Radio Test Report

Zinwave Ltd

Zinwave UNItivity 5000 Remote Unit

305-1007

47 CFR Part 22 Effective Date 1st October 2020
47 CFR Part 24 Effective Date 1st October 2020
47 CFR Part 2 Effective Date 1st October 2020
Test Date: 14th February 2022 to 28th April 2022
Report Number: 03-13344-1-22 Issue 01

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Certificate of Test 13344-1

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of FCC Parts 22 & 24. 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:	03-13344-1-22 Issue 01
Test Standards:	47 CFR Part 22 Effective Date 1st October 2020 47 CFR Part 24 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 parts 22 & 24, for details of testing to other rule parts please see RN reports: 03-13344-3-22 (Part 27), 03-13344-2-22 (Part 74H), 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 2022 to 28th April 2022
Test Engineer:	Charles Blatt
Approved By: Radio Manager	Digitally signed by: Daniel Sims DN: CN = Daniel Sims C = GB O = RN Electronics Ltd Date: 2022.05.03 16:54:36 Z
Customer Representative:	

1 Contents

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	11th February 2022	
Date of Test:	14th February 2022 to 28th 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	3rd 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, but 1995MHz is maximum frequency for these rule parts
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
EUT Declared Modulation Parameters	Device supports Public Mobile Radio Services and personal Communications services under this rule part
EUT Declared Power level	+20dBm
EUT Declared Signal Bandwidths	Device supports Public Mobile Radio Services and personal Communications services under this rule part
EUT Declared Channel Spacing's	Device supports Public Mobile Radio Services and personal Communications services under this rule part
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

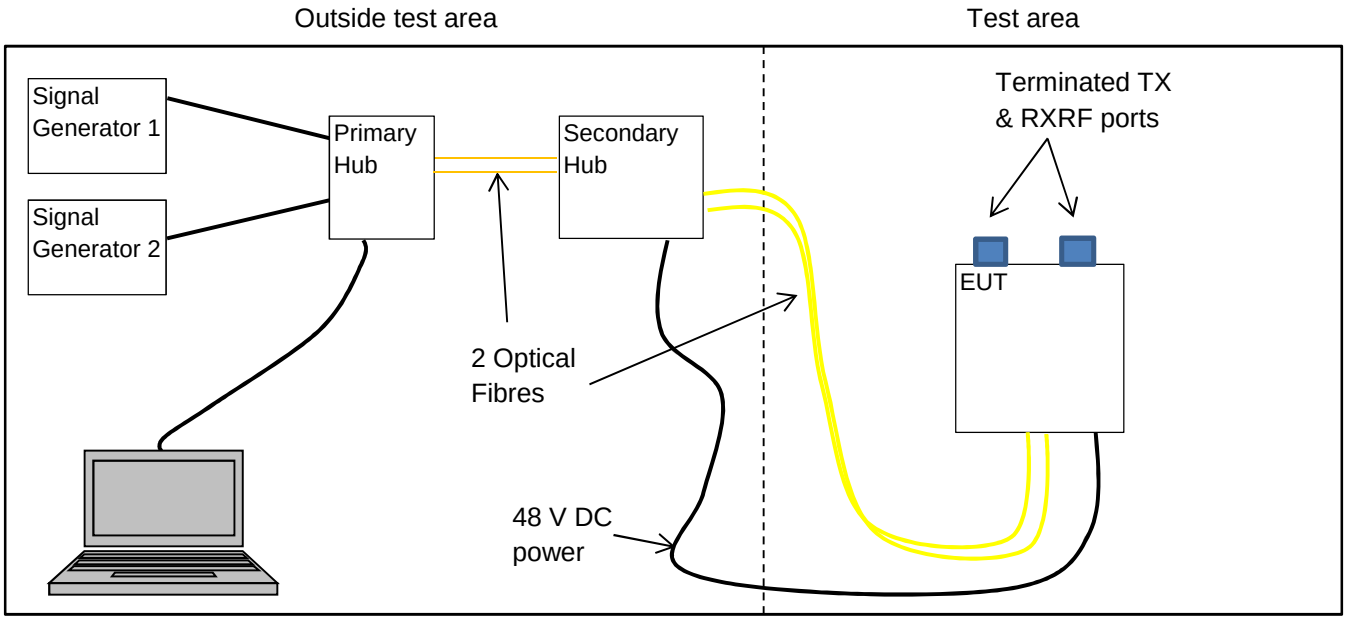
The Remote Unit is used as part of the Zinwave UNItivity 5000 system to provide cellular and private radio services within buildings, sports arenas and similar areas.
The system is wideband in nature and can support a wide range of radio services depending upon the system that is connected to the service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

2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 1	CW Sweep from 869-894 MHz to determine f0	Yes
Mode 2	Single mode Channel AWGN at f0 (869.075MHz) in band 869-894 MHz	Yes
Mode 3	Single Low channel AWGN at 871.5 MHz	Yes
Mode 4	Single Mid channel AWGN at 881.5 MHz	Yes
Mode 5	Single High channel AWGN at 891.5 MHz	Yes
Mode 6	Dual Low channel AWGN at 871.5 MHz & 876.5 MHz	Yes
Mode 7	Dual High channel AWGN at 886.5 MHz & 891.5 MHz	Yes
Mode 8	CW Sweep from 929 – 930 MHz to determine f0	Yes
Mode 9	Single mode Channel CW at f0 (929.2503MHz) in band 929 – 930 MHz	Yes
Mode 10	Single Low channel CW at 929.0125 MHz	Yes
Mode 11	Single Mid channel CW at 929.5 MHz	Yes
Mode 12	Single High channel CW at 929.9875 MHz	Yes
Mode 13	Dual channel CW at 929.2375 and 929.2625 MHz	Yes
Mode 14	CW Sweep from 931 – 932 MHz to determine f0	Yes
Mode 15	Single mode Channel CW at f0 (931.1612MHz) in band 931 – 932 MHz	Yes
Mode 16	Single Low channel CW at 931.0125 MHz	Yes
Mode 17	Single Mid channel CW at 931.5 MHz	Yes
Mode 18	Single High channel CW at 931.9875 MHz	Yes
Mode 19	Dual channel CW at 931.150 and 931.1725 MHz	Yes
Mode 20	CW Sweep from 1930 – 1995 MHz to determine f0	Yes
Mode 21	Single mode Channel AWGN at f0 (1930.8MHz) in band 1930 – 1995 MHz	Yes
Mode 22	Single Low channel AWGN at 1932.5 MHz	Yes
Mode 23	Single Mid channel AWGN at 1962.5 MHz	Yes
Mode 24	Single High channel AWGN at 1992.5 MHz	Yes
Mode 25	Dual Low channel AWGN at 1932.5 MHz & 1937.5 MHz	Yes
Mode 26	Dual High channel AWGN at 1987.5 MHz & 1992.5 MHz	Yes

Note: This report only pertains to the operation of the equipment to 47CFR part 22E,22H and 24E, for details of testing to other rule parts please see RN reports:03-13344-3-22 (Part 27)
03-13344-2-22 (Part 74H)
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 of used are stated in test modes section 2.4
The system supports operation with a number of wideband services, so testing was performed with AWGN modulation signal as per KDB 935210 D05, and a CW signal for narrowband operation.

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 22 Effective Date 1st October 2020
47 CFR Part 24 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. Spurious emissions at antenna terminals	FCC Part 22 Clause 22.917(a)(b) & 22.359 FCC Part 24 Clause 24.238 FCC Part 2 Clause 2.1051	PASSED[1]
2. RF Power Output	FCC Part 22 Clause 22.535 & 22.913 FCC Part 24 Clause 24.232(a) FCC Part 2 Clause 2.1046	PASSED
3. Frequency stability	FCC Part 2 Clause 2.1055	NOT APPLICABLE[2]
4. Occupied bandwidth	FCC Part 24 Clause 24.238 FCC Part 2 Clause 2.1049	PASSED
5. Field strength of spurious radiations	FCC Part 22 Clause 22.917 & 22.359 FCC Part 24 Clause 24.238 FCC Part 2 Clause 2.1053	PASSED[1]
6. Band edge emissions	FCC Part 22 Clause 22.917(a)(b) & 22.359 FCC Part 24 Clause 24.238 FCC Part 2 Clause 2.1051	PASSED
7. Modulation characteristics	FCC Part 2 Clause 2.1047	PROVIDED[3]
8. Determination of f_0	KDB 935210 D05 Clause 3.3	PERFORMED

[1] Spectrum investigated started at a frequency of 30MHz up to a frequency of 20GHz based on 10 times the highest channel of 1992.5 MHz.
[2] EUT does not contain an oscillator and only reproduces what is provided at its input.
[3] Modulation characteristics information provided in section 2.2.

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	FCC Part 22	2020	Part 22 – Public Mobile Services
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	FCC Part 24	2020	Part 24 – Personal Communications Services

4.2 Deviations

No deviations were applied.

5 Tests, methods and results

5.1 Spurious emissions at antenna terminals

5.1.1 Test methods

Test Requirements:	FCC Part 22 Clause 22.917 & 22.359 [Reference 4.1.1 of this report]
	FCC Part 24 Clause 24.238 [Reference 4.1.6 of this report]
	FCC Part 2 Clause 2.1053 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 2015 Clause 5.5 [Reference 4.1.4 of this report]
	KDB 935210 D05 Clause 3.6 / 4.7 [Reference 4.1.5 of this report]
Limits:	FCC Part 22 Clause 22.917 & 22.359 [Reference 4.1.1 of this report]
	FCC Part 24 Clause 24.238 [Reference 4.1.6 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, where applicable results are referenced to EIRP limits by consideration of the antenna gain used with the EUT of 8dBi (5.85dBd) and indicated.

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 results please refer to section 5.6 within this report

Single channel results.

Setup Table

Band	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channel	871.5 MHz

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

Plots

869-894_MHz_plot1
869-894_MHz_plot2
869-894_MHz_plot3

Setup Table

Band	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Mid channel	881.5 MHz

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

Plots
869-894_MHz_plot1
869-894_MHz_plot2
869-894_MHz_plot3

Setup Table

Band	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
High channel	891.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
894.0	-32.3	-19.3

Plots
869-894_MHz_plot1
869-894_MHz_plot2
869-894_MHz_plot3

Setup Table

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channel	1932.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
3865.5	-33.9	-20.9

Plots
1930-1995_MHz_plot1
1930-1995_MHz_plot2

Setup Table

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Mid channel	1962.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
3919.8	-36.52	-23.52

Plots
1930-1995_MHz_plot1
1930-1995_MHz_plot2

Setup Table

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
High channel	1992.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
3985.0	-37.8	-14.8

Plots
1930-1995_MHz_plot1
1930-1995_MHz_plot2

Setup Table

Band	929-930 MHz
Power Level	20 dBm
Channel Spacing	25kHz
Mod Scheme	CW
Mid channel	929.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)

1859.2	-26.8 (100 kHz RBW)	-13.8
1959.1	-31.5 (100 kHz RBW)	-18.5
2788.4	-34.5 (100 kHz RBW)	-21.5

Plots
929.5MHz_narrowband_CSE_10M-10G_Peak-detector

Setup Table

Band	931-932 MHz
Power Level	20 dBm
Channel Spacing	25kHz
Mod Scheme	CW
Mid channel	931.5 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
1863.2	-26.5 (100 kHz RBW)	-13.5
1950.2	-32.5 (100 kHz RBW)	-19.5
2794.4	-34.1 (100 kHz RBW)	-21.1

Plots
931.5MHz_narrowband_CSE_10M-10G_Peak-detector

Dual channel results.

Setup Table

Band	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channels	871.5 MHz + 876.5 MHz

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

Plots
Please refer to single channel plots as emissions were the same.

Setup Table

Band	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
High channels	886.5 MHz + 891.5 MHz

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

Plots
Please refer to single channel plots as emissions were the same.

Setup Table

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channels	1932.5 MHz + 1937.5 MHz

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

Plots
Please refer to single channel plots as emissions were the same.

Setup Table

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
High channels	1987.5 MHz + 1992.5 MHz

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

Plots
Please refer to single channel plots as emissions were the same.

Setup Table

Band	929-930 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channels	929.0015 MHz + 929.0265 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
Please refer to results in single channel mode		

Plots
Please refer to single channel plots as emissions were the same.

Setup Table

Band	931-932MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channels	931.0088 MHz + 931.0338 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
Please refer to results in single channel mode		

Plots
Please refer to single channel plots as emissions were the same.

Results are also presented graphically in section 6.

LIMITS:
22.917 (a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) 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 RF Power Output

5.2.1 Test methods

Test Requirements:	FCC Part 22 Clause 22.535 & 22.913 [Reference 4.1.1 of this report]
	FCC Part 24 Clause 24.232(a) [Reference 4.1.6 of this report]
	FCC Part 2 Clause 2.1053 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 2015 Clause 5.2 [Reference 4.1.4 of this report]
	KDB 935210 D05 Clause 3.5 / 4.5 [Reference 4.1.5 of this report]
Limits:	FCC Part 22 Clause 22.535 & 22.913 [Reference 4.1.1 of this report]
	FCC Part 24 Clause 24.232(a) [Reference 4.1.6 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 on the channel that encompassed the determined f0 in each applicable band. Test modes used were 3, 9, 15 and 22.

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 Channel power was measured using the channel power function.

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	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
f0 frequency	869.075 MHz (Chan 871.5 MHz)

Test conditions		Average Power (dBm)	TX power EIRP (dBm)	TX Power EIRP (W)	PK to Average Power ratio (dB)
Temp Ambient	Volts Nominal	20.13	28.13	0.650	10.22

Note: 8dBi Antenna gain used. 871.5 MHz is the lowest 5MHz channel centre frequency within the band of operation and encompasses f0 of 869.075MHz.

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
f0 frequency	1930.8 MHz (Chan 1932.5 MHz)

Test conditions		Average Power (dBm)	TX power EIRP (dBm)	TX Power EIRP (W)	PK to Average Power ratio (dB)
Temp Ambient	Volts Nominal	24.4	32.4	1.738	8.89

Note: 8dBi Antenna gain used. 1932.5 MHz is the lowest 5MHz channel centre frequency within the band of operation and encompasses f0 of 1930.8MHz.

Band	929-930 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
f0 frequency	929.2503 MHz

Test conditions		Average Power (dBm)	TX power EIRP (dBm)	TX Power EIRP (W)
Temp Ambient	Volts Nominal	20.34	28.34	0.682

Note: 8dBi Antenna gain used. PK to AV power ratio not required for Narrowband.

Band	931-932 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
f0 frequency	931.1612 MHz

Test conditions		Average Power (dBm)	TX power EIRP (dBm)	TX Power EIRP (W)
Temp Ambient	Volts Nominal	20.32	28.32	0.679

Note: 8dBi Antenna gain used. PK to AV power ratio not required for Narrowband.

Results are also presented graphically in section 6

LIMITS:
22E, 5W ERP
22H, 500W ERP
24.232(a) 1640 W ERP

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 / Input versus output signal

5.4.1 Test methods

Test Requirements: FCC Part 2 Clause 2.1053 [Reference 4.1.2 of this report]
Test Method: ANSI C63.26 2015 Clause 5.4 [Reference 4.1.4 of this report]
KDB 935210 D05 Clause 3.3 / 3.4, 4.3 / 4.4 [Reference 4.1.5 of this report]
Limits: None

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 on the channel that encompassed the determined f0 in each applicable band. Test modes used were 3, 9, 15 and 22

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. An RMS detector was set and sweeps made comparing the input and the output signals and their -26dBc points indicated on the plots taken.

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	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
f0 frequency	869.075 MHz (Chan 871.5 MHz)

	26dB BW (MHz)
Input measurement	4.64
Output measurement	4.65
Plot reference	869-894_MHz_input-output

Note: 8dBi Antenna gain used. 871.5 MHz is the lowest 5MHz channel centre frequency within the band of operation and encompasses f0 of 869.075MHz.

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
f0 frequency	1930.8 MHz (Chan 1932.5 MHz)

	26dB BW (MHz)
Input measurement	4.64
Output measurement	4.66
Plot reference	1930-1995_MHz_input-output

Note: 8dBi Antenna gain used. 1932.5 MHz is the lowest 5MHz channel centre frequency within the band of operation and encompasses f0 of 1930.8MHz.

Band	929-930 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
f0 frequency	929.2503 MHz

	26dB BW (kHz)
Input measurement	20.3203
Output measurement	20.0701
Plot reference	929-930_MHz_input-output

Band	931-932MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
f0 frequency	931.1612 MHz

	26dB BW (kHz)
Input measurement	20.6206
Output measurement	20.3704
Plot reference	931-932_MHz_input-output

Results are also presented graphically in section 6

LIMITS:
Emissions to be contained within the applicable emissions mask/band edges.

