Radio Test Report

Redtail Telematics Ltd

VLU6M4SP

47 CFR Part 90I Effective Date 1st October 2023

↳ 47CFR part 2J 2023

TNB: Licensed Non-Broadcast Station Transmitter

Test Date: 7th February 2025 to 5th March 2025

Report Number: 03-14765-5-25 Issue 01

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

Kiwa Electrical Compliance
Arnolds Court
Arnolds Farm Lane
Mountnessing
Essex
CM13 1UT
U.K.

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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).

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

Certificate of Test 14765-5

The equipment noted below has been fully tested by Kiwa Electrical Compliance and, where appropriate, conforms to the relevant subpart of 47 CFR Part 90I. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	VLU6M4SP
Model Number:	VLU6M4SP
Unique Serial Number:	(MSK) 13FC22D (FSK) 13FC236
Applicant:	Redtail Telematics Ltd Plextek Building London Road Great Chesterford Essex CB10 1NY UK
Proposed FCC ID	2AXBF-VLU6M4SP
Full measurement results are detailed in Report Number:	03-14765-5-25 Issue 01
Test Standards:	47 CFR Part 90I Effective Date 1st October 2023 ↳ 47CFR part 2J 2023 TNB: Licensed Non-Broadcast Station Transmitter

NOTE:
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 model variant VLU6M4SP (without Bluetooth) only. The results for model variant VLU6M4SP-EW (with the pre-approved Bluetooth module FCC ID RFRMS42 fitted) are contained within KEC report: 02-14765-4-25.

DEVIATIONS:
Deviation have been applied to the following test: TX Radiated Emissions

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:	7th February 2025 to 5th March 2025
Test Engineer: Graham Blake	Graham Blake Digitally signed by: Graham Blake DN: CN = Graham Blake email = graham.blake@kiwa.com C = GB OU = Kiwa Electrical Compliance Date: 2025.04.04 13:51:45 Z
Approved By: Test Development Engineer	Ian Rose Digitally signed by: Ian Rose DN: CN = Ian Rose email = ian.rose@kiwa.com C = GB OU = Kiwa Electrical Compliance Date: 2025.04.04 13:40:11 Z
Customer Representative:	

2360

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Redtail Telematics Ltd Plextek Building London Road Great Chesterford Essex CB10 1NY
Manufacturer of EUT	Redtail Telematics Ltd
Full Name of EUT	VLU6M4SP
Model Number of EUT (HVIN)	VLU6M4SP
Serial Number of EUT	13FC22D (MSK) 13FC236 (FSK)
Date Received	5th February 2025
Date of Test:	7th February 2025 to 5th March 2025
Date Report Issued	12th March 2025

Main Function	Stolen vehicle recovery.	
EUT Specification	Height	130 mm
	Width	60 mm
	Depth	40 mm
	Weight	0.2 kg
	Voltage	3 - 6 VDC
	Current	<1 Amp

2.2 Applicant declarations for testing

General Parameters	
EUT Normal use position	Vehicle mounted
Choice of model(s) for type tests	Sample
Antenna details	PVC coated wire, 2.14 m long
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	173.075 MHz
Lowest Signal generated in EUT	40 MHz
Hardware Version (HVIN)	VLU6M4SP
Software Version	Not applicable
Firmware Version (FVIN)	114.5
Type of Equipment	Stand alone
Technology Type	VHF PMR
Geo-location (yes/no)	Yes

TX Parameters	
Alignment range – transmitter	173.075 MHz
EUT Declared Modulation Parameters	MSK and FSK
EUT Declared Power level	+30dBm ±2.0dB max
EUT Declared Signal Bandwidths	10 kHz
EUT Declared Channel Spacings	12.5 kHz

EUT Declared Duty Cycle	Stolen/Active mode (MSK) = 200ms every 2 seconds Normal mode (MSK) = 200ms every 17.5 seconds +- 2.5 seconds Status update mode (FSK) = 1.75 seconds typically every week
Unmodulated carrier available?	CW test mode available
Declared frequency stability	<5 ppm
RX Parameters	
Alignment range – receiver	173.075 MHz
EUT Declared RX Signal Bandwidth	12.5 kHz
FCC Parameters	
FCC Transmitter Class	TNB: Licensed Non-Broadcast Station Transmitter

2.3 Functional description

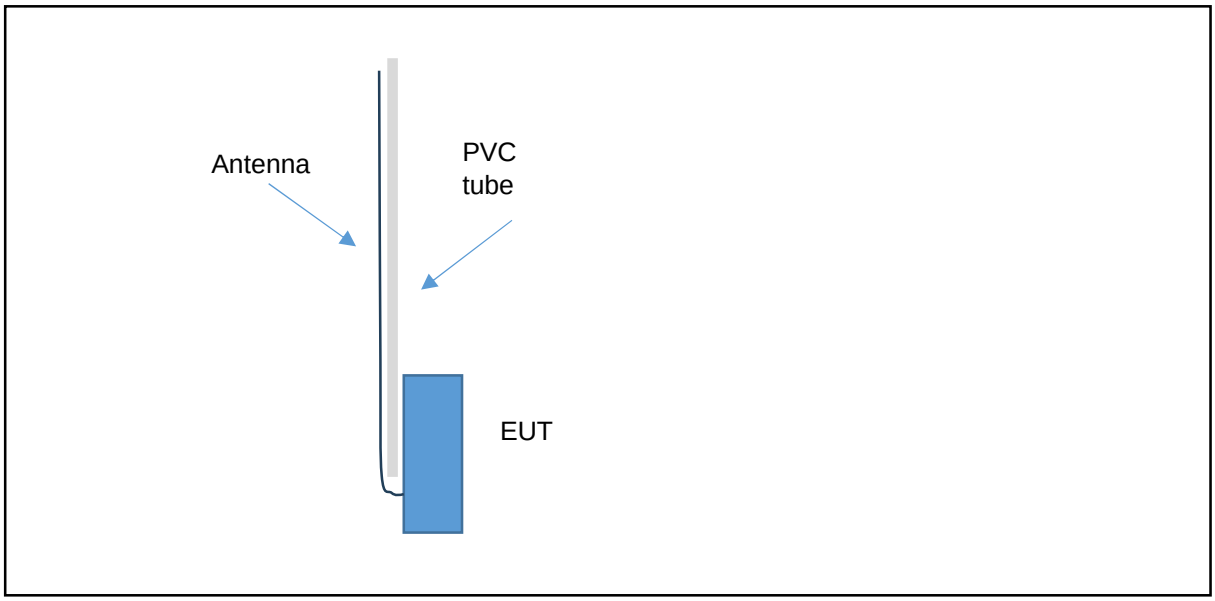
VLU6M3 is a vehicle security device, using proprietary VHF communication and radio location techniques to enable recovery of a stolen vehicle. The product is designed for covert installation and is powered from the vehicle. If the external power is lost it will run from an internal 6V primary cell. The radio transceiver is a discrete design, operating at a single frequency 173.075MHz (for US and Latam markets) with a nominal transmit power of 30 dBm, using either FSK or MSK modulation. Bit rates: FSK 50 bps, MSK 1200 bps.

