



2360

Radio Test Report

Redtail Telematics Ltd

VLU6M3

4901-2207-01

47 CFR Part 90B & 90I Effective Date 1st October 2019

↳ 47CFR part 2J 2019

TNB: Licensed Non-Broadcast Station Transmitter

Test Date: 30th July 2020 to 6th November 2020

Report Number: 09-12252-2-20 Issue 01

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Certificate of Test 12252-2

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of FCC Part 90B & 90I. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	VLU6M3
Model Number:	4901-2207-01
Unique Serial Number:	129701D (Transient frequency behaviour, frequency stability) 1297000 (All other tests)
Applicant:	Redtail Telematics Ltd Plextek Building London Road Great Chesterford Essex CB10 1NY
Proposed FCC ID	2AXBF-VLU6M32207-01
Full measurement results are detailed in Report Number:	09-12252-2-20 Issue 01
Test Standards:	47 CFR Part 90B & 90I Effective Date 1st October 2019 ↳ 47CFR part 2J 2019 TNB: Licensed Non-Broadcast Station Transmitter

NOTE:

Certain tests were not performed based upon manufacturer's declarations. Certain other requirements are subject to manufacturer declaration only and have not been tested / verified. For details refer to section 3 of this report.

DEVIATIONS:

No deviations have been applied.

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

Date Of Test: 30th July 2020 to 6th November 2020

Test Engineer:

Approved By:

Radio Approvals Manager

Customer

Representative:



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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	VLU6M3	
Model Number of EUT	4901-2207-01	
Serial Number of EUT	129701D (Transient frequency behaviour, frequency stability) 1297000 (All other tests)	
Date Received	21st July 2020	
Date of Test:	30th July 2020 to 1st September 2020	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	28 th November 2020	
Main Function	Stolen vehicle recovery.	
Information Specification	Height	33 mm
	Width	67 mm
	Depth	131 mm
	Weight	0.16 kg
	Voltage	9-30 V DC
	Current	0.8 A max @ 12 V DC

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Vehicle mounted
Choice of model(s) for type tests	Production samples
Antenna details	1metre PVC coated copper wire
Antenna port	yes (not 50ohms) antenna fitted to connector.
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	173.075 MHz
Lowest Signal generated in EUT	8 MHz (VCO)
Hardware Version	1.0.0
Software Version	N/A
Firmware Version	108.28
Type of Equipment	Stand alone
Technology Type	VHF PMR
Geo-location (yes/no)	
TX Parameters	
Alignment range – transmitter	173.075 MHz
EUT Declared Modulation Parameters	MSK 1200bps, FSK 50bps
EUT Declared Power level	+33dBm max
EUT Declared Signal Bandwidths	10 kHz
EUT Declared Channel Spacing's	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?	Yes in burst mode
Declared frequency stability	<5 ppm
RX Parameters	
Alignment range – receiver	173.075 MHz
EUT Declared RX Signal Bandwidth	12.5 kHz
Receiver Signal Level (RSL)	Not declared
Method of Monitoring Receiver BER	Not required
FCC Parameters	
FCC Transmitter Class	TNB: Licensed Non-Broadcast Station Transmitter

2.3 Functional description

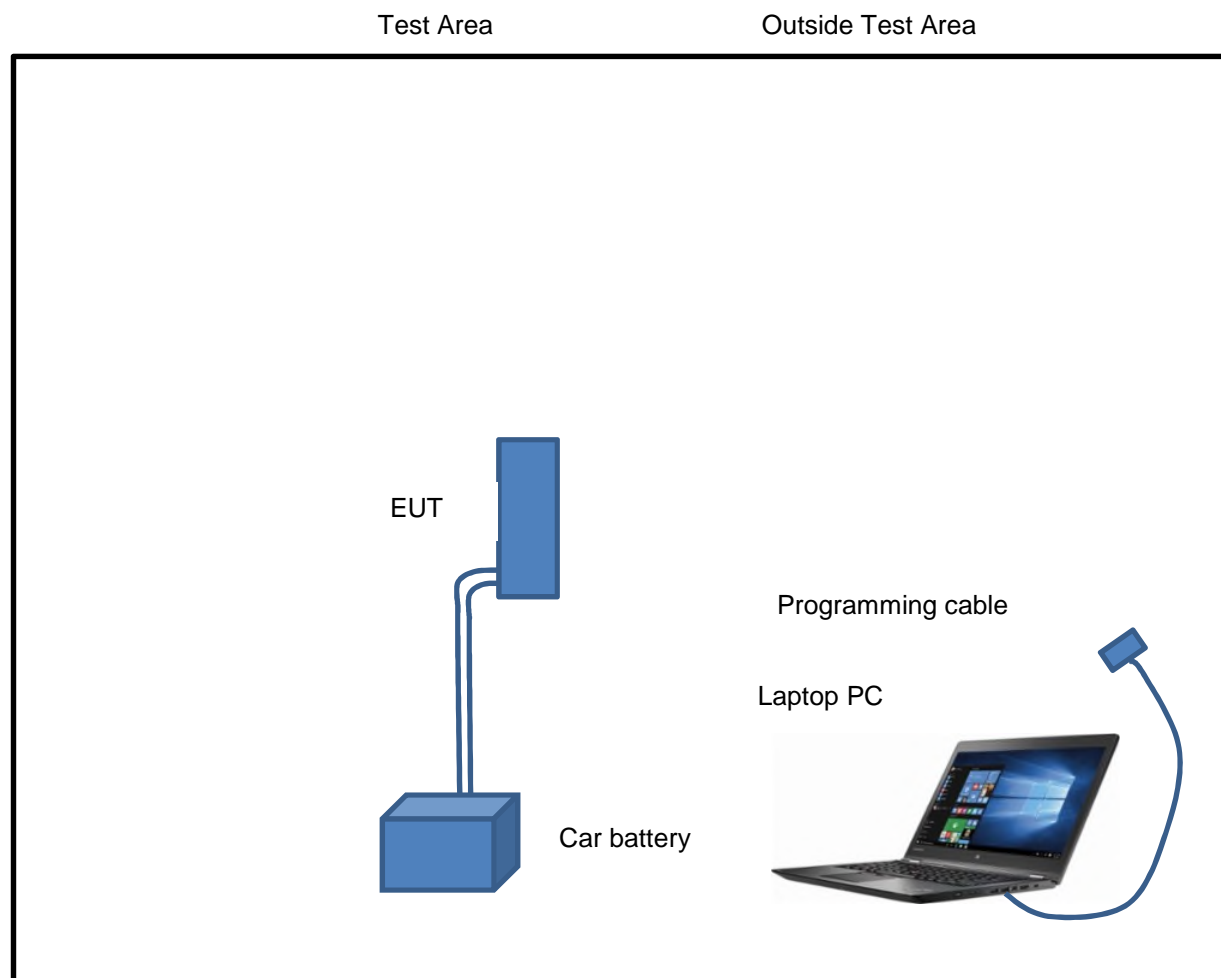
VLU6M3 is a vehicle security device, using proprietary VHF communication and radio location techniques to enable recovery of a stolen vehicle. The product is designed for covert installation and is powered from the vehicle. If the external power is lost it will run from an internal 6V primary cell. The radio transceiver is a discrete design, operating at a single frequency 173.075MHz (for US and Latam markets) with a nominal transmit power of 31.8dBm, 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
TX 1	The EUT is transmitting bursts of data every 2 seconds at 173.075 MHz, MSK 1200bps, stolen/active mode	Yes
TX 2	The EUT is transmitting bursts of data every 16 seconds at 173.075 MHz, MSK 1200bps, normal mode	Yes
TX 3	The EUT is transmitting bursts of data every 47 seconds at 173.075 MHz, FSK 50bps, update status mode	Yes
RX	The EUT is in continuous receive at 173.075 MHz	No
CW	The EUT is transmitting bursts unmodulated (CW) at 173.075 MHz	Yes

Note: TX3 mode is sped up for purposes of test and is typically once a week transmission.

2.5 Emissions configuration



The equipment under test was powered using a 12 Volt car battery and placed on a turntable. The EUT's wire antenna was extended vertically and attached to a plastic pole for support. Using a laptop PC running engineering software, the EUT was configured into the relevant test modes as stated in section 2.4. The laptop PC was removed from the chamber prior to test. In order to test frequency stability and transient frequency behaviour a matching circuit pcb board was provided by Redtail Telematics Ltd to allow connection of the 377 Ω antenna circuit to a 50 Ω measurement port, the circuit attenuated the conducted RF output power by approximately 15dB in band, and where applicable, was compensated for during tests.

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 VLU6M3, 4901-2207-01 was tested for compliance to the following standard :

47 CFR Part 90B & 90I Effective Date 1st October 2019

↳ 47CFR part 2J 2019

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	FCC Part 90I Clause 90.210(b), 47CFR part 2J Clause 2.1053	PASSED ¹
2. Conducted emissions	FCC Part 90I Clause 90.210(b), 47CFR part 2J Clause 2.1051	NOT APPLICABLE ²
3. Rated output Power	FCC Part 90B Clause 90.20(e)6(iii), 47CFR part 2J Clause 2.1046	PASSED
4. Frequency stability	FCC Part 90I Clause 90.213(a), 47CFR part 2J Clause 2.1055	PASSED
5. Occupied bandwidth	FCC Part 90I Clause 90.209, FCC Part 90B Clause 90.20(e)6(ii), 47CFR part 2J Clause 2.1049	PASSED
6. Emission mask	FCC Part 90I Clause 90.210(b)	PASSED
7. Modulation limiting	47CFR part 2J Clause 2.1047(b)	NOT APPLICABLE ³
8. Modulation frequency response	47CFR part 2J Clause 2.1047(a)	NOT APPLICABLE ³
9. Transient frequency behaviour	FCC Part 90I Clause 90.214	PASSED
10. Adjacent channel power	FCC Part 90I Clause 90.221	NOT APPLICABLE ⁴
11. Duty Cycle	FCC Part 90B Clause 90.20(e)6(v)	PASSED

¹ Spectrum investigated up to a frequency of 2 GHz based on the highest signal generated in equipment of 173.075 MHz. Integral antenna was in place for tests.