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 Field strength of spurious radiations

5.5.1 Test methods

Test Requirements:	FCC Part 22 Clause 22.917 & 22.359(a) [Reference 4.1.1 of this report]
	FCC Part 24 Clause 24.238 [Reference 4.1.6 of this report]
	FCC Part 2 Clause 2.1053 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 2015 Clause 5.5 [Reference 4.1.4 of this report]
	KDB 935210 D05 Clause 3.6 / 4.7 [Reference 4.1.5 of this report]
Limits:	FCC Part 22 Clause 22.917 & 22.359(a) [Reference 4.1.1 of this report]
	FCC Part 24 Clause 24.238 [Reference 4.1.6 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 50Ohm 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 – 20GHz.
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, 6 – 18 GHz at 1.2metres and 18 – 20 GHz at 0.3metres.
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	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channel	871.5 MHz

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

Setup Table

Band	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Mid channel	881.5 MHz

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

Setup Table

Band	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
High channel	891.5 MHz

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

Setup Table

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channel	1932.5 MHz

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

Setup Table

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Mid channel	1962.5 MHz

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

Setup Table

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
High channel	1992.5 MHz

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

Setup Table

Band	929-930 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
Low channel	929.0125 MHz

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

Setup Table

Band	929-930 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
Mid channel	929.5 MHz

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

Setup Table

Band	929-930 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
High channel	929.9875 MHz

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

Setup Table

Band	931-932 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
Low channel	931.0125 MHz

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

Setup Table

Band	931-935 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
Mid channel	931.5 MHz

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

Setup Table

Band	931-935 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
High channel	931.9875 MHz

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

DUAL CHANNEL RESULTS.

Setup Table

Band	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channels	871.5 MHz + 876.5 MHz

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

Setup Table

Band	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
High channels	886.5 MHz + 891.5 MHz

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

Setup Table

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channels	1932.5 MHz + 1937.5 MHz

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

Setup Table

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
High channels	1987.5 MHz + 1992.5 MHz

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

Setup Table

Band	929-930 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW
Low channels	929.0265 MHz + 929.0015 MHz

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

Setup Table

Band	931-932 MHz
Power Level	20 dBm
Channel Spacing	25 kHz

Mod Scheme	CW
Low channels	931.0338 MHz + 931.0088 MHz

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

LIMITS:
22.917 (a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) 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: 30MHz - 1GHz ± 3.9 dB, 1 – 18 GHz ±3.5dB, 18 – 27 GHz ±3.9dB

5.6 Band edge emissions

5.6.1 Test methods

Test Requirements:	FCC Part 22 Clause 22.917 & 22.359(a) [Reference 4.1.1 of this report]
	FCC Part 24 Clause 24.238 [Reference 4.1.6 of this report]
	FCC Part 2 Clause 2.1053 [Reference 4.1.2 of this report]
Test Method:	ANSI C63.26 2015 Clause 5.5 [Reference 4.1.4 of this report]
	KDB 935210 D05 Clause 3.6 / 4.7 [Reference 4.1.5 of this report]
Limits:	FCC Part 22 Clause 22.917 & 22.359(a) [Reference 4.1.1 of this report]
	FCC Part 24 Clause 24.238 [Reference 4.1.6 of this report]

5.6.2 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 all required modes as specified in section 2.4 of this report.

5.6.3 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, where applicable results are referenced to EIRP limits by consideration of the antenna gain used with the EUT of 8dBi (5.85dBd) and indicated.

Tests were performed in test site A.

5.6.4 Test equipment

F078, H071, E266, E777, E602

See Section 8 for more details

5.6.5 Test results

Temperature of test environment	17-23°C
Humidity of test environment	35-56%
Pressure of test environment	100-103kPa

Single channel results

Band	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channel	871.5 MHz
High channel	891.5 MHz

	Lower band edge (869MHz)	Upper band edge (894MHz)
(dBm)	-42.7	-43.5
Plot reference	13344-1 869-894_MHz_low-side	13344-1 869-894_MHz_high-side

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channel	1932.5 MHz

High channel	1992.5 MHz

	Lower band edge (1930MHz)	Upper band edge (1995MHz)
(dBm)	-34.7	-35
Plot reference	13344-1 1930-1995_MHz_low-side	13344-1 1930-1995_MHz_high-side

Dual channel results

Band	869-894 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channels	871.5 + 876.5 MHz
High channels	886.5 + 891.5 MHz

	Lower band edge (869MHz)	Upper band edge (894MHz)
(dBm)	-44.5	-46.9
Plot reference	13344-1 869-894_MHz_low-side_dual	13344-1 869-894_MHz_high-side_dual

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN
Low channels	1932.5 + 1937.5 MHz
High channels	1987.5 + 1992.5 MHz

	Lower band edge (1930MHz)	Upper band edge (1995MHz)
(dBm)	-37.7	-39.0
Plot reference	13344-1 1930-1995_MHz_low-side_dual	13344-1 1930-1995_MHz_high-side_dual

Band	929-930 MHz
Power Level	20 dBm
Channel Spacing	N/A
Mod Scheme	CW
channels	929.2375 and 929.2625 MHz

	Band edge / Intermodulation (929-930 MHz)
(dBm)	-37.18
Plot reference	Plot of 929-930 MHz intermodulation

Band	931-932 MHz
Power Level	20 dBm
Channel Spacing	N/A
Mod Scheme	CW
channels	931.150 and 931.1725 MHz

	Band edge / Intermodulation (931-932 MHz)
(dBm)	-37.39
Plot reference	Plot of 931-932 MHz intermodulation

Results are also presented graphically in section 6

LIMITS:
22.917 (a) & 24.238 (a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) 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

5.7 Modulation characteristics

EUT uses digital modulation techniques. Modulation schemes and information is detailed in section 2.2 of this report.

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, 8, 14 and 20.

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	869-894 MHz
Power Level	20 dBm
Channel Spacing	N/A
Mod Scheme	CW

Band (MHz)	f_0 determined(MHz)
869-894	869.075

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

Band	1930-1995 MHz
Power Level	20 dBm
Channel Spacing	N/A
Mod Scheme	CW

Band (MHz)	f_0 determined (MHz)
1930-1995	1930.8

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

Band	929-930 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW

Band (MHz)	f_0 determined (MHz)
929-930	929.2503

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

Band	931-932MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW

Band (MHz)	f_0 determined (MHz)
931-932	931.1612

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

Results are also presented graphically in section 6.

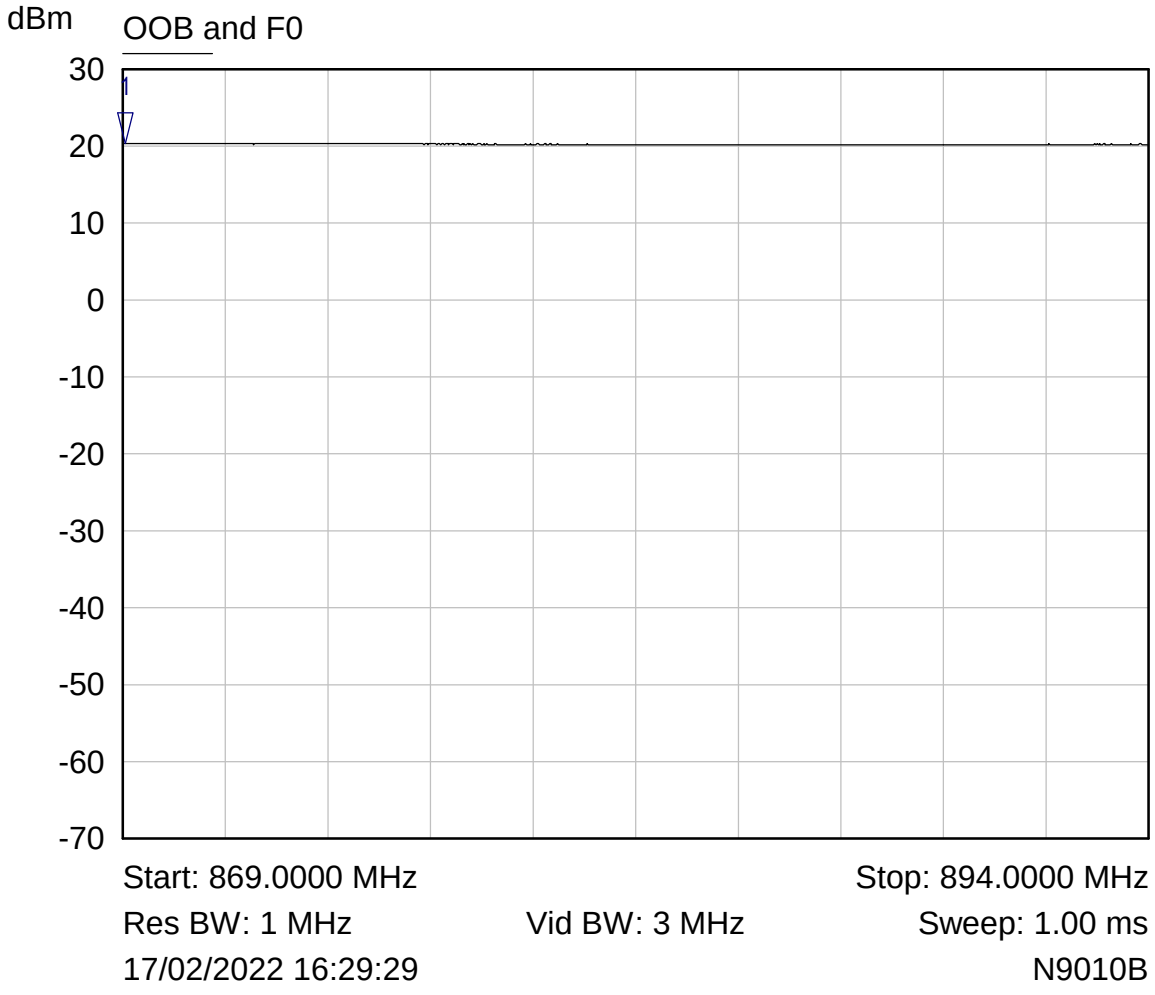
LIMITS:
None.

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 f_0

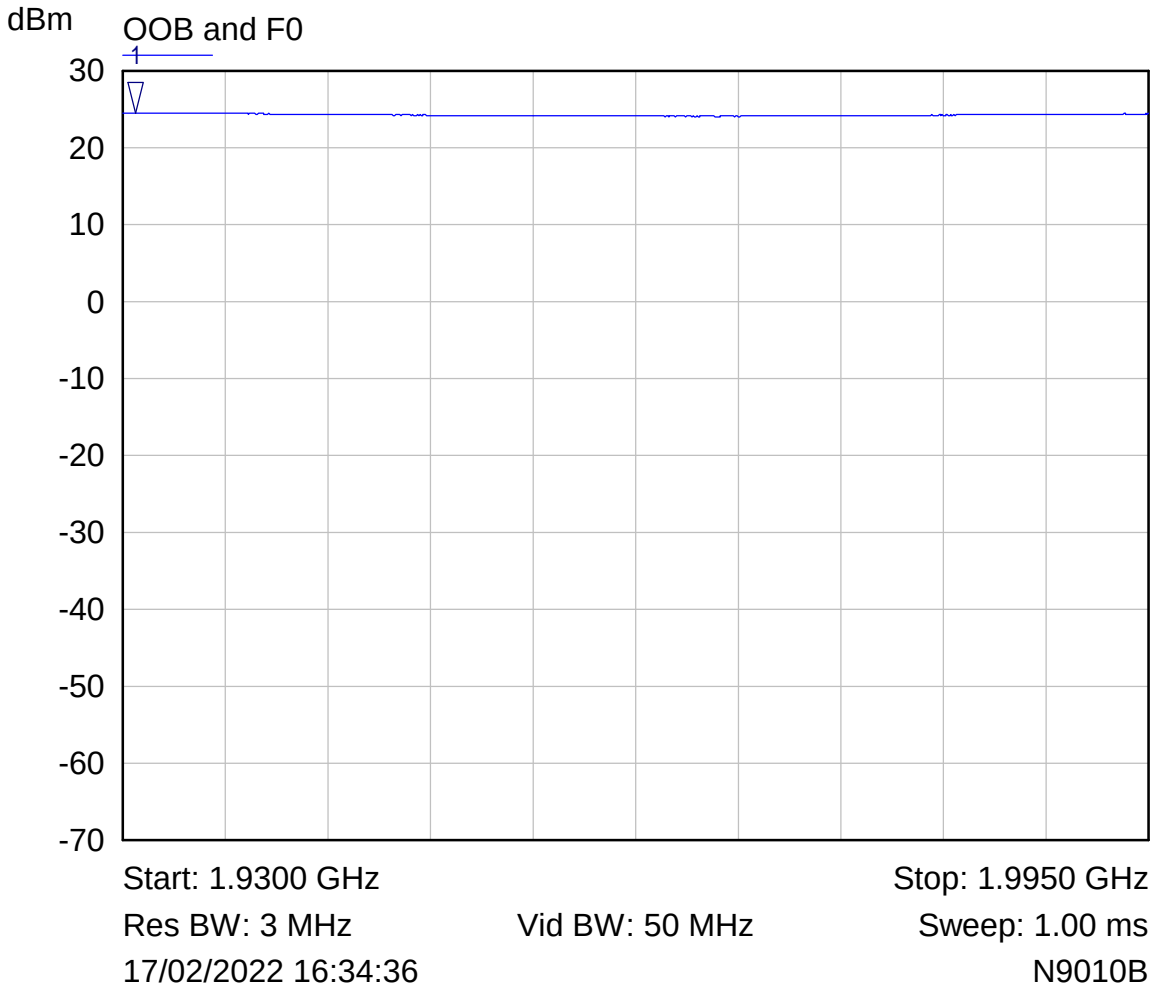
RF Parameters: Band 869-894 MHz, Power +20 dBm, Swept CW



Mkr	Trace	X-Axis	Value	Notes
1 ▽	OOB and F0	869.0750 MHz	20.40 dBm	f0

Plot of f0 determined in band 869-894 MHz.

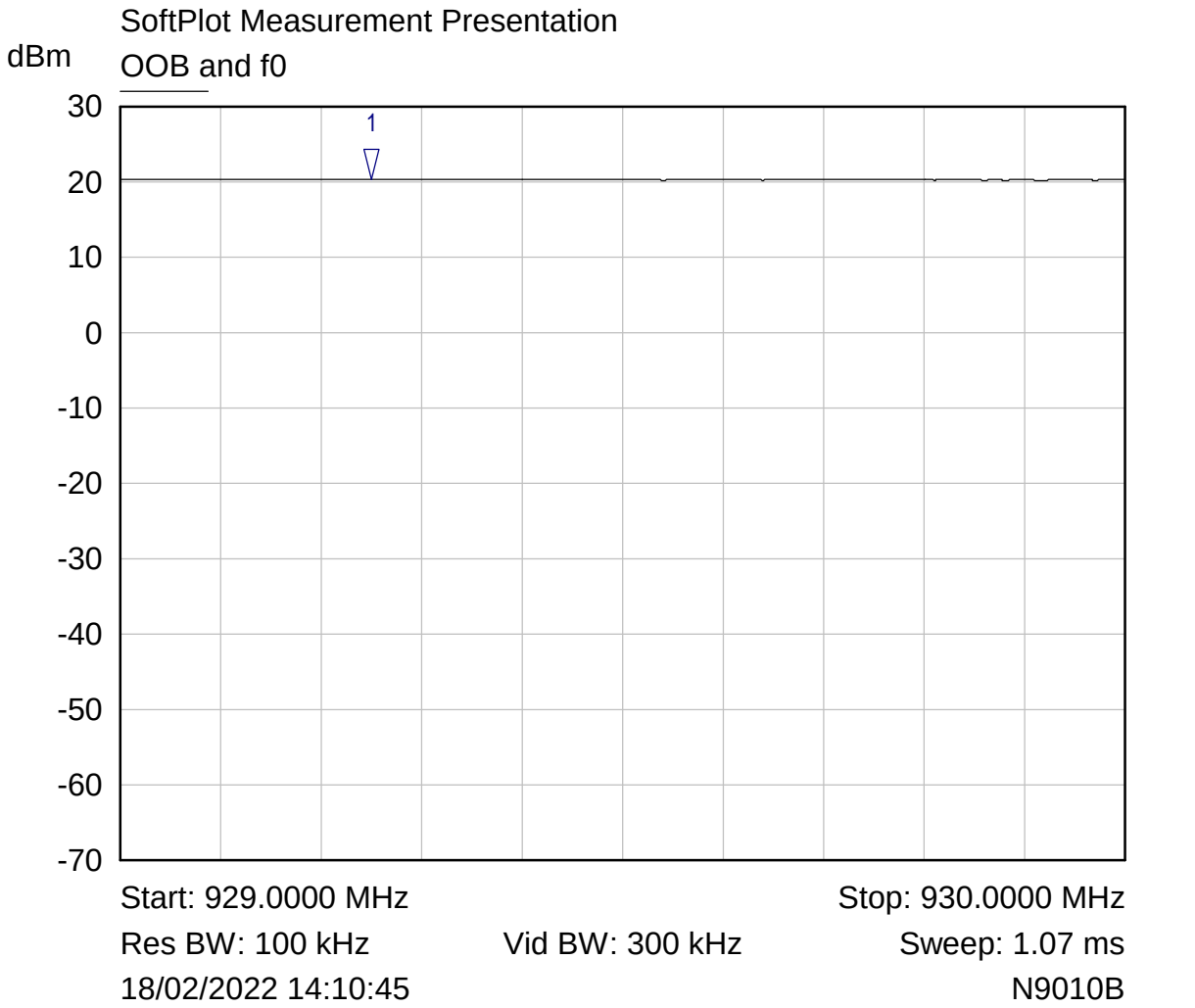
RF Parameters: Band 1930-1995 MHz, Power +20 dBm, Swept CW



Mkr	Trace	X-Axis	Value	Notes
1 ▽	OOB and F0	1.9308 GHz	24.55 dBm	f0

Plot of f0 determined in band 1930-1995 MHz.

