



Radio Test Report

Zinwave Ltd

**Zinwave UNItivity 5000 Remote Unit
305-1007**

47 CFR Part 74H Effective Date 1st October 2020

47 CFR Part 2 Effective Date 1st October 2020

Test Date: 14th February to 28th April 2022

Report Number: 03-13344-2-22 Issue 01

R.N. Electronics Ltd.

Arnolds Court
Arnolds Farm Lane
Mountnessing
Essex
CM13 1UT
U.K.

www.RNelectronics.com

Telephone: +44 (0) 1277 352219

Email: sales@RNelectronics.com

This report is not to be reproduced by any means except in full and in any case not without the written approval of R.N. Electronics Ltd.



Arnolds Court, Arnolds Farm Lane, Mountnessing, Brentwood Essex, CM13 1UT

Certificate of Test 13344-2

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of FCC Part 74H. 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:	305-1007
Unique Serial Number:	330100000001 (radiated unit) 330100000003 (conducted unit)
Applicant:	Zinwave Ltd Harston Mill, Royston Road Harston, Cambridge CB22 7GG
Proposed FCC ID	UPO3005-1007
Full measurement results are detailed in Report Number:	03-13344-2-22 Issue 01
Test Standards:	47 CFR Part 74H Effective Date 1st October 2020 47 CFR Part 2 Effective Date 1st October 2020

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: 03-13344-3-22 (Part 27), 03-13344-1-22 (Parts 22 & 24), and 03-13344-4-22 (Part 90).

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: 14th February to 28th April 2022

Test Engineer:

Approved By:
Radio Manager

Customer Representative:



1 Contents

1	Contents	3
2	Equipment under test (EUT)	4
2.1	Equipment specification	4
2.2	Configurations for testing	5
2.3	Functional description	6
2.4	Modes of operation	6
2.5	Emissions configuration	7
3	Summary of test results	8
4	Specifications	9
4.1	Relevant standards	9
4.2	Deviations	9
5	Tests, methods and results	10
5.1	Antenna port conducted spurious emissions	10
5.2	Maximum Average conducted output power	14
5.3	Frequency stability	16
5.4	Occupied bandwidth and bandwidth mask	17
5.5	Radiated emissions	19
5.6	Audio frequency response	22
5.7	Modulation limiting	22
5.8	Determination of f_0	23
6	Plots/Graphical results	25
6.1	Determination of f_0	25
6.2	RF Power Output	27
6.3	Occupied bandwidth / Input versus output signal / Mask	29
6.4	Spurious emissions at antenna terminals	33
6.5	Out of band dual channel emissions	37
7	Photographs	39
8	Test equipment calibration list	40
9	Auxiliary and peripheral equipment	41
9.1	Customer supplied equipment	41
9.2	RN Electronics supplied equipment	41
10	Condition of the equipment tested	42
10.1	Modifications before test	42
10.2	Modifications during test	42
11	Description of test sites	43
12	Abbreviations and units	44

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	305-1007	
Serial Number of EUT	330100000001 (radiated unit) 330100000003 (conducted unit)	
Date Received	11 th February 2022	
Date of Test:	14 th February 2022 to 28 th April 2022	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	6 th May 2022	
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	1.0
Software Version	N/A
Firmware Version	4.209
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 (470-608 MHz and 614-698 MHz this rule part)
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.

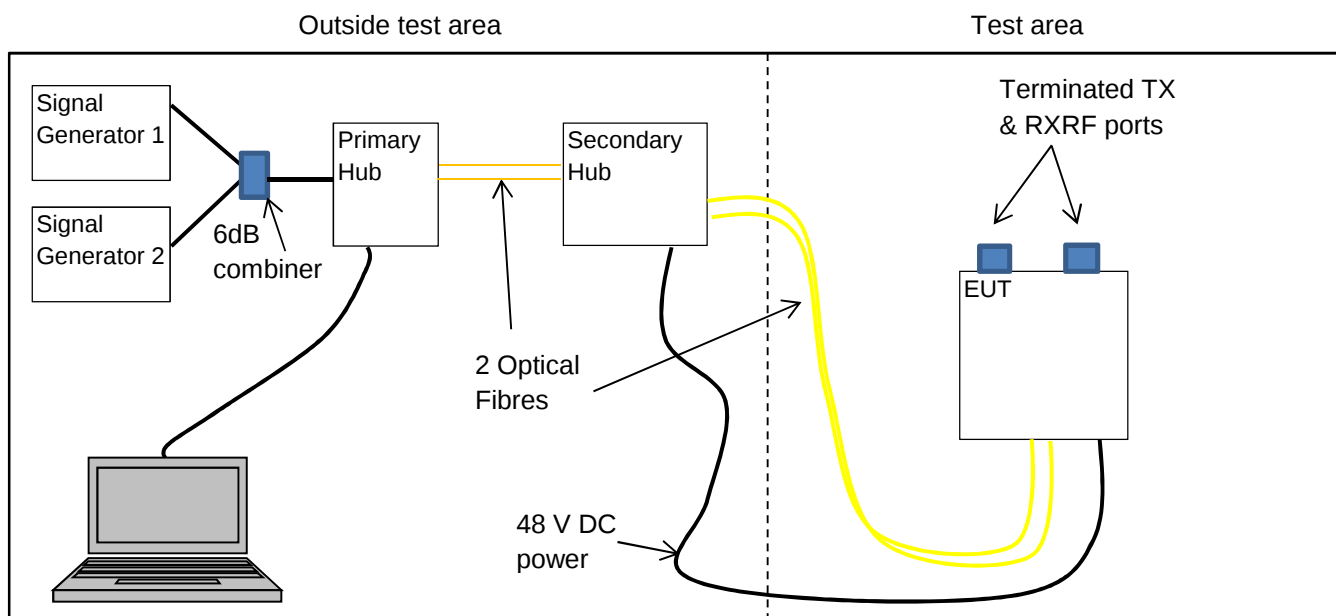
2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 1	CW Sweep from 470-608 MHz to determine f0	Yes
Mode 2	CW Sweep from 614-698 MHz to determine f0	Yes
Mode 3	EUT Being fed a Signal at f0 (608MHz) using FM modulation and 200kHz channel BW in band 470-608 MHz	Yes
Mode 4	EUT Being fed a Signal at f0 (628.042MHz) using FM modulation and 200kHz channel BW in band 614-698 MHz	Yes
Mode 5	EUT Being fed a Signal at 470.0125MHz using FM modulation and 25kHz channel BW	Yes
Mode 6	EUT Being fed a Signal at 566MHz using FM modulation and 25kHz channel BW	Yes
Mode 7	EUT Being fed a Signal at 606.585MHz using FM modulation and 25kHz channel BW	Yes
Mode 8	EUT Being fed a Signal at 614.0125MHz using FM modulation and 25kHz channel BW	Yes
Mode 9	EUT Being fed a Signal at 654MHz using FM modulation and 25kHz channel BW	Yes
Mode 10	EUT Being fed a Signal at 697.9875MHz 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:

03-13344-3-22 (Part 27)
03-13344-1-22 (Parts 22 & 24)
03-13344-4-22 (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. 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 used are stated in test modes section 2.4

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, 305-1007 was tested for compliance to the following standard(s) :

47 CFR Part 74H Effective Date 1st October 2020
47 CFR Part 2 Effective Date 1st October 2020

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	2020	PART 74—EXPERIMENTAL RADIO, AUXILIARY, SPECIAL BROADCAST AND OTHER PROGRAM DISTRIBUTIONAL SERVICES Subpart H - Low Power Auxiliary Stations
4.1.2	47CFR part 2J	2020	Part 2 – Frequency Allocations and radio treaty matters; General rules and regulations
4.1.3	KDB 971168 D01 v03r01	2018	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 v01r04	2020	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 N.

5.1.4 Test equipment

F078, H071, E266, E777, E602

See Section 8 for more details

5.1.5 Test results

Temperature of test environment	17-23°C
Humidity of test environment	35-58%
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	200 kHz
Mod Scheme	75 kHz FM
Low channel	470.1 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
940.295	-27.0	-14.0

Plots	
470-608_MHz_pt1	
470-608_MHz_pt2	

Setup Table

Band	470-608 MHz
Power Level	20 dBm
Channel Spacing	200 kHz
Mod Scheme	75 kHz FM
Mid channel	566 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
1078	-28.1	-15.1

Plots
470-608_MHz_pt1
470-608_MHz_pt2

Setup Table

Band	470-608 MHz
Power Level	20 dBm
Channel Spacing	200 kHz
Mod Scheme	75 kHz FM
High channel	607.9 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
1215.6	-27.0	-14.0

Plots
470-608_MHz_pt1
470-608_MHz_pt2

Setup Table

Band	614-698 MHz
Power Level	20 dBm
Channel Spacing	200 kHz
Mod Scheme	75 kHz FM
Low channel	614.1 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
1228.1	-27.5	-14.5

Plots
614-698_MHz_pt1
614-698_MHz_pt2

Setup Table

Band	614-698 MHz
Power Level	20 dBm
Channel Spacing	200 kHz
Mod Scheme	75 kHz FM
Mid channel	654 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
1312.1	-30.6	-17.6

Plots
614-698_MHz_pt1
614-698_MHz_pt2

Setup Table

Band	614-698 MHz
Power Level	20 dBm
Channel Spacing	200 kHz
Mod Scheme	75 kHz FM
High channel	697.9 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
1395.7	-40.1	-27.1

Plots
614-698_MHz_pt1
614-698_MHz_pt2

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 performed with frequencies centred on f0

Setup Table

Band	470-608 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
Low channels	607.8875 MHz + 607.9125 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
607.8625	-31.9	-18.9

Plots
470-608_MHz._intermodulation

Setup Table

Band	614-698 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
High channels	628.0295 MHz + 628.0545 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
628.0045	-31.8	-18.8

Plots
614-698_MHz_intermodulation

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, mode 3 and mode 4.