2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 1	The EUT is transmitting bursts of data at 173.075 MHz, MSK 1200bps, stolen/active mode.	Yes
Mode 2	The EUT is transmitting continuous bursts of data at 173.075 MHz, FSK 50bps.	Yes
Mode 3	The EUT is transmitting bursts of data at 173.075 MHz, MSK 1200bps, normal mode	Yes

2.5 Emissions configuration

Test Area



The equipment under test was powered using new internal batteries. The EUTs wire antenna was extended vertically and attached to a plastic pole for support. The EUT was enabled for test by joining two leads together. The EUT would transmit periodically. In order to perform conducted tests, a matching circuit pcb board was provided by Redtail Telematics Ltd to allow connection of the 377Ω antenna circuit to a 50Ω measurement port, the circuit attenuated the conducted RF output power by approximately 15dB in band, and where applicable, was compensated for during tests. This particular product comes in two model variants, both variants utilise exactly the same enclosure and internal pcb, but one model has the pre-approved Bluetooth module de-populated. This report pertains model variant model: VLU6M4SP which has the Bluetooth radio unpopulated. The results for variant model VLU6M4SP-EW with the pre-approved Bluetooth module fitted are contained within KEC report: 02-14765-4-25.

2.5.1 Signal leads

Port Name	Cable Type	Connected
VHF antenna	PVC coated wire	Yes
Supply ground	PVC coated wire	Yes
Vehicle supply	PVC coated wire	Yes
GPIO (3 lines)	PVC coated wire	Yes

3 Summary of test results

The VLU6M4SP was tested for compliance to the following standard(s):

47 CFR Part 90I Effective Date 1st October 2023
↳ 47CFR part 2J 2023
TNB: Licensed Non-Broadcast Station 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. Radiated emissions	47 CFR Part 90I Clause 90.210(d), 47 CFR Part 2J Clause 2.1053	PASSED[1]
2. Conducted emissions	47 CFR Part 90I Clause 90.210(d), 47 CFR Part 2J Clause 2.1051	NOT APPLICABLE[2]
3. Conducted power	47 CFR Part 90I Clause 2.1046, 47 CFR Part 90I Clause 90.20(e)(6)(iii)	PASSED
4. Frequency stability	47 CFR Part 90I Clause 90.213(a)	NOT TESTED[3]
5. Occupied bandwidth	47 CFR Part 90I Clause 90.209	PASSED
6. Emission mask	47 CFR Part 90I Clause 90.210(d)	PASSED
7. Modulation limiting	47 CFR Part 2J Clause 2.1047(b)	NOT APPLICABLE[4]
8. Modulation frequency response	47 CFR Part 2J Clause 2.1047(a)	NOT APPLICABLE[4]
9. Transient frequency behaviour	47 CFR Part 90I Clause 90.214	NOT TESTED[3]
10. Adjacent channel power	47 CFR Part 90I Clause 90.221	NOT APPLICABLE[5]
11. Duty Cycle	47 CFR Part 90B Clause 90.20(e)6(v)	PASSED

[1] Test performed up to 2 GHz only. Please refer to KEC test report 03-14765-4-25 for full measurements.
[2] The EUT has no antenna port and a temporary connection could not be made to 50 ohms measuring equipment without the need for a matching board which attenuated maximum power observed by approximately 15dB in band. Therefore, radiated emissions tests were performed with the permanent antenna in place.
[3] This test report covers limited testing on the main product variant. Please refer to KEC test report 03-14765-4-25 for full measurements.
[4] Not Applicable to Digitally modulated EUT's.
[5] Only applicable to transmitters within the 450 - 470 MHz, 809 - 824 MHz and 854 - 869 MHz frequency bands.

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 90I	October 2023	Part 90 - Private Land Mobile Radio Services - Subpart I - General Technical standards
4.1.2	47 CFR Part 2J	October 2023	Part 2 – Frequency Allocations and radio treaty matters; General rules and regulations
4.1.3	ANSI C63.26	2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

4.2 Deviations

The following deviation were applied: Radiated emissions. Test performed up to 2 GHz only.

4.3 Test fixtures

In order to measure RF parameters at temperature extremes, the EUT was tested in a temperature-controlled chamber as follows:

A temporary RF port was created for testing by use a matching network board supplied by applicant.

5 Tests, Methods and Results

5.1 Radiated emissions

5.1.1 Test methods

Test Requirements:	47 CFR Part 90I Clause 90.210(d) [Reference 4.1.1 of this report], 47 CFR Part 2J Clause 2.1053 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 Clause 5.5 [Reference 4.1.3 of this report]
Limits:	47 CFR Part 90I Clause 90.210(d)(3) [Reference 4.1.1 of this report]

5.1.2 Configuration of EUT

The EUT was tested in an ALSE and ambient conditions were monitored. Three orthogonal planes were examined. All test modes specified in section 2.4 were initially checked; MSK modulation scheme was found to be worst case for emissions and, therefore the EUT was operated in Mode 1 for this test.

5.1.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section at Site H. Peak field strength from the EUT was maximised by rotating it 360 degrees.

An RMS detector was used for final measurements.

25MHz - 1GHz.
The measuring antenna was scanned 1 - 4m in both Horizontal and Vertical polarisations. Substitution method was performed using tuned dipoles / a calibrated bi-conical antenna.

1GHz – 2 GHz.
The measuring antenna was used in both Horizontal and Vertical polarisations. Substitution method was performed using standard gain horn antennas.

5.1.4 Test equipment

E005, E268, E403, E410, E417, E642, E745, E914, LPE261, LPE333, P179, P189

See Section 8 for more details

5.1.5 Test results

Temperature of test environment	15°C
Humidity of test environment	50%
Pressure of test environment	101kPa

Setup Table

Band	173.075 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	MSK
Single channel	173.075 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
346.15	-39.9	-19.9	Vertical	Flat
346.15	-38.0	-18.0	Horizontal	Flat

LIMITS:
Part 90.210(d)(3), On any frequency removed from the centre of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation: 50 + 10 log (P) dB = -20 dBm.

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 - 1000MHz ±6.1dB; 1 – 2 GHz ±3.5dB

5.2 Conducted emissions

NOT APPLICABLE: The EUT has no antenna port and a temporary connection could not be made to 50ohms measuring equipment without the need for a matching board which attenuated maximum power observed by approx. 15dB in band. Therefore, Radiated emissions tests performed with permanent antenna in place.

5.3 Conducted power

5.3.1 Test methods

Test Requirements:	47 CFR Part 90I Clause 2.1046 [Reference 4.1.1 of this report], 47 CFR Part 90I Clause 90.20(e)(6)(iii) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.26 Clause 5.2 [Reference 4.1.3 of this report]
Limits:	47 CFR Part 90I Clause 90.20(e)(6)(iii) [Reference 4.1.1 of this report]

5.3.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the temporary RF port. The EUT was operated in Mode 1 and Mode 2 for this test. The EUT was set to each mode and test signal in turn (see section 2.4) and highest power levels recorded.

5.3.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section. Peak power measurements were made via a test fixture which matched the impedance of the radio to 50 ohms. The test fixture has a declared loss of 15 dB which has been compensated for in the final result.

5.3.4 Test equipment

E517, E755, E874

See Section 8 for more details

5.3.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	101kPa

Band	173.075 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	MSK
Channel	173.075 MHz

Test conditions	Carrier Power (dBm)	Carrier Power (Watts)
Maximum TX Power observed (dBm)	30.22	1.052

Band	173.075 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	FSK
Channel	173.075 MHz

Test conditions	Carrier Power (dBm)	Carrier Power (Watts)
Maximum TX Power observed (dBm)	30.04	1.009

LIMITS:

Part 90B: 90.20(e)(6) (iii) Mobile transmitters operating on this frequency with emissions authorized in a maximum bandwidth of 12.5 kHz are limited to 5.0 watts power output (37 dBm). Mobile transmitters operating on this frequency with emissions authorized in a maximum bandwidth of 20 kHz are limited to 2.5 watts power output (34 dBm).

