



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 Harston Mill, Royston Road Harston, Cambridge 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 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:

Approved By:

Radio Approvals Manager

Digitally signed by Daniel Sims
DN: CN = Daniel Sims C = GB O = RN Electronics Ltd
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 Harston Mill Royston Road Harston Cambridge 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	20 th 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.

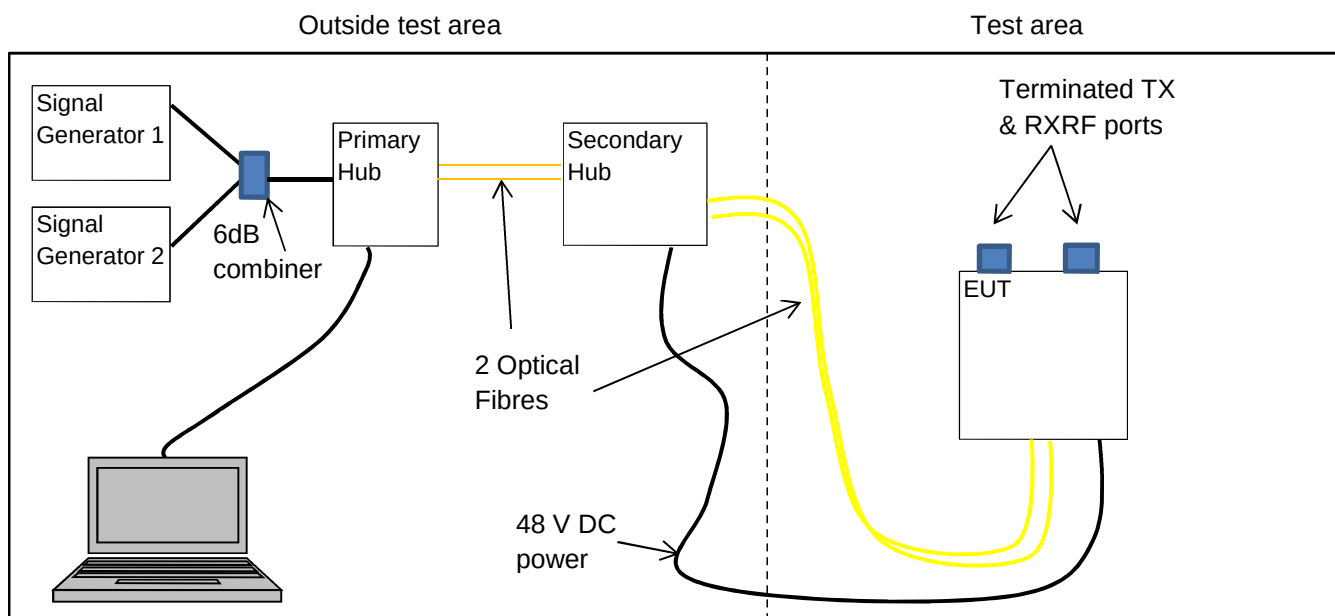
The system is wideband in nature and can support a wide range of radio services depending upon the system that is connected to the service module of the Primary Hub.

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 $\pi/4$ QPSK modulation and 25kHz channel BW	Yes
Single Mid channel band 470-608 MHz QPSK	EUT Being fed a Signal at 566MHz @ -5dBm using $\pi/4$ 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 $\pi/4$ 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 $\pi/4$ QPSK modulation and 25kHz channel BW	Yes
Single Mid channel band 614-698 MHz QPSK	EUT Being fed a Signal at 654MHz @ -5dBm using $\pi/4$ 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 $\pi/4$ 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 $\pm 75\text{kHz}$ 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 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	$\pi/4$ 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	$\pi/4$ 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	$\pi/4$ 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	$\pi/4$ 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	$\pi/4$ 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	$\pi/4$ 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 f_0 in each applicable band. Test modes used were, f_0 Determined in Band 470-608 MHz & f_0 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
f_0 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
f_0 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 $\pm 75\text{kHz}$ 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	$\pi/4$ QPSK
f_0 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
f_0 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	$\pi/4$ 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
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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:
 $< \pm 1.9\%$

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]
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 ± 3.5 dB

5.6 Audio frequency response

NOT APPLICABLE: EUT provides at its output what it receives at its input, therefore, audio response and modulation 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 modulation 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:

