



2360

Radio Test Report

Transense Technologies Plc

iTrack Sensor

TL-IT2-SEN-0001

47 CFR Part 15.231 Effective Date 1st October 2018
DXX: Part 15 Low Power Communication Device Transmitter
Test Date: 29th May 2019 to 30th May 2019
Report Number: 05-10969-1-19 Issue 01

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Certificate of Test 10969-1

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of 47 CFR Part 15C. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	iTrack Sensor
Model Number:	TL-IT2-SEN-0001
Unique Serial Number:	AbC1
Applicant:	Transense Technologies Plc 1 Landscape Close, Weston on the Green Oxon OX25 3SX
Full measurement results are detailed in Report Number:	05-10969-1-19 Issue 01
Test Standards:	47 CFR Part 15.231 Effective Date 1st October 2018 DXX: Part 15 Low Power Communication Device 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: 29th May 2019 to 30th May 2019

Test Engineer:

Approved By:
Radio Approvals Manager

Customer
Representative:



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2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Transense Technologies Plc 1 Landscape Close Weston on the Green Oxon OX25 3SX	
Manufacturer of EUT	Trent Electronics Ltd	
Full Name of EUT	iTrack Sensor	
Model Number of EUT	TL-IT2-SEN-0001	
Serial Number of EUT	AbC1	
Date Received	3rd May 2019	
Date of Test:	29th May 2019 to 30th May 2019	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	10th June 2019	
Main Function	Tyre pressure sensor.	
Information Specification	Height	40 mm
	Width	40 mm
	Depth	40 mm
	Weight	0.078
	Voltage	Not declared
	Current	Not declared

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Fitted inside a tyre
Choice of model(s) for type tests	Production sample
Antenna details	Internal pcb antenna
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	434.375 MHz
Lowest Signal generated in EUT	26 MHz
Hardware Version	A 13621A
Software Version	Not specified
Firmware Version	F 13622A
Type of Equipment	Tyre pressure monitor
Technology Type	SRD
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	434.375 MHz
EUT Declared Modulation Parameters	200KK1D on-off keying
EUT Declared Power level	-14.4 dBm
EUT Declared Signal Bandwidths	200 kHz
EUT Declared Channel Spacing's	Single channel
EUT Declared Duty Cycle	4.5 ms ON, 12 seconds OFF
Unmodulated carrier available?	No
Declared frequency stability	+/- 10 ppm
FCC Parameters	
FCC Transmitter Class	DXX: Part 15 Low Power Communication Device Transmitter

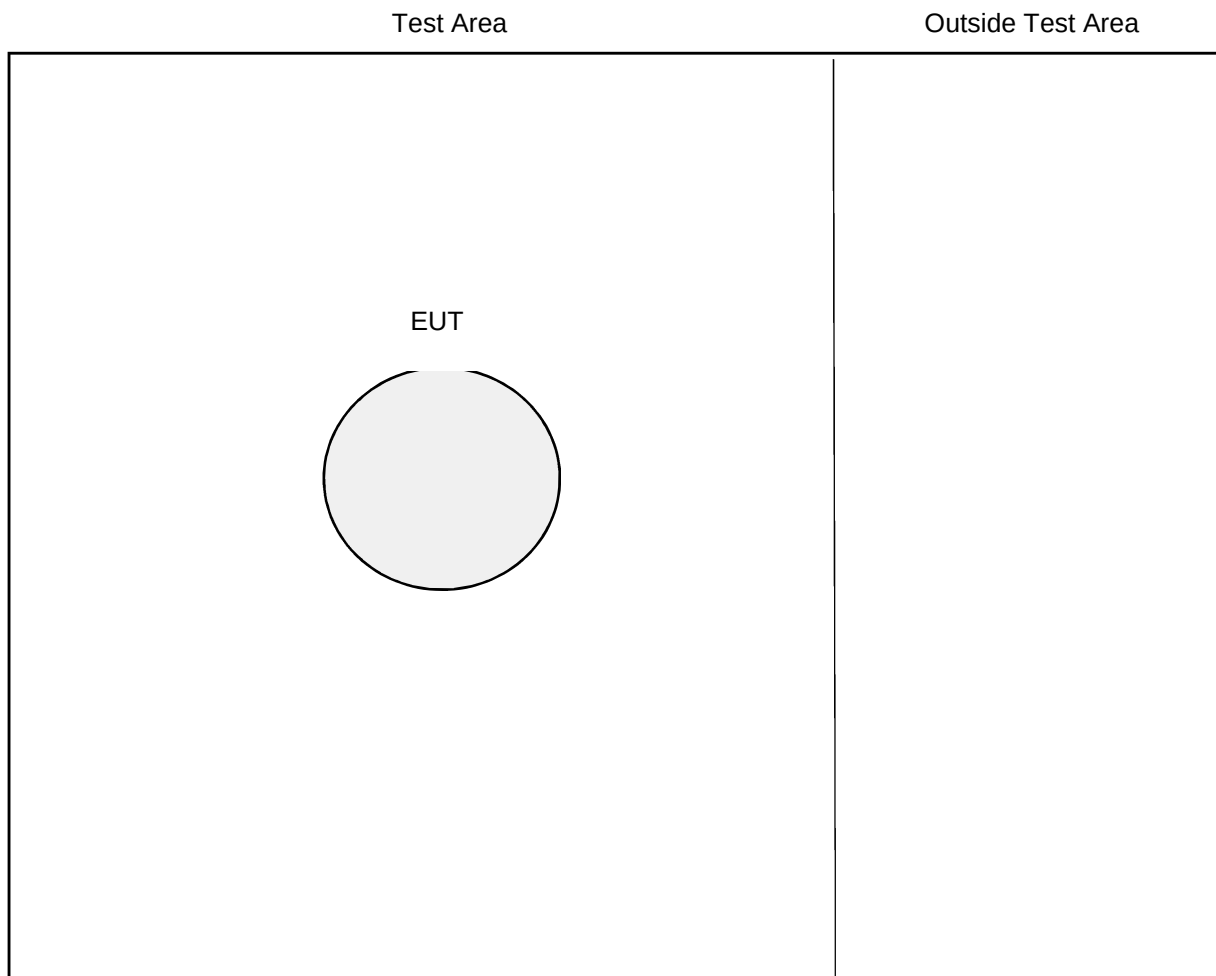
2.3 Functional description

The sensor is fitted inside a large mining tyre and measures the pressure and temperature inside. The sensor then transmits this data via 434 MHz every 12 seconds.

2.4 Modes of operation

Mode Reference	Description	Used for testing
TX1	434.375 MHz -14.4 dBm modulated burst	Yes

2.5 Emissions configuration



The unit was powered from a new battery. The unit was operating as normal on a single channel as stated within section 2.4 of this report. The transmit mode was one transmission every 12 seconds repeatedly with modulation and the power setting and channel were as stated below:-

Single Channel (434.375 MHz) = -14.4dBm

The unit has no signal lead ports.

3 Summary of test results

The iTrack Sensor, TL-IT2-SEN-0001 was tested for compliance to the following standard(s) :

47 CFR Part 15.231 Effective Date 1st October 2018
DXX: Part 15 Low Power Communication Device 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 15C Part 15.207	NOT APPLICABLE ¹
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Part 15.209 & 15.33(a)	PASSED
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Part 15.209 & 15.33(a)	PASSED
4. Radiated emissions 30 MHz -1 GHz	47 CFR Part 15C Part 15.231(e) & 15.209	PASSED
5. Radiated emissions above 1 GHz	47 CFR Part 15C Part 15.209 & 15.33(a)	PASSED ²
6. Intentional radiator field strength	47 CFR Part 15C Part 15.231(e)	PASSED
7. Band edge compliance	47 CFR Part 15C Part 15.231(d)/15.205	NOT APPLICABLE ³
8. Occupied bandwidth	47 CFR Part 15C Part 15.231(c)	PASSED
9. Periodic operation	47 CFR Part 15C Part 15.231(e)	PASSED
10. Frequency stability	47 CFR Part 15C Part 15.231(d)	NOT APPLICABLE ³
Receiver Tests		
11. Antenna Power conducted emissions for receivers	47 CFR Part 15C Part 15.111	NOT APPLICABLE ⁴

¹ EUT does not operate from the AC power lines nor contain provisions for operation while connected to AC power lines.

² Spectrum investigated started at a frequency of 30 MHz up to a frequency of 4.5 GHz based on 10 times the highest channel/ signal generated in equipment of 434.375 MHz.

³ EUT does not operate in the 40.66 - 40.70 MHz band, therefore no limits are specified.

⁴ EUT does not have an antenna port.

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	47 CFR Part 15C	2018	Federal Communications Commission PART 15 – RADIO FREQUENCY DEVICES
4.1.2	ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of 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

4.2 Deviations

No deviations were applied.

5 Tests, methods and results

5.1 AC power line conducted emissions

NOT APPLICABLE: EUT does not operate from the AC power lines nor contain provisions for operation while connected to AC power lines.

5.2 Radiated emissions 9 - 150 kHz

5.2.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.209 & 15.33(a) [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 15C Part 15.209 [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 with a new battery. The EUT was operated in TX1 mode.

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 made on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment and the antenna were rotated 360 degrees to record the worst case emissions. Tests were performed in Test Site M.

5.2.4 Test equipment

TMS81, ZSW1, E624, E411

See Section 9 for more details

5.2.5 Test results

Temperature of test environment	18°C
Humidity of test environment	67%
Pressure of test environment	102kPa

Band	410-608 MHz
Power Level	-14.4 dBm
Channel Spacing	Single Channel
Mod Scheme	200KK1D
Single channel	434.375 MHz

Plot refs

10969-1 Rad 1 9k-150kHz Para
10969-1 Rad 1 9k-150kHz Perp

No emissions observed within 20dB of the limits.

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.

15.231(e) limits are applicable elsewhere, although 15.209 limits may be used where these allow a higher field strength.

n.b. 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 - 30MHz ± 3.9 dB.

5.3 Radiated emissions 150 kHz - 30 MHz

5.3.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.209 & 15.33(a) [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 15C Part 15.209 [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 with a new battery. The EUT was operated in TX1 mode.

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 made on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment and the antenna were rotated 360 degrees to record the worst case emissions. Tests were performed in Test Site M.

