

Report on the Radio Testing

For

Lodar Ltd

on

P103

Report No. TRA-034693-47-01B

30 January 2019

Report Number: TRA-034693-47-01B
Issue: A

REPORT ON THE RADIO TESTING OF A
Lodar Ltd
P103
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.231

TEST DATE: 2018/10/23 to 2018/10/30

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Date: 30 January 2019
Department Manager - Radio

Disclaimers:

- [1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
- [2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED



1 Revision Record

| <i>Issue Number</i> | <i>Issue Date</i> | <i>Revision History</i> |
|---------------------|-------------------|-------------------------|
| A | 28 November 2018 | Original |
| B | 30 January 2019 | update |

2 Summary

TEST REPORT NUMBER: TRA-034693-47-01B

WORKS ORDER NUMBER: TRA-034693-14

PURPOSE OF TEST: USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.

TEST SPECIFICATION: 47CFR15.231

EQUIPMENT UNDER TEST (EUT): P103

FCC IDENTIFIER: M2HP103

MANUFACTURER/AGENT: Lodar Ltd

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Walsall
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ORDER NUMBER: 12630

SERIAL NUMBER: 000002

TEST DATE: 2018/10/23 to 2018/10/30

TESTED BY: Daniel Moncayola / Steven Garwell
Element

2.1 Test Summary

| Test Method and Description | Requirement Clause 47CFR15 | Applicable to this equipment | Result / Note |
|------------------------------------|---------------------------------------|---|----------------------|
| Radiated spurious emissions | 15.231(b) | <input checked="" type="checkbox"/> | PASS |
| AC power line conducted emissions | 15.207 | <input type="checkbox"/> | Note 1 |
| Occupied bandwidth | 15.215(c) 15.231(c) | <input checked="" type="checkbox"/> | PASS |
| Field strength of fundamental | 15.231(b) | <input checked="" type="checkbox"/> | PASS |
| Calculation of duty correction | 15.35(c) | <input checked="" type="checkbox"/> | PASS |
| Periodic Operation | 15.231(a) | <input checked="" type="checkbox"/> | PASS |

Notes:

Note 1: Not applicable the EUT is battery operated

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

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4 Introduction

This report TRA-034693-47-01B presents the results of the Radio testing on a Lodar Ltd, P103 to specification 47CFR15 Radio Frequency Devices: Category I Equipment.

The testing was carried out for Lodar Ltd by Element, at the address detailed below.

| | |
|---------------------------------------|--|
| <input type="checkbox"/> Element Hull | <input checked="" type="checkbox"/> Element North West |
| Unit E | Unit 1 |
| South Orbital Trading Park | Pendle Place |
| Hedon Road | Skemersdale |
| Hull | West Lancashire |
| HU9 1NJ | WN8 9PN |
| UK | UK |

This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

Throughout this report EUT denotes equipment under test.

FCC Site Listing:

Element is accredited for the above sites under the US-EU MRA, Designation number UK0009.

The test site requirements of ANSI C63.4-2014 are met up to 1 GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Test Specifications

5.1 *Normative References*

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- 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.

5.2 *Deviations from Test Standards*

There were no deviations from the test standard.

6 Glossary of Terms

| | |
|---------------|--|
| § | denotes a section reference from the standard, not this document |
| AC | Alternating Current |
| ANSI | American National Standards Institute |
| BW | bandwidth |
| C | Celsius |
| CFR | Code of Federal Regulations |
| CW | Continuous Wave |
| dB | decibel |
| dBm | dB relative to 1 milliwatt |
| DC | Direct Current |
| DSSS | Direct Sequence Spread Spectrum |
| EIRP | Equivalent Isotropically Radiated Power |
| ERP | Effective Radiated Power |
| EUT | Equipment Under Test |
| FCC | Federal Communications Commission |
| FHSS | Frequency Hopping Spread Spectrum |
| Hz | hertz |
| IC | Industry Canada |
| ITU | International Telecommunication Union |
| LBT | Listen Before Talk |
| m | metre |
| max | maximum |
| MIMO | Multiple Input and Multiple Output |
| min | minimum |
| MRA | Mutual Recognition Agreement |
| N/A | Not Applicable |
| PCB | Printed Circuit Board |
| PDF | Portable Document Format |
| Pt-mpt | Point-to-multipoint |
| Pt-pt | Point-to-point |
| RF | Radio Frequency |
| RH | Relative Humidity |
| RMS | Root Mean Square |
| Rx | receiver |
| s | second |
| SVSWR | Site Voltage Standing Wave Ratio |
| Tx | transmitter |
| UKAS | United Kingdom Accreditation Service |
| V | volt |
| W | watt |
| Ω | ohm |