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:
UR02D <3 GHz ±0.56 dB

5.4 Frequency stability

NOT TESTED: This test report covers limited testing on the main product variant. Please refer to KEC test report 03-14765-4-25 for full measurements.

5.5 Occupied bandwidth

5.5.1 Test methods

Test Requirements:	47 CFR Part 90I Clause 90.209 [Reference 4.1.1 of this report]
Test Method:	47 CFR Part 2J Clause 2.1049 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 90I Clause 90.209 [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the temporary RF port. The EUT was operated in Mode 1 and Mode 2.

5.5.3 Test procedure

Tests were performed using Test Site A.

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section. A 200 Hz RBW, 3x VBW, auto sweep time and max hold settings were used for the 99% bandwidth.

5.5.4 Test equipment

E517, E755, E874

See Section 8 for more details

5.5.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	101kPa

Band	173.075 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	MSK
Single channel	173.075 MHz

	Single channel
99 % Bandwidth (kHz) Nominal Temp & Volts	7.086
Plot for 99 % Bandwidth	14765-5 MSK

FLOW Worst case (MHz)	173.071457
FHIGH Worst case (MHz)	173.078543

Band	173.075 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	FSK
Single channel	173.075 MHz

	Single channel
99 % Bandwidth (kHz) Nominal Temp & Volts	7.082
Plot for 99 % Bandwidth	14765-5 FSK

FLOW Worst case (MHz)	173.071459
FHIGH Worst case (MHz)	173.078541

Analyser plots can be found in Section 6 of this report.

LIMITS:
Part 90.209 (B)(5), Operations using equipment designed to operate with a 12.5 kHz channel bandwidth will be authorized a 11.25 kHz bandwidth.

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:
UR19B ±0.17 %

5.6 Emission mask

5.6.1 Test methods

Test Requirements:	47 CFR Part 90I Clause 90.210(d) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.26 Clause 5.5 [Reference 4.1.3 of this report]
Limits:	47 CFR Part 90I Clause 90.210(d) [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the temporary RF port. The EUT was operated in Mode 1 and Mode 2.

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 analyser was tuned to the nominal centre frequency with span initially greater than 250% bandwidth and allowed to sweep enough times to capture the entire power envelope. The frequencies at which the spurious emission limits were last exceeded were noted. Plots were taken referenced to the applicable spectrum mask.

Tests were performed is test site A.

5.6.4 Test equipment

E517, E755, E874

See Section 8 for more details

5.6.5 Test results

Temperature of test environment	15°C
Humidity of test environment	50%
Pressure of test environment	101kPa

Band	173.075 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	MSK
Single Channel	173.075 MHz

	Single channel
Nominal plot reference	14765-5 MSK FCC part 90.210 emission mask D (12.5kHz)

Band	173.075 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	FSK
Single Channel	173.075 MHz

	Single channel
Nominal plot reference	14765-5 FSK FCC part 90.210 emission mask D (12.5kHz)

Any analyser plots can be found in Section 6 of this report.

LIMITS:

Part 90.210

(d) *Emission Mask D—12.5 kHz channel bandwidth equipment.* For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least $7.27(f_d - 2.88\ kHz)$ dB.

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation

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:
± 2.8 dB up to 26.5 GHz

5.7 Modulation limiting

NOT APPLICABLE: Not Applicable to Digitally modulated EUT's.

5.8 Modulation frequency response

NOT APPLICABLE: Not Applicable to Digitally modulated EUT's.

5.9 Transient frequency behaviour

NOT TESTED: This test report covers limited testing on the main product variant. Please refer to KEC test report 03-14765-4-25 for full measurements.

5.10 Adjacent channel power

NOT APPLICABLE: Only applicable to transmitters within the 450 - 470 MHz, 809 - 824 MHz and 854 - 869 MHz frequency bands.

5.11 Duty cycle

5.11.1 Test methods

Test Requirements:	FCC Part 90B Clause 90.20(e)6(v) [Reference 4.1.5 of this report]
Test Method:	ANSI C63.26 Clause 6.5.2.2 [Reference 4.1.3 of this report]
Limits:	FCC Part 90B Clause 90.20(e)6(v) [Reference 4.1.5 of this report]

5.11.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the temporary RF port. the EUT was operated in TX1, TX2 and TX3 modes for this test.

5.11.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment' Section. An analyser in zerospan/Time Domain mode, was centred on the EUT frequency and the EUT was allowed to automatically key up and down. The observed time domain was plotted and timings calculated.
Tests were performed in Site A.

5.11.4 Test equipment

E640, E755

See Section 8 for more details

5.115 Test results

Temperature of test environment	21°C
Humidity of test environment	60%
Pressure of test environment	102kPa

Band	173.075 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	MSK / FSK
Single channel	173.075 MHz

	Single channel
Normal mode – On time (ms)	201.3
Plot Reference	14765 Duty cycle - Normal mode On time MSK test mode
Normal mode – period (s)	18.4
Plot Reference	14765 Duty cycle - Normal mode MSK test mode
Tracking mode – On time (ms)	205.7
Plot Reference	14765 Duty cycle - On time Tracking mode MSK test mode
Tracking mode – period (s)	1.186
Plot Reference	14765 Duty cycle - Tracking mode MSK test mode
Status update mode – On time (s)	1.46
Plot Reference	14765 Duty cycle - On time Status update FSK test mode
Status update – period (s)	56.6
Plot Reference	14765 Duty cycle Status update FSK test mode

Note: Status update mode was provided in an increased cycle time/period for test only and is typically every seven days / once a week transmission rate.

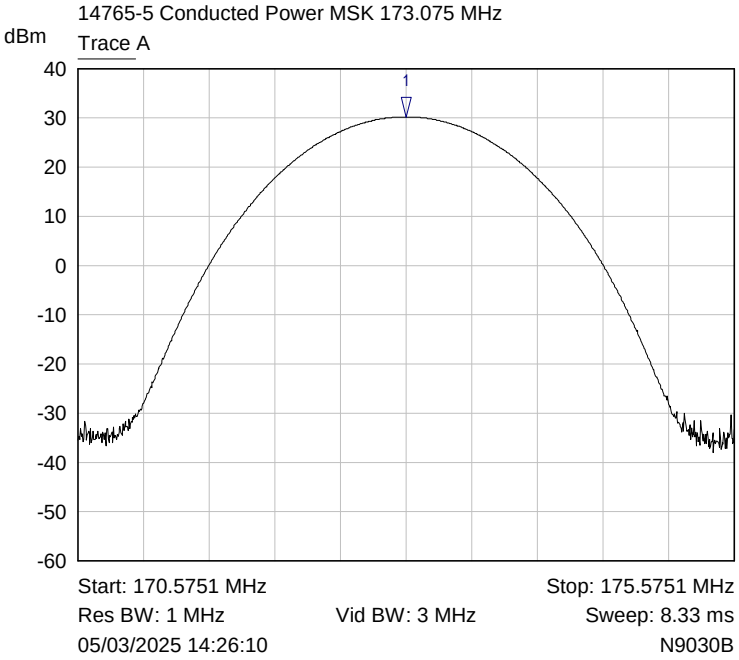
LIMITS:
90.20(e)6(v) Transmissions from mobiles shall be limited to 400 milliseconds for every 10 seconds, except when a vehicle is being tracked actively transmissions are limited to 400 milliseconds for every second. Alternatively, transmissions from mobiles shall be limited to 7200 milliseconds for every 300 seconds with a maximum of six such messages in any 30 minute period.