² 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.

³ Not applicable to digitally modulated equipment.

⁴ 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 R.N. Electronics Ltd procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	FCC Part 90I	2019	Part 90 - Private Land Mobile Radio Services - Subpart I - General Technical standards
4.1.2	47CFR part 2J	2019	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
4.1.4	TIA 603 E	2016	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
4.1.5	FCC Part 90B	2019	Part 90 - Private Land Mobile Radio Services - Subpart B – Public Safety Radio Pool

4.2 Deviations

No deviations were applied.

4.3 Tests at 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	12V DC
T minimum	-30 °C	V minimum	9V DC
T maximum	50 °C	V maximum	30V DC

Extremes of voltage are based upon manufacturer's declaration.

Extremes of temperature are based upon the requirements of 47 CFR 2.1055.

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

4.4 Test fixtures

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:	FCC Part 90I Clause 90.210(b) [Reference 4.1.1 of this report], 47CFR 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:	FCC Part 90I Clause 90.210(b)(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. No discernible difference was noted between TX1 to TX3 modes. Therefore, the EUT was operated in TX1 mode 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. Peak field strength from the EUT was maximised by rotating it 360 degrees.

8 -30 MHz.

The bottom of the loop antenna was placed at a height of 1m in line with the EUT and a pre scan was performed to determine any radiated emissions in this range.

30MHz - 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.

Tests were performed in Site H and B.

5.1.4 Test equipment

E005, E007-2, E289, E428, E534, E745, E777, E914, TMS81, TMS814

See Section 8 for more details

5.1.5 Test results

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

Setup Table

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

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
346.15	-30.8	-10.8	Vertical	Side
346.15	-33.1	-13.1	Horizontal	Flat
519.225	-54.8	-34.8	Vertical	Flat
519.225	-54.1	-34.1	Horizontal	Upright
865.375	-51.2	-31.2	Vertical	Side
865.375	-57.4	-37.4	Horizontal	Side
1038.45	-42.0	-22.0	Vertical	Side

1038.45	-42.7	-22.7	Horizontal	Upright
1384.6	-49.5	-29.5	Vertical	Side
1384.6	-48.2	-28.2	Horizontal	Flat
1557.675	-49.3	-29.3	Vertical	Side
1557.675	-49.3	-29.3	Horizontal	Upright

Note: results shown are with permanent antenna in place. No other signals were observed.

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 ± 6.1 dB, 1 – 2 GHz ± 3.5 dB

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 RF Output Power

5.3.1 Test methods

Test Requirements:	FCC Part 90B Clause 90.20(e)6(iii) [Reference 4.1.5 of this report], 47CFR 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:	FCC Part 90B Clause 90.20(e)6(iii) [Reference 4.1.5 of this report]

5.3.2 Configuration of EUT

The EUT was tested in a Chamber and ambient conditions were monitored. Three orthogonal planes were examined. No discernible difference was noted between TX1 to TX3 modes. Therefore, the EUT was operated in TX1 mode for this test.

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 field strength from the EUT was maximised by rotating it 360 degrees along with scanning the measuring antenna 1 – 4m in both Horizontal and Vertical polarisations. Substitution method was then performed using a calibrated bi-conical antenna. Peak E.R.P was then calculated from the measured results plus path loss from the substitution.

Tests were performed in Site H.

5.3.4 Test equipment

E534, E535, E745, E830, E914, TMS814

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	50kPa

Setup Table

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

Frequency (MHz)	Measured ERP (dBm)	Measured ERP (Watts)	Antenna polarisation	EUT polarisation
173.075	31.9	1.549	Vertical	Upright

Note: only maximum ERP/worst case power and position/polarisation shown.

LIMITS:

Part 90B: 90.20€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:
≤± 3.5 dB

5.4 Frequency stability

5.4.1 Test methods

Test Requirements: FCC Part 90I Clause 90.213(a) [Reference 4.1.1 of this report],
47CFR part 2J Clause 2.1055 [Reference 4.1.2 of this report]
Test Method: TIA 603-E Clause 2.2.2 [Reference 4.1.4 of this report]
Limits: FCC Part 90I Clause 90.213(a) [Reference 4.1.1 of this report]

5.4.2 Configuration of EUT

The EUT was placed in a temperature controlled chamber and thermal balance was achieved before tests began. Measurements were made at the temporary RF port. The EUT was operated in CW mode for this test.

5.4.3 Test procedure

Tests were made in accordance with the Test Method noted above, using the measuring equipment listed in the 'Test Equipment' Section. Temperature stability was achieved at each test level before taking measurements. The measurement was performed on a CW signal.
Tests were performed using Test Site A.

5.4.4 Test equipment

E434, E755, E866, P284, TMS38, TMS57, TMS80

See Section 8 for more details

5.4.5 Test results

Temperature of test environment 23°C
Humidity of test environment 60%
Pressure of test environment 102kPa

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

Test conditions		Frequency Error (MHz)
		Single channel
50°C	Volts Nominal (12)	173.074934
40°C	Volts Nominal (12)	173.074906
30°C	Volts Nominal (12)	173.074973
20°C	Volts Minimum (9)	173.075073
	Volts Nominal (12)	173.075035
	Volts Maximum (30)	173.075065
10°C	Volts Nominal (12)	173.075054
0°C	Volts Nominal (12)	173.074976
-10°C	Volts Nominal (12)	173.074845
-20°C	Volts Nominal (12)	173.074793
-30°C	Volts Nominal (12)	173.075033
Max Frequency Error per chan (Hz)		+94 / -207
Max Frequency Error observed (MHz)		0.000207
Max Frequency Error per chan (ppm)		1.2

LIMITS: Part 90.213: 5 ppm

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:
<± 0.7 ppm

5.5 Occupied bandwidth

5.5.1 Test methods

Test Requirements:	FCC Part 90I Clause 90.209 [Reference 4.1.1 of this report], FCC Part 90B Clause 90.206(ii) [Reference 4.1.5 of this report], 47CFR part 2J Clause 2.1049 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 Clause 5.4 [Reference 4.1.3 of this report]
Limits:	FCC Part 90I Clause 90.209 [Reference 4.1.1 of this report] FCC Part 90B Clause 90.206(ii) [Reference 4.1.5 of this report],

5.5.2 Configuration of EUT

The EUT was operated on a test bench and measurements were made at the temporary RF port. No discernible difference was noted between TX1 & TX2 modes. Therefore, the EUT was operated in TX1 and TX3 modes for this test.

5.5.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section. A 620 Hz RBW, 3x VBW, auto sweep time and max hold settings were used for the 99% bandwidth.

5.5.4 Test equipment

E534, E745, E914

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	7.8
Plot for 99 % Bandwidth (kHz) Nominal Temp & Volts	12252-1 MSK OBW

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	5.7
Plot for 99 % Bandwidth (kHz) Nominal Temp & Volts	12252-2 FSK OBW

Any 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:
<± 1.9 %

5.6 Emission mask

5.6.1 Test methods

Test Requirements:	FCC Part 90I Clause 90.210(b) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.26 Clause 5.5 [Reference 4.1.3 of this report]
Limits:	FCC Part 90I Clause 90.210(b) [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. No discernible difference was noted between TX1 & TX2 modes. Therefore, the EUT was operated in TX1 and TX3 modes for this test.

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 H.

5.6.4 Test equipment

E534, E535, E745, E914

See Section 8 for more details

5.6.5 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	FSK
Single channel	173.075 MHz

	Single channel
plot reference	MSK FCC part 90.210 emission mask D (12.5kHz)
plot reference	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 $7.27(f_d - 2.88 \text{ kHz})$ 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 equipment.

5.8 Modulation frequency response

NOT APPLICABLE: Not applicable to digitally modulated equipment.

5.9 Transient frequency behaviour

5.9.1 Test methods

Test Requirements:	FCC Part 90I Clause 90.214 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.26 Clause 6.5.2.2 [Reference 4.1.3 of this report]
Limits:	FCC Part 90I Clause 90.214 [Reference 4.1.1 of this report]

5.9.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the temporary RF port. The EUT was operated in CW mode for this test.

5.9.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment' Section. The EUT was repeatedly keyed up and down and the frequency vs. time curve observed from the discriminator output of a modulation analyser using a storage oscilloscope. Tests were performed in Site A.