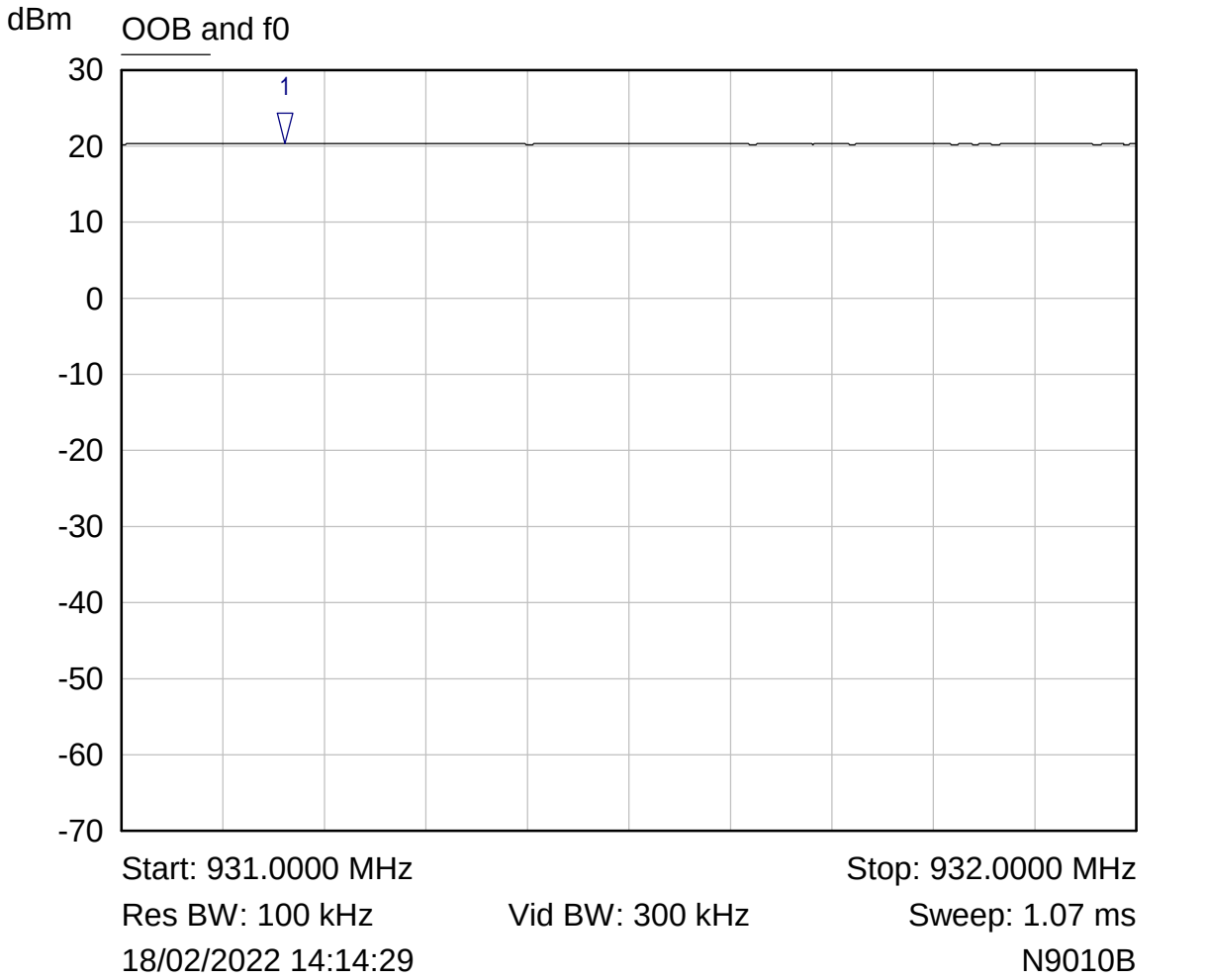
RF Parameters: Band 929-930 MHz, Power +20 dBm, Swept CW



Mkr	Trace	X-Axis	Value	Notes
1 ▽	OOB and f0	929.2503 MHz	20.34 dBm	f0

Plot of f0 determined in band 929-930 MHz.

RF Parameters: Band 931-932 MHz, Power +20 dBm, Swept CW

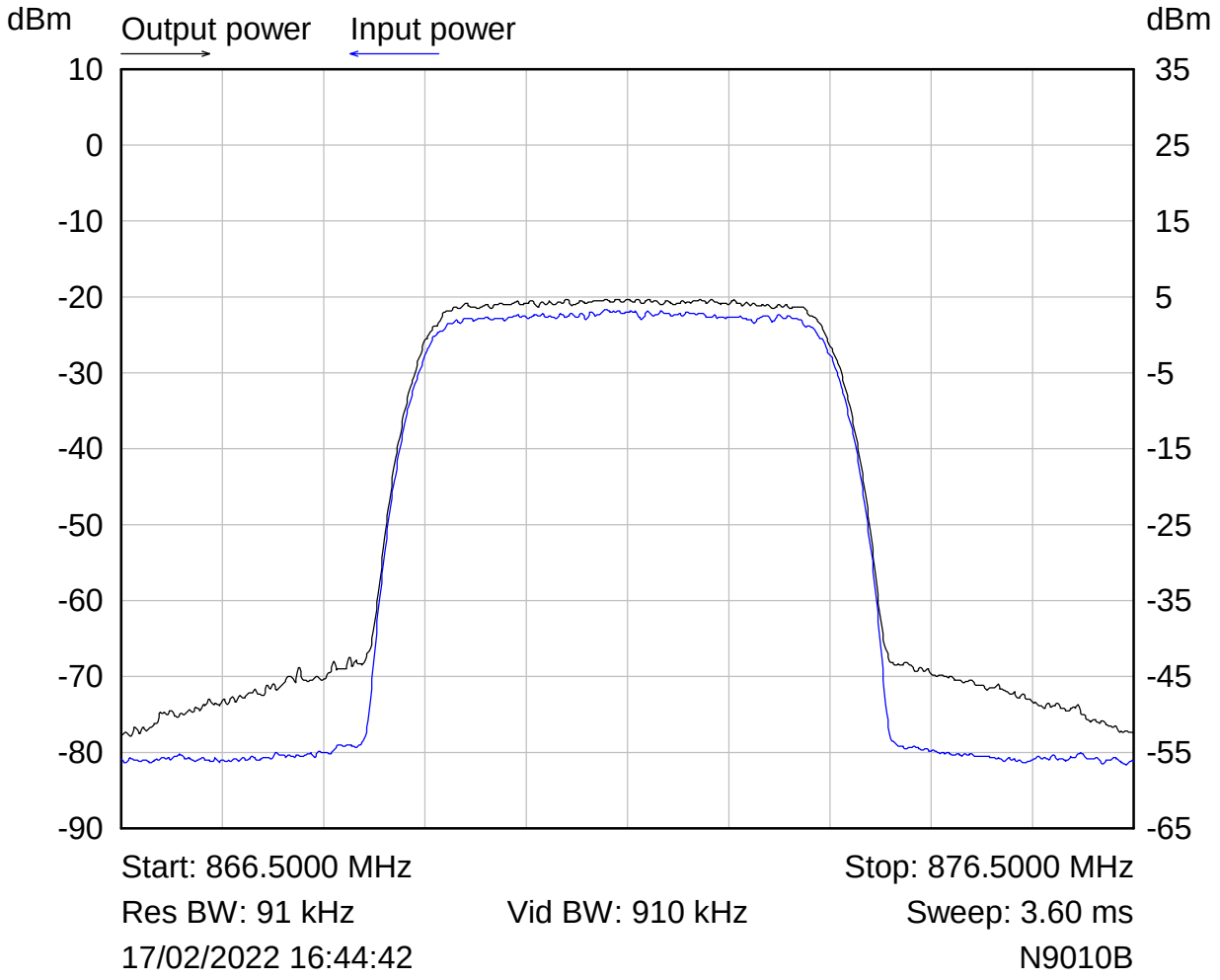


Mkr	Trace	X-Axis	Value	Notes
1 ▽	OOB and f0	931.1612 MHz	20.31 dBm	f0

Plot of f0 determined in band 931-932 MHz.

6.2 RF Power Output

RF Parameters: Band 869-894 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channel 871.5 MHz (channel centre near determined f_0 869.075 MHz)



Input power

Measurement Parameter	Value
Total channel power	-6.57 dBm

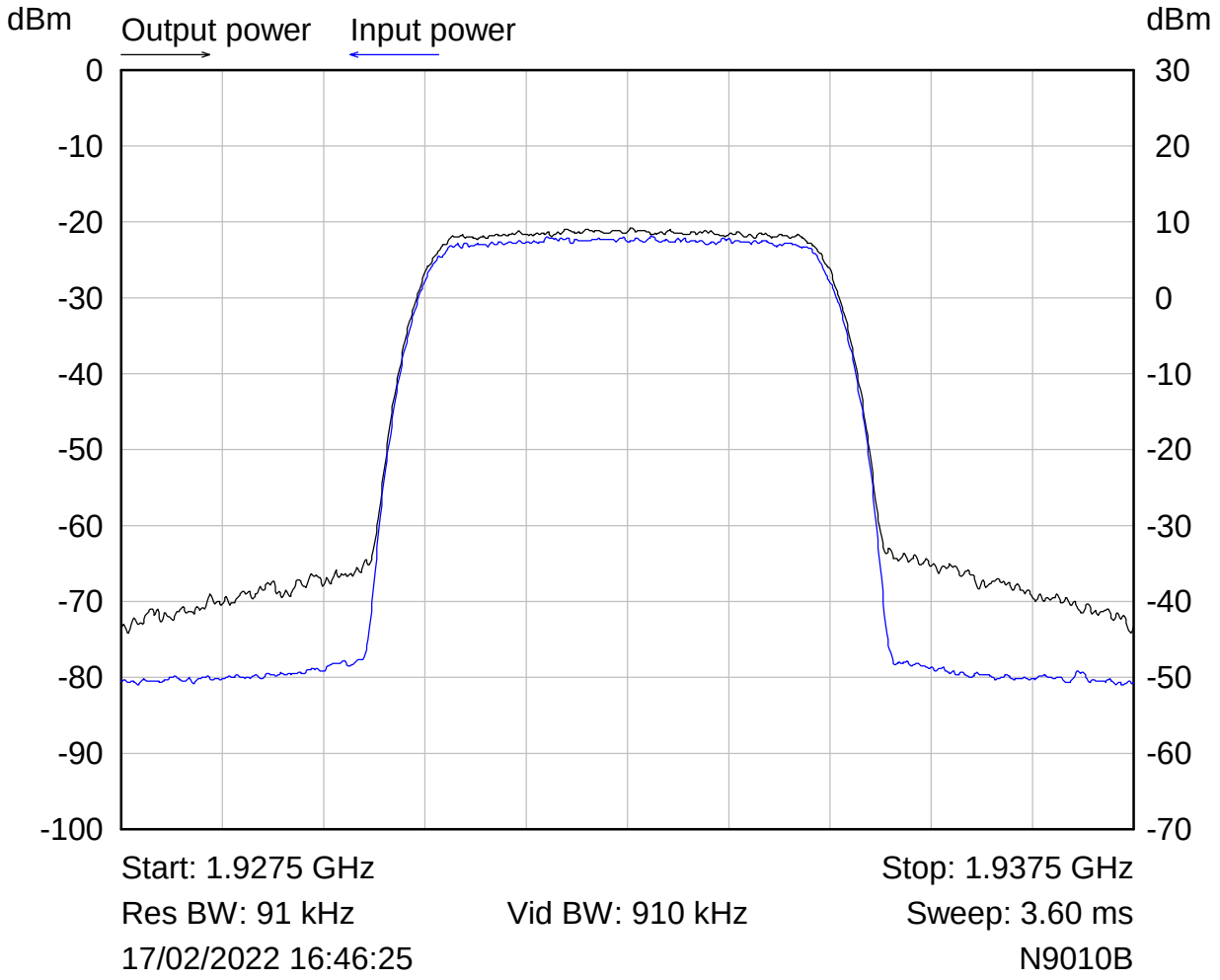
Output power

Measurement Parameter	Value
Total channel power	20.13 dBm

Plot of Channel power at determined f_0 in band 869-894 MHz (Chan 871.5 MHz)

Plot of Peak to Average power ratio at determined f_0 in band 869-894 MHz (Chan 871.5 MHz)

RF Parameters: Band 1930-1995 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channel 1932.5 MHz (channel centre near determined f_0 1930.8 MHz)



Input power

Measurement Parameter	Value
Total channel power	-6.68 dBm

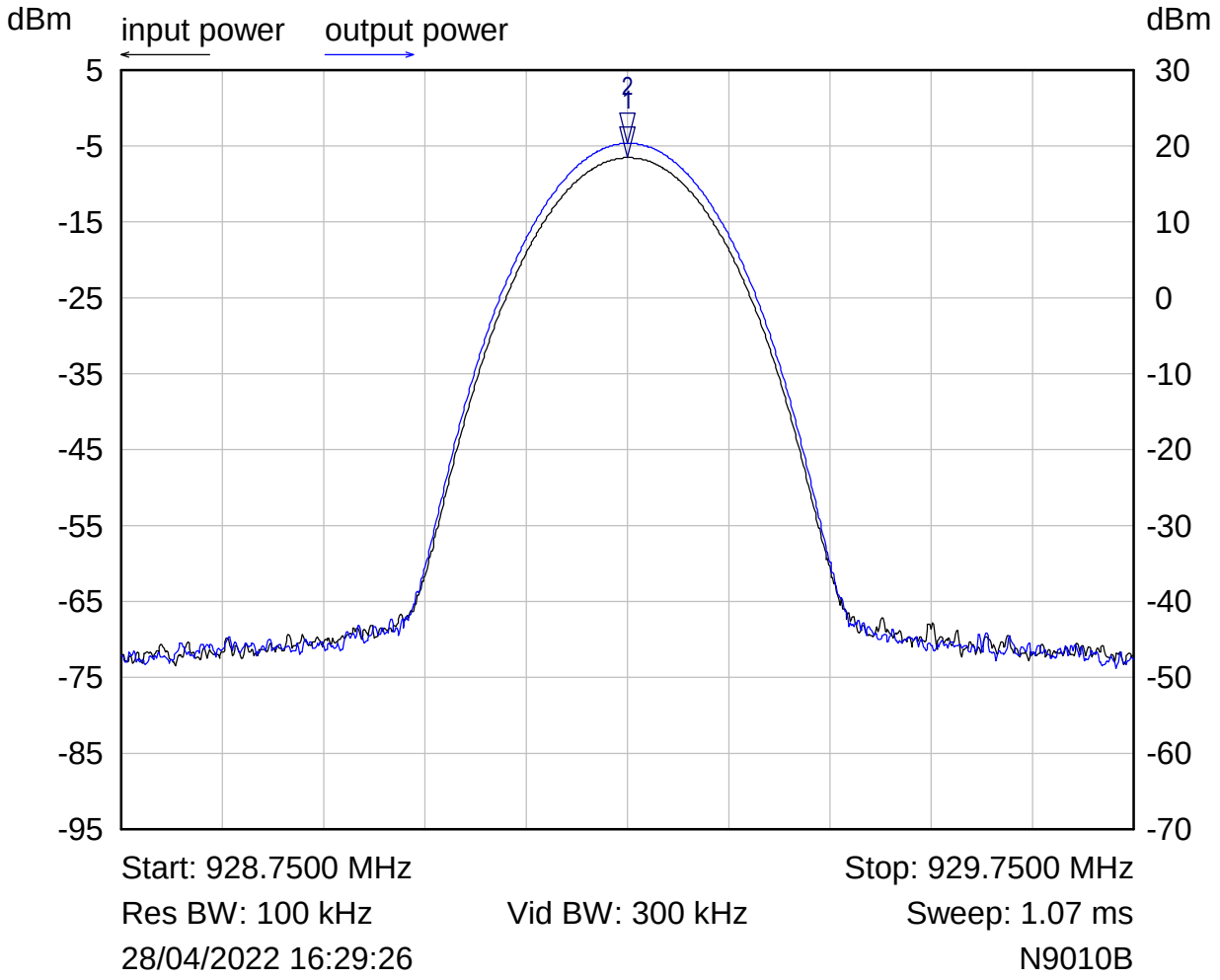
Output power

Measurement Parameter	Value
Total channel power	24.40 dBm

Plot of Channel power at determined f_0 in band 1930-1995 MHz (Chan 1932.5 MHz)

