



Radio Test Report

Monitor Audio Ltd

Caspian 4G

Streaming Pre-Amplifier

47 CFR Part 15.247 Effective Date 1st October 2024

DSS: Part 15 Spread Spectrum Transmitter

Test Date: 2nd March 2026 to 5th March 2026

Report Number: 24299-1-26 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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This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF communiqué dated April 2017).

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

Certificate of Test 24299-1

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
Model Number:	Streaming Pre-Amplifier
Unique Serial Number:	0432537100007
Applicant:	Monitor Audio Ltd 24 Brook Road Rayleigh Essex UK
FCC ID:	O7V-MA104210
Full measurement results are detailed in Report Number:	24299-1-26 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 only to the BTC functionality of the Streaming Pre-Amplifier. Equipment also Contains FCC ID's: 2AC7Z-ESPWROOM32UE and 2AATL-8223A-SR.

DEVIATIONS:

The following tests have had deviations applied: RF Power Output and Transmit Spurious emissions.

This test 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: 2nd March 2026 to 5th March 2026

Test Engineer:
Chee-Wah Yeung

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1 Contents

1	Contents	3
2	Equipment under test (EUT)	5
2.1	Equipment specification	5
2.2	Applicant declarations for testing	6
2.3	Functional description	7
2.4	Modes of operation.....	7
2.5	Emissions configuration	8
3	Summary of test results	11
4	Specifications	12
4.1	Relevant standards.....	12
4.2	Deviations	12
4.3	Declared extremes of temperature & voltage.....	12
4.4	Test fixtures	12
5	Tests, methods and results	13
5.1	AC power line conducted emissions	13
5.2	Radiated emissions 9 - 150 kHz.....	14
5.3	Radiated emissions 150 kHz - 30 MHz	16
5.4	Radiated emissions 30 MHz -1 GHz	18
5.5	Radiated emissions above 1 GHz	20
5.6	Effective radiated power field strength	23
5.7	Band Edge Compliance.....	24
5.8	Occupied bandwidth.....	26
5.9	Maximum Average conducted output power	26
5.10	Maximum Peak conducted output power	26
5.11	Maximum Power Spectral Density	26
5.12	Antenna power conducted emissions	26
5.13	Duty cycle	26
5.14	FHSS carrier frequency separation	26
5.15	Average time of occupancy	26
5.16	Number of Hop Channels	26
6	Plots/Graphical results	27
6.1	Radiated emissions 9 - 150 kHz.....	27
6.2	Radiated emissions 150 kHz - 30 MHz	28
6.3	Radiated emissions 30 MHz -1 GHz	29
6.4	Radiated emissions above 1 GHz	31
6.5	Effective radiated power field strength	42
6.6	Band Edge Compliance.....	44
7	Explanatory Notes.....	45
7.1	Explanation of Table of Signals Measured.....	45
7.2	Explanation of limit line calculations for radiated measurements	45
8	Photographs.....	47
8.1	EUT Front View	47
8.2	EUT Reverse Angle.....	48
8.3	EUT Left side View	49
8.4	EUT Right side View	49
8.5	EUT Antenna Port	50
8.6	EUT Display & Controls.....	51
8.7	EUT Internal photos	52
8.8	EUT ID Label.....	53
8.9	EUT Chassis.....	54
8.10	Radiated emissions 9 - 150 kHz.....	55
8.11	Radiated emissions 150 kHz - 30 MHz	55
8.12	Radiated emissions 30 MHz -1 GHz	56
8.13	Radiated emissions above 1 GHz	56
8.14	Radiated emission diagrams	58

9	Test equipment calibration list	59
10	Auxiliary and peripheral equipment.....	60
10.1	Customer supplied equipment.....	60
10.2	Kiwa Electrical Compliance supplied equipment.....	60
11	Condition of the equipment tested	61
11.1	Modifications before test	61
11.2	Modifications during test.....	61
12	Description of test sites	62
13	Abbreviations and units.....	63
14	Revision History	65

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Monitor Audio Ltd 24 Brook Road Rayleigh Essex SS6 7XJ UK	
Manufacturer of EUT	Monitor Audio Group	
Full Name of EUT	Caspian 4G	
Model Number of EUT (HVIN)	Streaming Pre-Amplifier	
Serial Number of EUT	0432537100007	
Date Received	21st October 2025	
Date of Test:	2nd March 2026 to 5th March 2026	
Date Report Issued	10th March 2026	
Main Function	Stereo Audio Pre-Amplifier and DAC (Digital to Analogue Converter) featuring digital and analogue inputs, A2DP Bluetooth, WiFi/Ethernet audio streaming and BLE control.	
EUT Specification	Height	93 mm
	Width	432 mm
	Depth	384.1 mm
	Weight	10.1 kg
	Voltage	85-265 VAC
	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
Integrated Amplifier	Without 2.4/5GHz WiFi, LAN (Ethernet), USB and HDMI.
Streaming Amplifier	With 2.4/5GHz WiFi, LAN (Ethernet), USB and HDMI.
Streaming Pre-Amplifier	With 2.4/5GHz WiFi, LAN (Ethernet), USB and HDMI. But without Left and Right speaker Outputs.

Streaming Pre-amplifier has been tested in this report.

2.2 Applicant declarations for testing

General Parameters	
EUT Normal use position	Table Top
Choice of model(s) for type tests	Production
Antenna details	Applicant designed PIFA antenna 104699 A.5 08/12/2023 fitted into chassis rear panel. Gain 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	5850 MHz
Lowest Signal generated in EUT	32.678 kHz
Hardware Version (HVIN)	Streaming Pre-Amplifier
Software Version	v1.27.367-DP
Firmware Version (FVIN)	v1.27.367-DP
Type of Equipment	Modular
Technology Type	2.4 & 5 GHz WiFi, BTC and BLE
Geo-location (yes/no)	No
Wi-Fi / Bluetooth / ZigBee Parameters	
TX Parameters	
Alignment range – transmitter	2402 - 2480 MHz
EUT Declared Modulation Parameters	GFSK, DQPSK & 8-DPSK
EUT Declared Power level	Not Provided
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 Wi-Fi / BT / ZigBee 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	v1 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 pre-amplifier with the following:

Inputs - 2x RCA Analogue, 2x RCA for Turntables, 2x Balanced XLR, 2x Digital Coaxial, 2x Digital Optical, USB (BluOS Module - Streaming Amplifier only), HDMI (BluOS Module - Streaming Amplifier only)

Outputs - 4x RCA Analogue, 2x Balanced XLR

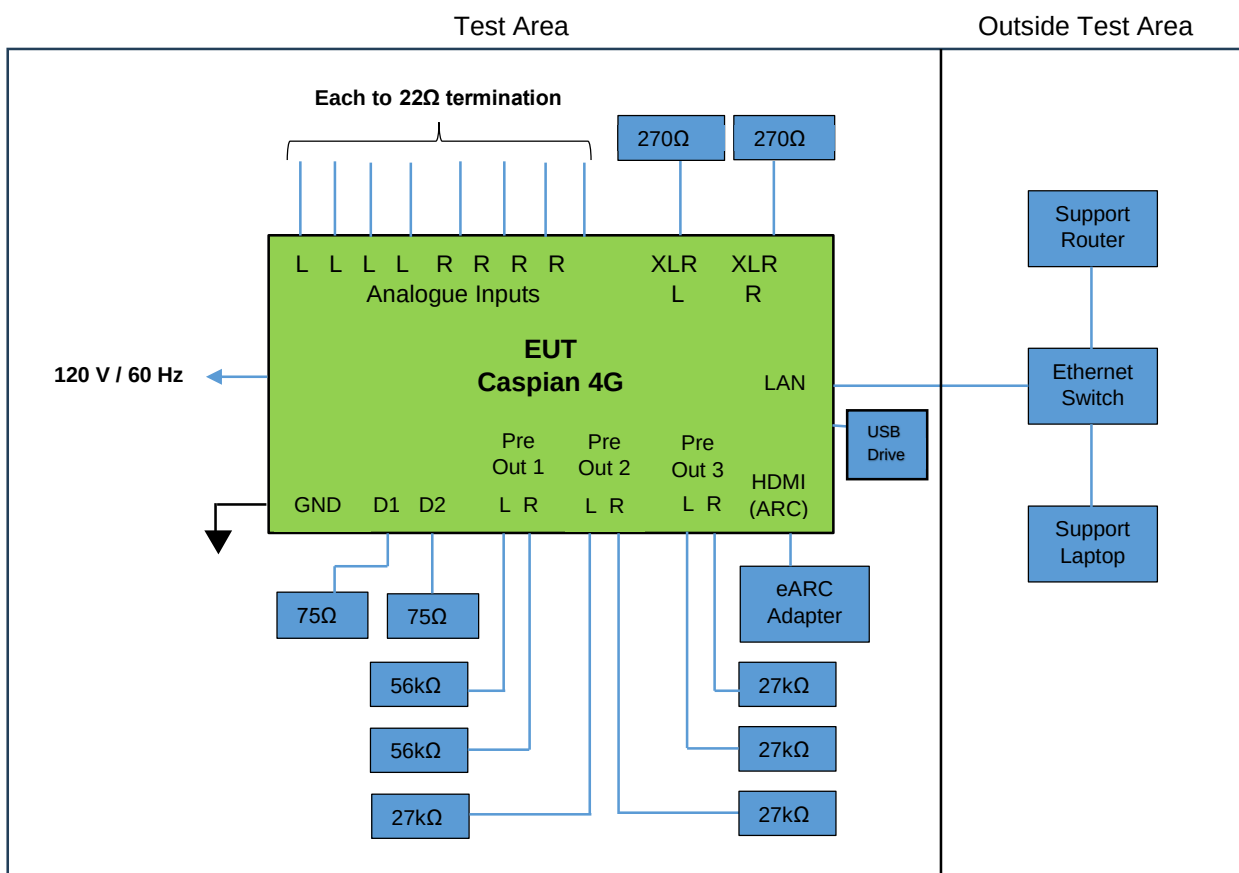
Networking - 1x A2DP Bluetooth Audio, 1x BLE/WiFi (ESP32), 1x WiFi (BluOS Module), 1x RJ45 Ethernet (BluOS Module)

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 WiFi and allows playback, audio and basic operation control. BluOS streaming module allows music streaming over WiFi 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	Yes
Mode 2	Constant Transmit, BTC, Mid Channel (2441 MHz), GFSK, DH5, Default Power setting	Yes
Mode 3	Constant Transmit, BTC, High Channel (2480 MHz), GFSK, DH5, Default Power setting	Yes
Mode 4	Constant Transmit, BTC, Mid Channel (2441 MHz), GFSK, DH5 + BLE Advertising, Default Power	Yes
Mode 5	Constant Transmit, BTC, 2441 MHz, GFSK, DH5, Default Power + BluOS 5500 MHz WiFi 802.11n MCS0 20 MHzBW, Power Setting:15	Yes

2.5 Emissions configuration

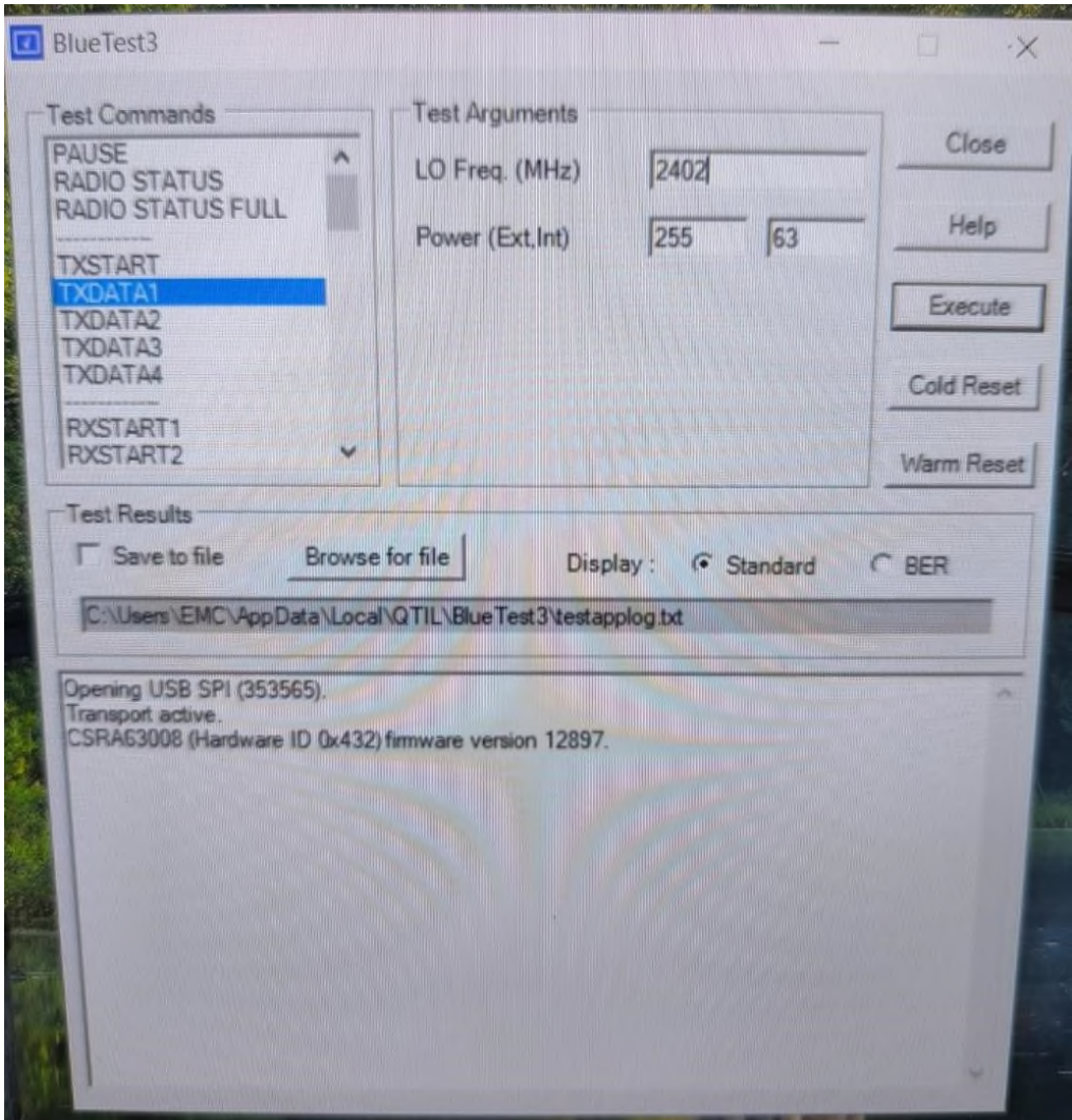


The unit was powered from 120 V AC mains. For conducted tests the internal antenna was disconnected and a UFL to SMA cable was connected in its place. The unit was configured using engineering software called “Blue test 3” provided by the Manufacturer to allow permanent transmit modes of device on the 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.

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

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



2.5.1 Signal leads

Port Name	Cable Type	Connected
AC port	3 core	Yes
A1	Analogue RCA Input	Yes
A2	Analogue RCA Input	Yes
A3	Balanced XLR Input	Yes
MC	Analogue RCA Input	Yes
MM	Analogue RCA Input	Yes
D1	Digital Coaxial Input	Yes
D2	Digital Coaxial Input	Yes
D3	Digital Optical Input	Yes
D4	Digital Optical Input	Yes
HDMI	HDMI Input	Yes
USB	USB A Input	Yes
LAN	Cat5 Bi-Directional	Yes
Pre Out 1	Balanced XLR Output	Yes
Pre Out 2	Analogue RCA Output	Yes
Pre Out 3	Analogue RCA Output	Yes
Wired IR	3.5mm Jack Input	Yes
12V Trigger	3.5mm Jack Input	Yes

3 Summary of test results

The Caspian 4G, Streaming Pre-Amplifier was tested for compliance to the following standard(s):

47 CFR Part 15.247:2024 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
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15.247 Part 15.209	PASSED
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
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 APPLICABLE ³
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. The EUT was tested for radiated emissions with its dedicated antenna in position.

³ EUT does not employ DTS technology.

Manufacturer declares highest internal source of the EUT to be 5825 MHz. Measurements were only made up to 25 GHz at the request of the applicant.