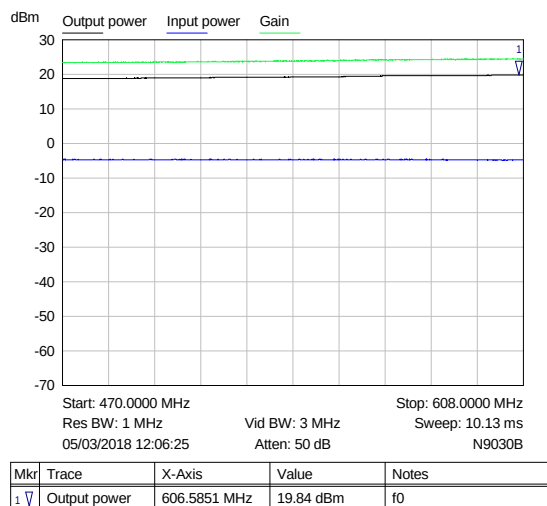
None.

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

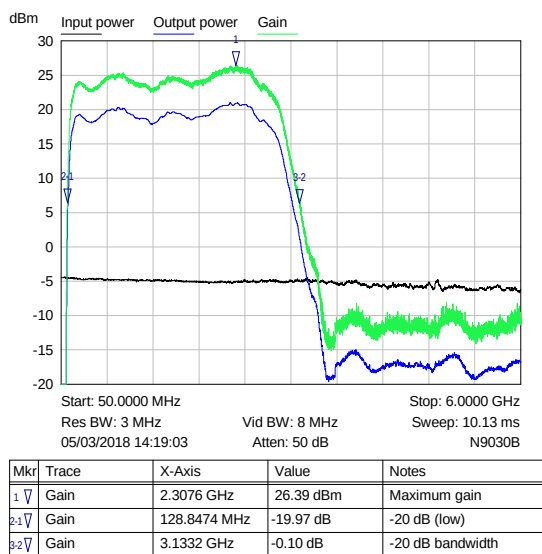


Plot of f0 determined in band 470-608 MHz.

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



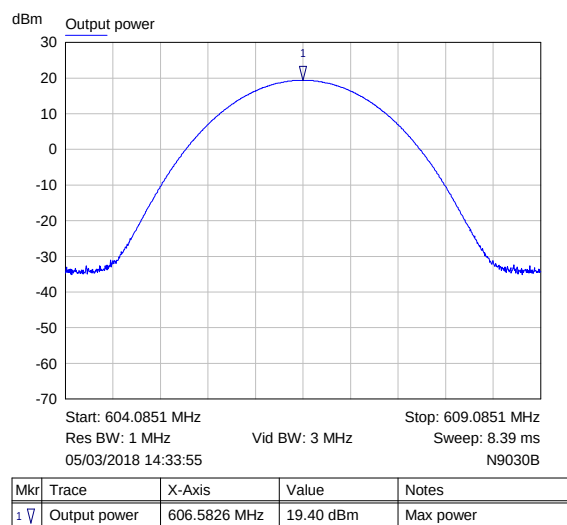
Plot of f0 determined in band 614-698 MHz.



