissions above 1 GHz	47 CFR Part 15.247 Part 15.247(d) & 15.209	PASSED ³
6. Effective radiated power field strength	47 CFR Part 15.247 Part 15.247(d)	PASSED
7. Band Edge Compliance	47 CFR Part 15.247 Part 15.215 & 15.247(d)	PASSED
8. Occupied bandwidth	47 CFR Part 15.247 Part 15.247(a)(1)(iii)	NOT TESTED ¹
9. Maximum Average conducted output power	47 CFR Part 15.247 Part 15.247(b3)	NOT TESTED ¹
10. Maximum Peak conducted output power	47 CFR Part 15.247 Part 15.247(b)(3)	NOT TESTED ¹
11. Maximum Power Spectral Density	47 CFR Part 15.247 Part 15.247(e)	NOT TESTED ¹
12. Antenna power conducted emissions	47 CFR Part 15.247 Part 15.247(d)	NOT APPLICABLE ²
13. Duty cycle	47 CFR Part 15.247 Part 15.35(c)	NOT TESTED ¹
14. FHSS carrier frequency separation	47 CFR Part 15.247 Part 15.247(a1)	NOT TESTED ¹
15. Average time of occupancy	47 CFR Part 15.247 Part 15.247(a)(1)(iii)	NOT TESTED ¹
16. Number of Hop Channels	47 CFR Part 15.247 Part 15.247(a)(1)(iii)	NOT TESTED ¹

¹ Not tested at the request of the applicant.

² Applies to EUT's with an antenna port. The EUT has an integral antenna only.

³ Spectrum investigated up to a frequency of 25GHz based on 10 times the highest Bluetooth Classic channel in equipment of 2480MHz.

⁴ Spectrum below 30MHz started at a frequency of 9 kHz up to a frequency of 30MHz based on the lowest signal generated/used within the equipment as declared by the applicant.

4 Specifications

The tests were performed and operated in accordance with Kiwa Electrical Compliance procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	47 CFR Part 15.247	2024	Part 15 - Radio Frequency Devices - Subpart C - Intentional Radiators 15.247 - Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
4.1.2	ANSI C63.10	2020	American National Standard for Testing Unlicensed Wireless Devices
4.1.3	ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
4.1.4	KDB 558074 D01 v05r02	2019	Federal Communications Commission Office of Engineering and Technology Laboratory Division; guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the FCC rules

4.2 Deviations

No deviations.

4.3 Declared extremes of temperature & voltage

The following nominal and extremes conditions were declared by the applicant.

Temperature Test Conditions		Voltage Test Conditions	
T nominal	20°C	V nominal	120 V AC
T minimum	5°C	V minimum	100 V AC
T maximum	35°C	V maximum	240 V AC

Extremes of temperature are based upon manufacturer's declaration.

The ambient test conditions of humidity and pressure in the laboratory were as specified in each specific test section within this report

4.4 Test fixtures

No test fixtures were used during this limited test suite.

5 Tests, methods and results

5.1 AC power line conducted emissions

NOT TESTED: Not tested at the request of the applicant.

5.2 Radiated emissions 9 - 150 kHz

5.2.1 Test methods

Test Requirements: 47 CFR Part 15.247 Part 15.209 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15.247 Part 15.209/15.247(d) [Reference 4.1.1 of this report]

5.2.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed whilst powered by 120 V, 60 Hz.

The EUT was operated in Modes 1, 2 and 3.

5.2.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. Measurements were made in a semi-anechoic chamber (pre-scan) with any final measurements required performed on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment was rotated 360 degrees to record the worst-case emissions.
At least 6 signals within 20 & dB and all signals within 10dB of the limit were investigated.
Tests were performed using Test Site M.

5.2.4 Test equipment

E411, E624, TMS81

See Section 8 for more details

5.2.5 Test results

Temperature of test environment 19°C
Humidity of test environment 65%
Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
Low channel	2402 MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
All emissions were greater than 20 dB below the limit				

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
Mid channel	2441 MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
All emissions were greater than 20 dB below the limit				

Plot refs
14745-9 Rad 1 9k-150kHz Para
14745-9 Rad 1 9k-50kHz Perp

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
High channel	2480 MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
All emissions were greater than 20 dB below the limit				

No discernible difference was noted in emissions between modulation (GFSK, $\pi/4$ -DQPSK & 8DPSK) therefore, the final measurements are presented for GFSK DH5 mode only.

Peak detector "Max held" Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:

15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.

The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: 9kHz to 30MHz ± 3.11 dB (UE30).

5.3 Radiated emissions 150 kHz - 30 MHz

5.3.1 Test methods

Test Requirements: 47 CFR Part 15.247 Part 15.209 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15.247 Part 15.209/15.247(d) [Reference 4.1.1 of this report]

5.3.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed whilst powered by 120 V, 60 Hz.

The EUT was operated in Modes 1, 2 and 3.

5.3.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made in a semi-anechoic chamber (pre-scan) with any final measurements required performed on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment was rotated 360 degrees to record the worst-case emissions.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site M.

5.3.4 Test equipment

E411, E624, TMS81

See Section 8 for more details

5.3.5 Test results

Temperature of test environment 19°C
Humidity of test environment 65%
Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
Low channel	2402 MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
All emissions were greater than 20 dB below the limit				

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
Mid channel	2441 MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
All emissions were greater than 20 dB below the limit				

Plot refs
14745-9 Rad 1 150k-30MHz Para
14745-9 Rad 1 150k-30MHz Perp

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
High channel	2480 MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
All emissions were greater than 20 dB below the limit				

No discernible difference was noted in emissions between modulation (GFSK, $\pi/4$ -DQPSK & 8DPSK) therefore, the final measurements are presented for GFSK DH5 mode only.

Peak detector "Max held" Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:

15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.

The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: (TMS81): 9kHz to 30MHz ± 3.11 dB (UE30).

5.4 Radiated emissions 30 MHz -1 GHz

5.4.1 Test methods

Test Requirements: 47 CFR Part 15.247 Part 15.247(d) & 15.209 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.5 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15.247 Part 15.247(d) & 15.209 [Reference 4.1.1 of this report]

5.4.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed whilst powered by 120 V, 60 Hz.

The EUT was operated in Modes 1, 2 and 3.

5.4.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

The equipment was rotated 360 degrees and the measuring antenna scanned 1 – 4 metres in both horizontal and vertical polarisations to record any worst-case emissions.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site M.

5.4.4 Test equipment

E411, E624, E743, LPE364

See Section 8 for more details

5.4.5 Test results

Temperature of test environment 19°C
Humidity of test environment 68%
Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
Low channel	2402 MHz

Plot refs
Low, Mid and High channel were identical - See Mid Channel plots.

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
Mid channel	2441MHz

Table of signals measured for Rad 1 Horizontal 30M-1GHz

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	196.613	32.4	31.0	-12.5
2	208.901	28.3	25.9	-17.6
3	245.766	35.6	33.8	-12.2
4	258.055	35.4	33.3	-12.7
5	282.631	33.2	31.2	-14.8
6	307.208	33.9	31.4	-14.6
7	356.361	34.7	32.1	-13.9
8	393.226	37.6	35.3	-10.7
9	442.379	39.6	37.9	-8.1
10	761.875	38.3	35.5	-10.5
11	786.451	41.1	38.2	-7.8
12	786.452	40.7	38.2	-7.8
13	786.452	41.4	39.1	-6.9
14	811.029	44.5	42.8	-3.2
15	835.605	45.9	44.4	-1.6
16	860.182	39.4	36.7	-9.3
17	884.759	46.0	44.7	-1.3

Table of signals measured for Rad 1 Vertical 30M-1GHz

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	49.153	29.7	27.7	-12.3
2	73.730	27.5	25.3	-14.7
3	86.018	28.8	26.5	-13.5
4	98.306	33.6	32.2	-11.3
5	147.460	34.7	33.0	-10.5
6	159.748	30.4	28.1	-15.4
7	208.901	32.0	30.4	-13.1
8	221.189	29.7	27.4	-18.6
9	245.766	34.3	32.0	-14.0
10	258.054	36.9	35.2	-10.8
11	282.631	35.6	33.6	-12.4
12	417.802	34.3	31.7	-14.3
13	442.379	36.3	33.3	-12.7
14	454.667	34.7	30.9	-15.1
15	466.955	37.6	35.4	-10.6
16	589.839	36.4	33.0	-13.0
17	638.991	39.8	37.6	-8.4
18	703.540	33.7	27.3	-18.7
19	737.298	39.1	36.2	-9.8
20	786.451	36.9	33.4	-12.6
21	811.028	42.2	39.8	-6.2
22	835.604	44.4	43.1	-2.9
23	884.758	39.3	36.7	-9.3

Plot refs

14745-9 Tx Spurious Emissions 30-300 MHz BTC Mid Ch (2441 MHz) + BLE Adv Horizontal
14745-9 Tx Spurious Emissions 30-300 MHz BTC Mid Ch (2441 MHz) + BLE Adv Vertical
14745-9 Tx Spurious Emissions 300-1000 MHz BTC Mid Ch (2441 MHz) + BLE Adv Horizontal
14745-9 Tx Spurious Emissions 300-1000 MHz BTC Mid Ch (2441 MHz) + BLE Adv Vertical

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
High channel	2480 MHz

Plot refs
Low, Mid and High channel were identical - See Mid Channel plots.

No discernible difference was noted in emissions between modulation (GFSK, $\pi/4$ -DQPSK & 8DPSK) therefore, the final measurements are presented for GFSK DH5 mode only.

Peak detector "Max held" Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

No discernible difference was noted in emissions between channel settings (exploratory measurements), therefore final measurements are presented for TX mid channel mode only for these test ranges.

Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only Mid channel plots are shown in this report.

LIMITS:

15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.

The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: 30MHz - 40MHz ± 10.67 dB (UE82), 40MHz - 50MHz ± 6.11 dB (UE83), 50MHz - 1GHz ± 6.48 dB (UE84).

5.5 Radiated emissions above 1 GHz

5.5.1 Test methods

Test Requirements: 47 CFR Part 15.247 Part 15.247(d) & 15.209 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.6 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15.247 Part 15.247(d) & 15.209 [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed whilst powered by 120 V, 60 Hz.

The EUT was operated in Mode 1, 2 and 3.

5.5.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. Measurements were made in a semi-anechoic chamber with appropriate absorbing material for use in this range. Horn antennas were used at heights where the whole of the EUT was contained within the main beam. Emissions pre-scans were performed, including Antenna height scanning to determine any worst-case maximised emissions/point sources of radiation for final test. Final tests were performed with the antenna in worst case position. The EUT was rotated through 360 degrees to record the worst-case emissions. A measurement distance of 3m was used between the test range 1 - 6GHz, 1.2m was used in the test range 6 - 18GHz and 0.3m was used in the test range 18 - 25GHz. At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site B.

5.5.4 Test equipment

E412, E428, E429, E856, E904, TMS78, TMS79

See Section 8 for more details

5.5.5 Test results

Temperature of test environment 20°C
Humidity of test environment 64%
Pressure of test environment 102kPa

Setup Table

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
Low channel	2402 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
4804	49.07	-24.93	35.33	-18.67	Upright	Vertical
4804	49.87	-24.13	37.92	-16.08	Upright	Horizontal

Plots

Low, Mid and High channel were identical with exception of the harmonics - See Mid Channel plots.

Setup Table

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
Mid channel	2441 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
2284.8	46.94	-27.06	34.91	-19.09	Upright	Horizontal
4882	46.67	48.62	-25.38	36.23	Upright	Vertical
4882	50.88	52.83	-21.17	39.51	Upright	Horizontal

Plots						
14745-9 Tx Spurious Emissions 1-2 GHz BTC Low Ch (2402 MHz) + BLE Adv Vertical						
14745-9 Tx Spurious Emissions 1-2 GHz BTC Low Ch (2402 MHz) + BLE Adv Horizontal						
14745-9 Tx Spurious Emissions 2-2.7 GHz BTC Mid Ch (2441 MHz) + BLE Adv Vertical						
14745-9 Tx Spurious Emissions 2-2.7 GHz BTC Mid Ch (2441 MHz) + BLE Adv Horizontal						
14745-9 Tx Spurious Emissions 2.7-5 GHz BTC Mid Ch (2441 MHz) + BLE Adv Vertical						
14745-9 Tx Spurious Emissions 2.7-5 GHz BTC Mid Ch (2441 MHz) + BLE Adv Horizontal						
14745-9 Tx Spurious Emissions 5-6 GHz BTC Mid Ch (2441 MHz) + BLE Adv Vertical						
14745-9 Tx Spurious Emissions 5-6 GHz BTC Mid Ch (2441 MHz) + BLE Adv Horizontal						
14745-9 Tx Spurious Emissions 6-7.77 GHz BTC Mid Ch (2441 MHz) + BLE Adv Vertical						
14745-9 Tx Spurious Emissions 6-7.77 GHz BTC Mid Ch (2441 MHz) + BLE Adv Horizontal						
14745-9 Tx Spurious Emissions 7.77-10 GHz BTC Mid Ch (2441 MHz) + BLE Adv Vertical						
14745-9 Tx Spurious Emissions 7.77-10 GHz BTC Mid Ch (2441 MHz) + BLE Adv Horizontal						
14745-9 Tx Spurious Emissions 10-12.5 GHz BTC Mid Ch (2441 MHz) + BLE Adv Vertical						
14745-9 Tx Spurious Emissions 10-12.5 GHz BTC Mid Ch (2441 MHz) + BLE Adv Horizontal						
14745-9 Tx Spurious Emissions 12-15 GHz BTC Mid Ch (2441 MHz) + BLE Adv Vertical						
14745-9 Tx Spurious Emissions 12-15 GHz BTC Mid Ch (2441 MHz) + BLE Adv Horizontal						
14745-9 Tx Spurious Emissions 15-18 GHz BTC Mid Ch (2441 MHz) + BLE Adv Vertical						
14745-9 Tx Spurious Emissions 15-18 GHz BTC Mid Ch (2441 MHz) + BLE Adv Horizontal						
14745-9 Tx Spurious Emissions 18-22 GHz BTC Mid Ch (2441 MHz) + BLE Adv Vertical						
14745-9 Tx Spurious Emissions 18-22 GHz BTC Mid Ch (2441 MHz) + BLE Adv Horizontal						
14745-9 Tx Spurious Emissions 22-25 GHz BTC Mid Ch (2441 MHz) + BLE Adv Vertical						
14745-9 Tx Spurious Emissions 22-25 GHz BTC Mid Ch (2441 MHz) + BLE Adv Horizontal						

Setup Table

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
High channel	2480 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
2324.1	46.1	-27.9	34.32	-19.68	Upright	Horizontal
2370.8	48.38	-25.62	34.53	-19.47	Flat	Horizontal
2376.7	46.58	-27.42	34.6	-19.4	Upright	Horizontal
4960	48.17	-25.83	35.47	-18.53	Upright	Vertical
4960	50.26	-23.74	36.58	-17.42	Upright	Horizontal

Plots

Low, Mid and High channel were identical with exception of the harmonics - See Mid Channel plots.

No discernible difference was noted in emissions between modulation (GFSK, $\pi/4$ -DQPSK & 8DPSK) therefore, the final measurements are presented for GFSK DH5 mode only.

Peak detector "Max held" Analyser plots against the Average limit line can be found in Section 6 of this report.

Note: Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only Mid channel plots are shown in this report. BLE was in advertising mode and operating simultaneously with the Bluetooth classic channels – to check for any intermodulation emissions.

LIMITS:

15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: 1GHz to 3GHz $\pm 4.81\text{dB}$ (UE77), 3GHz to 6GHz $\pm 4.81\text{dB}$ (UE78), 6GHz to 12.5GHz $\pm 5.39\text{dB}$ (UE79), 12GHz to 18GHz $\pm 5.38\text{dB}$ (UE80), 18GHz to 26.5GHz $\pm 6.02\text{dB}$ (UE110).

5.6 Effective radiated power field strength

5.6.1 Test methods

Test Requirements: 47 CFR Part 15.247 Part 15.247(d) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.5/6.6 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15.247 Part 15.247(d) & 15.209(a) [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was rotated in all three orthogonal planes to maximise emissions. Final measurements were taken at 3m.

The EUT was operated in Modes 1, 2 and 3.

5.6.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment used' section. The power stated is Peak radiated field strength.

Tests were performed in test site B.

5.6.4 Test equipment

E412, E428, E856, E904

See Section 8 for more details

5.6.5 Test results

Temperature of test environment 19°C
Humidity of test environment 59%
Pressure of test environment 101kPa

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
Low channel	2402 MHz
Mid channel	2441 MHz
High channel	2480 MHz

	Low channel	Mid channel	High channel
Peak Level (dBµV/m)	102.83	102.56	101.63
Plot reference	14745-9 Rad Power BTC Low Ch (2402 MHz)	14745-9 Rad Power BTC Mid Ch (2441 MHz)	14745-9 Rad Power BTC High Ch (2480 MHz)
Antenna Polarisation	Horiz	Vert	Horiz
EUT Polarisation	Upright	Upright	Upright

Based on the full testing in KEC report 08-14745-3-24 (Streaming Amplifier model), DH5 setting yielded the highest power and was repeated in this Integrated model variant testing.
Analyser plots can be found in Section 6 of this report.