5.3.4 Test equipment

TMS81, ZSW1, E624, E411

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	18°C
Humidity of test environment	67%
Pressure of test environment	102 kPa

Band	410-608 MHz
Power Level	-14.4 dBm
Channel Spacing	Single Channel
Mod Scheme	200KK1D
Single channel channel	434.375 MHz

Plot refs

10969-1 Rad 1 150k-30MHz Para
10969-1 Rad 1 150k-30MHz Perp

No emissions observed within 20dB of the limits.

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.

15.231(b)/(e) limits are applicable elsewhere, although 15.209 limits may be used where these allow a higher field strength.

n.b. 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 - 30MHz ± 3.9 dB.

5.4 Radiated emissions 30 MHz -1 GHz

5.4.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.231(e) & 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 15C Clause 15.231(e) & 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 with a new battery. The EUT was operated in TX1 mode.

5.4.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. Measurements were made on a site listed with the FCC. The equipment was rotated 360 degrees and the antenna scanned 1 – 4 metres in both horizontal and vertical polarisations 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.

5.4.4 Test equipment

E410, E411, E624, E743, LPE364, ZSW1

See Section 9 for more details

5.4.5 Test results

Temperature of test environment 18°C
Humidity of test environment 62%
Pressure of test environment 102kPa

Band	410-608 MHz
Power Level	-14.4 dBm
Channel Spacing	Single Channel
Mod Scheme	200KK1D
Single channel	434.375 MHz

Plot refs
10969-1 Rad 1 VHF Horiz
10969-1 Rad 1 VHF Vert
10969-1 Rad 1 UHF Horiz
10969-1 Rad 1 UHF Vert

Note: No emissions observed within 20dB of limits in any of the 3 EUT polarisations tested, As such only plots were taken in "flat" position and presented in this report to minimise report size.

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.

15.231(e) limits are applicable elsewhere, although 15.209 limits may be used where these allow a higher field strength.

n.b. 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 - 1000MHz ±6.1dB.

5.5 Radiated emissions above 1 GHz

5.5.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.209 & 15.33(a) [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 15C Part 15.209/15.231(e) [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 with a new battery. The EUT was operated in TX1 mode.

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. The EUT was raised and antenna was placed 1.5m above the ground in line with the EUT, which was rotated through 360 degrees to record the worst case emissions. A measurement distance of 3m was used between the test range 1GHz – 4.5GHz. Tests were performed in Test Site M.

5.5.4 Test equipment

E136, E411, E624, TMS82

See Section 9 for more details

5.5.5 Test results

Temperature of test environment	18°C
Humidity of test environment	67%
Pressure of test environment	102kPa

Setup Table

Band	410-608 MHz
Power Level	-14.4 dBm
Channel Spacing	Single Channel
Mod Scheme	200KK1D
Single channel	434.375 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
1303.125	63.5	-10.5	36.5	-17.5	Flat	Vertical
1303.125	64.3	-9.7	37.5	-16.5	Side	Horizontal
2171.875	64.5	-9.5	37.5	-16.5	Flat	Vertical
2171.875	66.7	-7.3	39.7	-14.3	Upright	Horizontal
2606.25	55.9	-18.1	28.9	-25.1	Side	Vertical
3040.625	72.3	-1.7	45.3	-8.7	Side	Vertical
3040.625	72.2	-1.8	45.2	-8.8	Upright	Horizontal
3475	60.5	-13.5	33.5	-20.5	Side	Vertical
3475	60.0	-14.0	33.0	-21.0	Side	Horizontal
3909.375	66.5	-7.5	39.5	-14.5	Side	Vertical
3909.375	71.2	-2.8	44.2	-9.8	Upright	Horizontal
4343.75	55.0	-19.0	28.0	-26.0	Side	Vertical

Note: Average emissions shown in the table above are calculated from the peak measurement in line with 15.35(c) (and ANSI C63.10:2013 clause 7.5) by averaging over 0.1seconds.

Therefore; $20 \text{ LOG } (100/4.48) = 27\text{dB}$ removed from Peak results to provide average emissions. 54dBuV/m @3m AV and 74 dBuV/m Peak limits applied. See limit section below.

Plots
10969-1 1-4.5 GHz vert flat
10969-1 1-4.5 GHz vert up
10969-1 1-4.5 GHz vert side
10969-1 1-4.5 GHz horiz flat
10969-1 1-4.5 GHz horiz up
10969-1 1-4.5 GHz horiz side

Peak detector “Max held” Analyser plots against the average limit line 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.

15.231(e) Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown 15.231(e) or to the general limits shown in §15.209, whichever limit permits a higher field strength. For an intentional radiator operating at 434MHz the average spurious emissions limit is calculated as 52.9dBuV/m @3m. 15.209 Average limit is 54 dBuV/m @ 3m (and Peak of 74dBuV/m @ 3m), therefore 54dBuV/m @ 3m is applied to average emissions. n.b. 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:
1 – 4.5 GHz ± 3.5 dB.

5.6 Intentional radiator field strength

5.6.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.231(e) [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 15C Part 15.231(e)/15.35 [Reference 4.1.1 of this report]

5.6.2 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 antenna was scanned 1-4m in height in both Horizontal and Vertical polarisations. The EUT was rotated in all three orthogonal planes. The EUT was operated in TX1 mode.

5.6.3 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. This site is listed with the FCC. Both the equipment and the antenna were rotated 360 degrees to record the maximised emission. Measurements were made at Site M.

5.6.4 Test equipment

E410, E411, E624, E743, LPE364

See Section 9 for more details

5.6.5 Test results

Temperature of test environment	15°C
Humidity of test environment	62%
Pressure of test environment	102kPa

Band	410-608 MHz
Power Level	-14.4 dBm
Channel Spacing	Single Channel
Mod Scheme	200KK1D
Single channel	434.375 MHz

	Single channel
Duty Cycle (%)	0.04
Duty Cycle correction	-27.0 dB

	Single channel
Peak Level (dBµV/m)	75.5
Average Level (dBµV/m)	48.5
Plot reference	10969-1 ERP
Antenna Polarisation	Vert
EUT Polarisation	Flat

Analyser plots showing the peak level @ 3 m can be found in Section 6 of this report.

LIMITS:

Fc = 434.379 MHz (peak from plot)

15.231(e) Average = 1500 uV/m at 260 MHz linearly increasing to 5000 uV/m at 470 MHz.

Applying linear interpolation = $1500 + ((434.379 - 260)(5000 - 1500) / (470 - 260)) = 4406 \text{ uV/m} = 72.9 \text{ dBuV/m @ 3 m}$

15.35(b) Peak = 20dB above the maximum permitted average emission limit = 92.9 dBuV/m @ 3 m.

15.35(c) Average correction applied based on a transmit on time of 4.48 ms during 100 ms observation period =

$20\log(4.48/100) = -27 \text{ dB}$.

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:
<± 3.9 dB.

5.7 Band edge compliance

NOT APPLICABLE: EUT does not operate in the 40.66 - 40.70 MHz band, therefore no limits are specified

5.8 Occupied bandwidth

5.8.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.231(c) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.9 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.231(c) [Reference 4.1.1 of this report]

5.8.2 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 operated in TX1 mode.

5.8.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. A 120kHz RBW, 3x VBW, auto sweep time and max hold settings were used for the 20 dB bandwidth. Tests were performed using Test Site M.

5.8.4 Test equipment

E410, E411, E624, E743, LPE364

See Section 9 for more details

5.8.5 Test results

Temperature of test environment	15°C
Humidity of test environment	62%
Pressure of test environment	102kPa

Band	410-608 MHz
Power Level	-14.4 dBm
Channel Spacing	Single Channel
Mod Scheme	200KK1D
Single channel	434.375 MHz

	Single channel
20 dB Bandwidth (kHz) Nominal Temp & Volts	504.683
Plot for 20 dB Bandwidth (kHz) Nominal Temp & Volts	10969-1 OBW 99%

Analyser plots for the 20 dB bandwidth can be found in Section 6 of this report.

LIMITS:

15.231(c) must be <0.25% (70-900 MHz fundamentals) of centre frequency.

$F_c = 434.375 \text{ MHz} = 1.086 \text{ MHz}$.

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 %.

5.9 Periodic operation

5.9.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.231(a)/(e) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 7.4/7.5/7.6 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.231(e) [Reference 4.1.1 of this report]

5.9.2 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 operated in TX1 mode.

5.9.3 Test procedure

A zero span was set on the analyser with the frequency set to the fundamental frequency of the EUT. Suitable triggering was also set and the TX on time and repetition times were evaluated and plotted. Tests were performed using Test Site M.

5.9.4 Test equipment

E410, E411, E624, E743, LPE364

See Section 9 for more details

5.9.5 Test results

Temperature of test environment	15°C
Humidity of test environment	64%
Pressure of test environment	102kPa

Band	410-608 MHz
Power Level	-14.4 dBm
Channel Spacing	Single Channel
Mod Scheme	200KK1D
Single channel	434.375 MHz

	Single channel
TX on time (ms)	4.4764
TX on Plot filename	10969-1 TX ON
TX repetition time (S)	11.1562
TX repetition Plot filename	10969-1 TX REP
Calculated TX Duty cycle (%)	0.040124774

Analyser plots for the dwell time and duty cycle can be found in Section 6 of this report.

LIMITS:

15.231(e) Transmitters shall be automatically limited so that the duration of each transmission shall not be greater than 1 second, with any silent period at least 30 times the transmission length but in no case less than 10 seconds.

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:
<± 2.57 ms.

5.10 Antenna Power conducted emissions for receivers

NOT APPLICABLE: EUT does not have an antenna port.

