



# **Radio Test Report**

## **Domo Tactical Communications**

### **NETnode Phase 4 1W OEM**

### **D1707-OEM+AP001973**

47 CFR Part 90I Effective Date 1st October 2018  
↳ 47CFR part 2J 2018

Test Date: 22nd January 2020 to 23rd January 2020  
Report Number: 01-11915-1-20 Issue 01

#### ***R.N. Electronics Ltd.***

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

[www.RNelectronics.com](http://www.RNelectronics.com)

Telephone: +44 (0) 1277 352219  
Email: [sales@RNelectronics.com](mailto:sales@RNelectronics.com)

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

### Certificate of Test 11915-1

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of FCC Part 90I. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

|                                                            |                                                                                                |
|------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Equipment:                                                 | NETnode Phase 4 1W OEM                                                                         |
| Model Number:                                              | D1707-OEM+AP001973                                                                             |
| Unique Serial Number:                                      | 1RC1                                                                                           |
| Applicant:                                                 | Domo Tactical Communications<br>Fusion 2, 1100 Parkway , Hampshire<br>Whiteley, UK<br>PO15 7AB |
| Proposed FCC ID                                            | XRF-NETNodeP41W                                                                                |
| Full measurement results are<br>detailed in Report Number: | 01-11915-1-20 Issue 01                                                                         |
| Test Standards:                                            | 47 CFR Part 90I Effective Date 1st October 2018<br>↳ 47CFR part 2J 2018                        |

**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.

**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: 22nd January to 23rd January 2020

Test Engineer:

A rectangular box containing a handwritten signature in black ink, which appears to read 'Charles Blunt'.

Approved By:  
Radio Approvals Manager

A rectangular box for a signature, currently empty.

Customer  
Representative:

A rectangular box for a signature, currently empty.



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## 2 Equipment under test (EUT)

### 2.1 Equipment specification

|                           |                                                                                                          |                   |
|---------------------------|----------------------------------------------------------------------------------------------------------|-------------------|
| Applicant                 | Domo Tactical Communications<br>Fusion 2<br>1100 Parkway<br>Hampshire<br>Whiteley<br>UK<br>PO15 7AB      |                   |
| Manufacturer of EUT       | Domo Tactical Communications                                                                             |                   |
| Full Name of EUT          | NETnode Phase 4 1W OEM                                                                                   |                   |
| Model Number of EUT       | D1707-OEM+AP001973                                                                                       |                   |
| Serial Number of EUT      | 1RC1                                                                                                     |                   |
| Date Received             | 22nd January 2020                                                                                        |                   |
| Date of Test:             | 22nd January 2020 to 23rd January 2020                                                                   |                   |
| Purpose of Test           | To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations. |                   |
| Date Report Issued        | 31st January 2020                                                                                        |                   |
| Main Function             | Licensed non-broadcast transmitter.                                                                      |                   |
| Information Specification | Height                                                                                                   | 190 mm            |
|                           | Width                                                                                                    | 130 mm            |
|                           | Depth                                                                                                    | 30 mm             |
|                           | Weight                                                                                                   | <1 kg             |
|                           | Voltage                                                                                                  | 10.2 to 13.8 V DC |
|                           | Current                                                                                                  | 1 A               |

## 2.2 Configurations for testing

| General Parameters                 |                                    |
|------------------------------------|------------------------------------|
| EUT Normal use position            | Fixed                              |
| Choice of model(s) for type tests  | Production Sample                  |
| Antenna details                    | External                           |
| Antenna port                       | 1 x N type (TX), 1x N-type RX      |
| Baseband Data port (yes/no)?       | No                                 |
| Highest Signal generated in EUT    | 2479 MHz                           |
| Lowest Signal generated in EUT     | Not specified                      |
| Hardware Version                   | SA4336 issue 1                     |
| Software Version                   | GUI 6.1.30 F-30                    |
| Firmware Version                   | 6.0 R-1 Build 116 image 151        |
| Type of Equipment                  | Licensed non-broadcast transmitter |
| Technology Type                    | COFDM                              |
| Geo-location (yes/no)              | No                                 |
| TX Parameters                      |                                    |
| Alignment range – transmitter      | 2450 – 2483.5 MHz                  |
| EUT Declared Modulation Parameters | COFDM                              |
| EUT Declared Power level           | +30 dBm (1 Watt)                   |
| EUT Declared Signal Bandwidths     | 6 MHz                              |
| EUT Declared Channel Spacing's     | 6 MHz                              |
| EUT Declared Duty Cycle            | Up to 100%                         |
| Unmodulated carrier available?     | No                                 |
| Declared frequency stability       | 1 ppm                              |
| RX Parameters                      |                                    |
| Alignment range – receiver         | 2450 – 2483.5 MHz                  |
| EUT Declared RX Signal Bandwidth   | Not declared                       |
| Receiver Signal Level (RSL)        | Not declared                       |

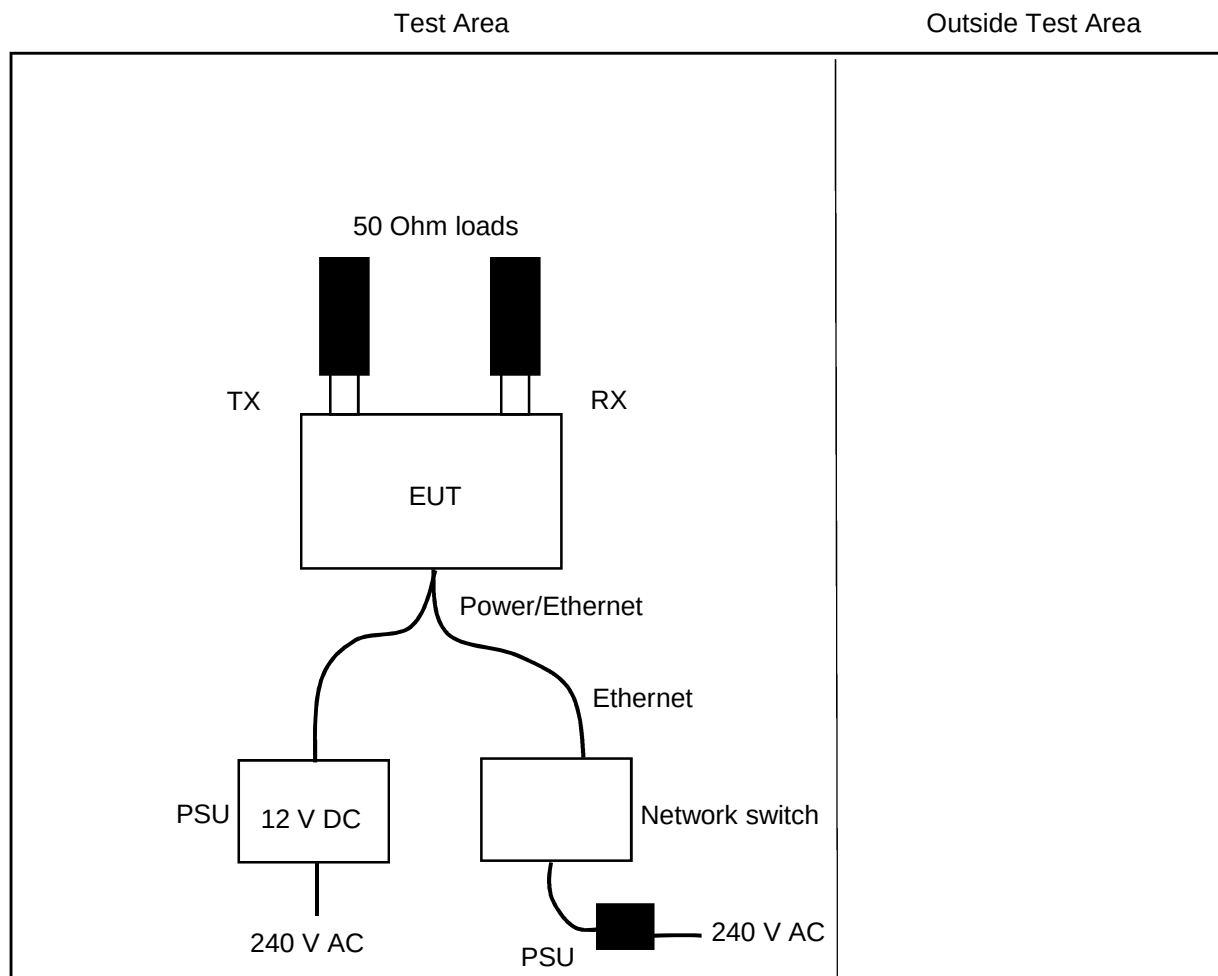
## 2.3 Functional description

Licensed non-broadcast transmitter operating under FCC part 90 in the 2450-2483.5 MHz band.

## 2.4 Modes of operation

| Mode Reference | Description                      | Used for testing |
|----------------|----------------------------------|------------------|
| TX1            | 2454 MHz 29 dBm COFDM modulation | Yes              |
| TX2            | 2467 MHz 29 dBm COFDM modulation | Yes              |
| TX3            | 2479 MHz 29 dBm COFDM modulation | Yes              |

## 2.5 Emissions configuration



The unit was powered from a 12 V DC bench supply. The network port was terminated via a 1.5m unscreened cable by a network switch. The unit was configured with engineering menus in software to allow permanent transmit modes of device on the top, middle and bottom channels as stated within section 2.4 of this report. The unit has a single modulation scheme and bandwidth. The transmit mode was 100% continuous with modulation and the power settings used for each channel were as stated below:-

Low Channel (2454 MHz) = +29 dBm  
Mid Channel (2467 MHz) only = +29 dBm  
High Channel (2479 MHz) = +29 dBm

### 2.5.1 Signal leads

| Port Name      | Cable Type  | Connected |
|----------------|-------------|-----------|
| RX             | N connector | Yes       |
| TX             | N connector | Yes       |
| Power/Ethernet | Circular    | Yes       |

### 3 Summary of test results

The NETnode Phase 4 1W OEM, D1707-OEM+AP001973 was tested for compliance to the following standard(s) :

47 CFR Part 90I Effective Date 1st October 2018

↳ 47CFR part 2J 2018

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                     |
|----------------------------------|---------------------------------------------------------------|-----------------------------|
| <b>Transmitter Tests</b>         |                                                               |                             |
| 1. Radiated emissions            | FCC Part 90I Clause 90.210(b),<br>47CFR part 2J Clause 2.1053 | PASSED <sup>1</sup>         |
| 2. Conducted emissions           | FCC Part 90I Clause 90.210(b),<br>47CFR part 2J Clause 2.1051 | PASSED <sup>1</sup>         |
| 3. Conducted power               | FCC Part 90I Clause 90.205(o),<br>FCC Part 90I Clause 2.1046  | PASSED                      |
| 4. Frequency stability           | FCC Part 90I Clause 90.213(a),<br>47CFR part 2J Clause 2.1055 | PASSED                      |
| 5. Occupied bandwidth            | FCC Part 90I Clause 90.209,<br>47CFR part 2J Clause 2.1049    | PASSED                      |
| 6. Emission mask                 | FCC Part 90I Clause 90.210(b)                                 | PASSED                      |
| 7. Modulation limiting           | 47CFR part 2J Clause 2.1047(b)                                | NOT APPLICABLE <sup>2</sup> |
| 8. Modulation frequency response | 47CFR part 2J Clause 2.1047(a)                                | NOT APPLICABLE <sup>2</sup> |
| 9. Transient frequency behaviour | FCC Part 90I Clause 90.214                                    | NOT APPLICABLE <sup>3</sup> |
| 10. Adjacent channel power       | FCC Part 90I Clause 90.221                                    | NOT APPLICABLE <sup>4</sup> |

<sup>1</sup> Spectrum investigated up to a frequency of 25 GHz based on 10 times the highest channel/ signal generated in equipment of 2479 MHz.