LIMITS:

The maximum output power in all cases is 30dBm/1 Watt. 30 dBm e.i.r.p. = 30 dBm + 95.23 = 125.23 dBµV/m @ 3 m.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: 1GHz to 3GHz ±4.81dB (UE77).

5.7 Band Edge Compliance

5.7.1 Test methods

Test Requirements: 47 CFR Part 15.247 Part 15.215 & 15.247(d) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.10 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15.247 Part 15.209(a) & 15.247(d) [Reference 4.1.1 of this report]

5.7.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres.

The EUT was operated in Modes 1 and 3.

5.7.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. The emission from the EUT was maximised before taking any plots/measurements.

Tests were performed using Test Site B.

5.7.4 Test equipment

E412, E428, E856, E904

See Section 8 for more details

5.7.5 Test results

Temperature of test environment 19°C
Humidity of test environment 59%
Pressure of test environment 101kPa

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
Low channel	2402 MHz
High channel	2480 MHz

Restricted Band Edges	Low channel	High channel
Restricted Peak Level measured (dBuV/m)	43.34	45.8
Restricted band edge Peak Plot	14745-9 Rest Band Edge Low chan GFSK DH5	14745-9 Rest Band Edge High chan GFSK DH5
Restricted Average Level measured (dBuV/m)	N/A	N/A
Restricted band edge Average Plot	Peak under Average limit	Peak under Average limit

Based on the full testing in KEC report 08-14745-3-24 (Streaming Amplifier model), DH5 setting yielded the highest result for restricted band edge and was therefore repeated in this Integrated model variant testing.

Restricted band edge plots are shown in section 6.

The tables list the field strengths observed in the adjacent restricted bands, which are required to meet the tighter 15.209 limits.

LIMITS:

AV = 54dBuV/m at band edges
PK = 74dBuV/m at band edges

The restricted band edges closest to the EUT frequency of 2400-2483.5MHz are 2390 & 2483.5MHz.

File Name: Monitor Audio Group.14745-9 Issue 01

QMF21J - Issue 05 - KEC Issue 02; 47 CFR Part 15.247 2024

Further wider span plots have been taken to show the fact that there are no spurious emissions above the restricted limits of 15.209.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
1GHz to 3GHz $\pm 4.81\text{dB}$ (UE77).

5.8 Occupied bandwidth

NOT TESTED: Not tested at the request of the applicant.

5.9 Maximum Average conducted output power

NOT TESTED: Not tested at the request of the applicant.

5.10 Maximum Peak conducted output power

NOT TESTED: Not tested at the request of the applicant.

5.11 Maximum Power Spectral Density

NOT TESTED: Not tested at the request of the applicant.

5.12 Antenna power conducted emissions

NOT APPLICABLE: Applies to EUT's with an antenna port. The EUT has an integral antenna only / The EUT was tested for radiated emissions with its dedicated antenna in position.

5.13 Duty cycle

NOT TESTED: Not tested at the request of the applicant.

5.14 FHSS carrier frequency separation

NOT TESTED: Not tested at the request of the applicant.

5.15 Average time of occupancy

NOT TESTED: Not tested at the request of the applicant.

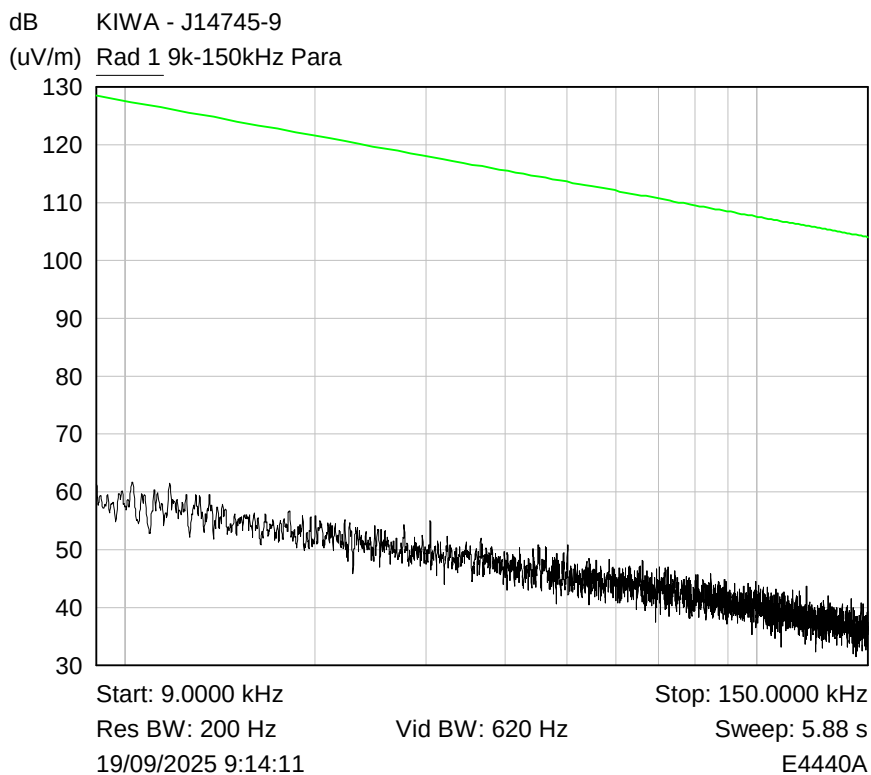
5.16 Number of Hop Channels

NOT TESTED: Not tested at the request of the applicant.

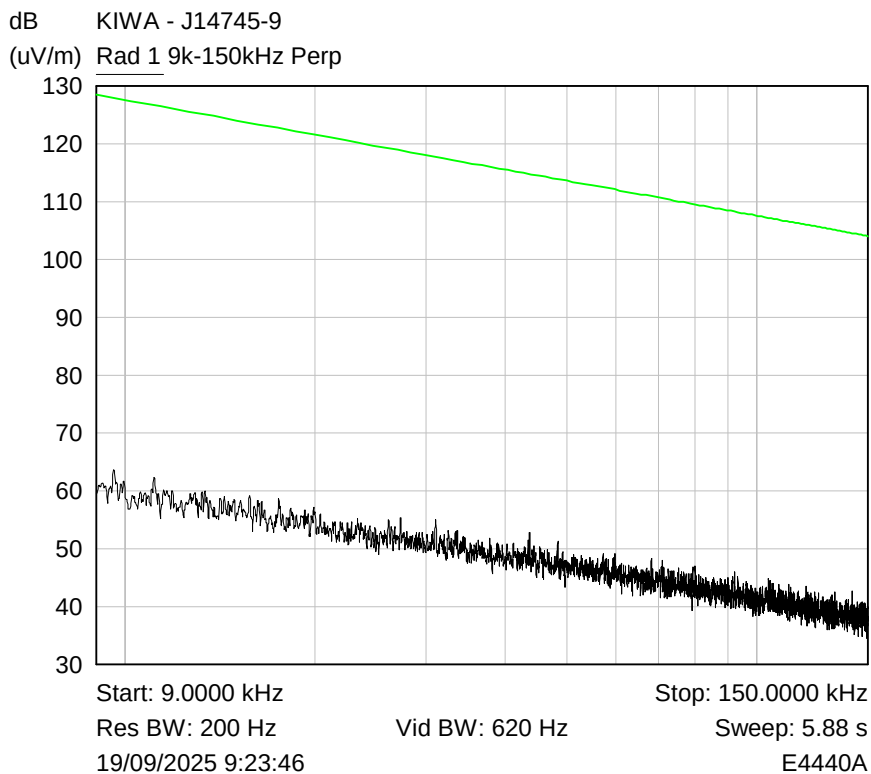
6 Plots/Graphical results

6.1 Radiated emissions 9 - 150 kHz

RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



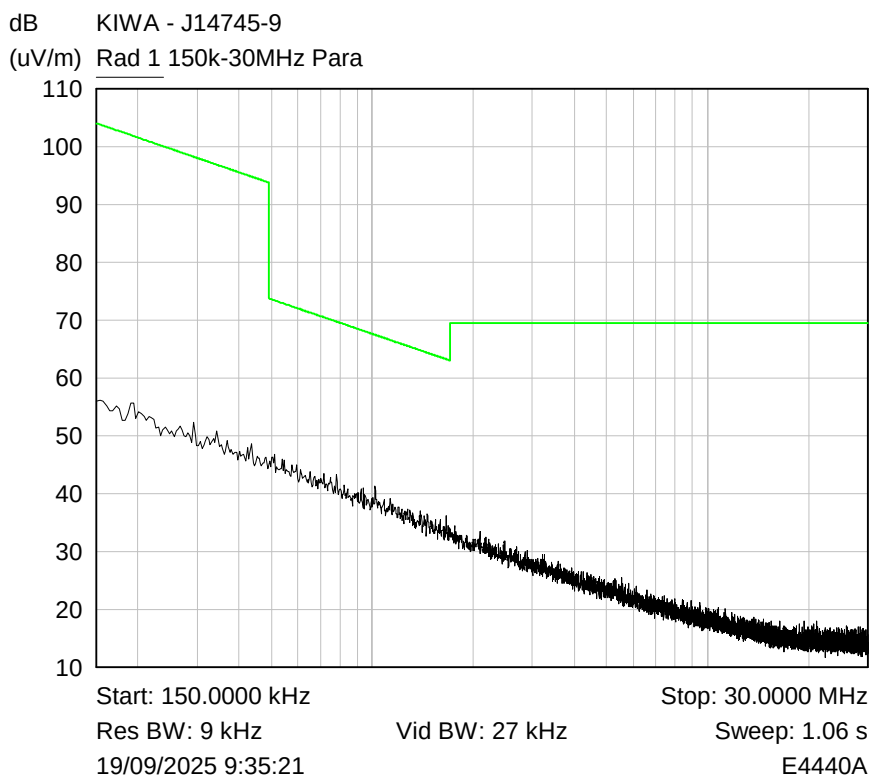
Plot of 9k-150kHz Parallel



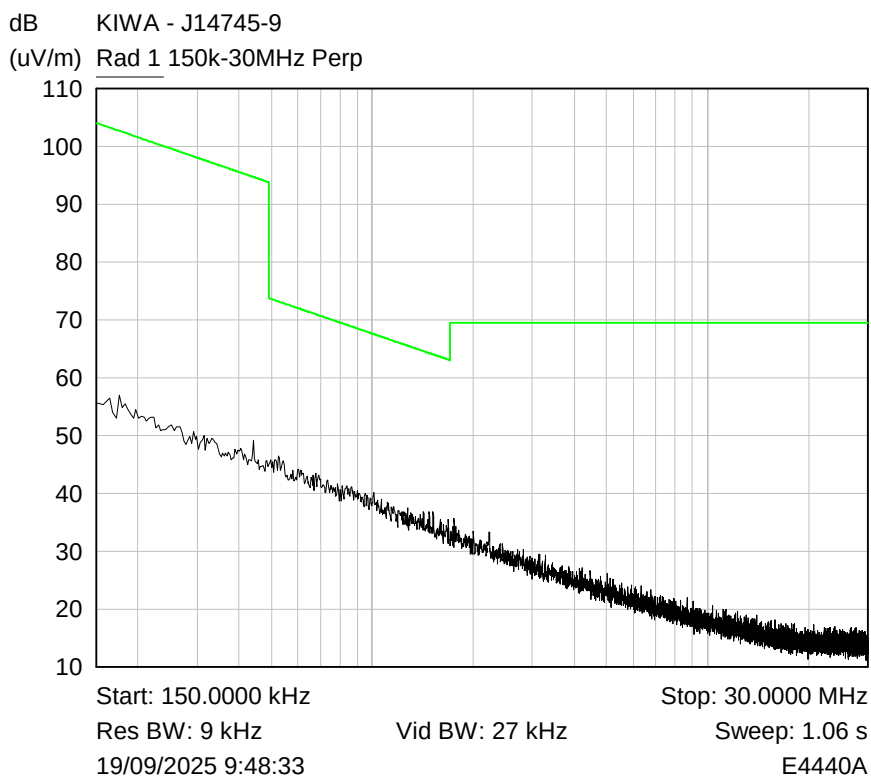
Plot of 9k-150kHz Perpendicular

6.2 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



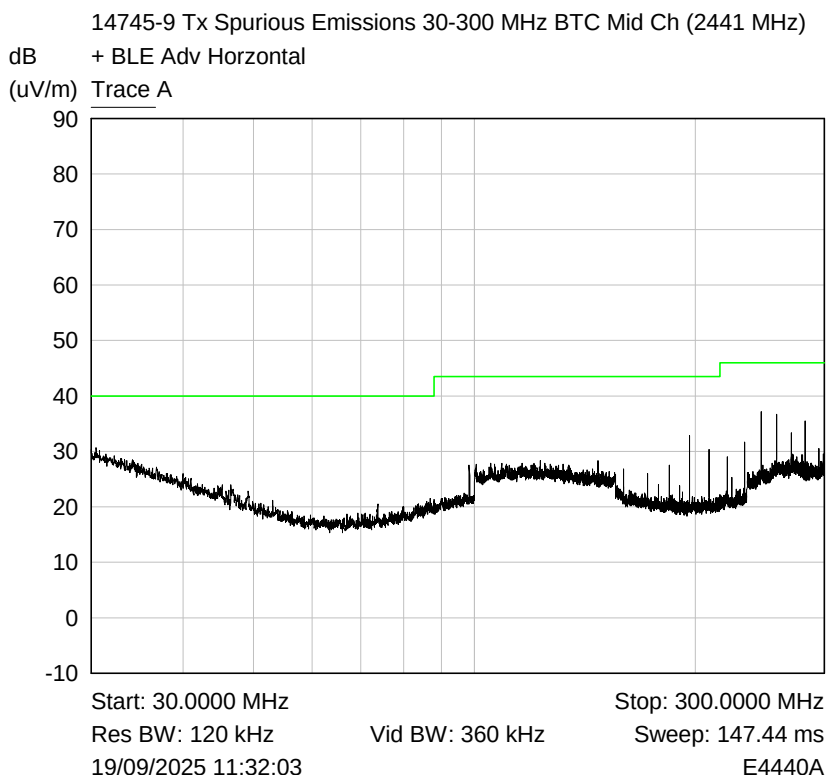
Plot of 150kHz-30MHz Parallel



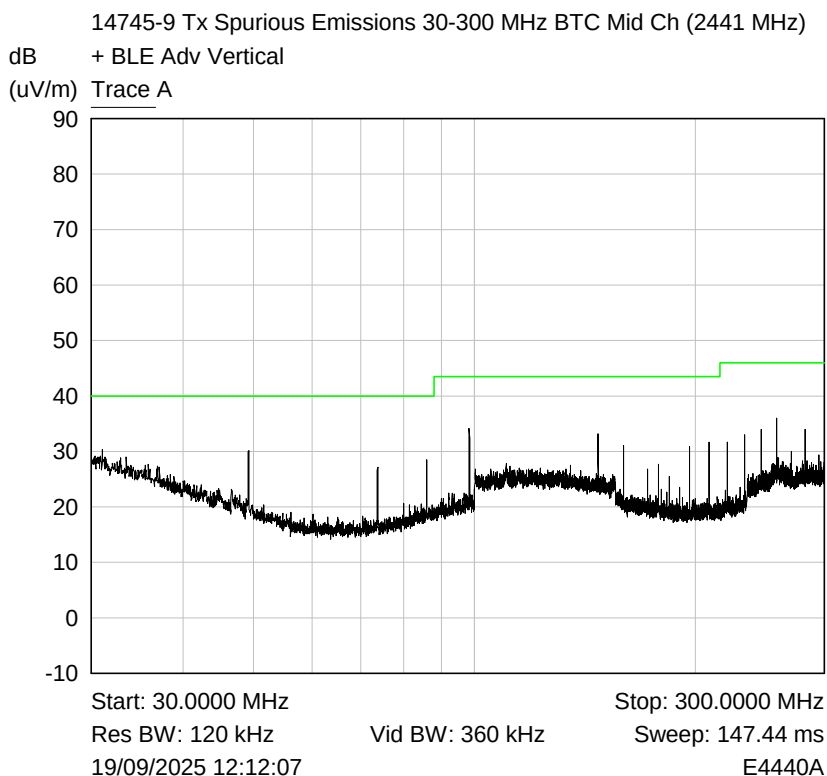
Plot of 150kHz-30MHz Perpendicular

6.3 Radiated emissions 30 MHz -1 GHz

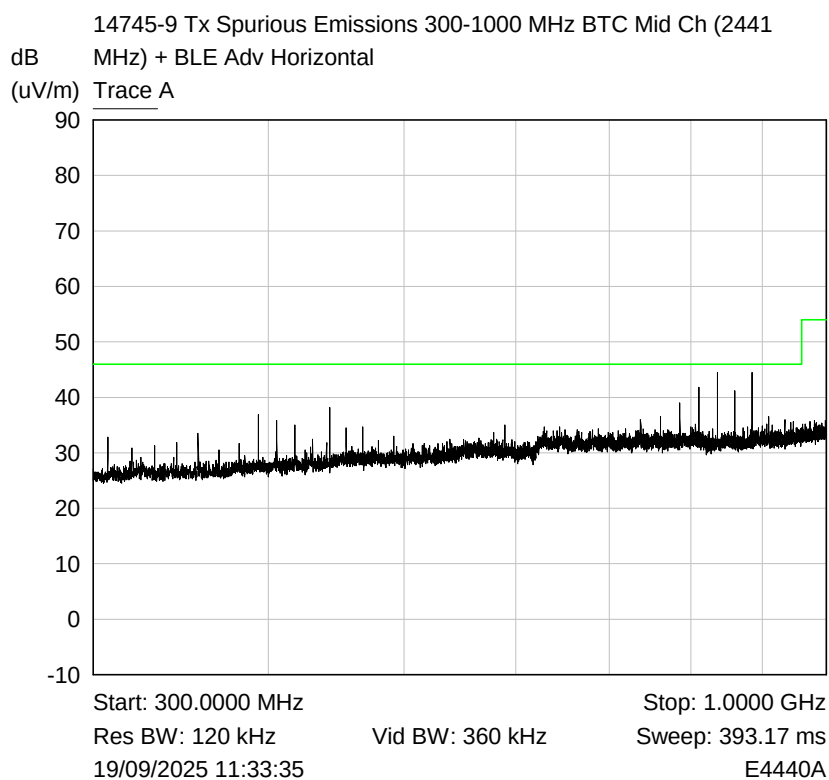
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