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:
Duty cycle|<± 2.57 ms

6 Plots/Graphical results

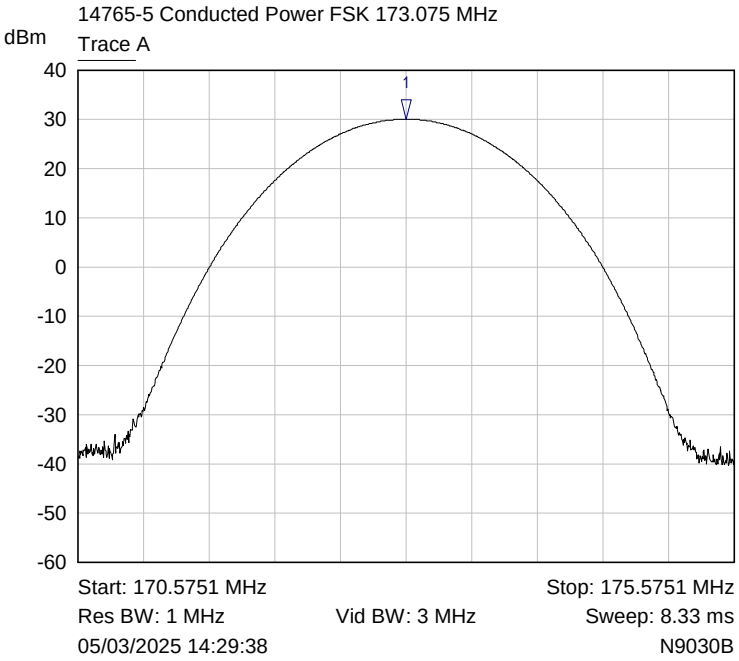
6.1 Conducted power

RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel, Modulation MSK, Channel 173.075 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	173.0751 MHz	30.22 dBm	

RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel, Modulation FSK, Channel 173.075 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	173.0751 MHz	30.04 dBm	

6.2 Occupied bandwidth

RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel, Modulation MSK, Channel 173.075 MHz

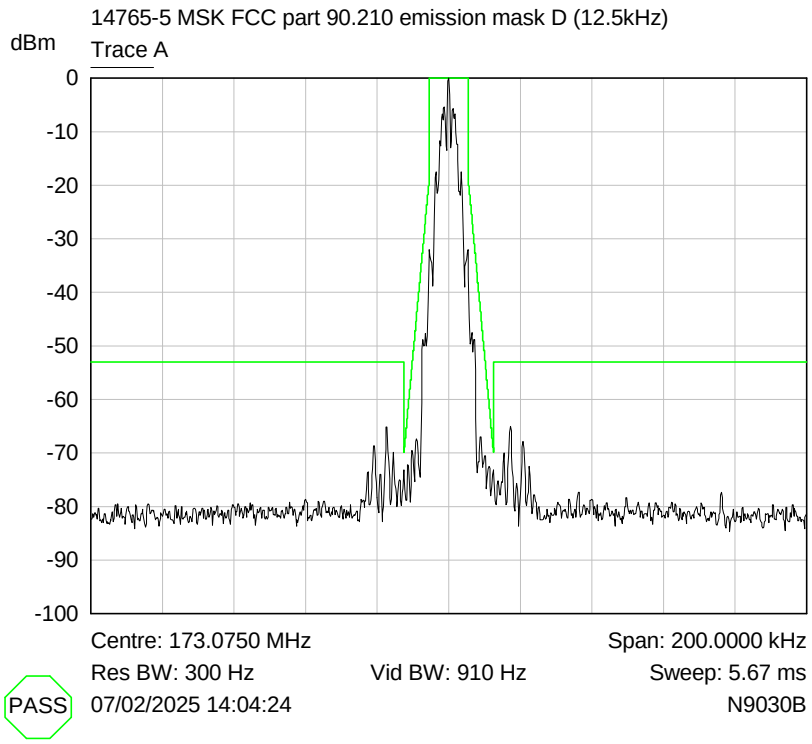
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel, Modulation FSK, Channel 173.075 MHz

Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

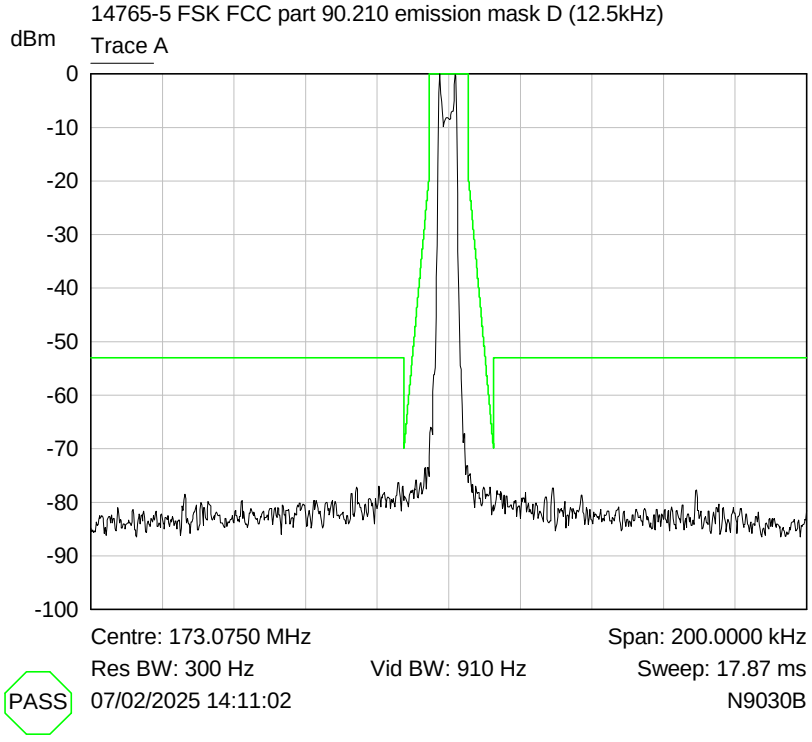
6.3 Emission mask

RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel, Modulation MSK, Channel 173.075 MHz