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

F078, H071, E266, E777, E602

See Section 8 for more details

5.2.5 Test results

Temperature of test environment	18-23°C
Humidity of test environment	35-58%
Pressure of test environment	100-103kPa

Band	470-608 MHz
Power Level	20 dBm
Channel Spacing	N/A
Mod Scheme	CW
f_0 frequency	607.9 MHz

Test conditions		Average Power (dBm)
Temp Ambient	Volts Nominal	20.93

Band	614-698 MHz
Power Level	20 dBm
Channel Spacing	N/A
Mod Scheme	CW
f_0 frequency	628.042MHz

Test conditions		Average Power (dBm)
Temp Ambient	Volts Nominal	20.59

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 ± 75 kHz was used.

5.4.4 Test equipment

F078, H071, E266, E777, E602

See Section 8 for more details

5.4.5 Test results

Temperature of test environment 18-24°C
Humidity of test environment 35-58%
Pressure of test environment 100-103kPa

Band	470-608 MHz
Power Level	20 dBm
Channel Spacing	200 kHz
Mod Scheme	± 75 kHz FM
f_0 frequency	607.9 MHz

Plot reference	607.9MHz_OBW 470-608 MHz band EN 300 422-1 v1.4.2 mask
----------------	---

Band	614-698 MHz
Power Level	20 dBm
Channel Spacing	200 kHz
Mod Scheme	± 75 kHz FM
Frequency	628.042 MHz

Plot reference	628.042 MHz_OBW 614-698 MHz band EN 300 422-1 v1.4.2 mask
----------------	--

Results are also presented graphically in section 6

LIMITS:

74.861(e)(5) The operating bandwidth shall not exceed 200 kHz.

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 – 7GHz.

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 – 7 GHz at 1.2metres.

Tests were performed in test sites B & M.

5.5.4 Test equipment

E624, E411, LPE364, E743, E136, TMS82, E602, E268, Cal07, E463, E478, F031, E621, E412, E296-2, E330

See Section 8 for more details

5.5.5 Test results

Temperature of test environment	13-18°C
Humidity of test environment	51-68%
Pressure of test environment	100-102kPa

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 **modes 1** and **2**.

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).

5.8.4 Test equipment

F078, H071, E266, E777, E602

See Section 8 for more details

5.8.5 Test results

Temperature of test environment 17-23°C
 Humidity of test environment 35-56%
 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	608
Plot ref	470-608_MHZ_f0

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	628.042
Plot ref	614-698_MHZ_f0

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

Results are also presented graphically in section 6.

LIMITS:

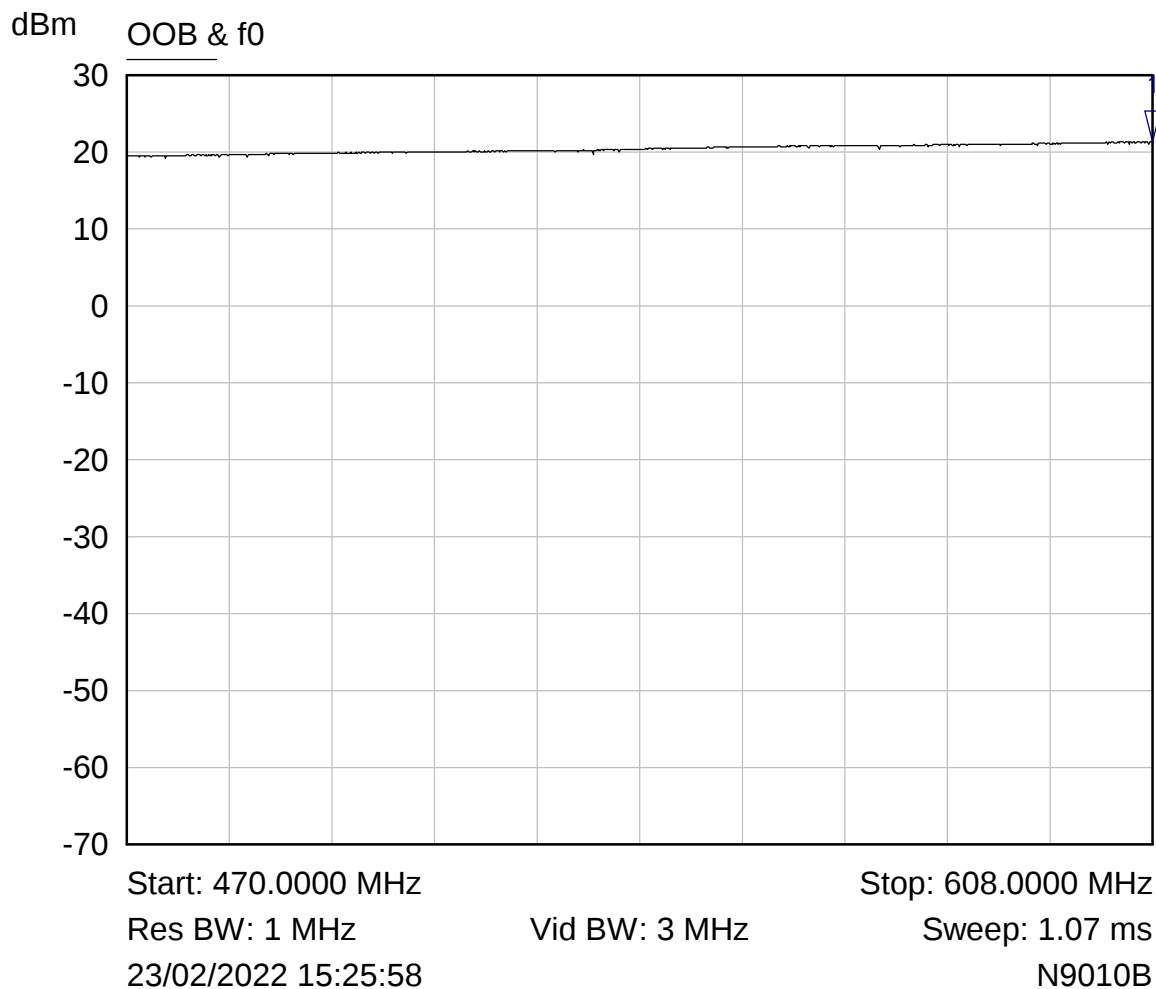
None.

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

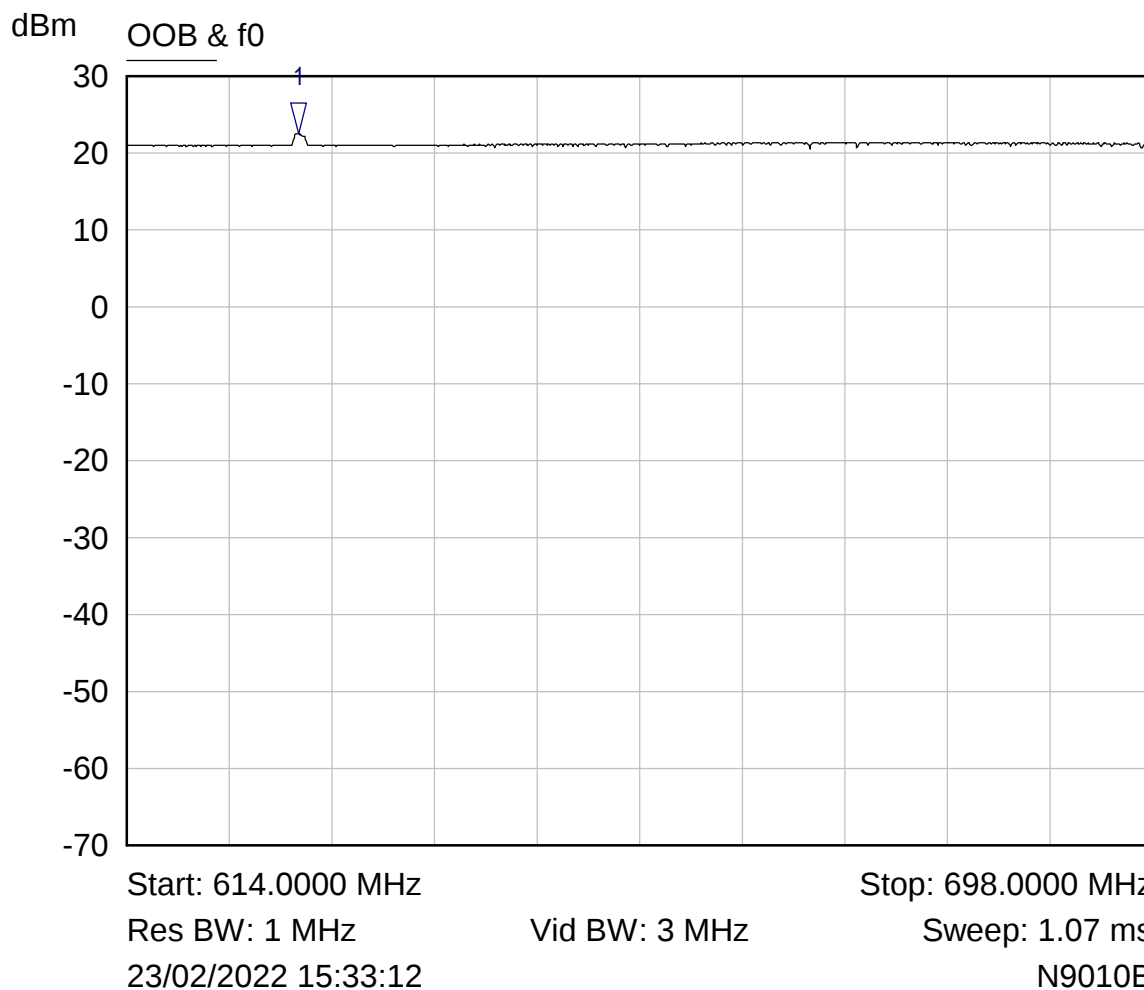
RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing N/A, Modulation N/A,
Channel N/A