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 of 32.768 kHz.

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

The following deviations were applied to 'RF Power Output' and 'Transmit Spurious emissions':

- Only GFSK, DH5 was tested at Default power as requested by the applicant for worst case testing in line with the Class II Permissive Change Certification.

4.3 Declared extremes of temperature & voltage

The following test conditions were used to simulate testing at nominal or extremes.

Temperature Test Conditions		Voltage Test Conditions	
T nominal	20 °C	V nominal	240 V AC
T minimum	5°C °C	V minimum	85 V AC
T maximum	40°C °C	V maximum	265 V AC

Extremes of temperature are based upon manufacturer's declaration.

The ambient test conditions of humidity and pressure in the laboratory are as specified in each 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, 3, 4 and 5.

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 20dB 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 17°C
Humidity of test environment 68%
Pressure of test environment 101kPa

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				

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

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 $\pm 3.11\text{dB}$ (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, 3, 4 and 5.

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

TMS81, E624, E411

See Section 8 for more details

5.3.5 Test results

Temperature of test environment 17°C
Humidity of test environment 68%
Pressure of test environment 101kPa

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				

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

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 $\pm 3.11\text{dB}$ (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, 3, 4 and 5.

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

E624, E743, LPE364

See Section 8 for more details

5.4.5 Test results

Temperature of test environment 18°C
Humidity of test environment 60%
Pressure of test environment 101kPa

Note: Low, Middle and High channel settings provided identical results in this test range – the results were also identical when BLE and then 5GHz Wi-Fi modes (4 & 5) were initiated. See Mid Channel plots and tables for results covering these modes/channels. GFSK DH5 modulation was used as the worst case setting in line with the previous two model variants: Streaming Amplifier and Integrated Amplifier.

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

Plot refs
24299-1 Tx Spurious Emissions 30-300 MHz BTC Mid Ch (2441 MHz) Horizontal
24299-1 Tx Spurious Emissions 30-300 MHz BTC Mid Ch (2441 MHz) Vertical
24299-1 Tx Spurious Emissions 300-1000 MHz BTC Mid Ch (2441 MHz) Horizontal
24299-1 Tx Spurious Emissions 300-1000 MHz BTC Mid Ch (2441 MHz) Vertical

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	30.360	30.5	23.6	-16.4
2	239.994	33.6	30.7	-15.3
3	259.980	36.0	31.4	-14.6
4	399.997	33.2	30.0	-16.0
5	651.526	36.7	31.7	-14.3
6	792.501	35.4	28.3	-17.7
7	799.998	35.9	30.3	-15.7
8	959.751	37.1	31.1	-14.9

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	30.298	30.2	23.7	-16.3
2	33.490	29.0	21.9	-18.1
3	716.699	35.9	29.8	-16.2
4	800.021	33.6	28.3	-17.7
5	864.030	33.9	27.9	-18.1
6	960.000	34.5	29.1	-16.9

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: 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 Modes 1, 2, 3, 4 and 5.

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 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

E428, E429, E642, E650, E653, E834, E904, F260, F424, TMS78, TMS79

See Section 8 for more details

5.5.5 Test results

Temperature of test environment 20°C
Humidity of test environment 38%
Pressure of test environment 102kPa

GFSK DH5 modulation was used as the worst case setting in line with the previous two model variants: Streaming Amplifier and Integrated Amplifier.

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	49.59	-24.41	42.66	-11.34	Side	Vertical
4804	51.1	-22.9	44.56	-9.44	Side	Horizontal
7206	51.76	-22.24	43.49	-10.51	Side	Vertical
7206	52.53	-21.47	44.29	-9.71	Side	Horizontal

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
4882	49.48	-24.52	41.87	-12.13	Side	Vertical
4882	50.01	-23.99	42.44	-11.56	Side	Horizontal
7323	52.16	-21.84	44.87	-9.13	Side	Vertical
7323	53.2	-20.8	45.67	-8.33	Side	Horizontal

Plots						
24299-1 Tx Spurious Emissions 1-2 GHz BTC Mid Ch (2441 MHz) Vertical						
24299-1 Tx Spurious Emissions 1-2 GHz BTC Mid Ch (2441 MHz) Horizontal						
24299-1 Tx Spurious Emissions 2-2.7 GHz BTC Mid Ch (2441 MHz) Vertical						
24299-1 Tx Spurious Emissions 2-2.7 GHz BTC Mid Ch (2441 MHz) Horizontal						
24299-1 Tx Spurious Emissions 2.7-5 GHz BTC Mid Ch (2441 MHz) Vertical						
24299-1 Tx Spurious Emissions 2.7-5 GHz BTC Mid Ch (2441 MHz) Horizontal						
24299-1 Tx Spurious Emissions 5-6 GHz BTC Mid Ch (2441 MHz) Vertical						
24299-1 Tx Spurious Emissions 5-6 GHz BTC Mid Ch (2441 MHz) Horizontal						
24299-1 Tx Spurious Emissions 6-7.77 GHz BTC Mid Ch (2441 MHz) Vertical						
24299-1 Tx Spurious Emissions 6-7.77 GHz BTC Mid Ch (2441 MHz) Horizontal						
24299-1 Tx Spurious Emissions 7.77-10 GHz BTC Mid Ch (2441 MHz) Vertical						
24299-1 Tx Spurious Emissions 7.77-10 GHz BTC Mid Ch (2441 MHz) Horizontal						
24299-1 Tx Spurious Emissions 10-12.5 GHz BTC Mid Ch (2441 MHz) Vertical						
24299-1 Tx Spurious Emissions 10-12.5 GHz BTC Mid Ch (2441 MHz) Horizontal						
24299-1 Tx Spurious Emissions 12.5-15 GHz BTC Mid Ch (2441 MHz) Vertical						
24299-1 Tx Spurious Emissions 12.5-15 GHz BTC Mid Ch (2441 MHz) Horizontal						
24299-1 Tx Spurious Emissions 15-18 GHz BTC Mid Ch (2441 MHz) Vertical						
24299-1 Tx Spurious Emissions 15-18 GHz BTC Mid Ch (2441 MHz) Horizontal						
24299-1 Tx Spurious Emissions 18-22 GHz BTC Mid Ch (2441 MHz) Vertical						
24299-1 Tx Spurious Emissions 18-22 GHz BTC Mid Ch (2441 MHz) Horizontal						
24299-1 Tx Spurious Emissions 22-25 GHz BTC Mid Ch (2441 MHz) Vertical						
24299-1 Tx Spurious Emissions 22-25 GHz BTC Mid Ch (2441 MHz) Horizontal						

Setup Table

Band	2400-2483.5 MHz
Power Level	Default
Channel Spacing	1 MHz
Mod Scheme	GFSK DH5
Mid 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
4960	49.78	-24.22	41.51	-12.49	Side	Vertical
4960	50.32	-23.68	42.01	-11.99	Side	Horizontal
7440	51.16	-22.84	43.03	-10.97	Side	Vertical
7440	52.1	-21.9	43.93	-10.07	Side	Horizontal

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. DH5 was found to yield the highest emission amplitudes and has been used for final measurements.

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 field strength.

Tests were performed in test site H.

5.6.4 Test equipment

E412, E856, F361, LPE261, LPE333

See Section 8 for more details

5.6.5 Test results

Temperature of test environment 20.5°C
Humidity of test environment 50%
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
Mid channel	2441 MHz
High channel	2480 MHz

	Low channel	Mid channel	High channel
Peak Level (dBµV/m)	103.09	103.46	102.39
Plot reference	Low Chan DH5 Horiz Upright	Mid Chan DH5 Vert Upright	High Chan DH5 Horiz Upright
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 result for Power and was therefore repeated in this "Streaming Pre-amplifier" 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. $30 \text{ dBm e.i.r.p.} = 30 \text{ dBm} + 95.23 = 125.23 \text{ dBµV/m @ 3 m.}$

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 $\pm 4.81\text{dB}$ (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 the max held plots / measurements.

Tests were performed using Test Site M.

5.7.4 Test equipment

E136, E624, TMS82

See Section 8 for more details

5.7.5 Test results

Temperature of test environment 18°C
Humidity of test environment 60%
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)	43.1	42.45
Restricted band edge Peak Plot	24299-1 Rest Band Edge Low chan GFSK DH5	24299-1 Rest Band Edge High chan GFSK DH5
Restricted Average Level measured (dBuV/m)	N/A	N/A
Restricted band edge Average Plot	Peak complied with Average limit	Peak complied with 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 "Streaming Pre-amplifier" model variant testing. As peak measurements complied with the Average limits, no Average measurements were performed.

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.

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 APPLICABLE: EUT does not employ DTS technology.

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.