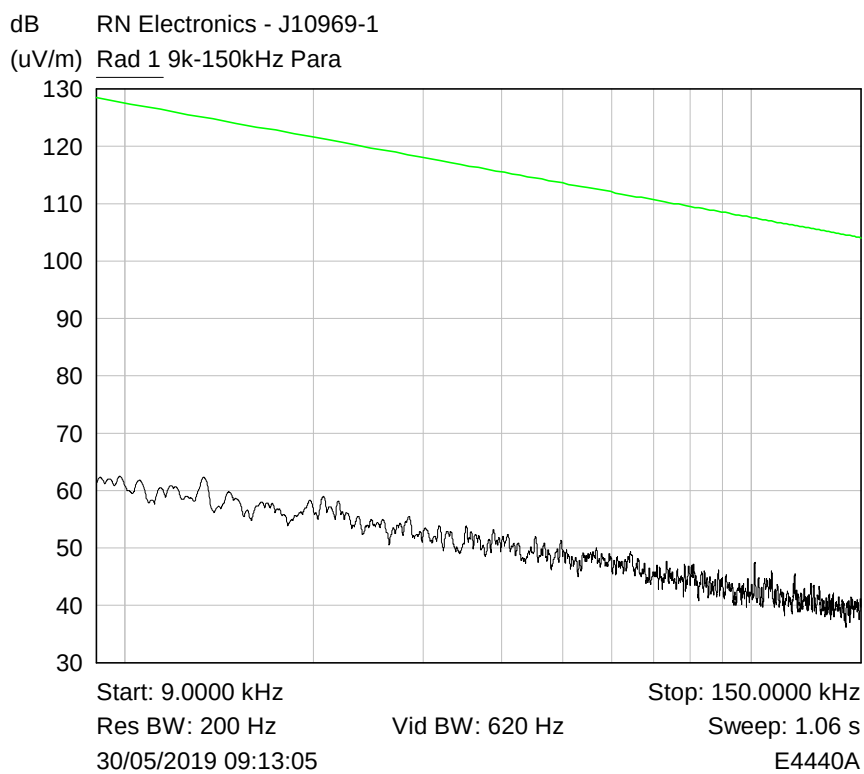
5.11 Frequency stability

NOT APPLICABLE: EUT does not operate in the 40.66 - 40.70 MHz band, therefore no limits are specified.

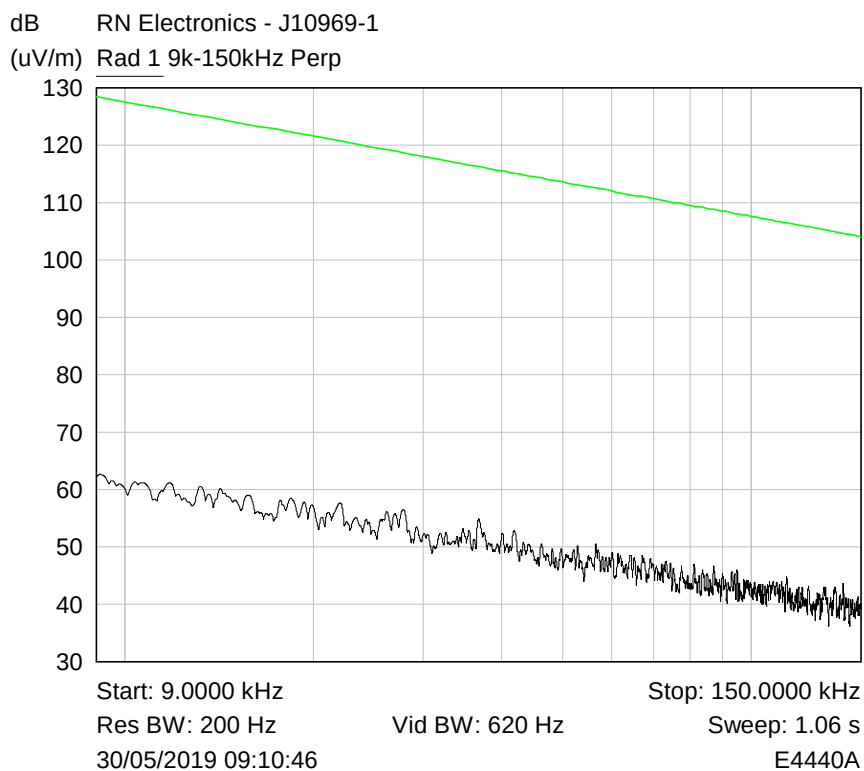
6 Plots/Graphical results

6.1 Radiated emissions 9 - 150 kHz

RF Parameters: Band 410-608 MHz, Power -14.4 dBm, Channel Spacing Single Channel,
Modulation 200KK1D, Channel 434.375 MHz



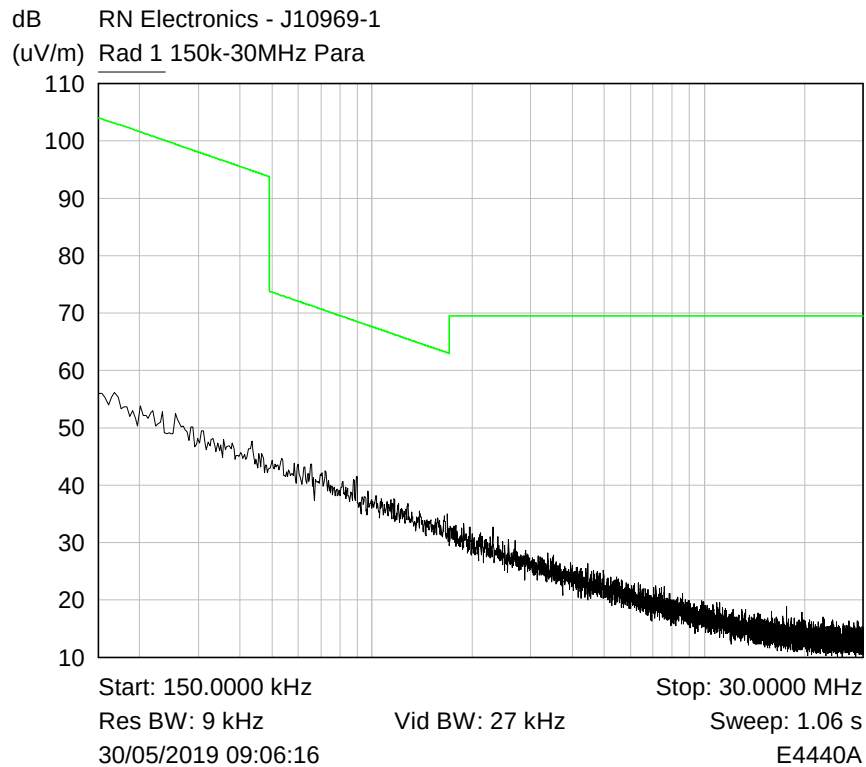
Plot of 9k-150kHz Parallel



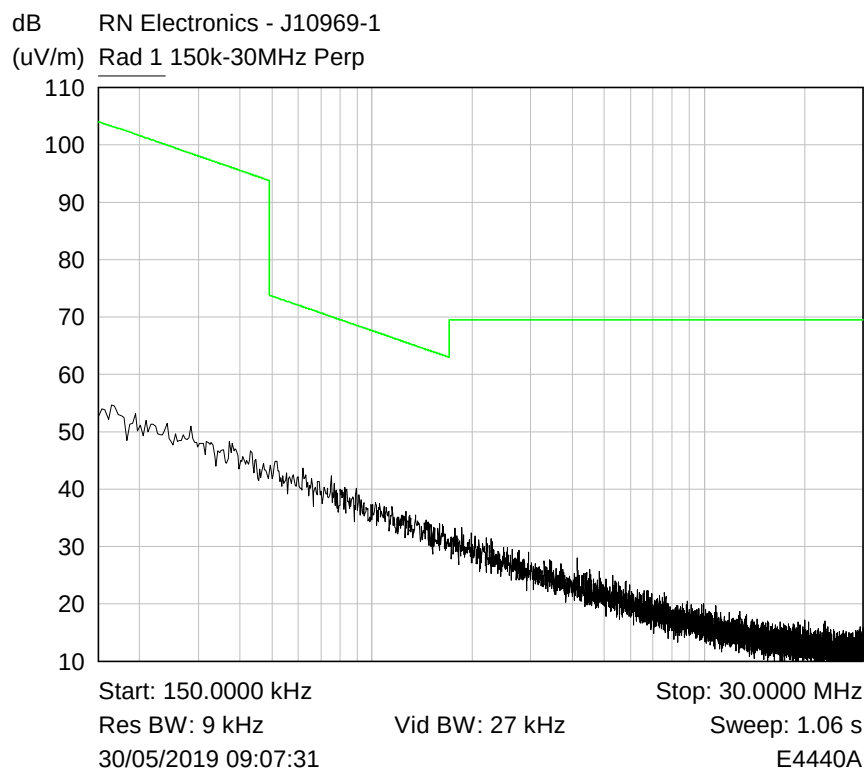
Plot of 9k-150kHz Perpendicular

6.2 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 410-608 MHz, Power -14.4 dBm, Channel Spacing Single Channel,
Modulation 200KK1D, Channel 434.375 MHz