Mkr	Trace	X-Axis	Value	Notes
1 ▾	OOB & f0	608.0000 MHz	21.33 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

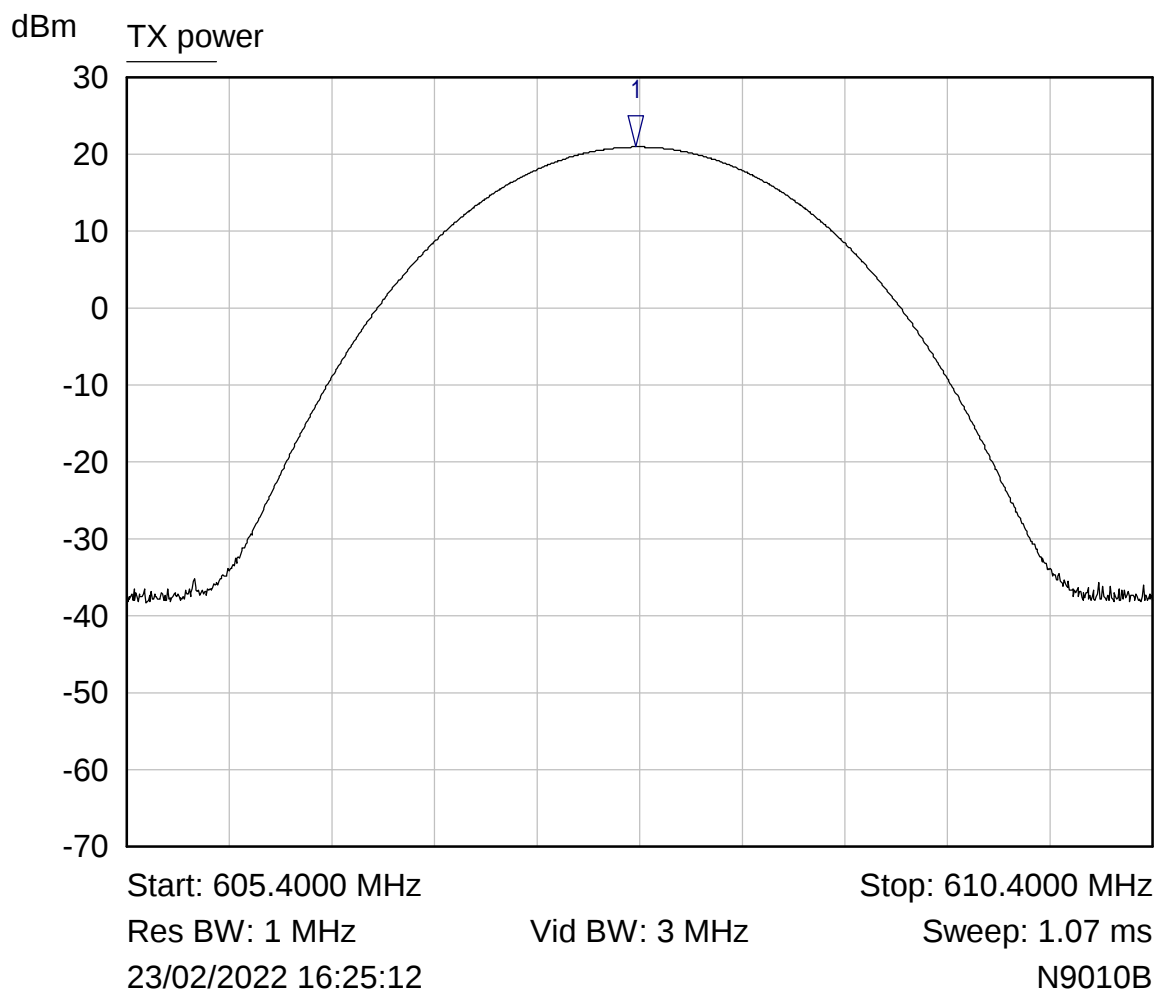


Mkr	Trace	X-Axis	Value	Notes
1 ▽	OOB & f0	628.0420 MHz	22.48 dBm	f0

Plot of f0 determined in band 614-698 MHz.

6.2 RF Power Output

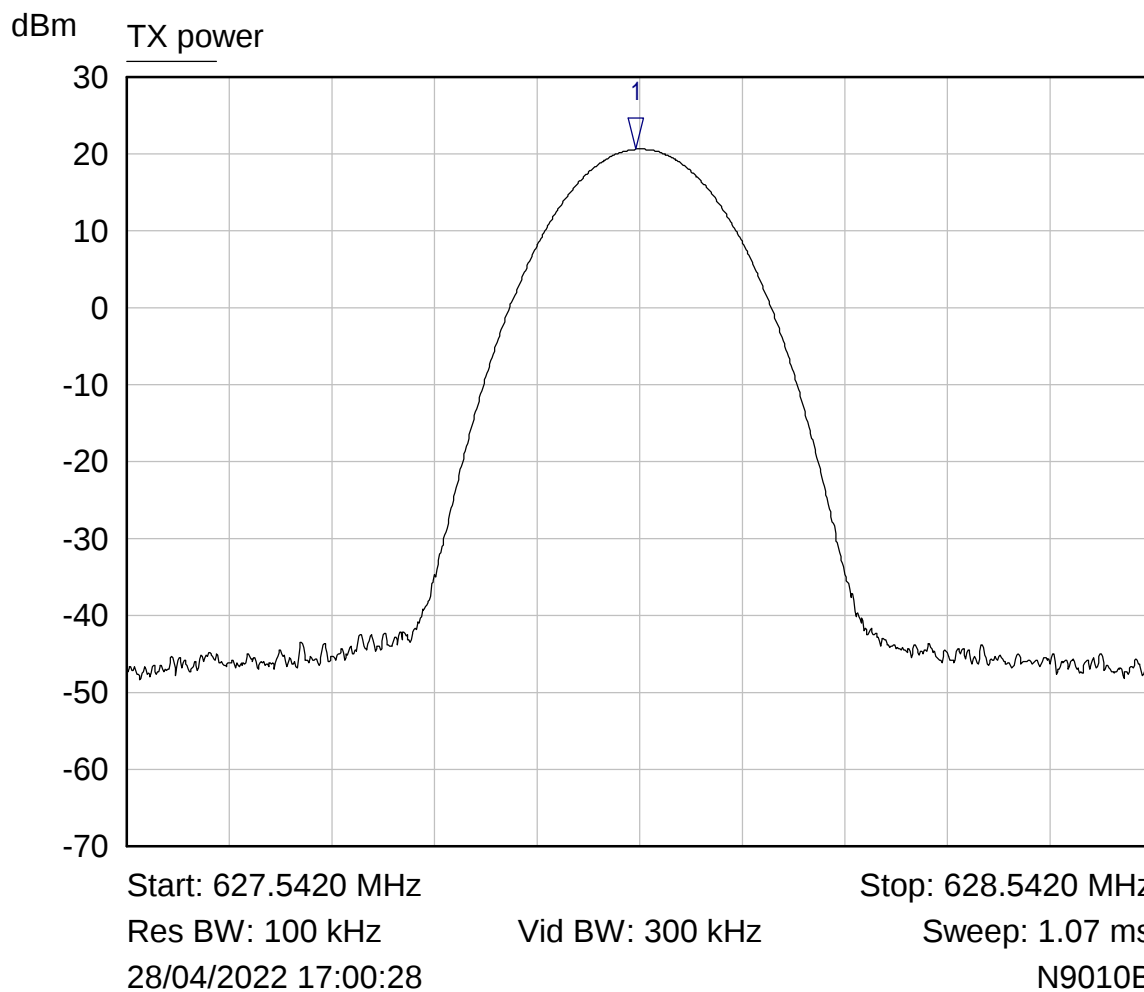
RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing N/A, Modulation CW,
Channel 607.9 MHz (channel centre near determined f_0 608 MHz)