7 Equipment Under Test

7.1 EUT Identification

- Name: P103
- Serial Number: 000002
- Model Number: TX2020
- Software Revision: V1.9
- Build Level / Revision Number: P103-5

7.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

Not Applicable – No support/monitoring equipment required.

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for Transmit tests was as follows:-

The device was supplied with test firmware programmed for both modulated and unmodulated operation on the required frequency.

7.4 EUT Radio Parameters

7.4.1 General

| | |
|------------------------------------|------------|
| Frequency of operation: | 433.92 MHz |
| Modulation type: | 2-FSK |
| Occupied channel bandwidth: | 70 kHz |
| Channel spacing: | WIDEBAND |
| Nominal Supply Voltage: | 6 V dc |
| Duty cycle: | < 30% |

7.4.2 Antennas

| | |
|--------------|-----------------|
| Type: | Printed Antenna |
| Gain: | < 1 dBi |

7.5 EUT Description

The EUT is a radio operated remote control for controlling heavy plant machinery.

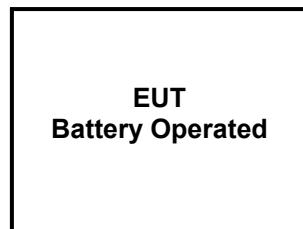
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 *Block Diagram*

The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:



10 General Technical Parameters

10.1 Normal Conditions

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 6 V dc from alkaline batteries.

10.2 Varying Test Conditions

There are no specific frequency stability requirements for the type of device. The results contained in this report demonstrate that the occupied bandwidth is contained within the authorised band and the manufacturer has declared sufficient frequency stability (refer to section 7.4).

Variation of supply voltage is required to ensure stability of the declared output power. During carrier power testing the following variations were made:

| | Category | Nominal | Variation |
|-------------------------------------|-----------------|------------------|------------------|
| <input type="checkbox"/> | Mains | 110 V ac +/- 2 % | 85 % and 115 % |
| <input checked="" type="checkbox"/> | Battery | New battery | N/A |

11 Radiated emissions

11.1 Definitions

Out-of-band emissions

Emissions on a frequency or frequencies immediately outside the necessary bandwidth which result from the modulation process, but exclude spurious emissions.

Spurious emissions

Emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Restricted bands

A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

11.2 Test Parameters

| | |
|---------------------------|--|
| Test Location: | Element Skelmersdale |
| Test Chamber: | Chamber 3 |
| Test Standard and Clause: | ANSI C63.10-2013, Clause 6.5 and 6.6 |
| EUT Frequency Measured: | 433.92 MHz |
| EUT Channel Bandwidths: | 70 kHz |
| Deviations From Standard: | None |
| Measurement BW: | 30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz |
| Measurement Detector: | Up to 1 GHz: quasi-peak Above 1 GHz: RMS average and Peak |

Environmental Conditions (Normal Environment)

| | |
|--------------------|----------------------------------|
| Temperature: 22 °C | +15 °C to +35 °C (as declared) |
| Humidity: 43 % RH | 20 % RH to 75 % RH (as declared) |
| Supply: 6 V dc | 6 V dc (as declared) |

11.3 Test Limit

In addition to the provisions of § 15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

| Fundamental Frequency (MHz) | Field Strength Of Fundamental (μV/m) | Field Strength Of Spurious Emissions (μV/m) |
|------------------------------------|--|---|
| 40.66-40.70 | 2,250 | 225 |
| 70-130 | 1,250 | 125 |
| 130-174 | 1,250 to 3,750 ¹ | 125 to 375 ¹ |
| 174-260 | 3,750 | 375 |
| 260-470 | 3,750 to 12,500 ¹ | 375 to 1,250 ¹ |
| Above 470 | 12,500 | 1,250 |

¹ Linear interpolations.

The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.

Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in § 15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of § 15.205 shall be demonstrated using the measurement instrumentation specified in that section.

The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in § 15.209, whichever limit permits a higher field strength.

General Field Strength Limits for License-Exempt Transmitters at Frequencies above 30 MHz

| Frequency (MHz) | Field Strength (μV/m at 3 m) |
|------------------------|--|
| 30 to 88 | 100 |
| 88 to 216 | 150 |
| 216 to 960 | 200 |
| Above 960 | 500 |

n.b. per FCC 47CFR15.35(b) peak limit is 20 dB above average.

11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver.

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst-case determined for function, operation, orientation, etc. for both vertical and horizontal polarisations. Pre-scan plots are shown with a peak detector and 100 kHz RBW.

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

For both horizontal and vertical polarizations, the EUT is then rotated through 360 degrees in azimuth until the highest emission is detected. At the previously determined azimuth the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected, this maximum value is recorded.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in dB μ V/m at the regulatory distance, using:

$$FS = PR + CL + AF - PA + DC - CF$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in dB μ V;

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

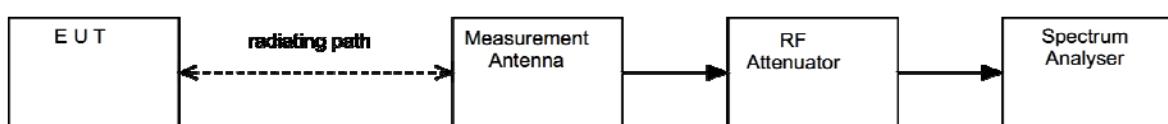
PA is the pre-amplifier gain in dB (where used);

DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);

CF is the distance factor in dB (where measurement distance different to limit distance);

This field strength value is then compared with the regulatory limit.

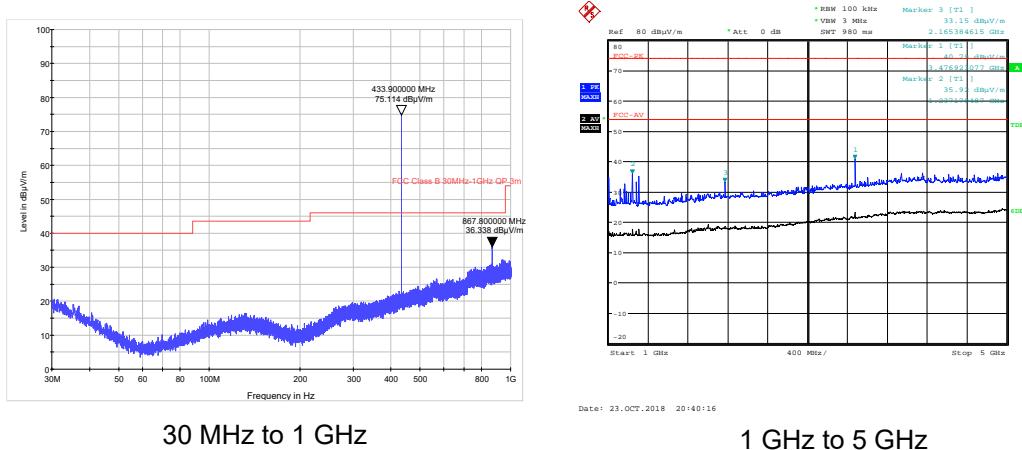
Figure i Test Setup



11.5 Test Equipment

| <i>Equipment Description</i> | <i>Manufacturer</i> | <i>Equipment Type</i> | <i>Element No</i> | <i>Due For Calibration</i> |
|------------------------------|---------------------|-----------------------|-------------------|----------------------------|
| Spectrum Analyser | R&S | FSU50 | U544 | 2019-05-22 |
| Pre Amp | Agilent | 8449B | L572 | 2019-10-12 |
| 1-18GHz Horn | EMCO | 3115 | L139 | 2019-09-25 |
| 1-18GHz Horn | EMCO | 3115 | U223 | 2019-10-25 |
| Receiver | R&S | ESVS10 | L317 | 2019-03-22 |
| Bilog | Chase | CBL611/A | U573 | 2019-08-02 |
| Log Periodic Ant | Chase | UPA6108 | L203 | 2020-06-11 |