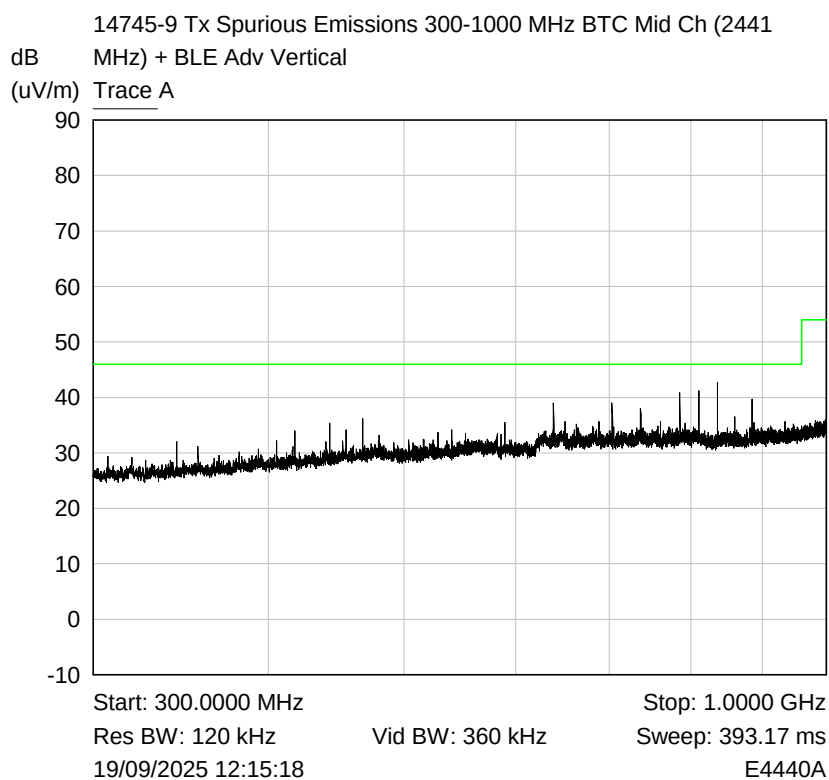
Plot of Peak emissions for VHF Horizontal against the QP limit line.



Plot of Peak emissions for VHF Vertical against the QP limit line.



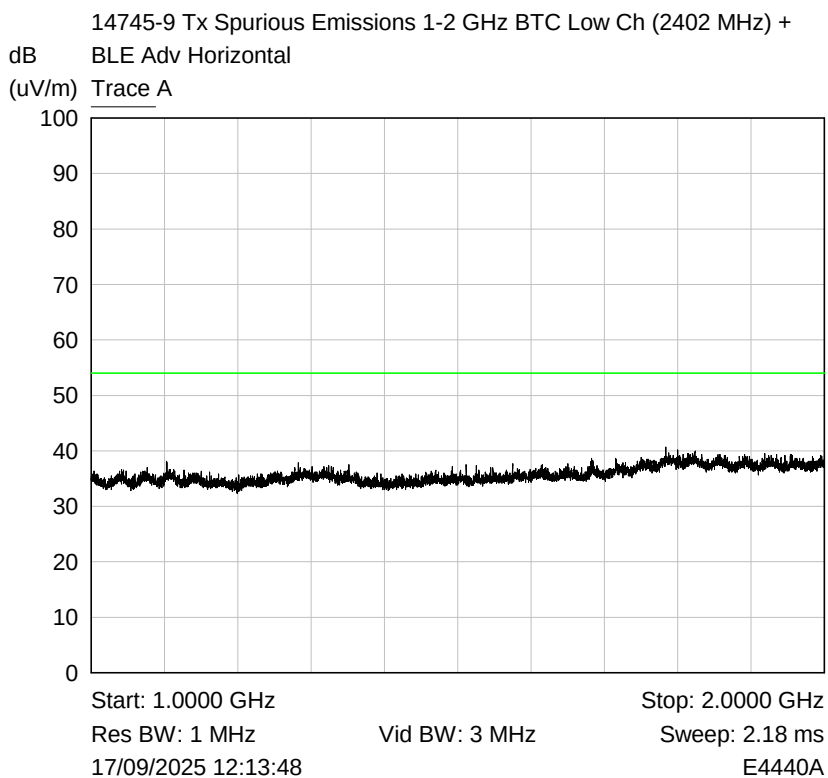
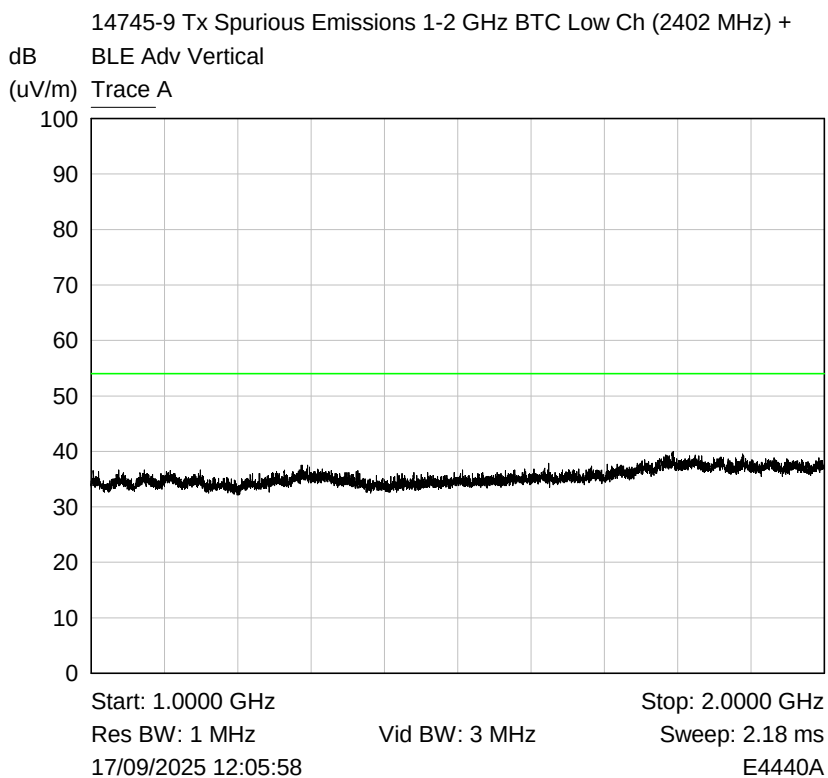
Plot of Peak emissions for UHF Horizontal against the QP limit line.

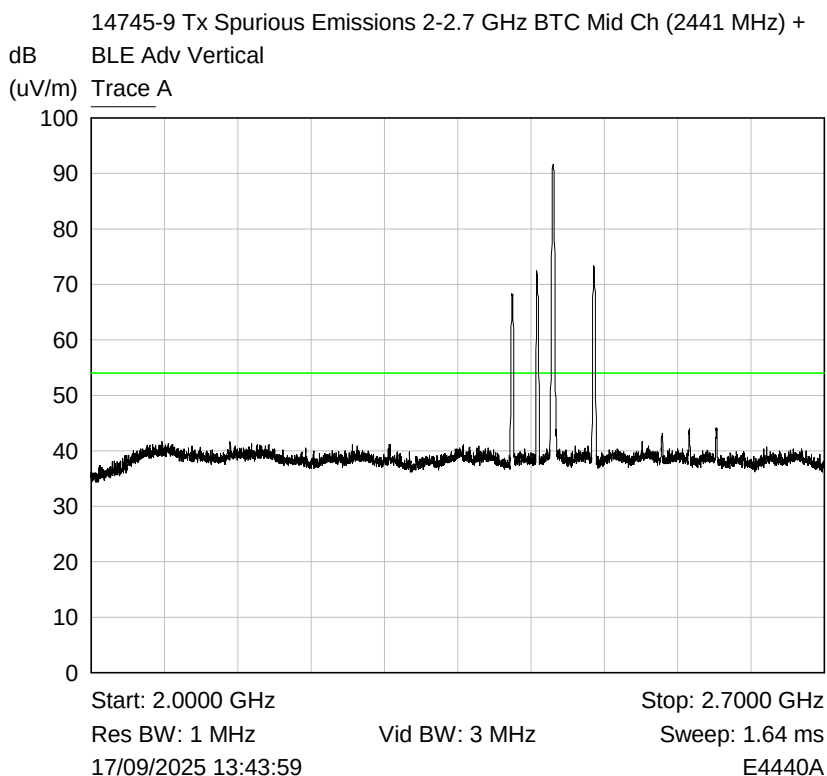


Plot of Peak emissions for UHF Vertical against the QP limit line.

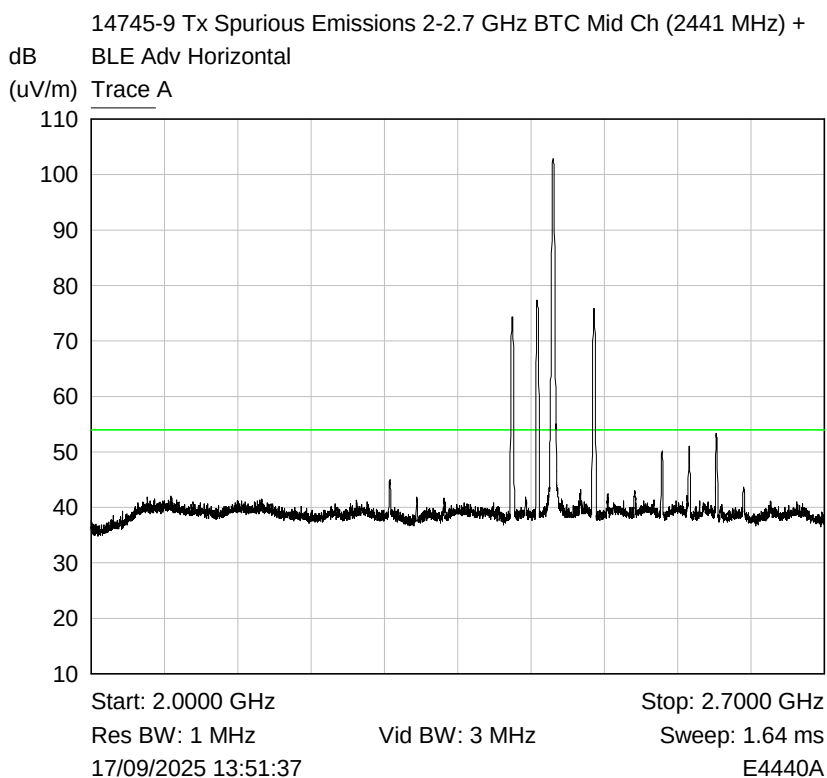
6.4 Radiated emissions above 1 GHz

RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz

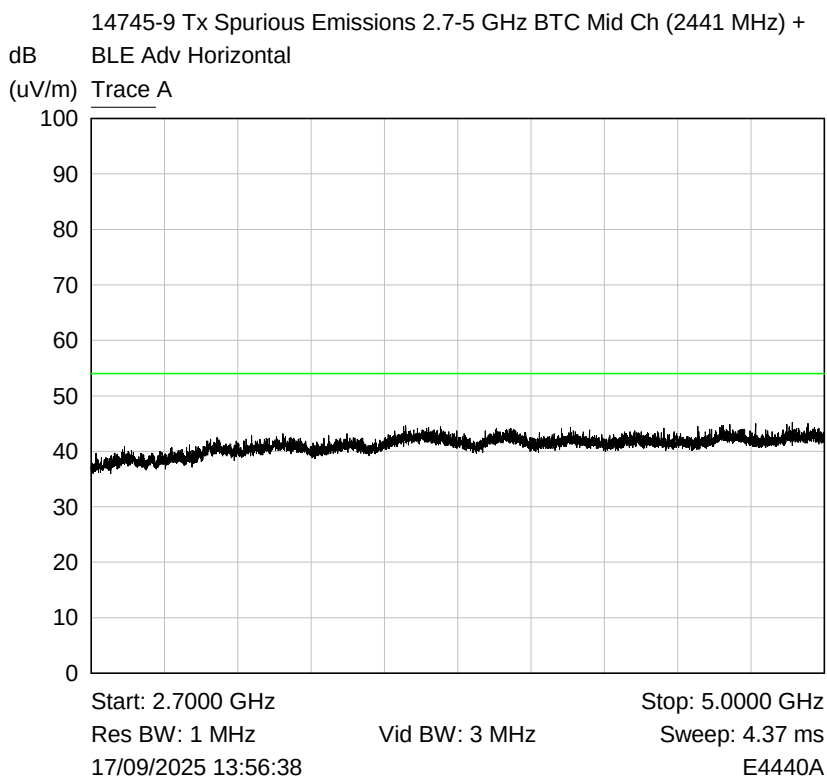
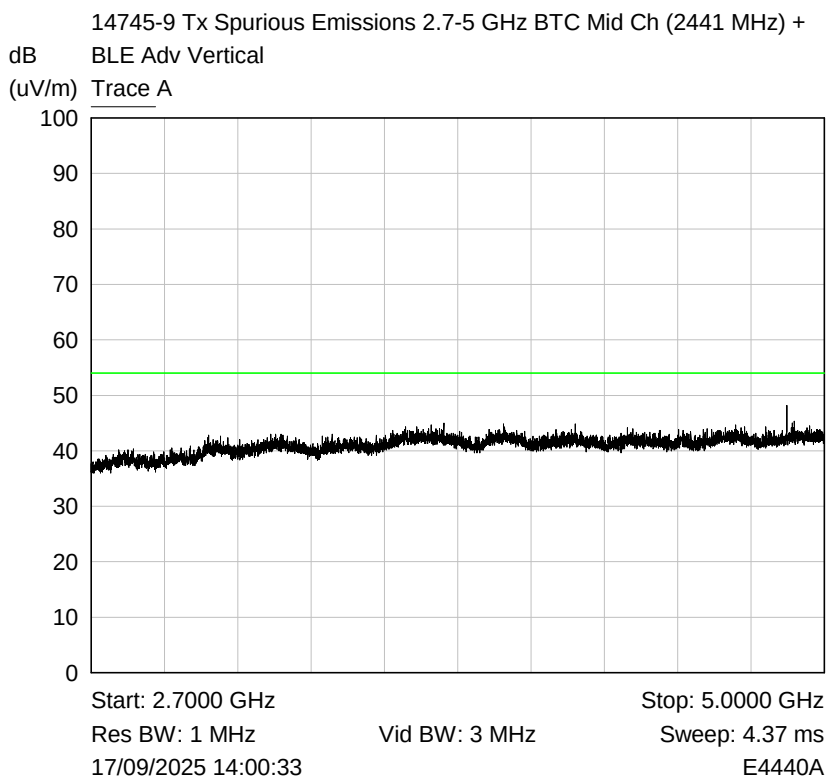