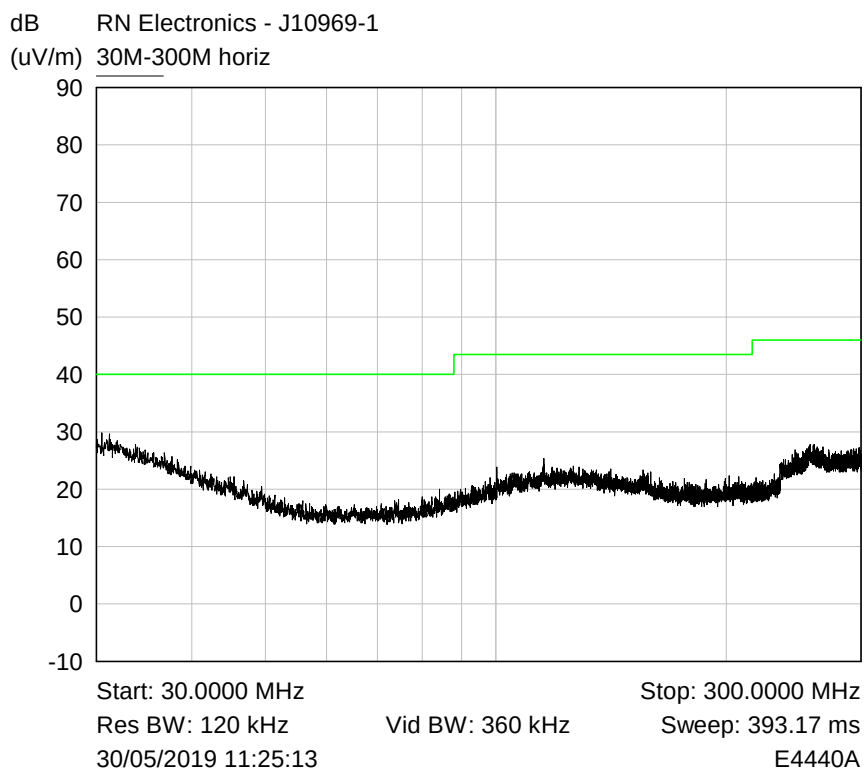
Plot of 150kHz-30MHz Parallel



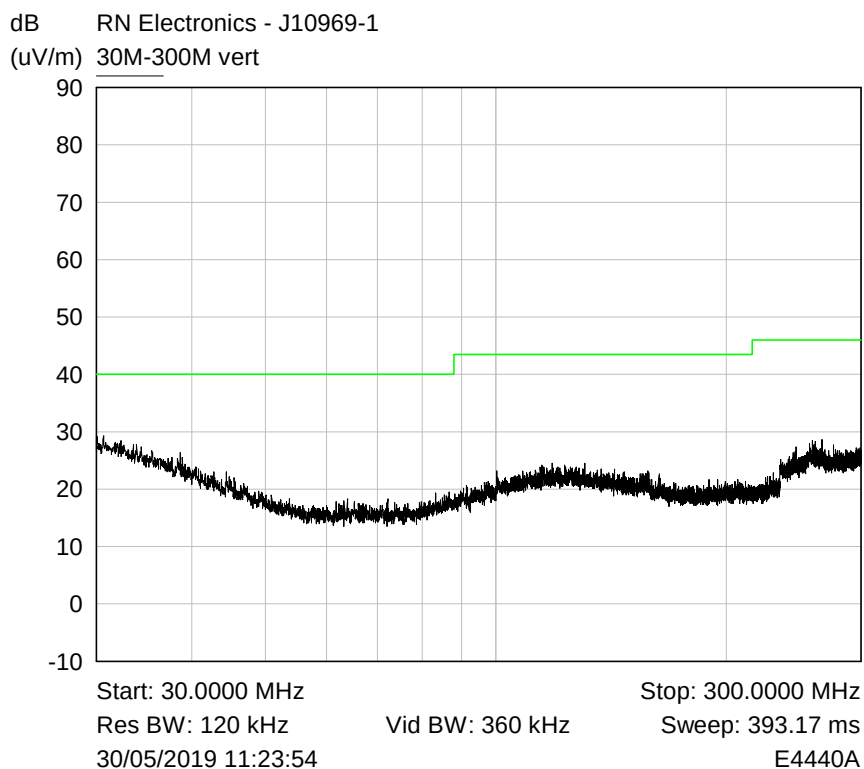
Plot of 150kHz-30MHz Perpendicular

6.3 Radiated emissions 30 MHz -1 GHz

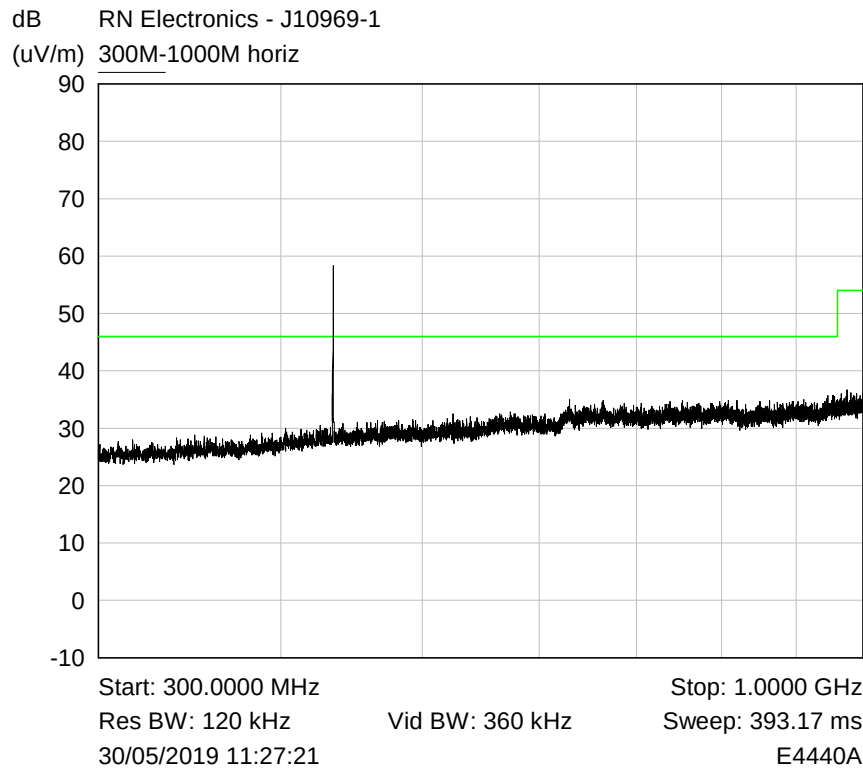
RF Parameters: Band 410-608 MHz, Power -14.4 dBm, Channel Spacing Single Channel,
Modulation 200KK1D, Channel 434.375 MHz



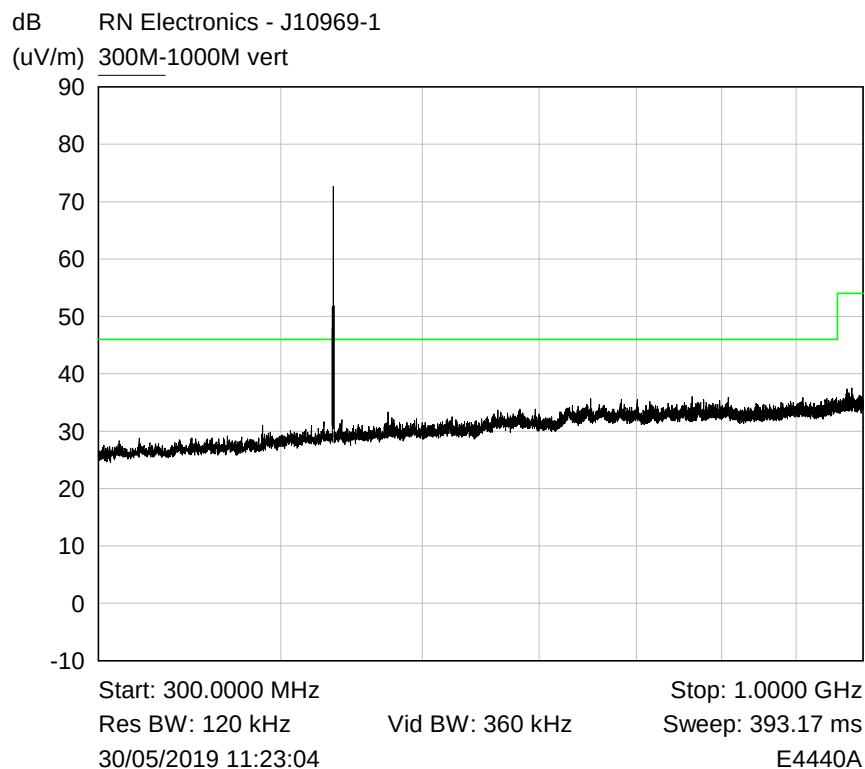
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



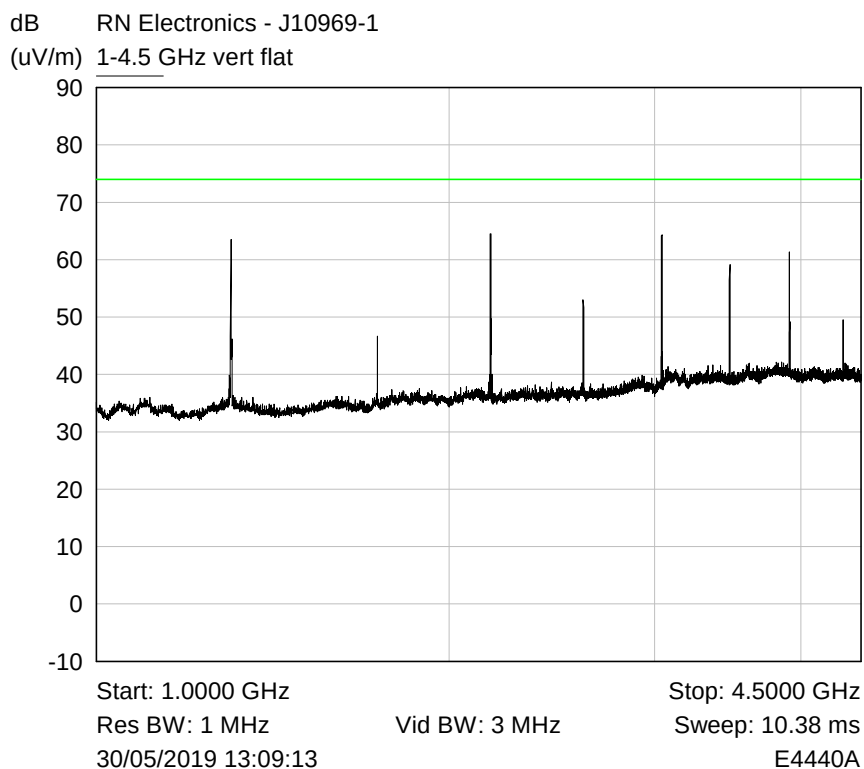
Plot of Peak emissions for UHF Horizontal against the QP limit line.
(Note: visible signal is fundamental at 434.375 MHz).