Mkr	Trace	X-Axis	Value	Notes
1 ▾	TX power	607.8825 MHz	20.93 dBm	

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,
628.042 MHz determined f_0

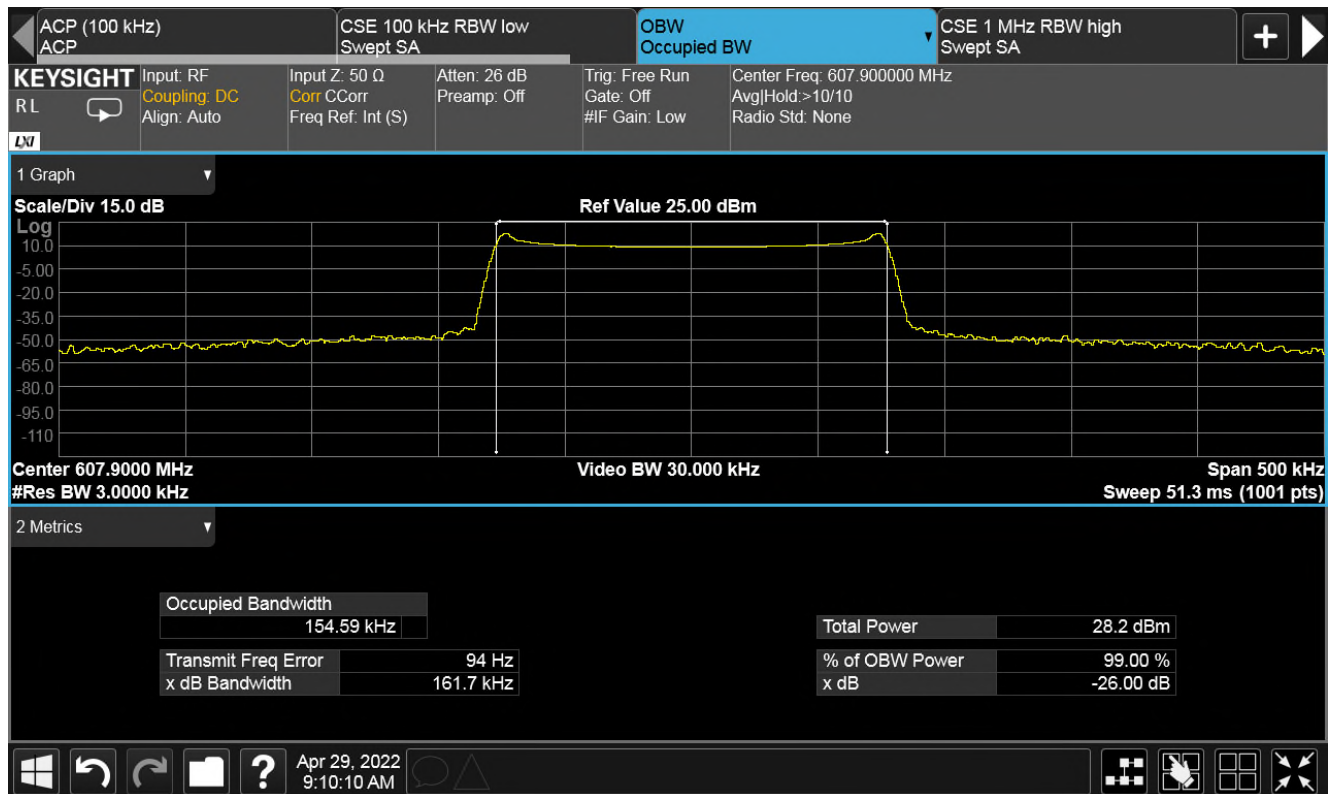


Mkr	Trace	X-Axis	Value	Notes
1 ▽	TX power	628.0385 MHz	20.59 dBm	

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

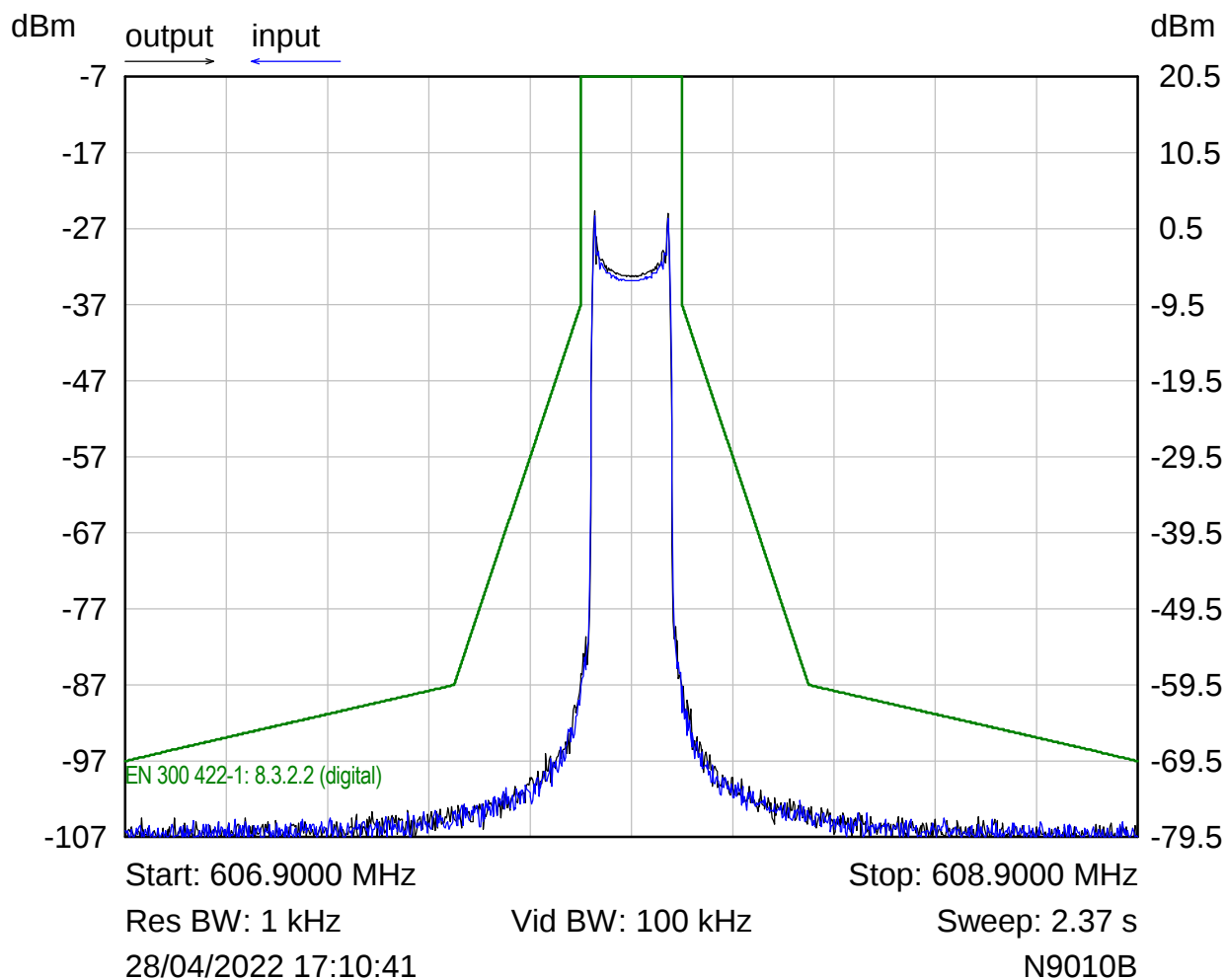
6.3 Occupied bandwidth / Input versus output signal / Mask

RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing 200kHz, Modulation FM,
Channel 607.9 MHz (channel centre near determined f_0 608 MHz)