Nominal Temperature, Nominal Voltage

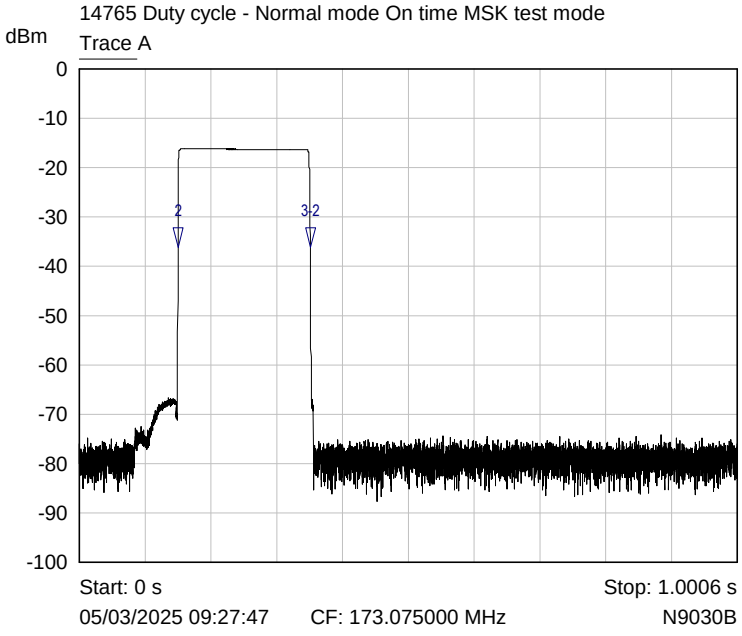
RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel, Modulation FSK, Channel 173.075 MHz



Nominal Temperature, Nominal Voltage

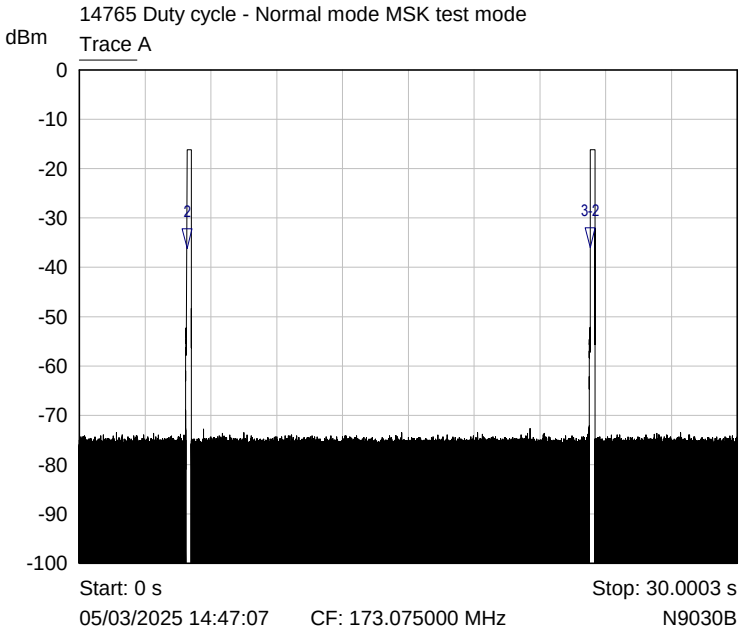
6.4 Duty cycle

RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel, Modulation MSK, Channel 173.075 MHz



Mkr	Trace	X-Axis	Value	Notes
2 ▽	Trace A	149.7145 ms	-36.21 dBm	
3-2 ▽	Trace A	201.2666 ms	-0.00 dB	

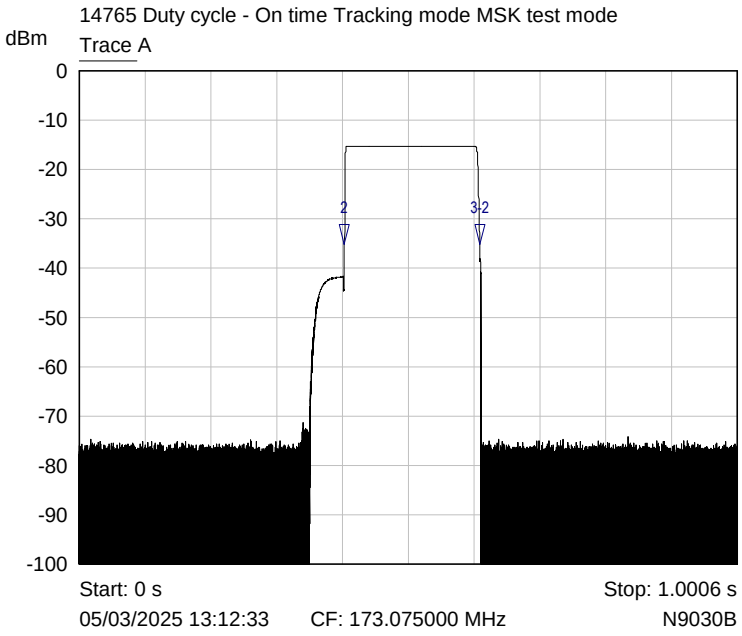
On time



Mkr	Trace	X-Axis	Value	Notes
2 ▽	Trace A	4.8951 s	-36.11 dBm	
3-2 ▽	Trace A	18.4040 s	0.00 dB	

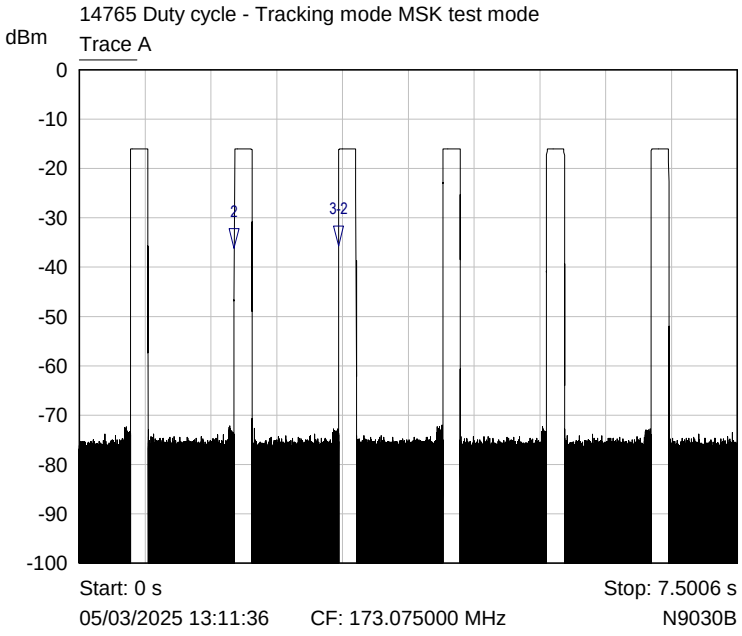
Cycle/period time

RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel, Modulation MSK, Channel 173.075 MHz



Mkr	Trace	X-Axis	Value	Notes
2 ▽	Trace A	403.2606 ms	-35.27 dBm	
3-2 ▽	Trace A	205.7257 ms	-0.00 dB	

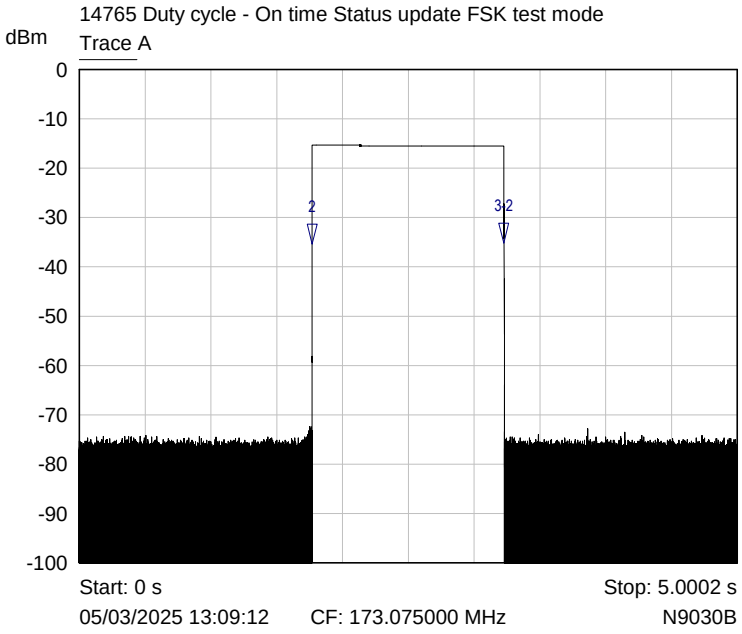
On time



Mkr	Trace	X-Axis	Value	Notes
2 ▽	Trace A	1.7676 s	-36.28 dBm	
3-2 ▽	Trace A	1.1857 s	-0.00 dB	