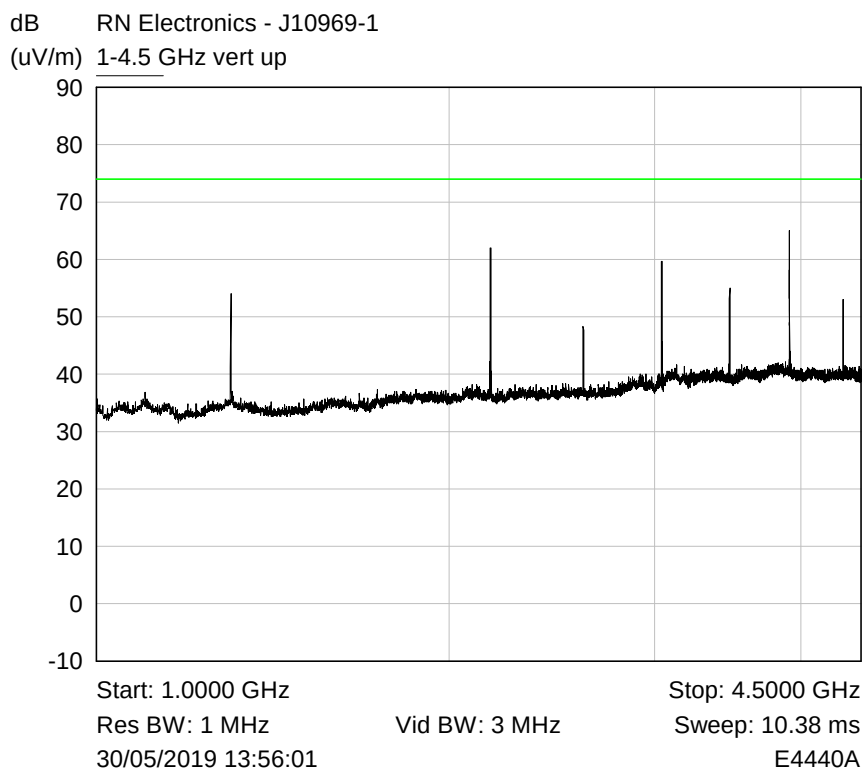
Plot of Peak emissions for UHF Vertical against the QP limit line.
(Note: visible signal is fundamental at 434.375 MHz).

6.4 Radiated emissions above 1 GHz

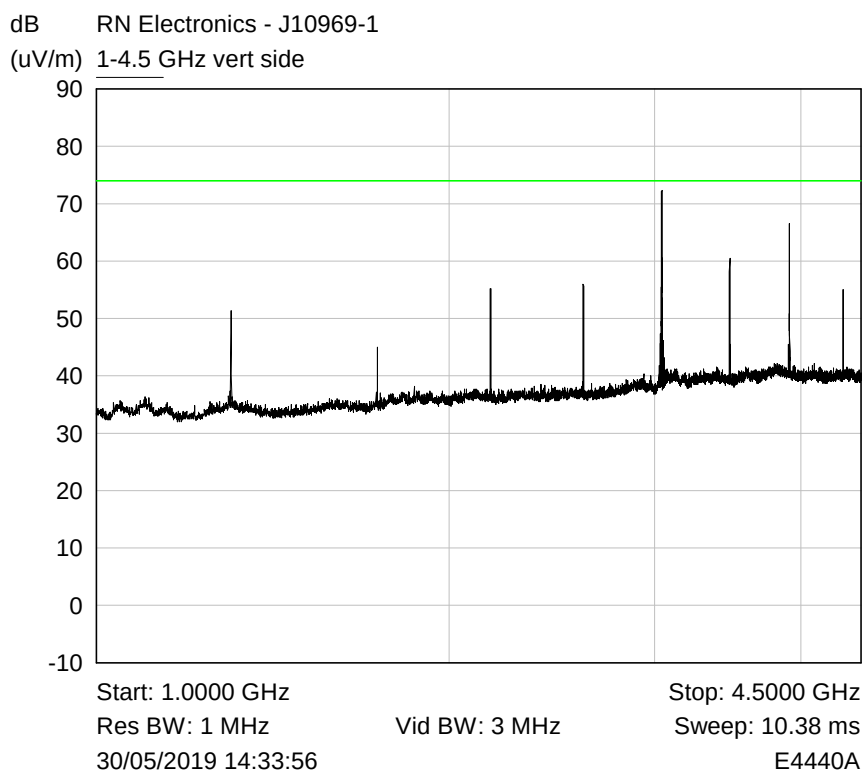
RF Parameters: Band 410-608 MHz, Power -14.4 dBm, Channel Spacing Single Channel,
Modulation 200KK1D, Channel 434.375 MHz



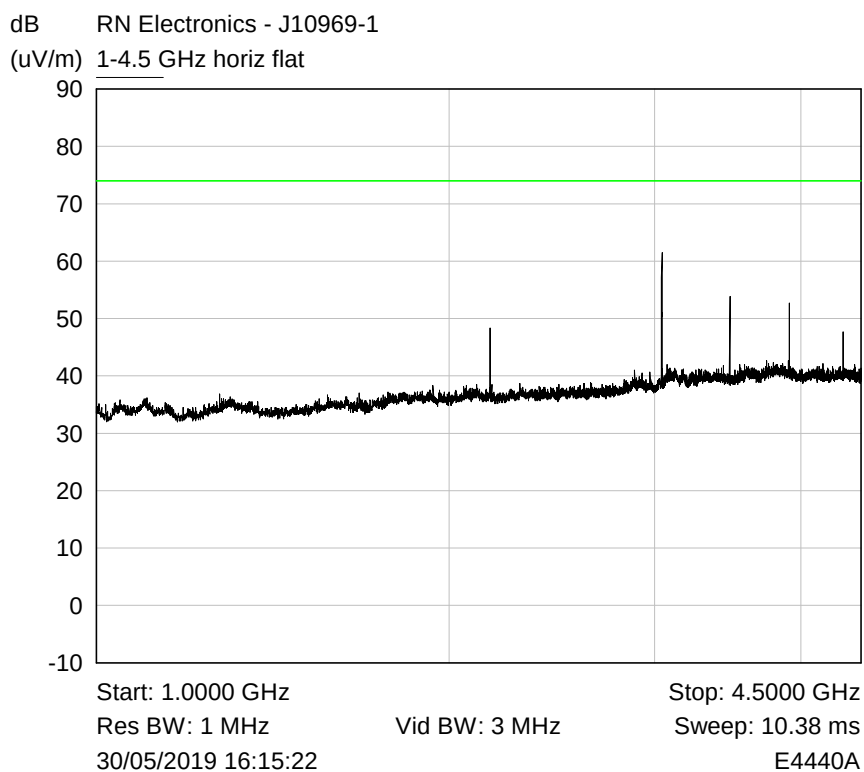
Peak Plot against peak limit of EUT in flat position using vertical measuring antenna



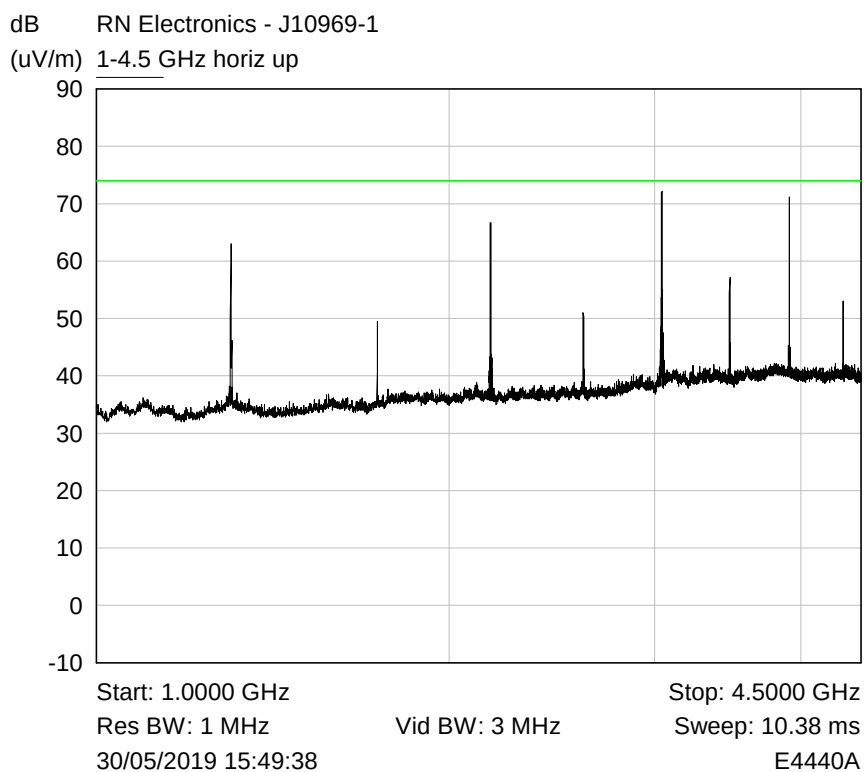
Peak Plot against peak limit of EUT in upright position using vertical measuring antenna



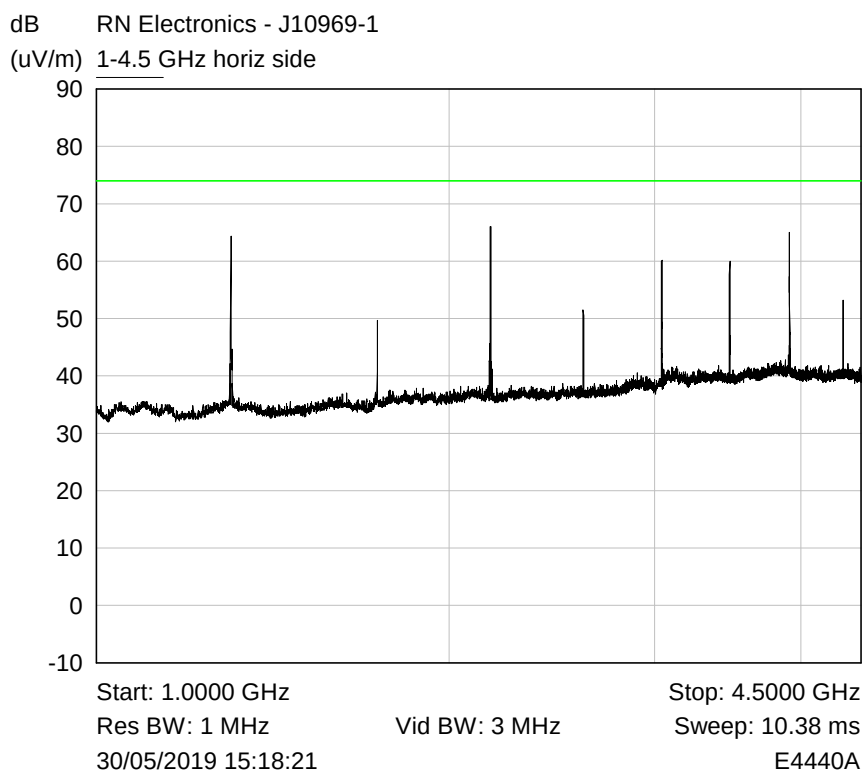
Peak Plot against peak limit of EUT in side position using vertical measuring antenna



