# Radio Test Report

## Zinwave Ltd

## Zinwave UNItivity 5000 Remote Unit

## 305-0007

47 CFR Part 74H Effective Date 1st October 2017
47 CFR Part 2 Effective Date 1st October 2017
Test Date: 23rd February 2018 to 4th June 2018
Report Number: 03-10383-3-18 Issue 01


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# Certificate of Test 10383-3

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of FCC Part 27. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

| | |
|---|---|
| Equipment: | Zinwave UNItivity 5000 Remote Unit |
| Model Number: | 305-0007 |
| Unique Serial Number: | 660100000021 |
| Applicant: | Zinwave Ltd<br>Harston Mill, Royston Road<br>Harston, Cambridge<br>CB22 7GG |
| Proposed FCC ID | UPO305-0007 |
| Full measurement results are detailed in Report Number: | 03-10383-2-18 Issue 01 |
| Test Standards: | 47 CFR Part 74H Effective Date 1st October 2017<br>47 CFR Part 2 Effective Date 1st October 2017 |

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.
This report only pertains to the operation of the equipment to 47CFR part 74H, for details of testing to other rule parts please see RN reports: 03-10383-4-18 (Part 90), 03-10383-1-18 (Parts 22 & 24), and 03-10383-2-18 (Part 27).

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: | 23rd February 2018 to 4th June 2018 |
| Test Engineer: | Charlie Blatt |
| Approved By:<br>Radio Approvals Manager | Digitally signed by: Daniel Sims<br>DN: CN = Daniel Sims C = GB O = RN Electronics Ltd<br>Date: 2018.06.14 11:13:31 Z |
| Customer Representative: | |

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# 2 Equipment under test (EUT)

## 2.1 Equipment specification

| | | |
|---|---|---|
| Applicant | Zinwave Ltd<br>Harston Mill<br>Royston Road<br>Harston<br>Cambridge<br>CB22 7GG | |
| | | |
| Manufacturer of EUT | Zinwave Ltd | |
| Full Name of EUT | Zinwave UNItivity 5000 Remote Unit | |
| Model Number of EUT | 305-0007 | |
| Serial Number of EUT | 660100000021 | |
| Date Received | 20th February 2018 | |
| Date of Test: | 23rd February 2018 to 4th June 2018 | |
| Purpose of Test | To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations. | |
| Date Report Issued | 14th June 2018 | |
| | | |
| Main Function | Distributed Antenna remote unit | |
| Information Specification | Height | 250mm |
| | Width | 250mm |
| | Depth | 50mm |
| | Weight | 2kg |
| | Voltage | 48 V DC |
| | Current | < 1 A (35W) |

## 2.2 Configurations for testing

| General Parameters | |
|---|---|
| EUT Normal use position | Wall mounted |
| Choice of model(s) for type tests | Production unit |
| Antenna details | external max 8dBi |
| Antenna port | External: 1x TX; 1x RX (N-type ports) |
| Baseband Data port (yes/no)? | NO |
| Highest Signal generated in EUT | 2690 MHz |
| Lowest Signal generated in EUT | Not stated |
| Hardware Version | 1.00 |
| Software Version | 4.209 |
| Firmware Version | N/A |
| Type of Equipment | Booster, Distributed Antenna System |
| Technology Type | Various – wideband distributed antenna system |
| Geo-location (yes/no) | No |
| TX Parameters | |
| Alignment range – transmitter | 150 - 2690 MHz |
| EUT Declared Modulation Parameters | FM (+-75kHz Deviation) |
| EUT Declared Power level | +20dBm |
| EUT Declared Signal Bandwidths | 200 kHz |
| EUT Declared Channel Spacing's | 200 kHz |
| EUT Declared Duty Cycle | up to 100% |
| Unmodulated carrier available? | Yes - EUT provides at its output whatever is presented to its input |
| Declared frequency stability | 0ppm (DAS without frequency translation) |
| RX Parameters | |
| Alignment range – receiver | As per Transmitter range |
| EUT Declared RX Signal Bandwidth | As per Transmitter |
| Receiver Signal Level (RSL) | N/A |
| Method of Monitoring Receiver BER | N/A |

## 2.3 Functional description

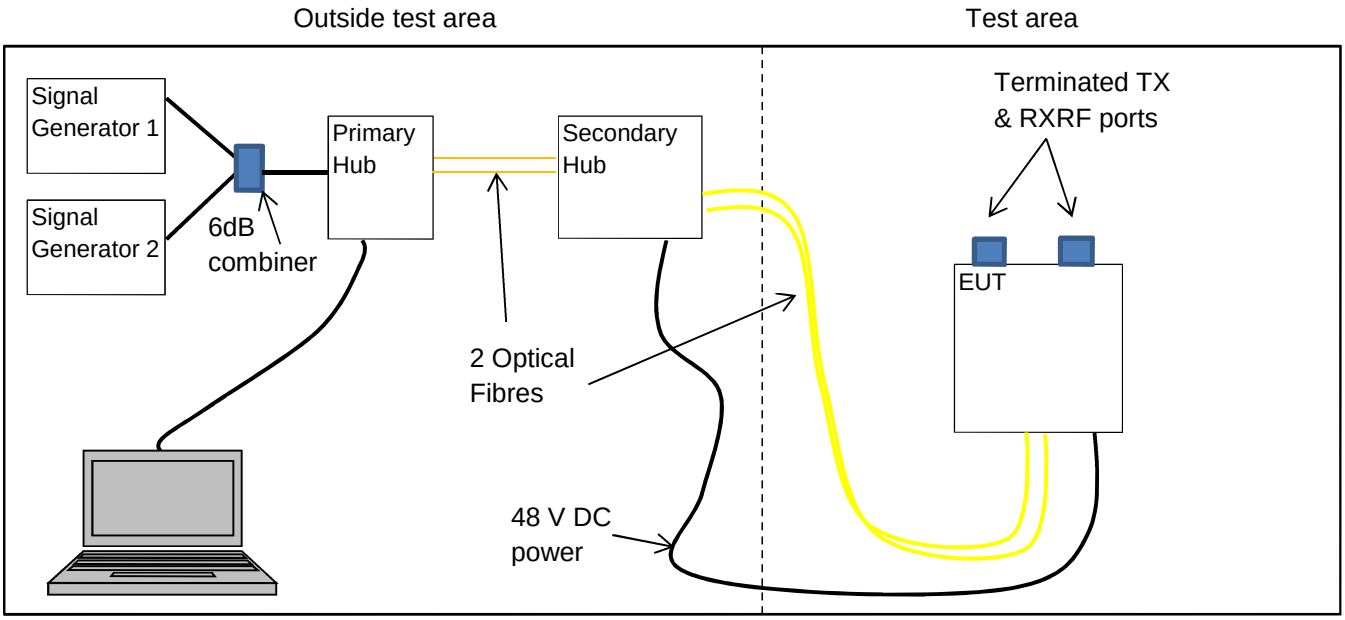
The Remote Unit is used as part of the Zinwave UNItivity 5000 system to provide cellular and private radio services within buildings, sports arenas and similar areas.
The system is wideband in nature and can support a wide range of radio services depending upon the system that is connected to the service module of the Primary Hub.