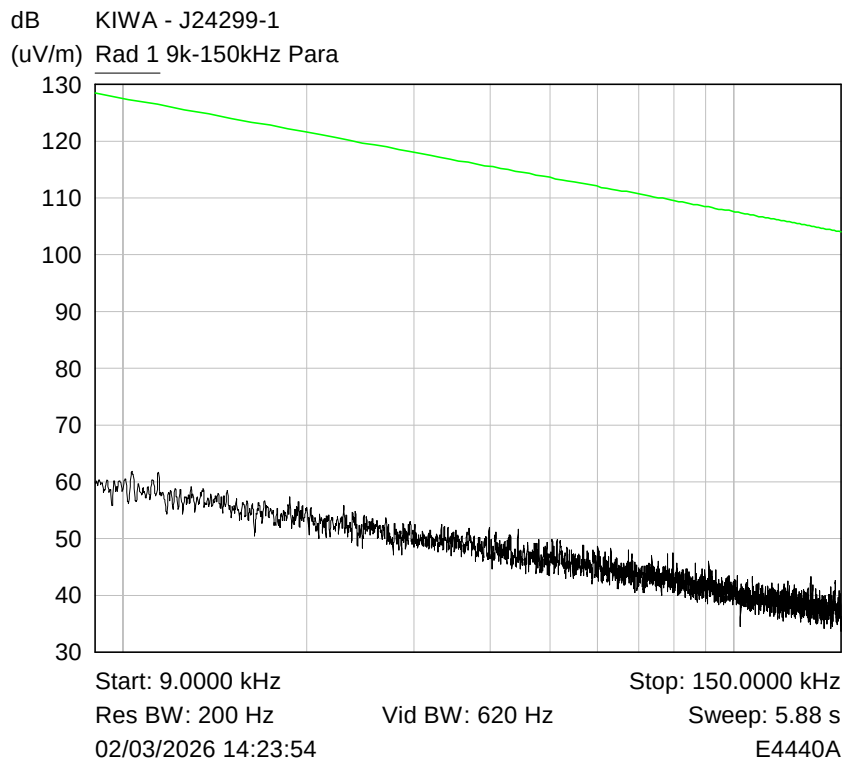
5.16 Number of Hop Channels

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

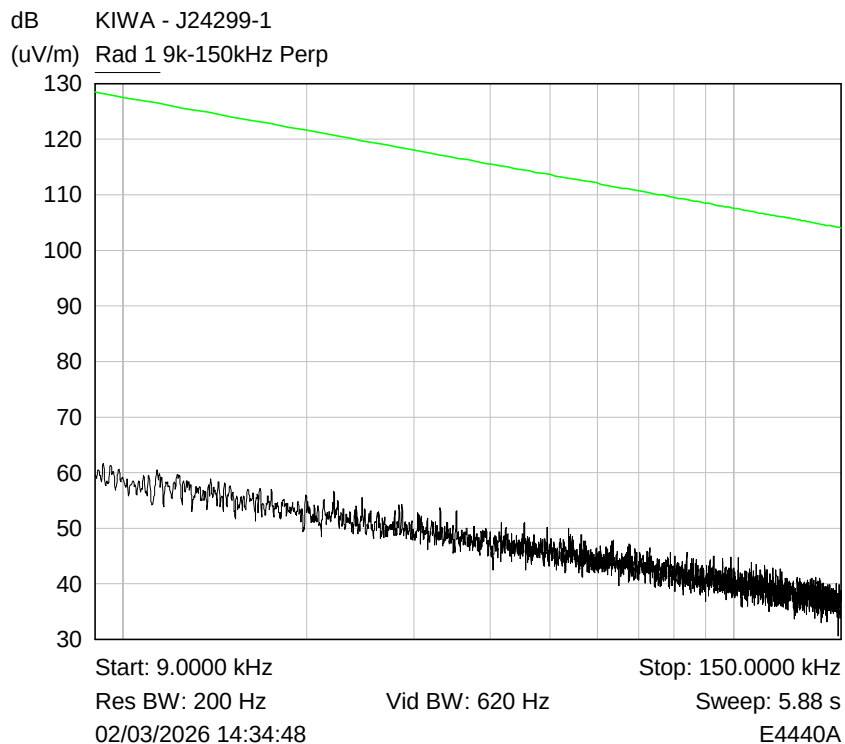
6 Plots/Graphical results

6.1 Radiated emissions 9 - 150 kHz

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



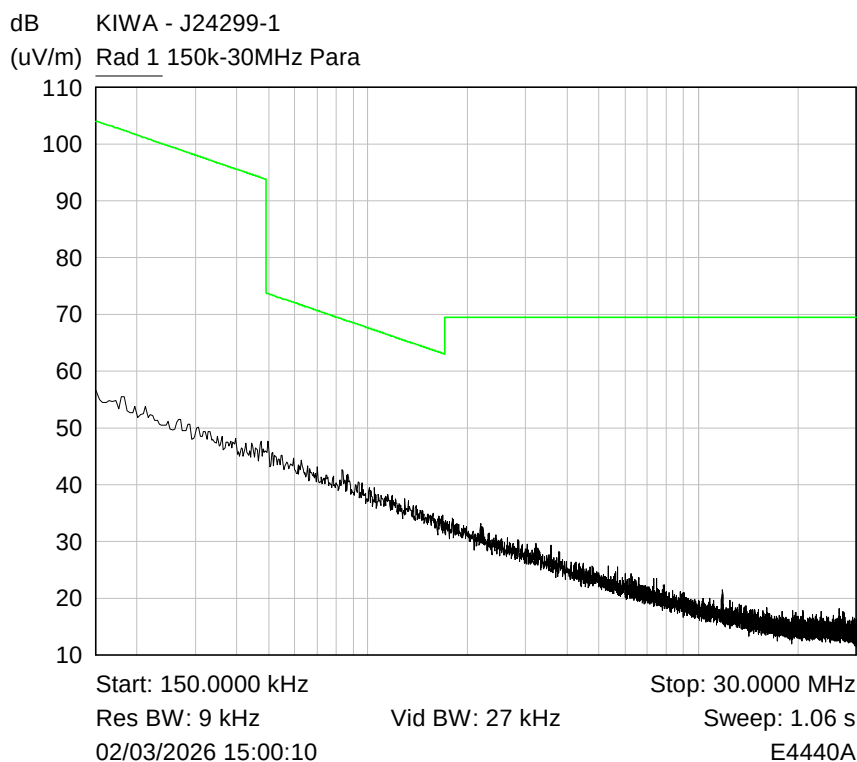
Plot of 9k-150kHz Parallel



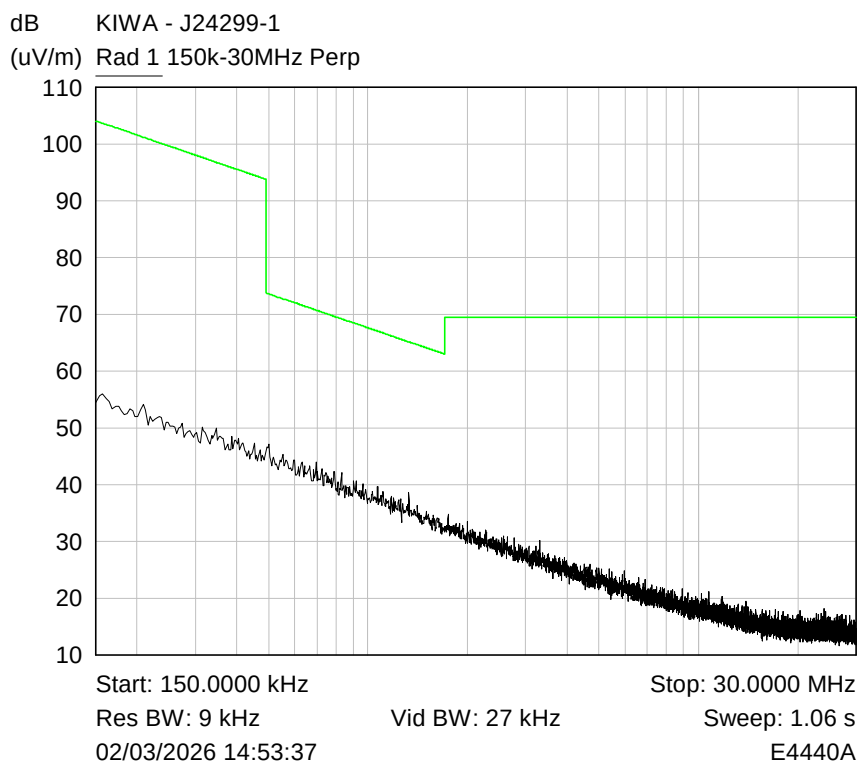
Plot of 9k-150kHz Perpendicular

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 2402 MHz



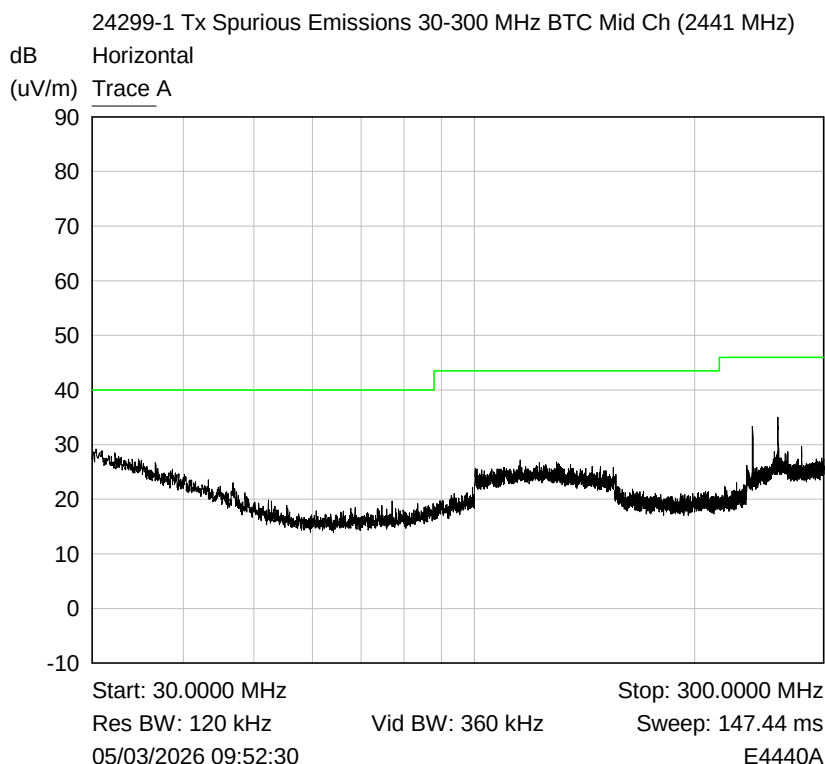
Plot of 150kHz-30MHz Parallel



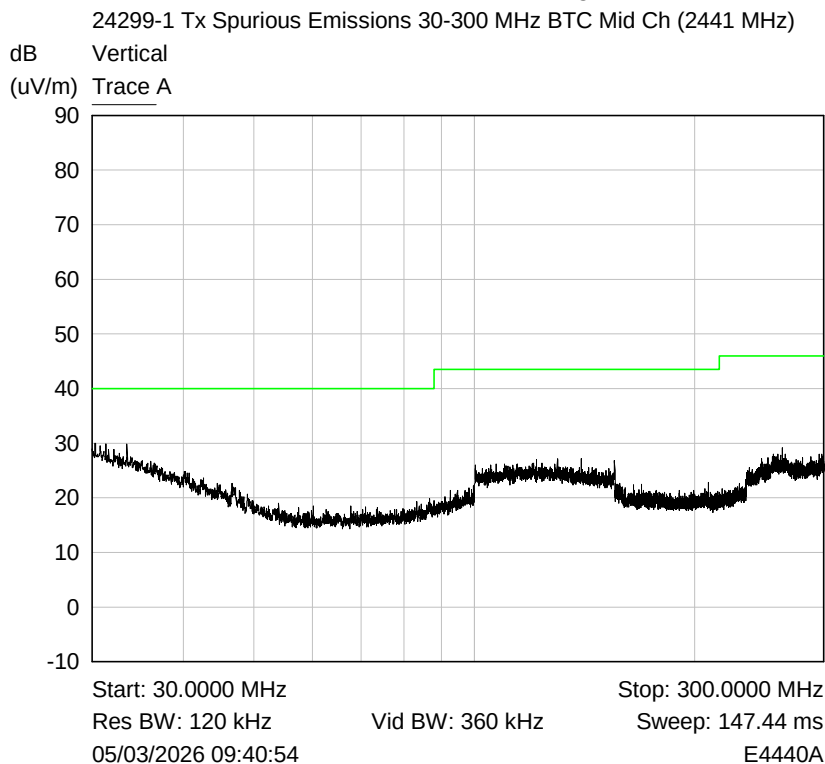
Plot of 150kHz-30MHz Perpendicular

6.3 Radiated emissions 30 MHz -1 GHz

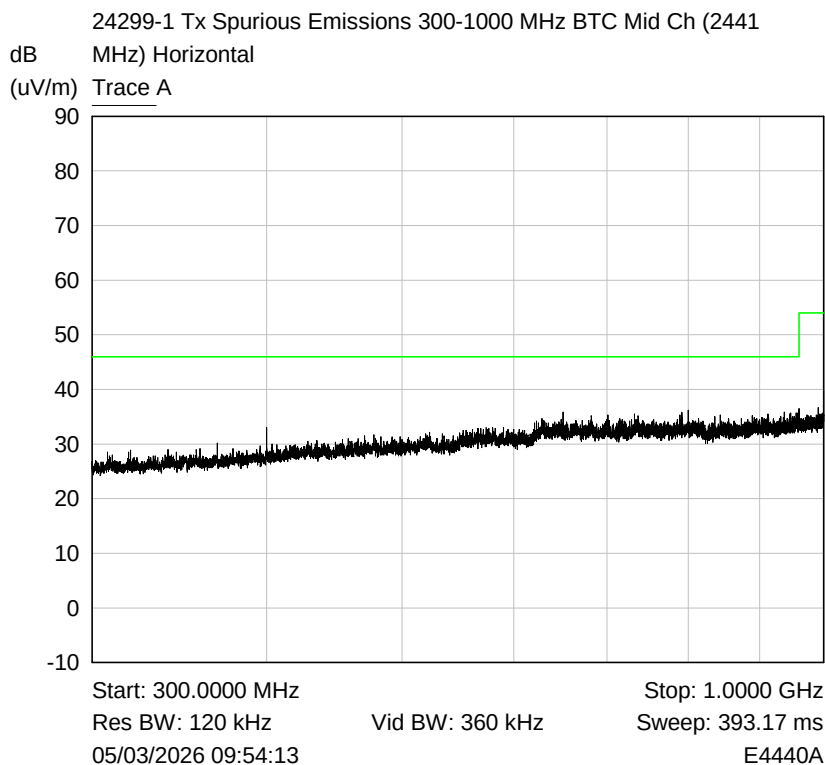
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2402 MHz



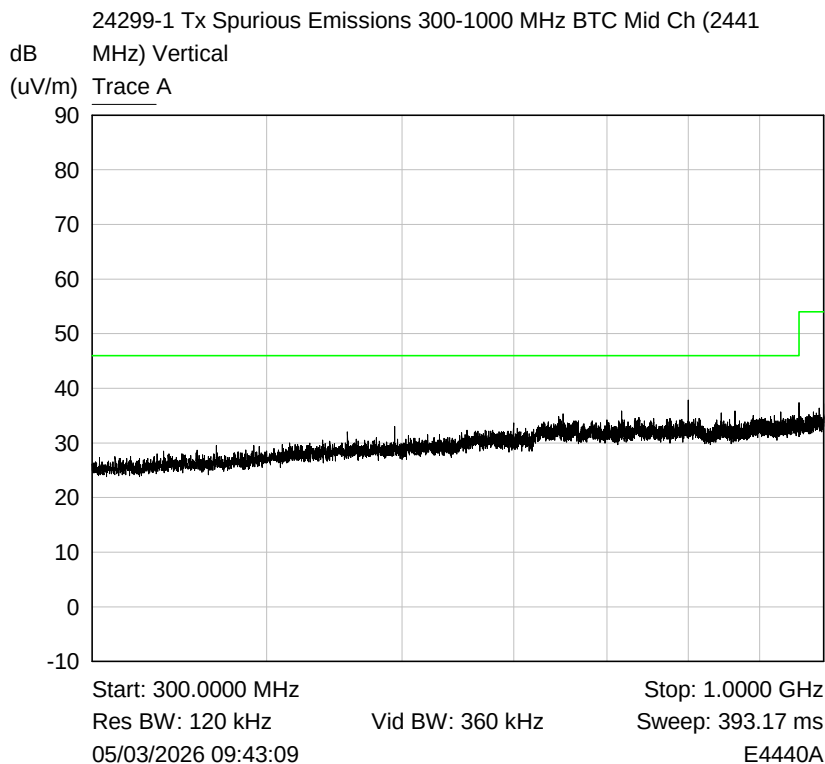
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



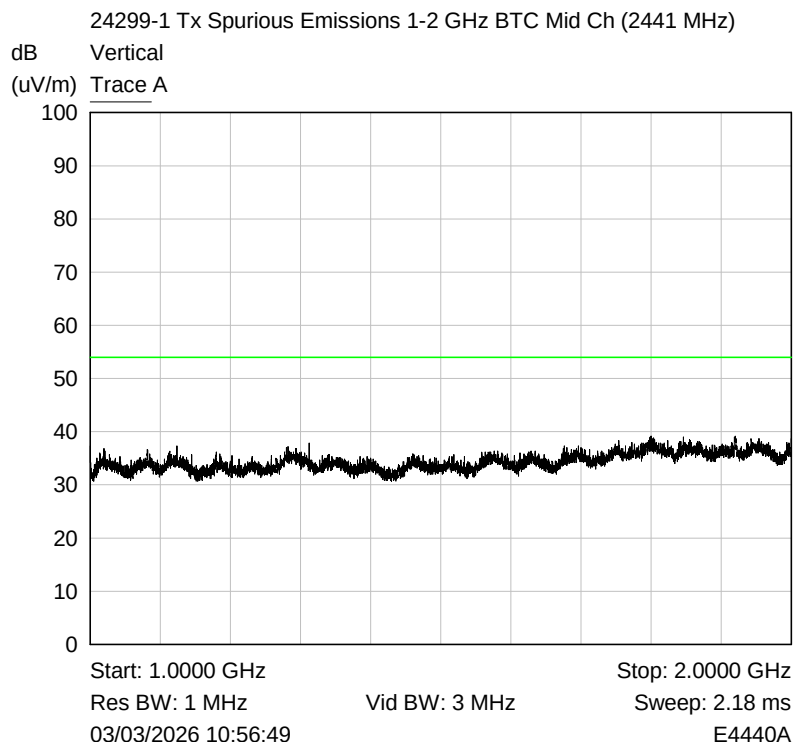
Plot of Peak emissions for UHF Horizontal against the QP limit line.



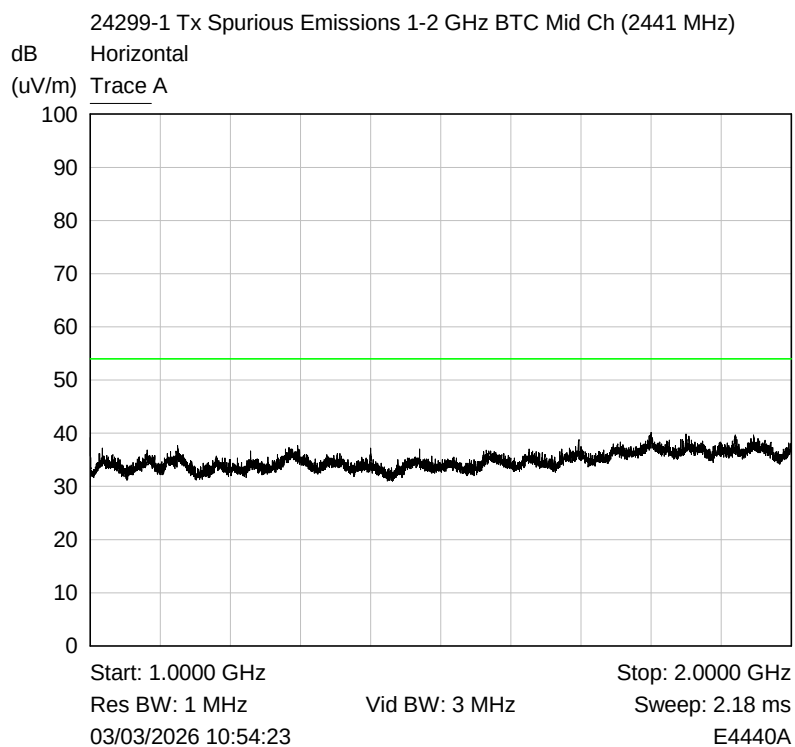
Plot of Peak emissions for UHF Vertical against the QP limit line.

6.4 Radiated emissions above 1 GHz

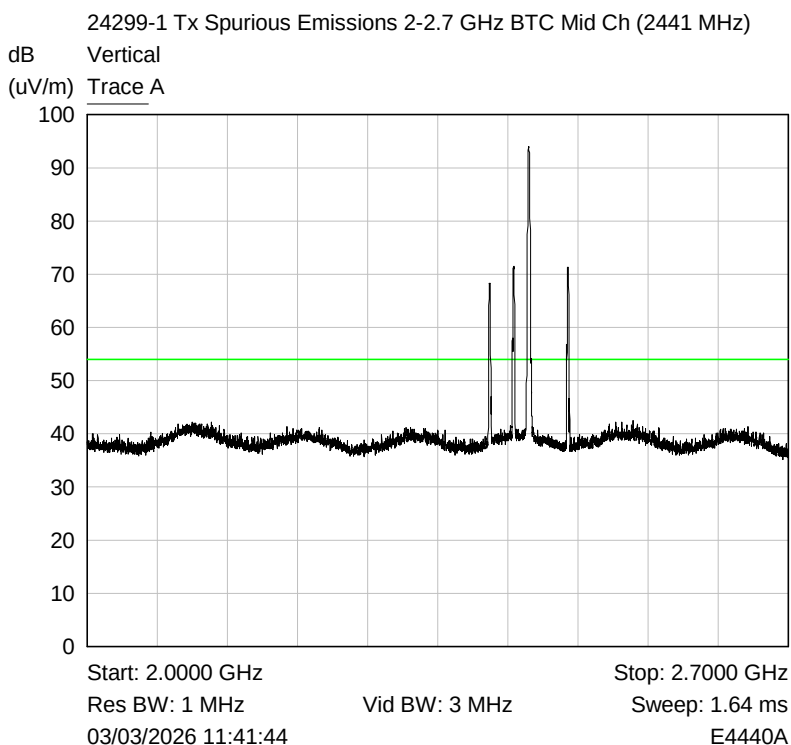
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