<sup>2</sup> EUT employs digital modulation.

<sup>3</sup> Transmitter does not operate in bands 150-174 MHz or 421-512 MHz.

<sup>4</sup> Transmitter does not operate in bands 450-470 MHz or 809-824 MHz or 854-869 MHz.

## 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 90I    | 2018    | Part 90 - Private Land Mobile Radio Services - Subpart I - General Technical standards            |
| 4.1.2 | 47CFR part 2J   | 2018    | Part 2 – Frequency Allocations and radio treaty matters; General rules and regulations            |
| 4.1.3 | ANSI C63.26     | 2015    | American National Standard for Compliance testing of transmitters used in Licensed radio services |

### 4.2 Deviations

No deviations were applied.

### 4.3 Tests at extremes of temperature & voltage

The following test conditions were used to simulate testing at nominal or extremes.

| Temperature Test Conditions |        | Voltage Test Conditions |          |
|-----------------------------|--------|-------------------------|----------|
| T nominal                   | 20 °C  | V nominal               | 12V DC   |
| T minimum                   | -30 °C | V minimum               | 10.2V DC |
| T maximum                   | 50 °C  | V maximum               | 13.8V DC |

Extremes of temperature and voltage are based upon manufacturer's declaration.

The ambient test conditions of humidity and pressure in the laboratory were as specified in each specific test section within this report

### 4.4 Test fixtures

In order to measure RF parameters at temperature extremes, the EUT was tested in a temperature controlled chamber as follows:

The equipment external RF port was used for testing.



## 5 Tests, methods and results

### 5.1 Radiated emissions

#### 5.1.1 Test methods

|                    |                                                                                                                                 |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Test Requirements: | FCC Part 90I Clause 90.210(b) [Reference 4.1.1 of this report],<br>47CFR part 2J Clause 2.1053 [Reference 4.1.2 of this report] |
| Test Method:       | ANSI C63.26 Clause 5.5 [Reference 4.1.3 of this report]                                                                         |
| Limits:            | FCC Part 90I Clause 90.210(b)(3) [Reference 4.1.1 of this report]                                                               |

#### 5.1.2 Configuration of EUT

The EUT was tested in an ALSE and ambient conditions were monitored. The separate transmit and receive ports were individually terminated with a 50 Ohm load. The unit was powered from 12 V DC. Three orthogonal planes were examined. All test modes specified in section 2.4 were tested and, therefore, the EUT was operated in TX1 to TX3 modes for this test.

#### 5.1.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section at Site M. Peak field strength from the EUT was maximised by rotating it 360 degrees. An RMS detector was used for final measurements.

30 MHz – 1 GHz.

The measuring antenna was scanned 1 - 4m in both Horizontal and Vertical polarisations. Substitution method was performed using tuned dipoles / a calibrated bi-conical antenna.

1 GHz – 25 GHz.

The measuring antenna was used in both Horizontal and Vertical polarisations. Substitution method was performed using standard gain horn antennas.

#### 5.1.4 Test equipment

CAL07, E005, E136, E268, E411, E453, E454, E602, E624, E743, LPE364, TMS78, TMS814, TMS82

See Section 8 for more details

#### 5.1.5 Test results

|                                 |            |
|---------------------------------|------------|
| Temperature of test environment | 16-19°C    |
| Humidity of test environment    | 52-57%     |
| Pressure of test environment    | 103-104kPa |

Note: only emissions within 20dB of limits are reported.

Setup Table

|                 |                 |
|-----------------|-----------------|
| Band            | 2450-2483.5 MHz |
| Power Level     | 29 dBm          |
| Channel Spacing | 6 MHz           |
| Mod Scheme      | COFDM           |
| Low channel     | 2454 MHz        |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) | Antenna Polarisation | EUT Polarisation |
|--------------------------|-------------------------------|--------------------------|----------------------|------------------|
| 7362                     | -32.5                         | -19.5                    | Vertical             | Upright          |

Setup Table

|                 |                 |
|-----------------|-----------------|
| Band            | 2450-2483.5 MHz |
| Power Level     | 29 dBm          |
| Channel Spacing | 6 MHz           |
| Mod Scheme      | COFDM           |
| Mid channel     | 2467 MHz        |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) | Antenna Polarisation | EUT Polarisation |
|--------------------------|-------------------------------|--------------------------|----------------------|------------------|
| 7401                     | -30.6                         | -17.6                    | Vertical             | Upright          |

Setup Table

|                 |                 |
|-----------------|-----------------|
| Band            | 2450-2483.5 MHz |
| Power Level     | 29 dBm          |
| Channel Spacing | 6 MHz           |
| Mod Scheme      | COFDM           |
| High channel    | 2479 MHz        |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) | Antenna Polarisation | EUT Polarisation |
|--------------------------|-------------------------------|--------------------------|----------------------|------------------|
| 7437                     | -32.7                         | -19.7                    | Vertical             | Upright          |

#### LIMITS:

Part 90.210(b)(3), -13 dBm

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 - 1000MHz  $\pm 6.1$ dB, 1 – 18 GHz  $\pm 3.5$ dB, 18 – 25 GHz  $\pm 3.9$ dB.

## 5.2 Conducted emissions

### 5.2.1 Test methods

Test Requirements: FCC Part 90I Clause 90.210(b) [Reference 4.1.1 of this report],  
47CFR part 2J Clause 2.1051 [Reference 4.1.2 of this report]  
Test Method: ANSI C63.26 Clause 5.7 [Reference 4.1.3 of this report]  
Limits: FCC Part 90I Clause 90.210(b)(3) [Reference 4.1.1 of this report]

### 5.2.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the 50 ohm coaxial transmit port. The EUT was operated in TX1 to TX3 modes for this test.

### 5.2.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section at Site A. A complete scan of emissions from the lowest frequency generated/ used within the equipment up to 10 times the highest frequency generated/ used was made, to identify any signals within 20dB of the limits. Any identified spurious signals were measured in the required bandwidths.

### 5.2.4 Test equipment

E755, E866, E874

See Section 8 for more details

### 5.2.5 Test results

Temperature of test environment 21°C  
Humidity of test environment 52%  
Pressure of test environment 104kPa

|                 |                 |
|-----------------|-----------------|
| Band            | 2450-2483.5 MHz |
| Power Level     | 29 dBm          |
| Channel Spacing | 6 MHz           |
| Mod Scheme      | COFDM           |
| Low channel     | 2454 MHz        |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|--------------------------|-------------------------------|--------------------------|
| 2447                     | -19.1                         | -6.1                     |

| Plots             |
|-------------------|
| 11915-1 2454-low  |
| 11915-1 2454-high |

|                 |                 |
|-----------------|-----------------|
| Band            | 2450-2483.5 MHz |
| Power Level     | 29 dBm          |
| Channel Spacing | 6 MHz           |
| Mod Scheme      | COFDM           |
| Mid channel     | 2467 MHz        |

| Spurious Frequency (MHz)                    | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|---------------------------------------------|-------------------------------|--------------------------|
| No spurious emissions within 20 dB of limit |                               |                          |

| Plots             |
|-------------------|
| 11915-1 2467-low  |
| 11915-1 2467-high |

|                 |                 |
|-----------------|-----------------|
| Band            | 2450-2483.5 MHz |
| Power Level     | 29 dBm          |
| Channel Spacing | 6 MHz           |
| Mod Scheme      | COFDM           |
| High channel    | 2479 MHz        |

| Spurious Frequency (MHz) | Measured Spurious Level (dBm) | Difference to Limit (dB) |
|--------------------------|-------------------------------|--------------------------|
| 2486.7                   | -21.3                         | -8.3                     |

| Plots             |
|-------------------|
| 11915-1 2479-low  |
| 11915-1 2479-high |

Any analyser plots can be found in Section 6 of this report.

**LIMITS:**

Part 90.210(b)(3), -13 dBm

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:  
 $\pm 2.8$  dB up to 25 GHz.

## 5.3 Conducted power

### 5.3.1 Test methods

|                    |                                                                                                                                |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Test Requirements: | FCC Part 90I Clause 90.205(o) [Reference 4.1.1 of this report],<br>FCC Part 90I Clause 2.1046 [Reference 4.1.1 of this report] |
| Test Method:       | ANSI C63.26 Clause 5.2 [Reference 4.1.3 of this report]                                                                        |
| Limits:            | FCC Part 90I Clause 90.205(o) [Reference 4.1.1 of this report]                                                                 |

### 5.3.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the external RF port via attenuation. The EUT was operated in TX1 to TX3 modes for this test and highest power levels recorded.

### 5.3.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment' Section. The channel power function of the analyser was used with an RMS detector. Measurements were made on a test bench in site A.

### 5.3.4 Test equipment

E755, E866, E874

See Section 8 for more details

### 5.3.5 Test results

|                                 |        |
|---------------------------------|--------|
| Temperature of test environment | 21°C   |
| Humidity of test environment    | 52%    |
| Pressure of test environment    | 104kPa |

|                 |                 |
|-----------------|-----------------|
| Band            | 2450-2483.5 MHz |
| Power Level     | 29 dBm          |
| Channel Spacing | 6               |
| Mod Scheme      | COFDM           |
| Low channel     | 2454 MHz        |
| Mid channel     | 2467 MHz        |
| High channel    | 2479 MHz        |

| Test conditions                 |              |              |              |
|---------------------------------|--------------|--------------|--------------|
|                                 | Low channel  | Mid channel  | High channel |
| Carrier Power (Watts)           | 0.85         | 0.86         | 0.83         |
| Maximum TX Power observed (dBm) | 29.29        | 29.36        | 29.19        |
| Plot reference                  | 11915-1 2454 | 11915-1 2467 | 11915-1 2479 |

Any analyser plots can be found in Section 6 of this report.