## 2.4 Modes of operation

| Mode Reference | Description | Used for testing |
|---|---|---|
| CW sweep Band 470-608 MHz | EUT being fed a swept CW signal across the band 470-608 MHz @ -5dBm amplitude level | Yes |
| CW sweep Band 614-698 MHz | EUT being fed a swept CW signal across the band 614-698 MHz @ -5dBm amplitude level | Yes |
| $f_o$ Determined in Band 470-608 MHz | EUT Being fed a Signal at 606.585MHz @ -5dBm using FM modulation and 200kHz channel BW | Yes |
| $f_o$ Determined in Band 614-698 MHz | EUT Being fed a Signal at 696.698MHz @ -5dBm using FM modulation and 200kHz channel BW | Yes |
| Single Low channel band 470-608 MHz FM | EUT Being fed a Signal at 470.0125MHz @ -5dBm using FM modulation and 25kHz channel BW | Yes |
| Single Mid channel band 470-608 MHz FM | EUT Being fed a Signal at 566MHz @ -5dBm using FM modulation and 25kHz channel BW | Yes |
| Single High channel band 470-608 MHz FM | EUT Being fed a Signal at 606.585MHz @ -5dBm using FM modulation and 25kHz channel BW | Yes |
| Single Low channel band 614-698 MHz FM | EUT Being fed a Signal at 614.0125MHz @ -5dBm using FM modulation and 25kHz channel BW | Yes |
| Single Mid channel band 614-698 MHz FM | EUT Being fed a Signal at 654MHz @ -5dBm using FM modulation and 25kHz channel BW | Yes |
| Single High channel band 614-698 MHz FM | EUT Being fed a Signal at 697.9875MHz @ -5dBm using FM modulation and 25kHz channel BW | Yes |
| Single Low channel band 470-608 MHz QPSK | EUT Being fed a Signal at 470.0125MHz @ -5dBm using π/4 QPSK modulation and 25kHz channel BW | Yes |
| Single Mid channel band 470-608 MHz QPSK | EUT Being fed a Signal at 566MHz @ -5dBm using π/4 QPSK modulation and 25kHz channel BW | Yes |
| Single High channel band 470-608 MHz QPSK | EUT Being fed a Signal at 606.585MHz @ -5dBm using π/4 QPSK modulation and 25kHz channel BW | Yes |
| Single Low channel band 614-698 MHz QPSK | EUT Being fed a Signal at 614.0125MHz @ -5dBm using π/4 QPSK modulation and 25kHz channel BW | Yes |
| Single Mid channel band 614-698 MHz QPSK | EUT Being fed a Signal at 654MHz @ -5dBm using π/4 QPSK modulation and 25kHz channel BW | Yes |
| Single High channel band 614-698 MHz QPSK | EUT Being fed a Signal at 697.9875MHz @ -5dBm using π/4 QPSK modulation and 25kHz channel BW | Yes |
| Dual Mid channels band 470-608 MHz | EUT Being fed a Signal at 566MHz & 566.025MHz @ -5dBm using FM modulation and 25kHz channel BW | Yes |
| Dual Mid channels band 614-698 MHz | EUT Being fed a Signal at 654MHz & 654.025MHz @ -5dBm using FM modulation and 25kHz channel BW | Yes |

Note: This report only pertains to the operation of the equipment to 47CFR part 74, for details of testing to other rule parts please see RN reports: 03-10383-1-18 (Parts 22E, 22H, 24E)
03-10383-2-18 (Part 27)
03-10383-4-18 (Part 90)

## 2.5 Emissions configuration




The unit was powered from the secondary hub at 48V DC. The unit was configured using the supplied network management software using the settings files prepared by Zinwave Ltd, this provided 25dB gain and +20dBm EUT output power in conjunction with the signal generator settings of -5dBm. Any attenuation introduced by the Primary/secondary hub system was also accounted for in the set-up files provided by Zinwave Ltd. Test channels and required modulations were set using the signal generators connected to the primary hub. Single channel operation was provided by generator 1 and dual channel was using two signal generators and a combiner. Output power of the signal generators was set to provide -5dBm at input to primary hub.
The transmit mode was 100% continuous with EUT output power maintained at +20dBm (25dB gain). Test channels and combinations of used are stated in test modes section 2.4
Testing was performed FM +-75kHz deviation modulated signal or with CW signal 25kHz spacing.

For conducted RF tests the RF ports were connected via suitable attenuation and filtering where required and connected directly to a spectrum analyser, with losses accounted for in the measurement results.

The system is designed for operation with antennas having a maximum gain of 8.0 dBi or 5.85 dBd. This is the value used for determining EIRP or ERP where required.

### 2.5.1 Signal leads

| Port Name | Cable Type | Connected |
|---|---|---|
| DC power | 2 core | Yes |
| Fibre TX | Fibre | Yes |
| Fibre RX | Fibre | Yes |
| Transmit port | N-type coaxial | Yes |
| Receive port | N-type coaxial | Yes |

# 3 Summary of test results

The Zinwave UNItivity 5000 Remote Unit, 305-0007 was tested for compliance to the following standard(s) :

47 CFR Part 74H Effective Date 1st October 2017
47 CFR Part 2 Effective Date 1st October 2017

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. Antenna power conducted emissions | 47CFR part 74H Clause (e) (6) | PASSED[1] |
| 2. Maximum Average conducted output power | 47CFR part 74H Clause (e) (1) (ii) | PASSED |
| 3. Frequency stability | 47CFR part 74H Clause 74.861 (e) (4) | NOT APPLICABLE[2] |
| 4. Occupied bandwidth | 47CFR part 74H Clause 74.861 (e) (5) | PASSED |
| 5. Radiated emissions | 47CFR part 74H Clause 74.861 (e) (6) (iii) | PASSED[1] |
| 6. Audio frequency response | 47CFR part 2J Clause 2.1047 | NOT APPLICABLE[3] |
| 7. Modulation limiting | 47CFR part 74H Clause 74.861 (e) (3) | NOT APPLICABLE[3] |
| 8. Determination of fo | KDB 935210 D05 Clause 3.3 | PERFORMED |

[1] Spectrum investigated started at a frequency of 30MHz up to a frequency of 7GHz based on 10 times the highest channel of 698MHz.
[2] EUT does not contain an oscillator and only reproduces what is provided at its input.
[3] EUT provides at its output what it receives at its input, therefore, audio response and mod limiting is controlled by the client/host it is connected to.

# 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 | 47CFR part 74H | 2017 | PART 74—EXPERIMENTAL RADIO, AUXILIARY, SPECIAL BROADCAST AND OTHER PROGRAM DISTRIBUTIONAL SERVICES<br>Subpart H - Low Power Auxiliary Stations |
| 4.1.2 | 47CFR part 2J | 2017 | Part 2 – Frequency Allocations and radio treaty matters; General rules and regulations |
| 4.1.3 | KDB 971168 D01 v02r02 | 2014 | Federal Communications Commission Office of Engineering and Technology Laboratory Division; Measurement Guidance for Certification of Licensed Digital Transmitters |
| 4.1.4 | ANSI C63.26 | 2015 | American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services |
| 4.1.5 | KDB 935210 D05 v01r02 | 2017 | Federal Communications Commission Office of Engineering and Technology Laboratory Division; Measurement guidance for Industrial and Non-consumer signal booster, repeater and amplifier devices |
| 4.1.6 | TIA-603-E | 2016 | Land Mobile FM or PM Communications Equipment Measurement and Performance Standards, Telecommunications Industry Association, 2016 |

## 4.2 Deviations

No deviations were applied.

# 5 Tests, methods and results

## 5.1 Antenna port conducted spurious emissions

### 5.1.1 Test methods

| | |
|---|---|
| Test Requirements: | 47CFR part 74H Clause (e) (6) [Reference 4.1.1 of this report} |
| Test Method: | 47CFR part 2J Clause 2.1051 [Reference 4.1.2 of this report] KDB 935210 D05 |
| Limits: | 47CFR part 74H Clause (e) (6) [Reference 4.1.1 of this report] |

### 5.1.2 Configuration of EUT

EUT was tested on a bench. The EUT RF port under test was connected to a spectrum analyser via suitable attenuation. RX port was terminated into a 50 Ohm load. EUT was tested across Low, Middle and High channels within each applicable band in a single channel input mode and in a dual channel input mode modes are specified in section 2.4 of this report.

### 5.1.3 Test procedure

The EUT system was set up to maximum gain using the network management software provided. EUT signal level was raised until maximum output power was reached per channel/band setting as required. Measurements were made and plots taken in the required Resolution bandwidths. Measurement performed using RMS detector and sweep averaging method.