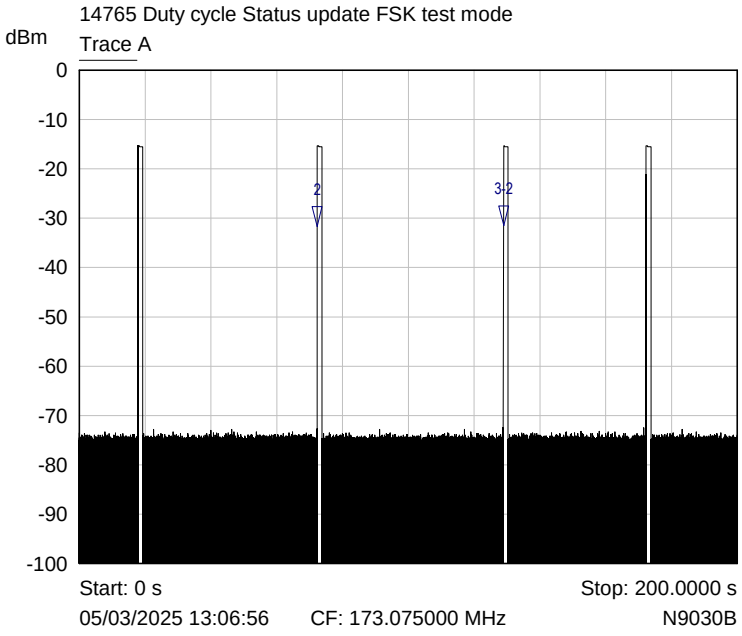
Cycle/period time

RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel, Modulation FSK, Channel 173.075 MHz



Mkr	Trace	X-Axis	Value	Notes
2 ▽	Trace A	1.7685 s	-35.28 dBm	
3-2 ▽	Trace A	1.4595 s	0.01 dB	

On time



Mkr	Trace	X-Axis	Value	Notes
2 ▽	Trace A	72.2834 s	-35.25 dBm	
3-2 ▽	Trace A	56.6057 s	-0.00 dB	

Cycle/period time

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 (dBuV)	Pk – Lim 1 (dB)	QP Amp (dBuV)	QP - Lim1 (dB)	Av Amp (dBuV)	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 . 10/3) = 60 dB μV/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 dBµV/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: $E_{Linear} = 10^{((E_{log}-120)/20)}$

And therefore equation 21 transposed is: $E_{Log} = 20xLog(E_{Linear}) +120$

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

Where:

EIRP is equivalent isotropically radiated power in dBm

λ is the wavelength of the emission under investigation (300/f(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: $PD = EIRP_{Linear} / 4\pi d^2$

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

Where:

PD is the power density at distance specified by the limit, in W/m^2

$EIRP_{Linear}$ is the equivalent isotropically radiated power in Watts

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

Equation 26: $PD = E^2_{Speclimit} / 377$

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

Where:

PD is the power density at distance specified by the limit, in W/m^2

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

Example:

Radiated spurious emissions limit at 3metres of $90pW/cm^2$.

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

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

And

Equation 26 transposed: $E_{Spec\ limit} = \sqrt{(0.9x10^{-6} \times 377)} = 0.01842$ V/m.