5.9.4 Test equipment

E131, E249, E434, E532, E627, E699, E755, P281, TMS206, TMS30

See Section 8 for more details

5.9.5 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	CW
Single channel	173.075 MHz

	Single channel
TX ON Result	PASSED
TX ON Plot Reference	12252-2 TX on transient
TX OFF Result	PASSED
TX OFF Plot Reference	12252-2 TX off transient

LIMITS:

Transient Frequency Behaviour for Equipment Designed to Operate on 12.5 kHz Channels for equipment operating in the frequency band 150 to 174 MHz:

t^1 (± 12.5 kHz)	5.0 ms
t^2 (± 6.25 kHz)	20.0 ms
t^3 (± 12.5 kHz)	5.0 ms

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:

< ± 185 Hz

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

E534, E535, E745, E830, E914

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	CW
Single channel	173.075 MHz

	Single channel
Normal mode – On time (ms)	200.5
Plot Reference	12252-2 MSK on time
Normal mode – period (s)	16.1
Plot Reference	12252-2 MSK cycle
Tracking mode – On time (ms)	200.3 ms
Plot Reference	12252-2 MSK stolen tracking mode Duty cycle
Tracking mode – period (s)	1.971
Plot Reference	12252-2 MSK stolen tracking mode Duty cycle
Status update mode – On time (s)	1.736
Plot Reference	12252-2 FSK on time
Status update – period (s)	47.22
Plot Reference	12252-2 FSK cycle

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€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.

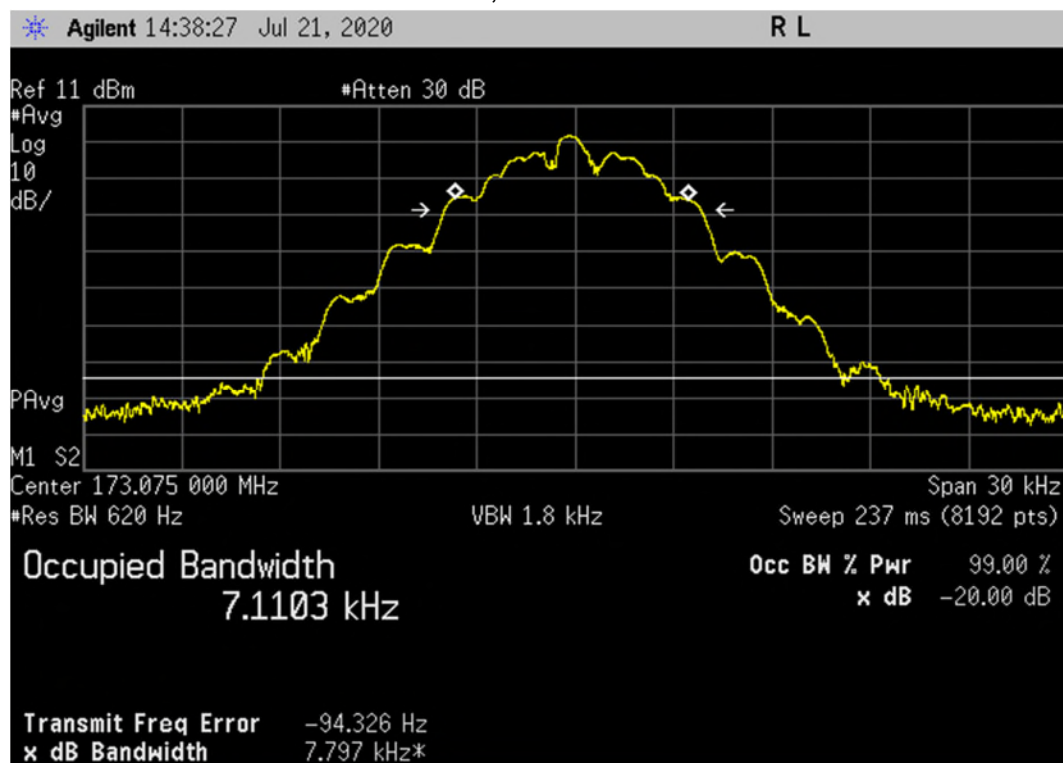
These results show that the EUT has PASSED this test.

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 Occupied bandwidth

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



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

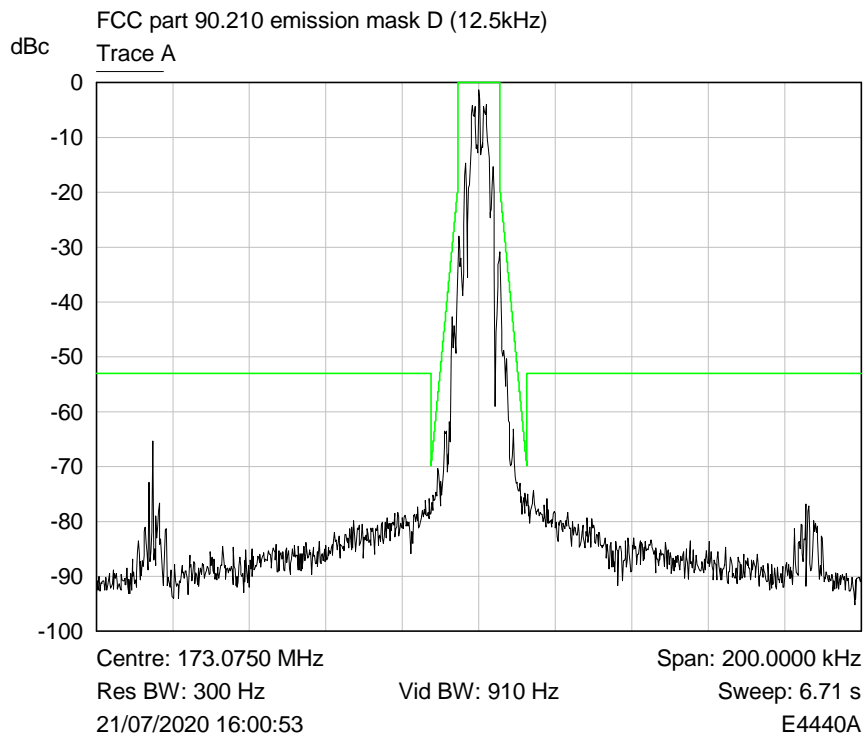
RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel,
Modulation FSK, Channel 173.075 MHz



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

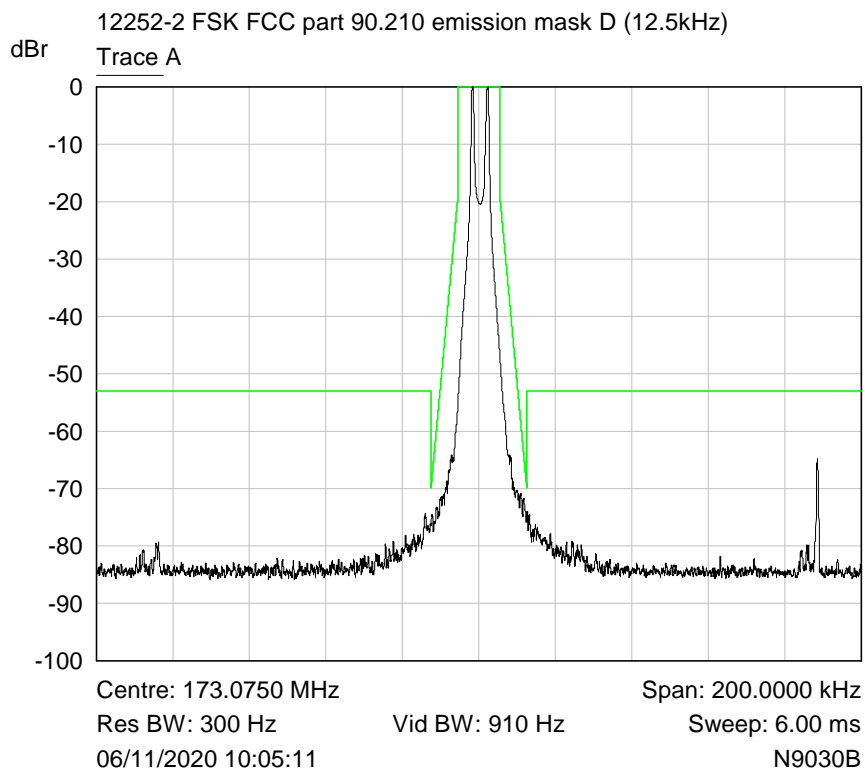
6.2 Emission mask

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



Nominal Temperature, Nominal Voltage

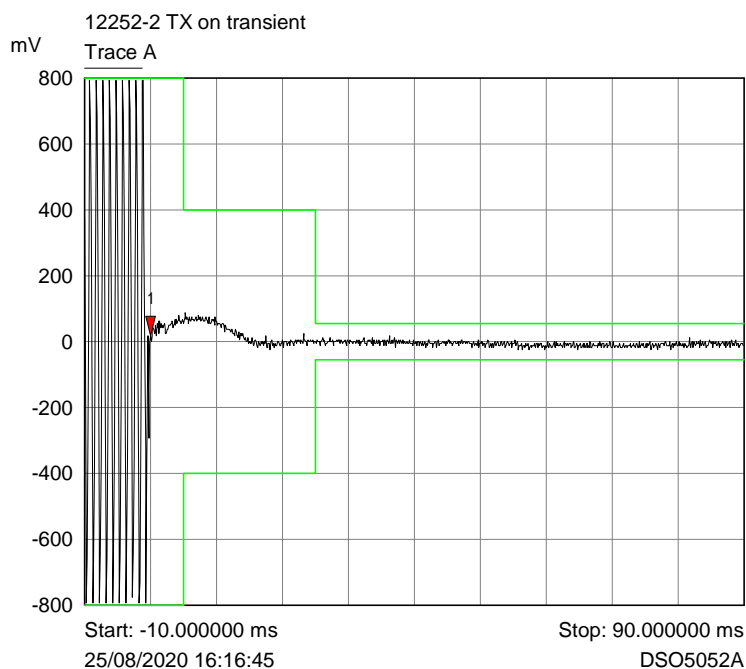
RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel,
Modulation FSK, Channel 173.075 MHz