Tests were performed in test site A.

### 5.1.4 Test equipment

E301, E412, E498, E642, E755

See Section 8 for more details

### 5.1.5 Test results

| | |
|---|---|
| Temperature of test environment | 17-22°C |
| Humidity of test environment | 30-42% |
| Pressure of test environment | 100-103kPa |

**For band edge/Mask results please refer to section 5.4 within this report**

## Single channel results.

Setup Table

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | π/4 QPSK |
| Low channel | 470.0125 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| 940.2149 | -30.5 | -17.5 |

| Plots |
|---|
| 30 – 7000 MHz range |

Setup Table

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |

| | |
|---|---|
| Channel Spacing | 25 kHz |
| Mod Scheme | π/4 QPSK |
| Mid channel | 566 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| 1080 | -30.6 | -17.6 |

| Plots |
|---|
| 30 – 7000 MHz range |

Setup Table

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | π/4 QPSK |
| High channel | 607.9875 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| 1216 | -33.6 | -20.6 |

| Plots |
|---|
| 30 – 5000 MHz range |

Setup Table

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | FM |
| Low channel | 470.0125 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| 940.1155 | -34.9 | -21.9 |

| Plots |
|---|
| 30 – 7000 MHz range |

Setup Table

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | FM |
| Mid channel | 566 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| 1080.1 | -34.2 | -21.2 |

| Plots |
|---|
| 30 – 7000 MHz range |

Setup Table

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |

| | |
|---|---|
| Channel Spacing | 25 kHz |
| Mod Scheme | FM |
| High channel | 607.9875 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| 1215.9 | -37.7 | -24.7 |

| Plots |
|---|
| 30 – 7000 MHz range |

Setup Table

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | π/4 QPSK |
| Low channel | 614.0125 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| 1228 | -33.8 | -20.8 |

| Plots |
|---|
| 30 – 7000 MHz range |

Setup Table

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | π/4 QPSK |
| Mid channel | 654 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| 1312 | --35.2 | -22.2 |

| Plots |
|---|
| 30 – 7000 MHz range |

Setup Table

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | π/4 QPSK |
| High channel | 697.9875 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| 1396 | -33 | -20 |

| Plots |
|---|
| 30 – 7000 MHz range |

Setup Table

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | FM |
| Low channel | 614.0125 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| 1228 | -38.3 | -25.3 |

| Plots |
|---|
| 30 – 7000 MHz range |

Setup Table

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | FM |
| Mid channel | 654 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| 1312 | -37.9 | -24.9 |

| Plots |
|---|
| 30 – 7000 MHz range |

Setup Table

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | FM |
| High channel | 697.9875 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| 1395.9 | -35.8 | -22.8 |

| Plots |
|---|
| 30 – 7000 MHz range |

## Dual channel results (Out of band)

Following narrow band test method in KDB section 4.7.2 Out-of-band/out-of-block emissions conducted measurements.

Setup Table

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | CW |
| Low channels | 470.0125 MHz + 470.0375 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| No Emissions observed within 20dB of limits. | | |

| Plots |
|---|
| Narrow band band-edge CW 470MHz edge |

Setup Table

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | CW |
| Low channels | 607.9625 MHz + 607.9875 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| No Emissions observed within 20dB of limits. | | |

| Plots |
|---|
| Narrow band band-edge CW 608MHz edge |

Setup Table

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | CW |
| High channels | 614.0125 MHz + 614.0375 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| No Emissions observed within 20dB of limits. | | |

| Plots |
|---|
| Narrow band band-edge CW 614MHz edge |

Setup Table

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |

| Mod Scheme | CW |
|---|---|
| High channels | 697.9625 MHz + 697.9875 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---|---|---|
| No Emissions observed within 20dB of limits. | | |

| Plots |
|---|
| Narrow band band-edge CW 698MHz edge |

Results are also presented graphically in section 6.

**LIMITS:**

74.861(e)(6) The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:
(i) On any frequency removed from the operating frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: at least 25 dB;
(ii) On any frequency removed from the operating frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: at least 35 dB;
(iii) On any frequency removed from the operating frequency by more than 250 percent of the authorized bandwidth: at least $43 + 10\log_{10}$ (mean output power in watts) 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: <± 2.8 dB

## 5.2 Maximum Average conducted output power

### 5.2.1 Test methods

Test Requirements: 47CFR part 74H Clause (e) (1) (ii) [Reference 4.1.1 of this report]
Test Method: 47CFR part 2J Clause 2.1046 [Reference 4.1.2 of this report]
Limits: 47CFR part 74H Clause (e) (1) (ii) [Reference 4.1.1 of this report]

### 5.2.2 Configuration of EUT

EUT was tested on a bench. The EUT RF port under test was connected to a spectrum analyser via suitable attenuation. RX port was terminated into a 50 Ohm load. EUT was tested at determined f0 in each applicable band. Test modes used were, $f_o$ Determined in Band 470-608 MHz & $f_o$ Determined in Band 614-698 MHz.

### 5.2.3 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 system was set up to maximum gain using the network management software provided. EUT signal level was raised until maximum output power was reached per channel/band setting as required and the frequency under test was set to an appropriate channel to include $f_0$ as determined in section 5.8. An RMS detector was set and a marker placed on the peak of the emitted signal. Plots were taken.

### 5.2.4 Test equipment

E301, E498, E642, E755

See Section 8 for more details

### 5.2.5 Test results

| | |
|---|---|
| Temperature of test environment | 17-22°C |
| Humidity of test environment | 30-42% |
| Pressure of test environment | 100-103kPa |

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | N/A |
| Mod Scheme | CW |
| f0 frequency | 606.585 MHz |

| Test conditions | | Average Power (dBm) |
|---|---|---|
| Temp Ambient | Volts Nominal | 19.4 |

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | N/A |
| Mod Scheme | CW |
| f0 frequency | 696.698 MHz |

| Test conditions | | Average Power (dBm) |
|---|---|---|
| Temp Ambient | Volts Nominal | 19.99 |

Results are also presented graphically in section 6

**LIMITS:**

74.861(e) For low power auxiliary stations operating in the 600 MHz duplex gap and the bands allocated for TV broadcasting, the following technical requirements apply: (ii) 470-608 and 614-698: 250 mW conducted power (+24dBm).

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 dB.

## 5.3 Frequency stability

NOT APPLICABLE: EUT does not contain an oscillator and only reproduces what is provided at its input.

## 5.4 Occupied bandwidth and bandwidth mask

### 5.4.1 Test methods

| | |
|---|---|
| Test Requirements: | 47CFR part 74H Clause 74.861 (e)(6) [Reference 4.1.1 of this report] |
| Test Method: | 47CFR part 2J Clause 2.1049 [Reference 4.1.2 of this report] |
| Limits: | 47CFR part 74H Clause 74.861 (e)(6)(i)(ii)(iii) [Reference 4.1.1 of this report] and 74861(e)(7) |

### 5.4.2 Configuration of EUT

EUT was tested on a bench. The EUT RF port under test was connected to a spectrum analyser via suitable attenuation. RX port was terminated into a 50 Ohm load. EUT was tested at determined $f_0$ for each applicable band.

### 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. The EUT system was set up to maximum gain using the network management software provided. EUT signal level was raised until maximum output power was reached per channel/band setting as required and the frequency under test was set to an appropriate channel to include $f_0$ as determined in section 5.8. A peak detector was set and sweeps made comparing the input and the output signals and applicable mask points indicated on the plots taken. For FM measurements a deviation of +-75kHz was used.