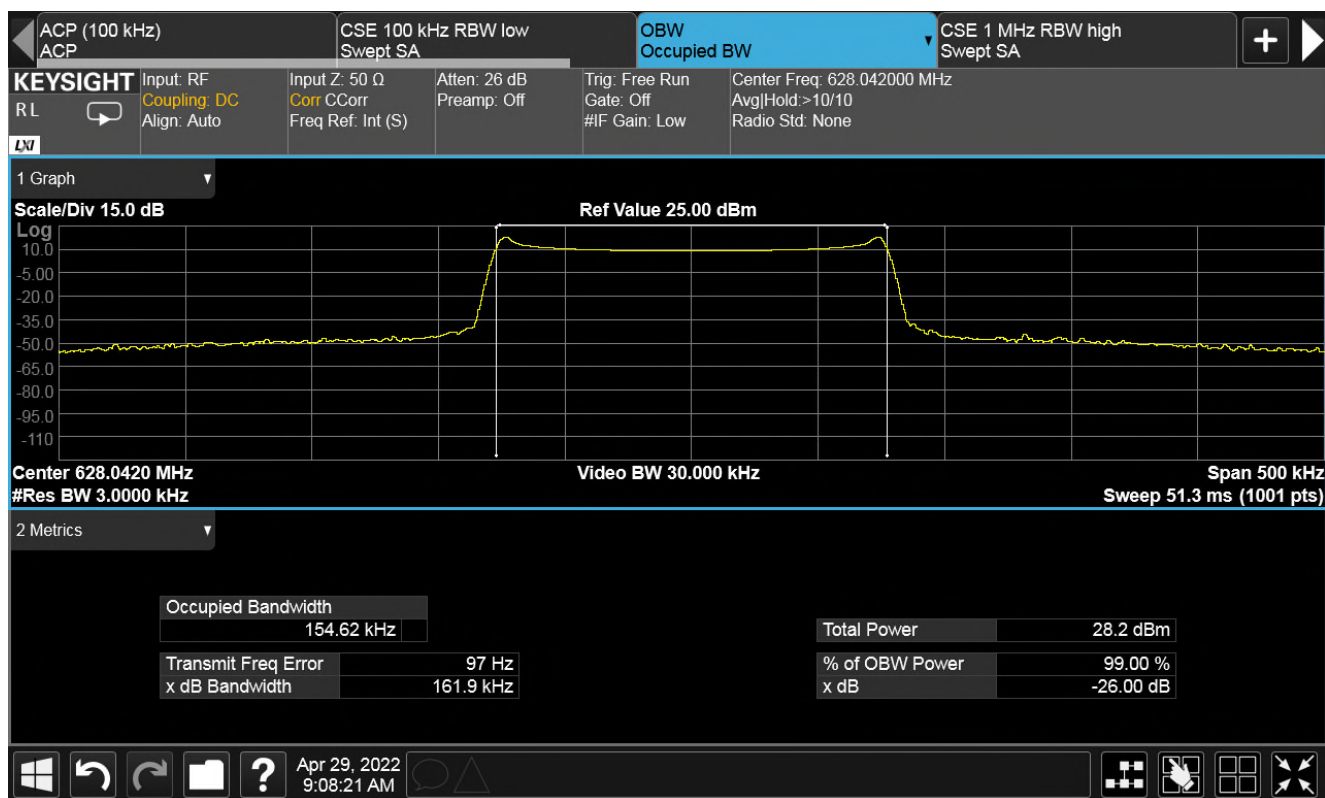
Occupied Bandwidth 607.9 MHz

RF Parameters: Band 470-608 MHz, Maximum power, Modulation FM,
Channel 607.9 MHz (channel centre near determined f_0 608 MHz)
470-608 MHz band EN 300 422-1 v1.4.2 mask



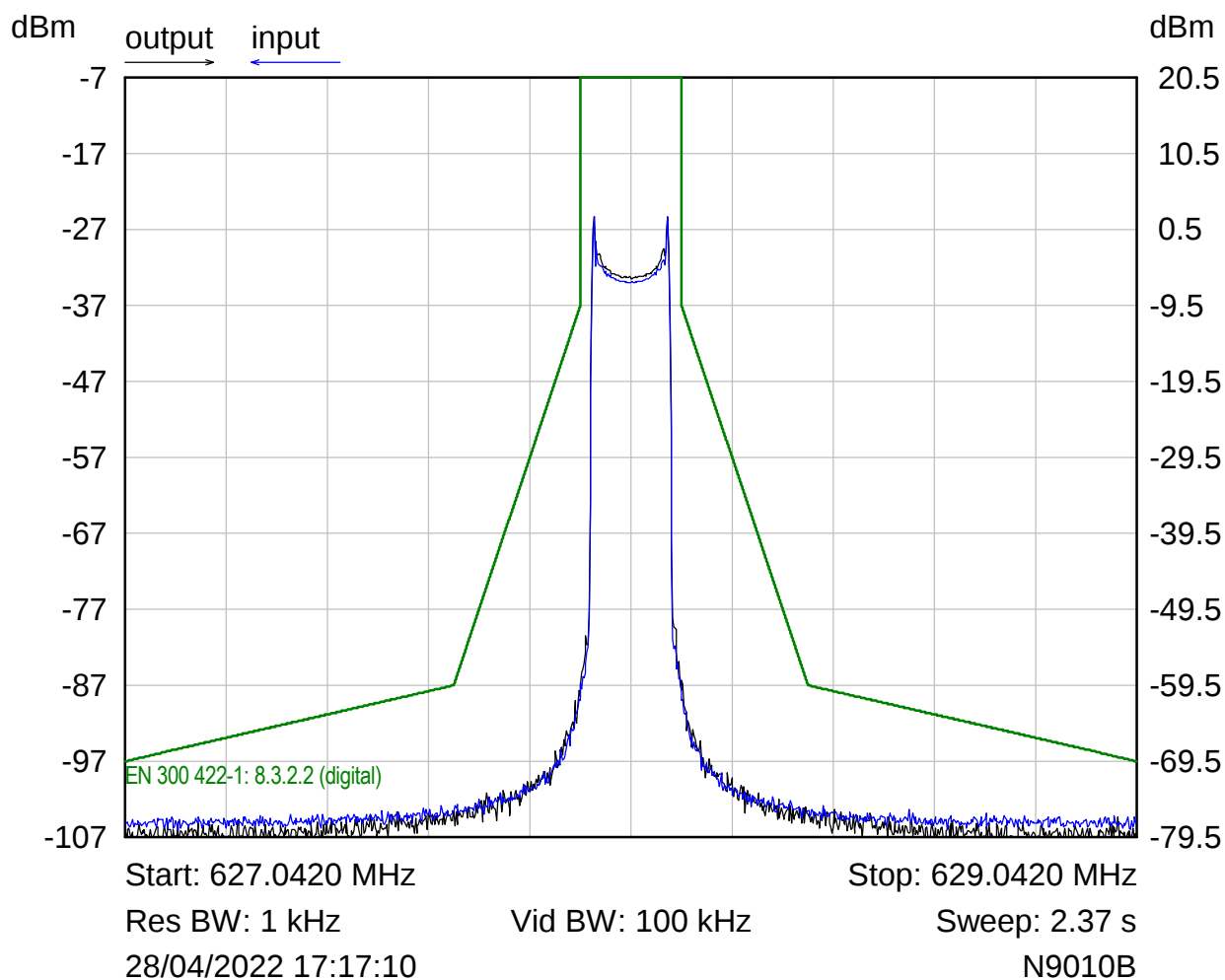
Input vs output graph for ETSI EN 300 422-1 v1.4.2 mask at 607.9 MHz

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



Occupied Bandwidth 628.042 MHz

RF Parameters: Band 614-698 MHz, Maximum power, Modulation FM, 628.042 MHz determined f_0
614-698 MHz band EN 300 422-1 v1.4.2 mask