#### LIMITS:

Part 90.205(o), 5 W

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:  
<± 1.0 dB

## 5.4 Frequency stability

### 5.4.1 Test methods

Test Requirements: FCC Part 90I Clause 90.213(a) [Reference 4.1.1 of this report],  
47CFR part 2J Clause 2.1055 [Reference 4.1.2 of this report]  
Test Method: ANSI C63.26 Clause 5.6 [Reference 4.1.3 of this report]  
Limits: FCC Part 90I Clause 90.213(a) [Reference 4.1.1 of this report]

### 5.4.2 Configuration of EUT

The EUT was placed in a temperature controlled chamber and thermal balance was achieved before tests began. Measurements were made at the EUT 50 ohm TX port. The EUT was operated in **TX2** mode for this test.

### 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. Temperature stability was achieved at each test level before taking measurements. No CW carrier was available for measurement since the EUT was digitally modulated, and therefore the mean frequency was calculated by measuring two points (at the same level) on the upper & lower sides of the modulation envelope using the Occupied Bandwidth function of the spectrum analyser. EUT supply was varied to 85 & 115% of nominal volts at nominal temperature. Tests were performed using Test Site A.

### 5.4.4 Test equipment

E755, E866, E874, P270, TMS38, TMS57, TMS80

See Section 8 for more details

### 5.4.5 Test results

Temperature of test environment 21°C  
Humidity of test environment 52%  
Pressure of test environment 104kPa

|                 |                 |
|-----------------|-----------------|
| Band            | 2450-2483.5 MHz |
| Power Level     | 29 dBm          |
| Channel Spacing | 6 MHz           |
| Mod Scheme      | COFDM           |
| High channel    | 2479 MHz        |

| Test conditions                    |                      | Frequency Error (MHz)<br>High channel |
|------------------------------------|----------------------|---------------------------------------|
| -30°C                              | Volts Nominal (12)   | 2478.998687                           |
| -20°C                              | Volts Nominal (12)   | 2478.998262                           |
| -10°C                              | Volts Nominal (12)   | 2479.000572                           |
| 0°C                                | Volts Nominal (12)   | 2478.998326                           |
| 10°C                               | Volts Nominal (12)   | 2478.994204                           |
| 20°C                               | Volts Minimum (10.2) | 2479.003315                           |
|                                    | Volts Nominal (12)   | 2479.003864                           |
|                                    | Volts Maximum (13.8) | 2479.003824                           |
| 30°C                               | Volts Nominal (12)   | 2478.994093                           |
| 40°C                               | Volts Nominal (12)   | 2478.994683                           |
| 50°C                               | Volts Nominal (12)   | 2478.994214                           |
| Max Frequency Error per chan (Hz)  |                      | +3864 / -5907                         |
| Max Frequency Error observed (ppm) |                      | +1.56 / -2.38                         |

Note: Refer to operational description provided with certification for justification on testing only a single channel within the EUT operational band.

**LIMITS:**

Part 90.213 Equipment operating above 2450 MHz, no limit is specified.

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:  
 $<\pm 0.7$  ppm

## 5.5 Occupied bandwidth

### 5.5.1 Test methods

Test Requirements: FCC Part 90I Clause 90.209 [Reference 4.1.1 of this report],  
47CFR part 2J Clause 2.1049(h) [Reference 4.1.2 of this report]  
Test Method: ANSI C63.26 Clause 5.4 [Reference 4.1.3 of this report]  
Limits: FCC Part 90I Clause 90.209 [Reference 4.1.1 of this report]

### 5.5.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the 50 ohm coaxial transmit port. The EUT was operated in TX1 to TX3 modes.

### 5.5.3 Test procedure

Tests were performed using Test Site A. Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section. A 91 kHz RBW, 3x VBW, auto sweep time and max hold settings were used for the 99% bandwidth measurement using the Occupied Bandwidth measurement function of the spectrum analyser.

### 5.5.4 Test equipment

E755, E866, E874

See Section 8 for more details

### 5.5.5 Test results

Temperature of test environment 21°C  
Humidity of test environment 52%  
Pressure of test environment 104kPa

|                 |                 |
|-----------------|-----------------|
| Band            | 2450-2483.5 MHz |
| Power Level     | 29 dBm          |
| Channel Spacing | 6 MHz           |
| Mod Scheme      | COFDM           |
| Low channel     | 2454 MHz        |
| Mid channel     | 2467 MHz        |
| High channel    | 2479 MHz        |

|                               | Low channel  | Mid channel  | High channel |
|-------------------------------|--------------|--------------|--------------|
| 99 % Bandwidth (MHz)          |              |              |              |
| Nominal Temp & Volts          | 5.5566       | 5.5549       | 5.5483       |
| Plot for 99 % Bandwidth (MHz) |              |              |              |
| Nominal Temp & Volts          | 11915-1 2454 | 11915-1 2467 | 11915-1 2479 |

Any analyser plots can be found in Section 6 of this report.

#### LIMITS:

Part 90.209

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:

$\pm 1.9 \%$



## 5.6 Emission mask

### 5.6.1 Test methods

Test Requirements: FCC Part 90I Clause 90.210(b) [Reference 4.1.1 of this report]  
Test Method: ANSI C63.26 Clause 5.7 [Reference 4.1.3 of this report]  
Limits: FCC Part 90I Clause 90.210(b) [Reference 4.1.1 of this report]

### 5.6.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the 50 ohm coaxial transmit port. The EUT was operated in TX1 to TX3 modes.

### 5.6.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test equipment used' Section. The analyser was tuned to the nominal centre frequency with span of 30MHz and RBW of 30kHz and allowed to sweep enough times to capture the entire power envelope. The frequencies at which the spurious emission limits were last exceeded were noted. Plots were taken referenced to the applicable spectrum mask. As the measurement bandwidth is less than the emission bandwidth, the mask is lowered by the ratio of the Occupied Bandwidth to measurement bandwidth

Highest occupied bandwidth = 5556.6 kHz  
Measurement resolution bandwidth = 30 kHz  
Ratio =  $10 \cdot \log(\text{OBW}/\text{RBW})$   
= 22.68 dB.

Lowest transmit power = 29.2 dBm

Reference level for graph =  $29.19 - 22.68 = 6.51$  dBm.

Tests were performed is test site A.

### 5.6.4 Test equipment

E755, E866, E874

See Section 8 for more details

### 5.6.5 Test results

Temperature of test environment 21°C  
Humidity of test environment 52%  
Pressure of test environment 104kPa

|                 |                 |
|-----------------|-----------------|
| Band            | 2450-2483.5 MHz |
| Power Level     | 29 dBm          |
| Channel Spacing | 6 MHz           |
| Mod Scheme      | COFDM           |
| Low channel     | 2454 MHz        |
| Mid channel     | 2467 MHz        |
| High channel    | 2479 MHz        |

|                        | Low channel       | Mid channel       | High channel      |
|------------------------|-------------------|-------------------|-------------------|
| Nominal plot reference | 11915-1 2454 mask | 11915-1 2467 mask | 11915-1 2479 mask |

Any analyser plots can be found in Section 6 of this report.

**LIMITS:**

Part 90.210(b) & (n)

Under Part 90 section 210, the masks for equipment designated to operate in the 2.45 - 2.4835GHz band are not specified in the Applicable Emission Masks Chart.

Therefore, while the EUT has no provision to inject an audio sub carrier into the transmitted RF signal, mask applied is Mask B as noted for "All other bands". Although Mask B generally pertains to equipment with an audio low pass filter, Mask C is completely inappropriate in that it does not allow for spread spectrum carriers within the designated bandwidth.

(b) Emission Mask B - For transmitters that are equipped with an audio low pass filter pursuant to 90.211(a), the power of any emission must be below the unmodulated carrier power (P) as follows:

- 1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.
- 2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth:  
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:  
 $\pm 2.8$  dB up to 26.5 GHz.

## 5.7 Modulation limiting

NOT APPLICABLE: EUT employs digital modulation.

## 5.8 Modulation frequency response

NOT APPLICABLE: EUT employs digital modulation.