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

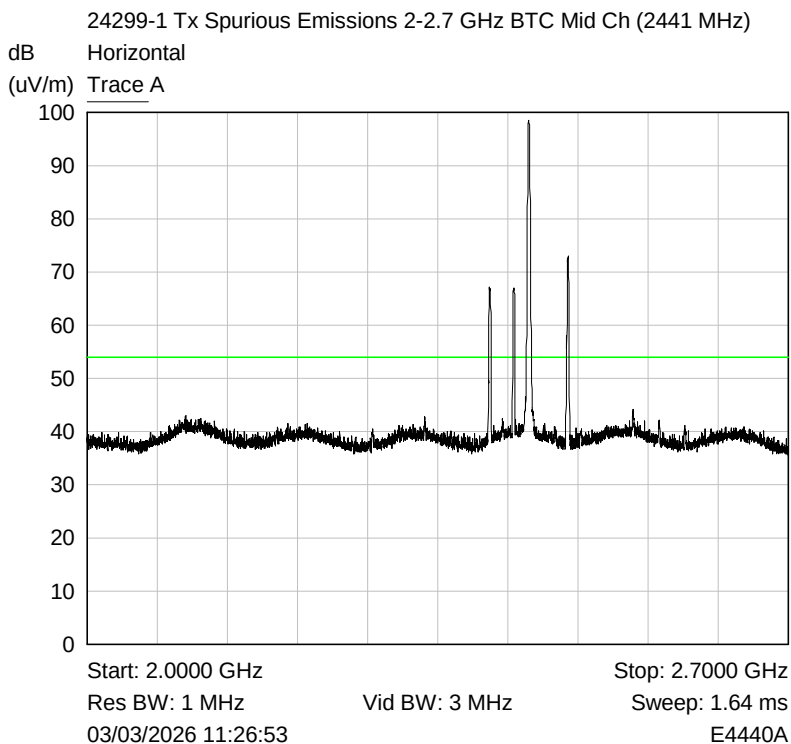


RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



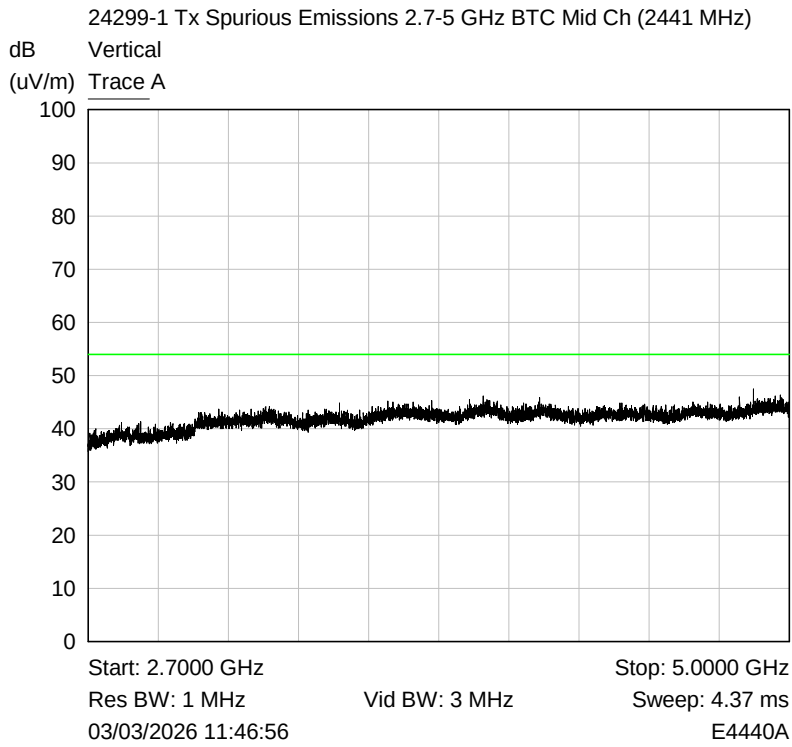
Note 1: The signals in the plot above exceeding the limit are the BTC fundamental transmit frequency and the BLE advertising channels
Note 2: The EUT uses several wireless technologies which can transmit simultaneously, therefore various combinations were investigated for intermodulation products (BTC+BLE, BTC+2.4GHz WiFi & BTC+5GHz WiFi) in which no intermods were observed.

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

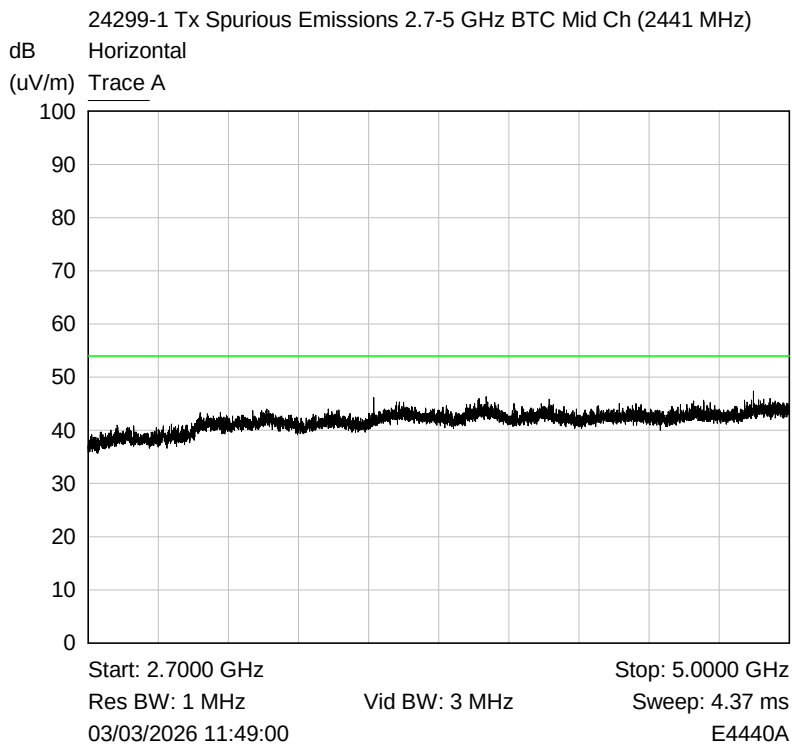


Note 1: The signals in the plot above exceeding the limit are the BTC fundamental transmit frequency and the BLE advertising channels
Note 2: The EUT uses several wireless technologies which can transmit simultaneously, therefore various combinations were investigated for intermodulation products (BTC+BLE, BTC+2.4GHz WiFi & BTC+5GHz WiFi) in which no intermods were observed.

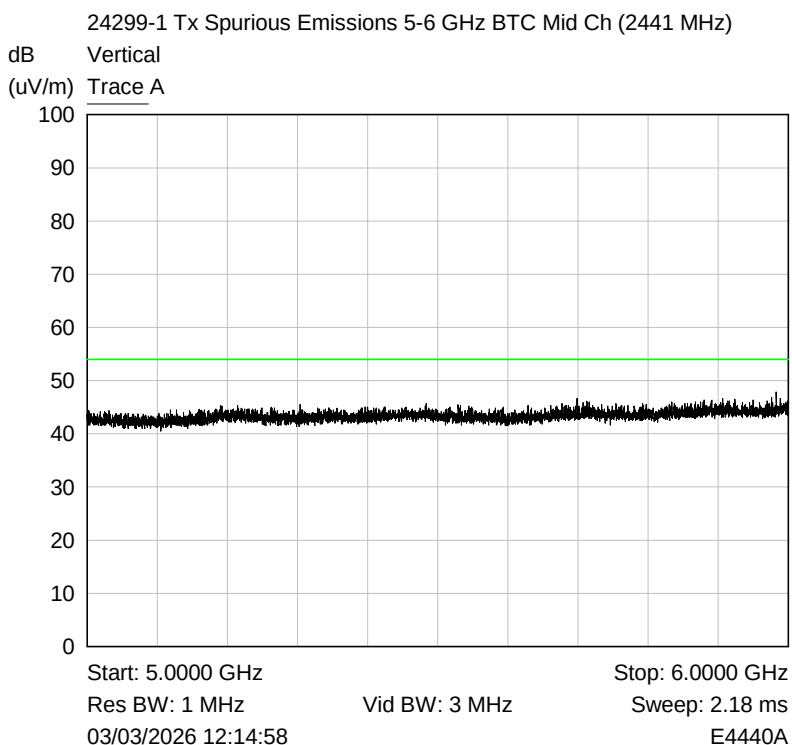
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



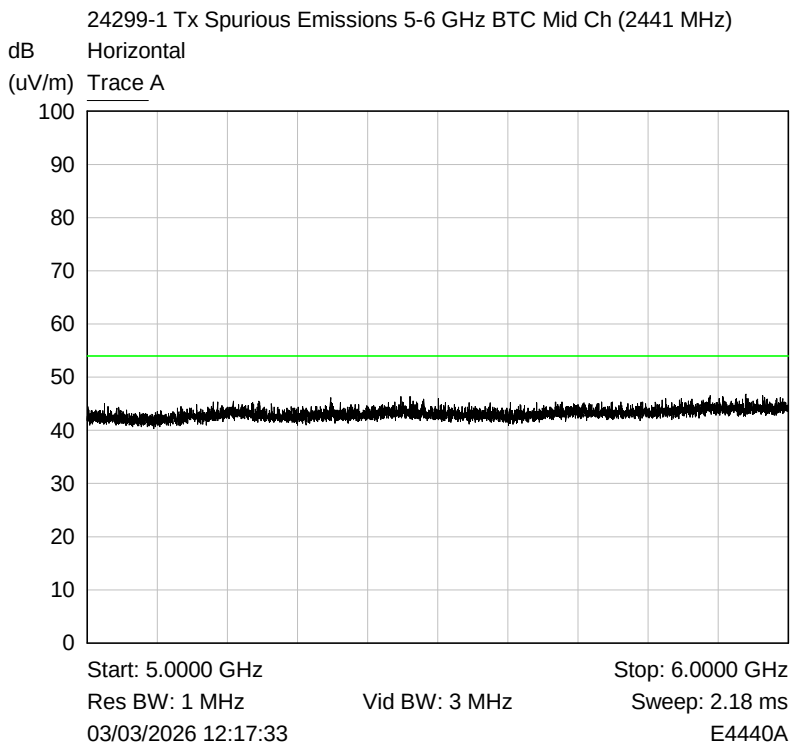
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



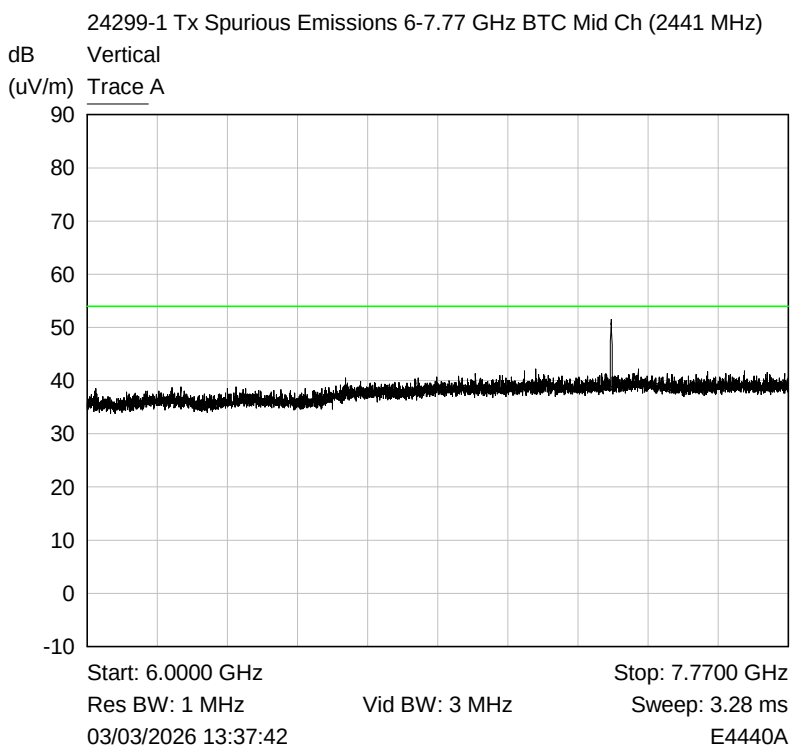
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



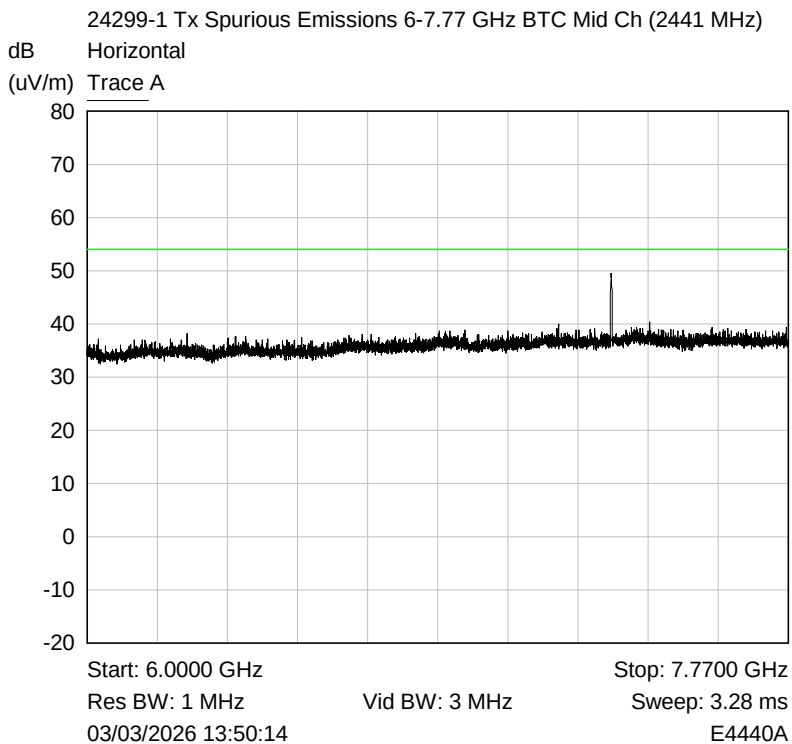
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



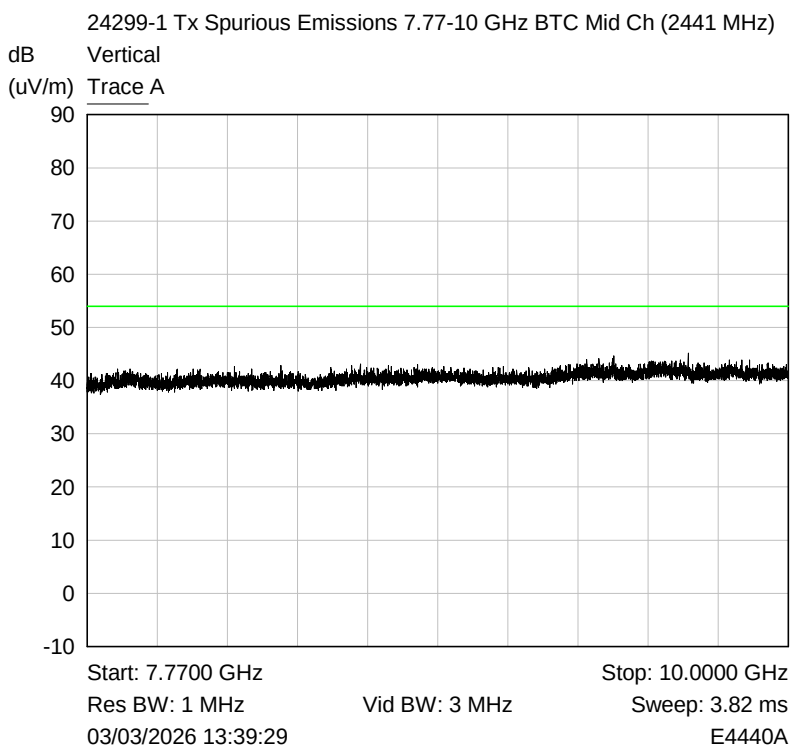
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