Plot of Peak to Average power ratio at determined f_0 in band 1930-1995 MHz (Chan 1932.5 MHz)

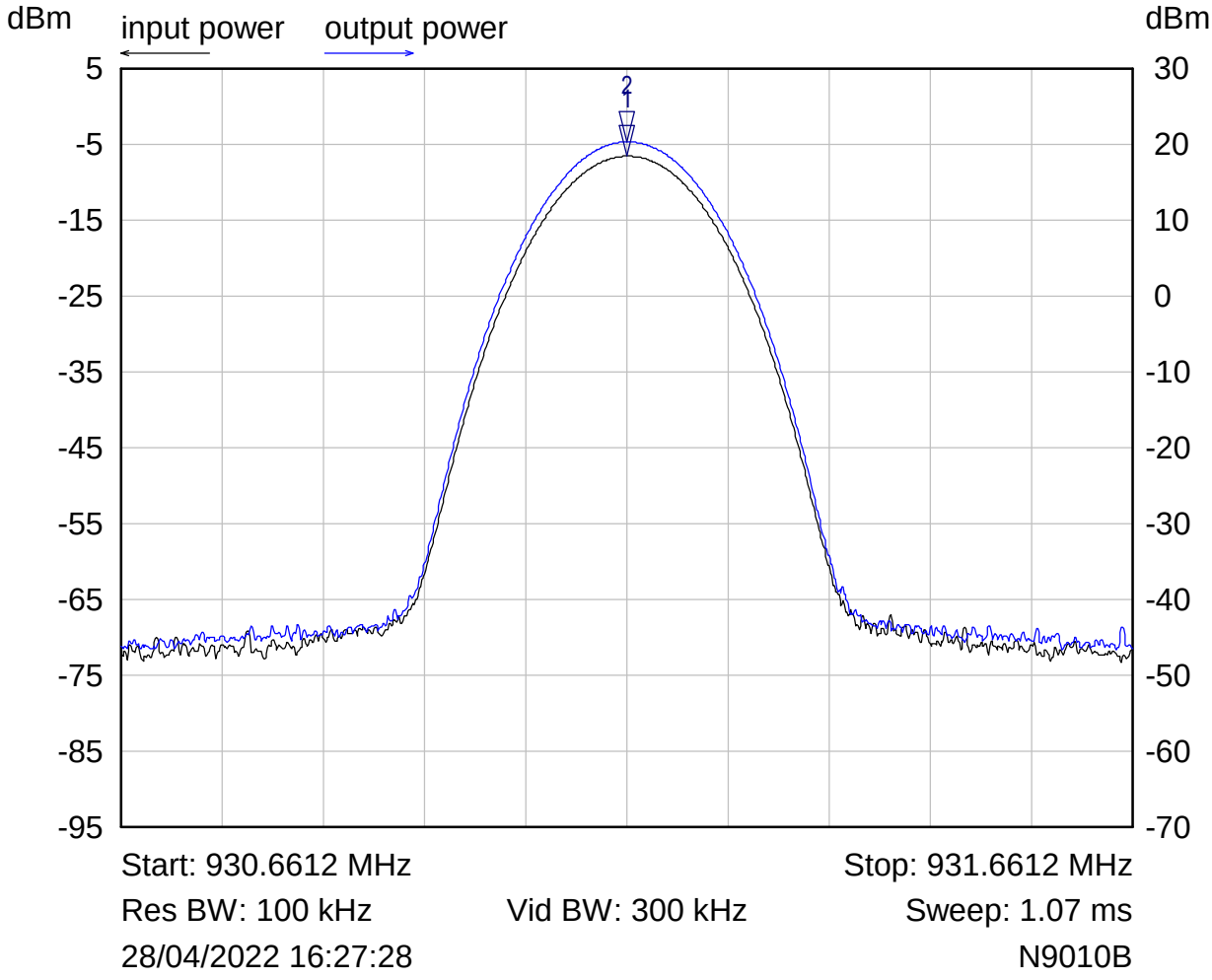
RF Parameters: Band 929-930 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW, Channel 929.2503 MHz (determined f_0)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	input power	929.2505 MHz	-6.55 dBm	input power
2 ▽	output power	929.2505 MHz	20.34 dBm	output power

Plot of Channel power at determined f_0 in band 929-930 MHz

RF Parameters: Band 931-932 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW, Channel 931.1612 MHz (determined f_0)

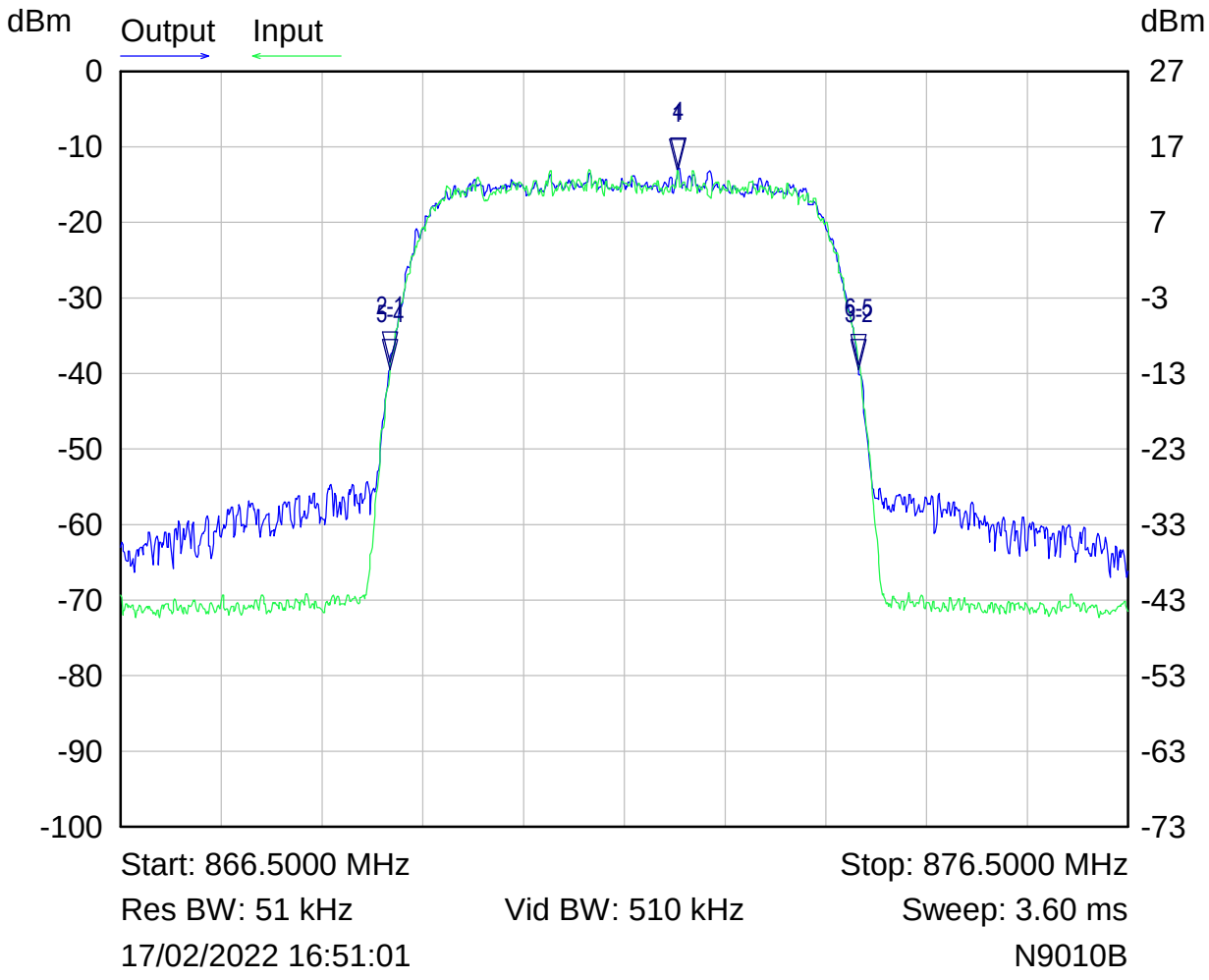


Mkr	Trace	X-Axis	Value	Notes
1 ▽	input power	931.1607 MHz	-6.56 dBm	input power
2 ▽	output power	931.1617 MHz	20.32 dBm	output power

Plot of Channel power at determined f_0 in band 931-932 MHz

6.3 Occupied bandwidth / Input versus output signal

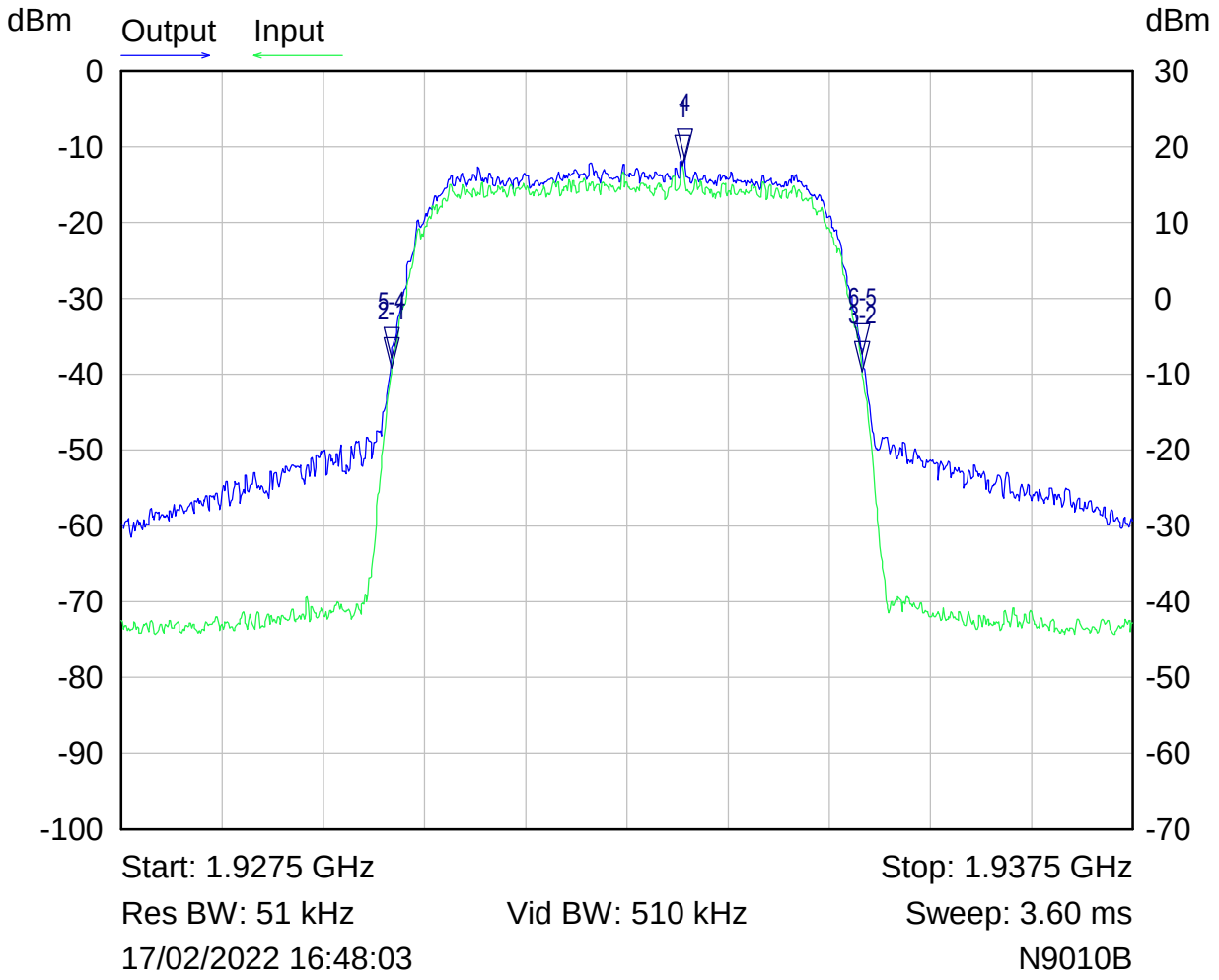
RF Parameters: Band 869-894 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channel 871.5 MHz (channel centre near determined f_0 869.075 MHz)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Input	872.0300 MHz	-12.95 dBm	
2-1 ▽	Input	-2.8500 MHz	-25.48 dB	-26 dB
3-2 ▽	Input	4.6400 MHz	-1.13 dB	input 26 dB BW
4 ▽	Output	872.0400 MHz	14.20 dBm	
5-4 ▽	Output	-2.8700 MHz	-26.66 dB	-26 dB
6-5 ▽	Output	4.6500 MHz	0.70 dB	output -26 dB BW

Occupied BW 871.5 MHz channel (channel centre near determined f0 869.075 MHz)

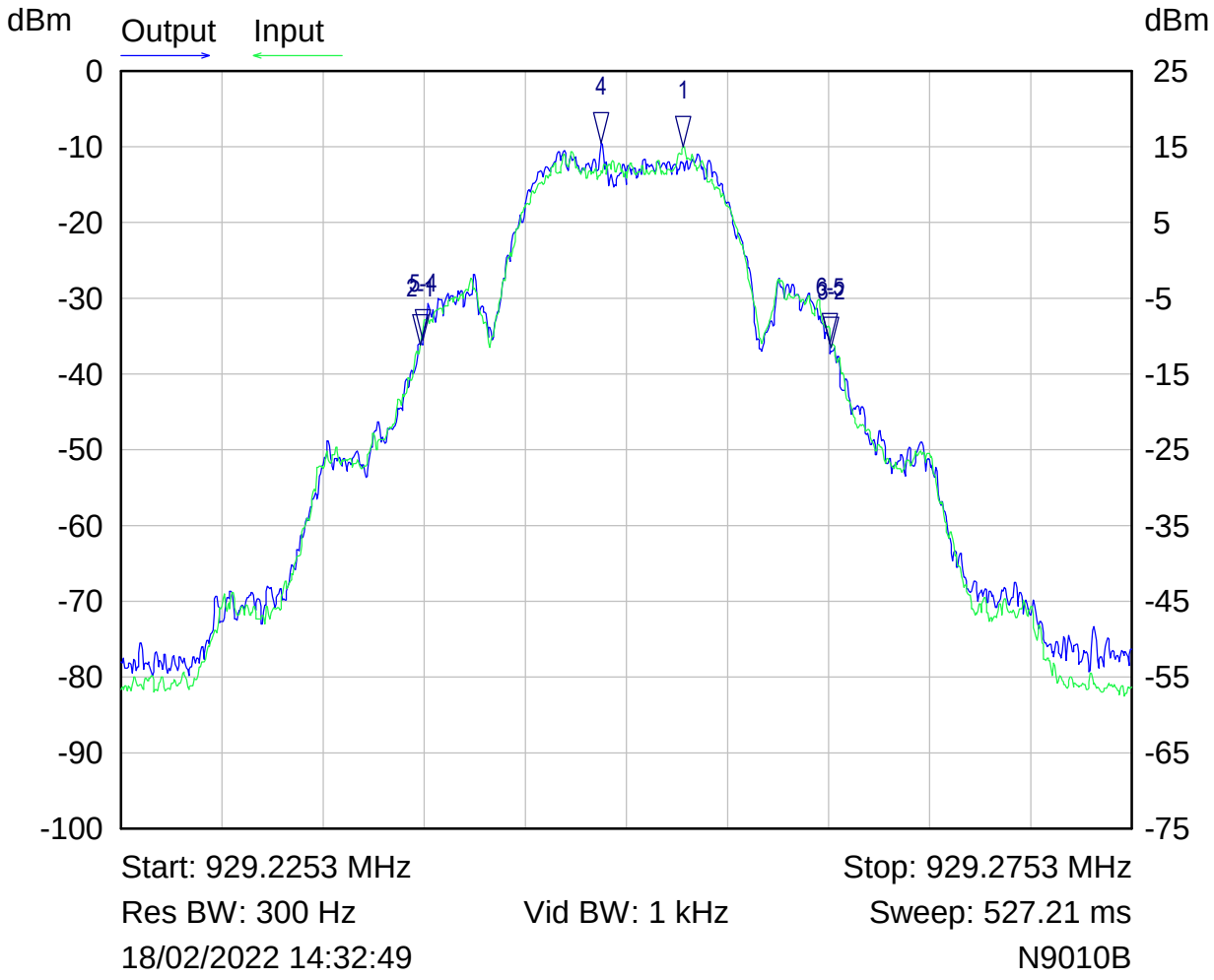
RF Parameters: Band 1930-1995 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channel 1932.5 MHz (channel centre near determined f_0 1930.8 MHz)