Peak Plot against peak limit of EUT in flat position using horizontal measuring antenna



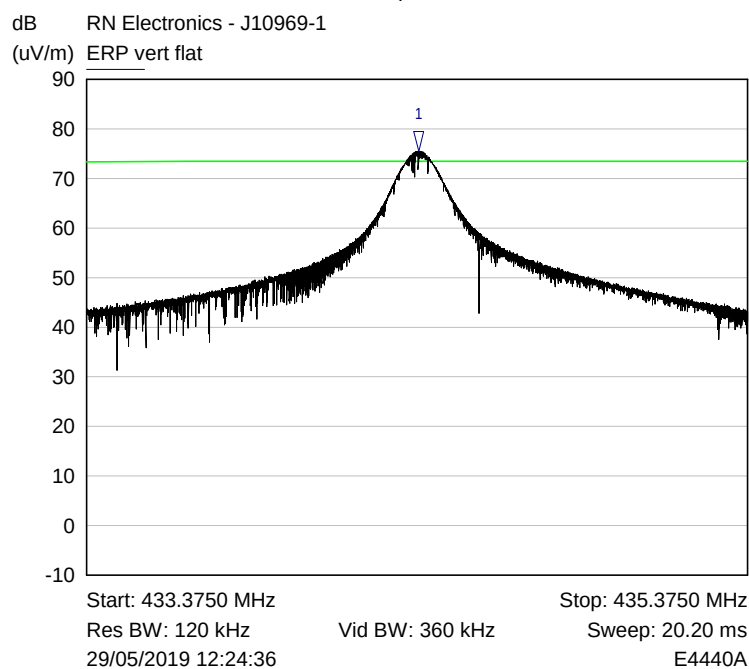
Peak Plot against peak limit of EUT in upright position using horizontal measuring antenna



Peak Plot against peak limit of EUT in side position using horizontal measuring antenna

6.5 Intentional radiator field strength

RF Parameters: Band 410-608 MHz, Power -14.4 dBm, Channel Spacing Single Channel, Modulation 200KK1D, Channel 434.375 MHz

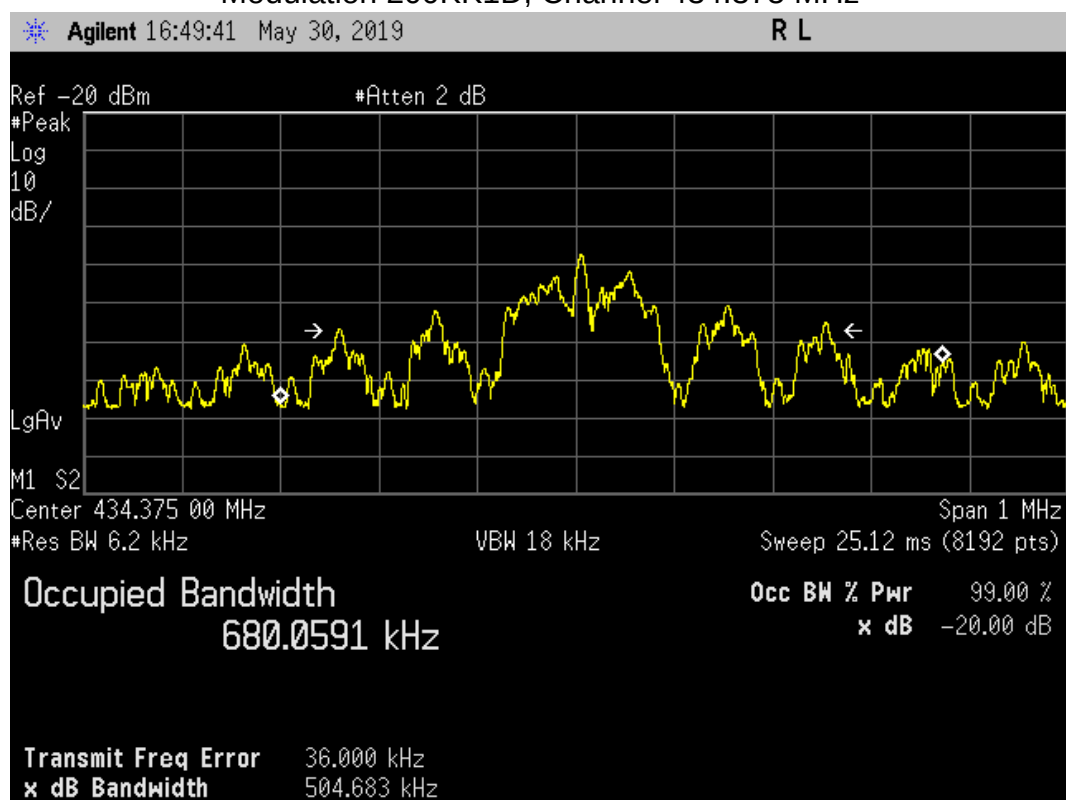


Mkr	Trace	X-Axis	Value	Notes
1 ▽	ERP vert flat	434.3790 MHz	75.50 dB(uV/m)	

Peak Plot of Vert polarisation and EUT in Flat position

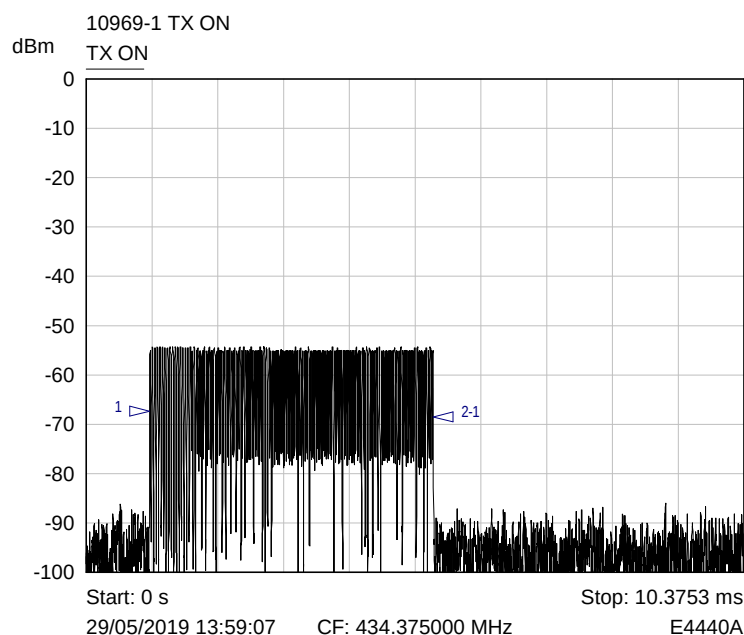
6.6 Occupied bandwidth

RF Parameters: Band 410-608 MHz, Power -14.4 dBm, Channel Spacing Single Channel,
Modulation 200KK1D, Channel 434.375 MHz



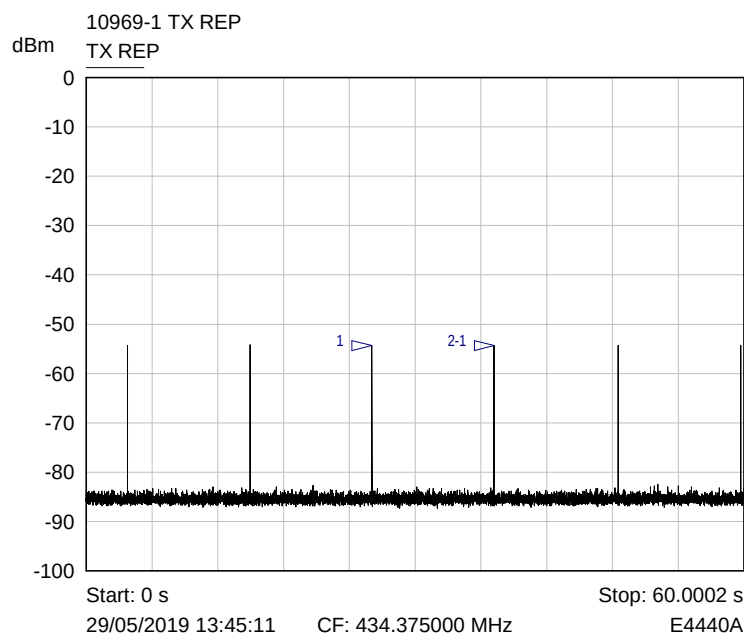
6.7 Periodic operation

RF Parameters: Band 410-608 MHz, Power -14.4 dBm, Channel Spacing Single Channel, Modulation 200KK1D



Mkr	Trace	X-Axis	Value	Notes
1 ▽	TX ON	999.4000 us	-67.29 dBm	
2-1 ▽	TX ON	4.4764 ms	-1.23 dB	

TX on time (ms)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	TX REP	26.0482 s	-54.34 dBm	
2-1 ▽	TX REP	11.1562 s	0.08 dB	

TX repetition time (S)

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. RN Electronics calibrate the test set-up to account for any path losses, antenna gains, etc. so that the value read at the receiver relates directly to the absolute value required, except that it is expressed in dB relative to one microVolt and may need to take account of any alternative measuring distance used. Examples:

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

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

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

The measurement receiver used for emissions testing, performs the field strength (FS) calculations automatically. The receiver combines the signal amplitude (RA), Antenna Factor (AF) and Cable Loss (CL) factors for the frequency to be measured.

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

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

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

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

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

Where:

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

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

Equation 22: $\text{EIRP} = E_{\text{Meas}} + 20 \log(d_{\text{Meas}}) - 104.7$

Where:

EIRP is equivalent isotropically radiated power in dBm

E_{Meas} is the field strength of the emission at the measurement distance in dBμV/m

d_{Meas} is the measurement distance in metres

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.