## 5.9 Transient frequency behaviour

NOT APPLICABLE: Transmitter does not operate in bands 150-174 MHz or 421-512 MHz

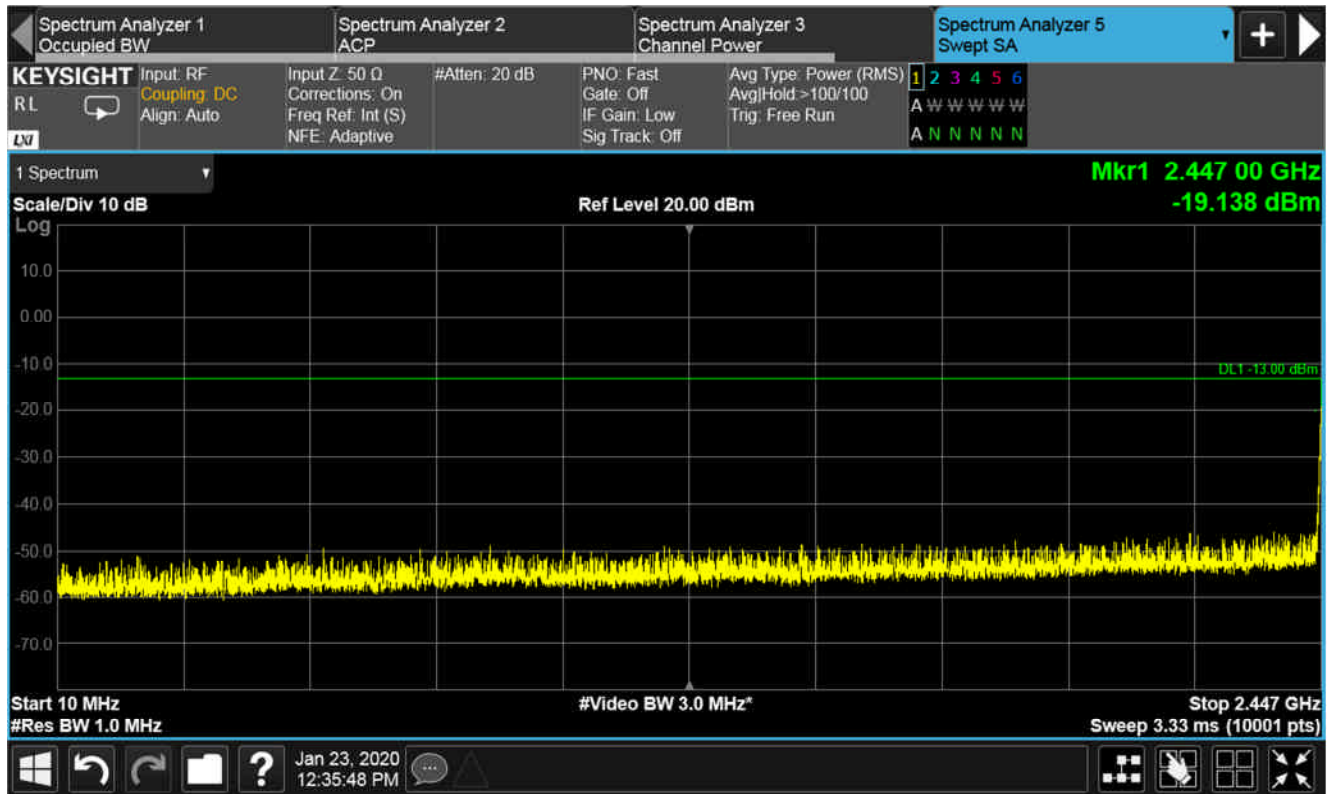
## 5.10 Adjacent channel power

NOT APPLICABLE: Transmitter does not operate in bands 450-470 MHz or 809-824 MHz or 854-869 MHz

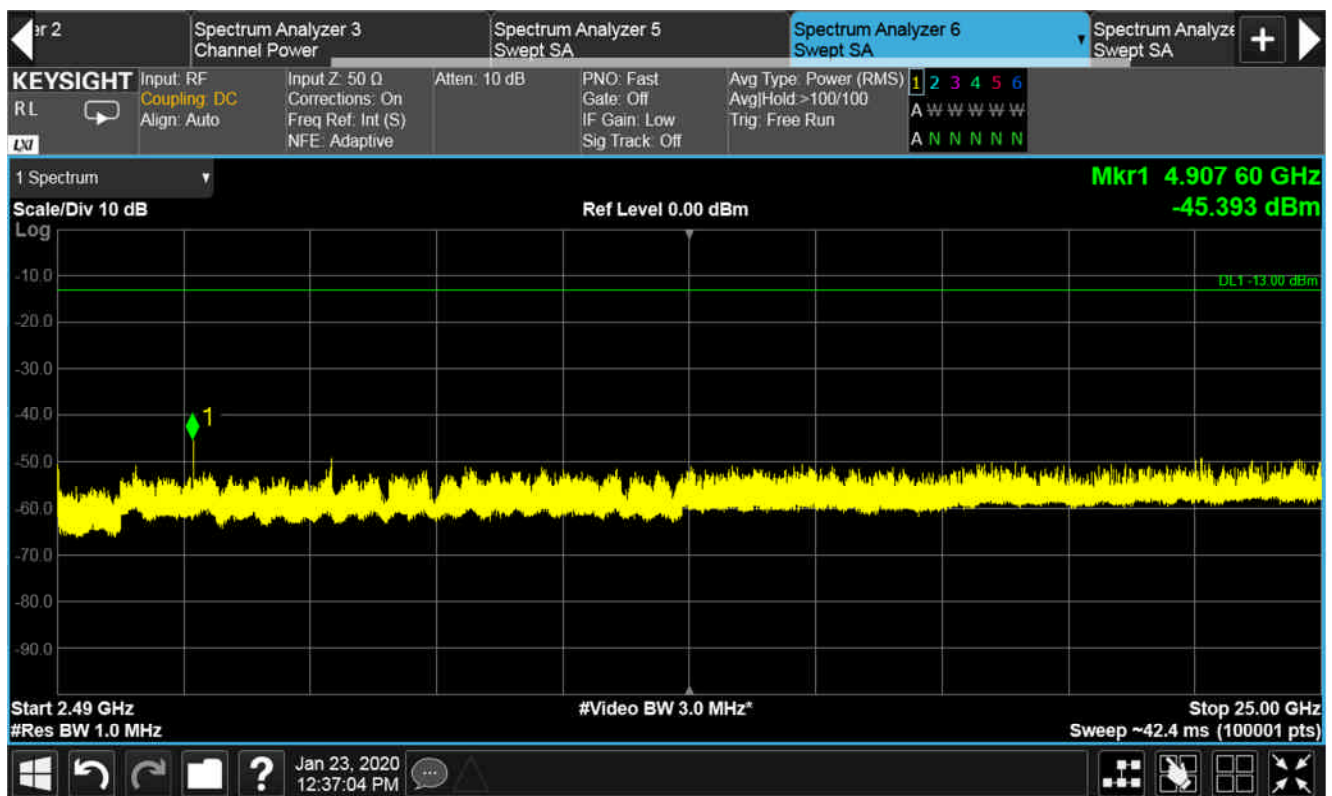
## 6 Plots/Graphical results

### 6.1 Conducted emissions

RF Parameters: Band 2450-2483.5 MHz, Power 29 dBm, Channel Spacing 6 MHz,  
Modulation COFDM