Mkr	Trace	X-Axis	Value	Notes
1	Input	1.9331 GHz	-12.53 dBm	
2-1	Input	-2.8700 MHz	-26.56 dB	-26 dB
3-2	Input	4.6400 MHz	-0.60 dB	input 26 dB BW
4	Output	1.9331 GHz	18.25 dBm	
5-4	Output	-2.9000 MHz	-26.11 dB	-26 dB
6-5	Output	4.6600 MHz	0.47 dB	output 26 dB BW

Occupied BW 1992.5MHz channel (channel centre near determined f0 1930.8 MHz)

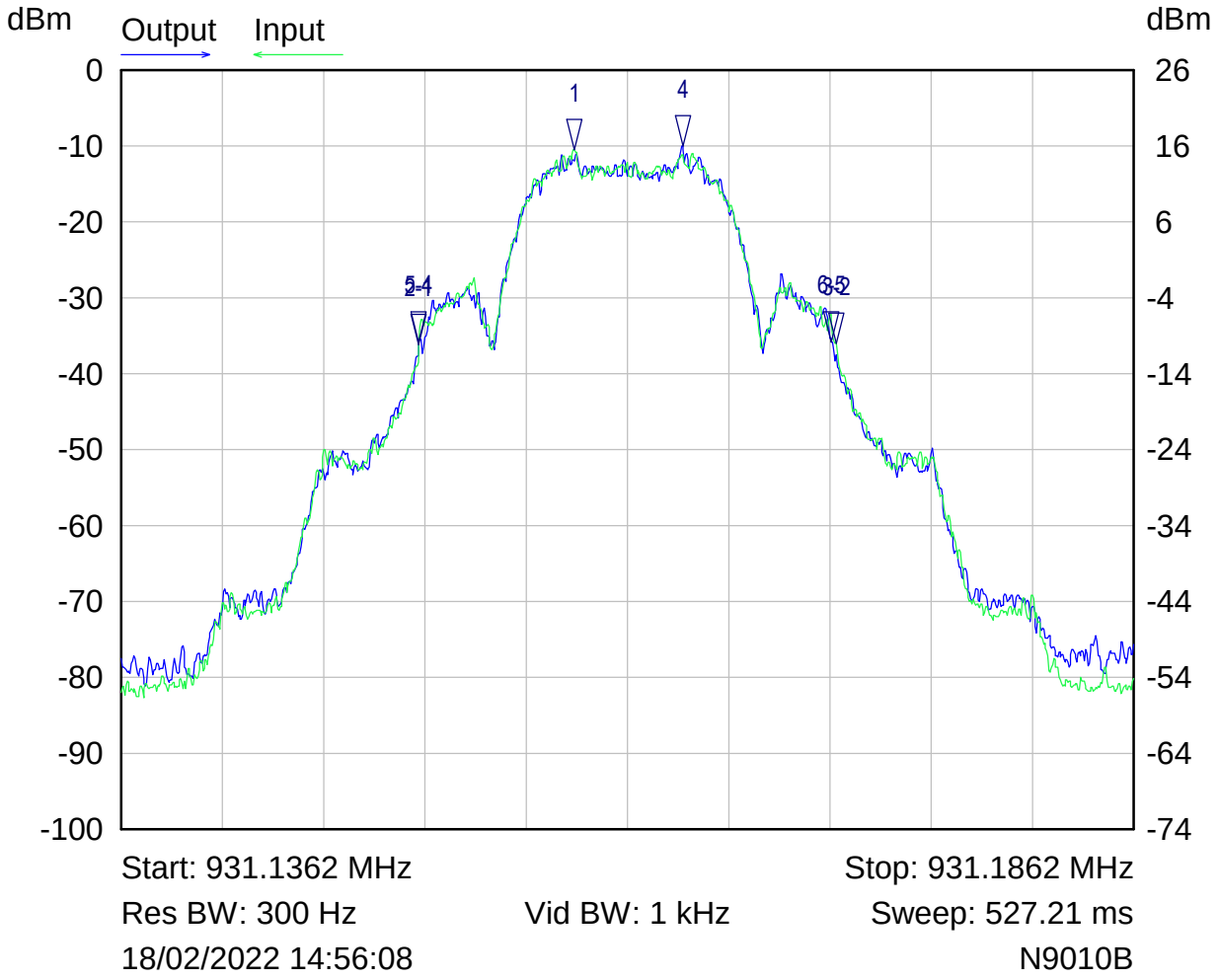
RF Parameters: Band 929-930 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW, Channel 929.2503 MHz (determined f_0)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Input	929.2531 MHz	-9.99 dBm	
2-1 ▽	Input	-13.0130 kHz	-26.25 dB	-26 dB
3-2 ▽	Input	20.3203 kHz	-0.19 dB	input 26 dB BW
4 ▽	Output	929.2491 MHz	15.45 dBm	
5-4 ▽	Output	-8.8088 kHz	-25.97 dB	-26 dB
6-5 ▽	Output	20.0701 kHz	-0.46 dB	output 26 dB BW

Occupied BW 929.2503 MHz channel

RF Parameters: Band 931-932 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW, Channel 931.1612 MHz (determined f_0)

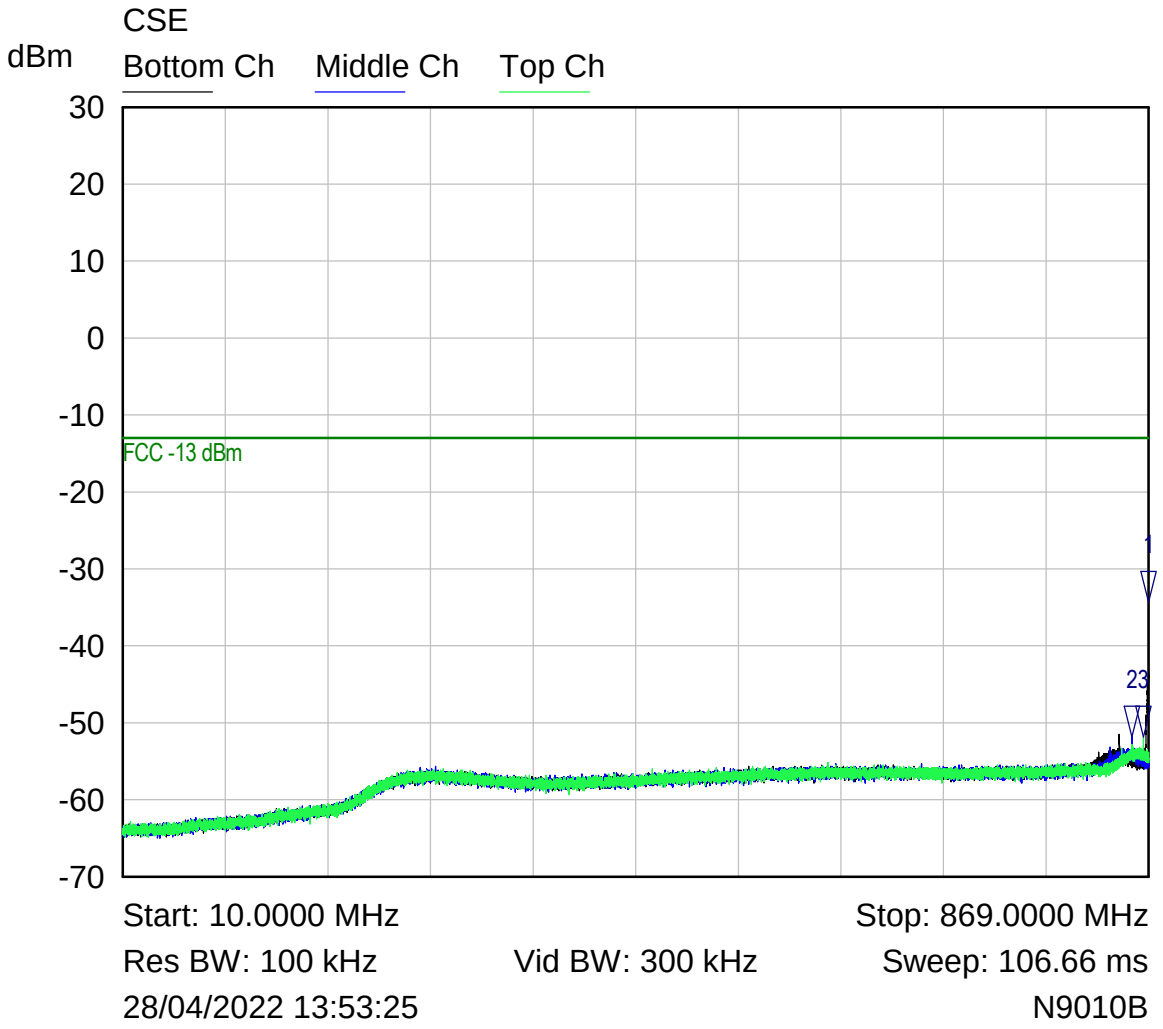


Mkr	Trace	X-Axis	Value	Notes
1	Input	931.1586 MHz	-10.51 dBm	
2-1	Input	-7.6577 kHz	-25.58 dB	
3-2	Input	20.6206 kHz	0.16 dB	input 26 dB BW
4	Output	931.1639 MHz	16.05 dBm	
5-4	Output	-13.0130 kHz	-25.86 dB	
6-5	Output	20.3704 kHz	0.01 dB	output 26 dB BW

Occupied BW 931.1612 MHz channel

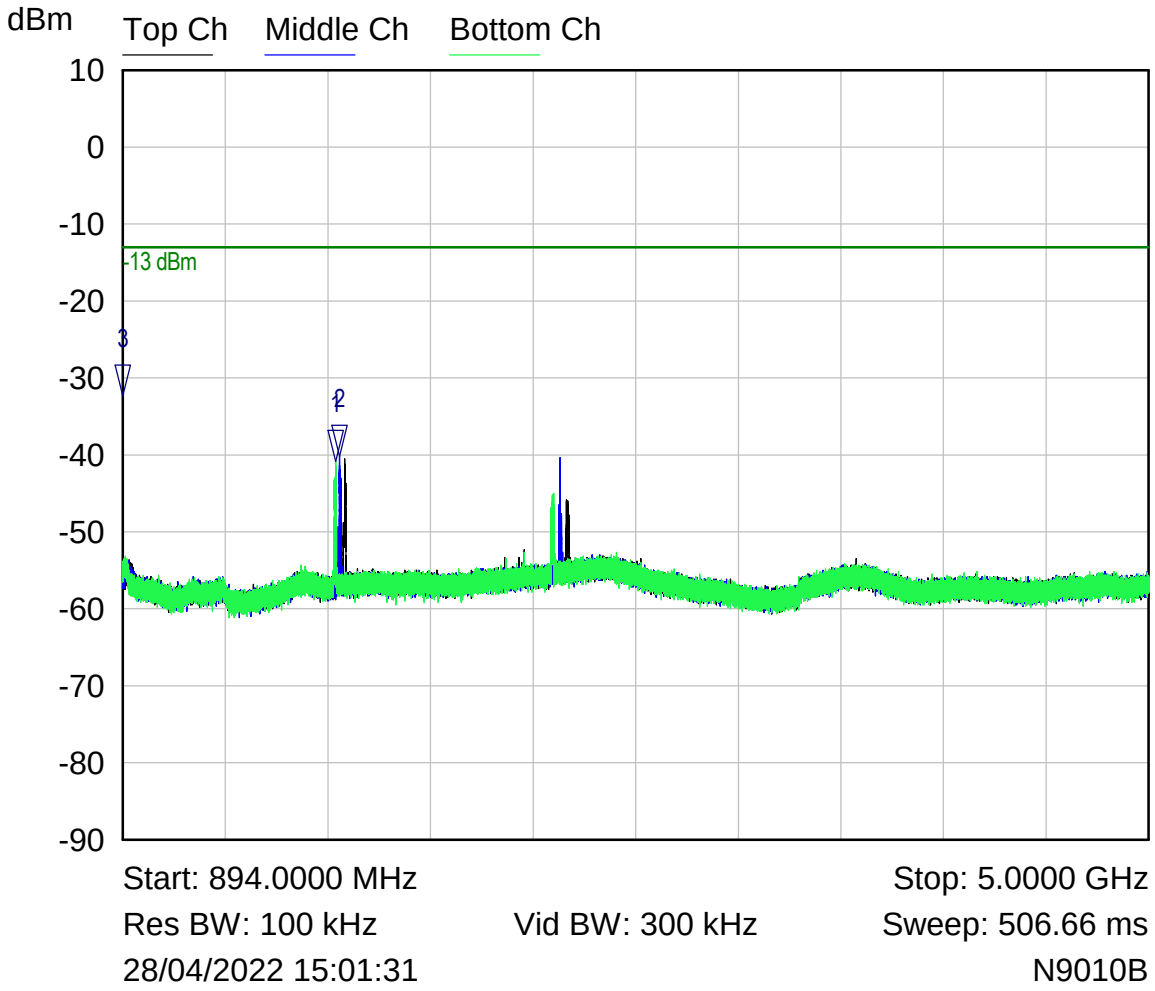
6.4 Spurious emissions at antenna terminals

RF Parameters: Band 869-894 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channels 871.5 MHz, 881.5 MHz, 891.5 MHz, Single channel mode



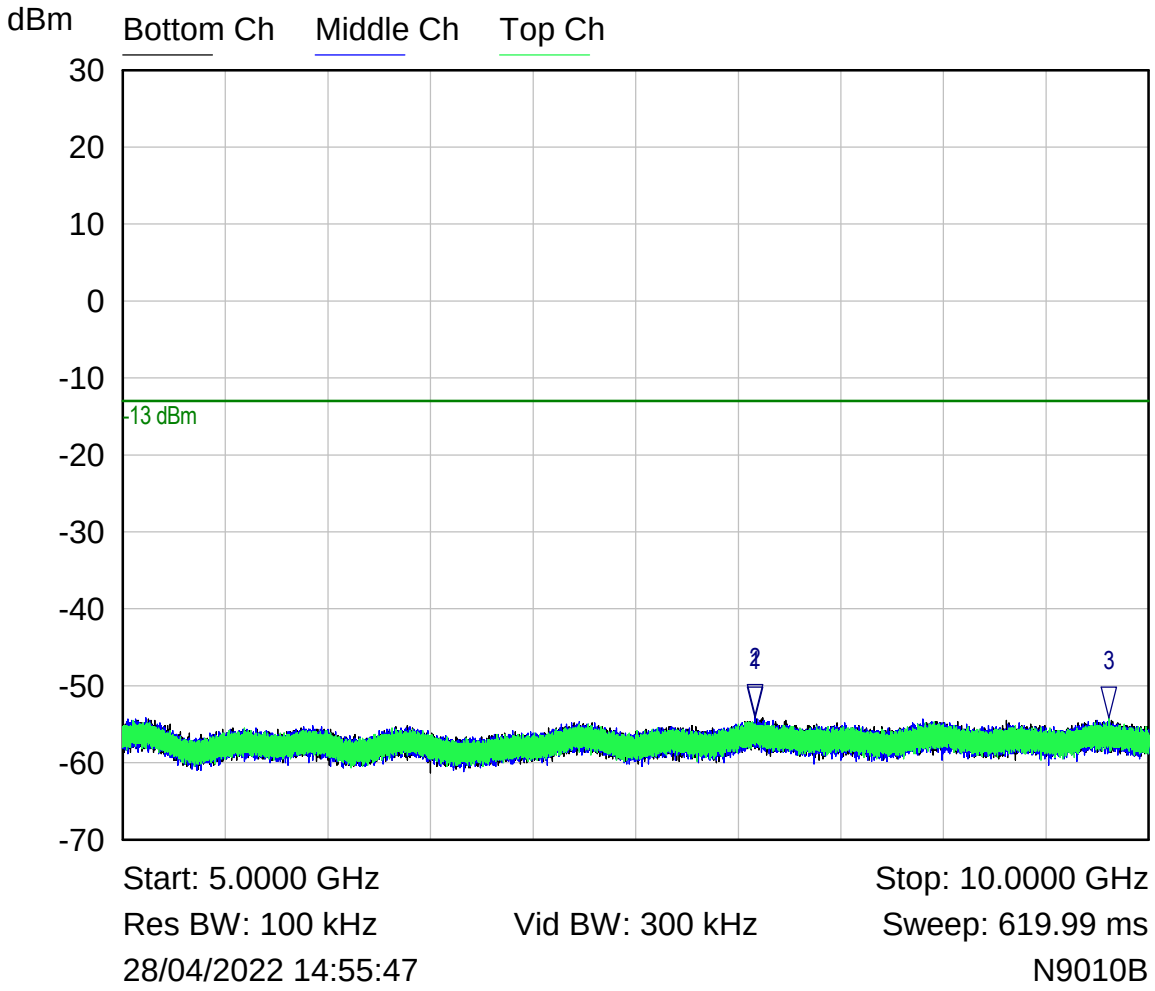
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bottom Ch	869.0000 MHz	-34.39 dBm	
2 ▽	Middle Ch	854.7399 MHz	-51.80 dBm	
3 ▽	Top Ch	864.7477 MHz	-51.88 dBm	