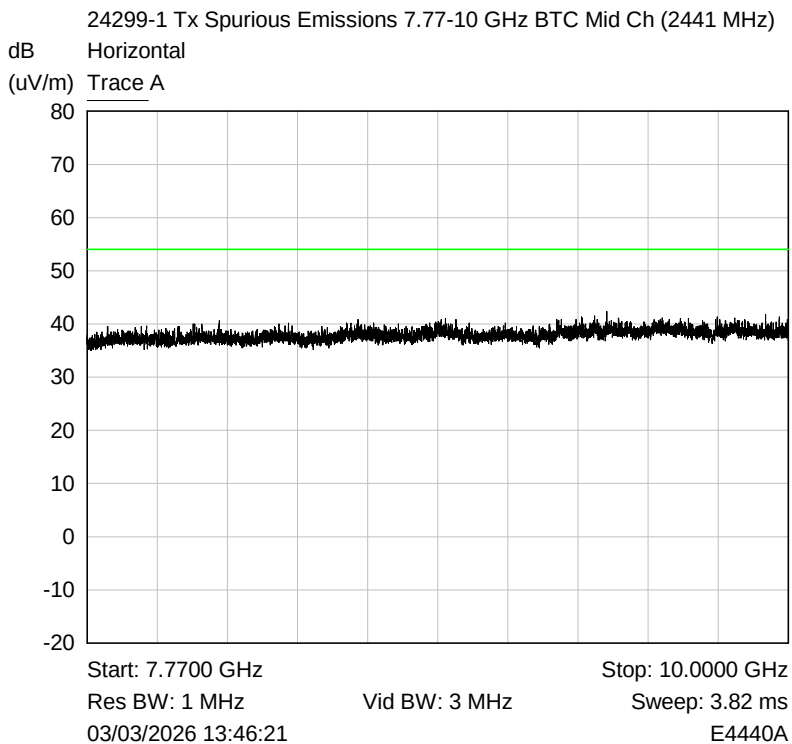
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



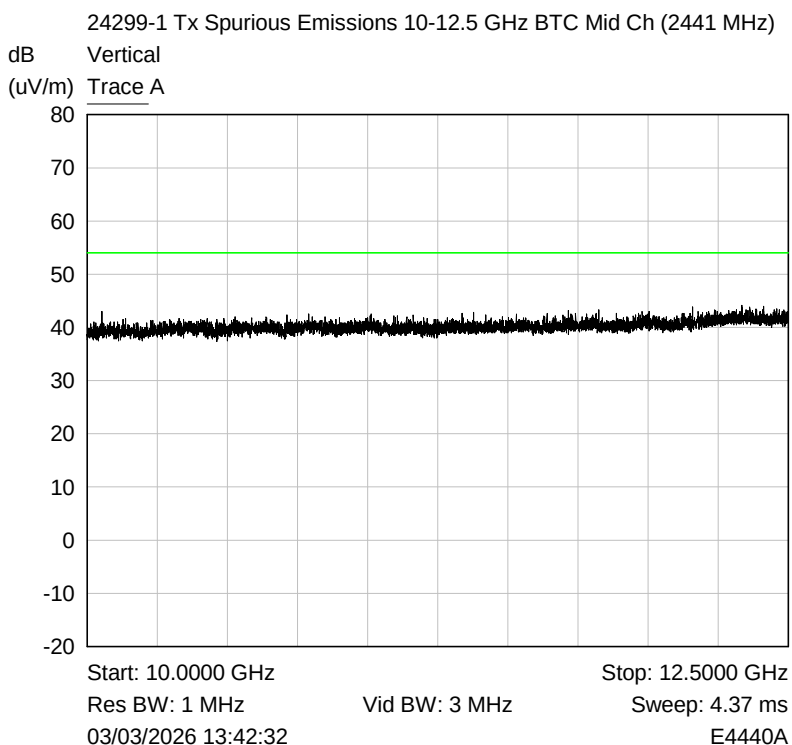
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



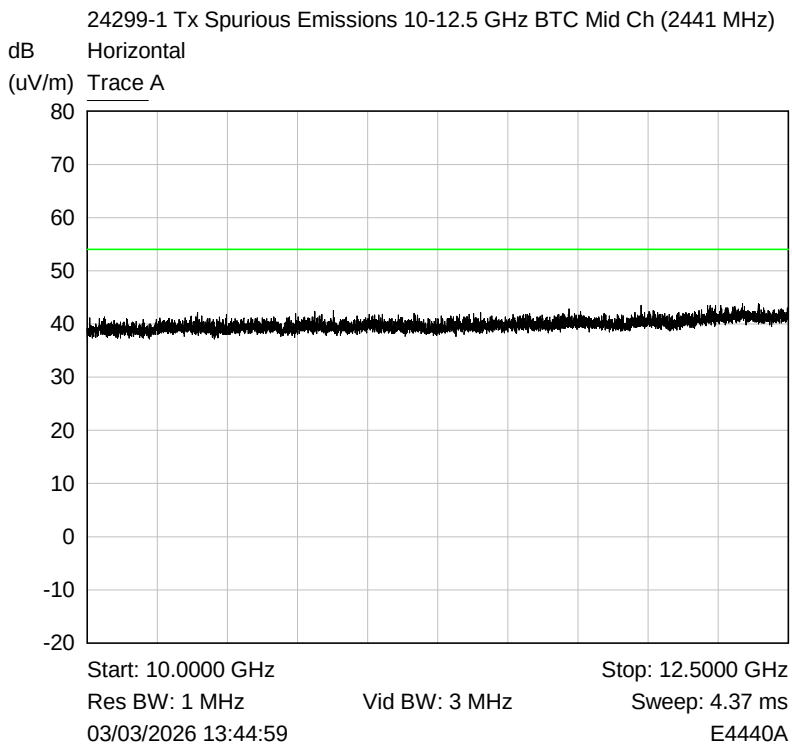
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



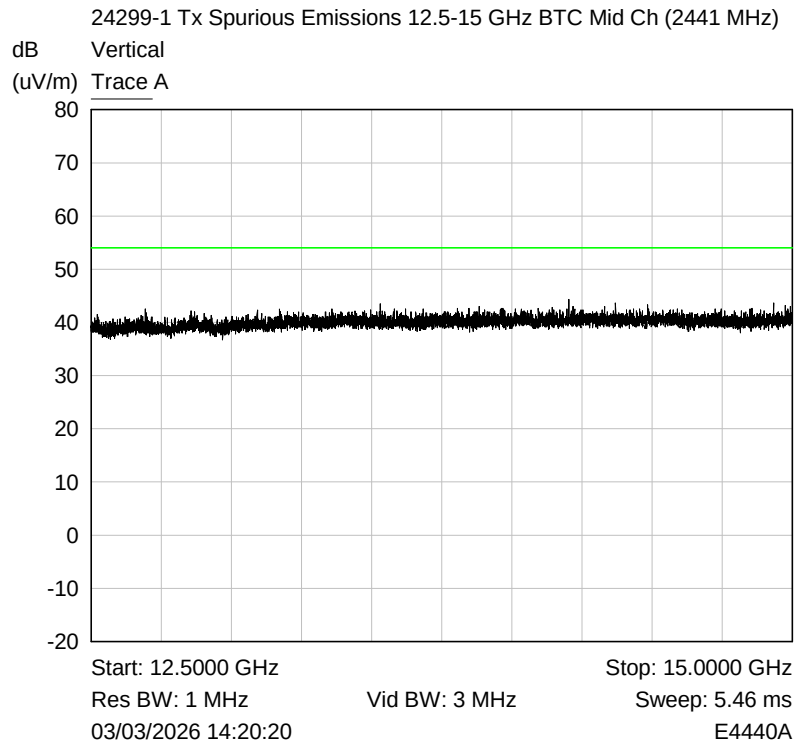
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



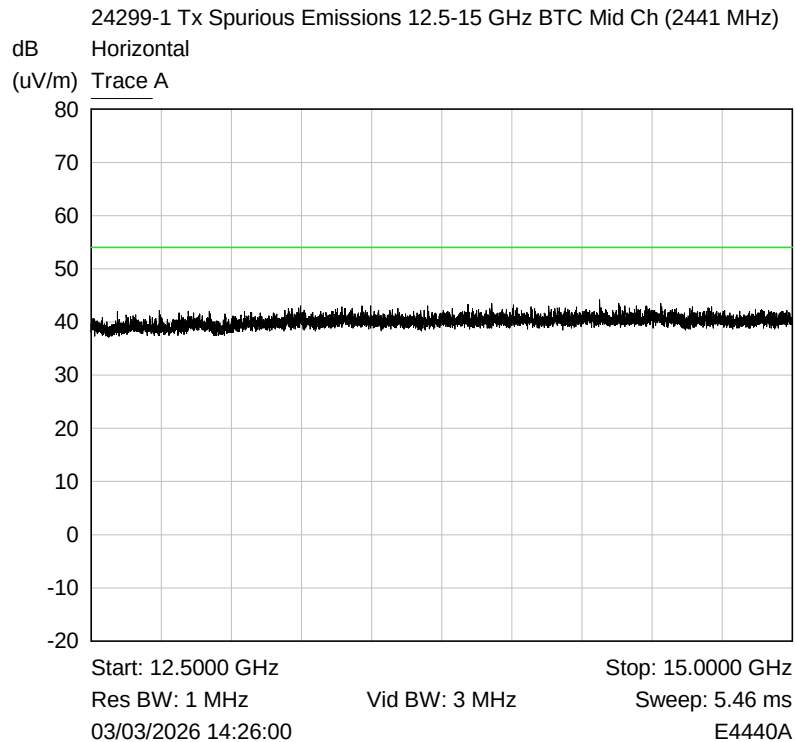
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



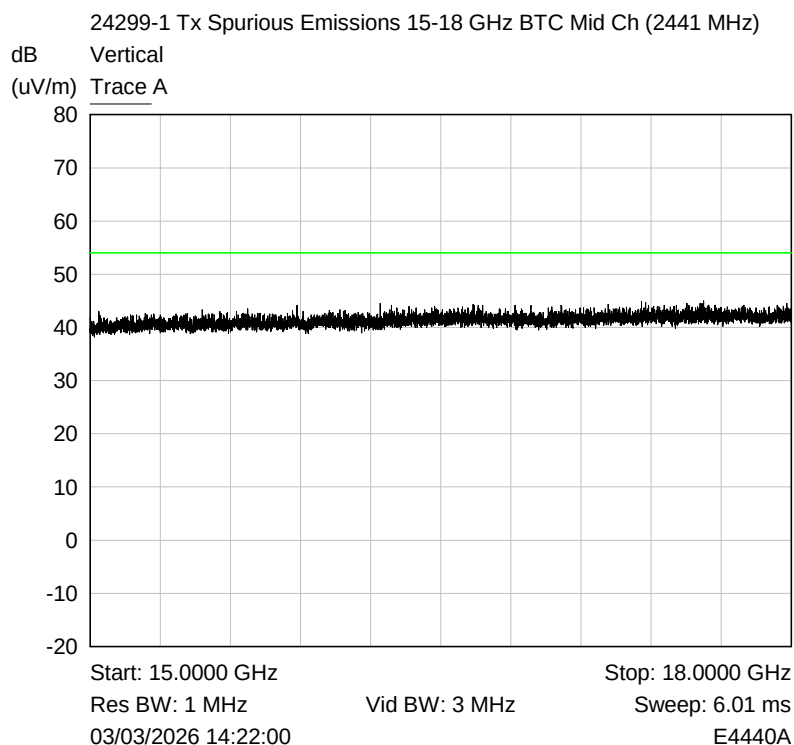
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



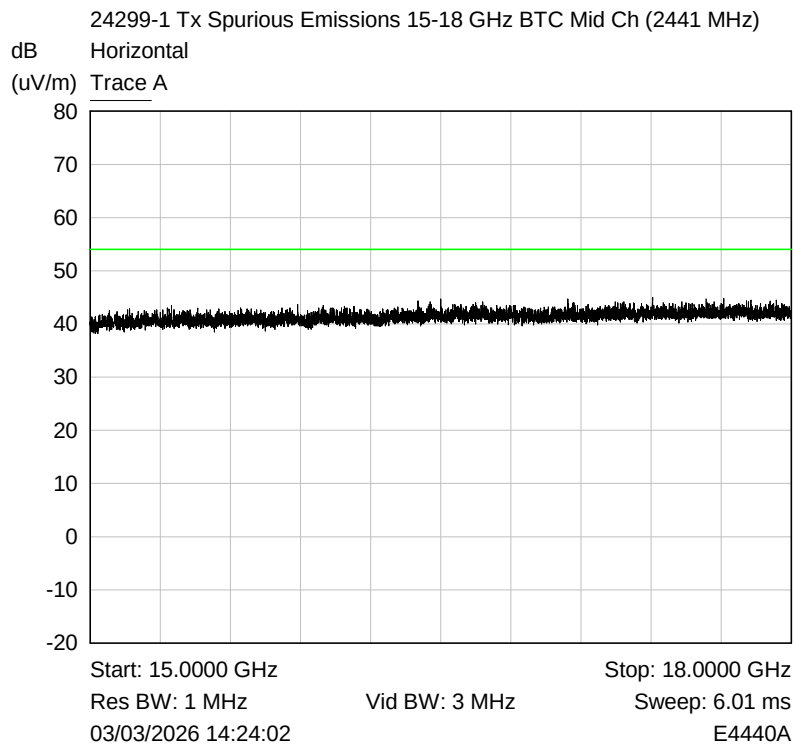
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



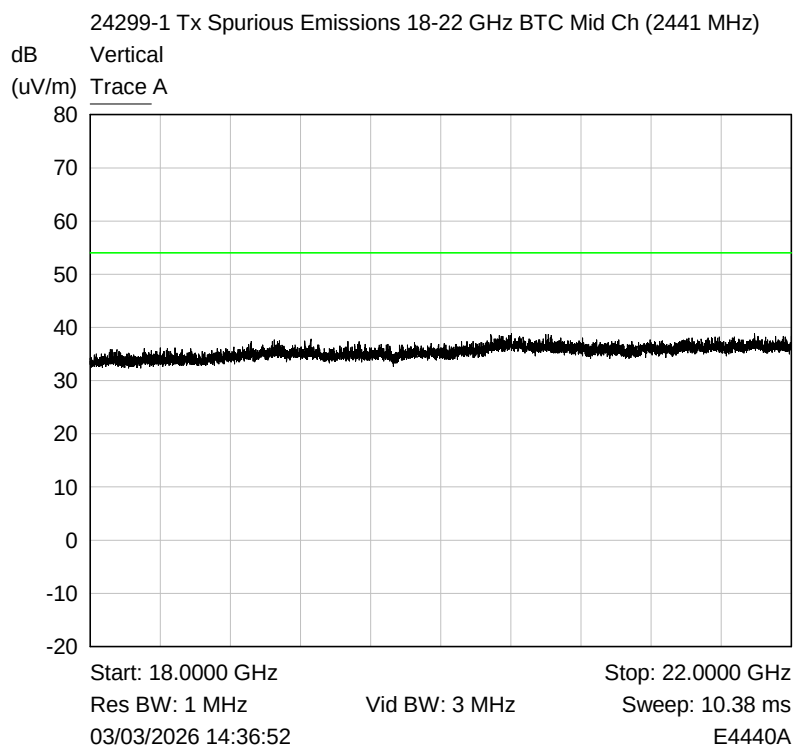
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



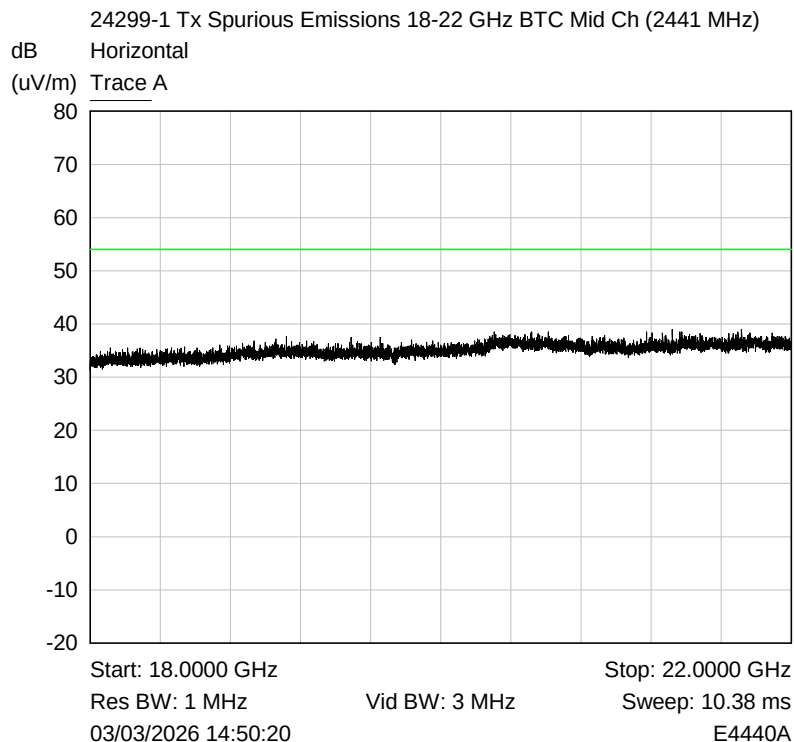
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