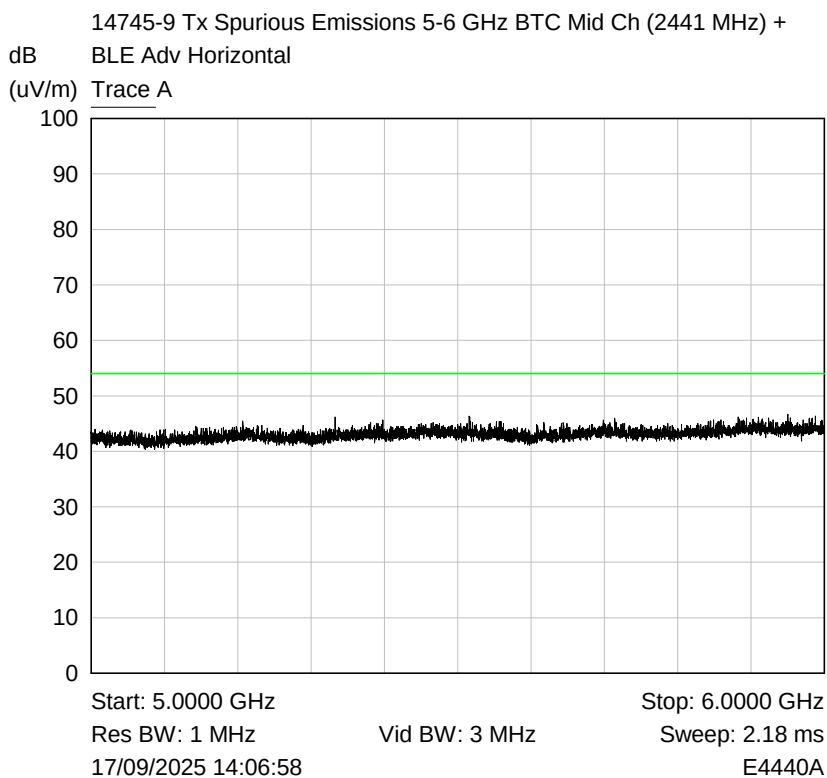
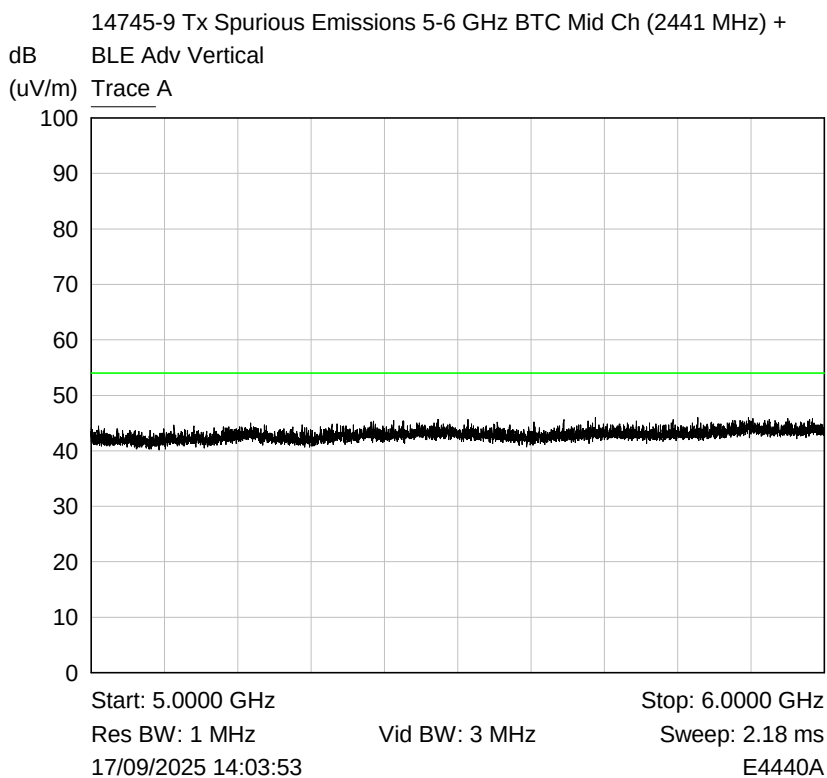


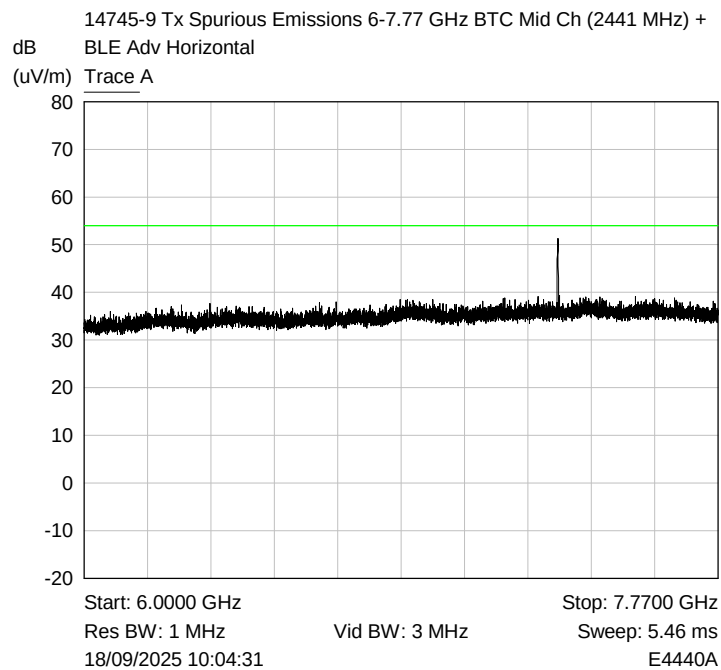
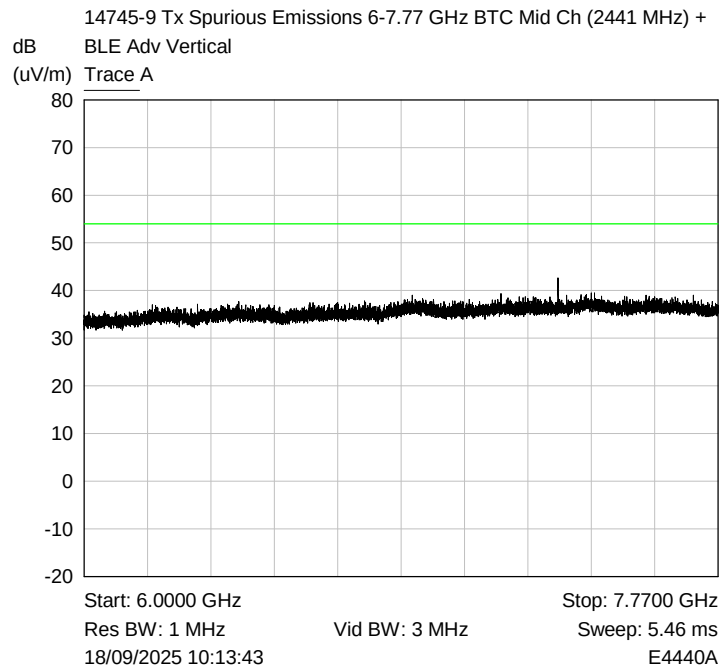
Note: The 4 signals above the limit are the 3 BLE advertising channels (2402, 2426 & 2480 MHz) and the BTC Middle channel (2441 MHz).

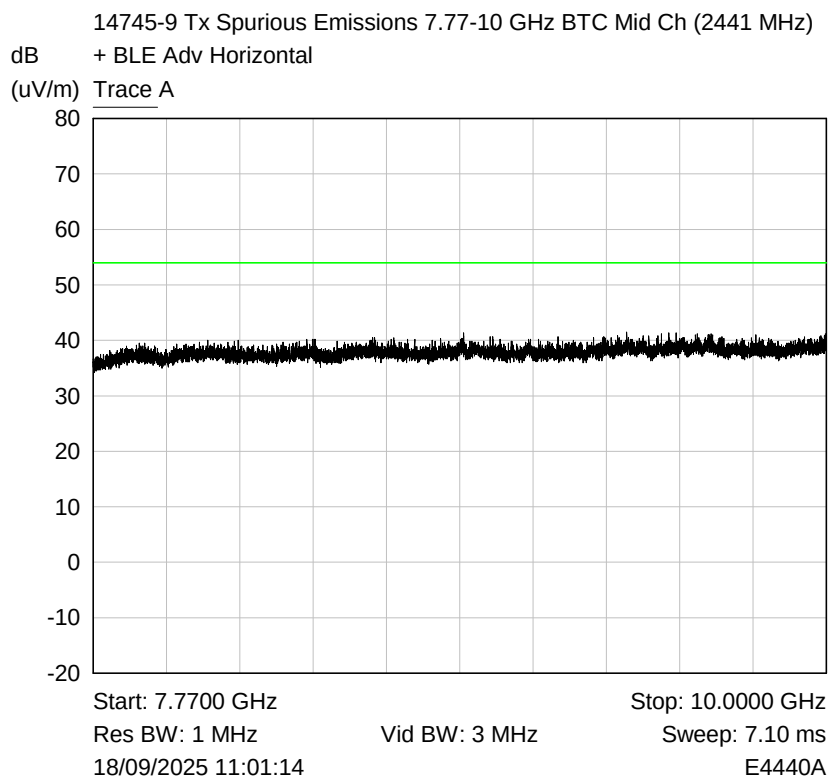
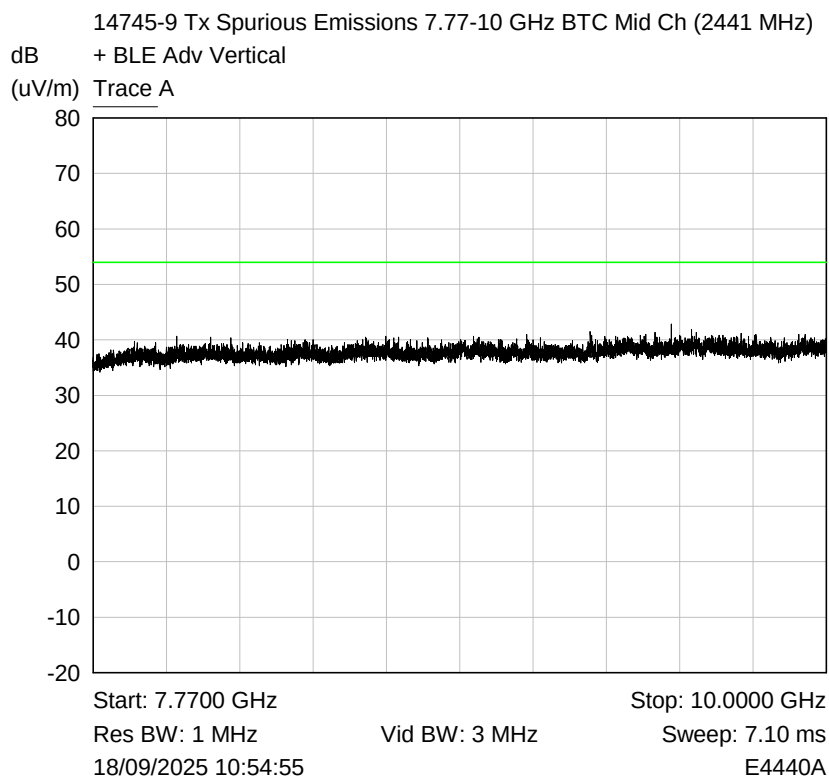


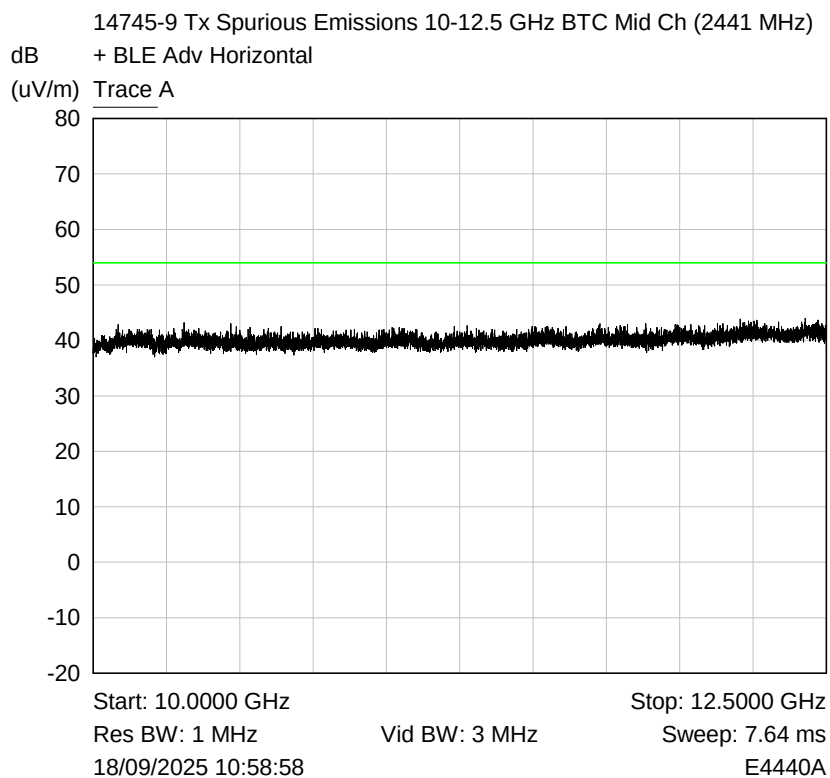
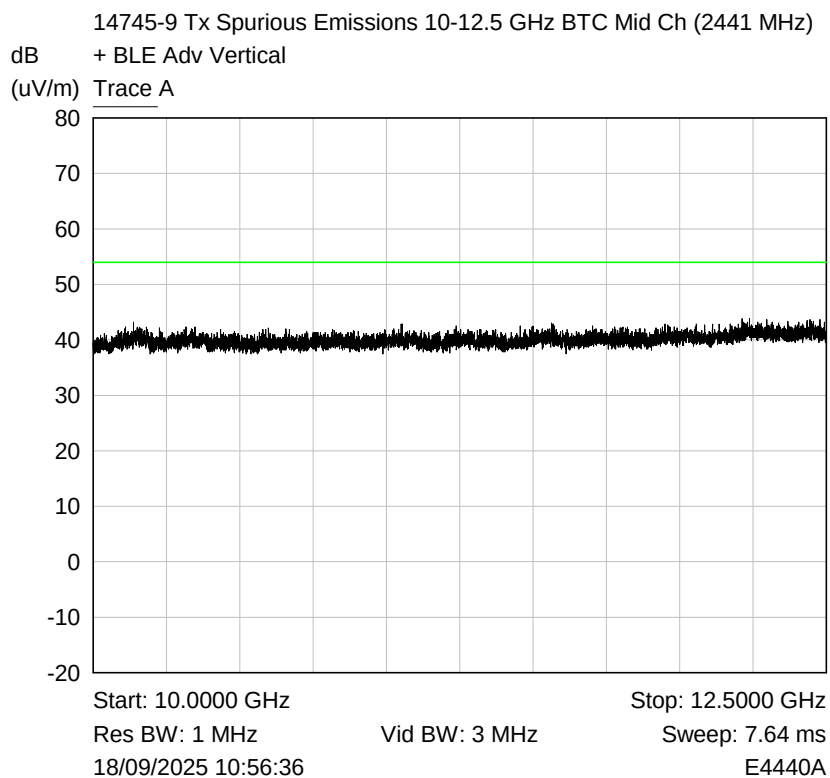
Note: The 4 signals above the limit are the 3 BLE advertising channels (2402, 2426 & 2480 MHz) and the BTC Middle channel (2441 MHz).