### 5.4.4 Test equipment

E301, E498, E642, E755

See Section 8 for more details

### 5.4.5 Test results

| | |
|---|---|
| Temperature of test environment | 17-22°C |
| Humidity of test environment | 30-44% |
| Pressure of test environment | 100-103kPa |

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | π/4 QPSK |
| f0 frequency | 606.656 MHz |

| | |
|---|---|
| Plot reference | Occupied BW 606.656MHz QPSK |

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | FM |
| f0 frequency | 606.656 MHz |

| | |
|---|---|
| Plot reference | Occupied BW 606.656MHz FM |

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |

| | |
|---|---|
| Channel Spacing | 25 kHz |
| Mod Scheme | FM |
| f0 frequency | 606.656 MHz |

| | |
|---|---|
| Plot reference | 470-608 MHz band EN 300 422-1 v1.4.2 mask |

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | π/4 QPSK |
| f0 frequency | 696.698 MHz |

| | |
|---|---|
| Plot reference | Occupied BW 696.698MHz QPSK |

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | FM |
| f0 frequency | 696.698 MHz |

| | |
|---|---|
| Plot reference | Occupied BW 696.698MHz FM |

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | FM |
| Frequency | 654.54 MHz |

| | |
|---|---|
| Plot reference | 614-698 MHz band EN 300 422-1 v1.4.2 mask |

Results are also presented graphically in section 6

**LIMITS:**

74.861(e)(6) The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:
(i) On any frequency removed from the operating frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: at least 25 dB;
(ii) On any frequency removed from the operating frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: at least 35 dB;
(iii) On any frequency removed from the operating frequency by more than 250 percent of the authorized bandwidth: at least $43 + 10\log_{10}$ (mean output power in watts) dB.
74.861(e)(7) : section 8.3.2.2 (Figure 4) of the European Telecommunications Institute Standard ETSI EN 300 422-1 v1.4.2 (2011-08),

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%

## 5.5 Radiated emissions

### 5.5.1 Test methods

Test Requirements: 47CFR part 74H Clause 74.861 (e) (6) (iii) [Reference 4.1.1 of this report]
Test Method: 47CFR part 2J Clause 2.1053 [Reference 4.1.2 of this report]t]
Limits: 47CFR part 74H Clause 74.861 (e) (6) (iii) [Reference 4.1.1 of this report]

### 5.5.2 Configuration of EUT

The EUT was tested in an ALSE and ambient conditions were monitored. The EUT was examined in its declared normal use position. The transmit port was terminated into a 30dB Attenuator and a 50 Ohm load. RX port was terminated into a 50 Ohm load. EUT was tested across all required modes as specified in section 2.4 of this report.

### 5.5.3 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 system was set up to maximum gain using the network management software provided. EUT signal level was raised until maximum output power was reached. Peak field strength pre-scans using the field strength method were performed. The EUT's emissions were maximised by rotating it 360 degrees. This method was used to determine any signals for substitution. An RMS detector was used for any final measurements.

30MHz - 1GHz.
The measuring antenna was scanned 1 - 4m in both Horizontal and Vertical polarisations. Where required a Substitution method was performed using tuned dipoles / a calibrated bi-conical antenna. Measurement distance of 3metres was used.

1GHz – 8GHz.
The measuring antenna was used in both Horizontal and Vertical polarisations. Where required a Substitution method was performed using standard gain horn antennas. Measurement distances used were: 1 – 6 GHz at 3metres and 6 – 8 GHz at 1.2metres.
Tests were performed in test sites B & M.

### 5.5.4 Test equipment

LPE364, E743, E624, E411, E412, E755, TMS82, E268, E428, E602, E433,

See Section 8 for more details

### 5.5.5 Test results

| | |
|---|---|
| Temperature of test environment | 15-20°C |
| Humidity of test environment | 30-42% |
| Pressure of test environment | 102kPa |

## Single channel results.

Setup Table

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | CW |
| Low channel | 470.0125 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) | Antenna Polarisation | EUT Polarisation |
|---|---|---|---|---|
| No spurious emissions observed within 20dB of limits | | | | |

Setup Table

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | CW |
| Mid channel | 566 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) | Antenna Polarisation | EUT Polarisation |
|---|---|---|---|---|
| No spurious emissions observed within 20dB of limits | | | | |

Setup Table

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | CW |
| High channel | 607.9875 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) | Antenna Polarisation | EUT Polarisation |
|---|---|---|---|---|
| No spurious emissions observed within 20dB of limits | | | | |

Setup Table

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | CW |
| Low channel | 614.0125 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) | Antenna Polarisation | EUT Polarisation |
|---|---|---|---|---|
| No spurious emissions observed within 20dB of limits | | | | |

Setup Table

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | CW |
| Mid channel | 654 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) | Antenna Polarisation | EUT Polarisation |
|---|---|---|---|---|
| No spurious emissions observed within 20dB of limits | | | | |

Setup Table

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |

| | |
|---|---|
| Mod Scheme | CW |
| High channel | 697.9875 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) | Antenna Polarisation | EUT Polarisation |
|---|---|---|---|---|
| No spurious emissions observed within 20dB of limits | | | | |

## DUAL CHANNEL RESULTS.

Setup Table

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | CW |
| Low channels | 566 MHz + 566.025 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) | Antenna Polarisation | EUT Polarisation |
|---|---|---|---|---|
| No spurious emissions observed within 20dB of limits | | | | |

Setup Table

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | 25 kHz |
| Mod Scheme | CW |
| High channels | 654 MHz + 654.025 MHz |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) | Antenna Polarisation | EUT Polarisation |
|---|---|---|---|---|
| No spurious emissions observed within 20dB of limits | | | | |

**LIMITS:**
74.861(e)(6) The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:
(iii) On any frequency removed from the operating frequency by more than 250 percent of the authorized bandwidth: at least 43 + $10\log_{10}$ (mean output power in watts) dB. (-13dBm).

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 - 1GHz ± 3.9 dB, 1 – 18 GHz ±3.5dB

## 5.6 Audio frequency response

NOT APPLICABLE: EUT provides at its output what it receives at its input, therefore, audio response and mod limiting is controlled by the client/host it is connected to.

## 5.7 Modulation limiting

NOT APPLICABLE: EUT provides at its output what it receives at its input, therefore, audio response and mod limiting is controlled by the client/host it is connected to.

## 5.8 Determination of $f_0$

### 5.8.1 Test methods

| | |
|---|---|
| Test Requirements: | KDB 935210 D05 Clause 3.3 / 4.3 [Reference 4.1.5 of this report] |
| Test Method: | ANSI C63.26 2015 Clause 5.5 [Reference 4.1.4 of this report] |
| | KDB 935210 D05 Clause 3.3 / 4.3 [Reference 4.1.5 of this report] |
| Limits: | None. |

### 5.8.2 Configuration of EUT

EUT was tested on a bench. The EUT RF port under test was connected to a spectrum analyser via suitable attenuation. RX port was terminated into a 50 Ohm load. EUT was swept across the 4 operational bands with a CW signal to determine the frequency of highest power in the band. Test performed in **CW sweep Band 470-608 MHz, and CW sweep Band 614-698 MHz** modes.

### 5.8.3 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 system was set up to maximum gain using the network management software provided. EUT signal level was raised until maximum output power was reached. The EUT input signal was then swept across the applicable service band frequency and plots taken showing the frequency of highest power in the band ($f_0$). An additional sweep across the whole band was also performed.

### 5.8.4 Test equipment

E498, E642, E755

See Section 8 for more details

### 5.8.5 Test results

| | |
|---|---|
| Temperature of test environment | 17-22°C |
| Humidity of test environment | 30-44% |
| Pressure of test environment | 100-103kPa |

| | |
|---|---|
| Band | 470-608 MHz |
| Power Level | 20 dBm |
| Channel Spacing | N/A |
| Mod Scheme | CW |

| Band (MHz) | $f_0$ determined(MHz) |
|---|---|
| 470-608 | 606.585 |

Note: Measurement was performed over the service band frequency range only.

| | |
|---|---|
| Band | 614-698 MHz |
| Power Level | 20 dBm |
| Channel Spacing | N/A |
| Mod Scheme | CW |

| Band (MHz) | $f_0$ determined (MHz) |
|---|---|
| 614-698 | 696.698 |

Note: Measurement was performed over the service band frequency range only.