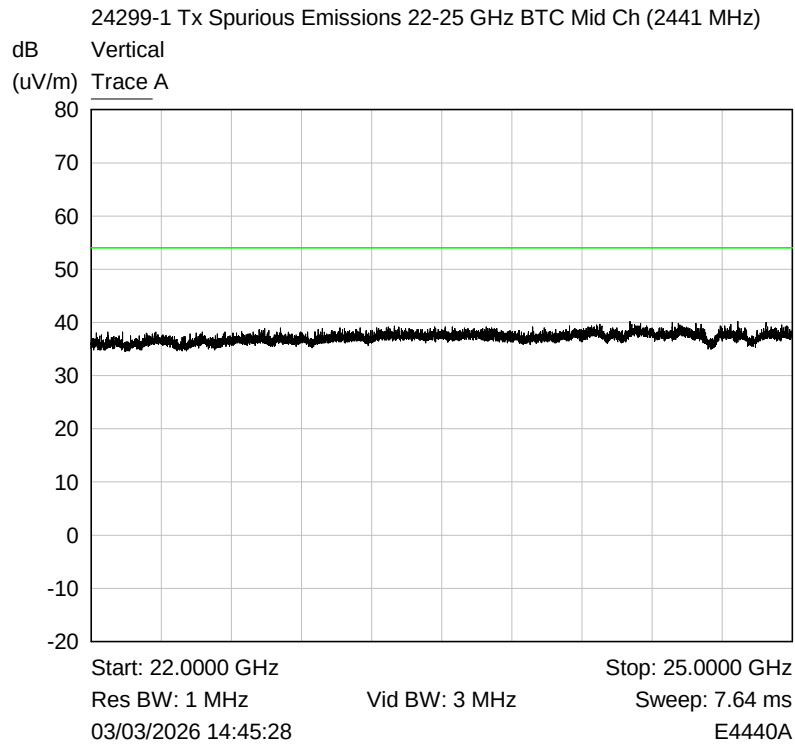
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



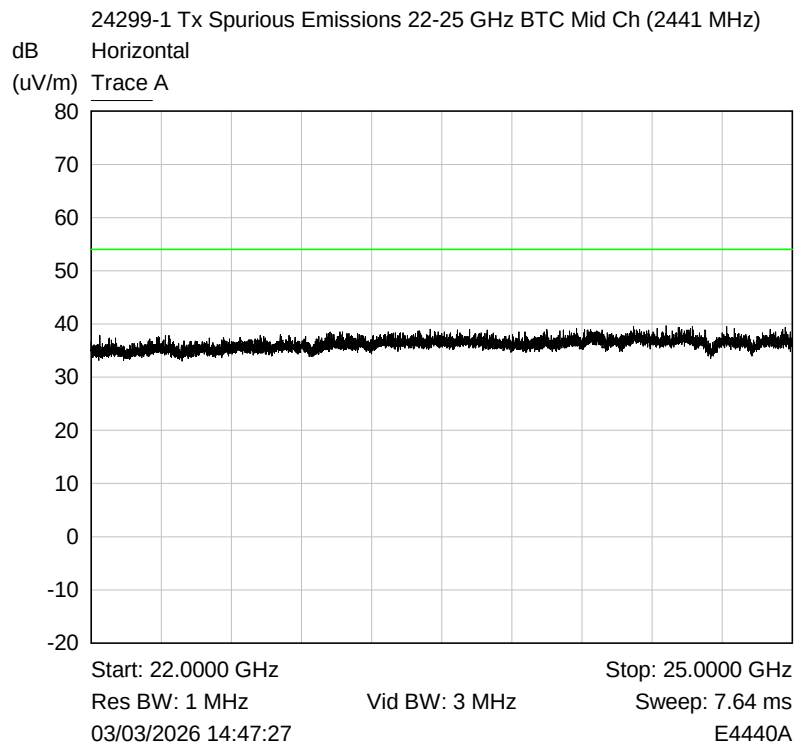
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



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

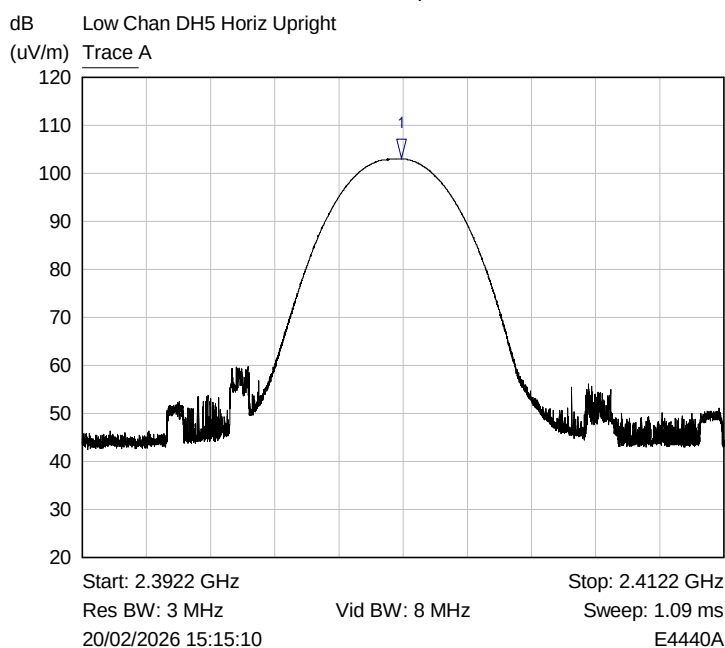


RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



6.5 Effective radiated power field strength

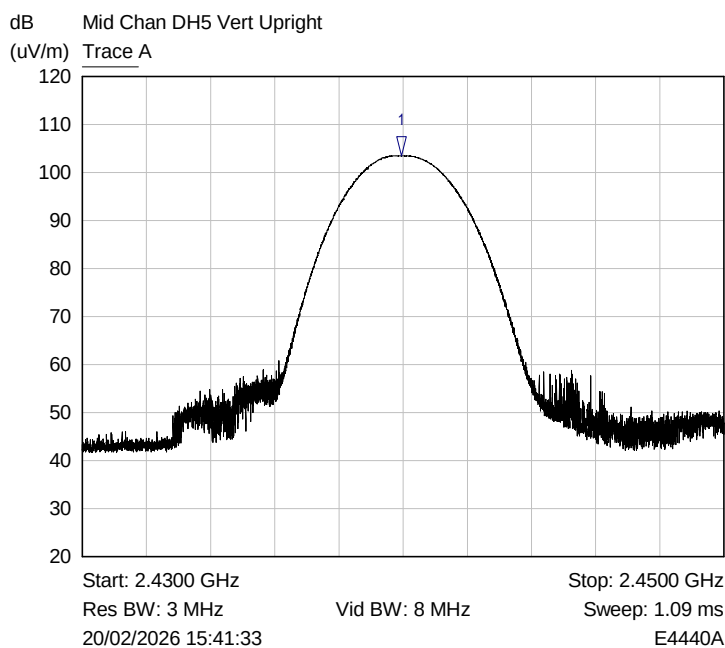
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2402 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	2.4022 GHz	103.09 dB(uV/m)	

Plot of Horiz polarisation and EUT in Upright position

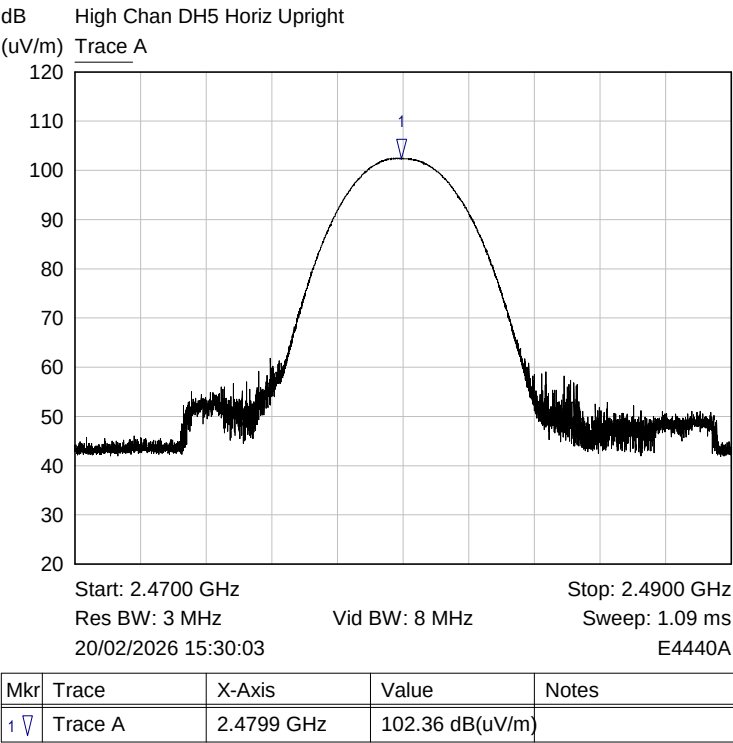
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2441 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	2.4399 GHz	103.46 dB(uV/m)	

Plot of Horiz polarisation and EUT in Upright position

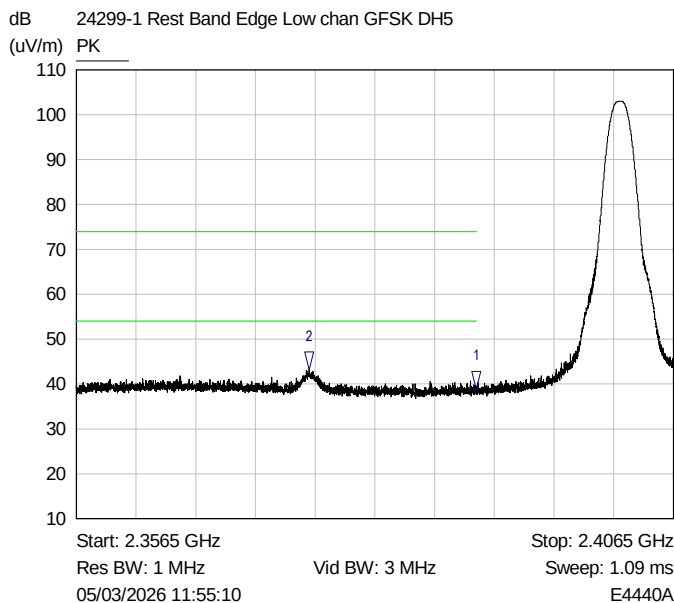
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2480 MHz



Plot of Horiz polarisation and EUT in Upright position

6.6 Band Edge Compliance

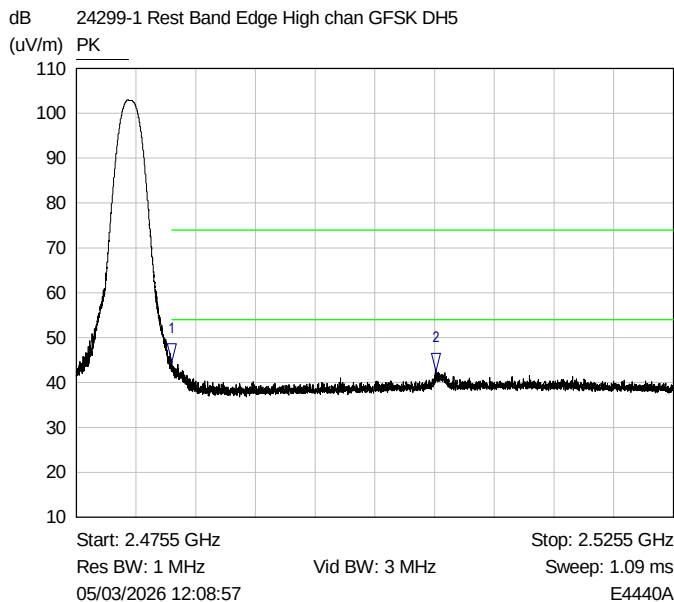
RF Parameters: Band 2400-2483.5 MHz, Power Default, Channel Spacing 1 MHz,
Modulation GFSK DH5, Channel 2402 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▾	PK	2.3900 GHz	38.75 dB(uV/m)	
2 ▾	PK	2.3760 GHz	43.10 dB(uV/m)	

Plot of Restricted Band Edge on Low Channel (2402 MHz)

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	44.68 dB(uV/m)	
2 ▾	PK	2.5056 GHz	42.45 dB(uV/m)	

Plot of Restricted Band Edge on High Channel (2480 MHz)

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 $20.\log(500) = 54$ dB μV/m.

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

(c) limit of 30 $\mu\text{V/m}$ 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).

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 dB $\mu\text{V/m}$

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

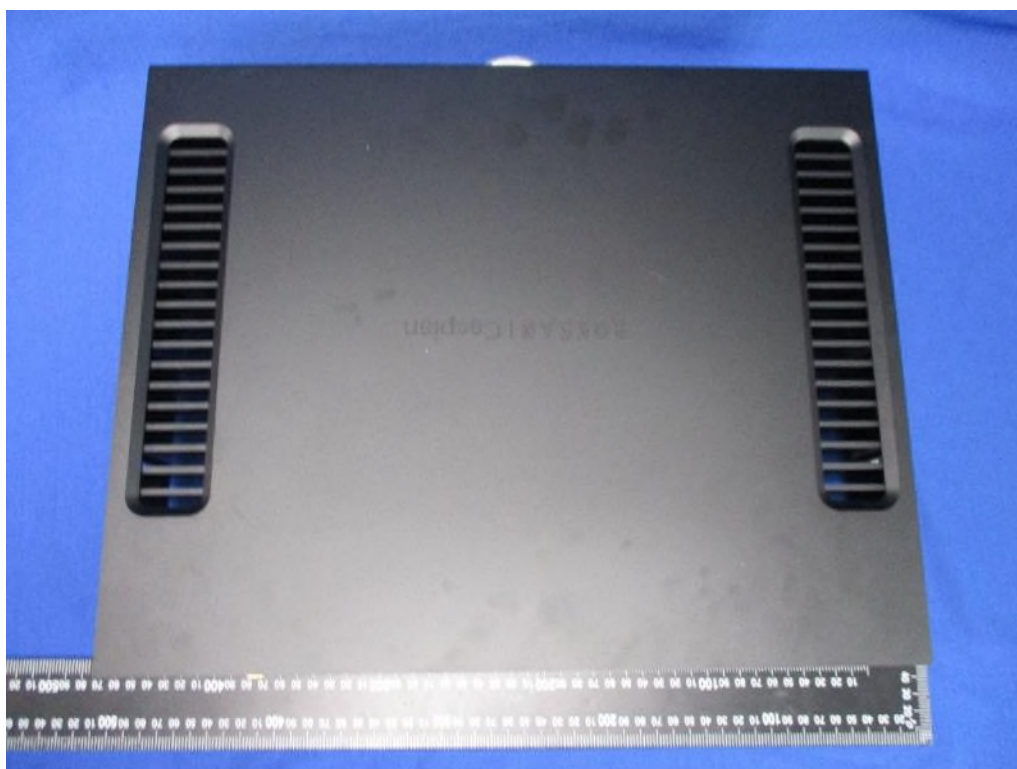
Equation 26 transposed: $E_{\text{Spec limit}} = \sqrt{(0.9 \times 10^{-6} \times 377)} = 0.01842 \text{ V/m}$.