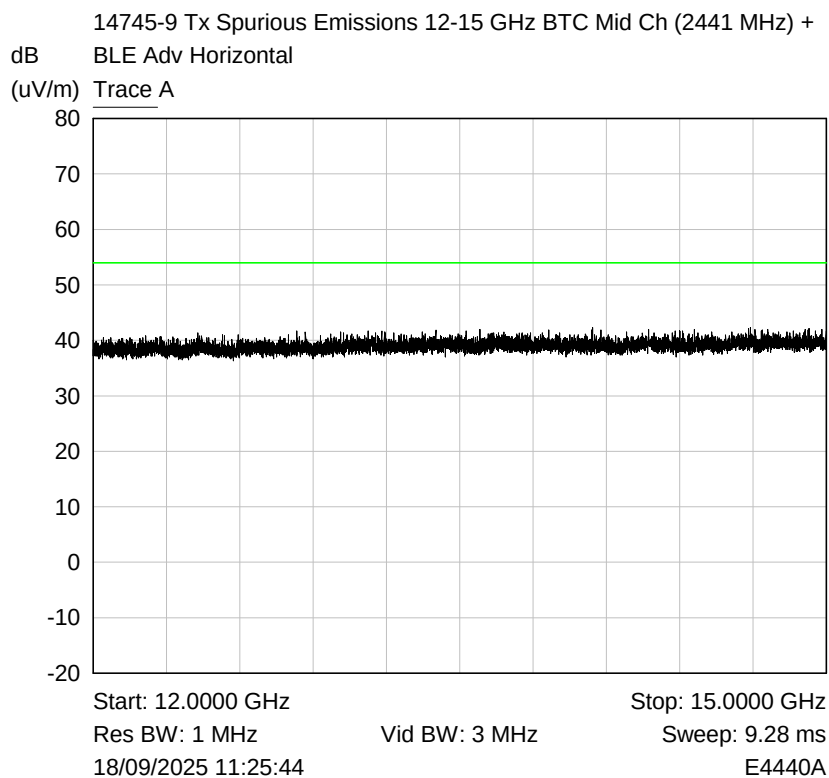
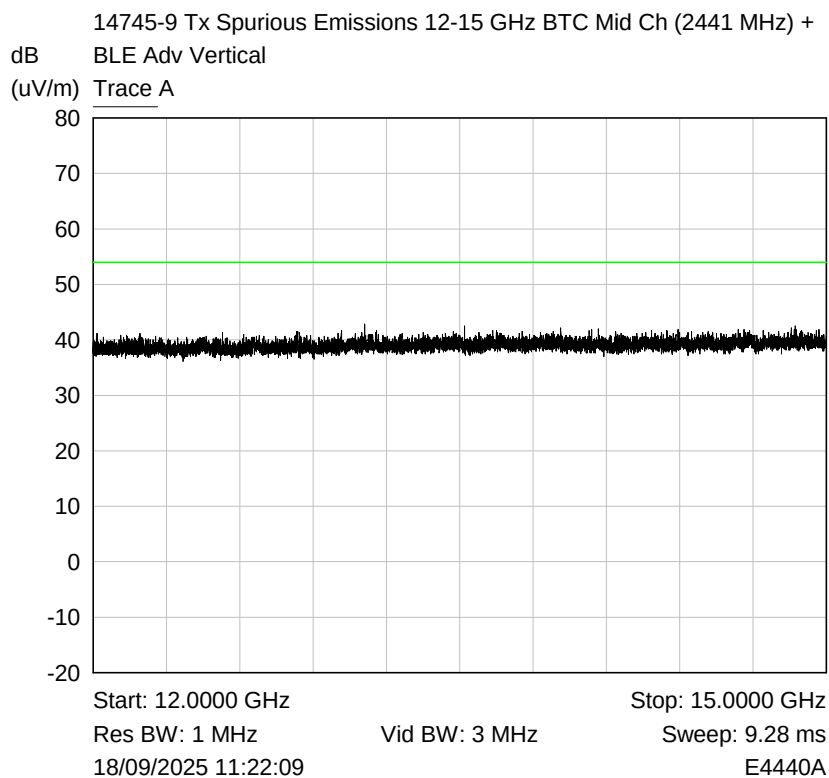


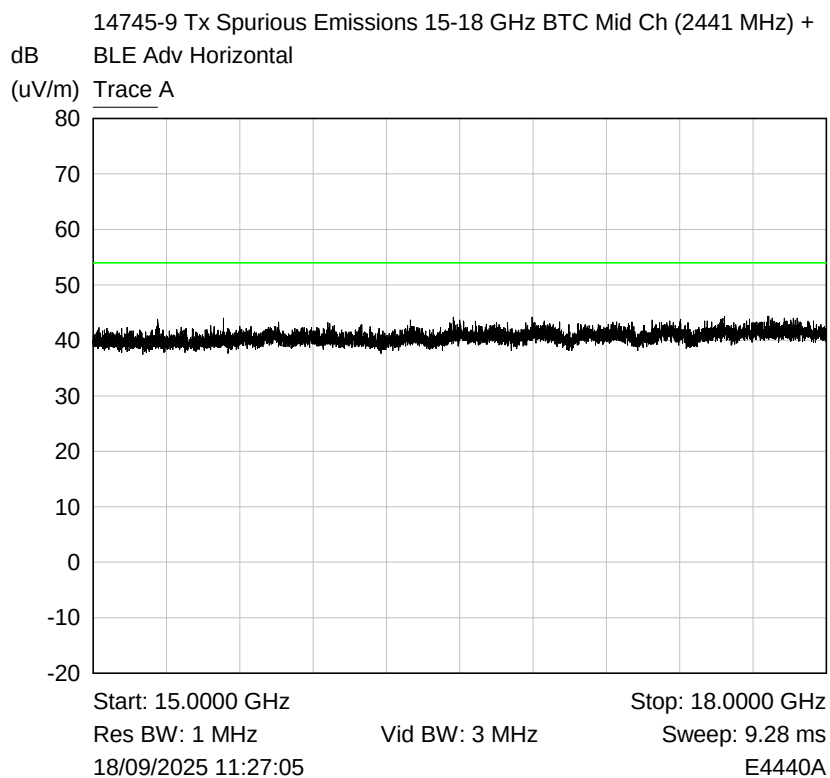
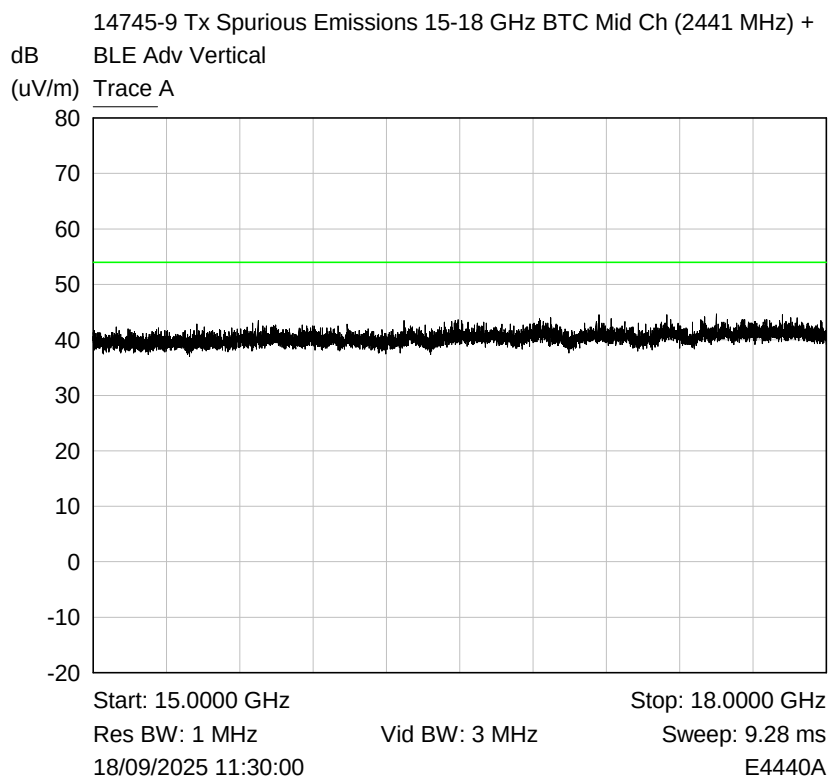


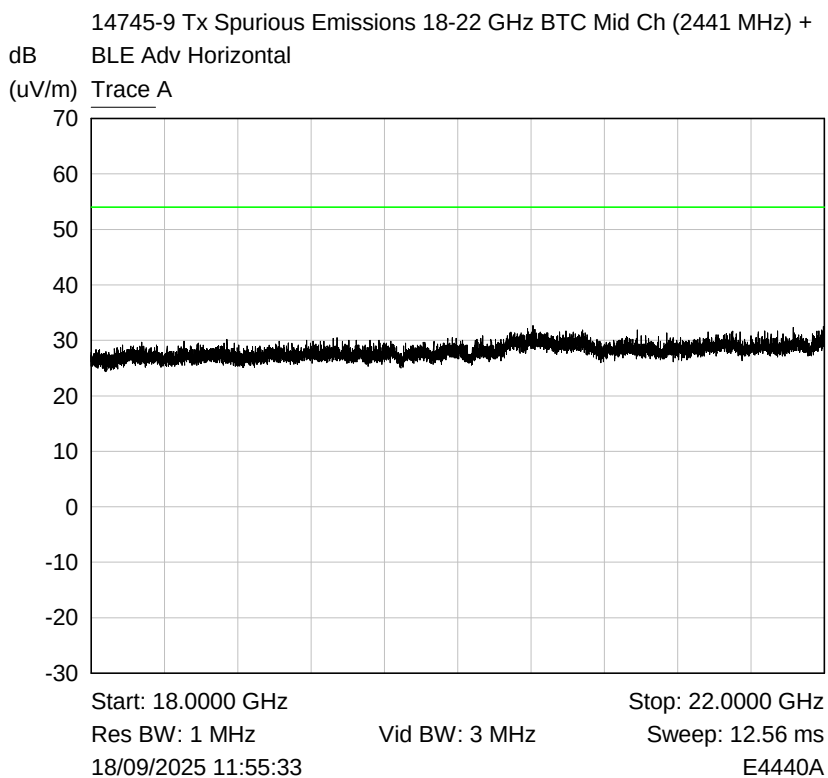
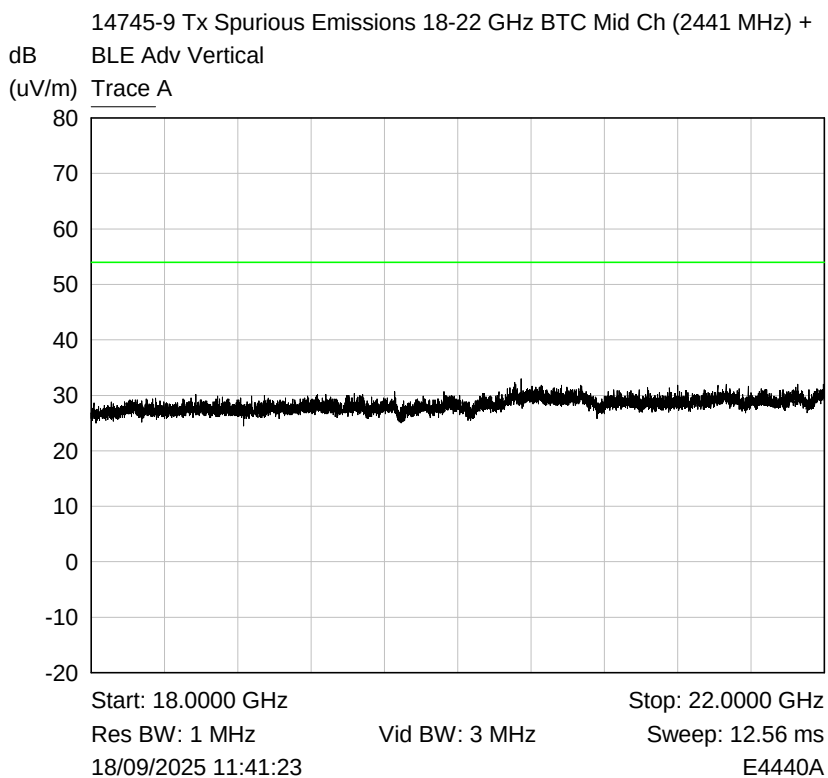


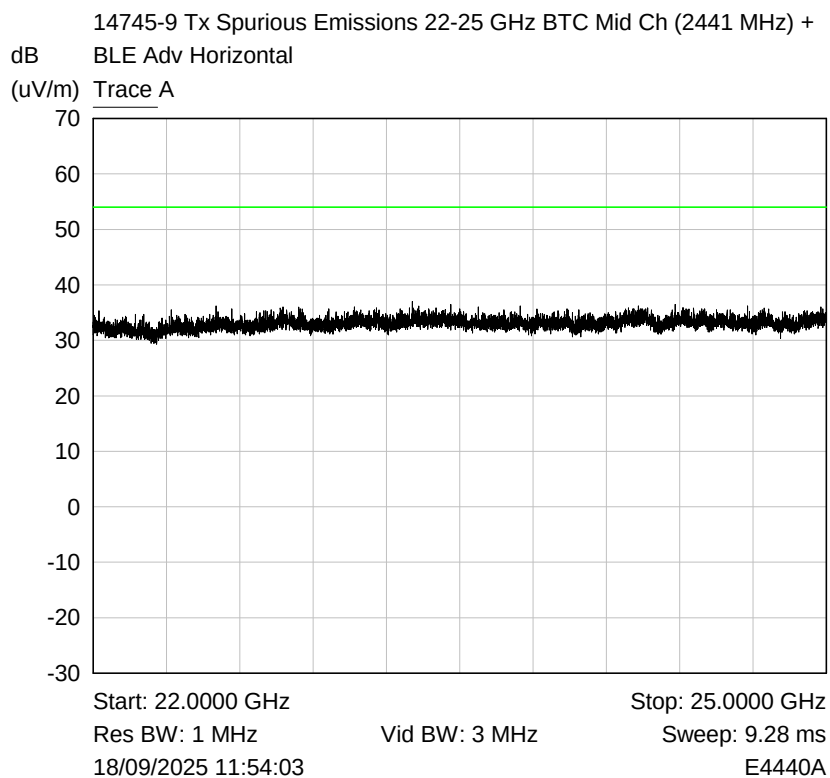
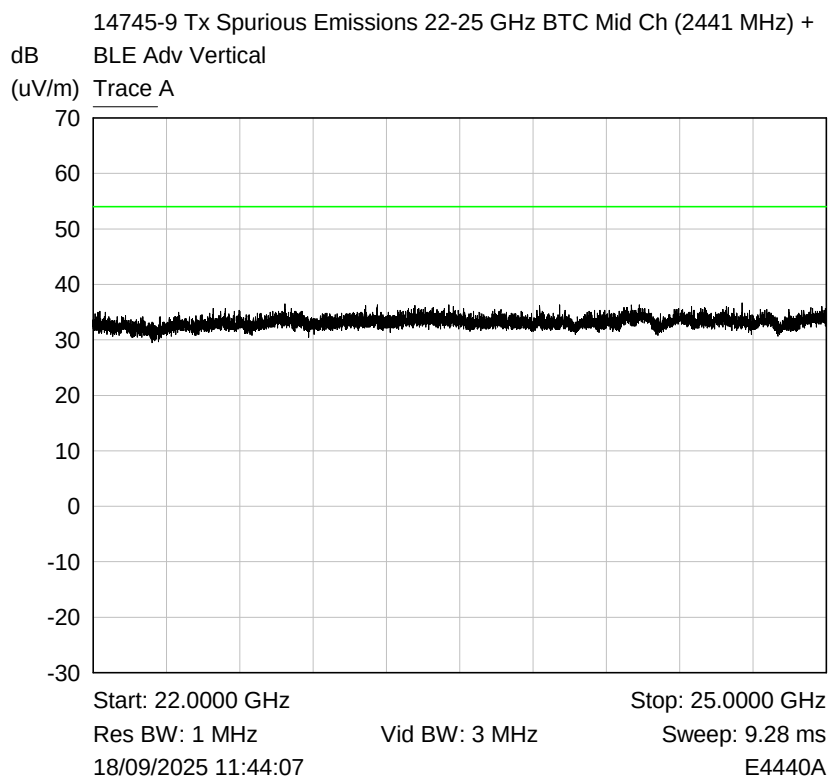






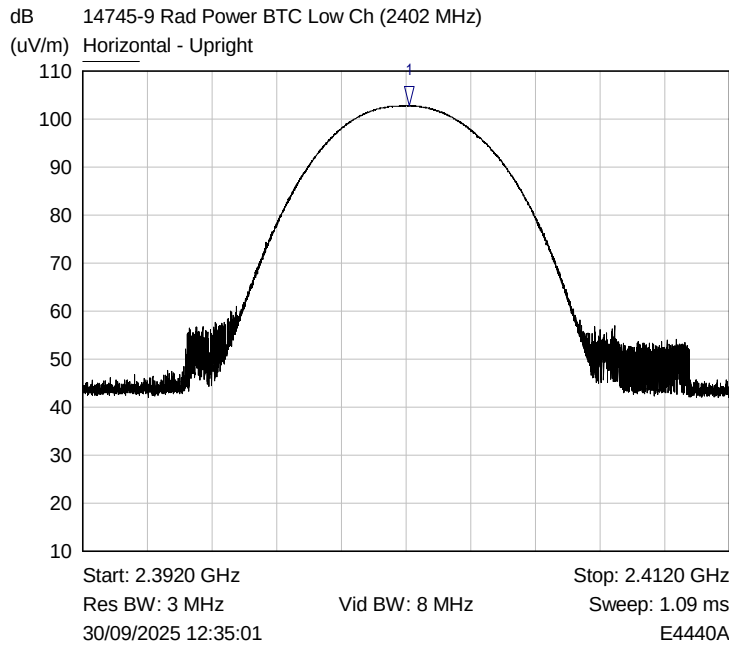






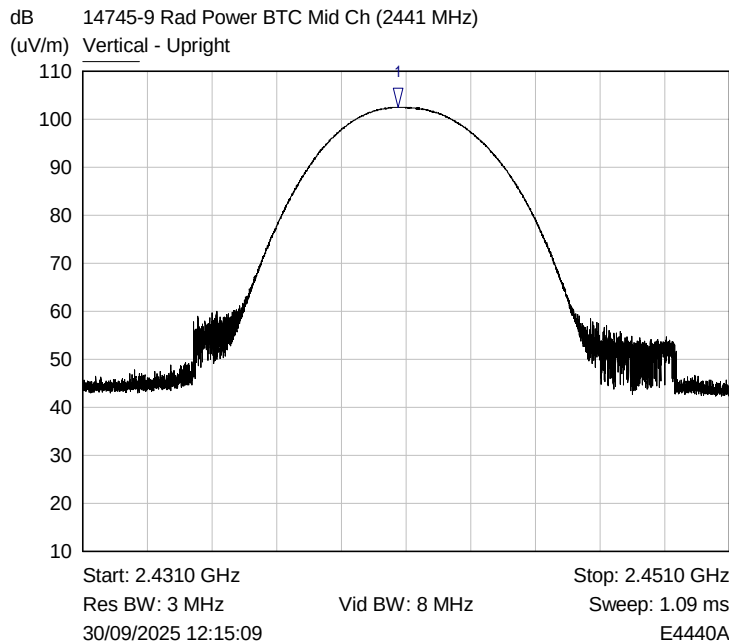
6.5 Effective radiated power field strength

RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
 Modulation GFSK DH5, Channel 2402 MHz



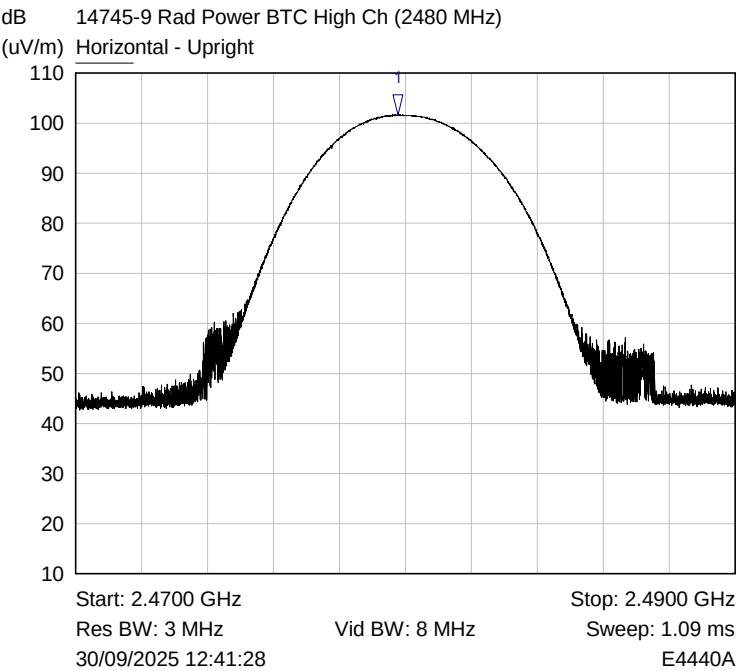
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horizontal - Upright	2.4021 GHz	102.83 dB(uV/m)	

RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
 Modulation GFSK DH5, Channel 2441 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Vertical - Upright	2.4407 GHz	102.56 dB(uV/m)	

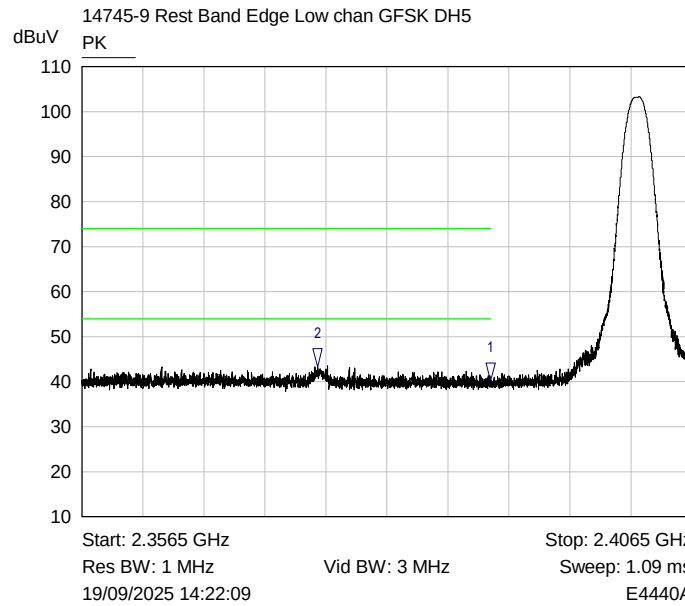
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2480 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horizontal - Upright	2.4798 GHz	101.63 dB(uV/m)	

6.6 Band Edge Compliance

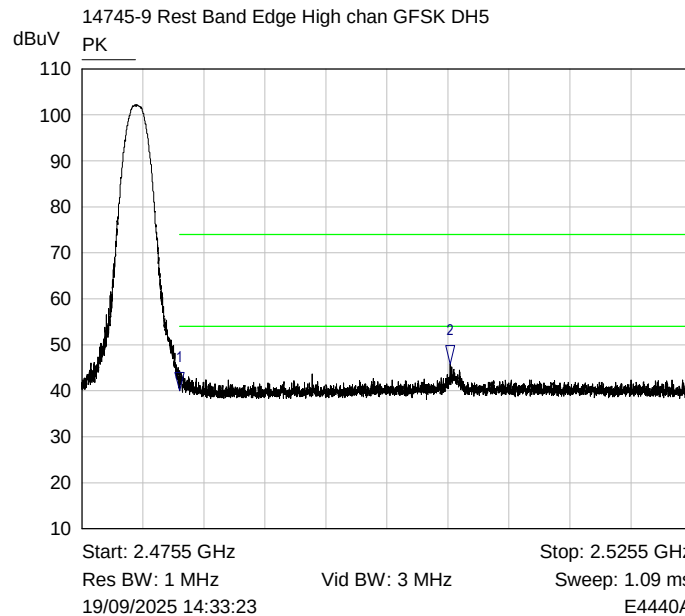
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2402 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▾	PK	2.3900 GHz	40.11 dBuV	
2 ▾	PK	2.3758 GHz	43.34 dBuV	

Restricted band edge Peak Plot

RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2480 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▾	PK	2.4835 GHz	40.05 dBuV	
2 ▾	PK	2.5057 GHz	45.80 dBuV	

Restricted band edge Peak Plot

7 Explanatory Notes

7.1 Explanation of Table of Signals Measured

Measurements are made as required by the standard. These measurements are made and recorded using detectors, either peak, quasi peak or average dependant on the test. A table of results has been given following the relevant plots. This table looks similar to the one illustrated below dependant on the measurements required by the test: -

Signal No.	Freq (MHz)	Peak Amp (dBμV)	Pk – Lim 1 (dB)	QP Amp (dBμV)	QP - Lim1 (dB)	Av Amp (dBμV)	Av - Lim1 (dB)
1	12345	54.9	-10.5	48	-12.6	37.6	-14.4

Column One - Labelled Signal No. is an incremental number that the receiver has given to each signal that has been measured.

Column Two - Labelled Freq (MHz) is the approximate frequency of the signal received.

Column Three - Labelled Peak Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the peak detector.

Column Four - Labelled Pk - Lim1 (dB) is the difference in level from the peak signal given to the active limit line. If this column appears in the table the peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Five - Labelled QP Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the quasi-peak detector.

Column Six - Labelled QP - Lim1 (dB) is the difference in level from the quasi-peak signal given to the active limit line. If this column appears in the table the quasi-peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Seven - Labelled Av Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the average detector.

Column Eight - Labelled Av - Lim1 (dB) is the difference in level from the average signal given to the active limit line. If this column appears in the table the average detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Only signals highlighted in red are deemed to exceed the limit of the detector required.

7.2 Explanation of limit line calculations for radiated measurements

The limits given in the test standard are normally expressed as absolute values (e.g. in μV/m at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in dBμV/m referenced to the measuring instrument inputs. Kiwa Electrical Compliance calibrate the test set-up to account for any path losses, antenna gains, etc. so that the value read at the receiver relates directly to the absolute value required, except that it is expressed in dB relative to one microVolt and may need to take account of any alternative measuring distance used. Examples:

(a) limit of 500 μV/m equates to $20.\log(500) = 54 \text{ dB } \mu\text{V/m}$.

(b) limit of 300 μV/m at 10m equates to $20.\log(300 \cdot 10/3) = 60 \text{ dB } \mu\text{V/m at 3m}$

(c) limit of 30 μV/m at 30m, but below 30MHz, equates to $20.\log(30) + 40.\log(30/3) = 69.5 \text{ dB}\mu\text{V/m at 3m}$, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

File Name: Monitor Audio Group.14745-9 Issue 01

QMF21J - Issue 05 - KEC Issue 02; 47 CFR Part 15.247 2024

The measurement receiver used for emissions testing, performs the field strength (FS) calculations automatically.

The receiver combines the signal amplitude (RA), Antenna Factor (AF) and Cable Loss (CL) factors for the frequency to be measured.

Example calculation: - FS = RA + AF + CL.

Receiver amplitude (RA)	Antenna factor (3m) (AF)	Cable loss (CL)	Field strength result (3m) (FS)
20dBuV	25 dB	3 dB	48dBuV/m

Additional calculation examples per ANSI C63.10 clause 9.4 – 9.6 equations 21, 22, 25 & 26:

Equation 21: $E_{\text{Linear}} = 10^{((E_{\text{Log}} - 120)/20)}$

And therefore equation 21 transposed is: $E_{\text{Log}} = 20 \times \log(E_{\text{Linear}}) + 120$

Where:

E_{Linear} is the field strength of the emission in V/m

E_{Log} is the field strength of the emissions in dBμV/m

Equation 22: $\text{EIRP} = 21.98 - 20 \log(\lambda) + 20 \log(d_{\text{Meas}}) + P - G$

Where:

EIRP is equivalent isotropically radiated power in dBm

λ is the wavelength of the emission under investigation ($300/f(\text{MHz})$) in m

d_{Meas} is the measurement distance in metres

P is the power measured at the output of the measurement antenna, in dBm

G is the gain of the measurement antenna in dBi

Equation 25: $\text{PD} = \text{EIRP}_{\text{Linear}} / 4\pi d^2$

And therefore equation 25 transposed is: $\text{EIRP}_{\text{Linear}} = \text{PD} \times 4\pi d^2$

Where:

PD is the power density at distance specified by the limit, in W/m²

$\text{EIRP}_{\text{Linear}}$ is the equivalent isotropically radiated power in Watts

d is the distance at which the power density limit is specified in metres

Equation 26: $\text{PD} = E_{\text{Spec limit}}^2 / 377$

And therefore equation 26 transposed is: $E_{\text{Spec limit}} = \sqrt{(\text{PD} \times 377)}$

Where:

PD is the power density at distance specified by the limit, in W/m²

$E_{\text{Spec limit}}$ is the field strength at the distance specified by the limit in V/m

Example:

Radiated spurious emissions limit at 3metres of 90pW/cm².

$90\text{pW/cm}^2 \times 100^2 = 0.9 \mu\text{W/m}^2 = (\text{EIRP Linear})$

Equation 25 transposed: $0.9 \times 10^{-6} \times 4 \times \pi \times 3^2 = 0.0001017876 \text{ W}$

And

Equation 26 transposed: $E_{\text{Spec limit}} = \sqrt{(0.9 \times 10^{-6} \times 377)} = 0.01842 \text{ V/m.}$

And

Equation 21 transposed: $E_{\text{Log}} = 20 \log(0.01842) + 120 = 85.3\text{dB}\mu\text{V/m @ 3m.}$

8 Photographs

8.1 EUT Front View



8.2 EUT Reverse Angle





8.3 EUT Left side View



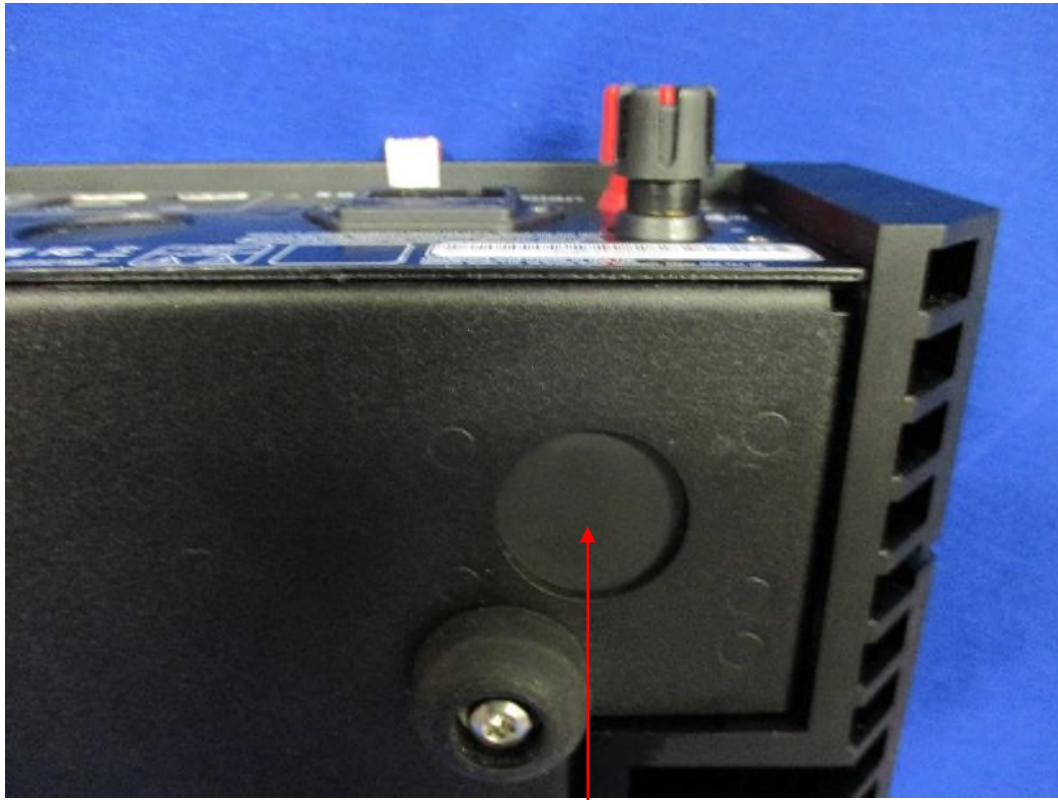
8.4 EUT Right side View



8.5 EUT Antenna Port



Bluetooth Classic Antenna



ESP32 Antenna (BLE & 2.4 GHz WiFi)