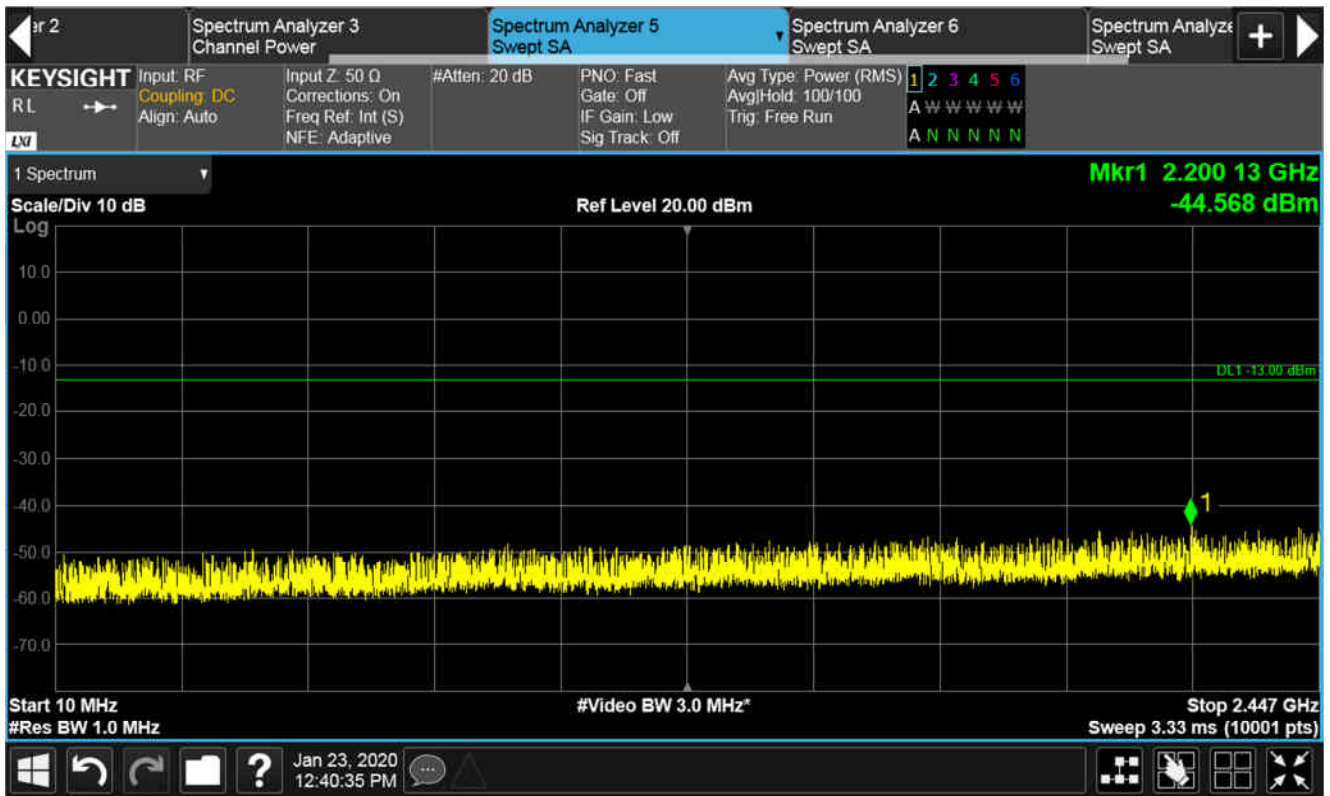


10 MHz to 2.447 MHz range.

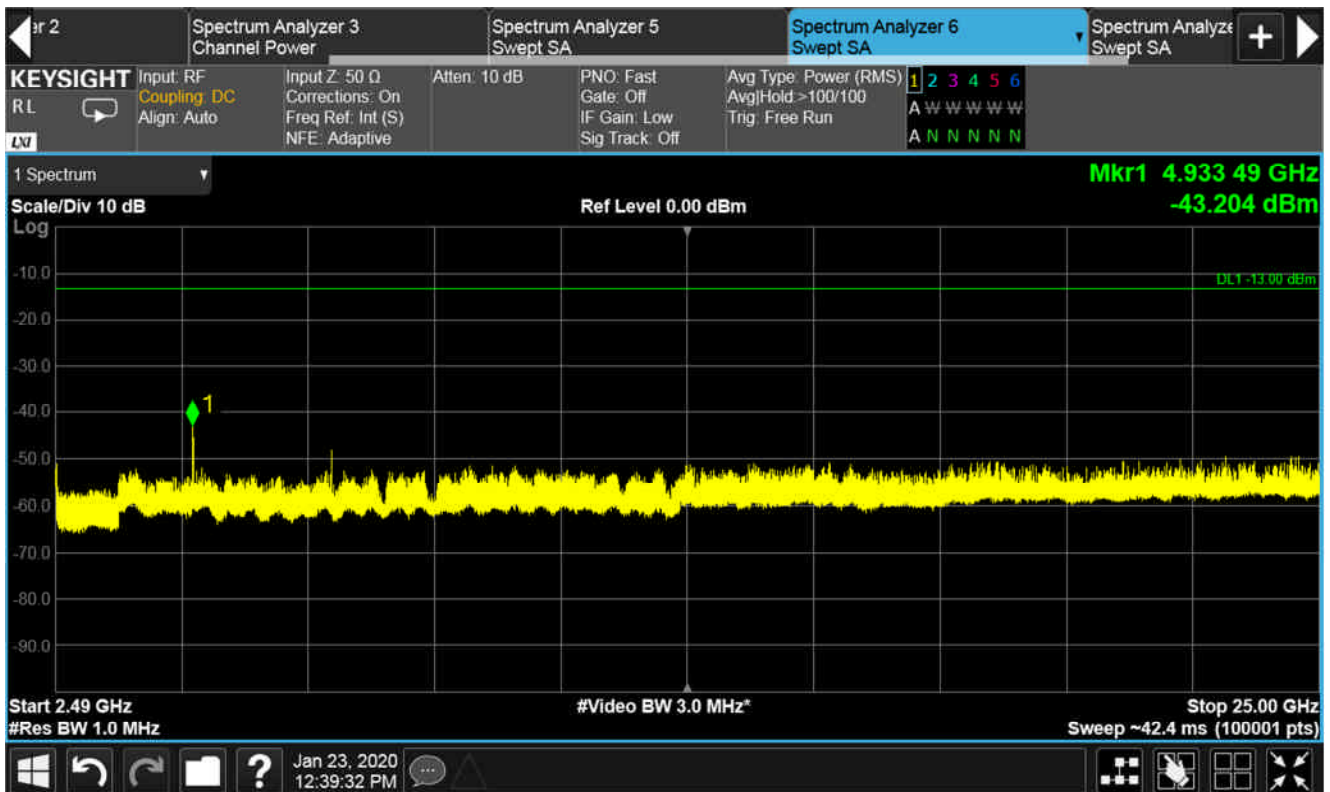


2490 MHz to 25 GHz range.

RF Parameters: Band 2450-2483.5 MHz, Power 29 dBm, Channel Spacing 6 MHz,  
Modulation COFDM

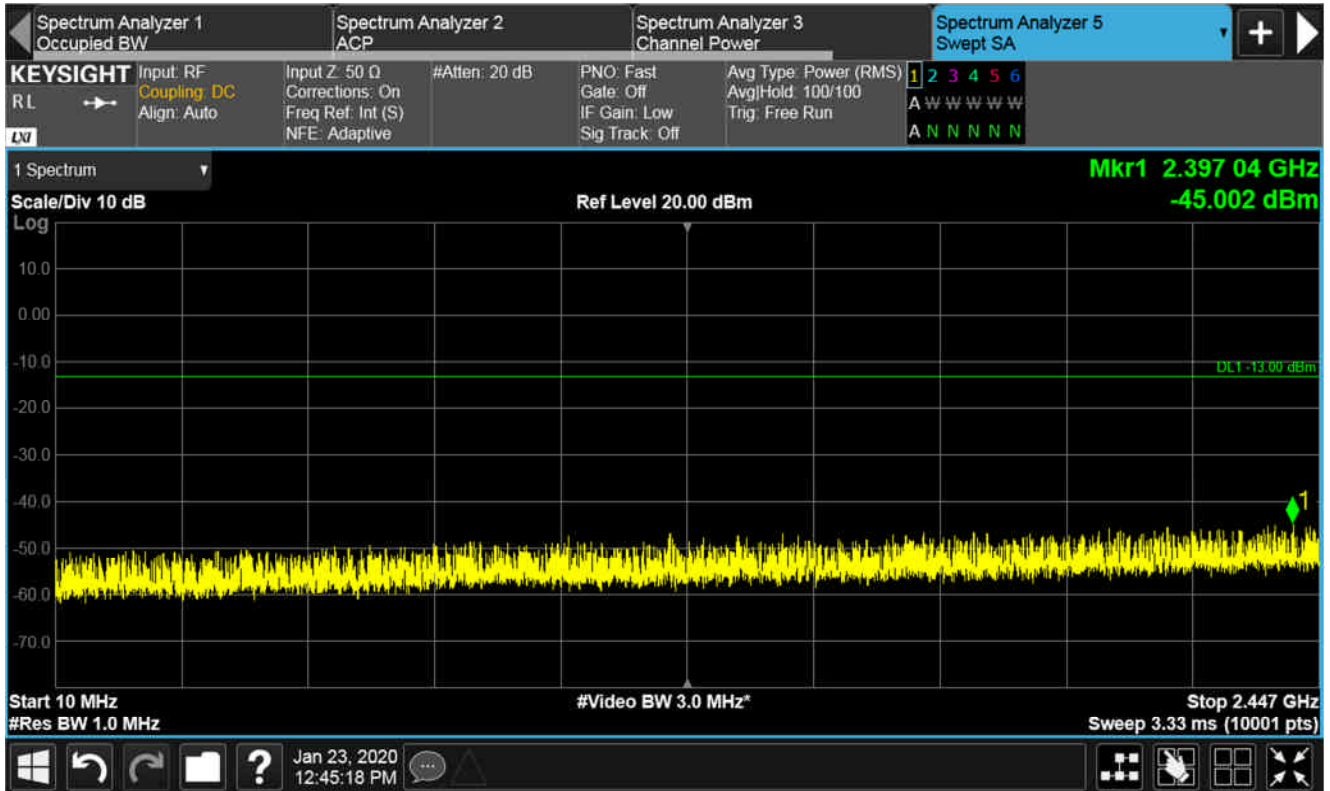


10 MHz to 2.447 MHz range.

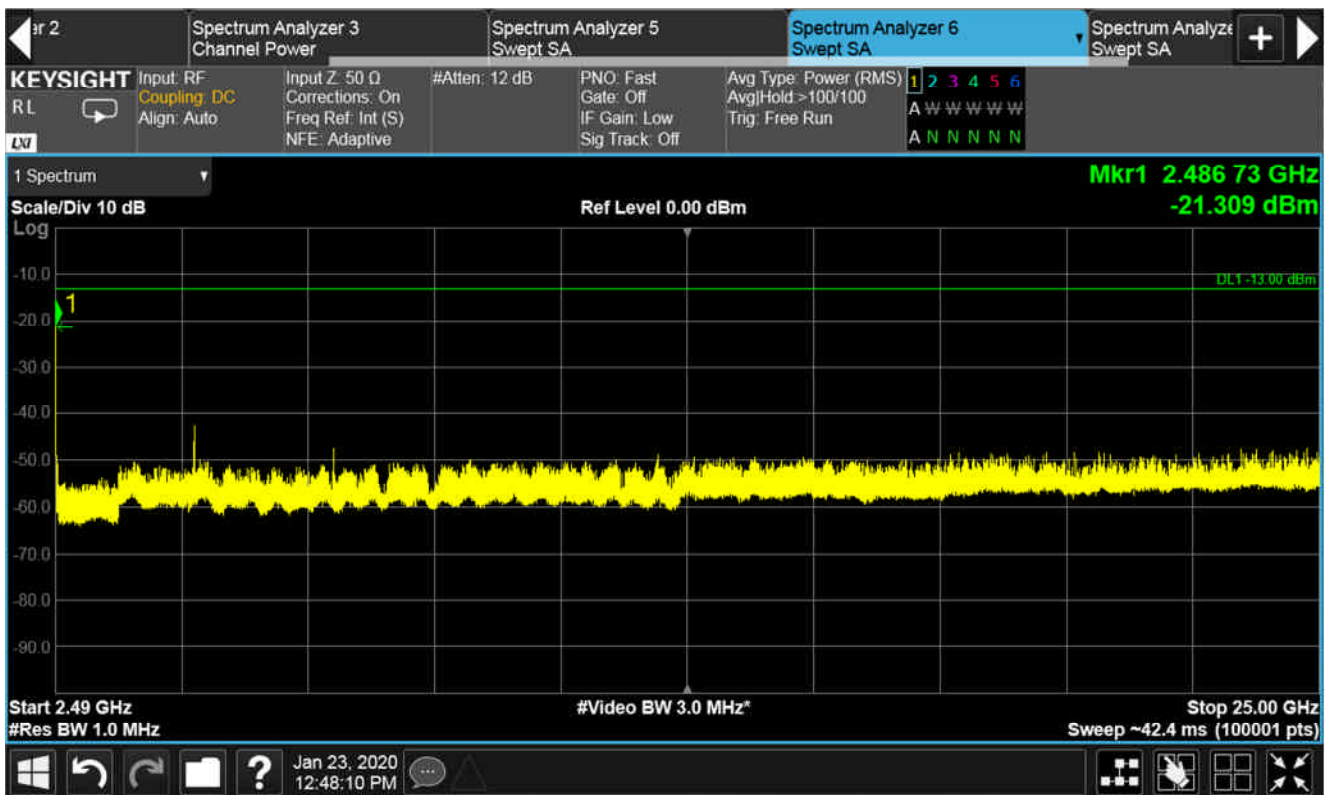


2490 MHz to 25 GHz range.

RF Parameters: Band 2450-2483.5 MHz, Power 29 dBm, Channel Spacing 6 MHz,  
Modulation COFDM