11.6 Test Results



| Frequency 433.920 MHz | | | | | | | | | | |
|-----------------------|--|------------------------|-----------------|-----------------------|-------------------|------------------------|-------------------------------|-------------------------|-----------------------|--------------|
| Detector | Freq. (MHz) | Meas'd Emission (dBμV) | Cable Loss (dB) | Antenna Factor (dB/m) | Pre-amp Gain (dB) | Duty Cycle Corr'n (dB) | Distance Extrap'n Factor (dB) | Field Strength (dBμV/m) | Field Strength (μV/m) | Limit (μV/m) |
| 1 | No Emissions Within 20 dB of The Limit | | | | | | | | | PASS |

12 Occupied Bandwidth

12.1 Definitions

Occupied bandwidth

The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5 % of the emitted power. This is also known as the 99 % *emission bandwidth*. For transmitters in which there are multiple carriers, contiguous or non-contiguous in frequency, the occupied bandwidth is to be the sum of the occupied bandwidths of the individual carriers.

20 dB bandwidth

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal.

12.2 Test Parameters

| | |
|--|------------------------------|
| Test Location: | Element Skelmersdale |
| Test Chamber: | Radio Laboratory |
| Test Standard and Clause: | ANSI C63.10-2013, Clause 6.9 |
| EUT Frequency Measured: | 433.92 MHz |
| EUT Channel Bandwidths: | 70 kHz |
| EUT Test Modulations: | 2-FSK |
| Deviations From Standard: | None |
| Measurement BW: (requirement: 1 % to 5 % OBW) | 1 kHz |
| Spectrum Analyzer Video BW: (requirement at least 3x RBW) | 3 kHz |
| Measurement Span: (requirement 2 to 5 times OBW) | 300 kHz |
| Measurement Detector: | Peak |

Environmental Conditions (Normal Environment)

| | |
|--------------------|----------------------------------|
| Temperature: 22 °C | +15 °C to +35 °C (as declared) |
| Humidity: 43 % RH | 20 % RH to 75 % RH (as declared) |
| Supply: 6 V dc | 6 V dc (as declared) |

12.3 Test Limit

Federal Communications Commission:

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

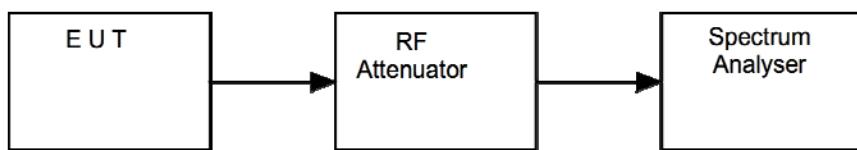
The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

12.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iii, the bandwidth of the EUT was measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure iii Test Setup