Nominal Temperature, Nominal Voltage

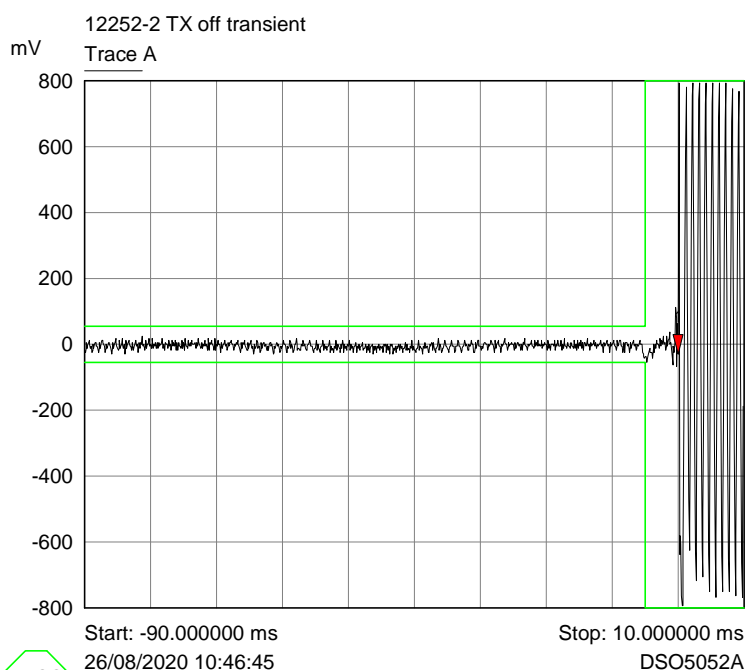
6.3 Transient frequency behaviour

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



Mkr	Trace	X-Axis	Value	Notes
1 ▼	Trace A	-0.006217 ps	18.7500 mV	Ton

TX ON Result



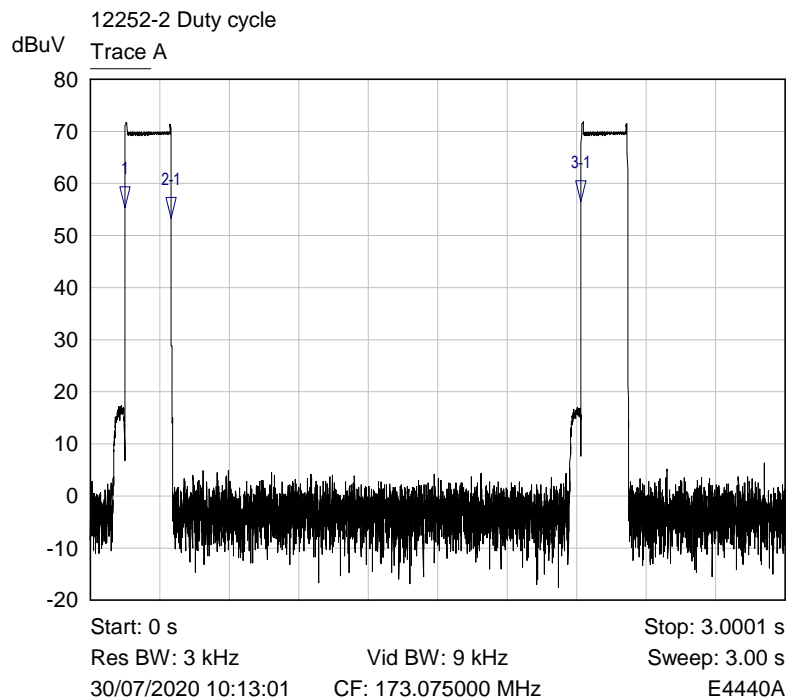
PASS

Mkr	Trace	X-Axis	Value	Notes
1 ▼	Trace A	-0.041744 ps	-31.2500 mV	Toff

TX OFF Result

6.4 Duty Cycle

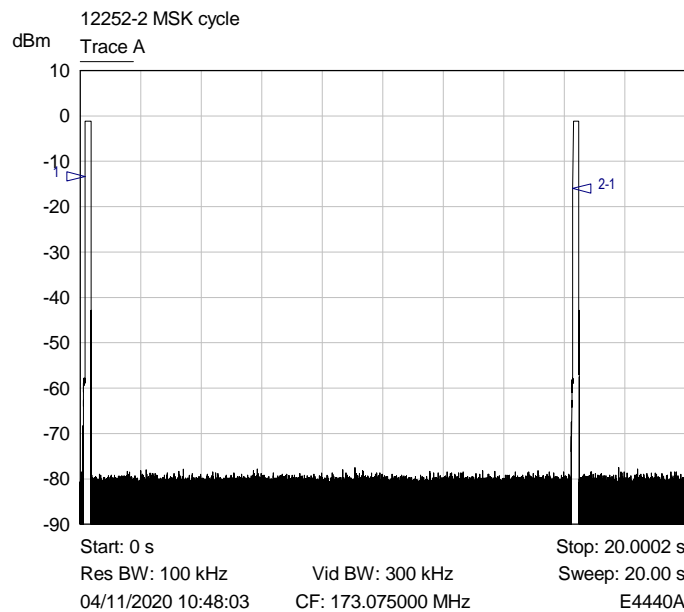
RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel,
Modulation MSK, Channel 173.075 MHz – Active/stolen tracking mode



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	149.4368 ms	55.37 dBuV	
2-1 ▽	Trace A	200.3479 ms	-2.00 dB	
3-1 ▽	Trace A	1.9705 s	1.09 dB	

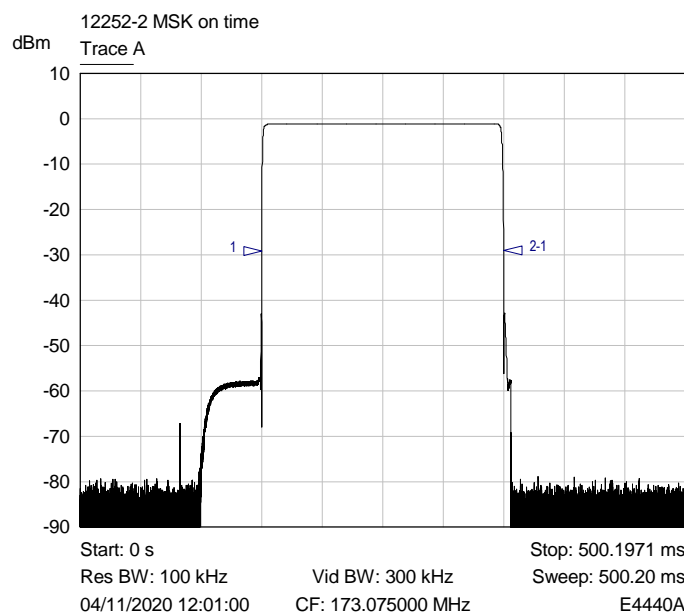
Cycle/period and on time

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



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	144.0623 ms	-13.33 dBm	
2-1 ▽	Trace A	16.1399 s	-16.02 dBm	

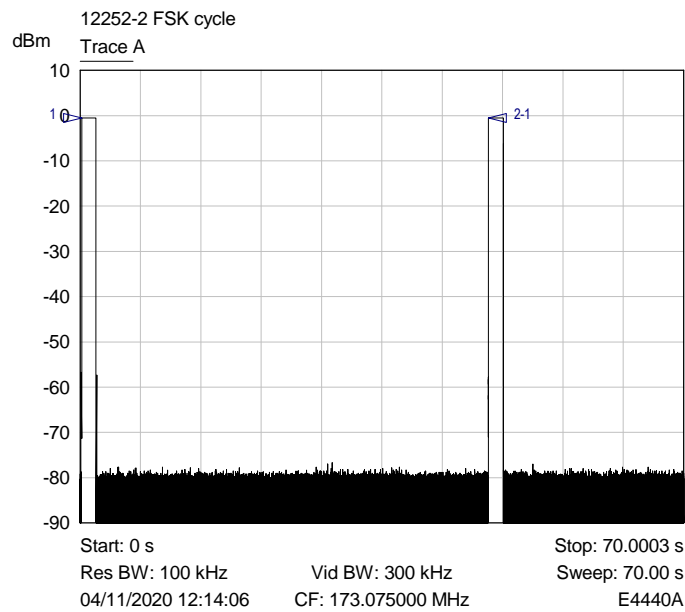
Cycle/period time



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	149.9187 ms	-29.12 dBm	
2-1 ▽	Trace A	200.0544 ms	-28.95 dBm	

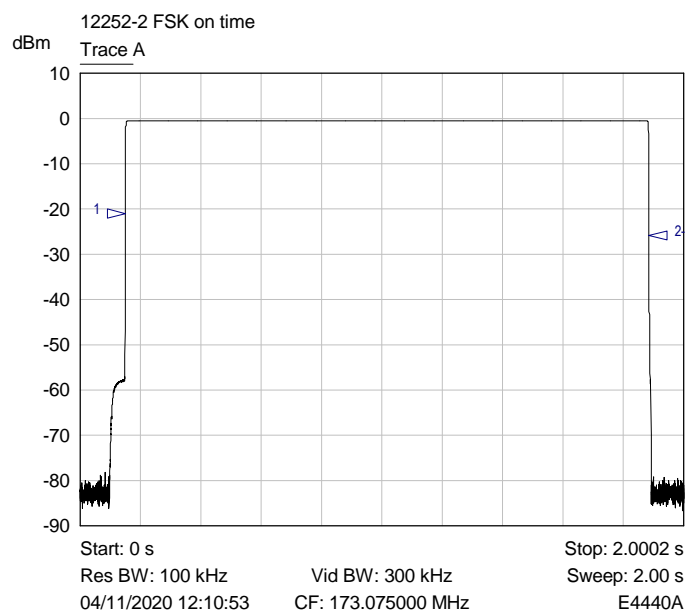
TX on time

RF Parameters: Band 173.075 MHz, Power Maximum, Channel Spacing Single Channel,
Modulation FSK, Channel 173.075 MHz – Status update mode