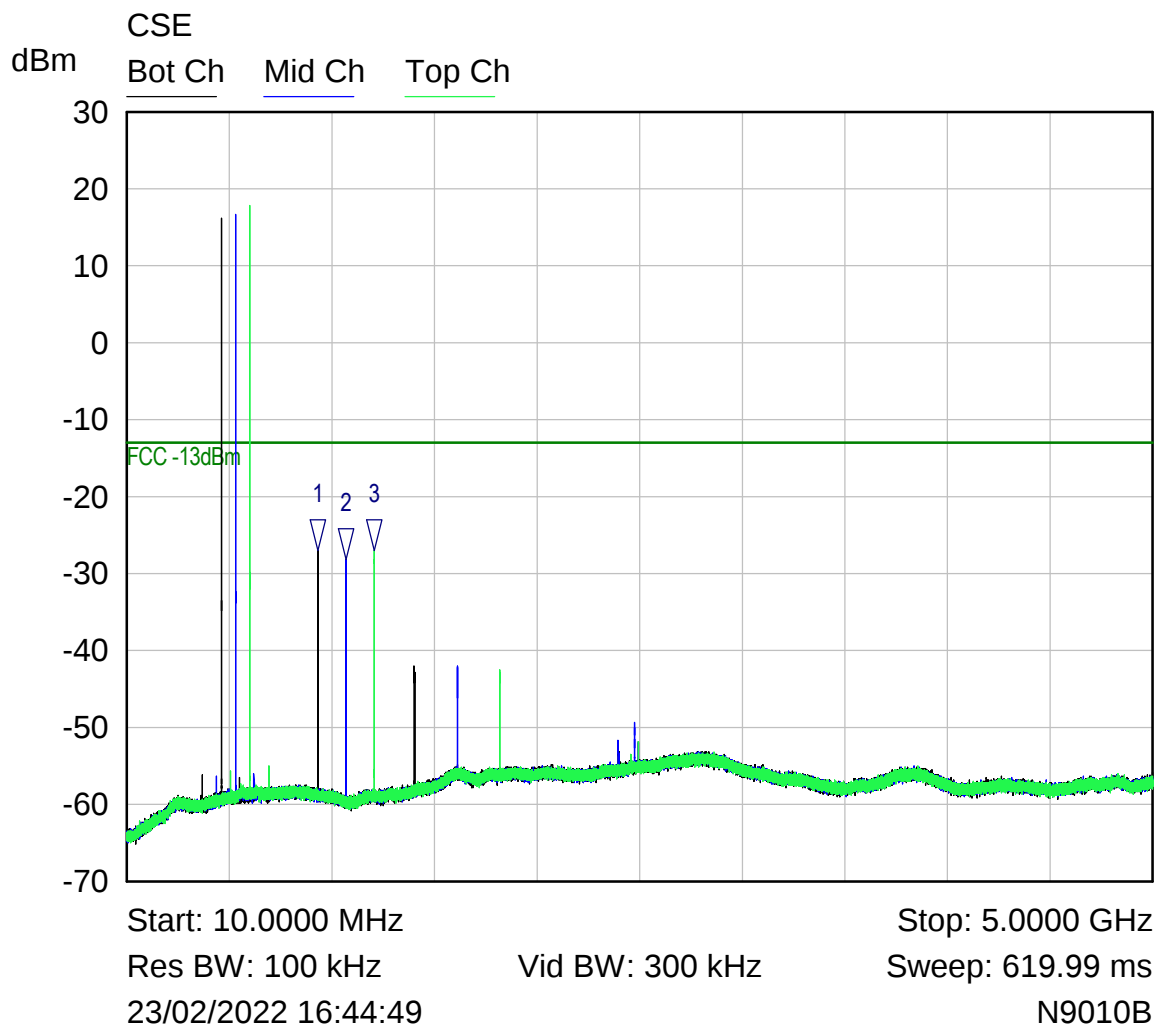


Input vs output graph for ETSI EN 300 422-1 v1.4.2 mask at 628.042 MHz

6.4 Spurious emissions at antenna terminals

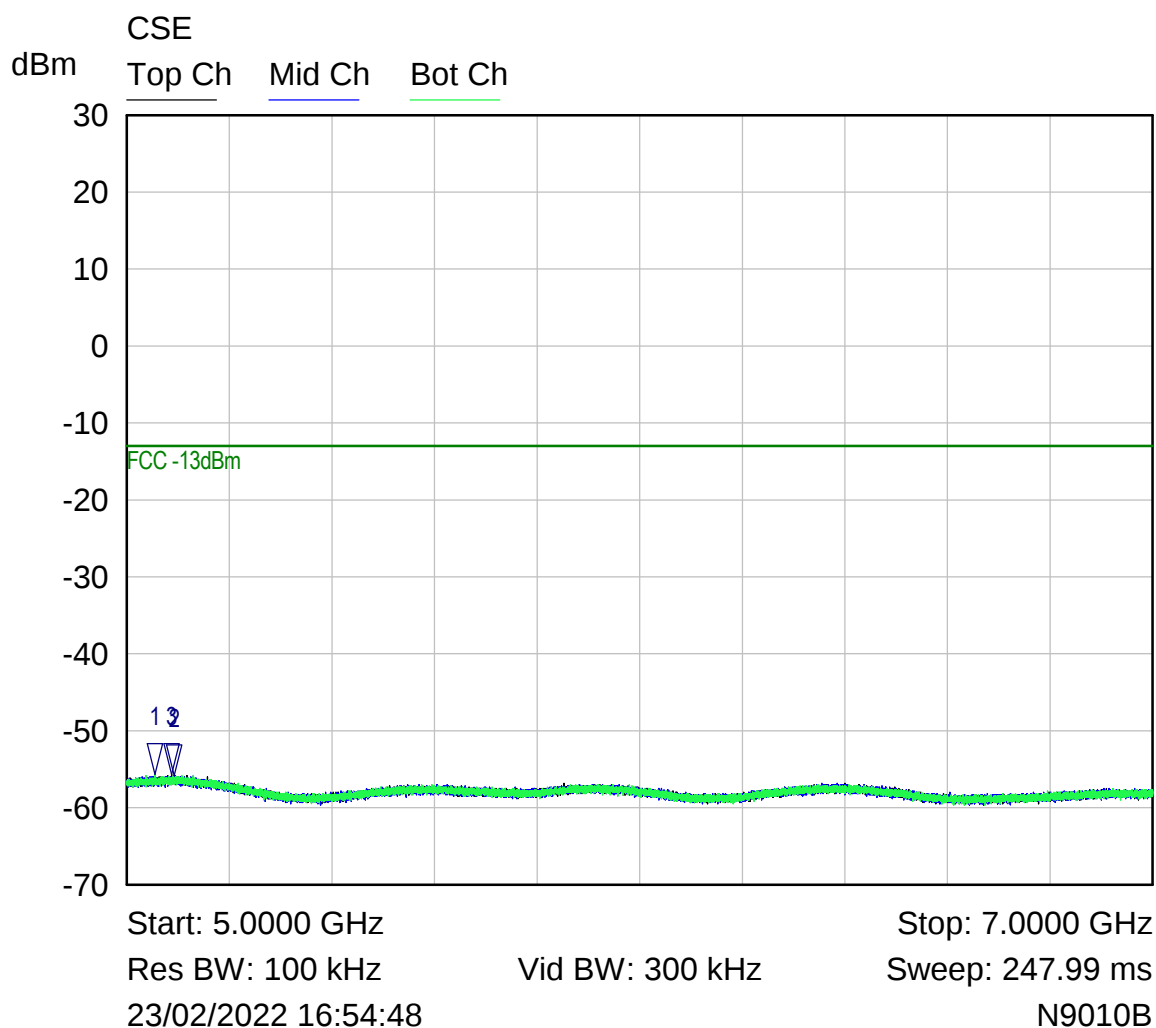
Note: Low, Mid and high channels are shown (overlaid) on a single plot.

RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing 200 kHz, Modulation FM,
Channels 470.1 MHz, 566 MHz and 469.9 MHz, Single channel mode



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bot Ch	940.2950 MHz	-26.98 dBm	
2 ▽	Mid Ch	1.0780 GHz	-28.10 dBm	
3 ▽	Top Ch	1.2156 GHz	-26.99 dBm	

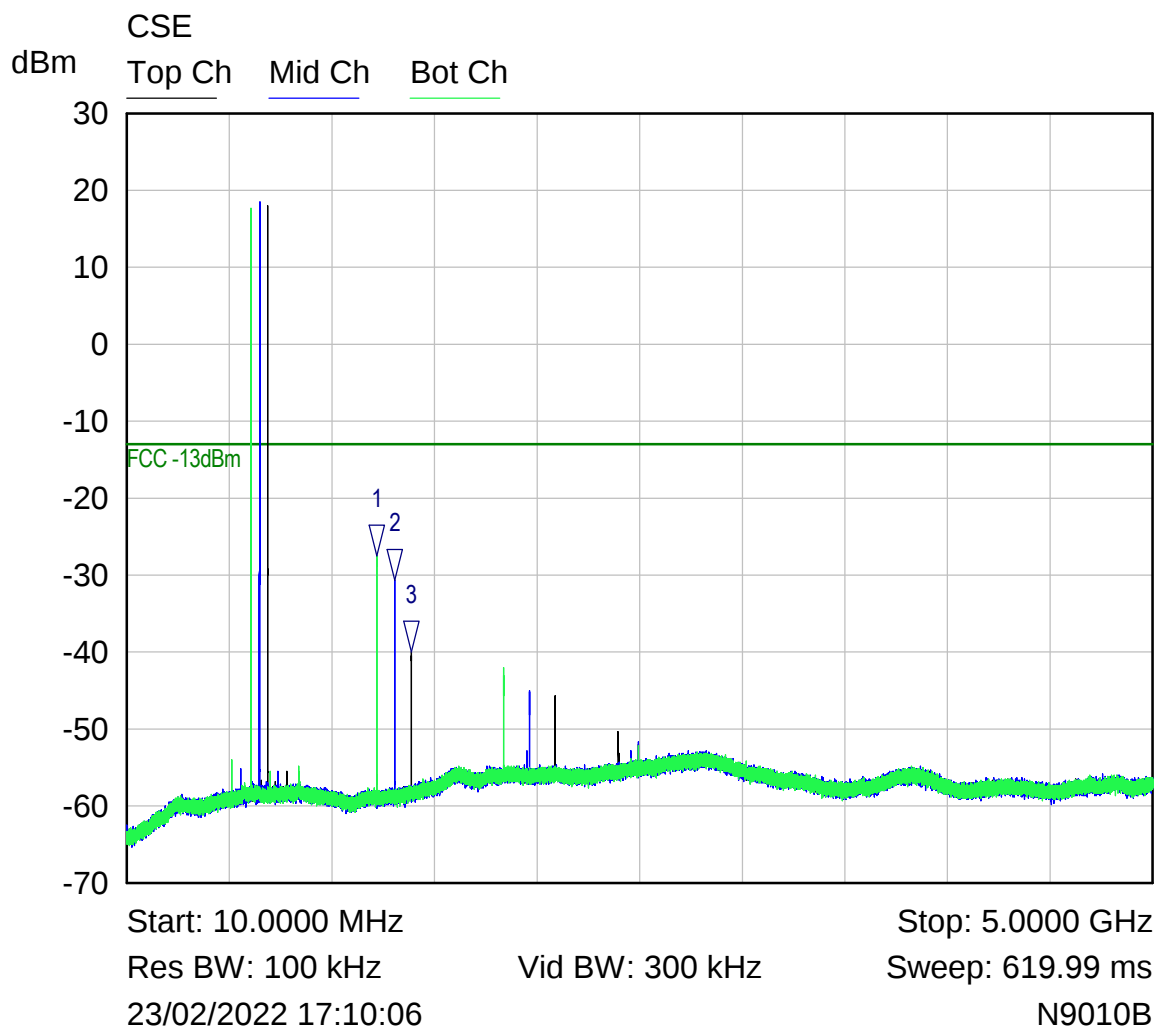
Plot of conducted emissions single Low, Mid and High channels (470-608 MHz band) 10 – 5000 MHz range