8.6 EUT Display & Controls

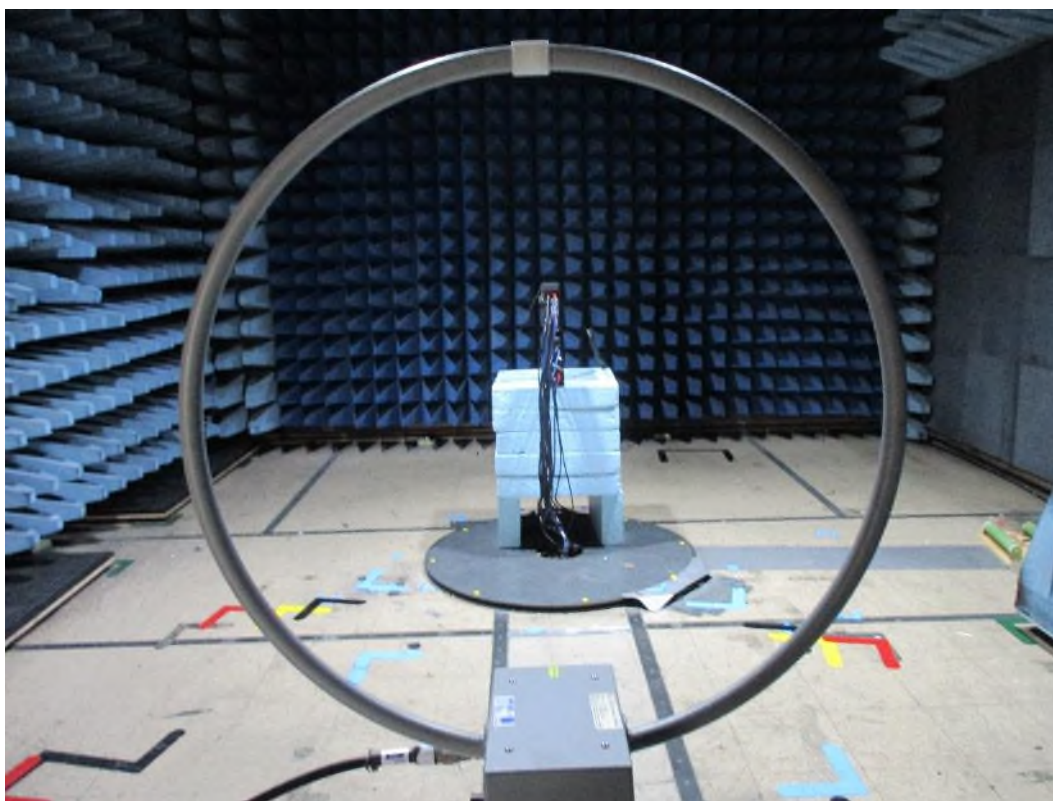




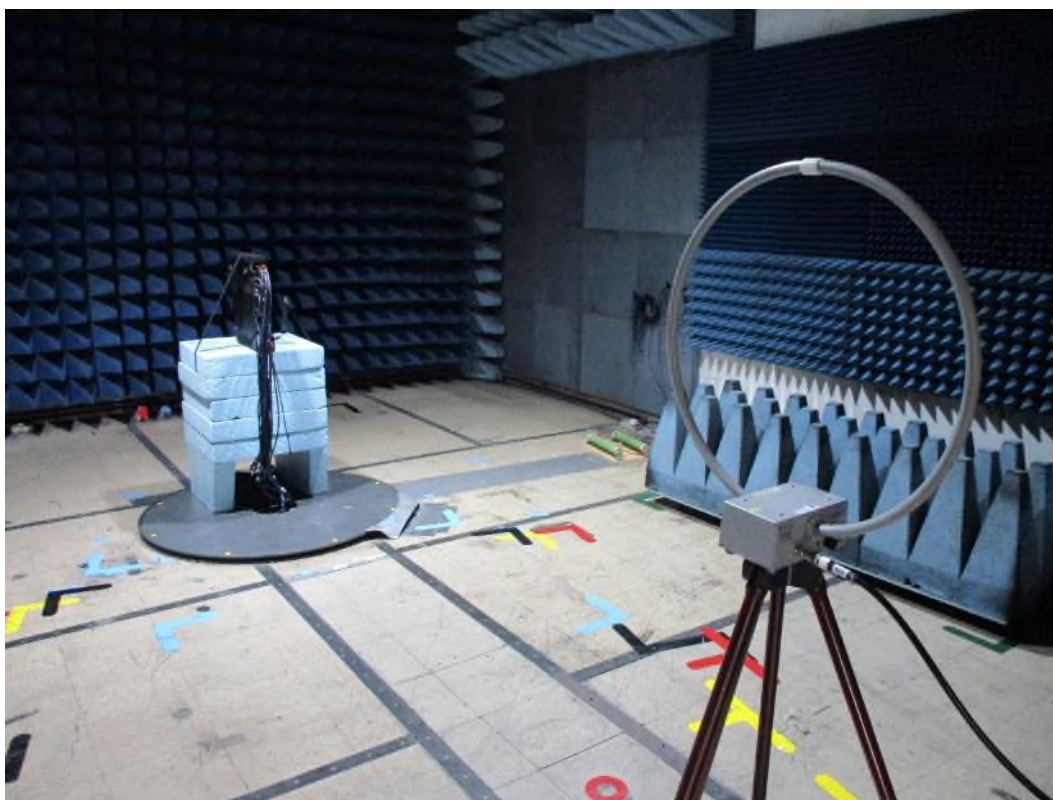
8.9 EUT Chassis



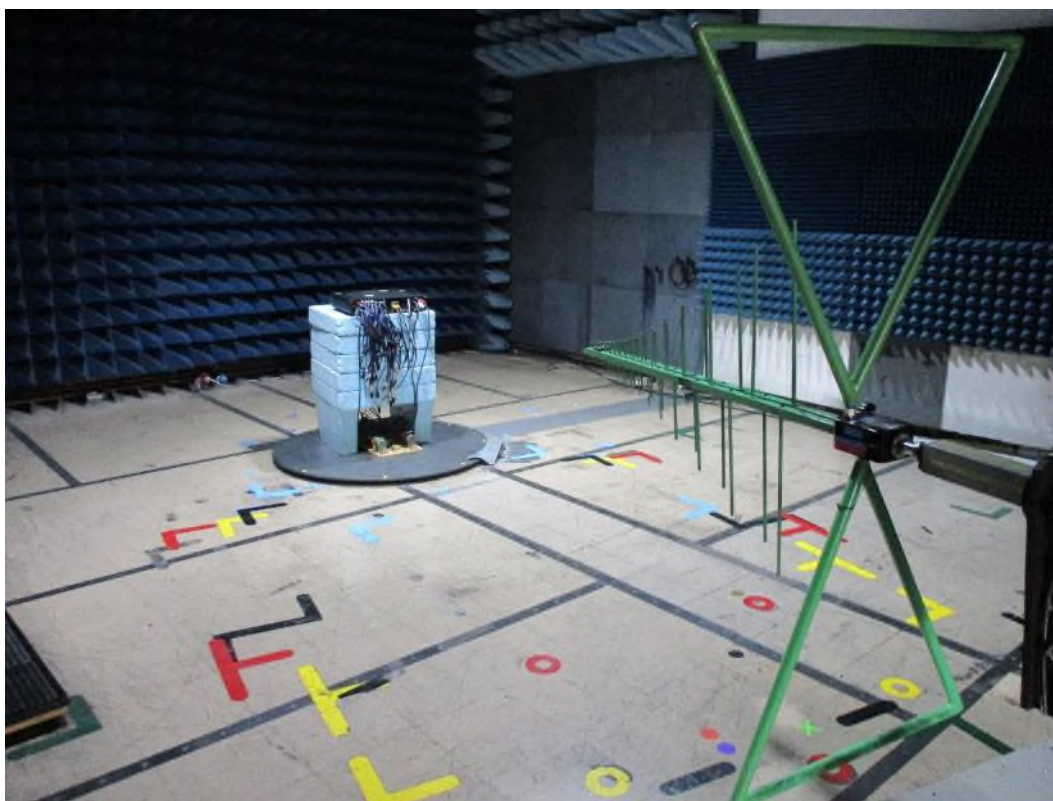
8.10 Radiated emissions 9 - 150 kHz



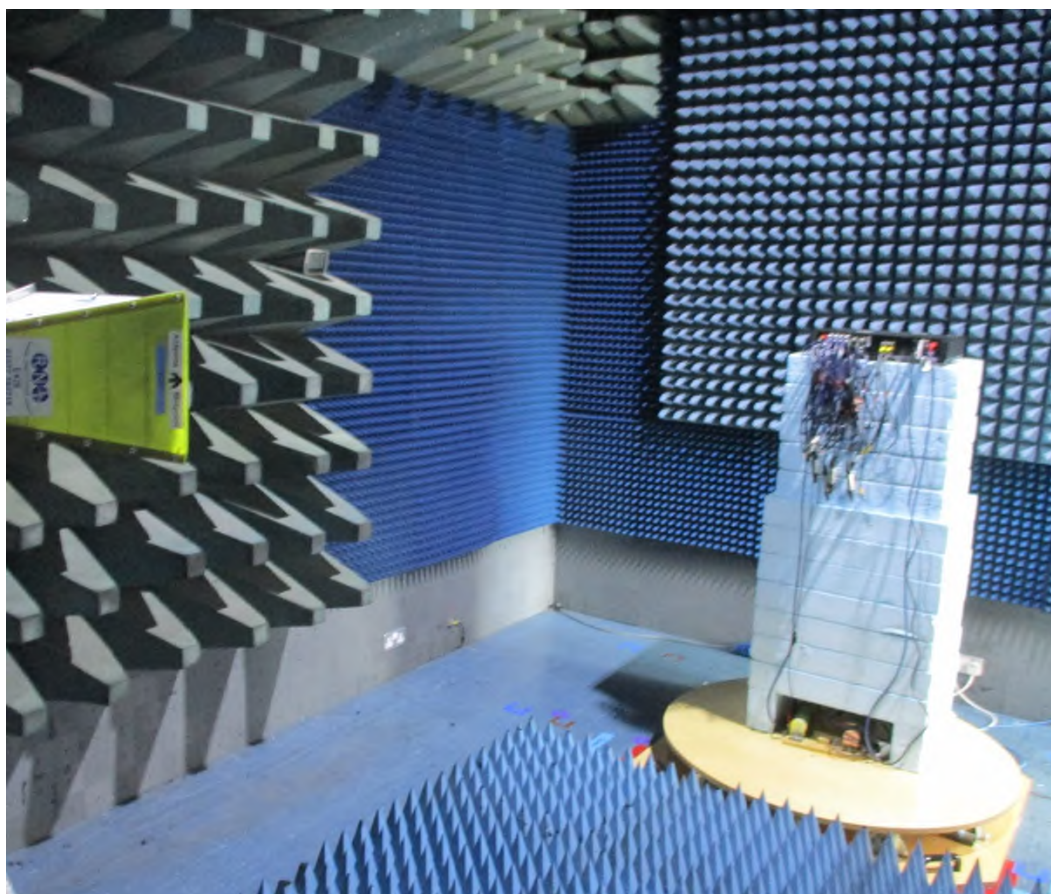
8.11 Radiated emissions 150 kHz - 30 MHz

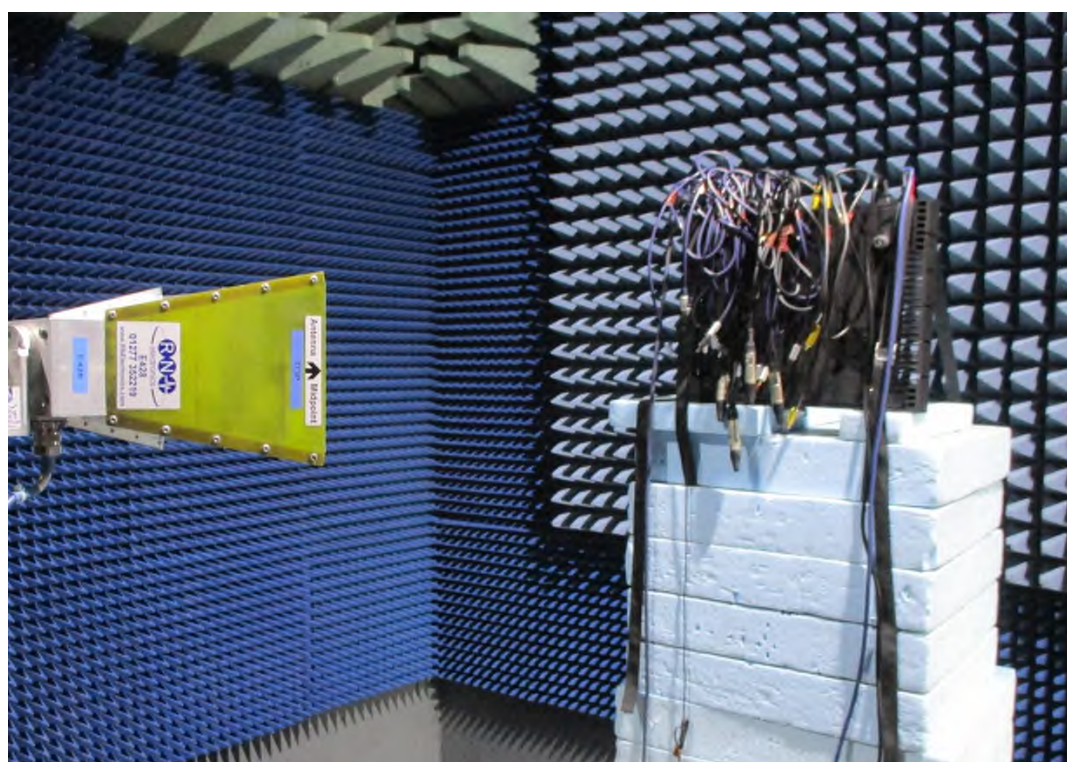
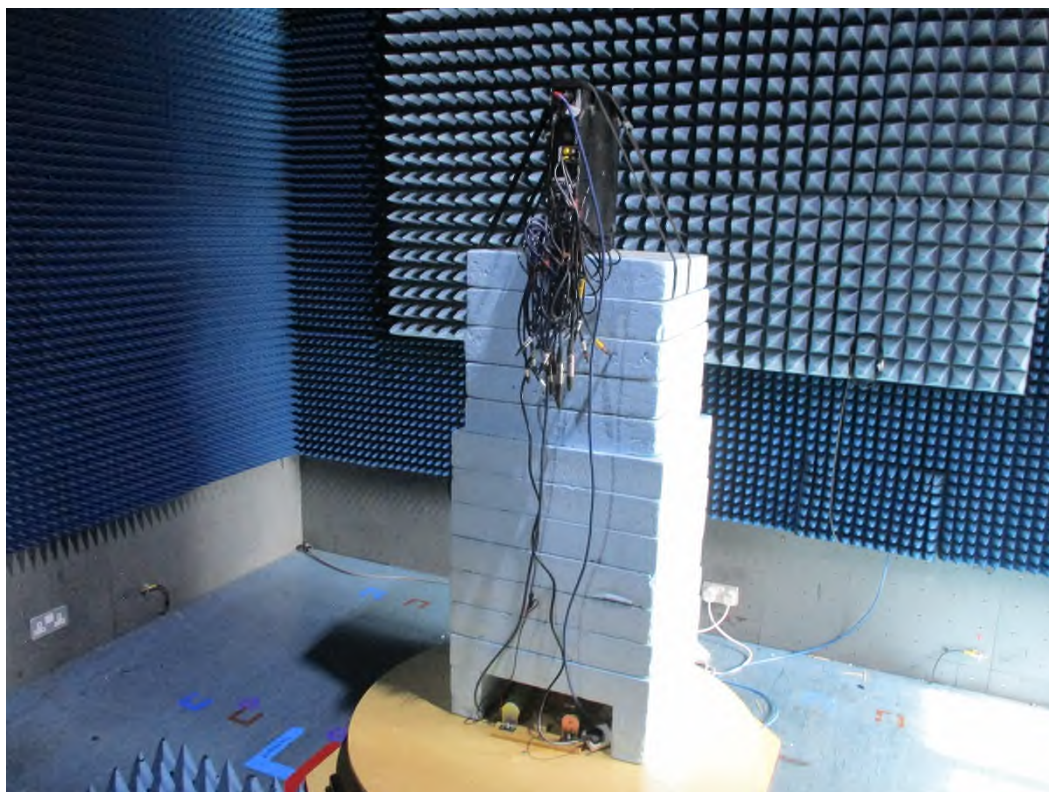


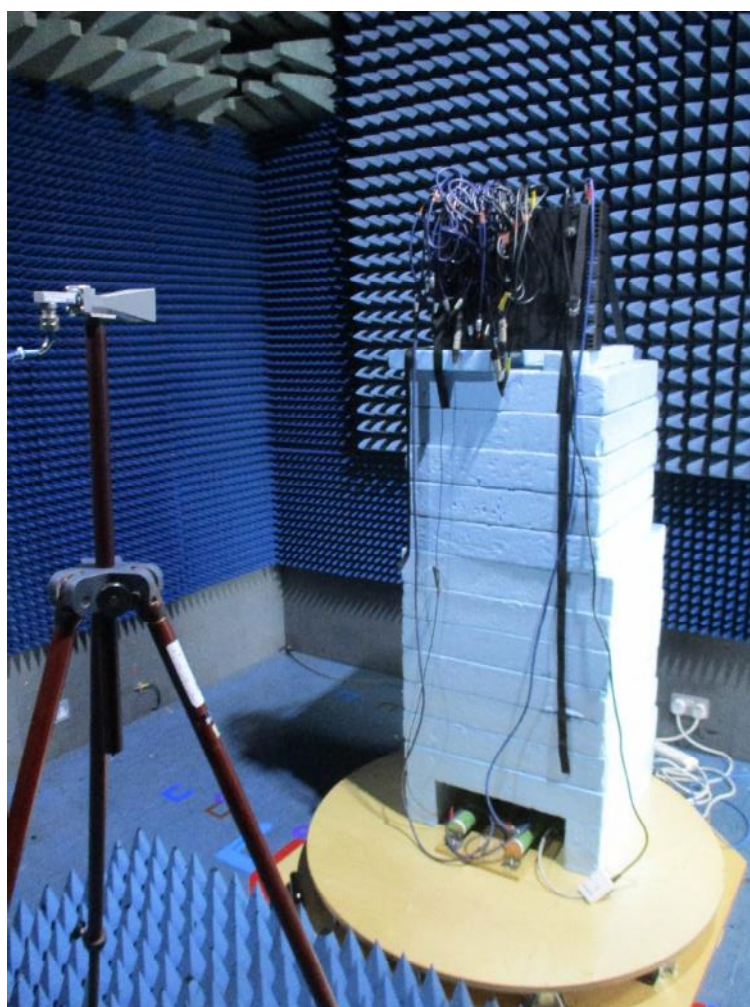
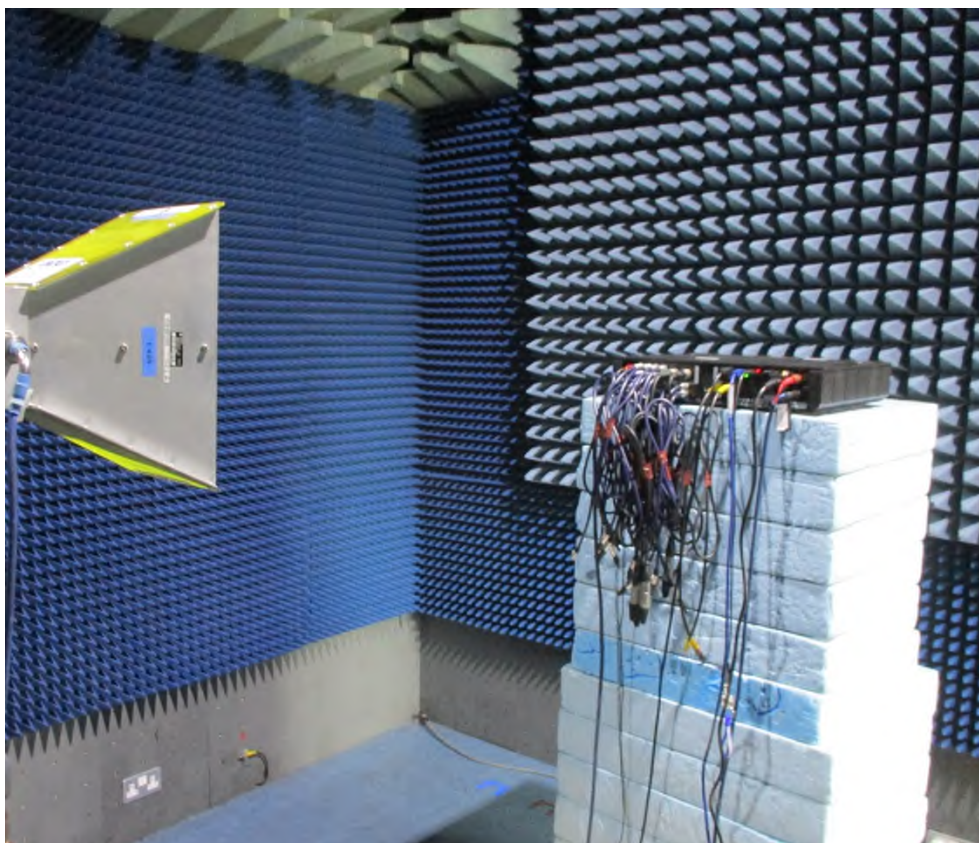
8.12 Radiated emissions 30 MHz -1 GHz