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	145.2820 ms	-0.48 dBm	
2-1 ▽	Trace A	47.2252 s	-0.49 dBm	

Cycle/period time

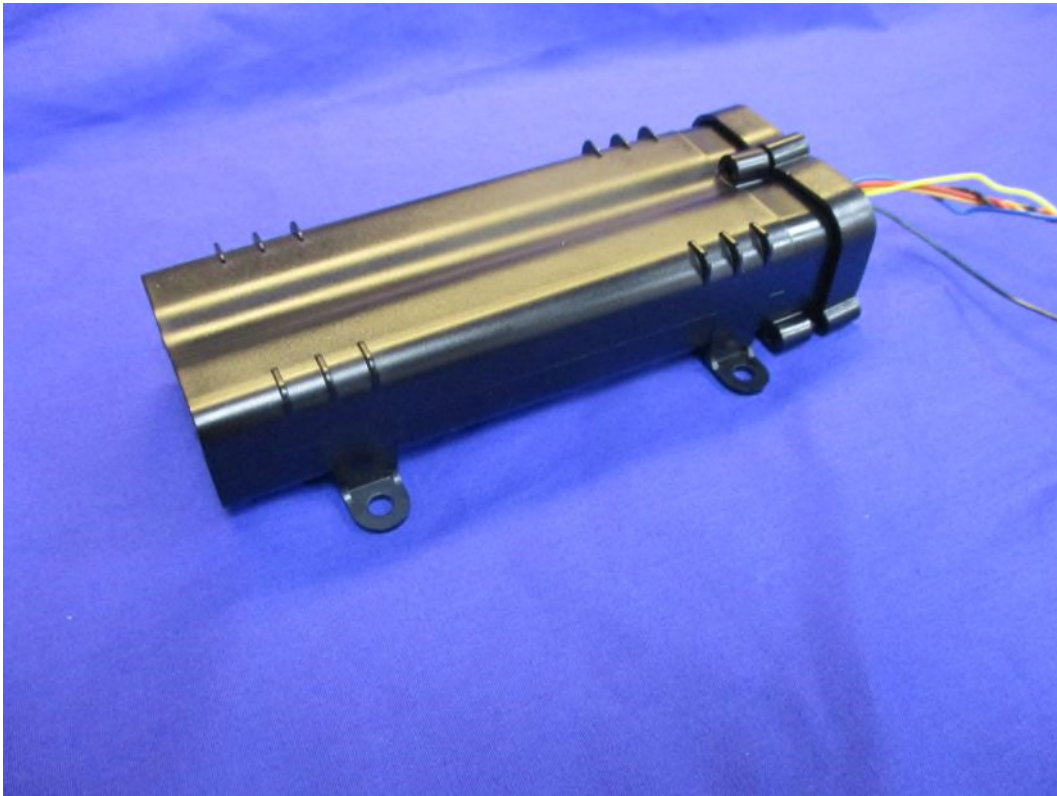


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	149.6946 ms	-20.95 dBm	
2-1 ▽	Trace A	1.7360 s	-25.83 dBm	