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bot Ch	5.0550 GHz	-55.61 dBm	
2 ▽	Mid Ch	5.0931 GHz	-55.76 dBm	
3 ▽	Top Ch	5.0880 GHz	-55.74 dBm	

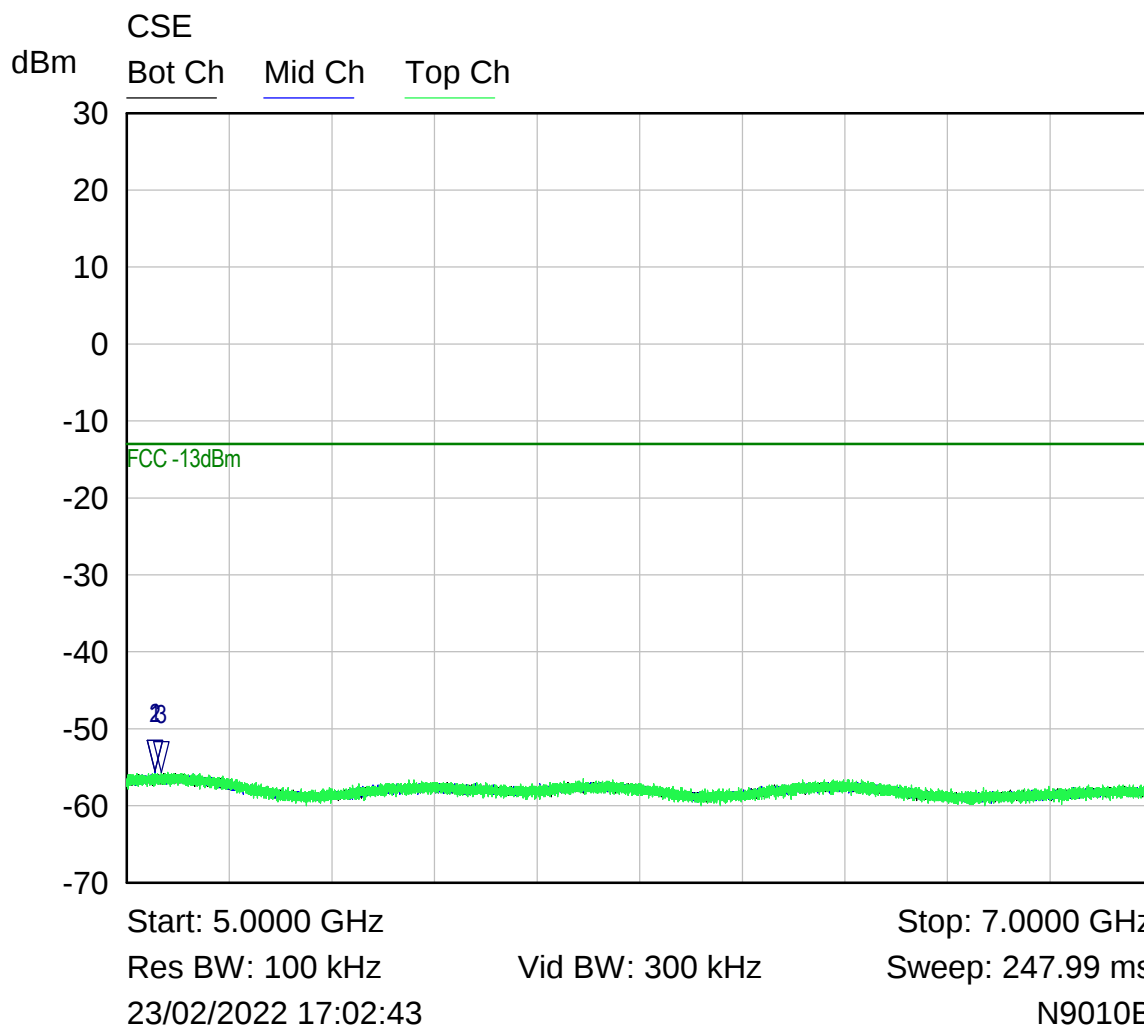
Plot of conducted emissions single Low, Mid and High channels (470-608 MHz band) 5 – 7 GHz range

RF Parameters: Band 614-698 MHz, Power +20 dBm, Channel Spacing 200 kHz, Modulation FM,
Channels 614.1 MHz, 654 MHz and 697.9 MHz, Single channel mode



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bot Ch	1.2281 GHz	-27.49 dBm	
2 ▽	Mid Ch	1.3121 GHz	-30.64 dBm	
3 ▽	Top Ch	1.3957 GHz	-40.07 dBm	

Plot of conducted emissions single Low, Mid and High channels (614-698 MHz band) 10 – 5000 MHz range



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bot Ch	5.0550 GHz	-55.49 dBm	
2 ▽	Mid Ch	5.0550 GHz	-55.57 dBm	
3 ▽	Top Ch	5.0672 GHz	-55.62 dBm	

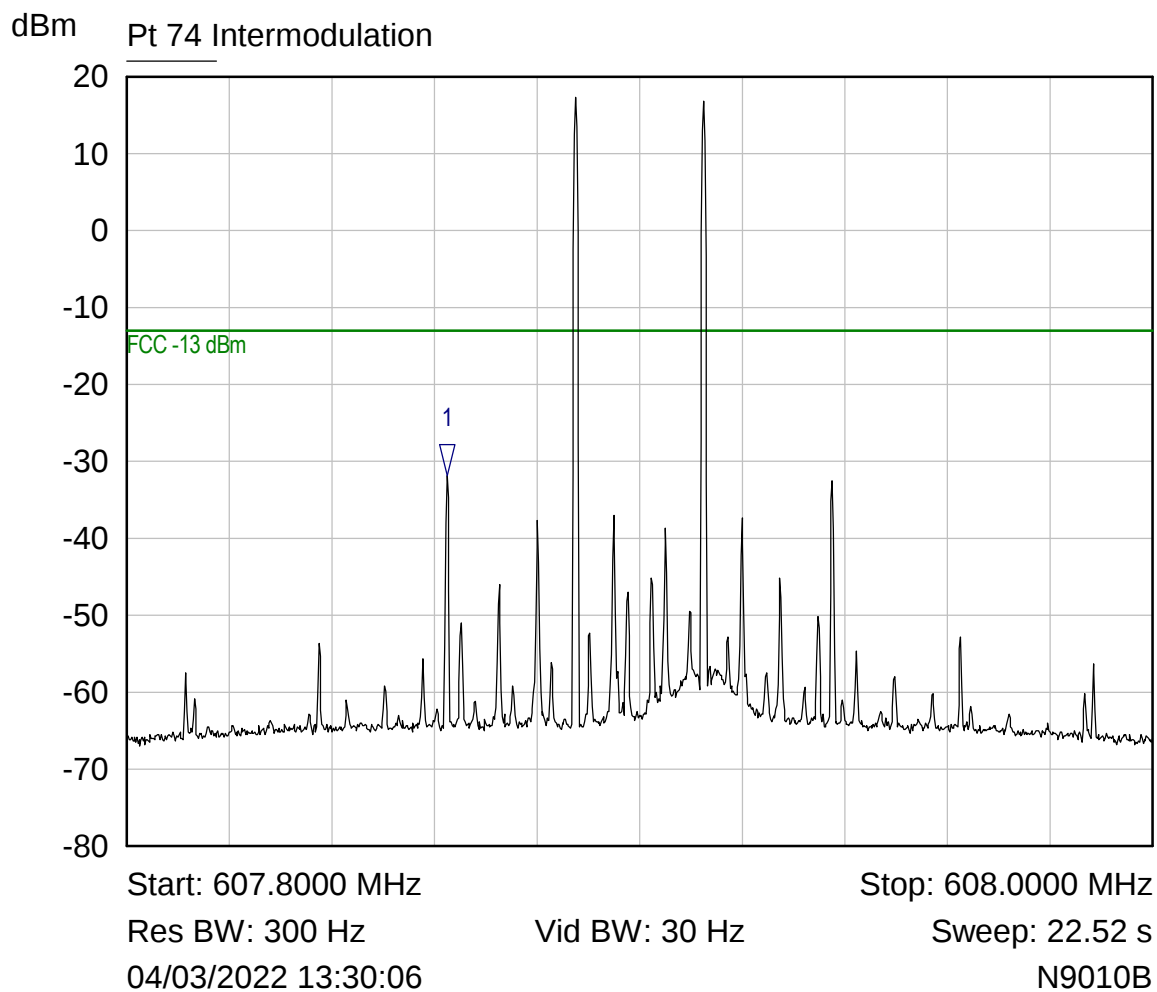
Plot of conducted emissions single Low, Mid and High channels (614-698 MHz band) 5 – 7 GHz range

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.