And

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

8 Photographs

8.1 EUT Front View



8.2 EUT Reverse Angle



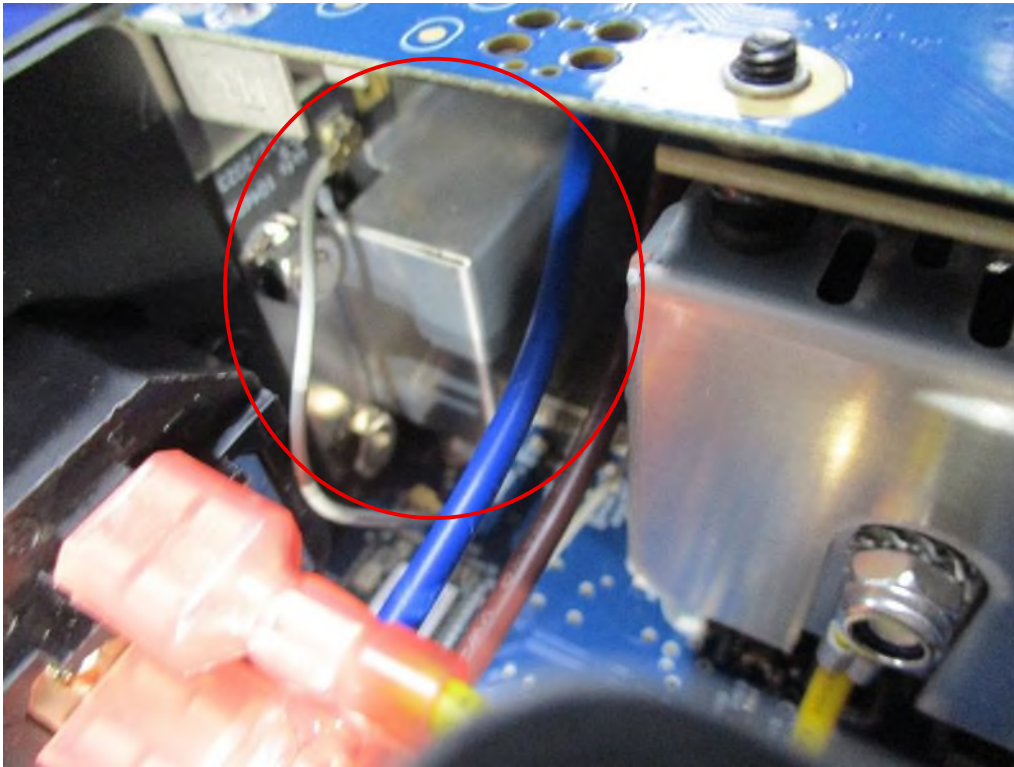
8.3 EUT Left side View



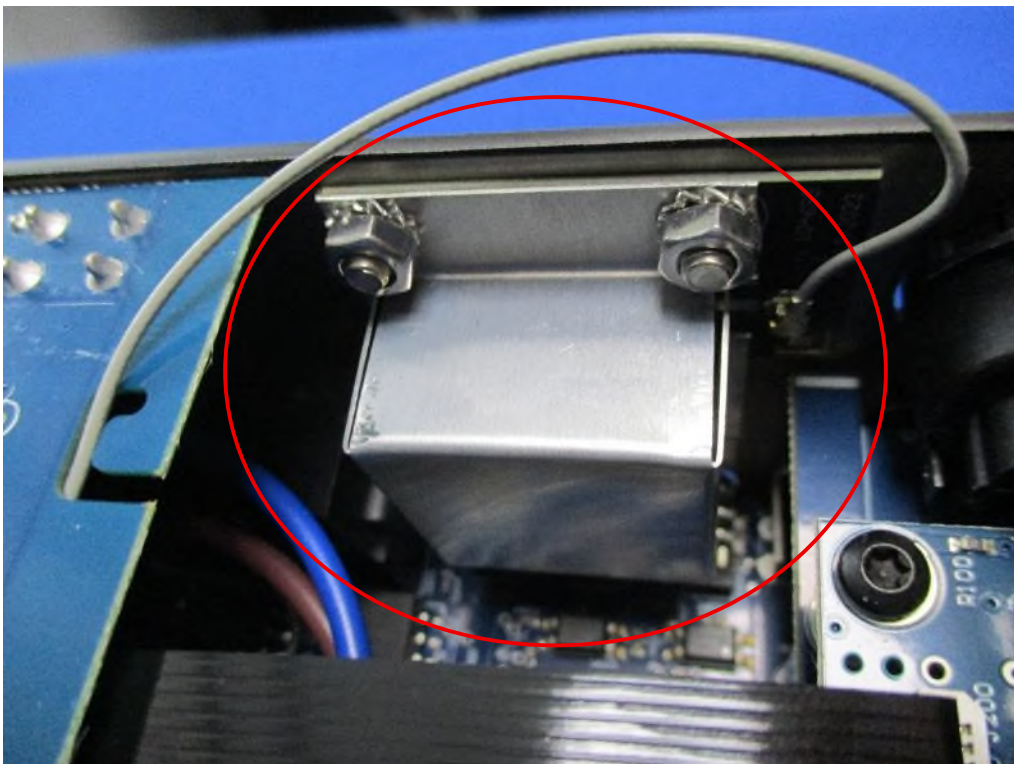
8.4 EUT Right side View



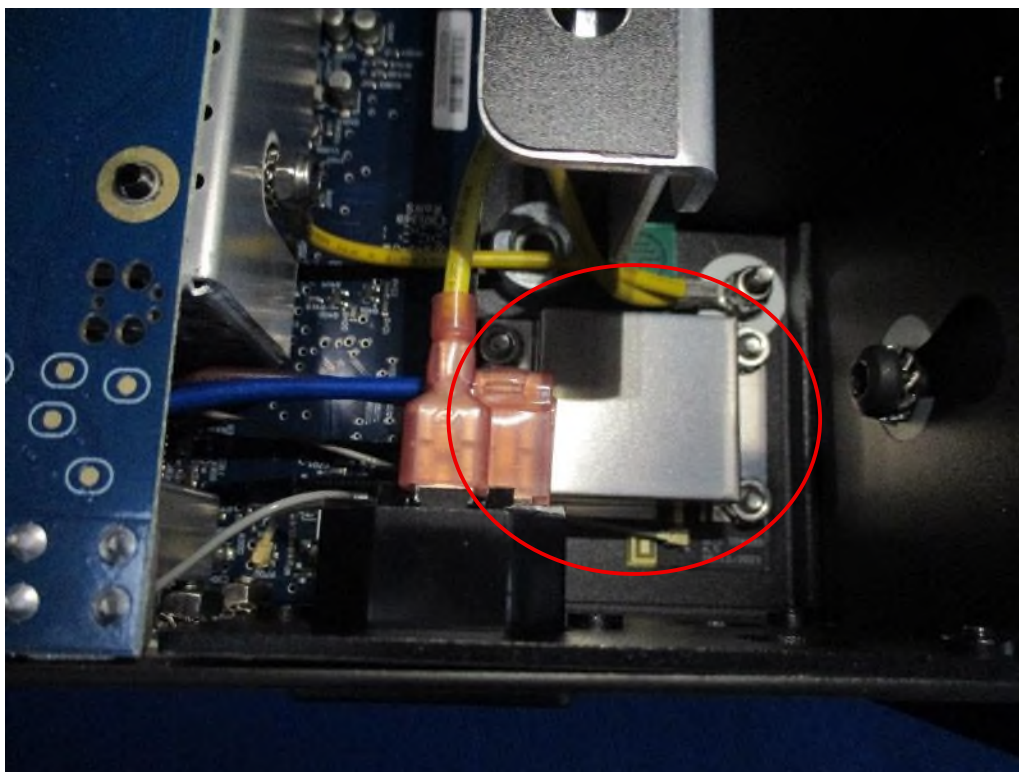
8.5 EUT Antenna Port



Audio Bluetooth Classic Antenna

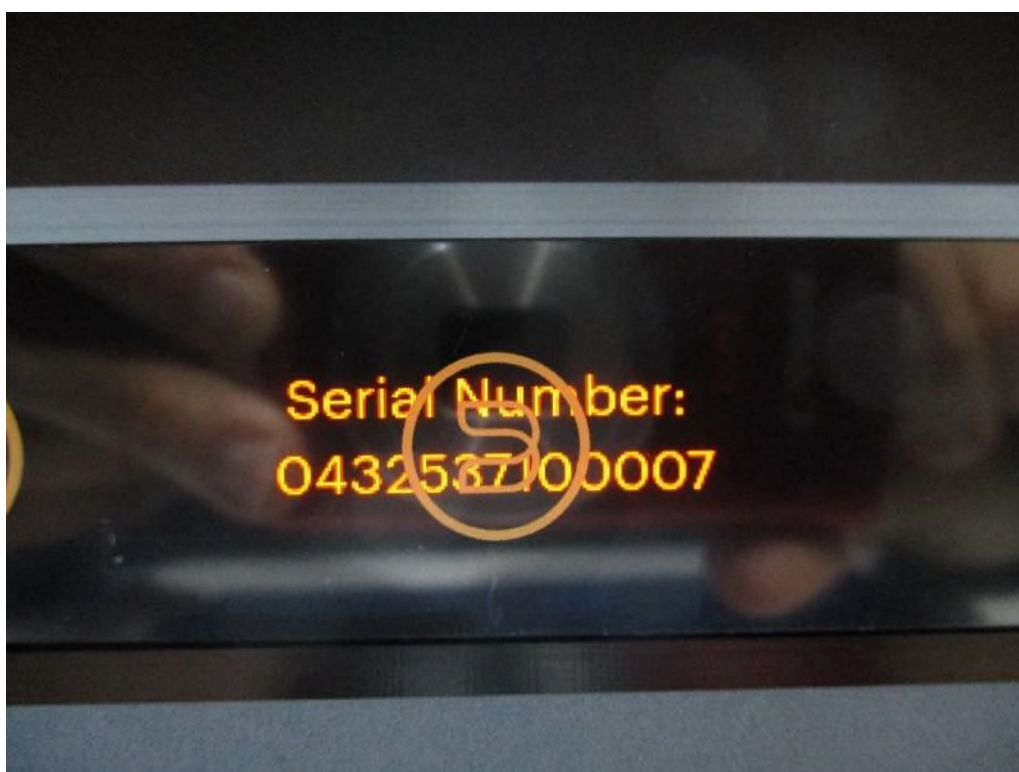


2.4 & 5 GHz WiFi Antenna



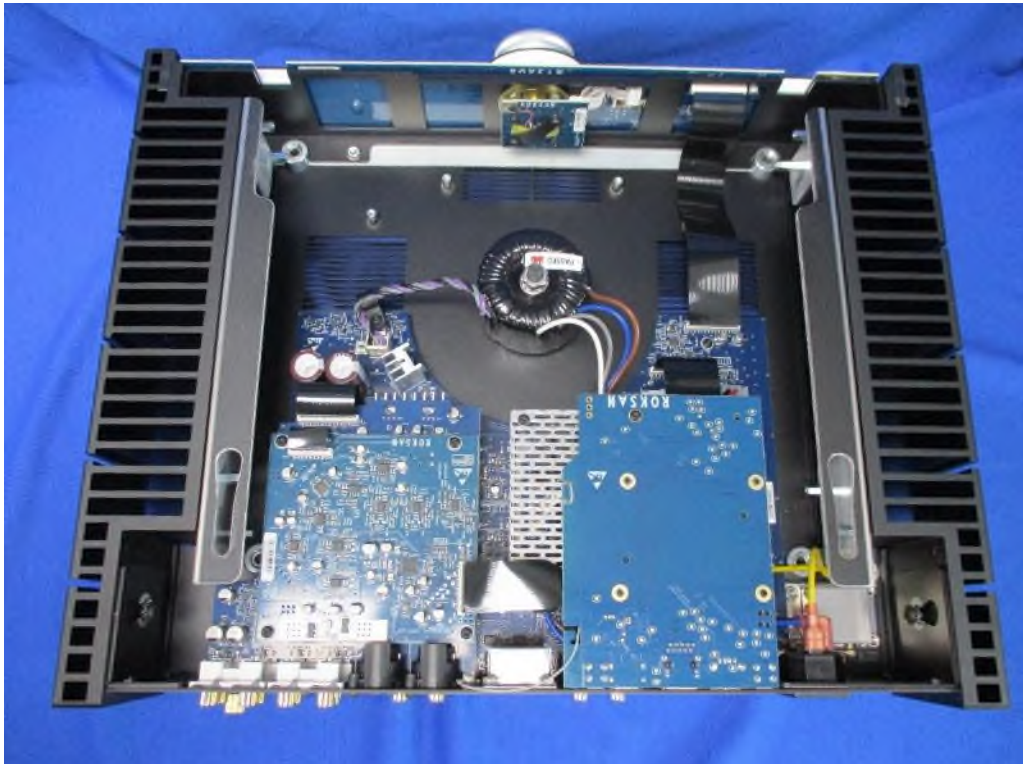
ESP32 Bluetooth Low Energy & 2.4 GHz WiFi Antenna