TX on time

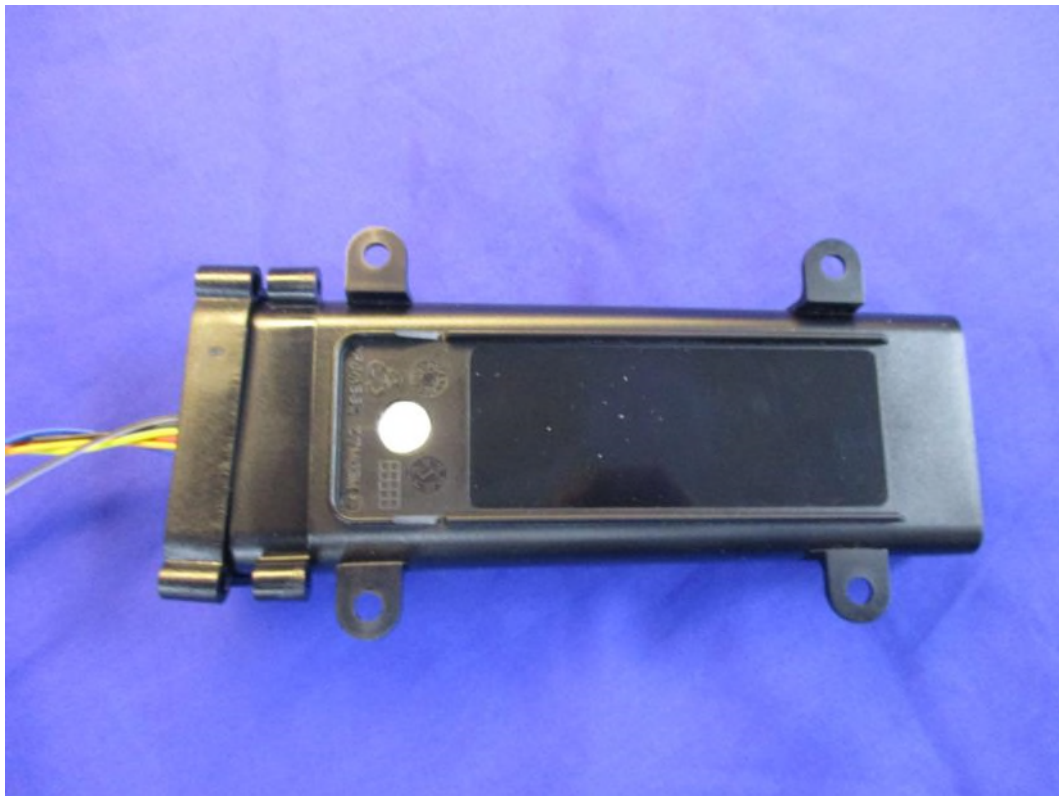
7 Photographs

7.1 EUT Front View





7.2 EUT Reverse Angle



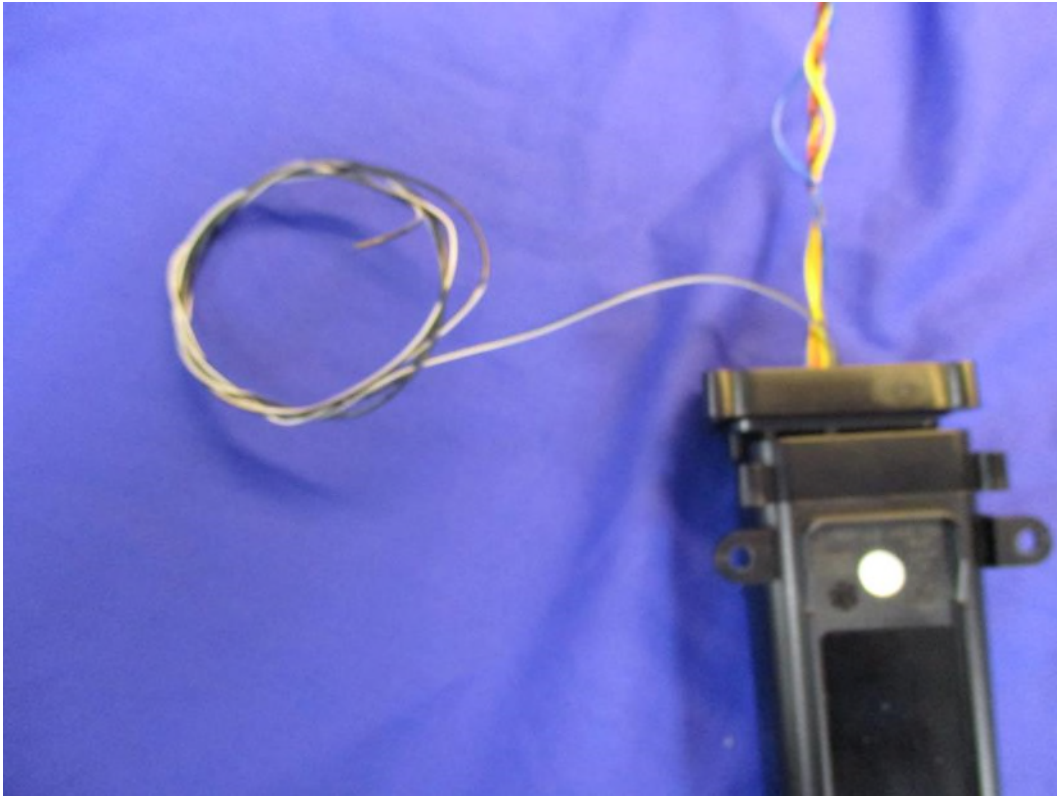
7.3 EUT Left side View



7.4 EUT Right side View



7.5 EUT Antenna

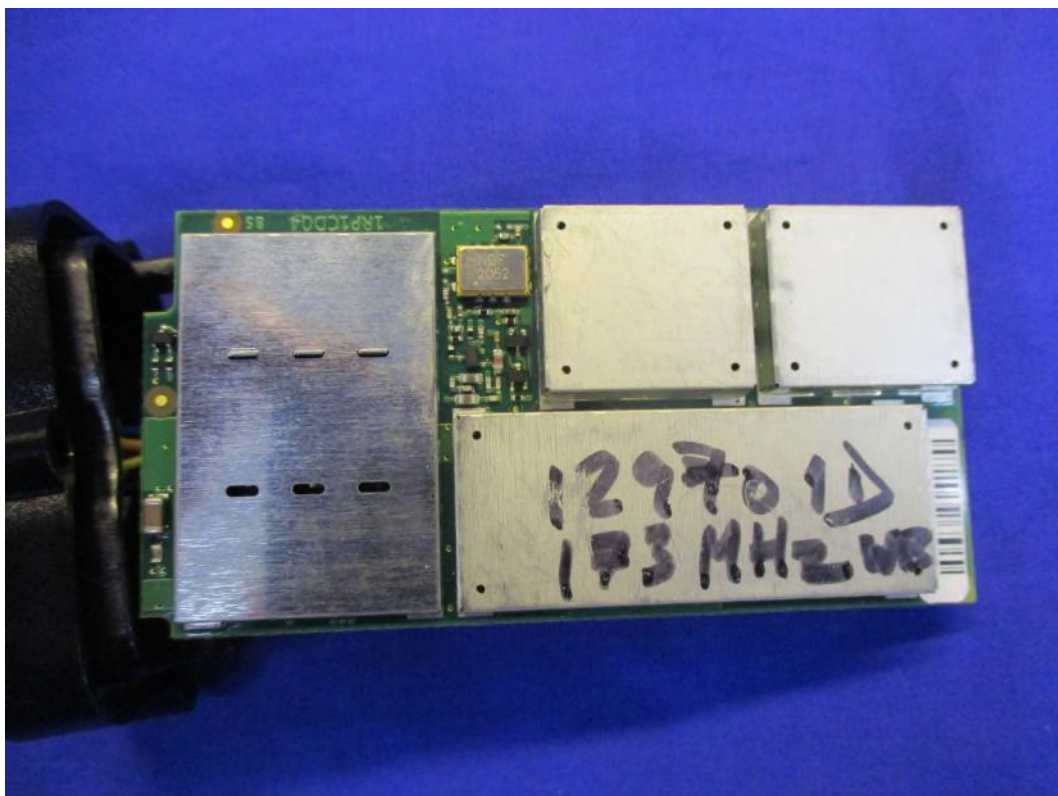
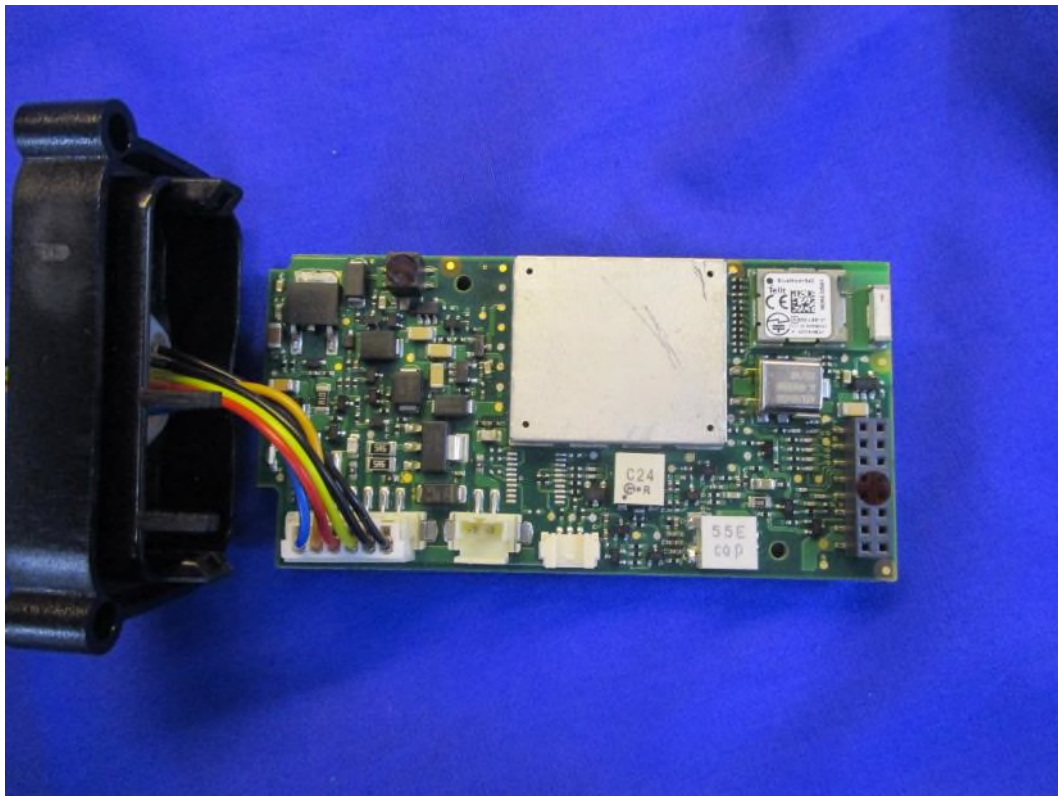


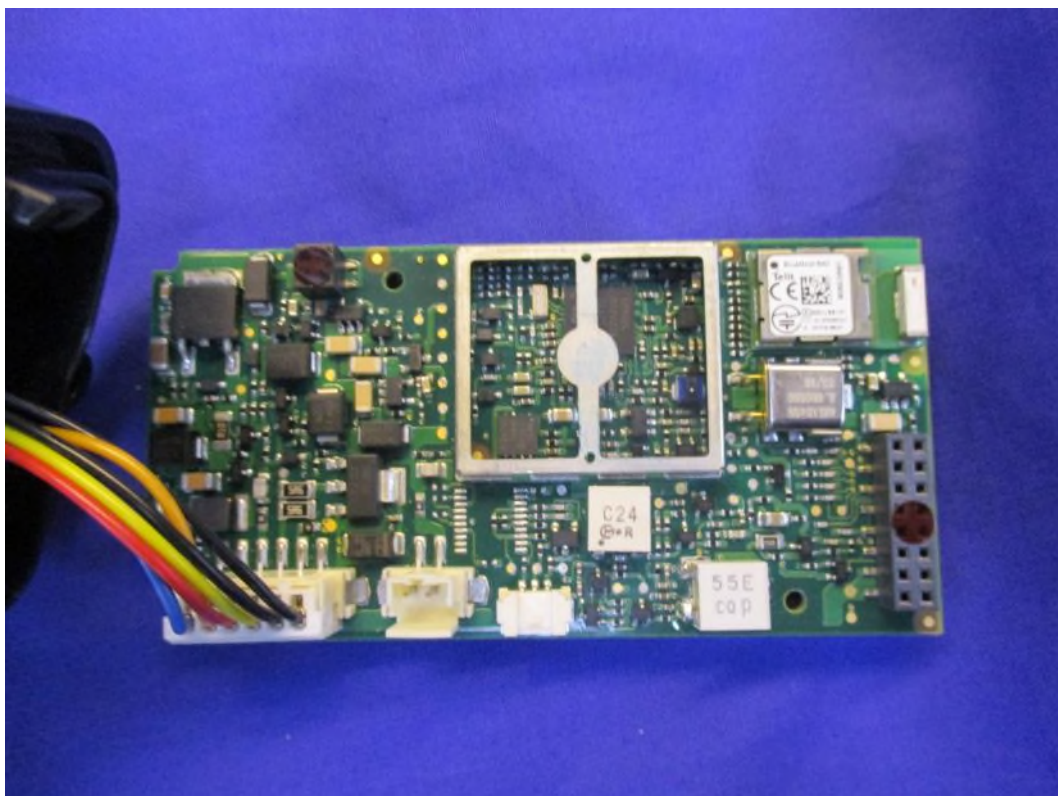
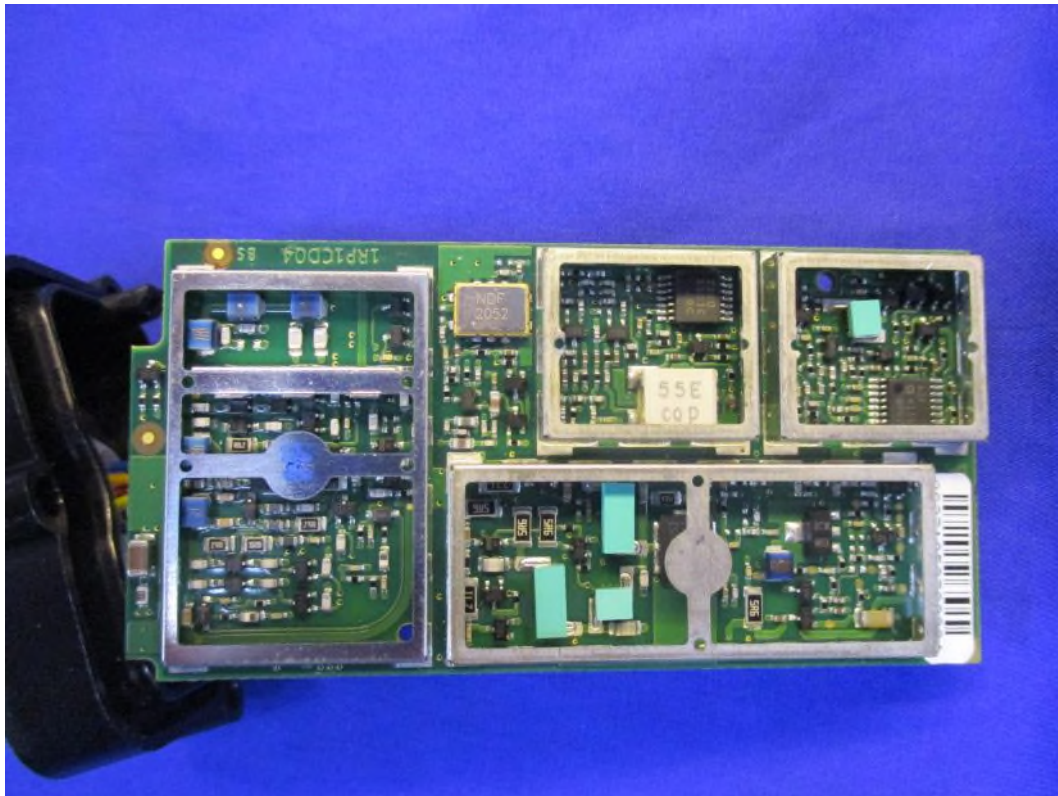
Note: Antenna shown coiled up, for test purposes this was vertically stretched out.