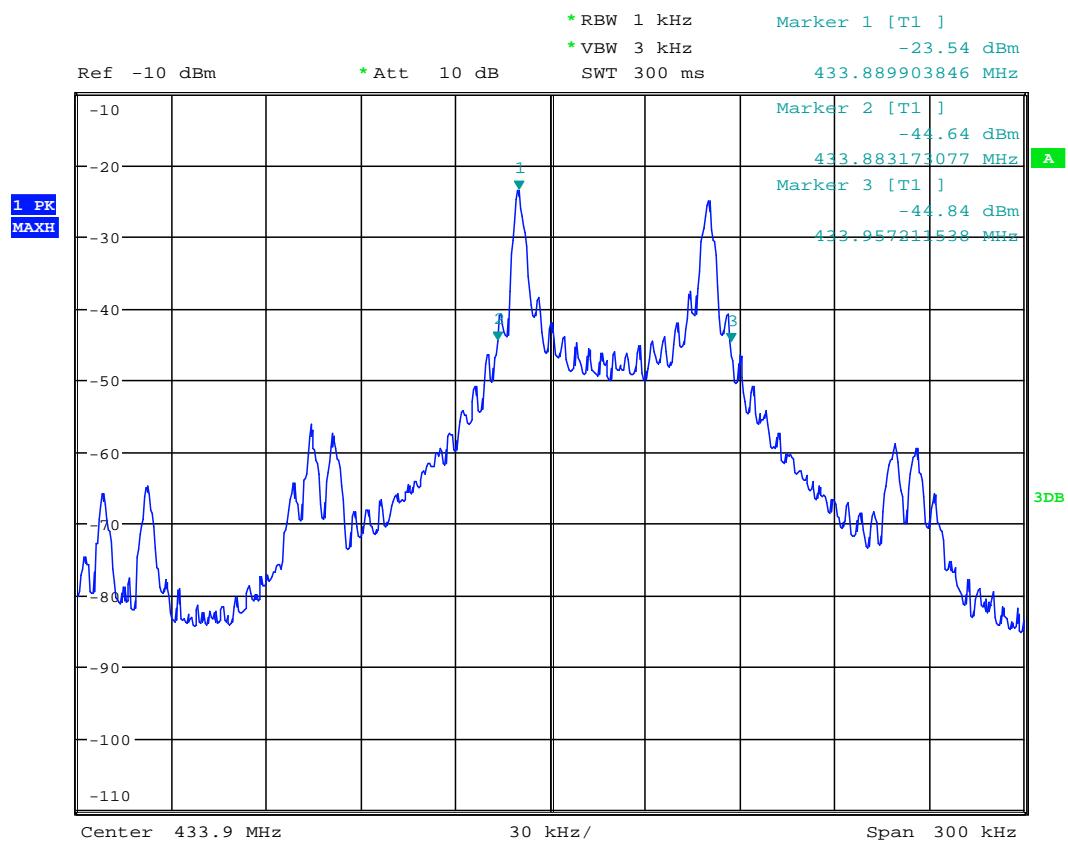


12.5 Test Equipment

| Equipment Type | Manufacturer | Equipment Description | Element No | Due For Calibration |
|-------------------|--------------|-----------------------|------------|---------------------|
| Spectrum Analyser | R&S | FSU50 | U544 | 2019-05-22 |

12.6 Test Results

| Frequency 433.92 MHz: | | | | | |
|-------------------------|-------------|-------------|----------------------|-------------|--------|
| Channel Frequency (MHz) | F_L (MHz) | F_H (MHz) | 20dB Bandwidth (kHz) | Limit (MHz) | Result |
| 433.92 | 433.8831731 | 433.9572115 | 74.038461 | 1.085 | PASS |



Date: 26.OCT.2018 17:01:02

13 Transmitter output power (fundamental radiated emission)

13.1 Definition

The RF power dissipated in the standard output termination when operating under the rated duty cycle selected by the applicant for approval.

13.2 Test Parameters

| | |
|--|--|
| Test Location: | Element Skelmersdale |
| Test Chamber: | Chamber 3 |
| Test Standard and Clause: | ANSI C63.10-2013, Clause 6.5 / 6.6 |
| EUT Frequency Measured: | 433.920 MHz |
| EUT Channel Bandwidths: | 70 kHz |
| Deviations From Standard: | None |
| Measurement BW: | 100 kHz |
| Spectrum Analyzer Video BW: (requirement at least 3x RBW) | 1 MHz |
| Measurement Detector: | Up to 1 GHz: Quasi-peak Above 1 GHz: Average RMS and Peak |
| Voltage Extreme Environment Test Range: | Battery Power = new battery. |

Environmental Conditions (Normal Environment)

| | |
|--------------------|----------------------------------|
| Temperature: 22 °C | +15 °C to +35 °C (as declared) |
| Humidity: 43 % RH | 20 % RH to 75 % RH (as declared) |

13.3 Test Limit

The field strength measured at 3 meters shall not exceed the limits in the following table:

| Fundamental frequency (MHz) | Field strength (μV/m at 3 m) |
|--|--|
| 40.66-40.70 | 2,250 |
| 70-130 | 1,250 |
| 130-174 | 1,250 to 3,750 ¹ |
| 174-260 | 3,750 |
| 260-470 | 3,750 to 12,500 ¹ |
| Above 470 | 12,500 |

¹ Linear interpolations.

Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in § 15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of § 15.205 shall be demonstrated using the measurement instrumentation specified in that section.

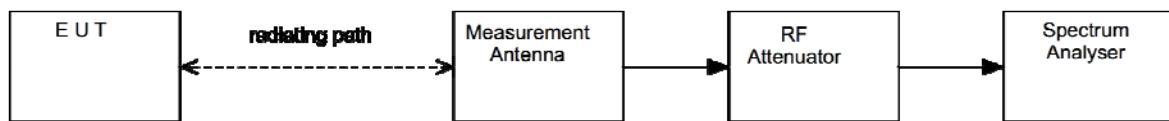
n.b. per FCC 47CFR15.249(e) peak limit is 20 dB above average.