10 MHz to 2.447 MHz range.

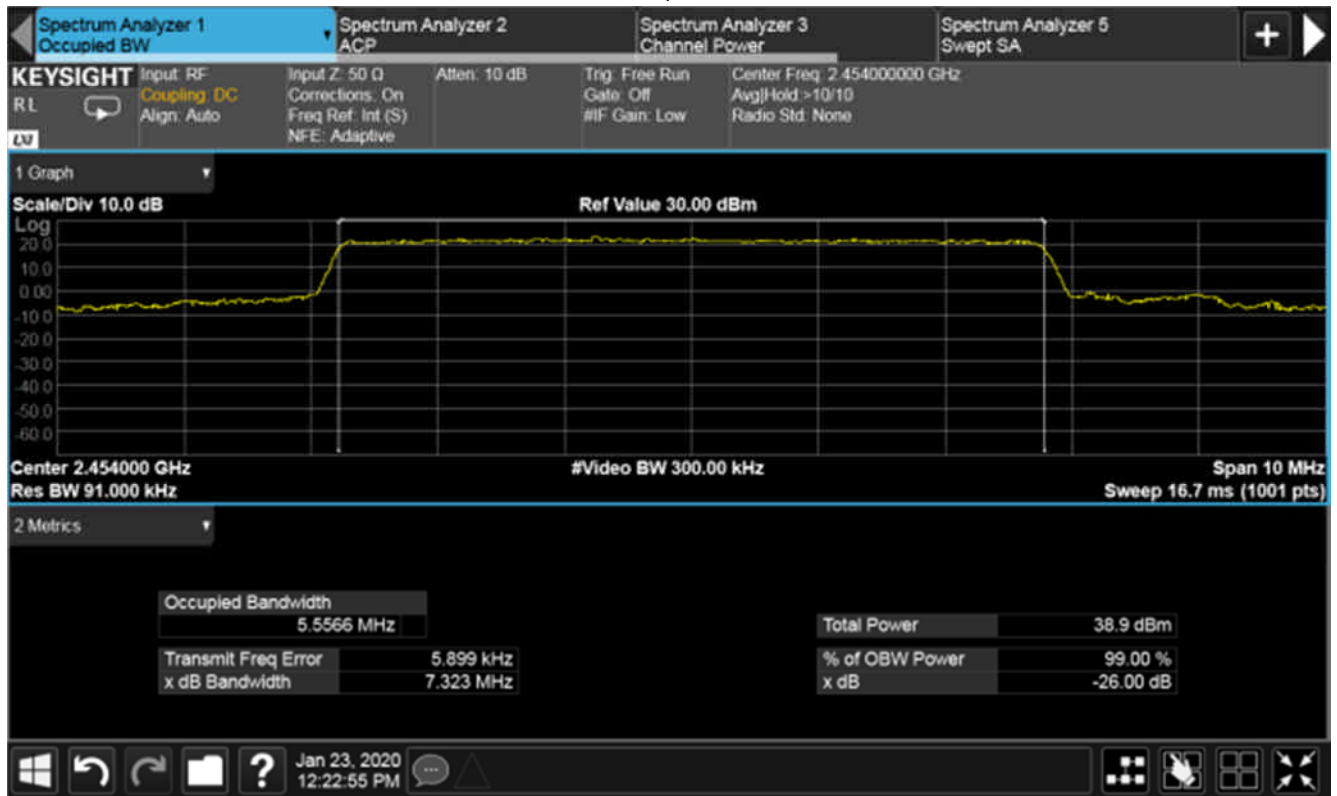


2490 MHz to 25 GHz range.



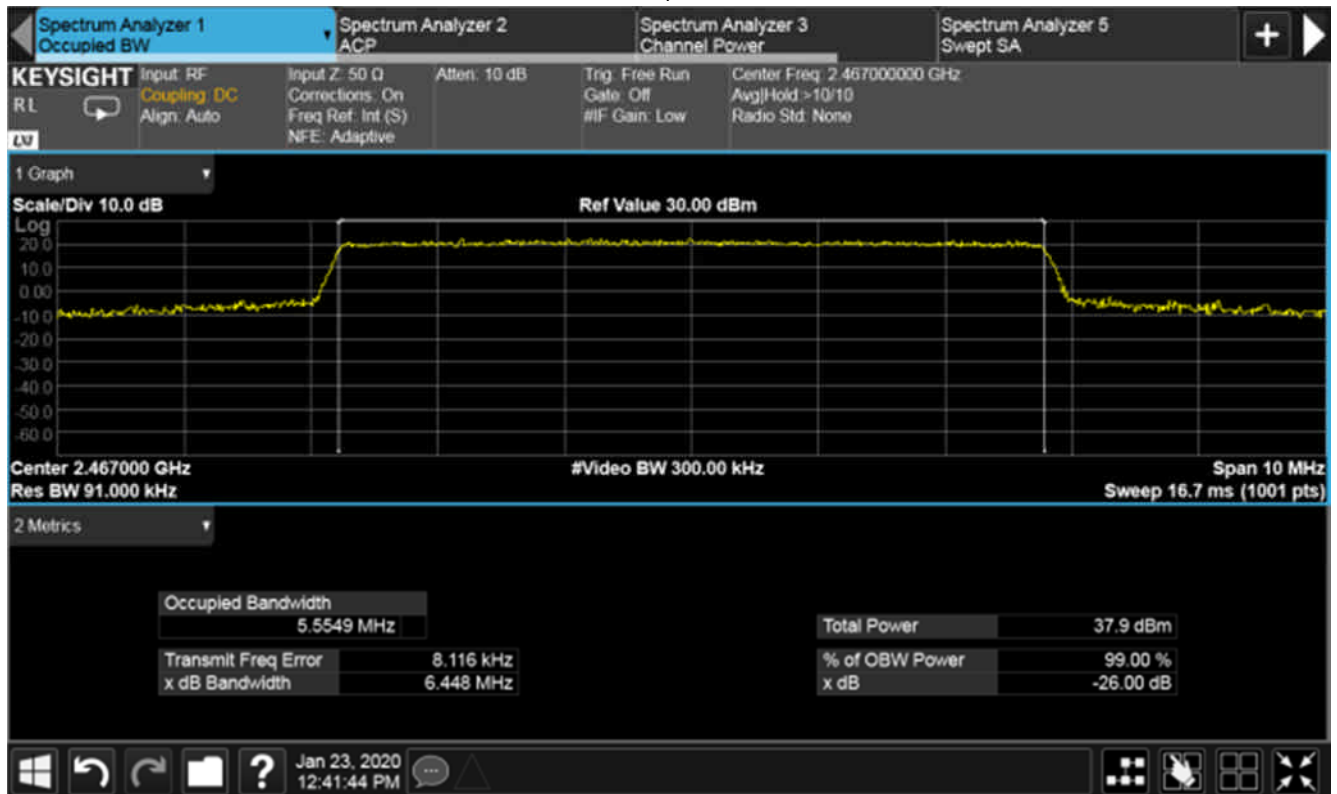
## 6.2 Occupied bandwidth

RF Parameters: Band 2450-2483.5 MHz, Power 29 dBm, Channel Spacing 6 MHz,  
Modulation COFDM, Channel 2454 MHz



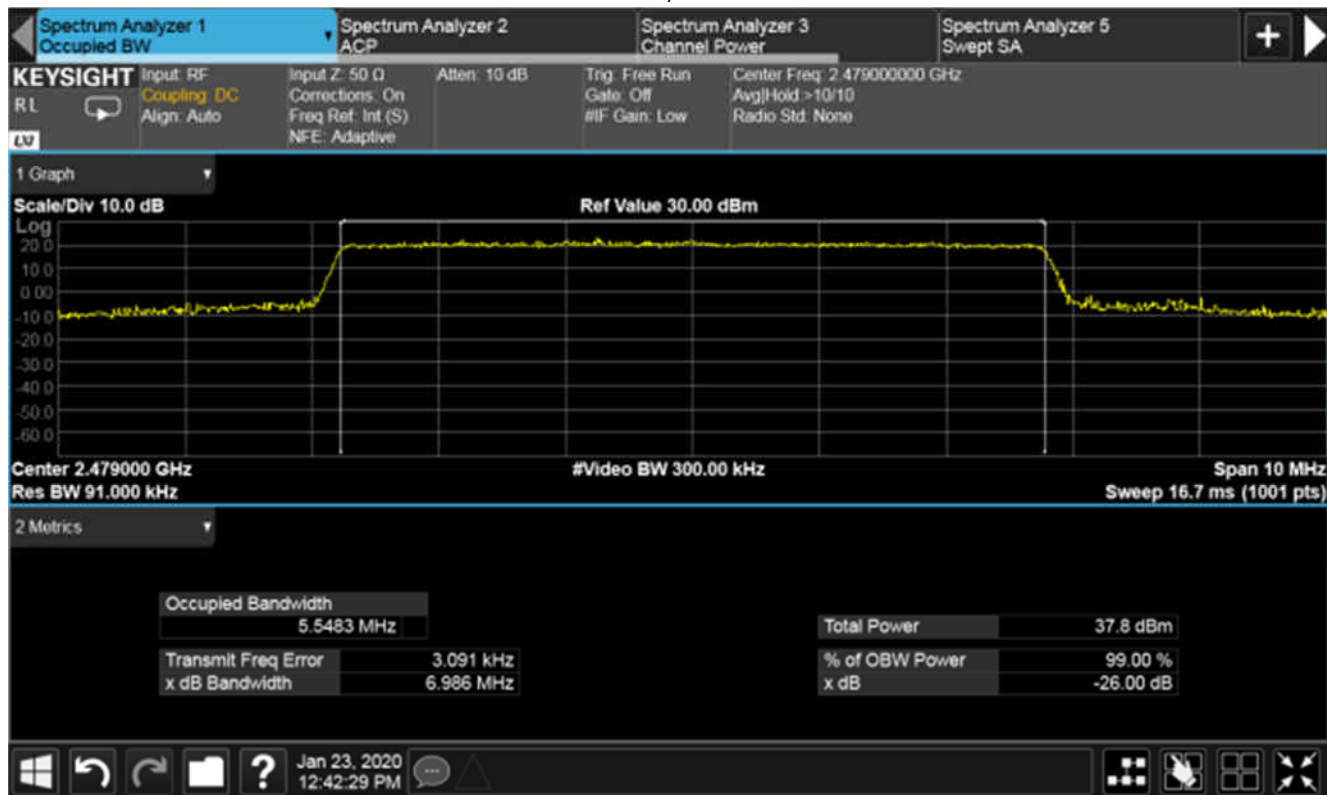
Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 2450-2483.5 MHz, Power 29 dBm, Channel Spacing 6 MHz,  
Modulation COFDM, Channel 2467 MHz



Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 2450-2483.5 MHz, Power 29 dBm, Channel Spacing 6 MHz,  
Modulation COFDM, Channel 2479 MHz