Plot of whole band 200-2700 MHz

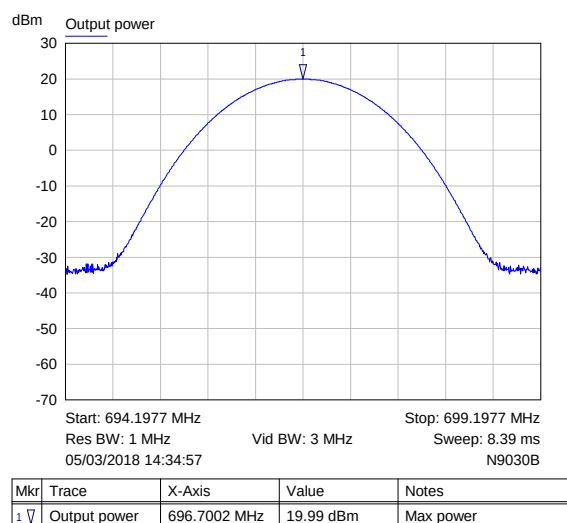
6.2 RF Power Output

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



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

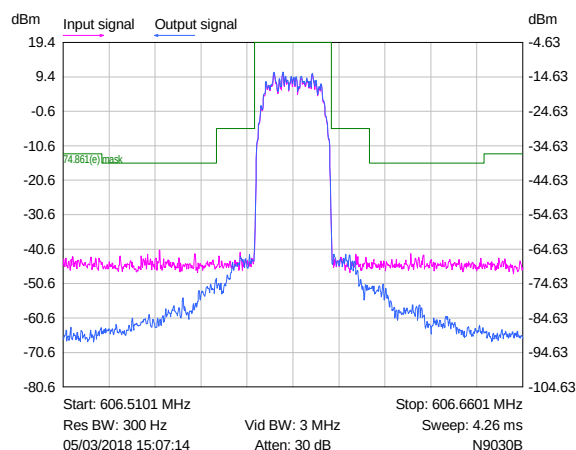
RF Parameters: Band 614-698 MHz, Power +20 dBm, Channel Spacing N/A, Modulation CW,
Channel 696.698 MHz (determined f_0)



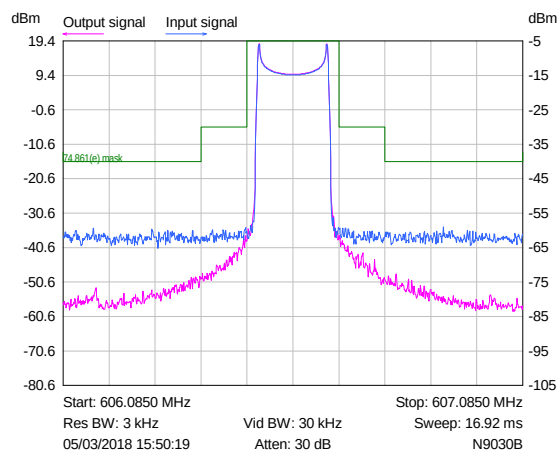
Plot of Channel power at determined f_0 in band 614-698 MHz

6.3 Occupied bandwidth / Input versus output signal / Mask

RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation $\pi/4$ 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)



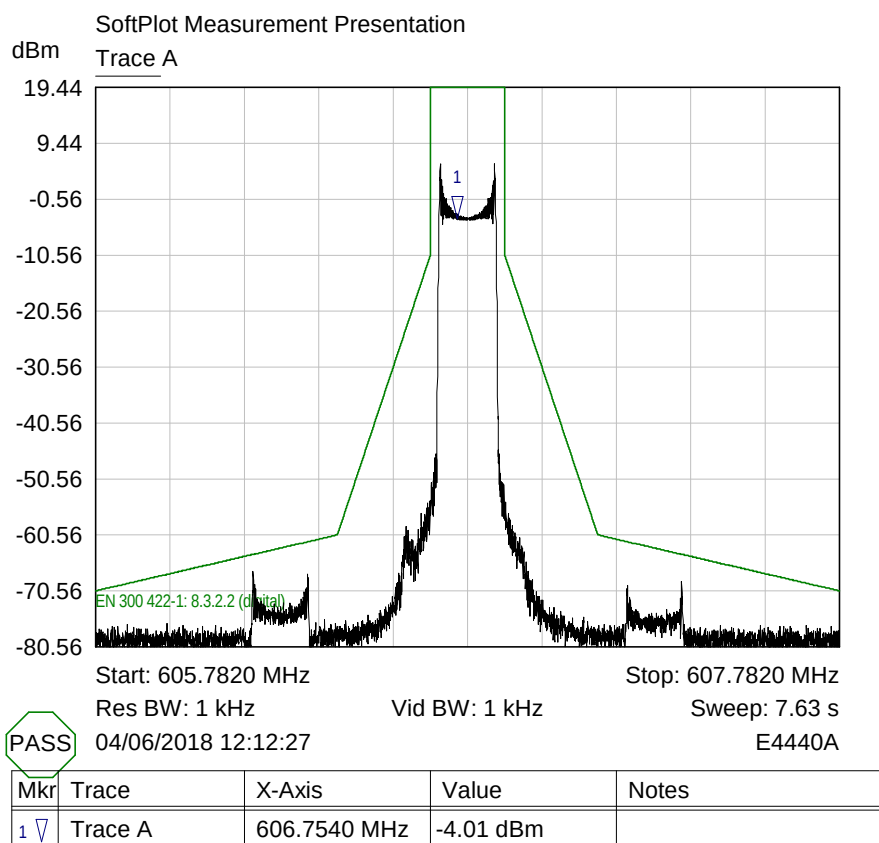
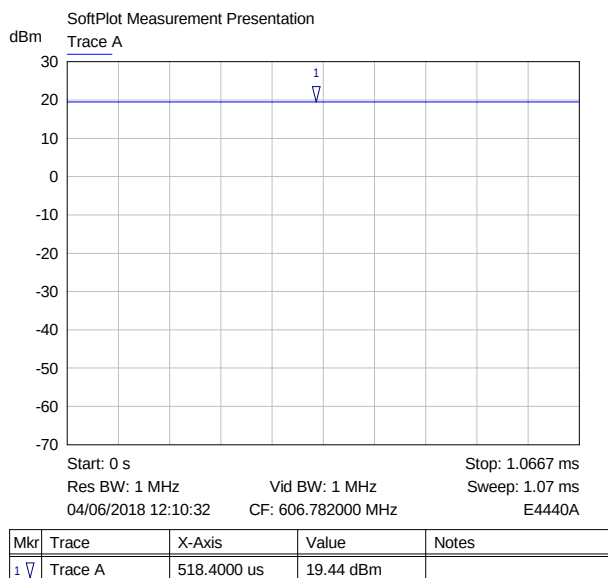
Output signal