7.6 EUT Display & Controls

The EUT has not display or controls

7.7 EUT Internal photos





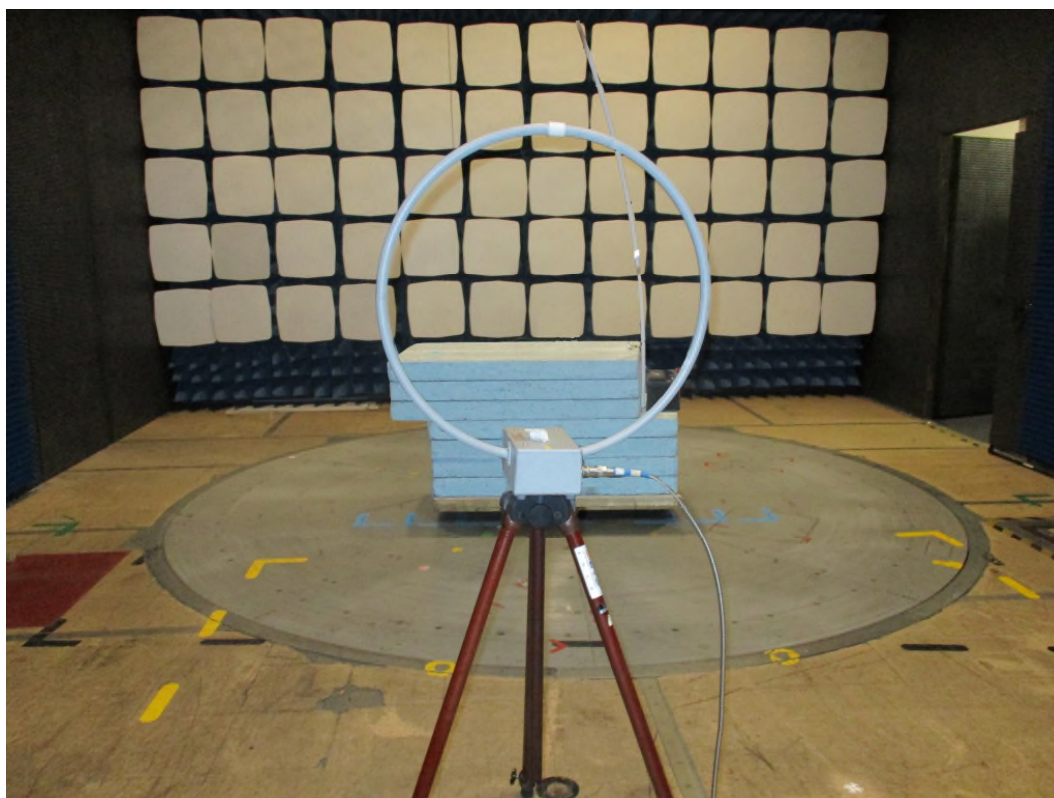
7.8 EUT ID Label

No label was available at the time of test.

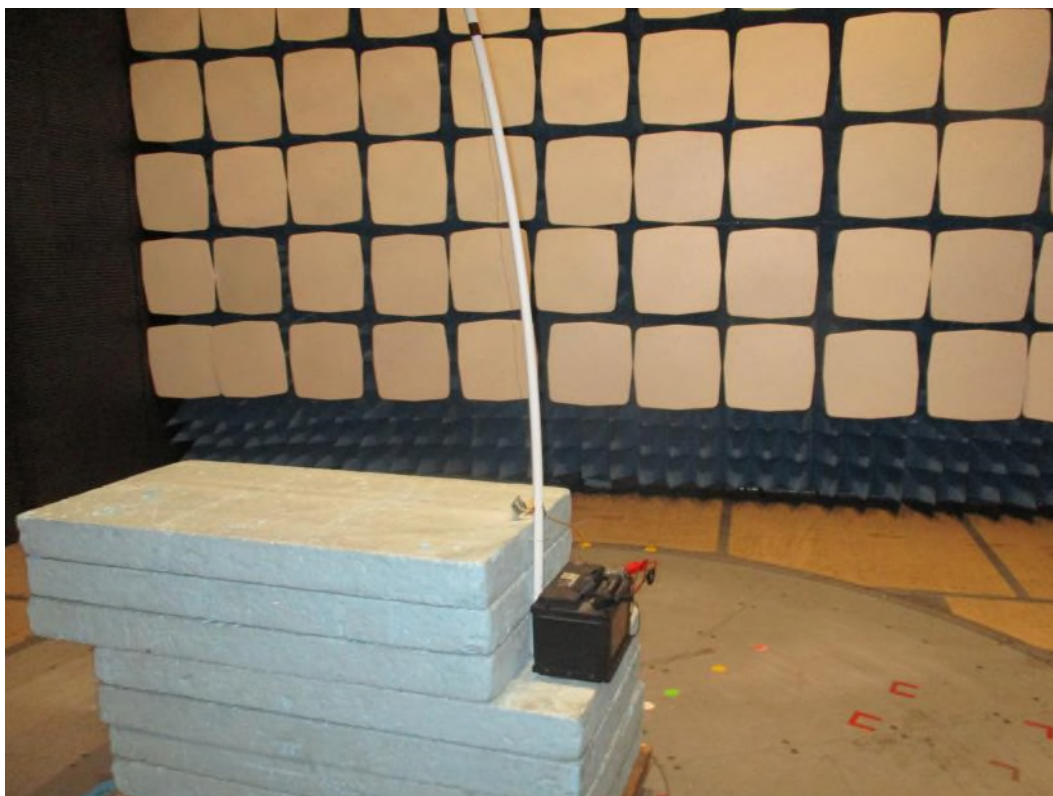
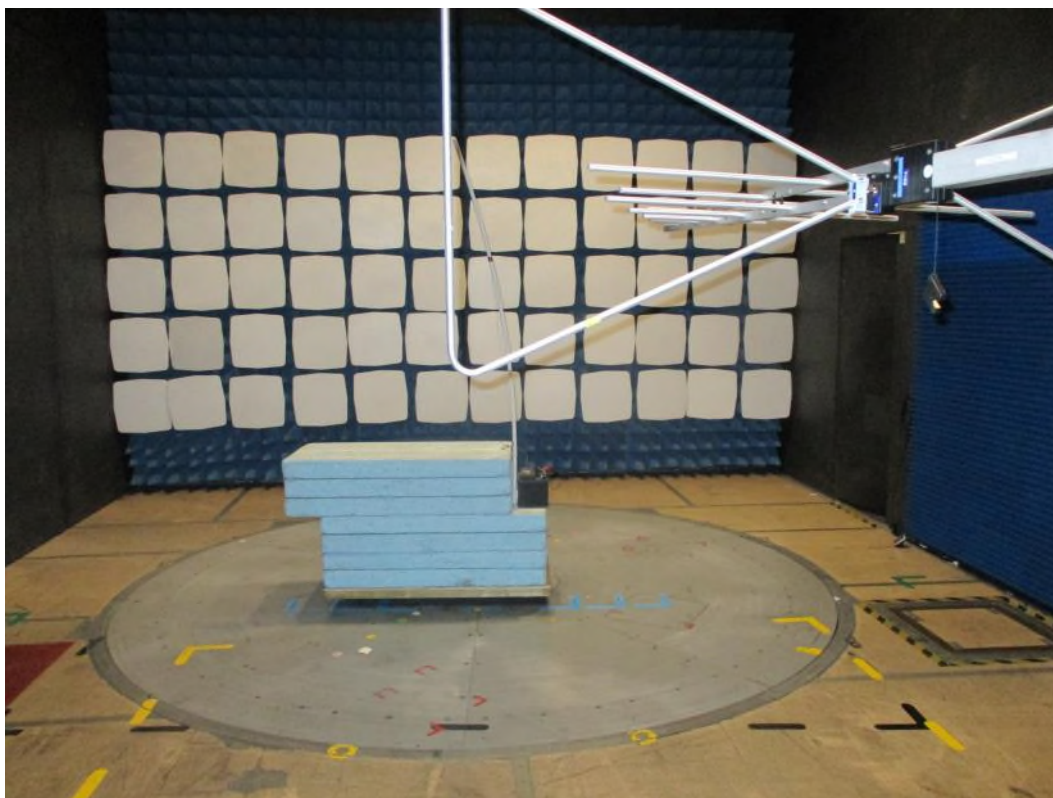
7.9 EUT Chassis

The EUT has no chassis.