Plot of conducted emissions single channel mode 10 – 869 MHz range
(Note: Low, Mid and High channels overlaid on a single plot using 3 separate traces)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bottom Ch	1.7456 GHz	-40.77 dBm	
2 ▽	Middle Ch	1.7630 GHz	-40.22 dBm	
3 ▽	Top Ch	894.0000 MHz	-32.30 dBm	

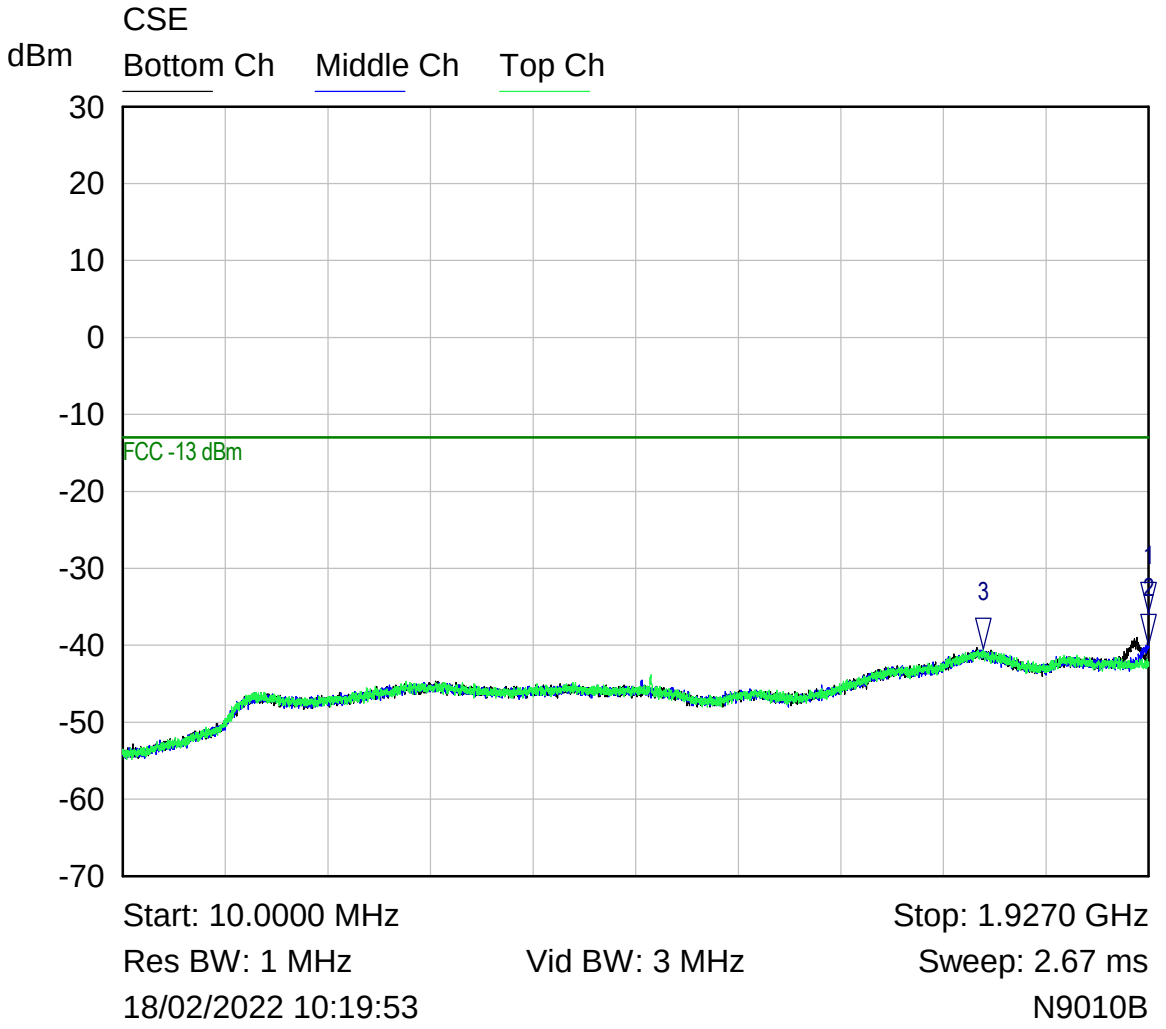
Plot of conducted emissions single channel mode 894 - 5000 MHz range
(Note: Low, Mid and High channels overlaid on a single plot using 3 separate traces)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bottom Ch	8.0812 GHz	-54.23 dBm	
2 ▽	Middle Ch	8.0815 GHz	-53.78 dBm	
3 ▽	Top Ch	9.8046 GHz	-54.17 dBm	

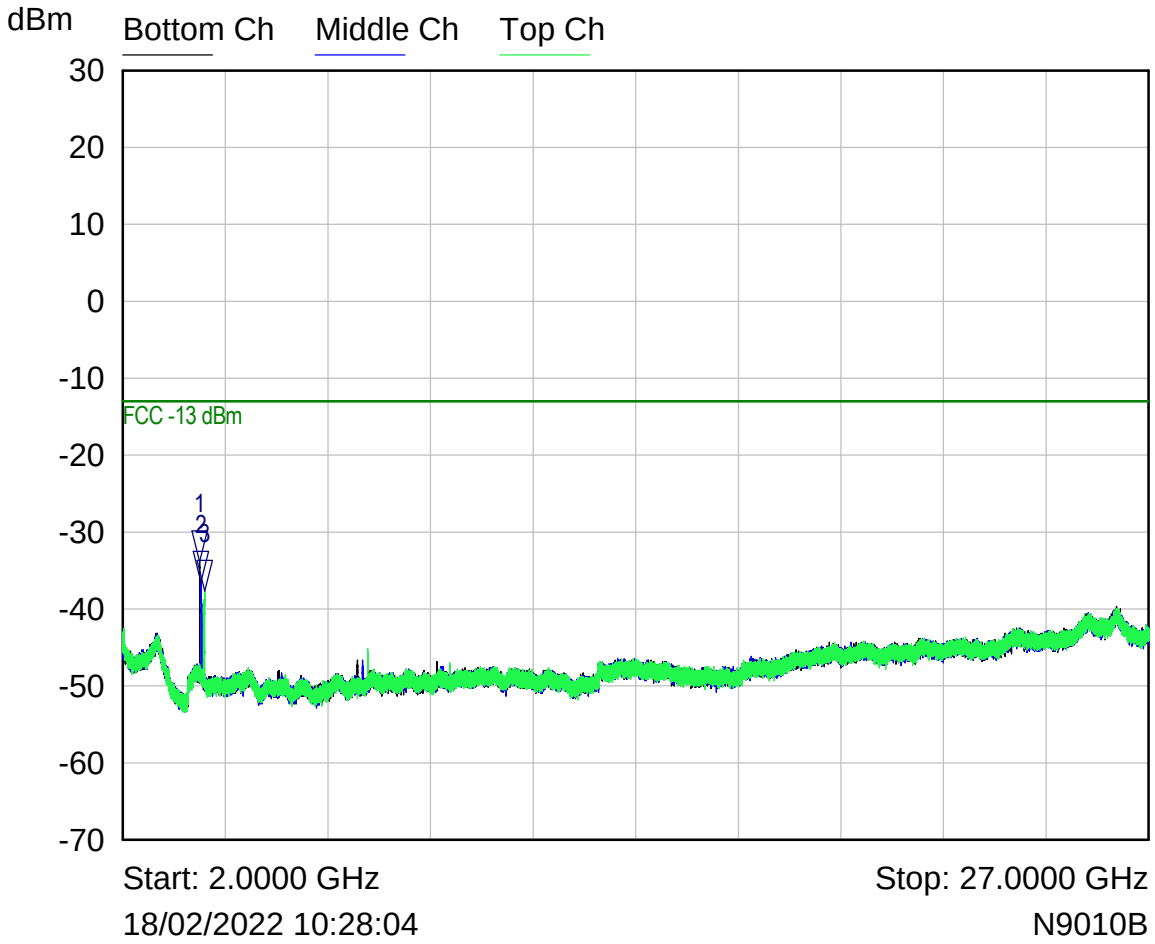
Plot of conducted emissions single channel mode 5 – 10 GHz range
(Note: Low, Mid and High channels overlaid on a single plot using 3 separate traces)

RF Parameters: Band 1930-1995 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channels 1932.5 MHz, 1962.5 MHz, 1992.5 MHz, Single channel mode



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bottom Ch	1.9270 GHz	-35.78 dBm	
2 ▽	Middle Ch	1.9270 GHz	-40.05 dBm	
3 ▽	Top Ch	1.6183 GHz	-40.53 dBm	

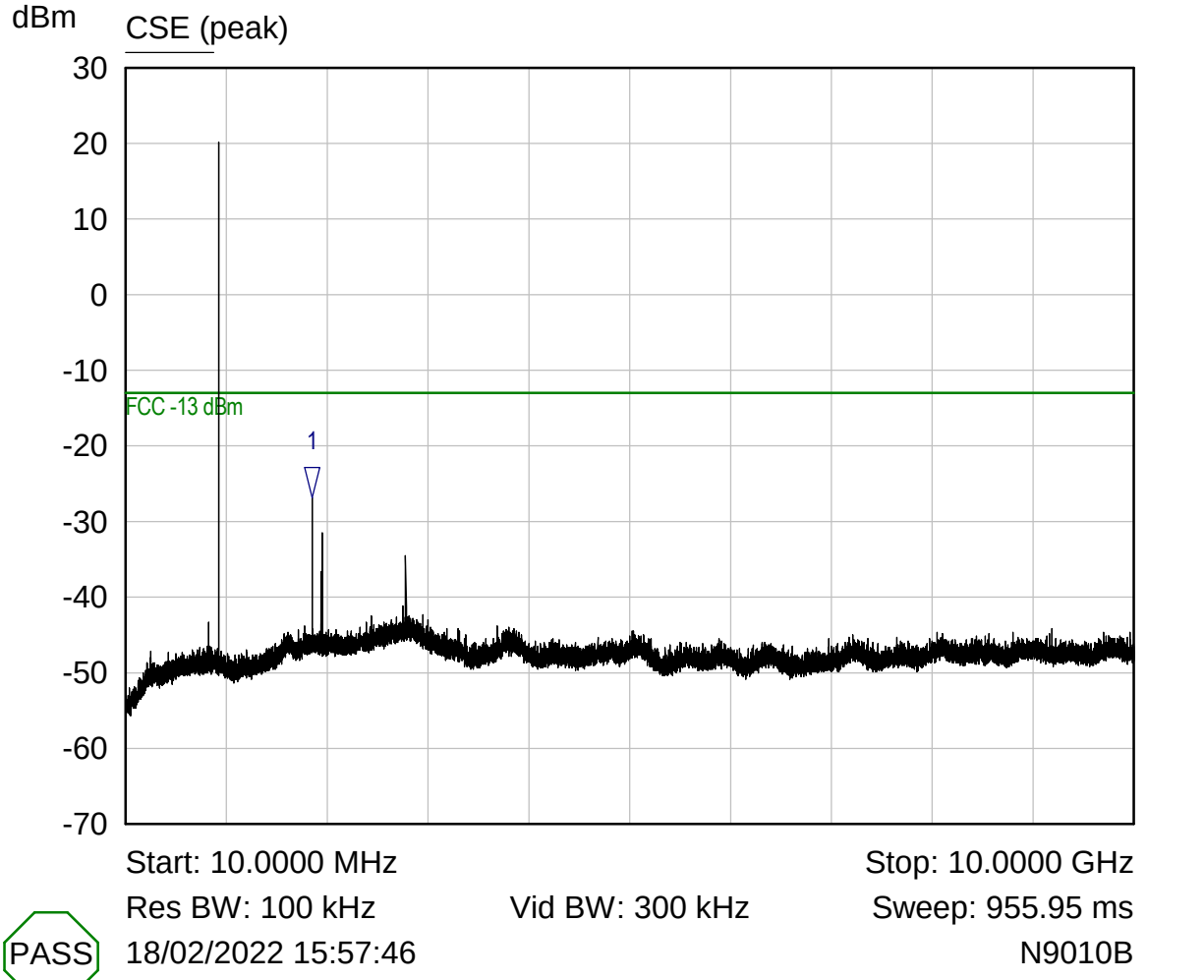
Plot of conducted emissions 10 MHz – 1.927 GHz range



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Bottom Ch	3.8655 GHz	-33.91 dBm	
2 ▽	Middle Ch	3.9198 GHz	-36.52 dBm	
3 ▽	Top Ch	3.9850 GHz	-37.75 dBm	

Plot of conducted emissions 2 GHz – 27 GHz range

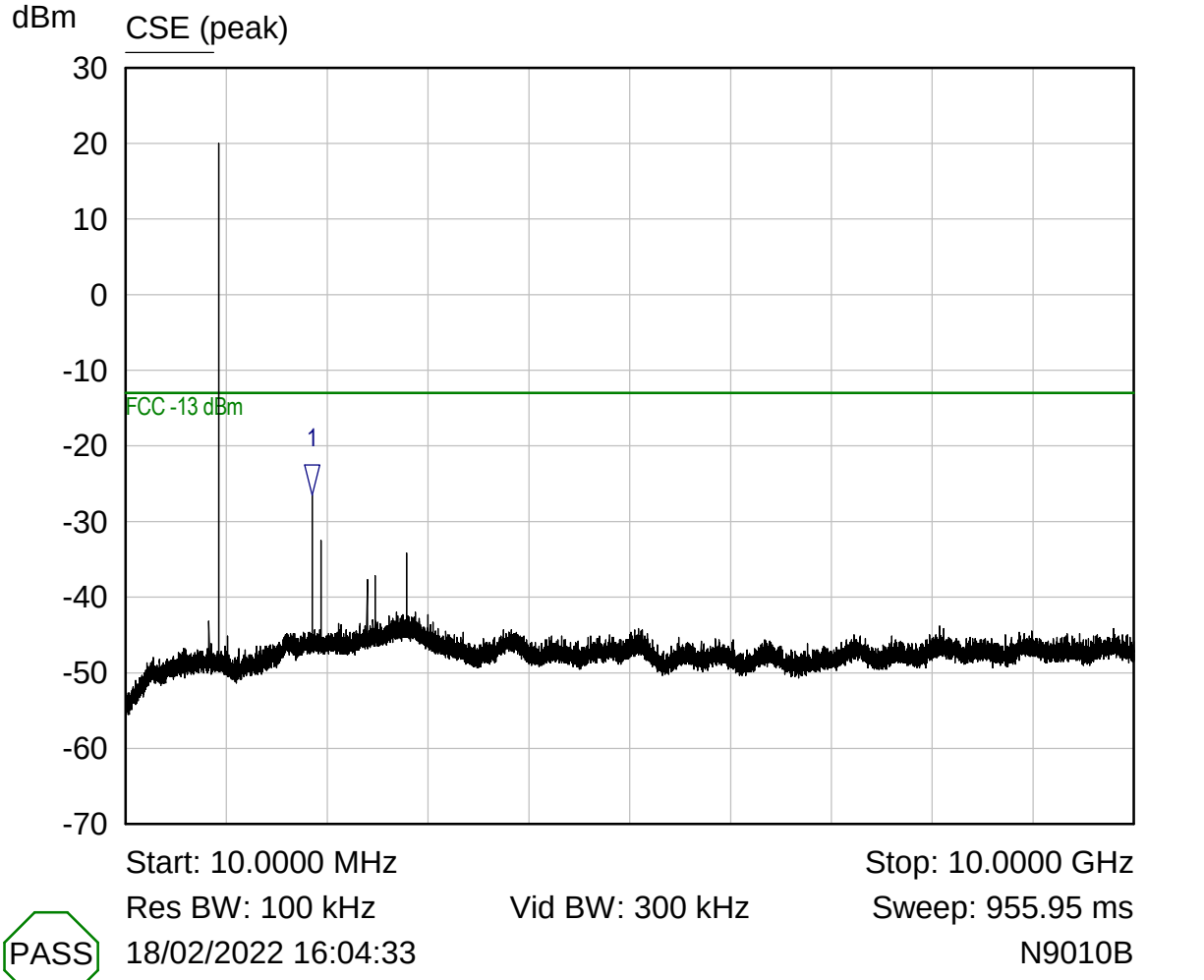
RF Parameters: Band 929-930 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW, Channel 929.5 MHz, Single channel mode



Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE (peak)	1.8592 GHz	-26.81 dBm	

Plot of conducted emissions single Mid channel (929.5 MHz) 10 MHz – 10 GHz range

RF Parameters: Band 931-932MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW, Channel 931.5 MHz, Single channel mode

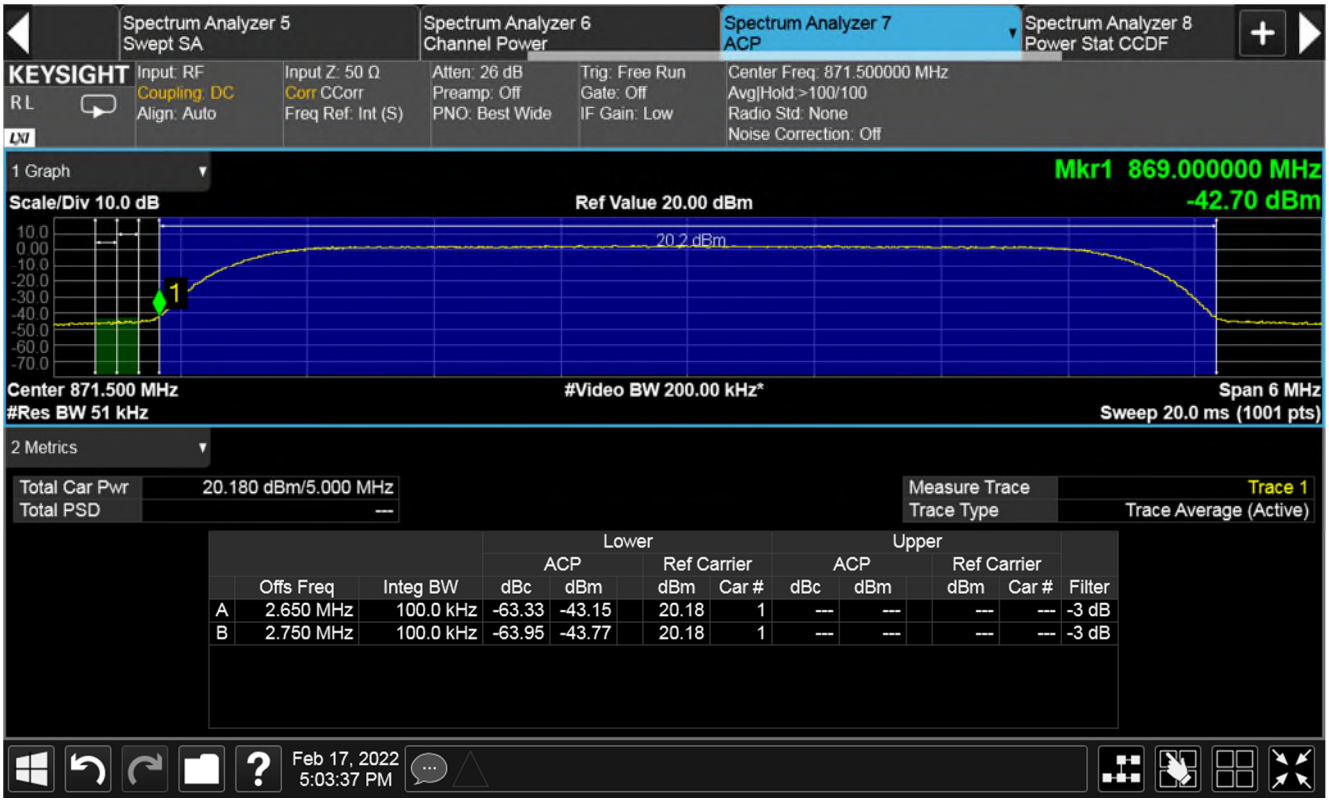


Mkr	Trace	X-Axis	Value	Notes
1 ▽	CSE (peak)	1.8632 GHz	-26.51 dBm	

Plot of conducted emissions single Mid channel (931.5 MHz) 10 MHz – 10 GHz range

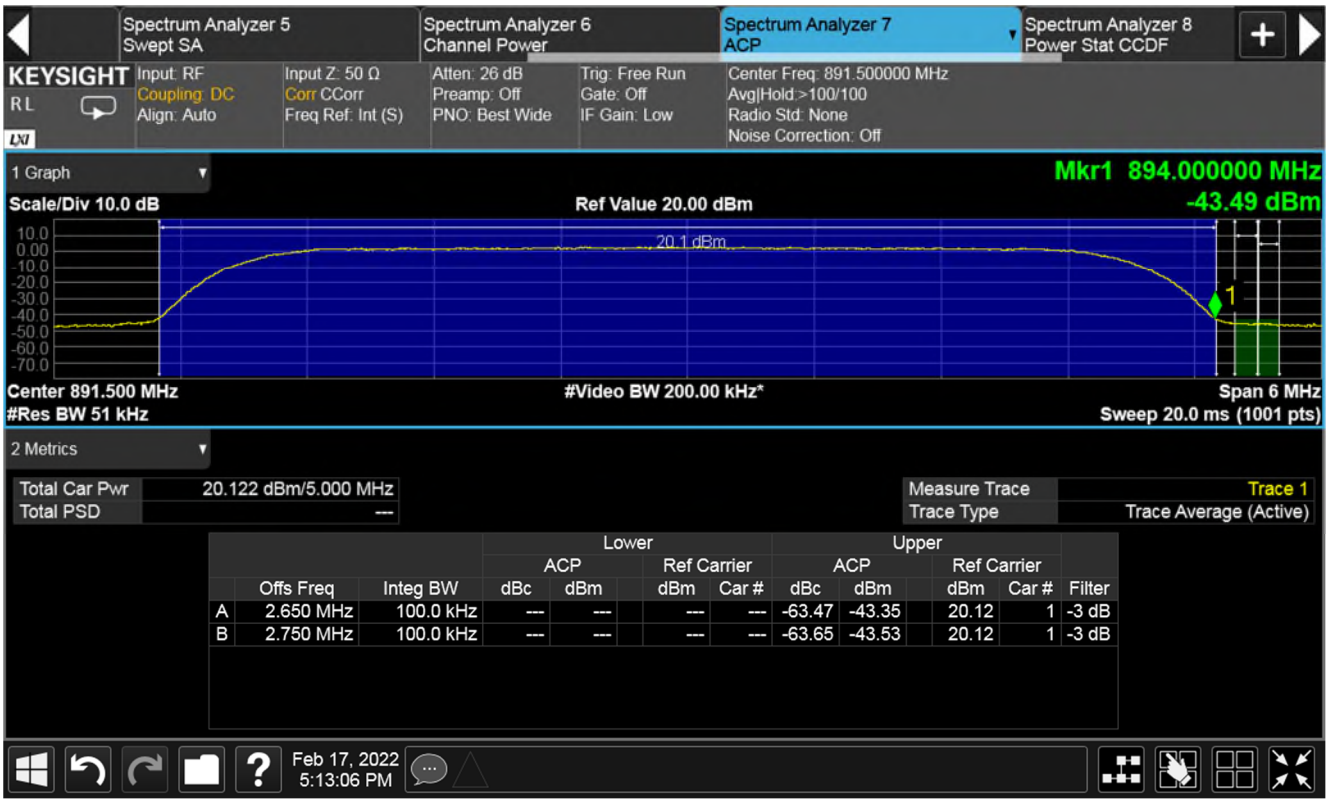
6.5 Band edge emissions

RF Parameters: Band 869-894 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channel 871.5 MHz, Single channel mode



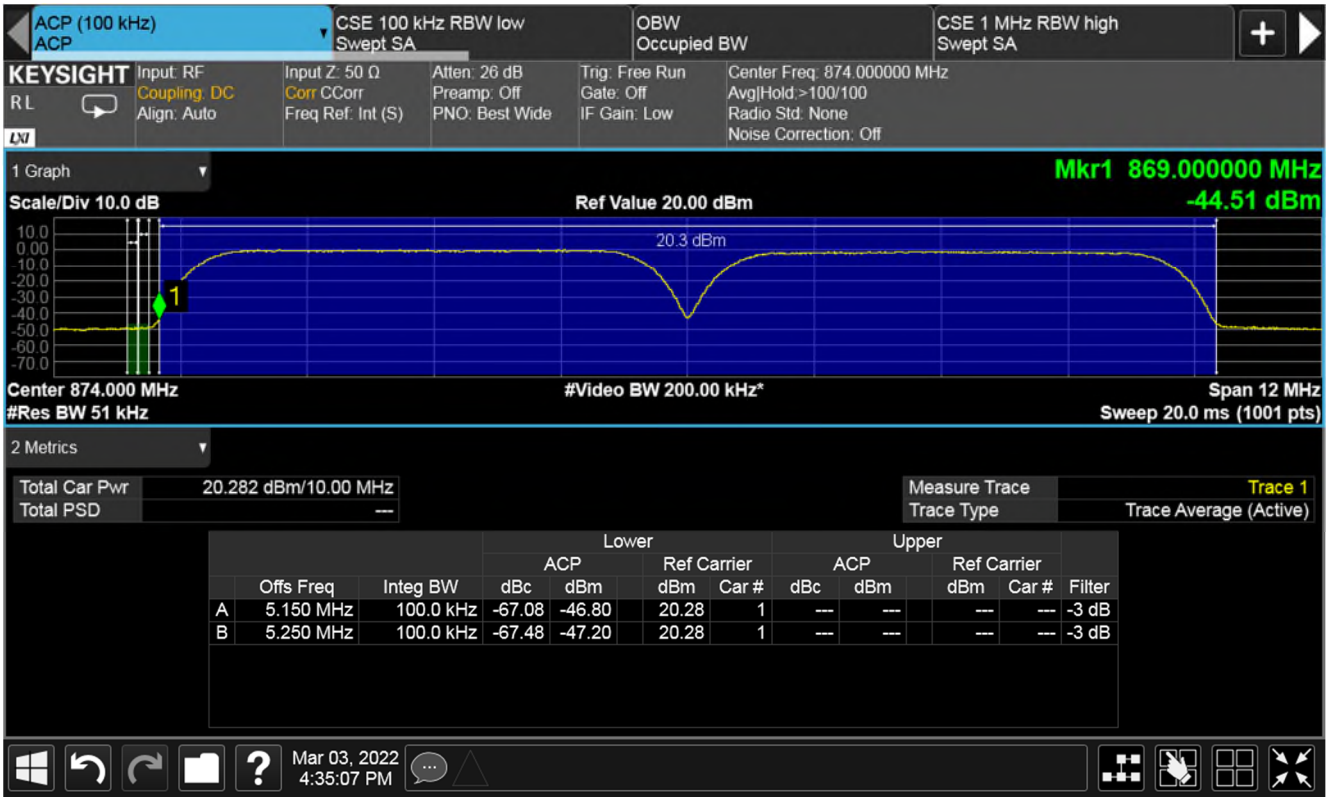
Plot of lower band edge for Low channel (871.5 MHz)

RF Parameters: Band 869-894 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channel 891.5 MHz, Single channel mode



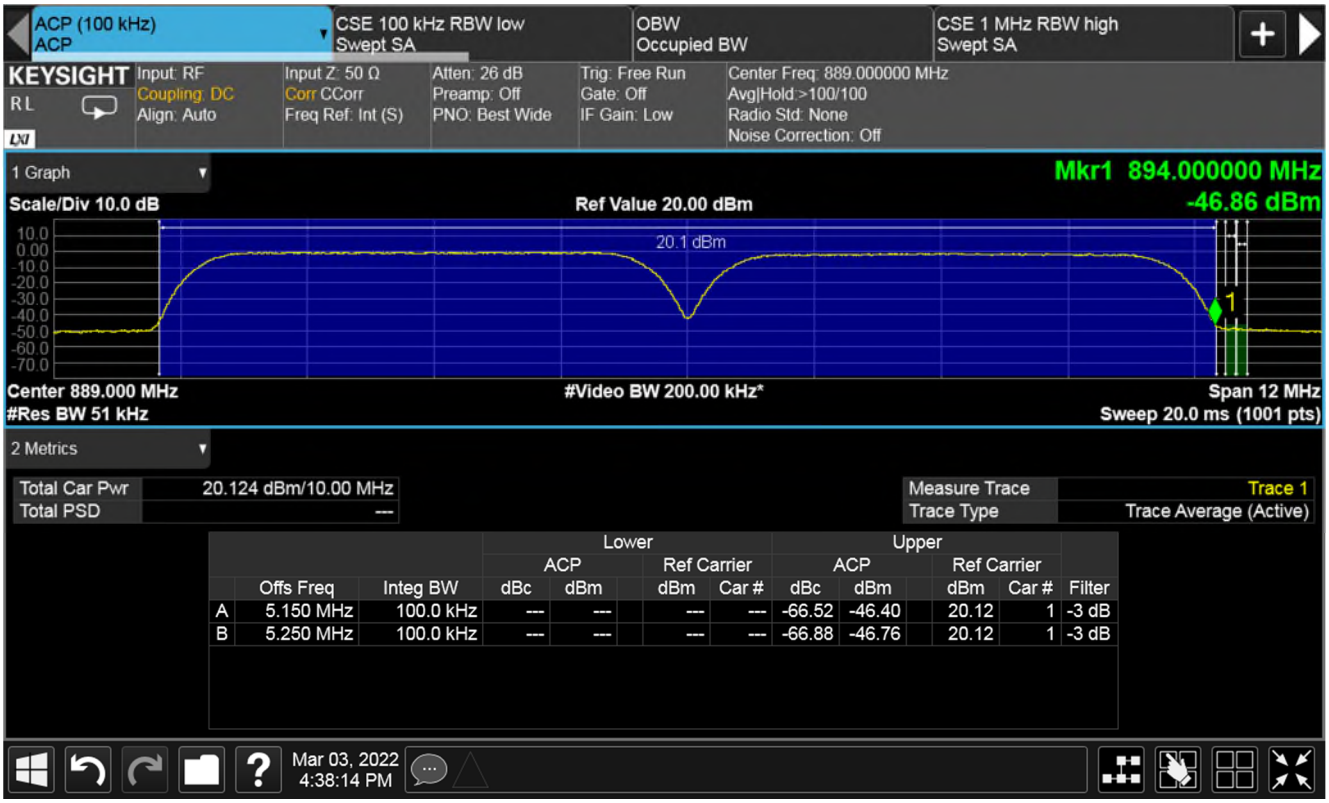
Plot of upper band edge for High channel (891.5 MHz)

RF Parameters: Band 869-894 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channel 871.5 & 876.5 MHz, Dual channel mode



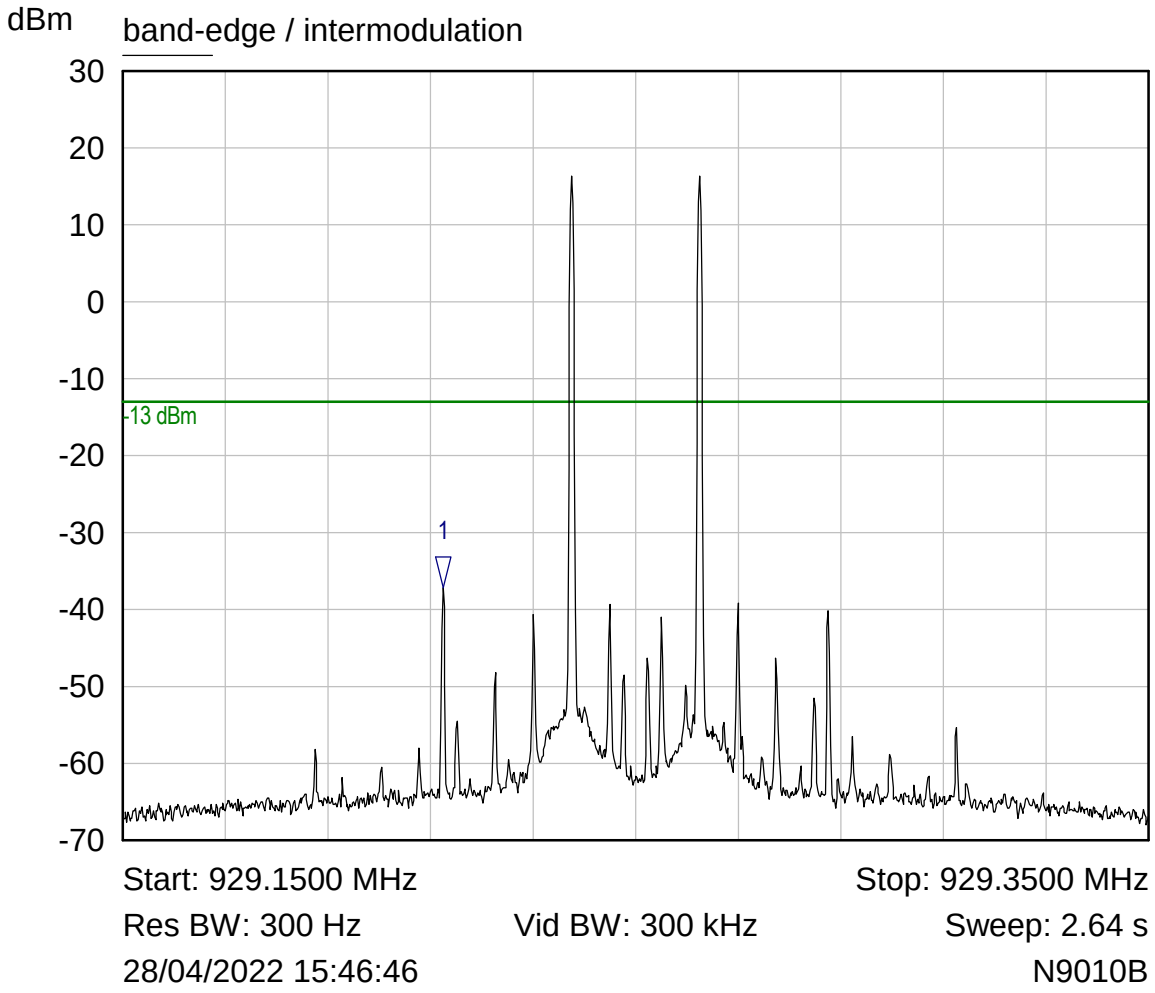
Plot of lower band edge for Low channels (871.5 & 876.5 MHz)