And

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

8.6 EUT Display & Controls

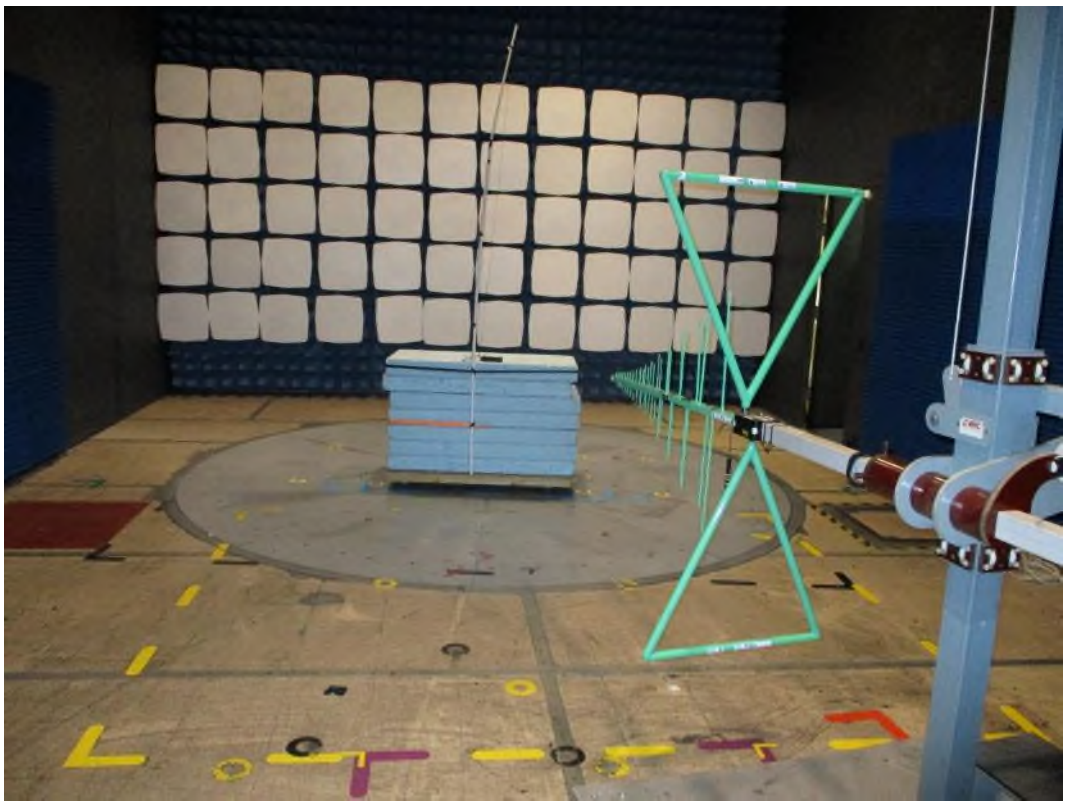
The EUT has display or controls

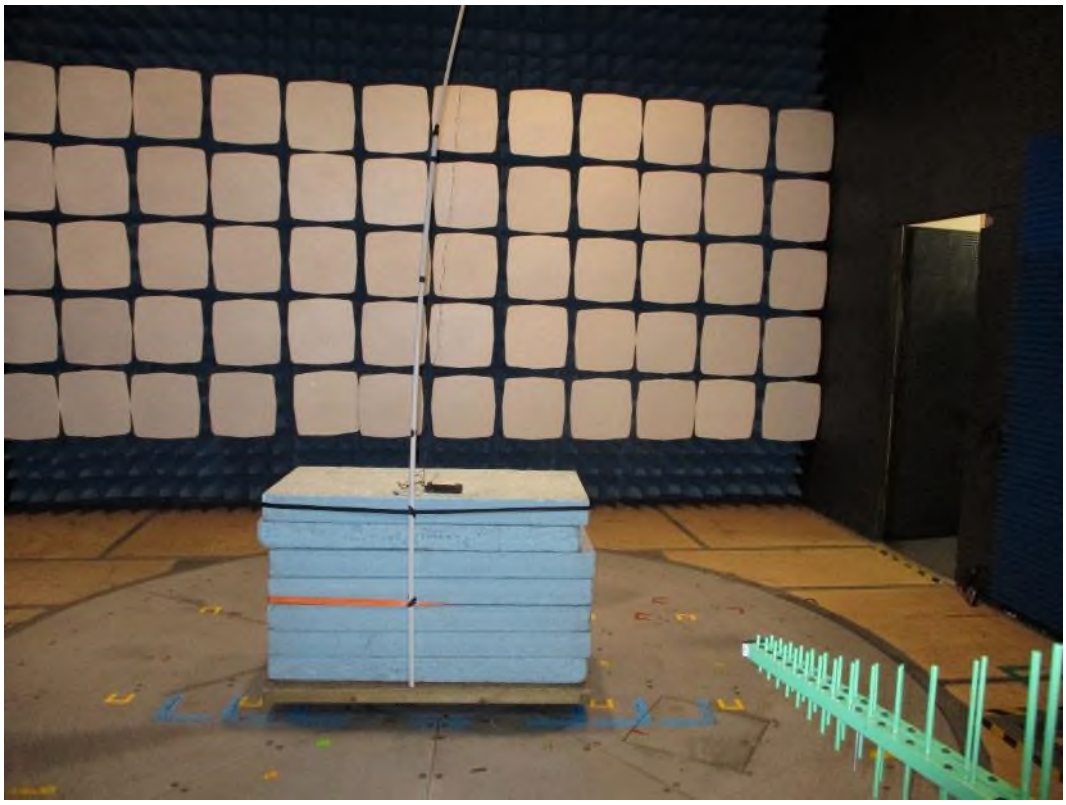
8.7 EUT Internal photos

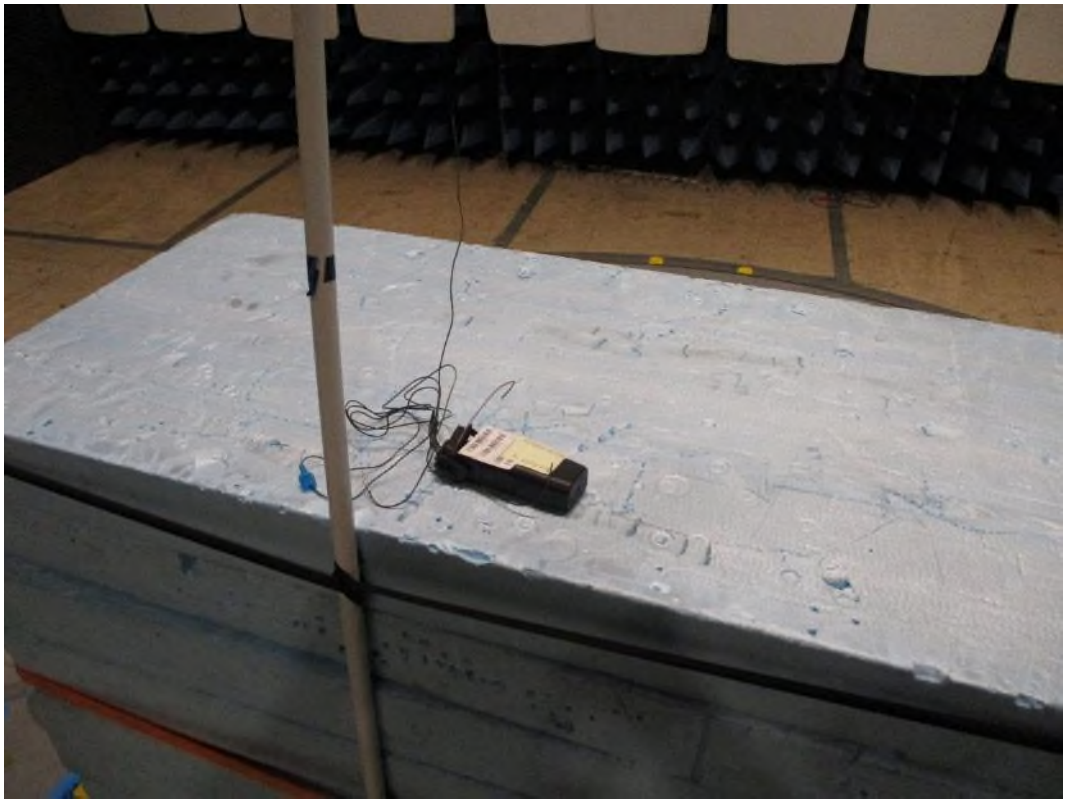
Photos removed for confidentiality.

8.8 EUT ID Label

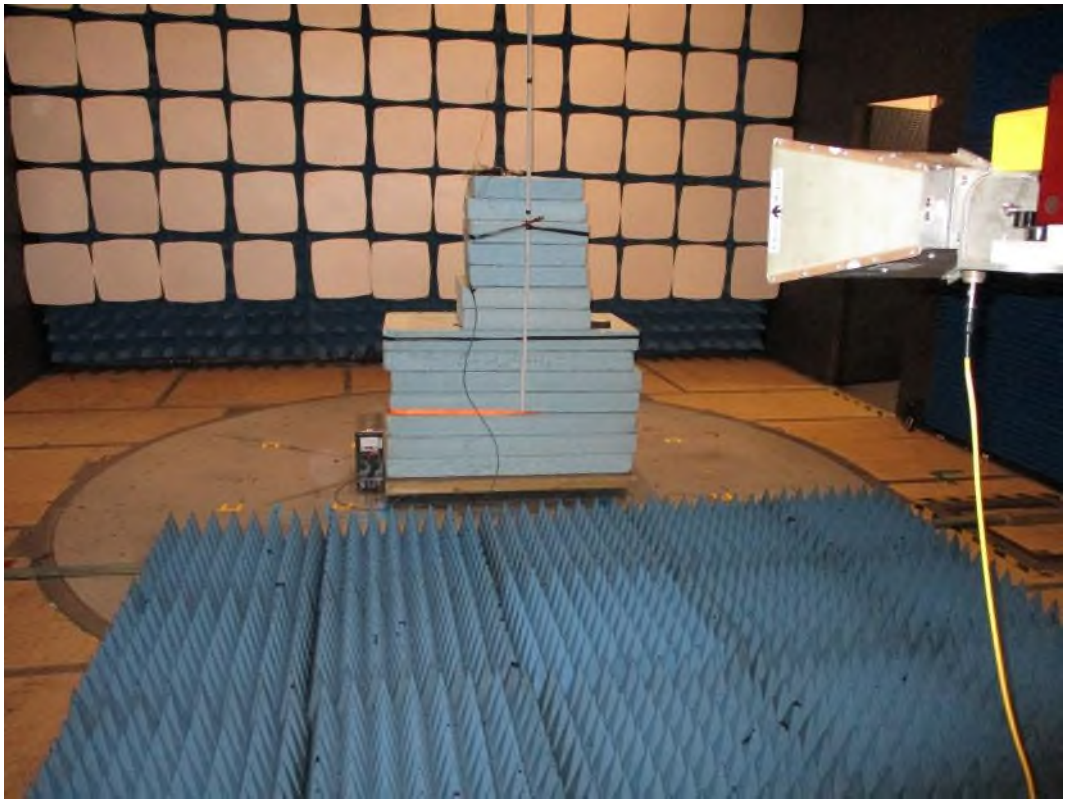
8.9 25-1000MHz Spurious emissions test set-up