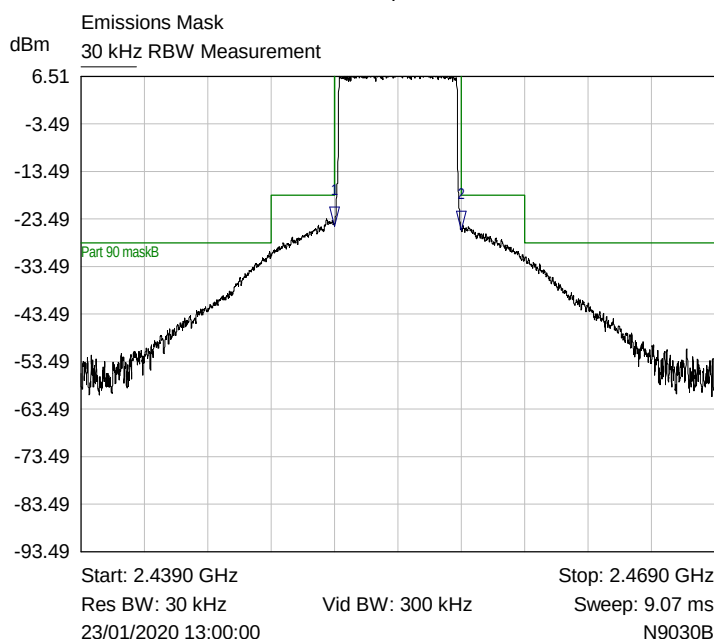


Plot for 99 % Bandwidth (MHz) Nominal Temp & Volts



### 6.3 Emission mask

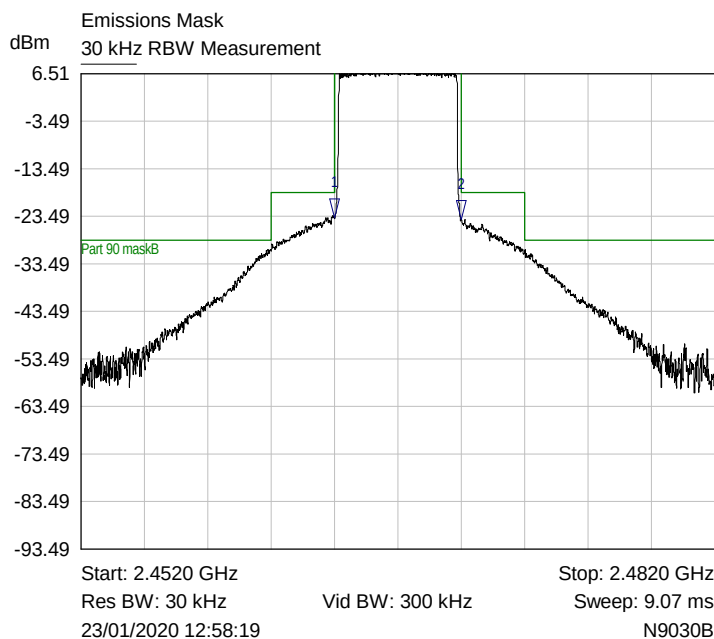
RF Parameters: Band 2450-2483.5 MHz, Power 29 dBm, Channel Spacing 6 MHz,  
Modulation COFDM, Channel 2454 MHz



| Mkr | Trace                  | X-Axis     | Value      | Notes |
|-----|------------------------|------------|------------|-------|
| 1 ▽ | 30 kHz RBW Measurement | 2.4510 GHz | -24.96 dBm |       |
| 2 ▽ | 30 kHz RBW Measurement | 2.4570 GHz | -25.74 dBm |       |

Nominal Temperature, Nominal Voltage low channel mask

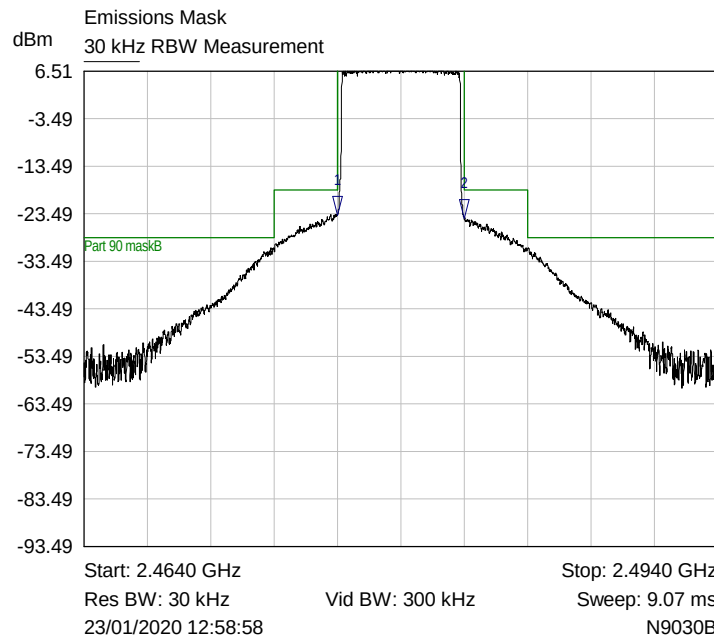
RF Parameters: Band 2450-2483.5 MHz, Power 29 dBm, Channel Spacing 6 MHz,  
Modulation COFDM, Channel 2467 MHz



| Mkr | Trace                  | X-Axis     | Value      | Notes |
|-----|------------------------|------------|------------|-------|
| 1 ▽ | 30 kHz RBW Measurement | 2.4640 GHz | -23.75 dBm |       |
| 2 ▽ | 30 kHz RBW Measurement | 2.4700 GHz | -24.19 dBm |       |

Nominal Temperature, Nominal Voltage mid channel mask

RF Parameters: Band 2450-2483.5 MHz, Power 29 dBm, Channel Spacing 6 MHz,  
Modulation COFDM, Channel 2479 MHz

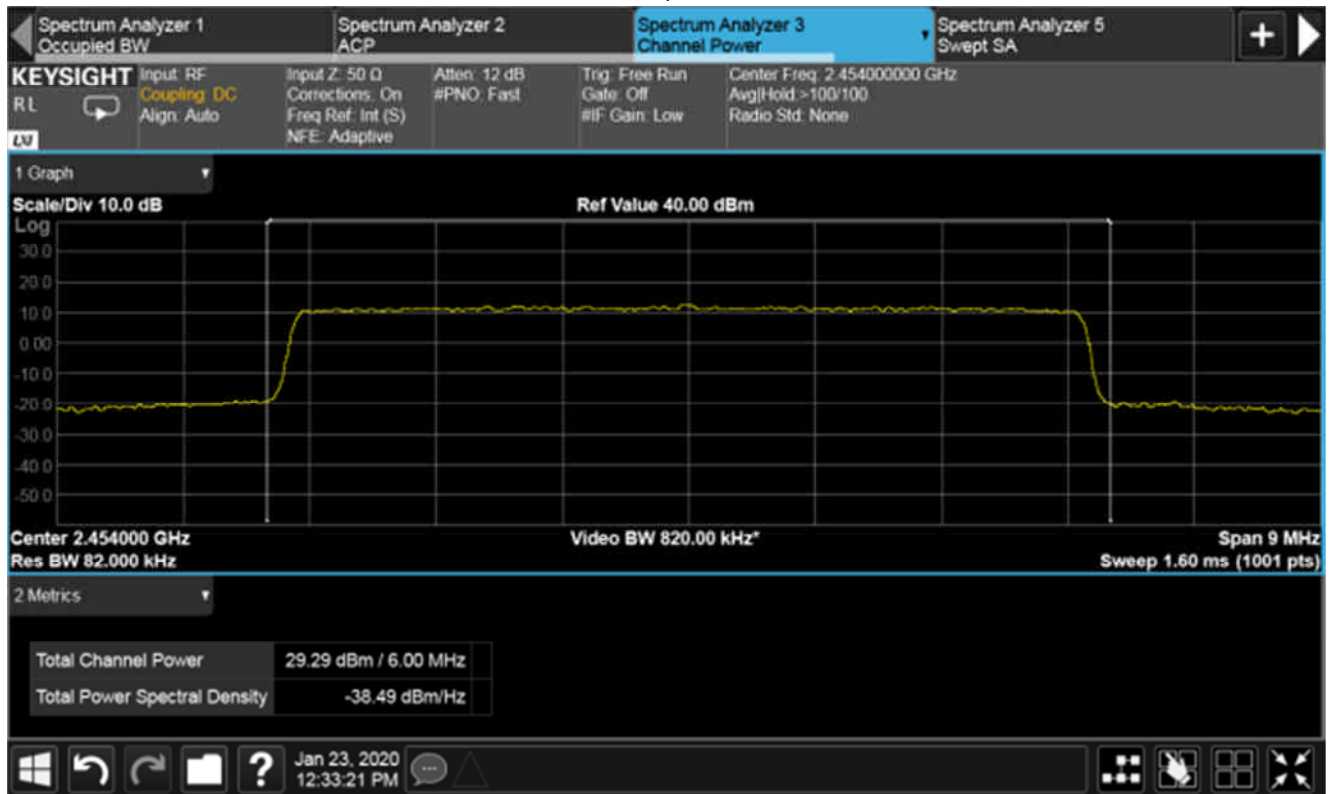


| Mkr | Trace                  | X-Axis     | Value      | Notes |
|-----|------------------------|------------|------------|-------|
| 1   | 30 kHz RBW Measurement | 2.4760 GHz | -23.76 dBm |       |
| 2   | 30 kHz RBW Measurement | 2.4820 GHz | -24.57 dBm |       |

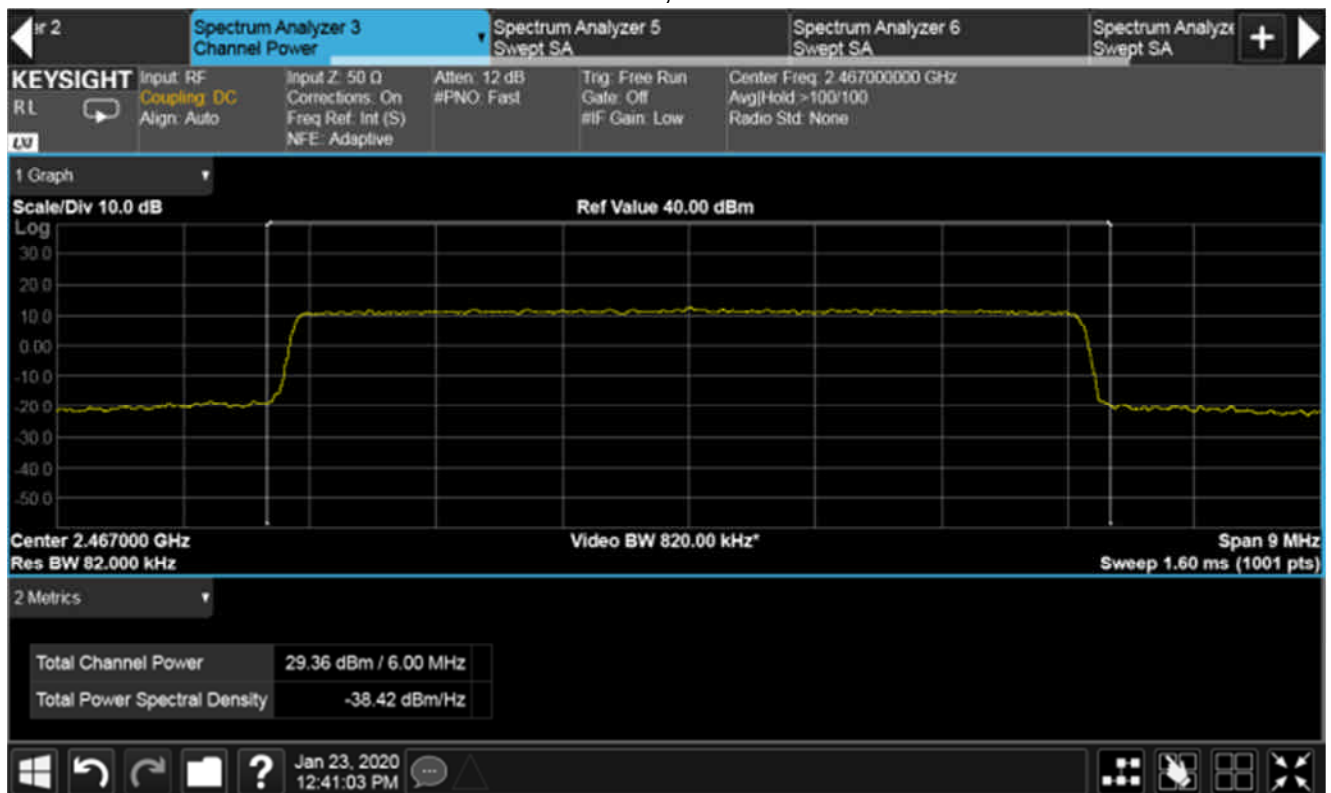
Nominal Temperature, Nominal Voltage high channel mask