**Gain across whole band:**

| | |
|---|---|
| Band | 200-2700 MHz |
| Power Level | 20 dBm |
| Channel Spacing | N/A |
| Mod Scheme | CW |

| Band (MHz) | $f_0$ determined (MHz) |
|---|---|
| 200-2700 | 2307.6 |

Results are also presented graphically in section 6.

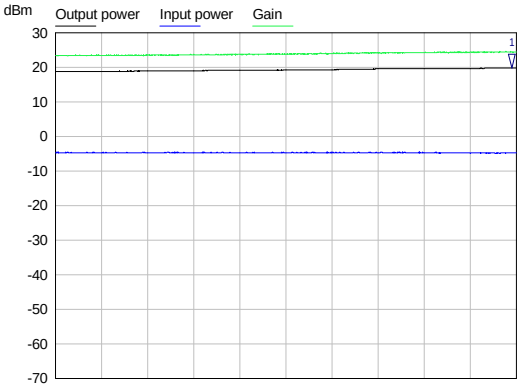
**LIMITS:**
None.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1 dB

# 6 Plots/Graphical results

## 6.1 Determination of f0

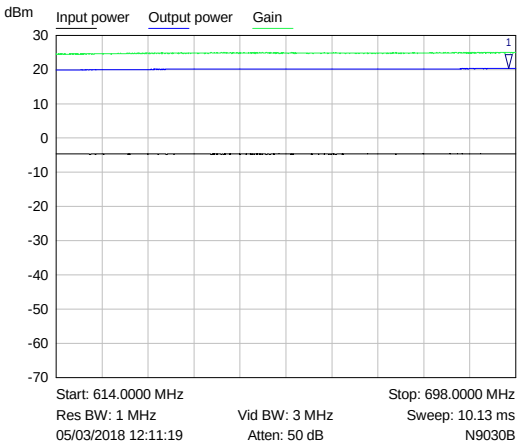
RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing N/A, Modulation N/A, Channel N/A




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Output power | 606.5851 MHz | 19.84 dBm | f0 |

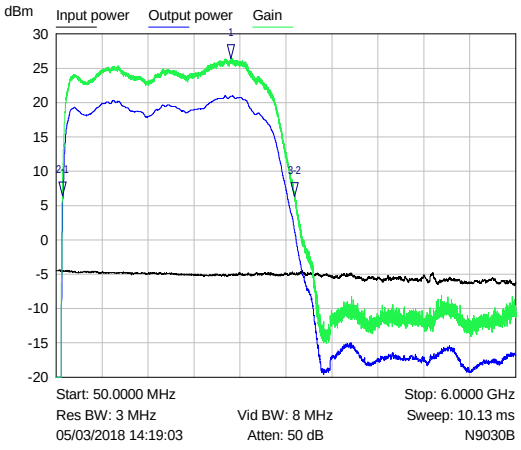
Plot of f0 determined in band 470-608 MHz.

RF Parameters: Band 614-698 MHz, Power +20 dBm, Channel Spacing N/A, Modulation N/A, Channel N/A




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Output power | 696.6977 MHz | 20.33 dBm | f0 |

Plot of f0 determined in band 614-698 MHz.

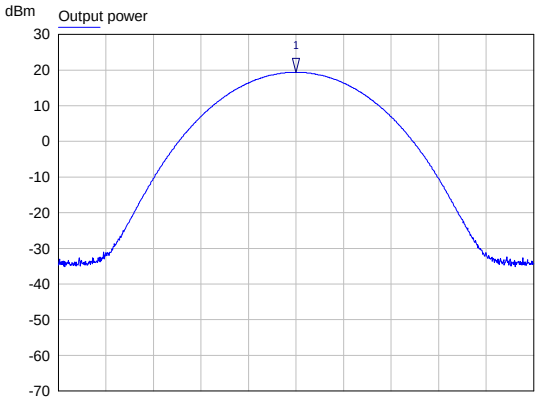



| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Gain | 2.3076 GHz | 26.39 dBm | Maximum gain |
| 2-1 | Gain | 128.8474 MHz | -19.97 dB | -20 dB (low) |
| 3-2 | Gain | 3.1332 GHz | -0.10 dB | -20 dB bandwidth |

Plot of whole band 200-2700 MHz

## 6.2 RF Power Output

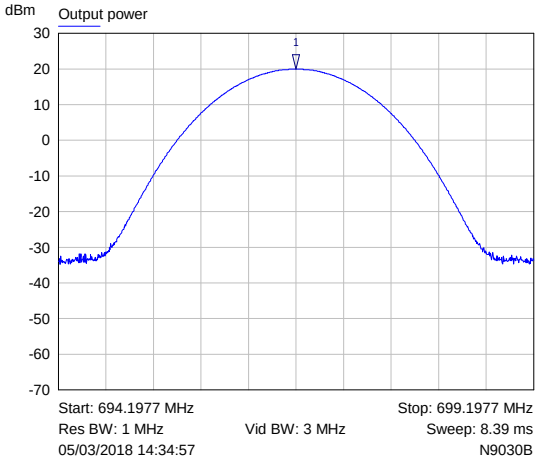
RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing N/A, Modulation CW, Channel 606.585 MHz (determined $f_0$)




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Output power | 606.5826 MHz | 19.40 dBm | Max power |

Plot of Channel power at determined $f_0$ in band 470-608 MHz

RF Parameters: Band 614-698 MHz, Power +20 dBm, Channel Spacing N/A, Modulation CW, Channel 696.698 MHz (determined $f_0$)



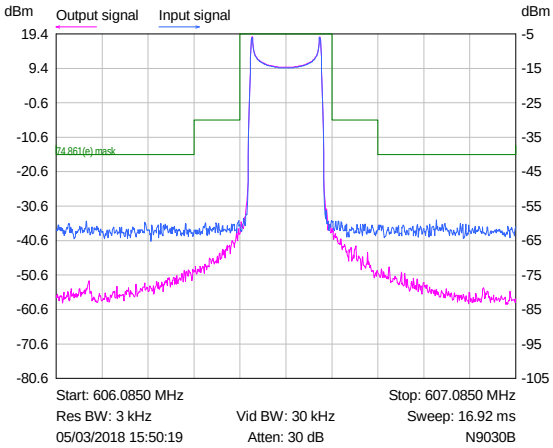

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Output power | 696.7002 MHz | 19.99 dBm | Max power |

Plot of Channel power at determined $f_0$ in band 614-698 MHz

## 6.3 Occupied bandwidth / Input versus output signal / Mask

RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation π/4 QPSK, Channel 606.585 MHz (determined $f_0$)

RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation FM, Channel 606.585 MHz (determined $f_0$)



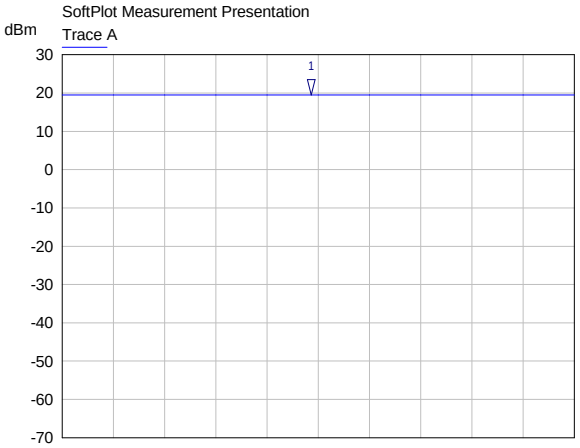

Output signal

| Measurement Parameter | Value |
|---|---|
| Occupied Bandwidth | 154.81 kHz |
| Power in Occupied Bandwidth | 28.84 dBm |
| Transmit Freq Error | 12.97 Hz |
| -26.00 dB Bandwidth | 161.84 kHz |