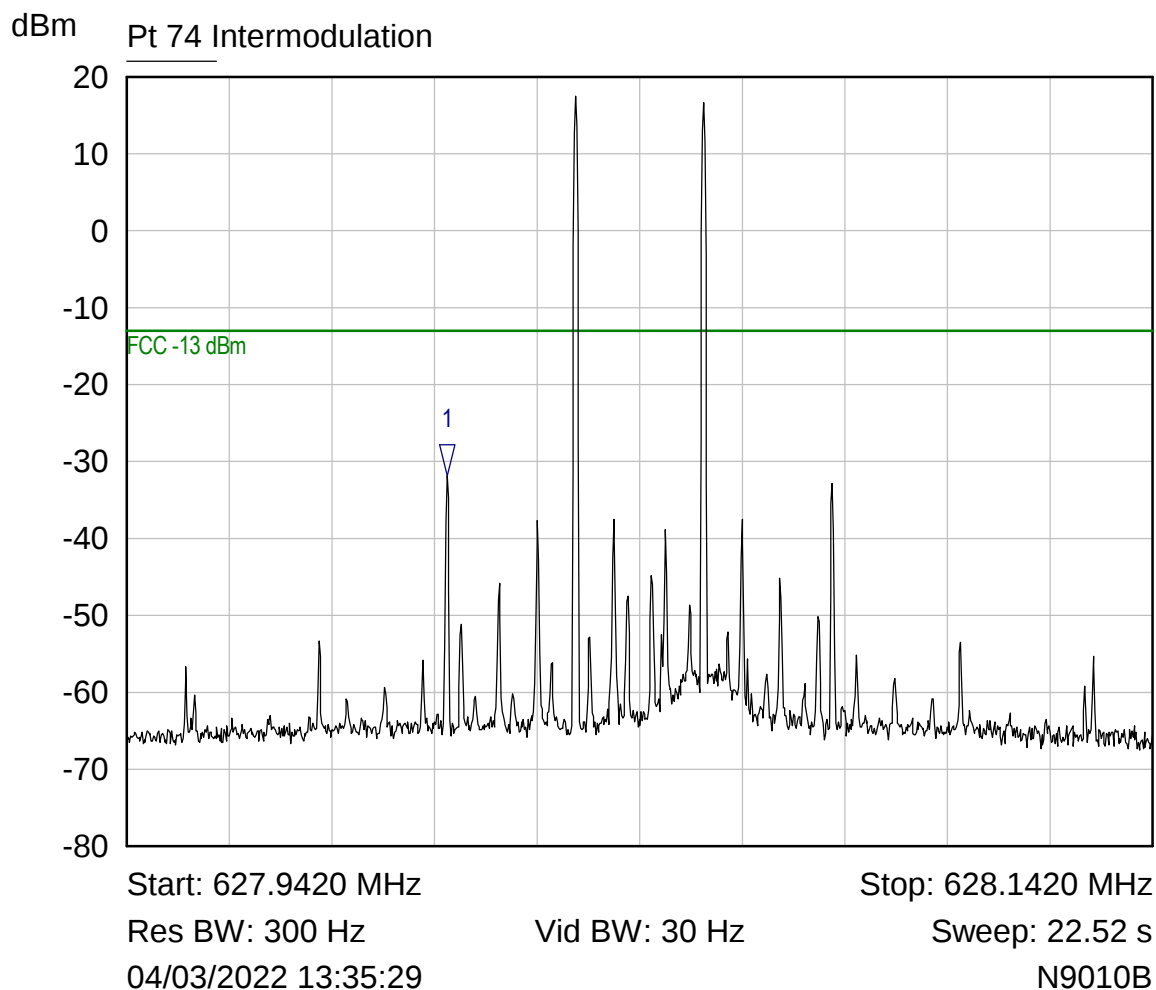
RF Parameters: Band 470-608 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW,
Channel 607.8875 MHz + 607.9125 MHz, Dual channel mode



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Pt 74 Intermodulation	607.8625 MHz	-31.88 dBm	

Plot of 2 channel intermodulation for 470-608 MHz band
(Note: centre frequency is the 200 kHz channel nearest to f0 within the band of operation)

RF Parameters: Band 614-698 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW,
Channel 628.0295 MHz + 628.0545 MHz, Dual channel mode



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Pt 74 Intermodulation	628.0045 MHz	-31.83 dBm	

Plot of 2 channel intermodulation for 614-698 MHz band

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
CAL07	MWX221	Cable N Type to SMA Blue 2m	Junflon	14-Dec-2021	6 months
E136	3105	Horn Antenna 1 - 12.5 GHz	EMCO	#02-Apr-2022	12 months
E266	2032	Signal Generator 10kHz - 5.4GHz	Marconi Instruments	24-Jan-2022	12 months
E268	BHA 9118	Horn Antenna 1 - 18 GHz	Schaffner	#02-Apr-2022	12 months
E296-2	11970A	Harmonic Mixer 26.5-40GHz	Hewlett Packard	07-Jul-2021	12 months
E330	2224-20	Horn Antenna 26.5-40GHz	Flann (FMI)	#22-Apr-2022	12 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	08-Jul-2021	12 months
E412	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	30-Jun-2020	24 months
E463	8431A	Filter Band pass 2-4 GHz	Hewlett Packard	25-Oct-2021	12 months
E478	LQ2992/H	Filter Band pass 1-3GHz	RACAL-MESL	#11-Mar-2022	12 months
E602	MG3692A	Signal Generator 10 MHz - 20 GHz	Anritsu	#21-Feb-2022	12 months
E621	360B	Filter Low Pass Filter 1200 MHz	Hewlett Packard	N/A	N/A
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	08-Jul-2021	24 months
E743	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	#10-Mar-2022	12 months
E777	MG3695B	Signal Generator 8 MHz - 50 GHz	Anritsu	14-Jun-2021	12 months
F031	X6L120-1250-0017-0001-00	Filter Low Pass 1250MHz	K&L Microwave Inc	N/A	N/A
F078	AA18-10H	Attenuator SMA 10dB 18GHz	AtlanTecRF	30-Jul-2021	12 months
H071	N9010B	EXA Signal Analyser 10 Hz to 44 GHz	Keysight Technologies	09-Nov-2020	24 months
LPE364	CBL6112A	Antenna BiLog 30MHz - 2GHz	Chase Electronics Ltd	#28-Mar-2022	24 months
TMS82	8449B	Pre-Amplifier 1GHz - 26.5GHz	Agilent Technologies	16-Dec-2021	12 months

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

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	UNAT-20+	20 dB attenuator	Mini-Circuits	-
5	UNAT-20+	20 dB attenuator	Mini-Circuits	-
6	305-0001	UNItivity 5000 Primary Hub	Zinwave Ltd	650110010101
7	305-0004	Zinwave Secondary Hub	Zinwave Ltd	621100002218
8	E4433B	ESG-D signal generator	Keysight	GB38450326
9	E4433B	ESG-D signal generator	Keysight	GB39340714
10	-	Dual long fibre optic cables	-	-
11	-	DC power cable	-	-
12	-	Male to Male N RF cables (x4)	-	-
13	305-0001	UNItivity 5000 primary hub	Zinwave Ltd	650110010102
14	305-0004	Zinwave Secondary Hub	Zinwave Ltd	620110000204

9.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
E558	18N20W-30dB	Attenuator 30dB 20W	Inmet	-

10 Condition of the equipment tested

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

10.1 Modifications before test

No modifications were made before test by RN Electronics Ltd.

10.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

11 Description of test sites

Site A	Radio Laboratory and Anechoic Chamber
Site B	Semi-Anechoic Chamber and Control Room FCC Registration No. 293246, ISED Registration No. 5612A-4
Site C	Transient Laboratory
Site D	Screened Room (Conducted Immunity)
Site E	Screened Room (Control Room for Site D)
Site F	Screened Room (Conducted Emissions)
Site G	Screened Room (Control Room for Site H)
Site H	3m Semi-Anechoic Chamber (indoor OATS) FCC Registration No. 293246, ISED Registration No. 5612A-2, VCCI Registration No. 4065
Site J	Transient Laboratory
Site K	Screened Room (Control Room for Site M)
Site M	3m Semi-Anechoic Chamber (indoor OATS) FCC Registration No. 293246, ISED Registration No. 5612A-3
Site N	Radio Laboratory
Site Q	Fully-Anechoic Chamber
Site OATS 3m and 10m Open Area Test Site	FCC Registration No. 293246, ISED Registration No. 5612A-1
Site R	Screened Room (Conducted Immunity)
Site S	Safety Laboratory
Site T	Transient Laboratory

RN Electronics CAB identifier as issued by Innovation, Science and Economic Development Canada is UK0002
RN Electronics CAB identifier as issued by FCC is UK0015

12 Abbreviations and units

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