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

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

And

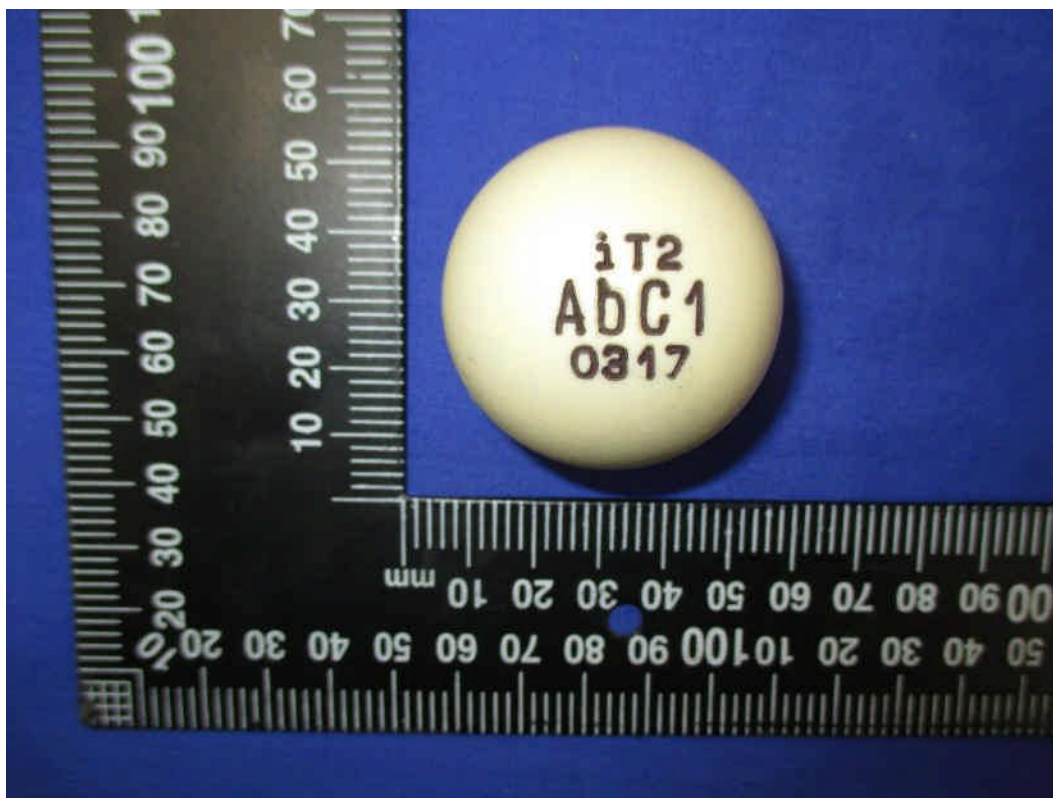
Equation 26 transposed: $E_{\text{Spec limit}} = \sqrt{(0.9 \times 10^{-6} \times 377)} = 0.01842 \text{ V/m.}$

And

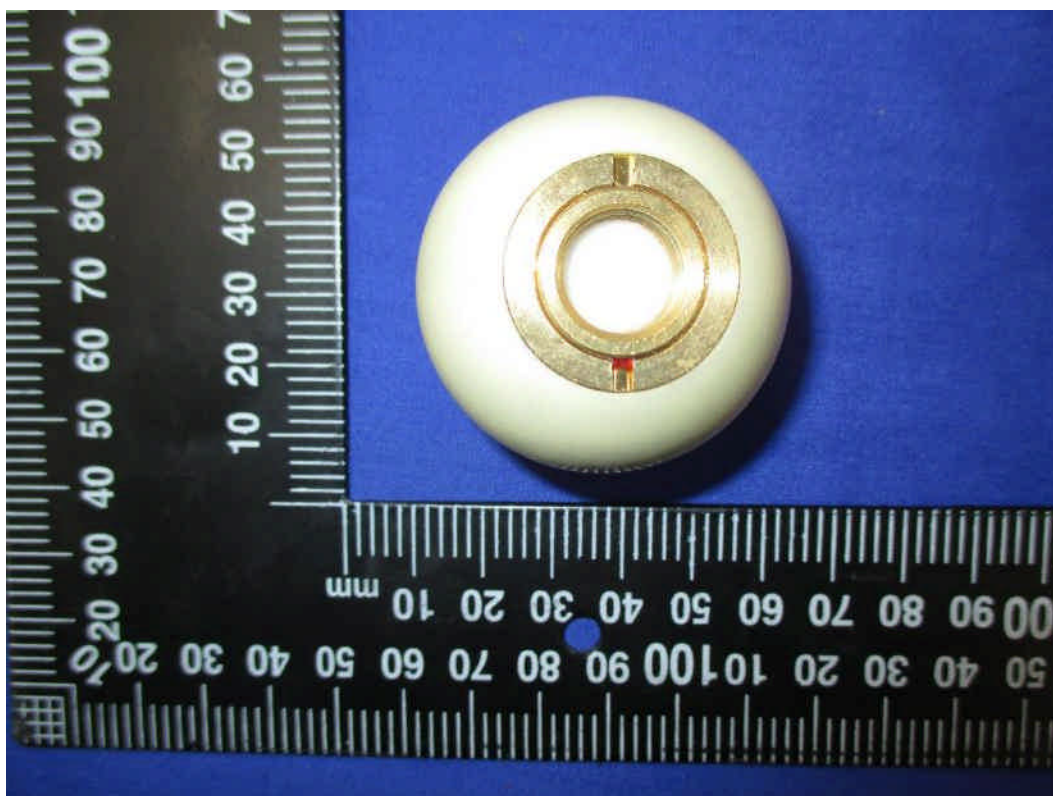
Equation 21 transposed: $E_{\text{Log}} = 20\text{Log}(0.01842) + 120 = 85.3\text{dB}\mu\text{V/m @ 3m.}$

8 Photographs

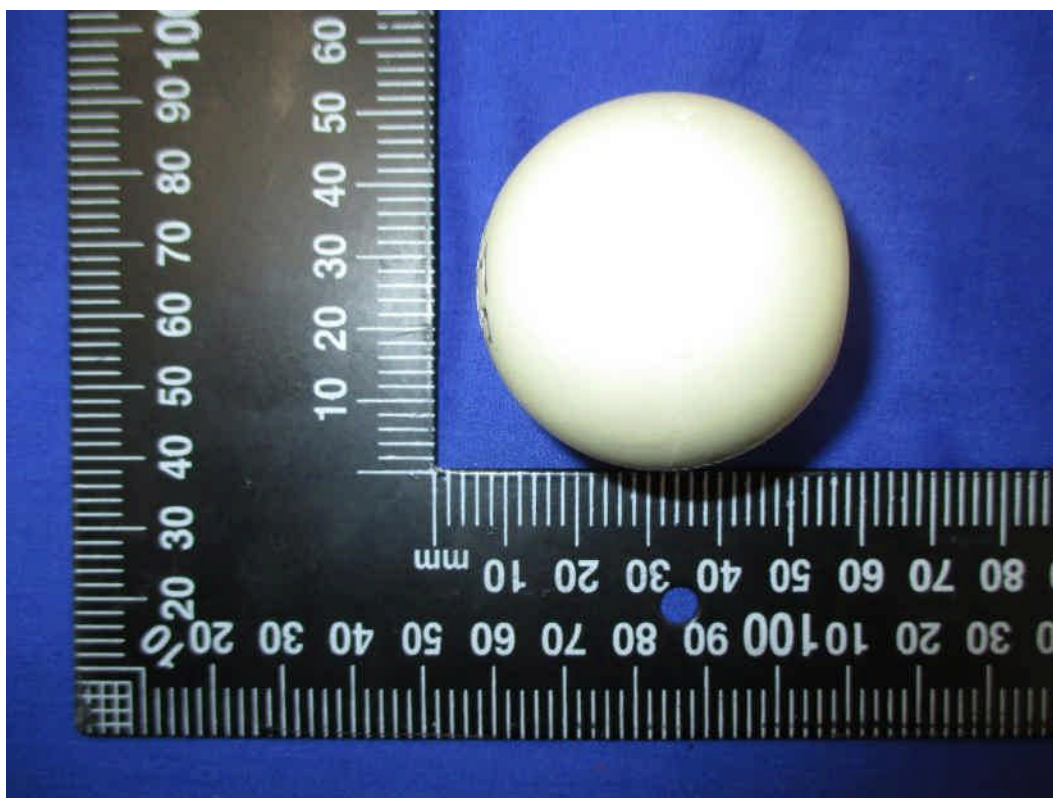
8.1 EUT Front View



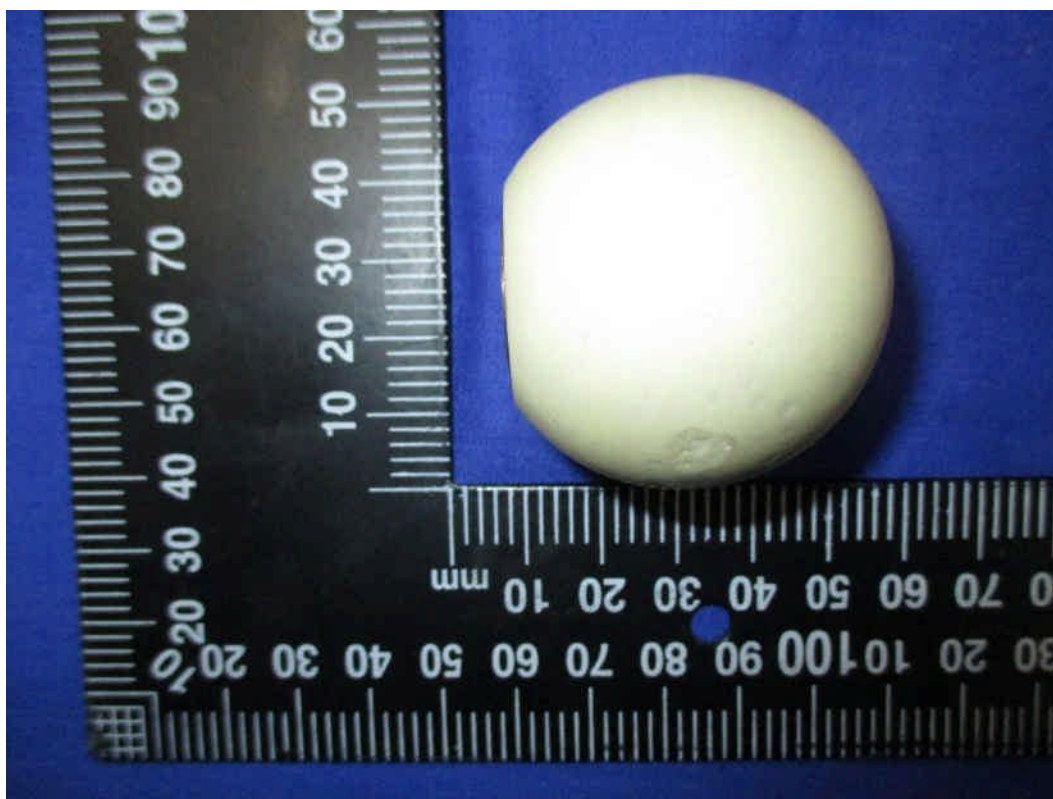
8.2 EUT Reverse Angle



8.3 EUT Left side View



8.4 EUT Right side View



8.5 EUT Antenna Port

EUT does not have an antenna port.