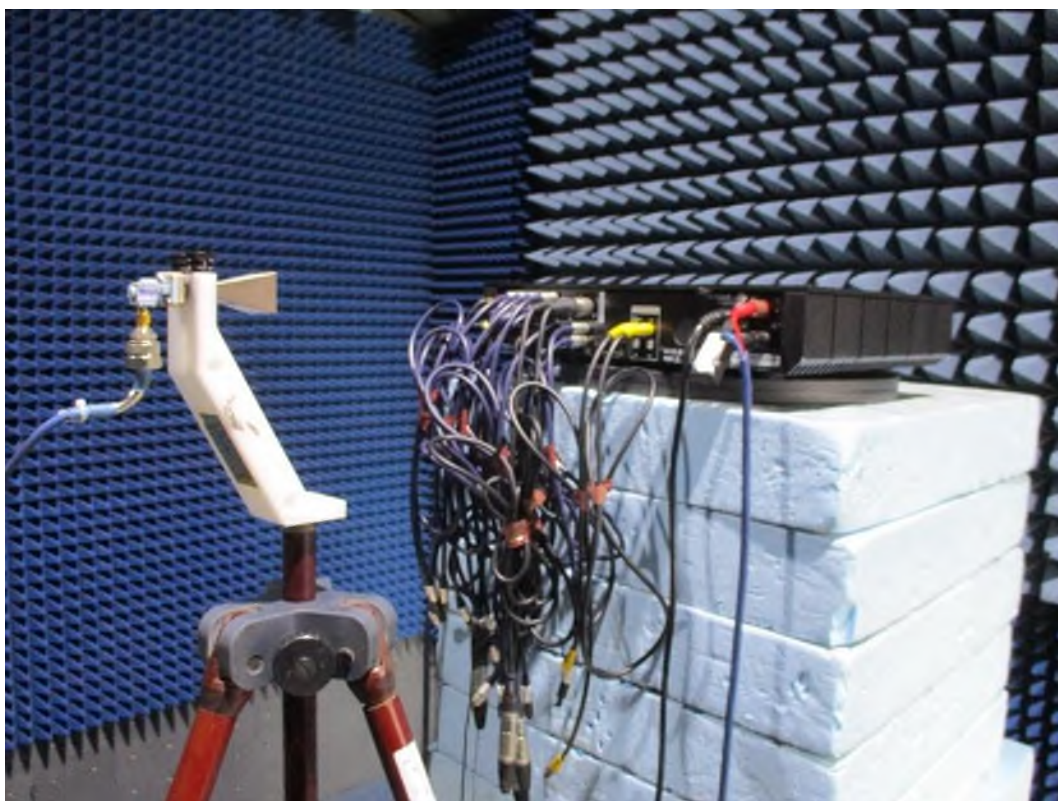


8.13 Radiated emissions above 1 GHz

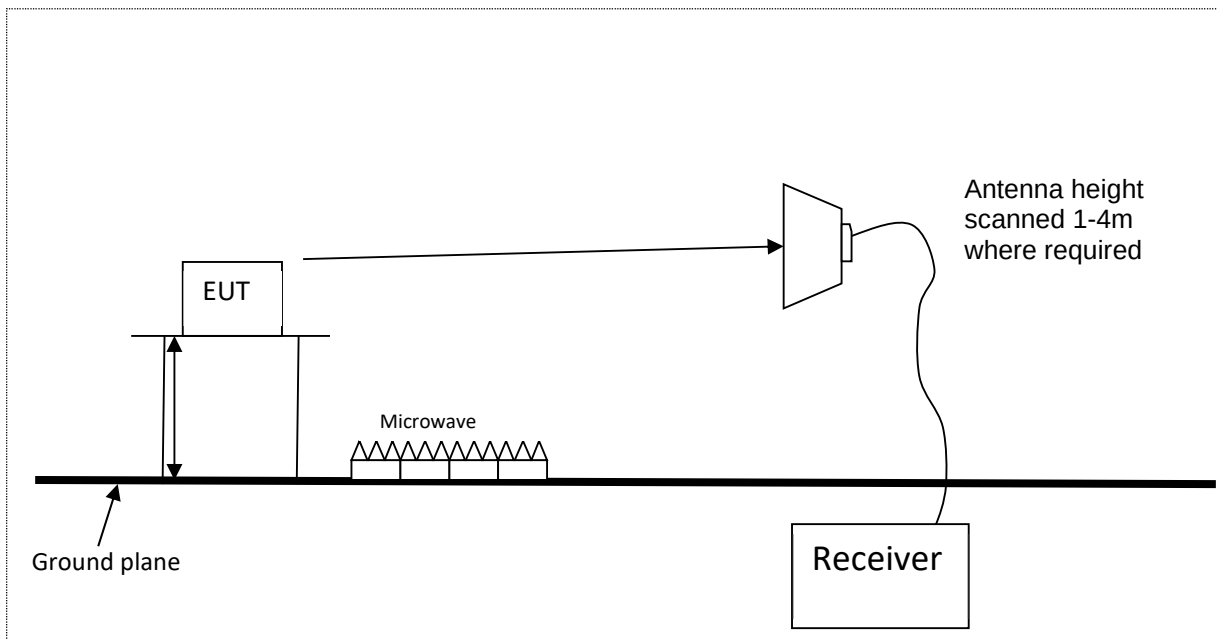
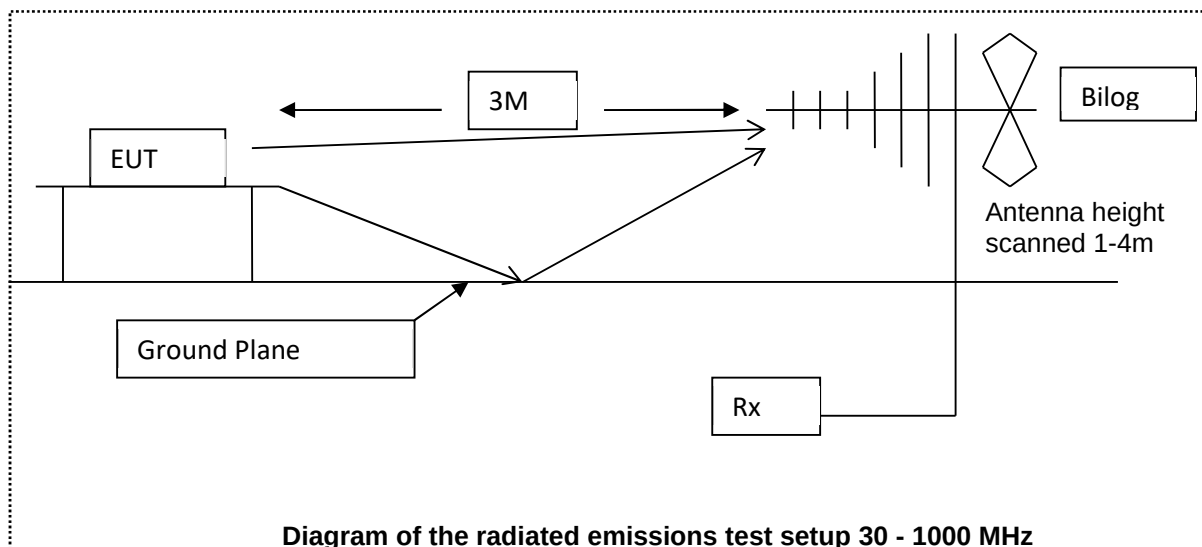








8.14 Radiated emission diagrams



9 Test equipment calibration list

The following is a list of the test equipment used by Kiwa Electrical Compliance to test the unit detailed within this report. In line with our procedures, the equipment was within calibration for the period during which testing was carried out.

KEC No	Model	Description	Manufacturer	Calibrated Date	Period
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	10/07/2025	12 months
E412	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	#22/09/2023	24 months
E428	HF906	Horn Antenna 1 - 18 GHz	Rohde & Schwarz	23/05/2023	36 months
E429	-	Filter Box 5 Switch Filters 0.91 GHz - 16.3 GHz	RN Electronics	28/08/2025	12 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	10/07/2025	24 months
E743	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	KEC	17/02/2025	12 months
E856	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	19/03/2025	12 months
E904	5086-7805	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	04/07/2025	12 months
LPE364	CBL6112A	Antenna BiLog 30MHz - 2GHz	Chase Electronics Ltd	04/08/2025	36 months
TMS78	3160-08	Horn Std Gain 12.4 - 18 GHz	ETS Systems	#26/09/2024	12 months
TMS79	3160-09	Horn Std Gain 18 - 26.5 GHz	ETS Systems	21/07/2025	12 months
TMS81	6502	Antenna Active Loop	EMCO	02/09/2025	24 months

Equipment was within calibration dates for tests and has been re-calibrated since/during date of tests.

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	P56F	Laptop	Dell	5986433846
2	Arcana	eARC Adpater	Arcana	6000522018785
3	None Specified	8R5 Load Jig	Monitor Audio Group	None Specified
4	H13516v1_VAR0a	SPI-USB Converter	Not Specified	353565
5	2049L	ESP32 Prog Adaptor	Not Specified	None Specified
6	GL-MT300N-V2	300M Mini Smart Router	GL iNet	dB10e51bf3e8cbf0

10.2 Kiwa Electrical Compliance supplied equipment

No Kiwa Electrical Compliance supplied equipment was used.

11 Condition of the equipment tested

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

11.1 Modifications before test

No modifications were made before test by Kiwa Electrical Compliance.

11.2 Modifications during test

No modifications were made during test by Kiwa Electrical Compliance.

12 Description of test sites

Site A	Radio Laboratory and Anechoic Chamber
Site B	Semi-Anechoic Chamber and Control Room FCC Registration No. 654321, ISED Registration No. 5612A-4
Site C	Transient Laboratory
Site D	Screened Room (Conducted Immunity)
Site E	Screened Room (Control Room for Site D)
Site F	Screened Room (Conducted Emissions)
Site G	Screened Room (Control Room for Site H)
Site H	3m Semi-Anechoic Chamber (indoor OATS) FCC Registration No. 654321, ISED Registration No. 5612A-2, VCCI Registration No. 4065
Site J	Transient Laboratory
Site K	Screened Room (Control Room for Site M)
Site M	3m Semi-Anechoic Chamber (indoor OATS) FCC Registration No. 654321, ISED Registration No. 5612A-3
Site N	Radio Laboratory
Site Q	Fully-Anechoic Chamber
Site OATS 3m and 10m Open Area Test Site	FCC Registration No. 654321, ISED Registration No. 5612A-1
Site R	Screened Room (Conducted Immunity)
Site S	Safety Laboratory
Site T	Transient Laboratory

CAB identifier as issued by Innovation, Science and Economic Development Canada is UK0002
CAB identifier as issued by FCC is UK2015

13 Abbreviations and units

%	Percent	dBμV	decibels relative to 1μV
λ	Wavelength	dBμV/m	decibels relative to 1μV/m
μA/m	microAmps per metre	dBc	decibels relative to Carrier
μV	microVolts	dBd	decibels relative to dipole gain
μW	microWatts	dBi	decibels relative to isotropic gain
AC	Alternating Current	dBm	decibels relative to 1mW
ACK	ACKnowledgement	dBv	decibels relative to a maximum value
ACP	Adjacent Channel Power	dBW	decibels relative to 1W
AFA	Adaptive Frequency Agility	DC	Direct Current
ALSE	Absorber Lined Screened Enclosure	DFS	Dynamic Frequency Selection
AM	Amplitude Modulation	DMO	Dynamic Modulation Order
Amb	Ambient	DSSS	Direct Sequence Spread Spectrum
ANSI	American National Standards Institute	DTA	Digital Transmission Analyser
ATPC	Automatic Transmit Power Control	EIRP	Equivalent Isotropic Radiated Power
AVG	Average	emf	electromotive force
AWGN	Additive White Gaussian Noise	ERC	European Radiocommunications Committee
BER	Bit Error Rate	ERP	Effective Radiated Power
BPSK	Binary Phase Shift Keying	ETSI	European Telecommunications Standards Institute
BT	BlueTooth	EU	European Union
BLE	BlueTooth Low Energy	EUT	Equipment Under Test
BW	Bandwidth	FCC	Federal Communications Commission
°C	Degrees Celsius	FER	Frame Error Rate
C/I	Carrier / Interferer	FHSS	Frequency Hopping Spread Spectrum
CAC	Channel Availability Check	FM	Frequency Modulation
CCA	Clear Channel Assessment	FSK	Frequency Shift Keying
CEPT	European Conference of Postal and Telecommunications Administrations	FSS	Fixed Satellite Service
CFR	Code of Federal Regulations	g	Grams
CISPR	Comité International Spécial des Perturbations Radioélectriques	GHz	GigaHertz
cm	centimetre	GNSS	Global Navigation Satellite System
COFDM	Coherent OFDM	GPS	Global Positioning System
COT	Channel Occupancy Time	Hz	Hertz
CS	Channel Spacing	IEEE	Institute of Electrical and Electronics Engineers
CW	Continuous Wave	IF	Intermediate Frequency
DAA	Detect And Avoid	ISED	Innovation Science and Economic Development
dB	decibels	ITU	International Telecommunications Union
dBμA/m	decibels relative to 1μA/m	KDB	Knowledge DataBase

kg	kilogram	pW	picoWatts
kHz	kiloHertz	QAM	Quadrature Amplitude Modulation
kPa	Kilopascal	QP	Quasi Peak
LBT	Listen Before Talk	QPSK	Quadrature Phase Shift Keying
LISN	Line Impedance Stabilisation Network	RBW	Resolution Band Width
LNA	Low Noise Amplifier	RED	Radio Equipment Directive
LNB	Low Noise Block	R&TTE	Radio and Telecommunication Terminal Equipment
LO	Local Oscillator	Ref	Reference
m	metre	RF	Radio Frequency
mA	milliAmps	RFC	Remote Frequency Control
max	maximum	RFID	Radio Frequency IDentification
Mbit/s	MegaBits per second	RLAN	Radio Local Area Network
MCS	Modulation and Coding Scheme	RMS	Root Mean Square
MHz	MegaHertz	RNSS	Radio Navigation Satellite Service
mic	Microphone	RSL	Received Signal Level
MIMO	Multiple Input, Multiple Output	RSSI	Received Signal Strength Indicator
min	minimum	RTP	Room Temperature and Pressure
mm	millimetres	RTPC	Remote Transmit Power Control
ms	milliseconds	Rx	Receiver
mW	milliWatts	s	Seconds
NA	Not Applicable	SINAD	Signal to Noise And Distortion
NFC	Near Field Communications	SRD	Short Range Device
nom	Nominal	Tx	Transmitter
nW	nanoWatt	UKAS	United Kingdom Accreditation Service
OATS	Open Area Test Site	UKCA	United Kingdom Conformity Assessed
OBW	Occupied Band Width	UKRER	United Kingdom Radio Equipment Regulations
OCW	Occupied Channel Width	UHF	Ultra High Frequency
OFDM	Orthogonal Frequency Division Multiplexing	U-NII	Unlicensed National Information Infrastructure
OOB	Out Of Band	USB	Universal Serial Bus
ppm	Parts per million	UWB	Ultra Wide Band
PER	Packet Error Rate	V	Volts
PK	Peak	V/m	Volts per metre
PMR	Private Mobile Radio	VBW	Video Band Width
PRBS	Pseudo Random Bit Sequence	VHF	Very High Frequency
PRF	Pulse Repetition Frequency	VSAT	Very Small Aperture Terminal
PSD	Power Spectral Density	W	Watts
PSU	Power Supply Unit		

13 Revision History

Issue Number	Revision History	Page Reference(s)
01	First Issue	-

===== END OF TEST REPORT =====