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

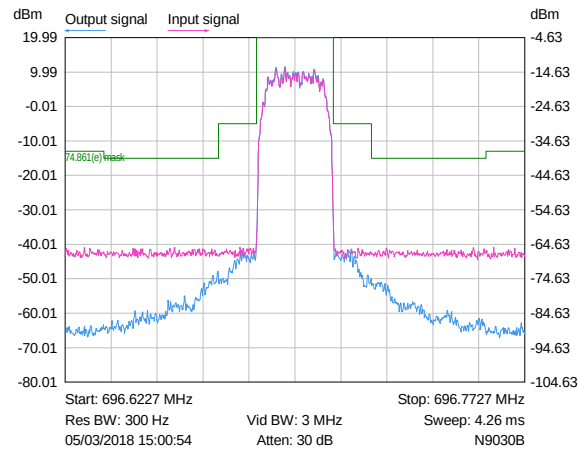
Input signal

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

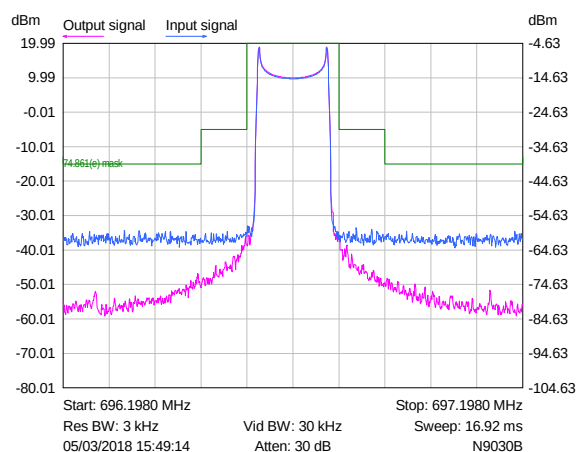
RF Parameters: Band 470-608 MHz, Maximum power, Modulation FM, Channel 606.782 MHz
470-608 MHz band EN 300 422-1 v1.4.2 mask



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)