8.6 EUT Display & Controls

EUT does not have any displays or controls.

8.7 EUT Internal photos

It was not possible to deconstruct the product to expose internal assembly.

8.8 EUT ID Label



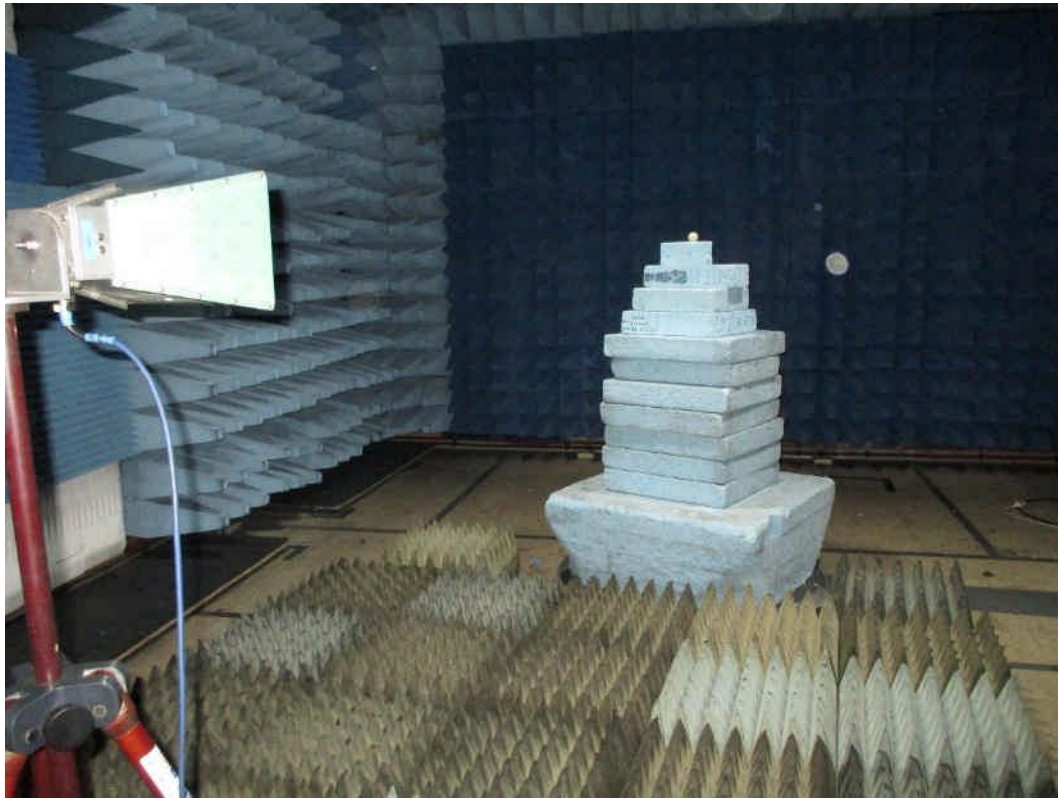
8.9 Radiated emissions 9 kHz - 30 MHz



8.10 Radiated emissions 30 MHz -1 GHz



8.11 Radiated emissions above 1 GHz



8.12 Radiated emission diagrams

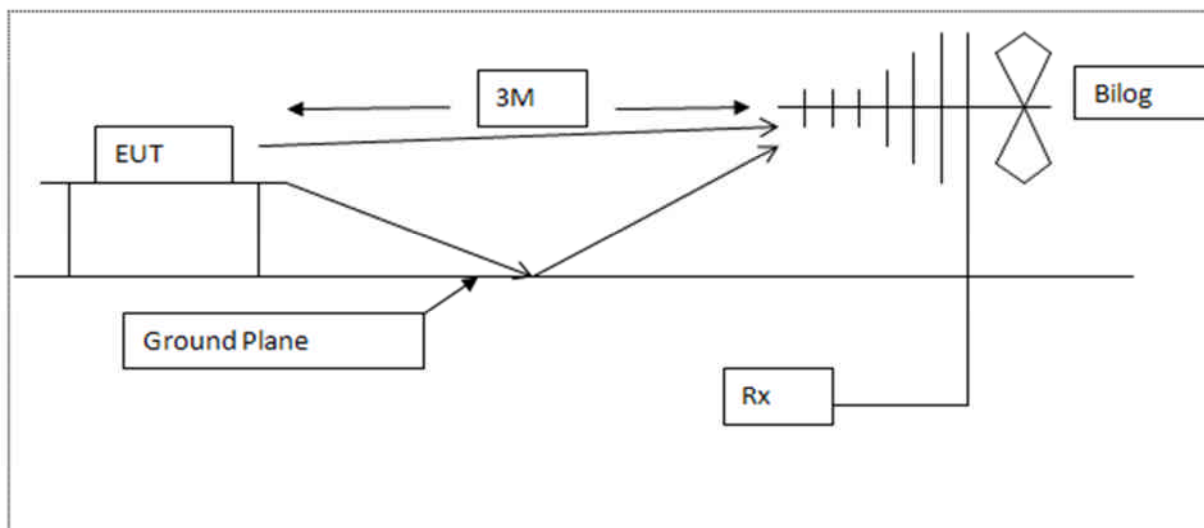


Diagram of the radiated emissions test setup 30 - 1000 MHz

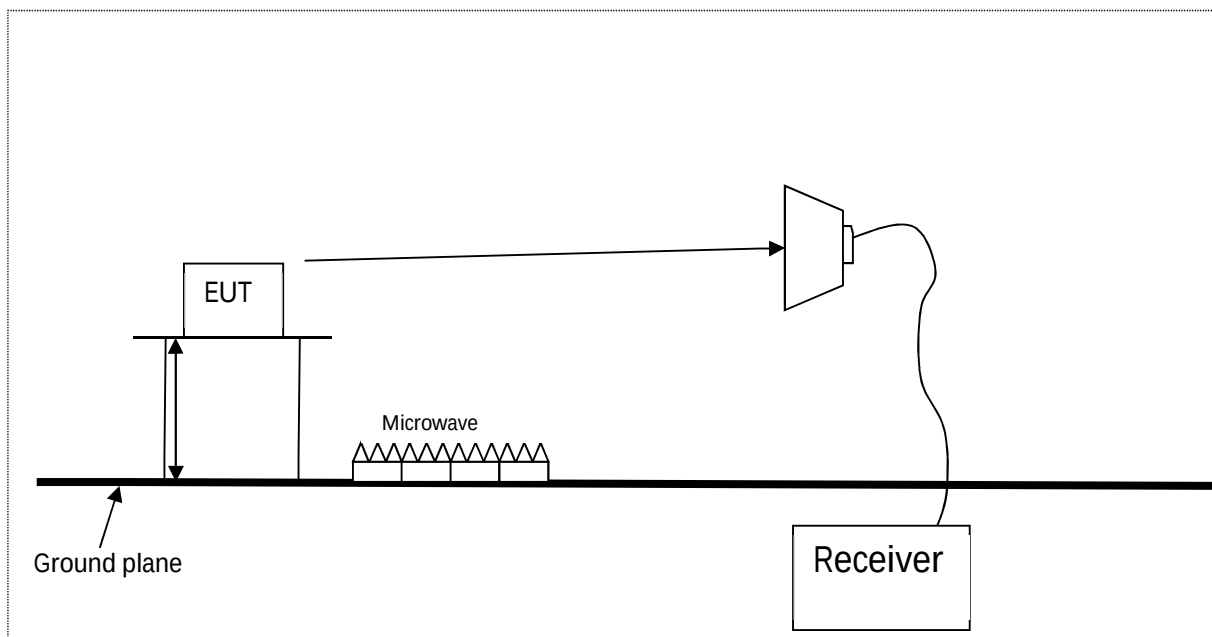


Diagram of the radiated emissions test setup above 1GHz

9 Test equipment calibration list

The following is a list of the test equipment used by 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
E136	3105	Horn Antenna 1-12.5GHz	EMCO	27-Apr-2019	12 months
E410	N5181A	Signal Generator 3 GHz MXG	Agilent Technologies	13-Jul-2018	36 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	10-Jul-2018	12 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	09-Jan-2018	24 months
E743	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	11-Feb-2019	12 months
LPE364	CBL6112A	Antenna BiLog 30MHz - 2GHz	Chase Electronics Ltd	21-Mar-2018	24 months
TMS81	6502	Antenna Active Loop	EMCO	08-Jun-2017	24 months
TMS82	8449B	Pre-Amplifier 1GHz - 26.5GHz	Agilent Technologies	17-Dec-2018	12 months
ZSW1	V2.3	Measurement Software Suite	RN Electronics	N/A	N/A

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

No customer equipment was supplied.

10.2 RN Electronics supplied equipment

No RN Electronics Ltd 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 RN Electronics Ltd.

11.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

12 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

13 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	decibel	OFDM	Orthogonal Frequency Division Multiplexing
dBμA/m	decibel relative to 1μA/m	ppm	Parts per million
dBμV	decibel relative to 1μV	PRBS	Pseudo Random Bit Sequence
dBc	decibel relative to Carrier	QAM	Quadrature Amplitude Modulation
dBm	decibel 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		