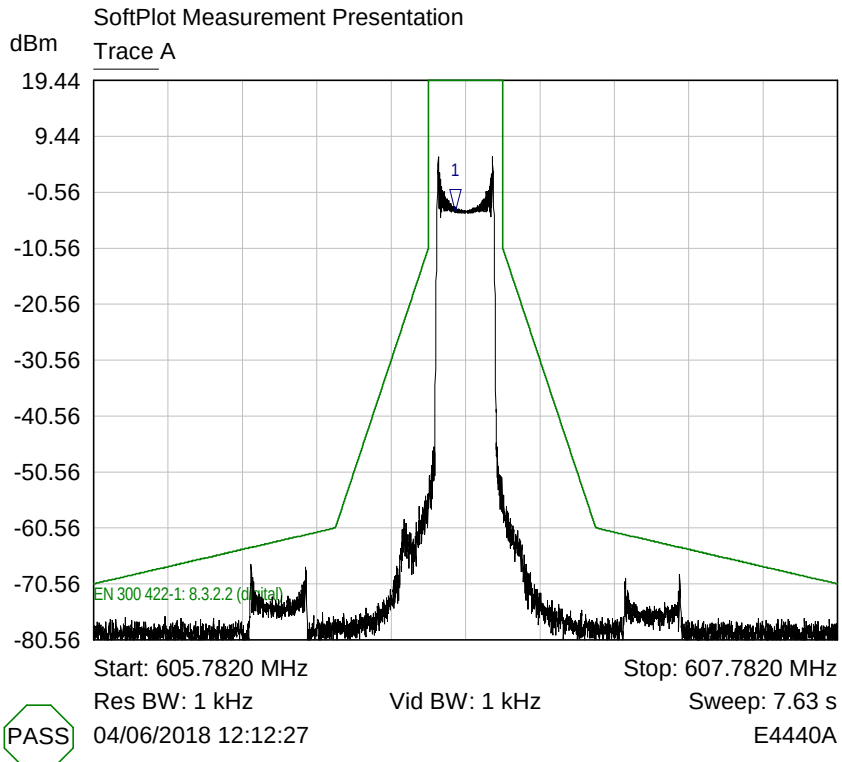
Input signal

| Measurement Parameter | Value |
|---|---|
| Occupied Bandwidth | 154.81 kHz |
| Power in Occupied Bandwidth | 4.29 dBm |
| Transmit Freq Error | 15.96 Hz |
| -26.00 dB Bandwidth | 161.81 kHz |

RF Parameters: Band 470-608 MHz, Maximum power, Modulation FM, Channel 606.782 MHz
470-608 MHz band EN 300 422-1 v1.4.2 mask



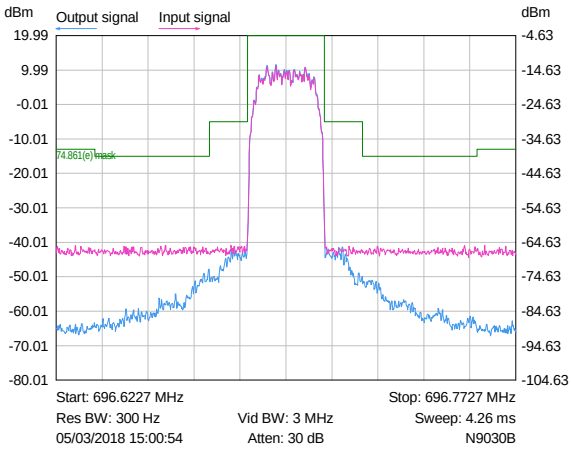

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Trace A | 518.4000 us | 19.44 dBm | |



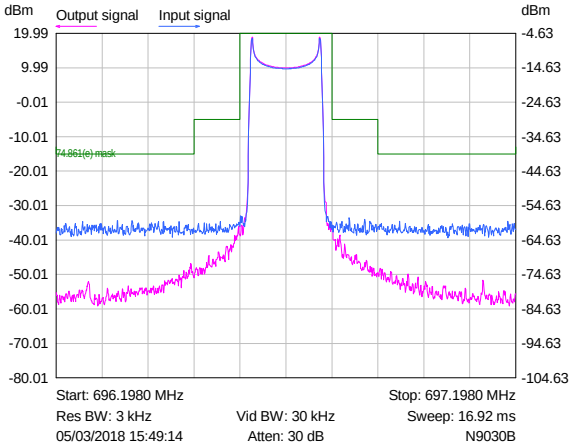

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Trace A | 606.7540 MHz | -4.01 dBm | |

RF Parameters: Band 614-698 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation π/4

QPSK, Channel 696.698MHz (determined $f_0$)



RF Parameters: Band 614-698 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation FM, Channel 696.698MHz (determined $f_0$)



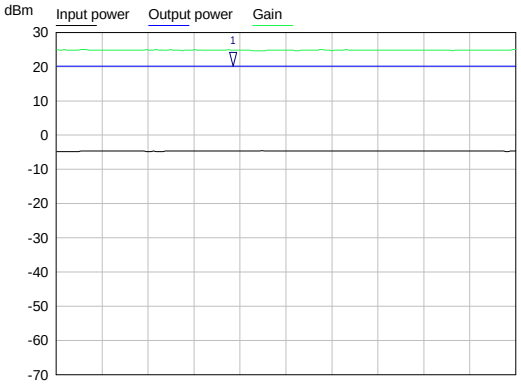

Output signal

| Measurement Parameter | Value |
|---|---|
| Occupied Bandwidth | 154.82 kHz |
| Power in Occupied Bandwidth | 29.12 dBm |
| Transmit Freq Error | 12.02 Hz |
| -26.00 dB Bandwidth | 161.84 kHz |

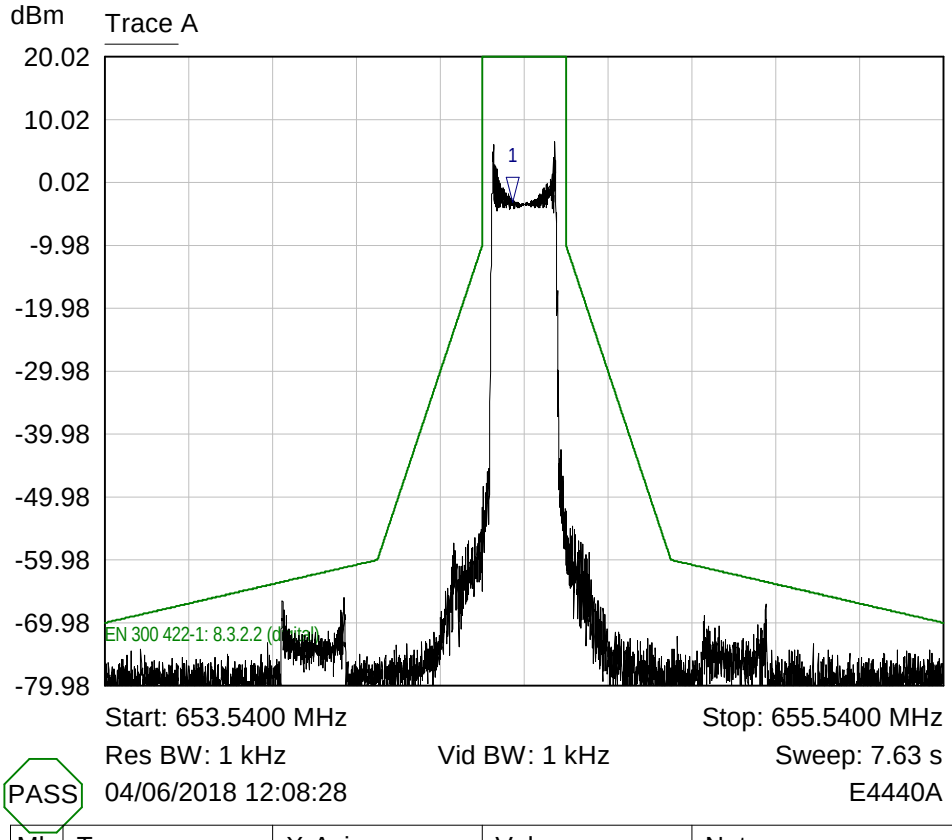
Input signal

| Measurement Parameter | Value |
|---|---|
| Occupied Bandwidth | 154.81 kHz |
| Power in Occupied Bandwidth | 4.23 dBm |
| Transmit Freq Error | 15.85 Hz |
| -26.00 dB Bandwidth | 161.83 kHz |