13.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the resolution bandwidth of the spectrum analyser was increased above the EUT occupied bandwidth and the peak emission data noted.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure iv Test Setup



13.5 Test Equipment

| Equipment Type | Manufacturer | Equipment Description | Element No | Due For Calibration |
|-------------------|--------------|-----------------------|------------|---------------------|
| Spectrum Analyser | R&S | FSU50 | U544 | 2019-05-22 |
| Bilog | Chase | CBL611/A | U573 | 2019-08-02 |

13.6 Test Results

| Detector | Freq. (MHz) | Meas'd Emission (dB μ V) | Cable Loss (dB) | Antenna Factor (dB/m) | Pre-amp Gain (dB) | Duty Cycle Corr'n (dB) | Distance Extrap'n Factor (dB) | Field Strength (dB μ V/m) | Field Strength (μ V/m) | Limit (μ V/m) |
|----------|-------------|------------------------------|-----------------|-----------------------|-------------------|------------------------|-------------------------------|-------------------------------|-----------------------------|--------------------|
| Pk | 433.92 | 62.32 | 2.84 | 22.88 | N/A | 0.00 | 0.00 | 88.04 | 25234.81 | 110027.185 |
| Av | 433.92 | N/A | N/A | N/A | N/A | -10.7 | N/A | 77.34 | 7362.07 | 11002.73185 |

14 Duty Cycle

14.1 Definition

The ratio of the sum of all pulse durations to the total period, during a specified period of operation. The duty cycle is determined on the basis of one complete pulse train for pulse trains not exceeding 100 milliseconds. Where the pulse train exceeds 100 milliseconds, the duty cycle is determined on the basis of the 100 millisecond interval with the highest average value of emission.

14.2 Test Parameters

| | |
|---|------------------------------|
| Test Location: | Element Skelmersdale |
| Test Chamber: | Radio Laboratory |
| Test Standard and Clause: | ANSI C63.10-2013, Clause 7.5 |
| EUT Frequencies Measured: | 433.92 MHz |
| EUT Channel loading: | 30% |
| Deviations From Standard: | None |
| Temperature Extreme Environment Test Range: | N/A |
| Voltage Extreme Environment Test Range: | N/A |

Environmental Conditions (Normal Environment)

| | |
|--------------------|----------------------------------|
| Temperature: 22 °C | +15 °C to +35 °C (as declared) |
| Humidity: 32 % RH | 20 % RH to 75 % RH (as declared) |
| Supply: 6 V dc | 6 V dc (as declared) |

14.3 Test Limit

N/A.

Note, the maximum duty cycle correction factor which may be used is 20dB.

14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vii, the duty of the EUT was calculated from the sum of total on and off times over the observation period.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, bandwidths, data rates and power settings were used to observe the worst-case configuration.

[1] Single antenna output devices

Duty was measured at the antenna port / at a distance of 3 m.

[2] Multiple antenna output devices

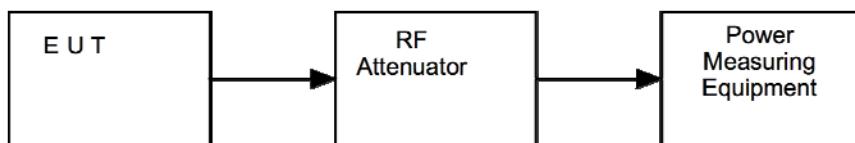
Duty was measured as the combination of all ports simultaneously / at a distance of 3 m.

The duty cycle correction factor, DC, is used to adjust peak emissions (voltage) to give an average value and is calculated by:

$$DC = 20 \log (\text{duty ratio})$$

Where, duty ratio is total on-time divided by total off-time in the worst-case pulse train or 100 ms, whichever is longer.