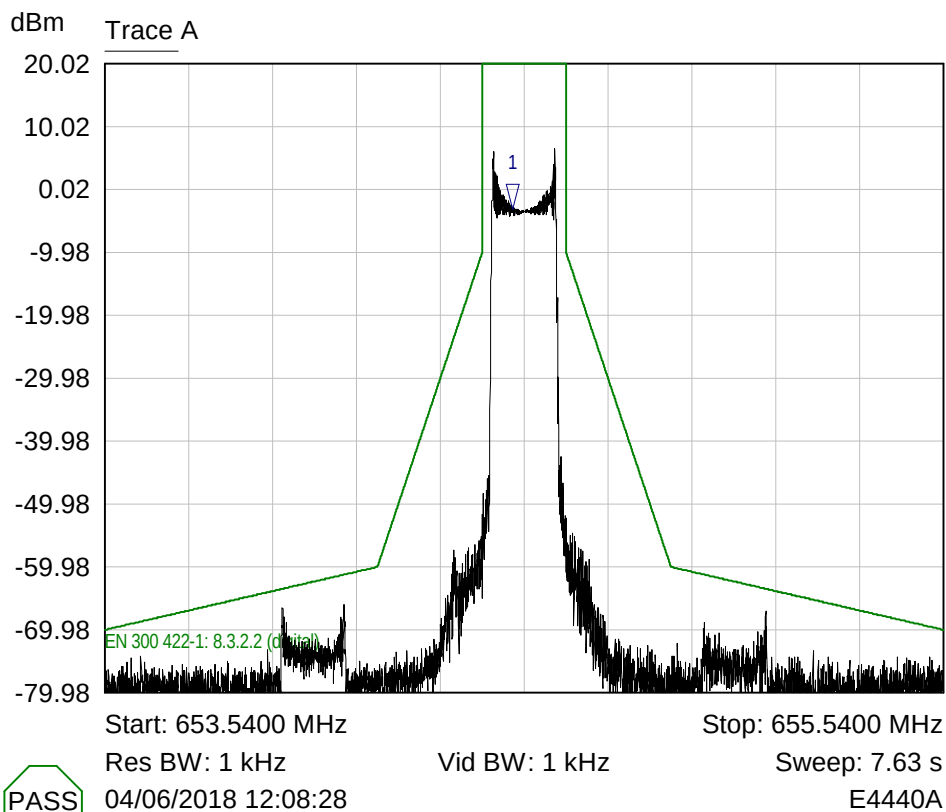
Output signal

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

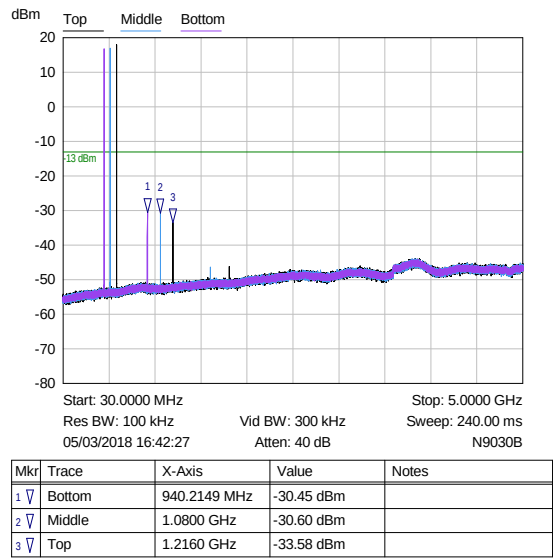


Mkr	Trace	X-Axis	Value	Notes
1	Trace A	654.5120 MHz	-3.22 dBm	

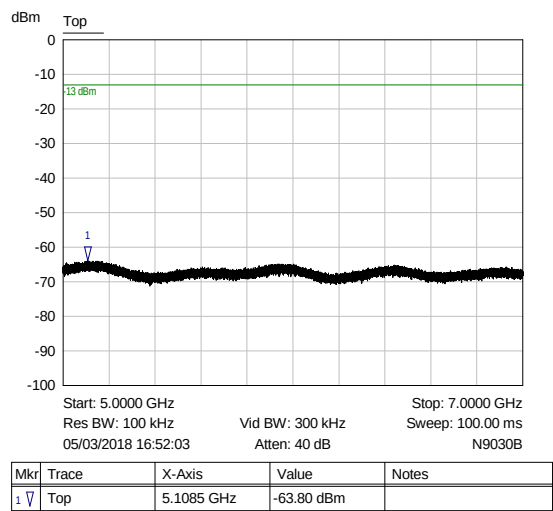
6.4 Spurious emissions at antenna terminals

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 $\pi/4$ QPSK, Channels 470.0125 MHz, 566 MHz and 469.9875 MHz, Single channel mode

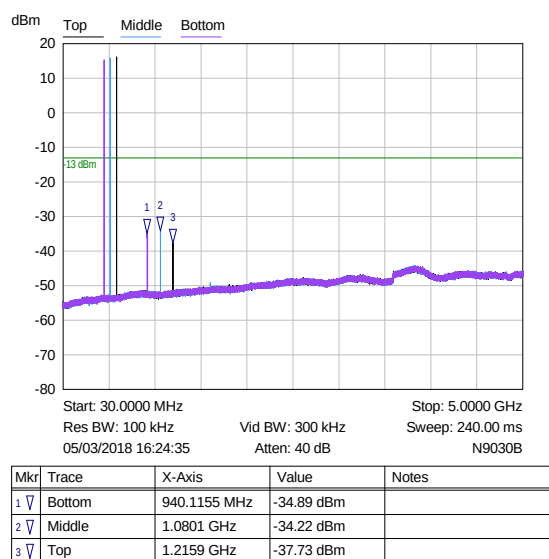


Plot of conducted emissions single Low, Mid and High channels (470-608 MHz band) 30 – 5000 MHz range



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.