RF Parameters: Band 869-894 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channel 886.5 & 891.5 MHz, Dual channel mode



Plot of upper band edge for High channels (886.5 & 891.5 MHz)

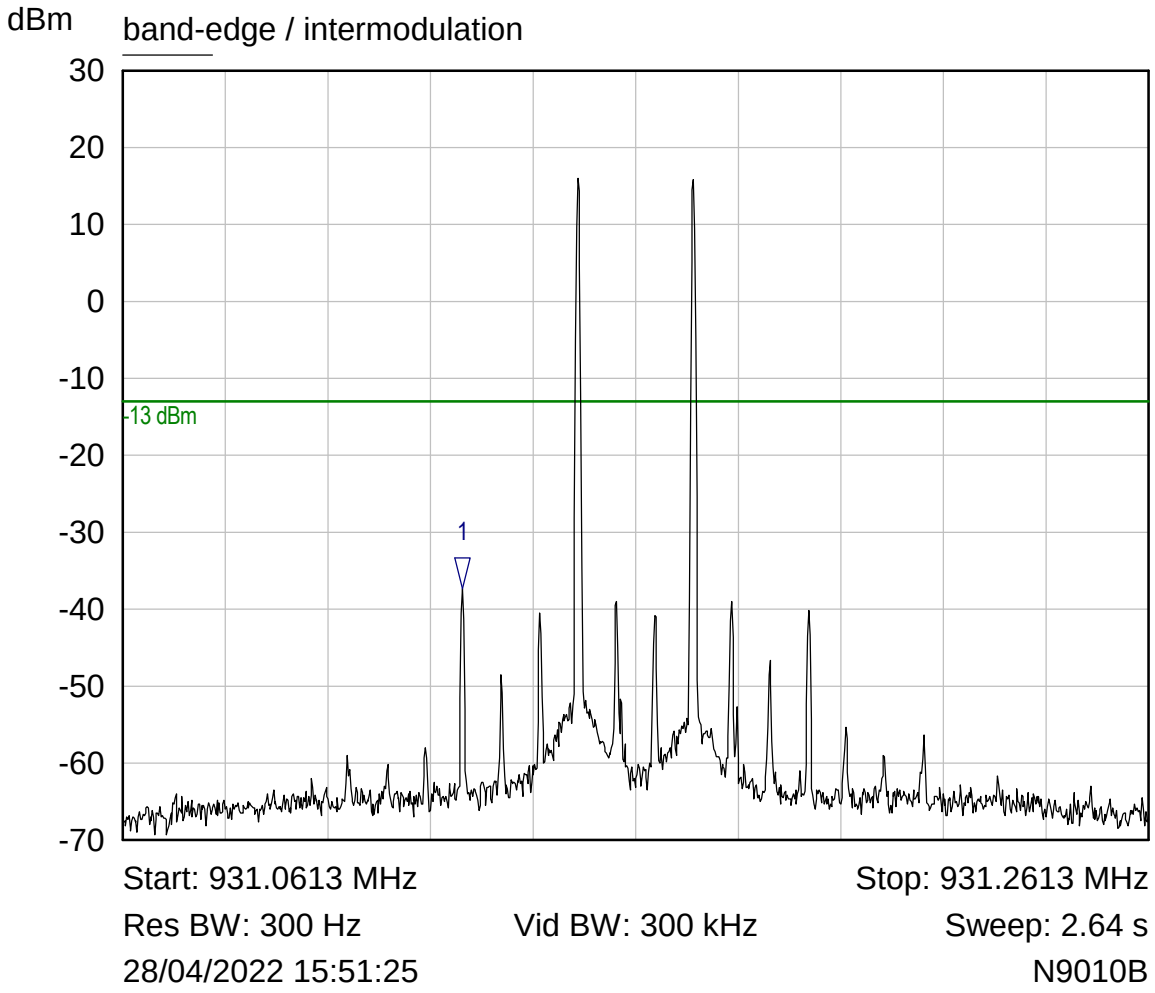
RF Parameters: Band 929-930 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW, Channel 929.2375 and 929.2625, dual channel mode centred on f0



Mkr	Trace	X-Axis	Value	Notes
1 ▽	band-edge / intermodulation	929.2125 MHz	-37.18 dBm	

Plot of 929-930 MHz intermodulation

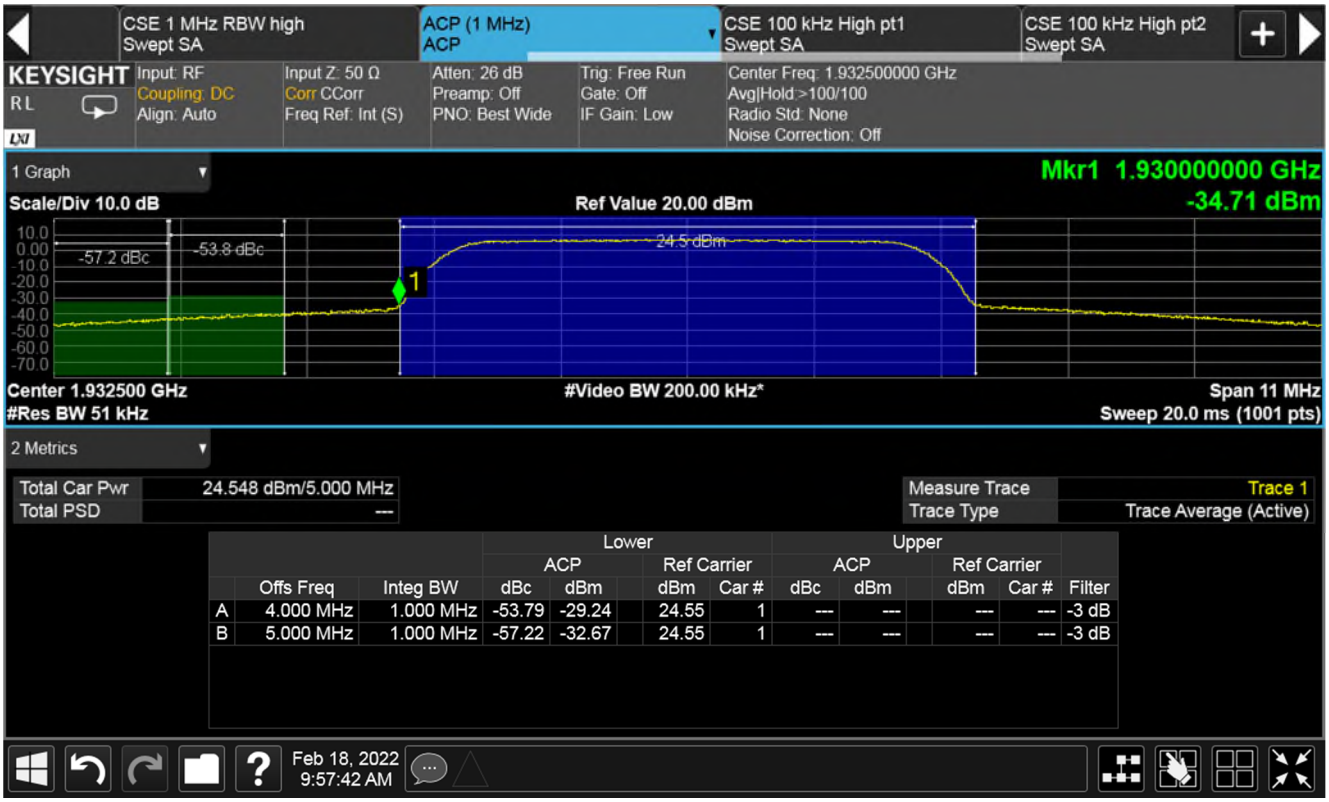
RF Parameters: Band 931 – 932 MHz, Power +20 dBm, Channel Spacing 25kHz, Modulation CW, Channel 931.150 and 931.1725, dual channel mode centred on f0



Mkr	Trace	X-Axis	Value	Notes
1 ▽	band-edge / intermodulation	931.1275 MHz	-37.39 dBm	

Plot of 931 – 932 MHz intermodulation

RF Parameters: Band 1930-1995 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channel 1932.5 MHz, Single channel mode

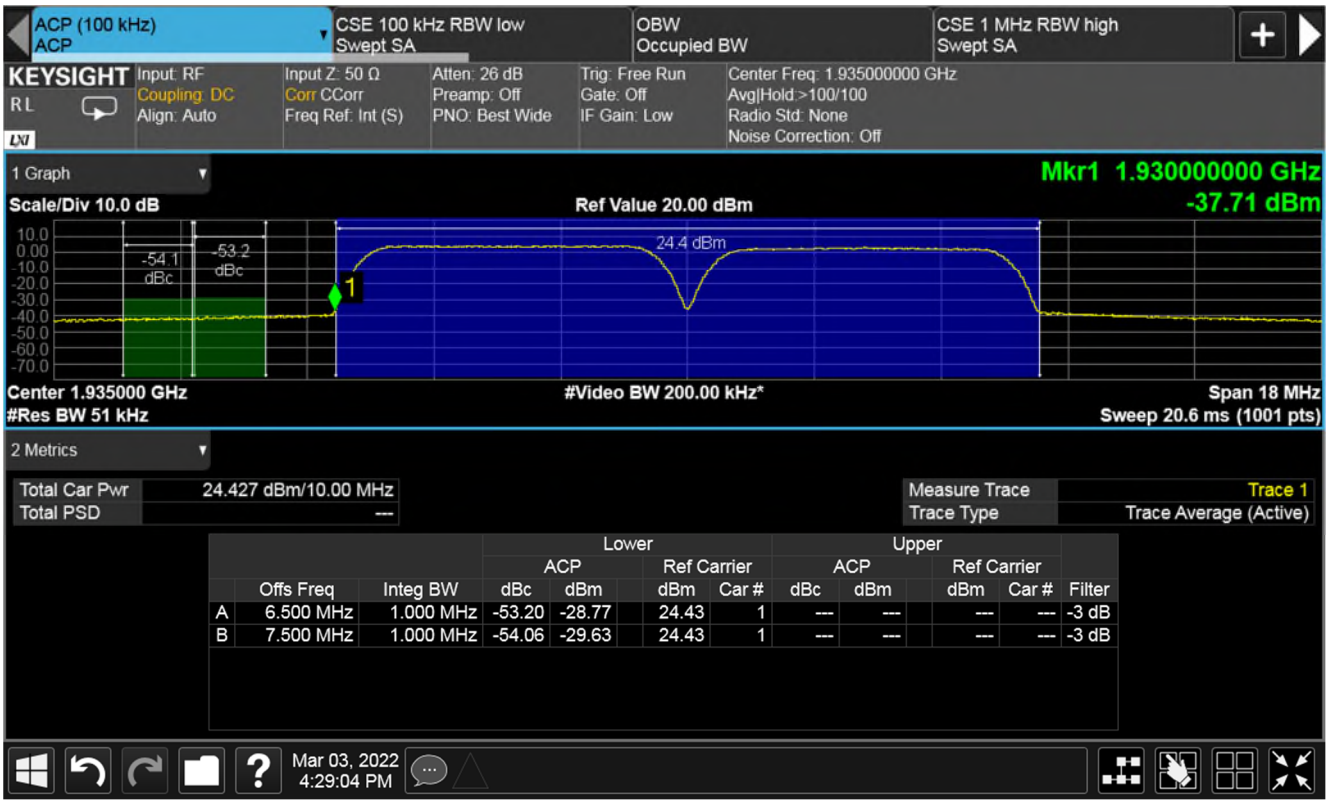


Plot of lower band edge for Low channel (1932.5 MHz)

RF Parameters: Band 1930-1995 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channel 1992.5 MHz, Single channel mode

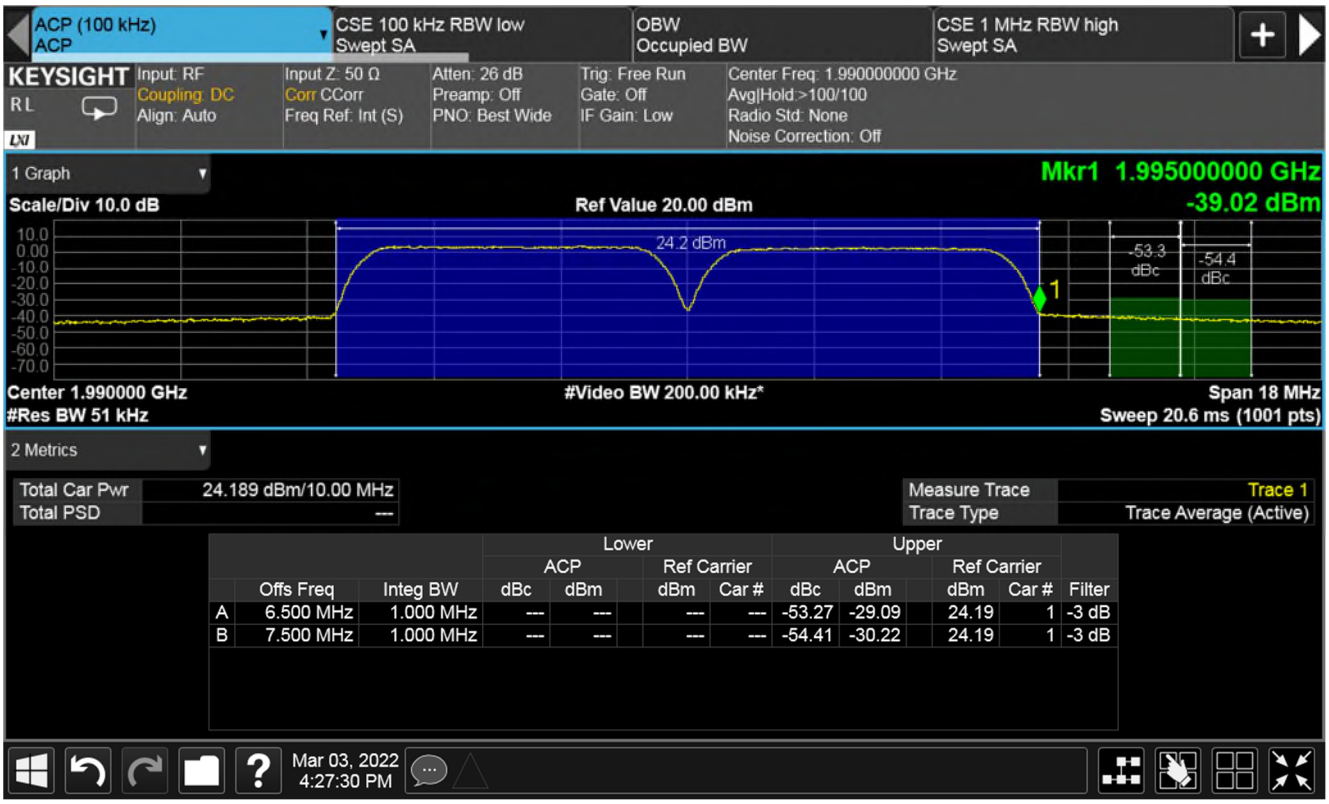
Plot of upper band edge for High channel (1992.5 MHz)

RF Parameters: Band 1930-1995 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channels 1932.5 & 1937.5 MHz, Dual channel mode



Plot of lower band edge for Low channels (1932.5 & 1937.5 MHz)

RF Parameters: Band 1930-1995 MHz, Power +20 dBm, Channel Spacing 5MHz, Modulation AWGN, Channels 1987.5 & 1992.5 MHz, Dual channel mode



Plot of upper band edge for High channels (1987.5 & 1992.5 MHz)

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