Figure vii Test Setup

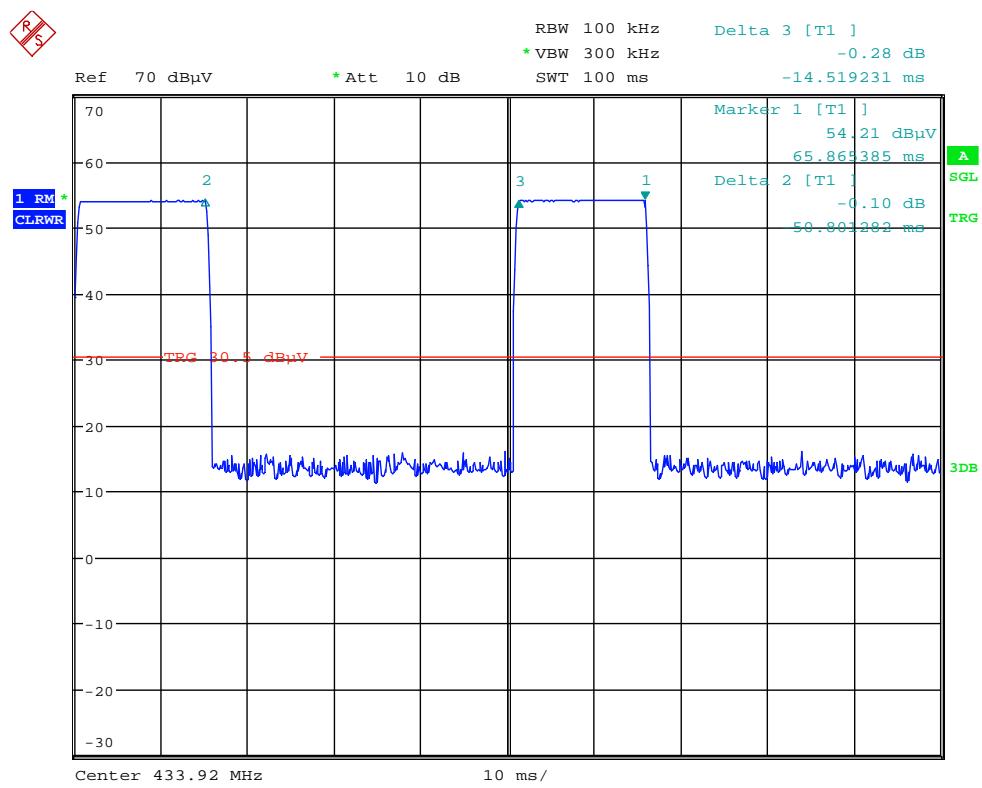


14.5 Test Equipment

| Equipment Type | Manufacturer | Equipment Description | Element No | Due For Calibration |
|----------------|--------------|-----------------------|------------|---------------------|
| FSU50 | R&S | Spectrum Analyser | U544 | 2019-05-22 |

14.6 Test Results

| Frequency 433.92 MHz: | | | | | | |
|-----------------------|----------------------|-------------------------------|----------------------|-------------------------|----------|------------------------|
| Test Environment | | Single Channel TxOn time (ms) | Total TxOn time (ms) | Observation period (ms) | Duty (%) | Calculated Factor (dB) |
| V _{nominal} | T _{nominal} | 14.52 | 29.04 | 100 | 29.04 | -10.7 |



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15 Periodic Operation

15.1 Definition

Measurement of the time period a device transmits for after a specified trigger.

15.2 Test Parameters

| | |
|---|------------------------------|
| Test Location: | Element Skelmersdale |
| Test Chamber: | Radio Laboratory |
| Test Standard and Clause: | ANSI C63.10-2013, Clause 7.4 |
| EUT Frequencies Measured: | 433.92 MHz |
| Deviations From Standard: | None |
| Temperature Extreme Environment Test Range: | N/A |
| Voltage Extreme Environment Test Range: | N/A |

Environmental Conditions (Normal Environment)

| | |
|--------------------|----------------------------------|
| Temperature: 22 °C | +15 °C to +35 °C (as declared) |
| Humidity: 32 % RH | 20 % RH to 75 % RH (as declared) |
| Supply: 6 V dc | 6 V dc (as declared) |

15.3 Test Limit

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

A transmitter activated automatically shall cease transmission within 5 seconds after activation.

Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition

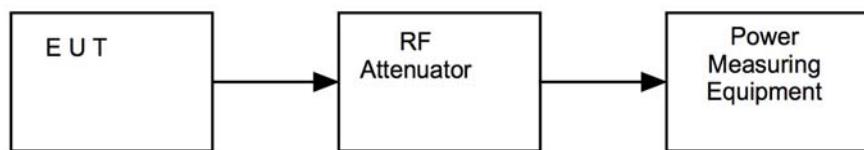
Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.

15.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure viii, the Unit was triggered manually and the measurement instrumentation set to trigger on release of the manual operation.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, bandwidths, data rates and power settings were used to observe the worst-case configuration.

Figure viii Test Setup

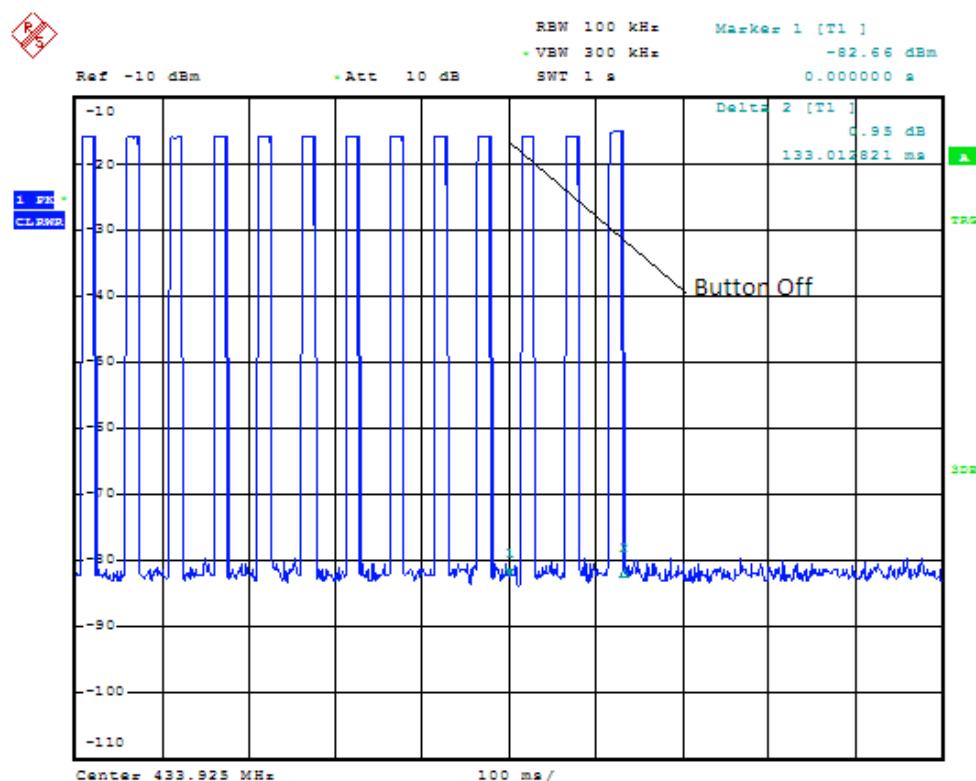


15.5 Test Equipment

| Equipment Type | Manufacturer | Equipment Description | Element No | Due For Calibration |
|----------------|--------------|-----------------------|------------|---------------------|
| FSU50 | R&S | Spectrum Analyser | U544 | 2019-05-22 |

Test Results

| Frequency 433.92 MHz: | | | |
|-----------------------|---|-----------|---------|
| Activation | Transmit time (ms) | Limit (s) | Results |
| Manual | 133.01 | 5 | Pass |
| Automatic | Not applicable (no Automatic transmissions) | | |



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16 Measurement Uncertainty

Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence:

[1] Carrier power

Uncertainty in test result (Power Meter) = **1.08 dB**

Uncertainty in test result (Spectrum Analyser) = **2.48 dB**

[2] Spurious emissions

Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**

Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

[3] AC power line conducted emissions

Uncertainty in test result = **3.4 dB**

[4] Occupied bandwidth

Uncertainty in test result = **15.5 %**

[5] Maximum frequency error

Uncertainty in test result (Power Meter) = **0.113 ppm**

Uncertainty in test result (Spectrum Analyser) = **0.265 ppm**

[6] Duty cycle

Uncertainty in test result = **7.98 %**