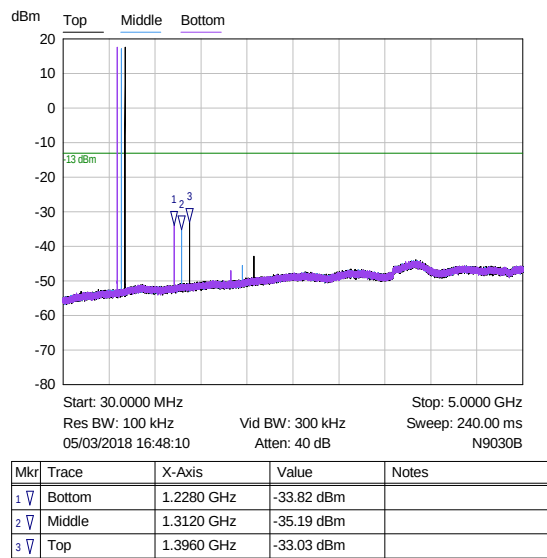
RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation FM,
Channels 470.0125 MHz, 566 MHz and 469.9875 MHz, Single channel mode



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

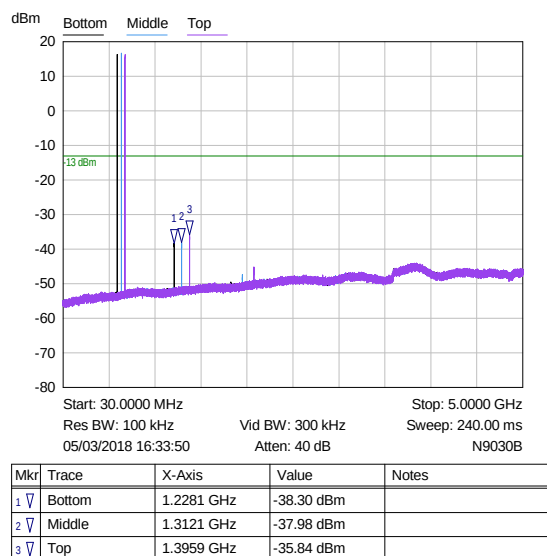
Note: Low, Mid and high channels are shown (overlaid) on a single plot.

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



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



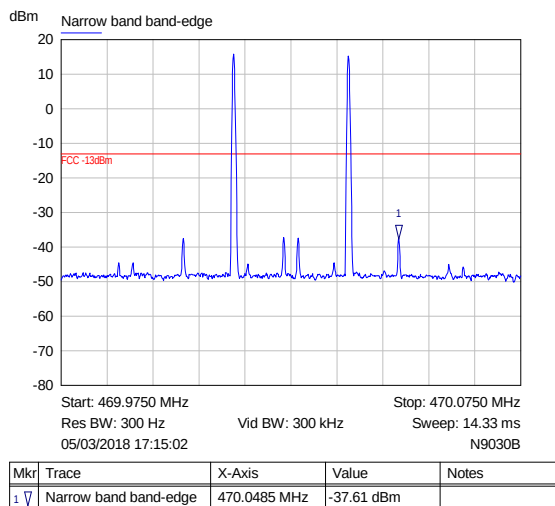
Plot of conducted emissions single Low, Mid and High channels (470-608 MHz band) 30 – 5000 MHz
range

6.5 Out of band dual channel emissions

Please refer to section 6.3 for Mask emissions results.