8.10 Above 1GHz Spurious emissions test set-up



8.11 Radiated emission diagrams

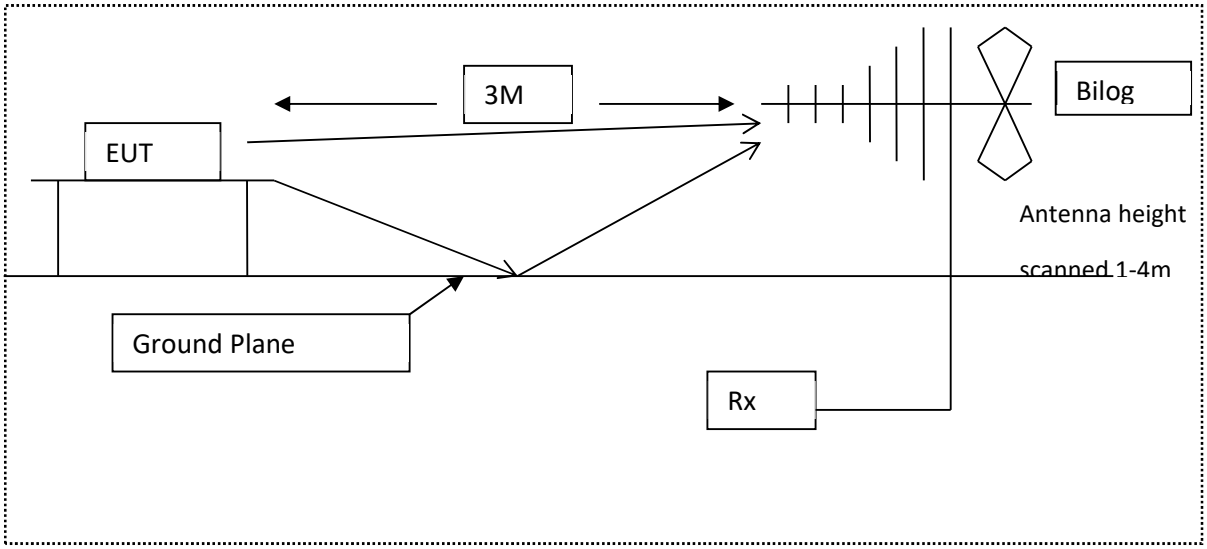


Diagram of the radiated emissions test setup 30 - 1000 MHz

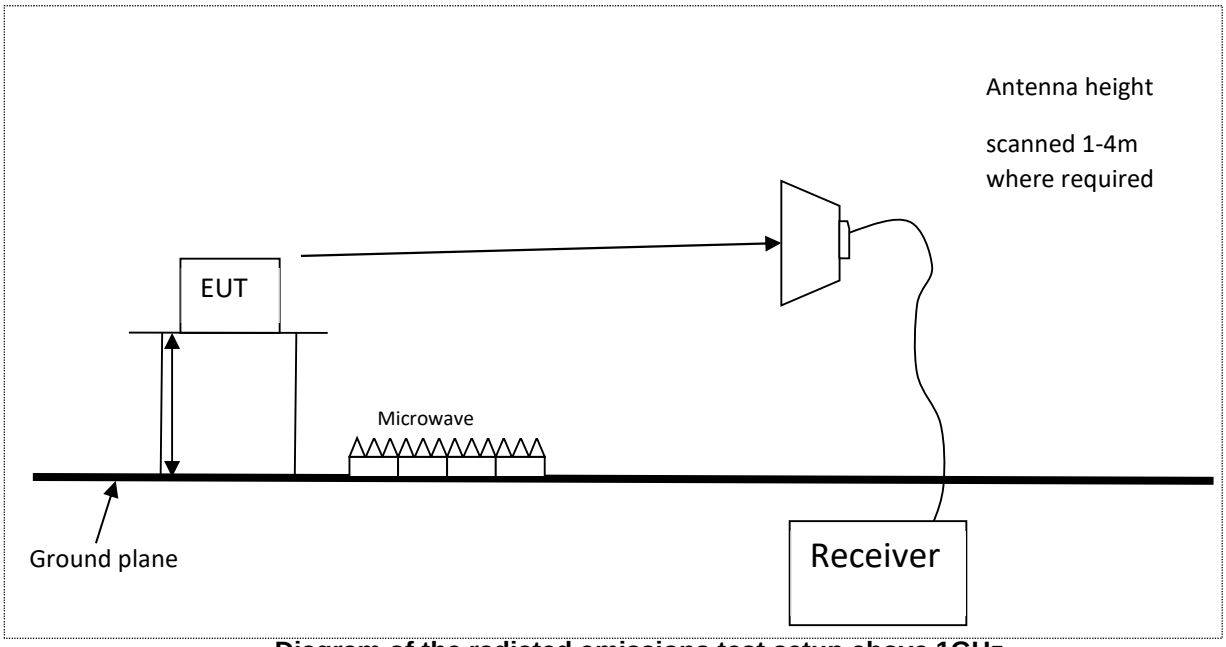


Diagram of the radiated emissions test setup above 1GHz

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
E005	8447F	Pre-Amplifier 10MHz to 1000MHz	MCL Microwave+Mini-circuits	17/06/2024	12 months
E268	BHA 9118	Horn Antenna 1 - 18 GHz	Schaffner	15/05/2024	12 months
E403	TTR190-3EE	Filter Notch Filter 125-250 MHz	Telonic Berkeley Inc	Not applicable	
E410	N5181A	Signal Generator 3 GHz MXG	Agilent Technologies	03/07/2024	36 months
E417	MW-1120-7	Filter BPF 182 - 518 MHz	AEL	Not applicable	
E517	E4421B	Signal Generator 250 kHz - 3 GHz	Hewlett Packard	10/09/2024	12 months
E640	6630.19.AA	Attenuator 30dB 18GHz	Suhner	08/04/2024	12 months
E642	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	20/02/2024	24 months
E745	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	#17/02/2025	12 months
E755	N9030B	PXA Signal Analyser 3 Hz to 50 GHz	Keysight Technologies	13/08/2024	12 months
E874	Model2-20	Attenuator N type 20dB 18GHz	Weinschel	03/04/2024	12 months
E914	VULB 9163	Antenna BiLog 30MHz to 3GHz	Schwarzbeck	28/06/2024	24 months
LPE261	3115	Horn Antenna 1 - 18 GHz	EMCO	15/05/2024	12 months
LPE333	8449B	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	09/07/2024	12 months
P179	FU301	Filter High Pass Filter 400-2000MHz	Rantec	Not applicable	
P189	RN-140	Filter Low Pass Filter 140MHz	RN Electronics	04/04/2024	12 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

No customer supplied equipment was used.

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

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

13 Revision History

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

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