8.6 EUT Display & Controls





8.7 EUT Internal photos



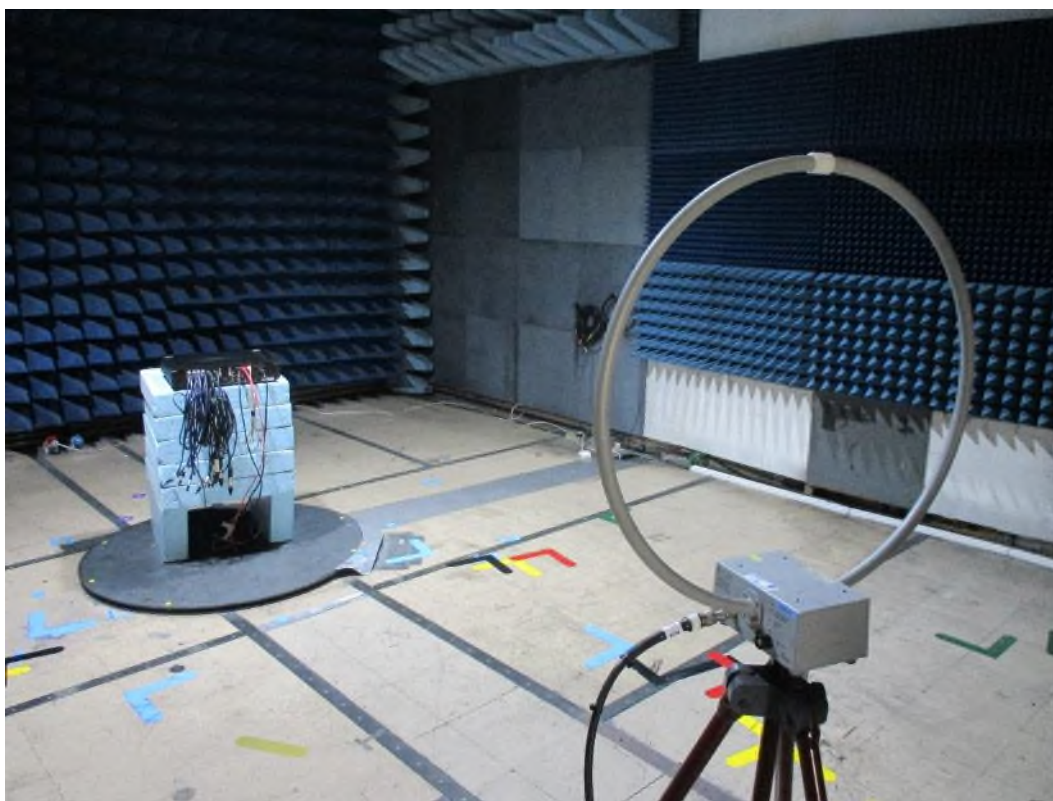
8.8 EUT ID Label



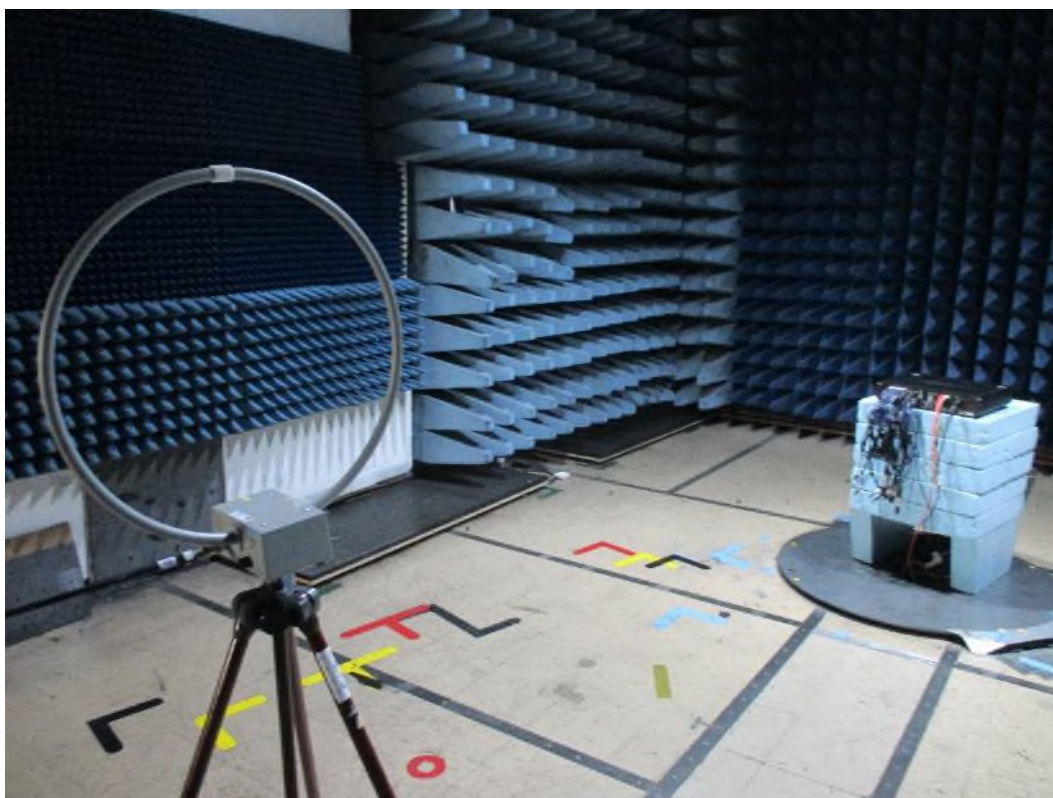
8.9 EUT Chassis



8.10 Radiated emissions 9 - 150 kHz



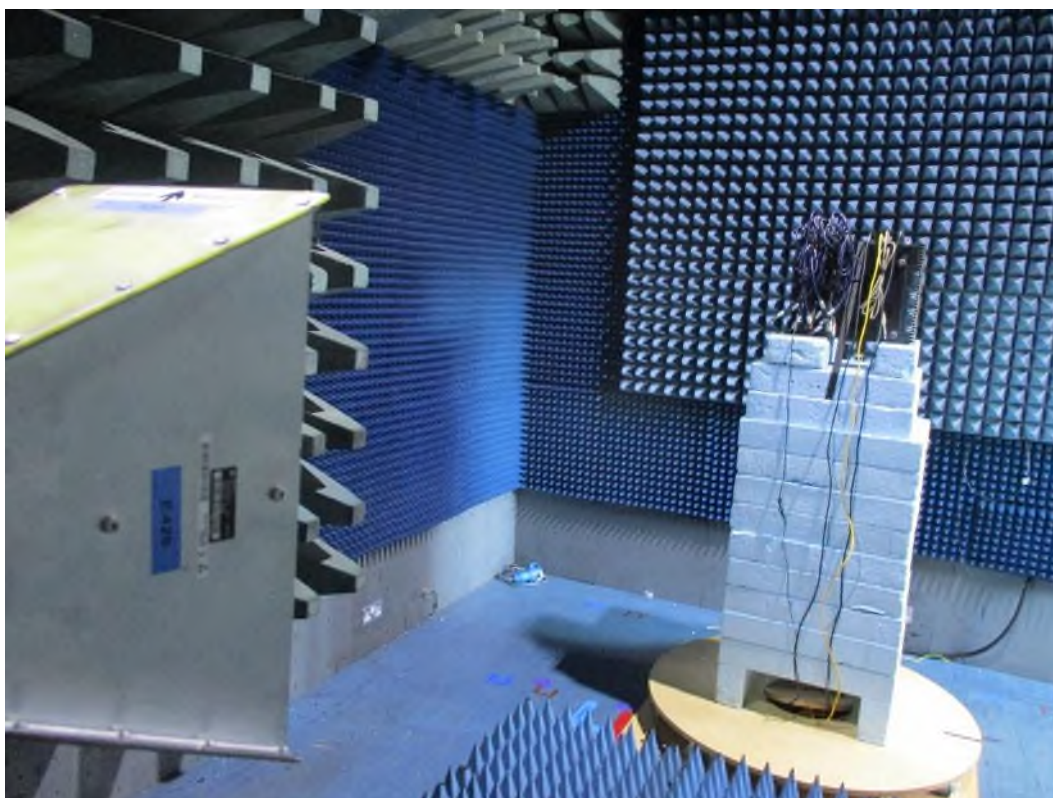
8.11 Radiated emissions 150 kHz - 30 MHz

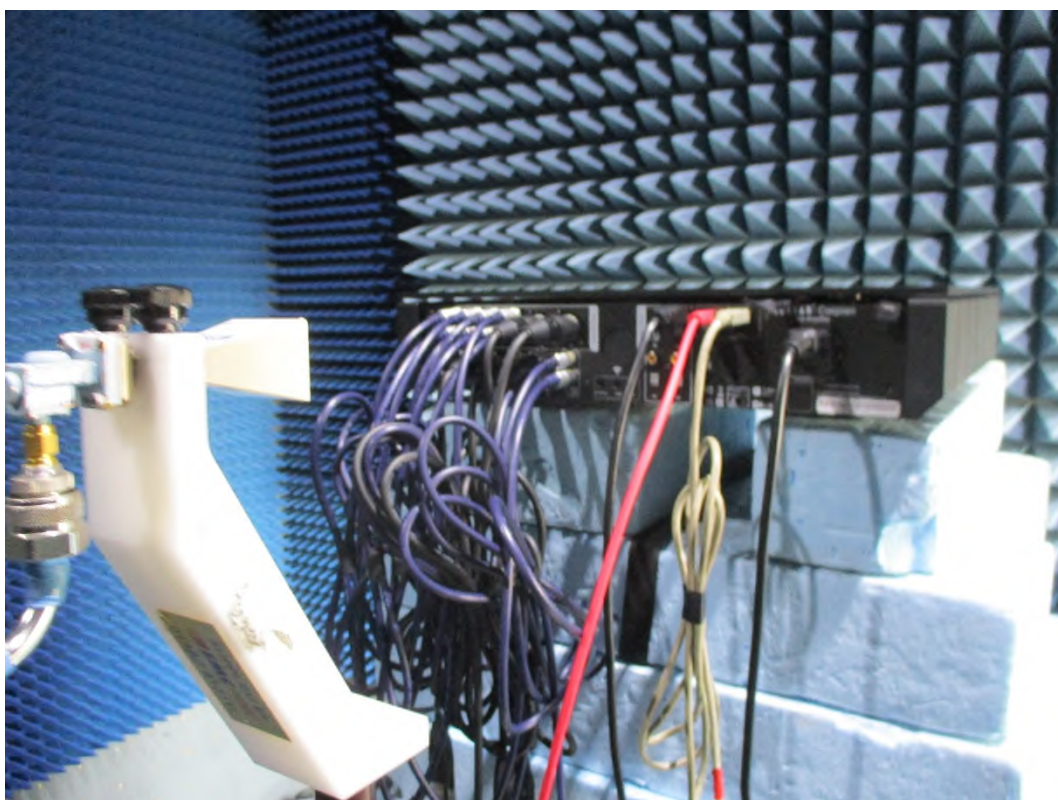
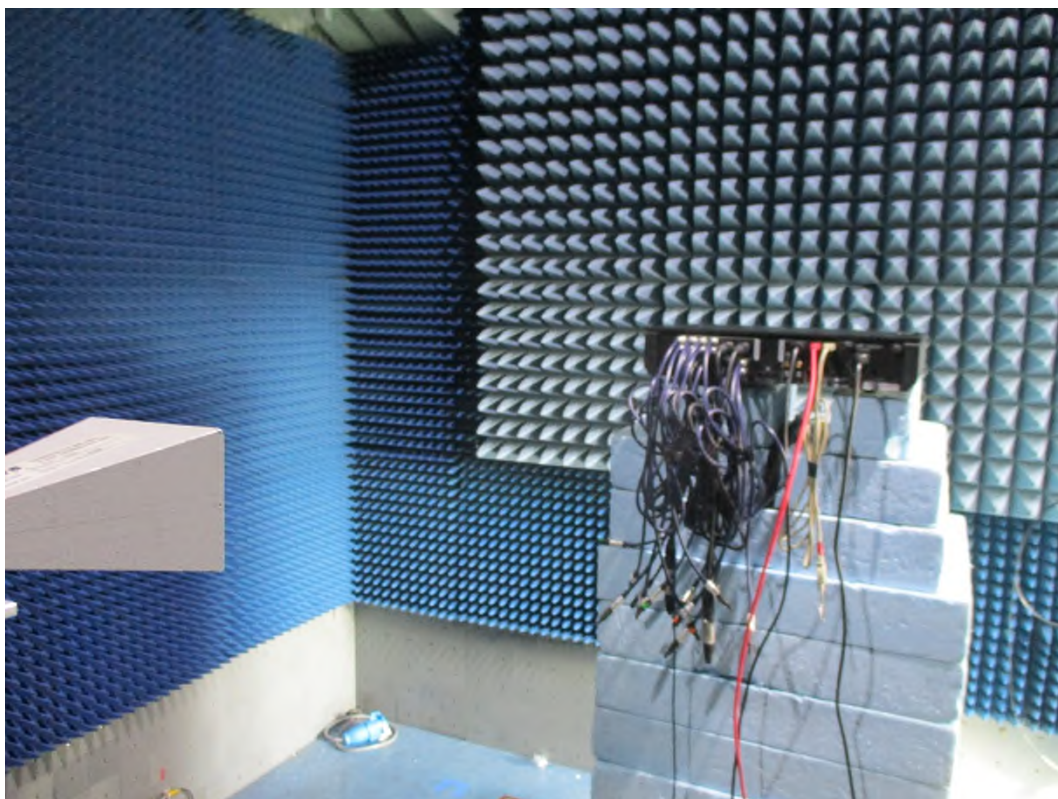


8.12 Radiated emissions 30 MHz -1 GHz



8.13 Radiated emissions above 1 GHz





8.14 Radiated emission diagrams

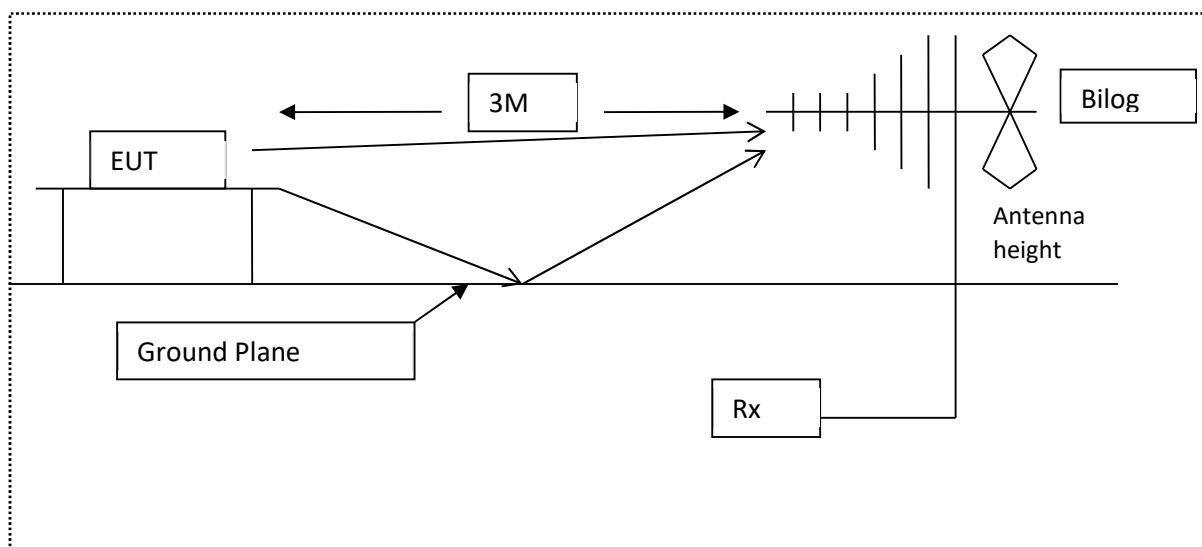


Diagram of the radiated emissions test setup 30 - 1000 MHz

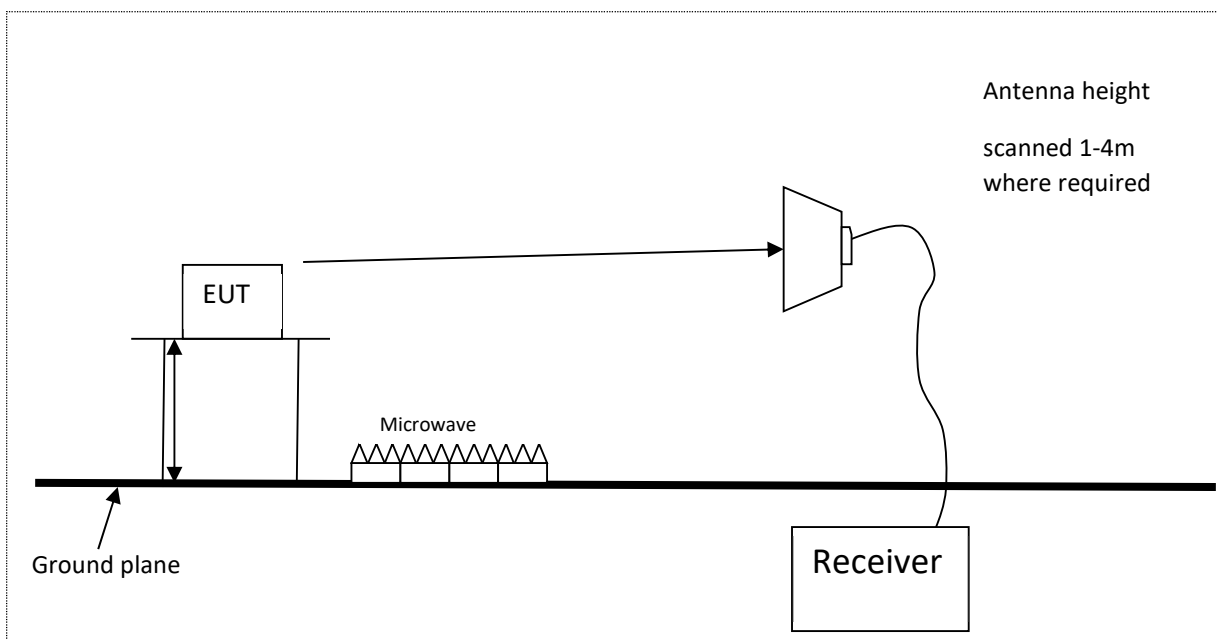


Diagram of the radiated emissions test setup above 1GHz

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
E136	3105	Horn Antenna 1 - 12.5 GHz	EMCO	15/03/2025	12 months
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	22/09/2025	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
E642	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	27/08/2025	24 months
E650	FA210B0010003030	Cable SMA-SMA Light green 1m (B)	Micro-coax	#23-Apr-2026	12 months
E653	MWX221	Cable N-Type-SMA Blue 2m (B)	Junflon	#23-Apr 2026	12 months
E834	MWX221	Cable N-Type-SMA Blue 2m (B)	Junflon	27-Oct-2025	12 months
E743	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	KEC	#08/04/2026	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
F260	-	Cable Heliac Control room to chamber side wall (B)	KEC	30-Sep-2024	36 months
F361	ACO-055-510070-K4K4	Cable SMA to SMA 5.5m (H)	Atlantic Microwave	31/03/2025	12 months
F424	ACO-035-510001-K4K4	Cable 2.92mm male to 2.92mm male 3.5m (B)	Etl Systems	#23-Apr-2026	12 months
LPE261	3115	Horn Antenna 1 - 18 GHz	EMCO	24/02/2026	12 months
LPE333	8449B	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	10/07/2025	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	30/10/2025	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
TMS82	8449B	Pre-Amplifier 1GHz - 26.5GHz	Agilent Technologies	22/01/2026	12 months
ZSW1	V2.5.7	KEC Measurement Software Suite	KEC	Not Applicable	

Equipment items marked # have 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
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		

14 Revision History

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

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