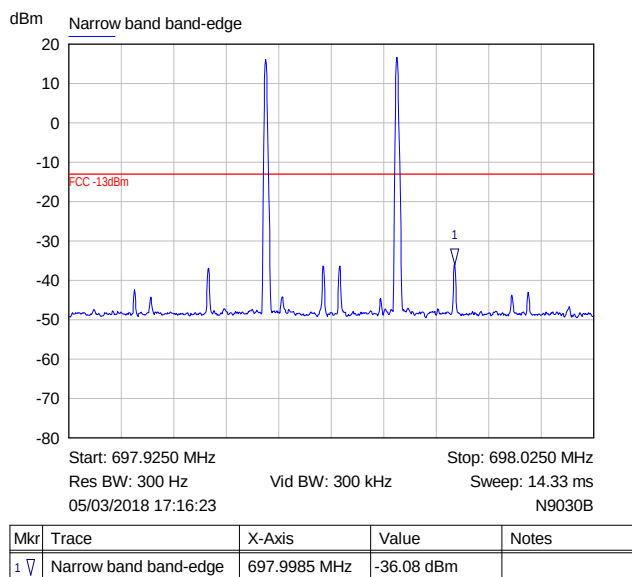
Below plots are for Narrowband dual channel tests.

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



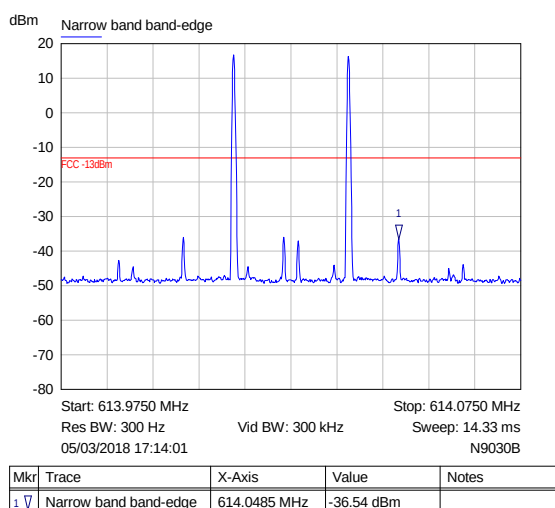
Plot of lower band edge (470MHz)

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



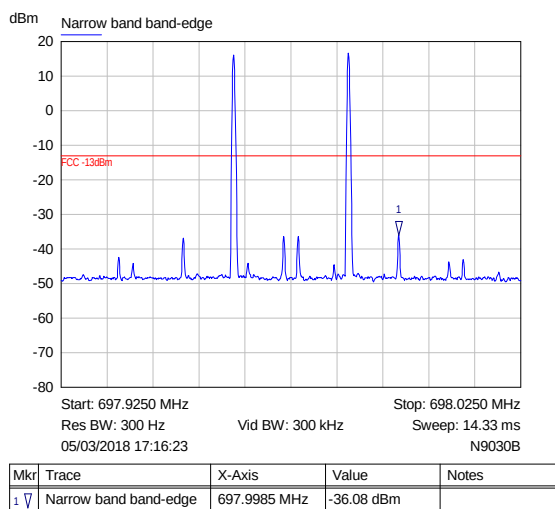
Plot of upper band edge (608MHz)

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



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



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
°C	Degrees Celsius	ms	milliSeconds
C/I	Carrier / Interferer	mW	milliWatts
CEPT	European Conference of Postal and Telecommunications Administrations	NA	Not Applicable
COFDM	Coherent OFDM	nom	Nominal
CS	Channel Spacing	nW	nanoWatt
CW	Continuous Wave	OATS	Open Area Test Site
dB	decibels	OFDM	Orthogonal Frequency Division Multiplexing
dBµA/m	decibels relative to 1µA/m	ppm	Parts per million
dBµV	decibels relative to 1µV	PRBS	Pseudo Random Bit Sequence
dBc	decibels relative to Carrier	QAM	Quadrature Amplitude Modulation
dBm	decibels relative to 1mW	QPSK	Quadrature Phase Shift Keying
DC	Direct Current	R&TTE	Radio and Telecommunication Terminal Equipment
DTA	Digital Transmission Analyser	Ref	Reference
EIRP	Equivalent Isotropic Radiated Power	RF	Radio Frequency
ERP	Effective Radiated Power	RFC	Remote Frequency Control
EU	European Union	RSL	Received Signal Level
EUT	Equipment Under Test	RTP	Room Temperature and Pressure
FM	Frequency Modulation	RTPC	Remote Transmit Power Control
FSK	Frequency Shift Keying	Rx	Receiver
g	Grams	s	Seconds
GHz	GigaHertz	SINAD	Signal to Noise And Distortion
Hz	Hertz	Tx	Transmitter
IF	Intermediate Frequency	V	Volts
kHz	kiloHertz		