RF Parameters: Band 614-698 MHz, Maximum power, Modulation FM, Channel 654.54 MHz
614-698 MHz band EN 300 422-1 v1.4.2 mask




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Output power | 654.5401 MHz | 20.16 dBm | f0 |

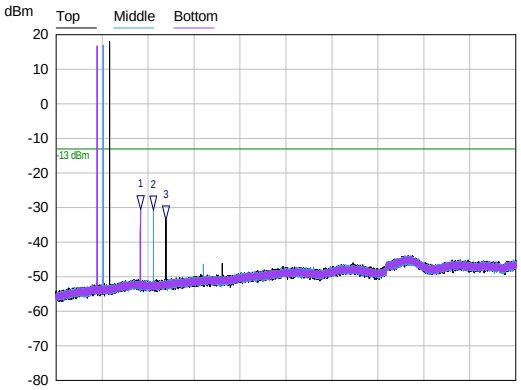



| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Trace A | 654.5120 MHz | -3.22 dBm | |

## 6.4 Spurious emissions at antenna terminals

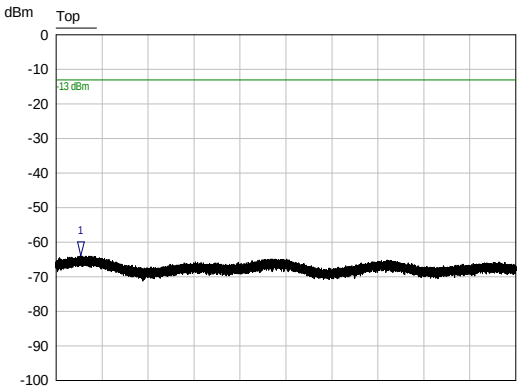
Note: Low, Mid and high channels are shown (overlaid) on a single plot.

RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation π/4 QPSK, Channels 470.0125 MHz, 566 MHz and 469.9875 MHz, Single channel mode




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Bottom | 940.2149 MHz | -30.45 dBm | |
| 2 | Middle | 1.0800 GHz | -30.60 dBm | |
| 3 | Top | 1.2160 GHz | -33.58 dBm | |

Plot of conducted emissions single Low, Mid and High channels (470-608 MHz band) 30 – 5000 MHz range

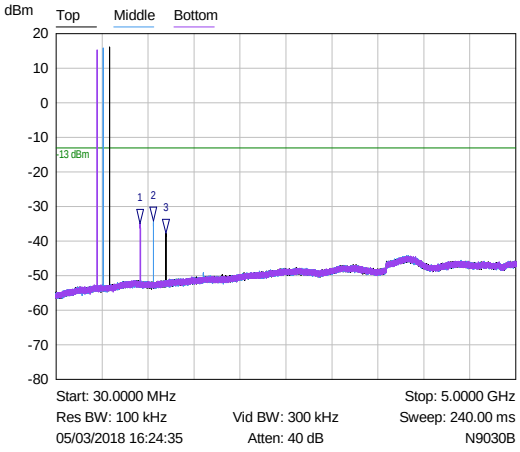



| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Top | 5.1085 GHz | -63.80 dBm | |

Plot of conducted emissions single Mid channel (566 MHz band) 5000 – 7000 MHz range

Note: no discernible difference is noted in emissions above 5GHz for any band, channel or modulation type setting, therefore only a single plot is included here for reference.

RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation FM, Channels 470.0125 MHz, 566 MHz and 469.9875 MHz, Single channel mode

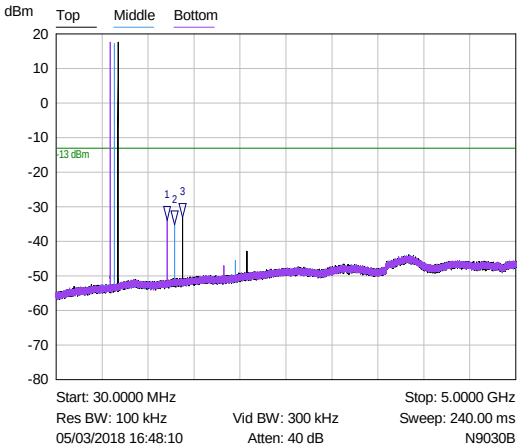



| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Bottom | 940.1155 MHz | -34.89 dBm | |
| 2 | Middle | 1.0801 GHz | -34.22 dBm | |
| 3 | Top | 1.2159 GHz | -37.73 dBm | |

Plot of conducted emissions single Low, Mid and High channels (470-608 MHz band) 30 – 5000 MHz range

Note: Low, Mid and high channels are shown (overlaid) on a single plot.

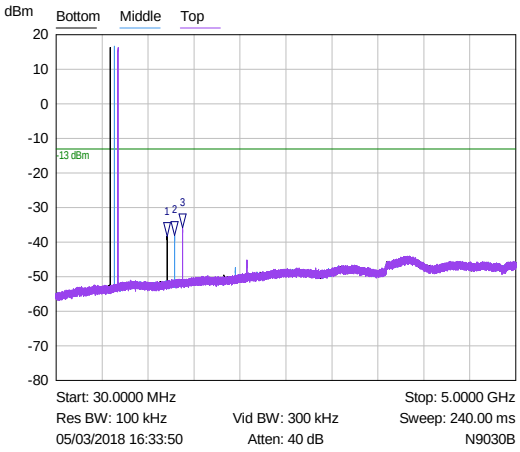
RF Parameters: Band 614-698 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation π/4 QPSK, Channels 614.0125 MHz, 654 MHz and 697.9875 MHz, Single channel mode




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Bottom | 1.2280 GHz | -33.82 dBm | |
| 2 | Middle | 1.3120 GHz | -35.19 dBm | |
| 3 | Top | 1.3960 GHz | -33.03 dBm | |

Plot of conducted emissions single Low, Mid and High channels (614-698 MHz band) 30 – 5000 MHz range

RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation FM, Channels 470.0125 MHz, 566 MHz and 469.9875 MHz, Single channel mode




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Bottom | 1.2281 GHz | -38.30 dBm | |
| 2 | Middle | 1.3121 GHz | -37.98 dBm | |
| 3 | Top | 1.3959 GHz | -35.84 dBm | |

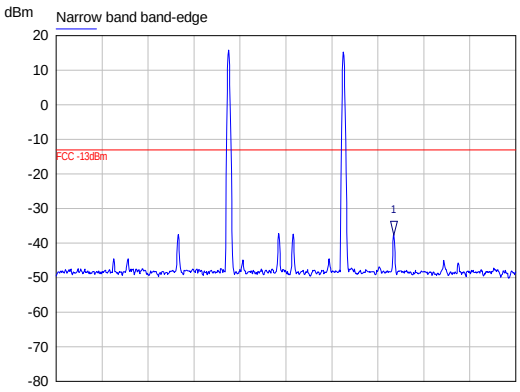
Plot of conducted emissions single Low, Mid and High channels (470-608 MHz band) 30 – 5000 MHz range

## 6.5 Out of band dual channel emissions

Please refer to section 6.3 for Mask emissions results.

Below plots are for Narrowband dual channel tests.