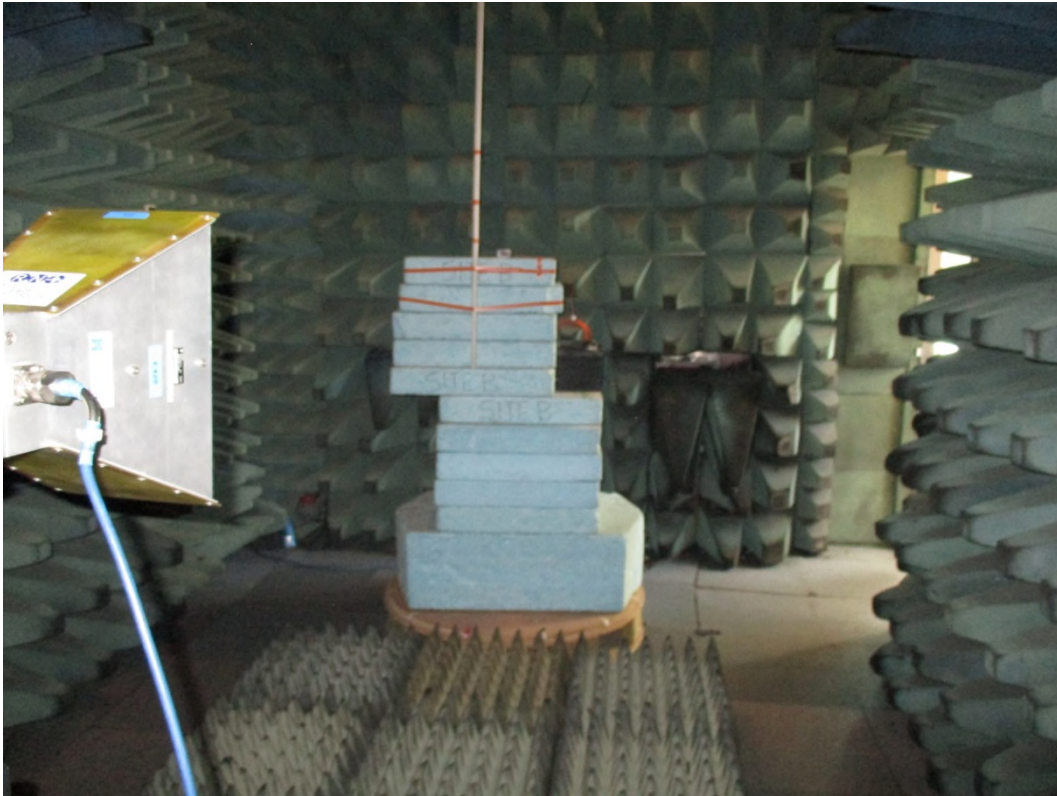
7.10 8-30MHz Spurious emissions test set-up



7.11 30-1000MHz Spurious emissions test set-up



7.12 Above 1GHz Spurious emissions test set-up



8 Test equipment calibration list

The following is a list of the test equipment used by R.N. Electronics Ltd 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.

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E005	8447F	Pre-Amplifier 10MHz to 1000MHz	MCL Microwave+Mini-circuits	05-Jun-2020	12 months
E007-2	VHA9103	Antenna Bi-con	Schwarzbeck	21-Apr-2020	36 months
E131	E4421A (ESG-3000A)	Signal Generator 250kHz – 3GHz	Hewlett Packard	15-Jan-2019	24 months
E249	8471E	Detector 0.01 to 12GHz	Hewlett Packard	12-Mar-2020	12 months
E289	8449B	Pre-Amplifier 1GHz – 26.5GHz	Hewlett Packard	24-Apr-2020	12 months
E428	HF906	Horn Antenna 1-18 GHz	Rohde & Schwarz	30-Apr-2020	12 months
E434	G3RUH	10MHz GPS Disciplined Oscillator	G3RUH - James Miller	#28-Aug-2020	6 months
E532	-	Power Combiner 75-225MHz	AFL	Not applicable	
E534	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	20-Jan-2020	24 months
E535	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	20-Jan-2020	12 months
E627	DSO5052A	Oscilloscope 500MHz 2CH 4GSa/s	Agilent Technologies	15-Jul-2020	12 months
E699	2305	Modulation Meter	Marconi Instruments	14-Oct-2019	12 months
E745	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	07-Feb-2020	12 months
E755	N9030B	PXA 3Hz to 50GHz	Keysight Technologies	#04-Aug-2020	12 months
E777	MG3695B	Signal Generator 8MHz - 50GHz	Anritsu	19-Jun-2020	12 months
E830	N5181A	Signal Generator 100kHz to 6GHz	Agilent Technologies	21-Aug-2020	12 months
E866	42N50A-30	Attenuator 18GHz 50W N-type	Anritsu	30-Jan-2020	12 months
E914	VULB 9163	Antenna BiLog 30MHz to 3GHz	Schwarzbeck	30-Apr-2020	12 months
P281	L30-2	PSU 30V 2A	Farnell	07-Apr-2020	12 months
P284	9231	PSU Dual 30V 1A	Racal-Dana	08-Apr-2020	12 months
TMS206	4901.01B	Power Divider 50Ω 6dB 1W DC-2GHz	Suhner	28-Jul-2020	12 months
TMS30	778D	Dual Directional Coupler 100MHz to 2GHz	Hewlett Packard	29-Jun-2020	12 months
TMS38	VMT04/140	Environmental Oven	Heraeus Votsch	Not applicable	
TMS57	PM2534	Digital Multimeter	Philips	20-Mar-2019	24 months
TMS80	206-3722	Digital Thermometer & K Probe	RS Components	20-Nov-2019	12 months
TMS81	6502	Antenna active loop	EMCO	24-Jun-2019	24 months
TMS814	MP627A	Antenna Doublet 200-1700 MHz	Anritsu	27-May-2020	12 months

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

9 Auxiliary and peripheral equipment

9.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	E6540	Laptop PC	Dell	3680025917
2	Not stated	USB to serial adapter	Generic	Not stated
3	8TP3CD01	VLU7 Test Fixture	Plextek Ltd	8T212

9.2 RN Electronics supplied equipment

No RN Electronics Ltd supplied equipment was used.

10 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.

10.1 Modifications before test

No modifications were made before test by RN Electronics Ltd.

10.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

11 Description of test sites

Site A	Radio Laboratory and Anechoic Chamber
Site B	Semi-Anechoic Chamber and Control Room FCC Registration No. 293246, IC 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. 293246, IC Registration No. 5612A-2
Site J	Transient Laboratory
Site K	Screened Room (Control Room for Site M)
Site M	3m Semi-Anechoic Chamber (indoor OATS) FCC Registration No. 293246, IC 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. 293246, IC Registration No. 5612A-1
Site R	Screened Room (Conducted Immunity)
Site S	Safety Laboratory
Site T	Transient Laboratory

RN Electronics CAB identifier as issued by Innovation, Science and Economic Development Canada is UK0002

RN Electronics CAB identifier as issued by FCC is UK0015

12 Abbreviations and units

%	Percent	LBT	Listen Before Talk
µA/m	microAmps per metre	LO	Local Oscillator
µV	microVolts	mA	milliAmps
µW	microWatts	max	maximum
AC	Alternating Current	kPa	Kilopascal
ALSE	Absorber Lined Screened Enclosure	Mbit/s	MegaBits per second
AM	Amplitude Modulation	MHz	MegaHertz
Amb	Ambient	mic	Microphone
ATPC	Automatic Transmit Power Control	min	minimum
BER	Bit Error Rate	mm	milliMetres
°C	Degrees Celsius	ms	milliSeconds
C/I	Carrier / Interferer	mW	milliWatts
CEPT	European Conference of Postal and Telecommunications Administrations	NA	Not Applicable
COFDM	Coherent OFDM	nom	Nominal
CS	Channel Spacing	nW	nanoWatt
CW	Continuous Wave	OATS	Open Area Test Site
dB	decibels	OFDM	Orthogonal Frequency Division Multiplexing
dBµA/m	decibels relative to 1µA/m	ppm	Parts per million
dBµV	decibels relative to 1µV	PRBS	Pseudo Random Bit Sequence
dBc	decibels relative to Carrier	QAM	Quadrature Amplitude Modulation
dBm	decibels relative to 1mW	QPSK	Quadrature Phase Shift Keying
DC	Direct Current	R&TTE	Radio and Telecommunication Terminal Equipment
DTA	Digital Transmission Analyser	Ref	Reference
EIRP	Equivalent Isotropic Radiated Power	RF	Radio Frequency
ERP	Effective Radiated Power	RFC	Remote Frequency Control
EU	European Union	RSL	Received Signal Level
EUT	Equipment Under Test	RTP	Room Temperature and Pressure
FM	Frequency Modulation	RTPC	Remote Transmit Power Control
FSK	Frequency Shift Keying	Rx	Receiver
g	Grams	s	Seconds
GHz	GigaHertz	SINAD	Signal to Noise And Distortion
Hz	Hertz	Tx	Transmitter
IF	Intermediate Frequency	V	Volts
kHz	kiloHertz		