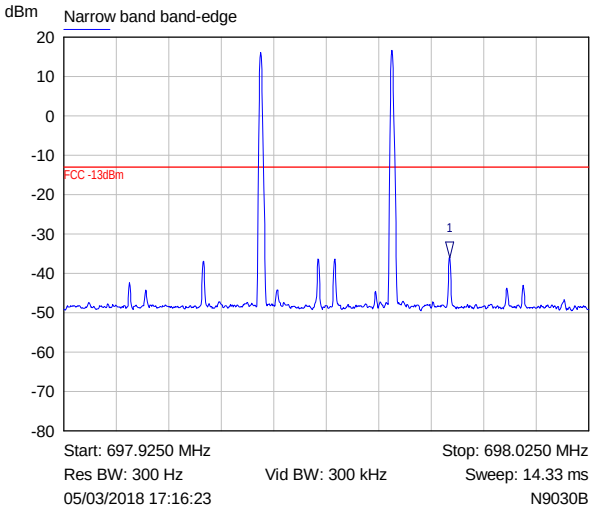
RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW, Channel 470.0125 & 470.0375 MHz, Dual channel mode




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Narrow band band-edge | 470.0485 MHz | -37.61 dBm | |

Plot of lower band edge (470MHz)

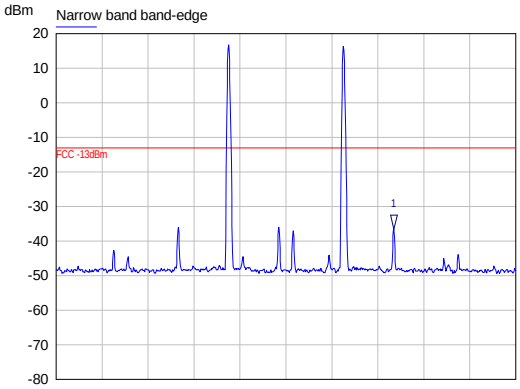
RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW, Channel 607.9625 & 607.9875 MHz, Dual channel mode




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Narrow band band-edge | 697.9985 MHz | -36.08 dBm | |

Plot of upper band edge (608MHz)

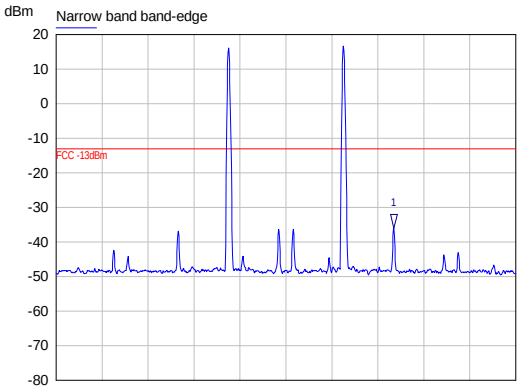
RF Parameters: Band 614-698 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW, Channel 470.0125 & 470.0375 MHz, Dual channel mode




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Narrow band band-edge | 614.0485 MHz | -36.54 dBm | |

Plot of lower band edge (614MHz)

RF Parameters: Band 614-698 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW, Channel 607.9625 & 607.9875 MHz, Dual channel mode




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Narrow band band-edge | 697.9985 MHz | -36.08 dBm | |

Plot of upper band edge (698MHz)

# 7 Photographs

For confidentiality purposes, photographs are not included at client's request.

# 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 |
|---|---|---|---|---|---|
| E268 | BHA 9118 | Horn Antenna 1-18 GHz | Schaffner | 03-Apr-2017 | 12 months |
| E301 | 8493C | Attenuator 20dB 26.5GHz | Hewlett Packard | 19-May-2017 | 12 months |
| E411 | N9039A | 9 kHz - 1 GHz RF Filter Section | Agilent Technologies | 11-Jul-2017 | 12 months |
| E412 | E4440A | PSA 3 Hz - 26.5 GHz | Agilent Technologies | 10-Jul-2017 | 24 months |
| E428 | HF906 | Horn Antenna 1-18 GHz | Rohde & Schwarz | 03-Apr-2017 | 12 months |
| E433 | MG3693A | Signal Generator 30GHz | Anritsu | 23-Jun-2016 | 24 months |
| E452 | 22240-20 | Std Gain Horn Antenna 26.4 - 40.1 GHz | FMI Ltd | 02-May-2017 | 12 months |
| E453 | 20240-20-AA | Std Gain Horn Antenna 17.6 - 26.7 GHz | FMI Ltd | 02-May-2017 | 12 months |
| E454 | 18240-20 | Std Gain Horn Antenna 11.9 - 18.0 GHz | FMI Ltd | 25-Jul-2017 | 12 months |
| E498 | 4768-20 | Attenuator 20dB 40GHz | Narda | 24-May-2017 | 12 months |
| E602 | MG3692A | Signal Generator 10MHz - 20GHz | Anritsu | 30-Jan-2017 | 24 months |
| E624 | E4440A | PSA 3 Hz - 26.5 GHz | Agilent Technologies | 09-Jan-2018 | 24 months |
| E642 | E4440A | PSA 3 Hz - 26.5 GHz | Keysight | 29-Nov-2017 | 24 months |
| E743 | RR2017 4/2dB | Attenuator 4/2dB 30-1000MHz | RN Electronics | 12-Feb-2018 | 12 months |
| E755 | N9030B | 3Hz to 50GHz PXA | Keysight | 08-May-2017 | 12 months |
| LPE364 | CBL6112A | Antenna Bilog 30MHz - 2GHz | Chase Electronics Ltd | 15-Jan-2018 | 24 months |
| TMS78 | 3160-08 | Std Gain Horn Antenna 12.4-18 GHz | ETS Systems | 25-Jul-2017 | 12 months |
| TMS79 | 3160-09 | Std Gain Horn Antenna 18-26.5 GHz | ETS Systems | 25-Jul-2017 | 12 months |
| TMS82 | 8449B | Pre Amplifier 1 - 26 GHz | Agilent Technologies | 19-Dec-2017 | 12 months |

# 9 Auxiliary and peripheral equipment

## 9 .1 Customer supplied equipment

| Item No. | Model No. | Description | Manufacturer | Serial No. |
|---|---|---|---|---|
| 1 | N5172B | EXG signal generator | Agilent | MY53050810 |
| 2 | N5172B | EXG signal generator | Keysight | MY53050728 |
| 3 | 15542 | 30 dB attenuator | Mini-Circuits | VUU78901032 |
| 4 | | TX 50 Ohm load | | |
| 5 | | RX 50 Ohm load | | |
| 6 | 305-0001 | UNItivity 5000 Primary Hub | Zinwave Ltd | 650100000002 |
| 7 | 305-0004 | Zinwave Secondary Hub | Zinwave Ltd | 620100000018 |
| 8 | E4432B | signal generator | HP | Zinwave 000001 |
| 9 | SMJ100A | signal generator | R&S | Zinwave 000094 |
| 10 | SLP-550+ | 520MHz LPF | Mini circuits | R0029901116 |
| 11 | SLP-630+ | 630MHz LPF | Mini circuits | 3 0719 |
| 12 | SLP-1200+ | 1000MHz LPF | Mini circuits | R8169700721 |
| 13 | 305-0001 | UNItivity 5000 primary hub | Zinwave Ltd | 00-17-68-00-13-DE |
| 14 | 305-0004 | Zinwave Secondary Hub | Zinwave Ltd | 620100000004 |

## 9 .2 RN Electronics supplied equipment

| RN No. | Model No. | Description | Manufacturer | Serial No |
|---|---|---|---|---|
| E401 | 1506A | Splitter 18 GHz 6dB | Weinschel | LT261 |
| I224 | E442-142H16 | Laptop 15.6" | emachines | LXNBF02002038164171601 |

# 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 / Calibration Laboratory and anechoic chamber

Site B Semi-anechoic chamber
FCC Registration No. 293246
IC Registration No. 5612A-4

Site B1 Control Room for Site B

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 Screened Room

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 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

# 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 |
| ºC | 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 | | |