## 6.4 Conducted Power

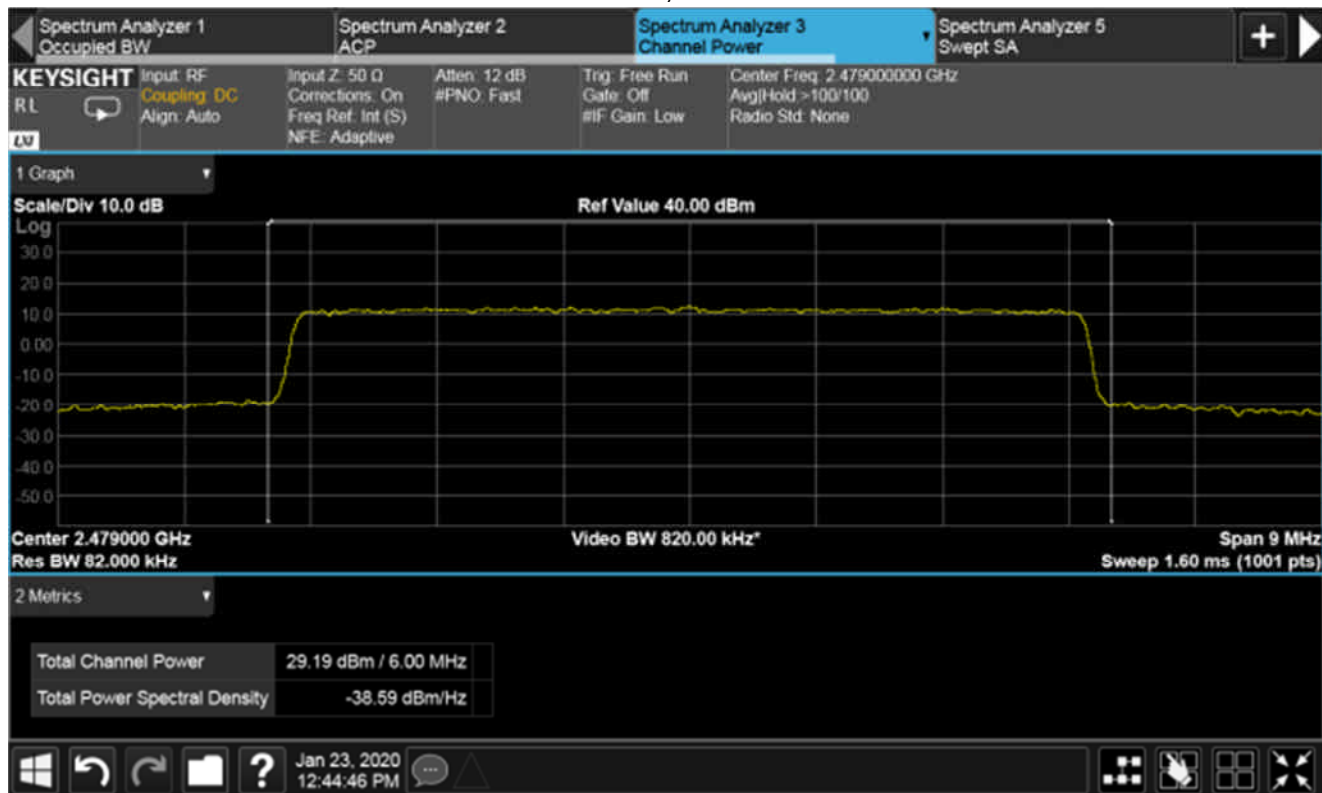
RF Parameters: Band 2450-2483.5 MHz, Power 29 dBm, Channel Spacing 6 MHz,  
Modulation COFDM, Channel 2454 MHz



RF Parameters: Band 2450-2483.5 MHz, Power 29 dBm, Channel Spacing 6 MHz,  
Modulation COFDM, Channel 2467 MHz

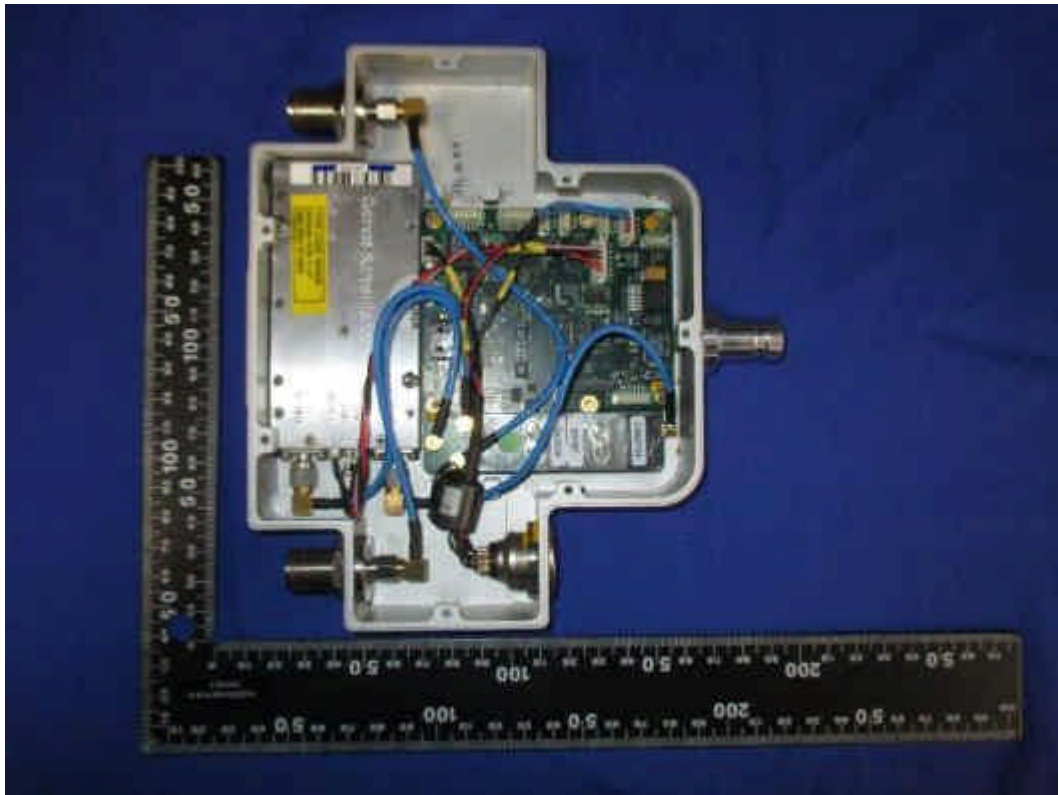


RF Parameters: Band 2450-2483.5 MHz, Power 29 dBm, Channel Spacing 6 MHz,  
Modulation COFDM, Channel 2479 MHz

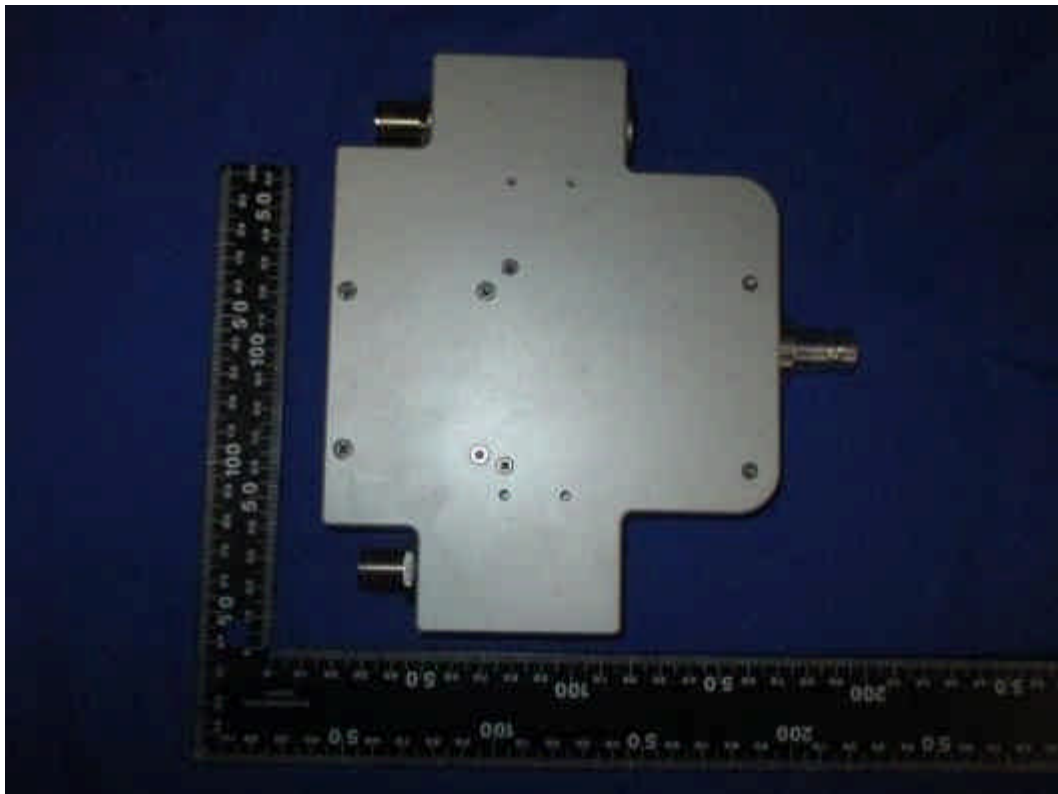


## 7 Photographs

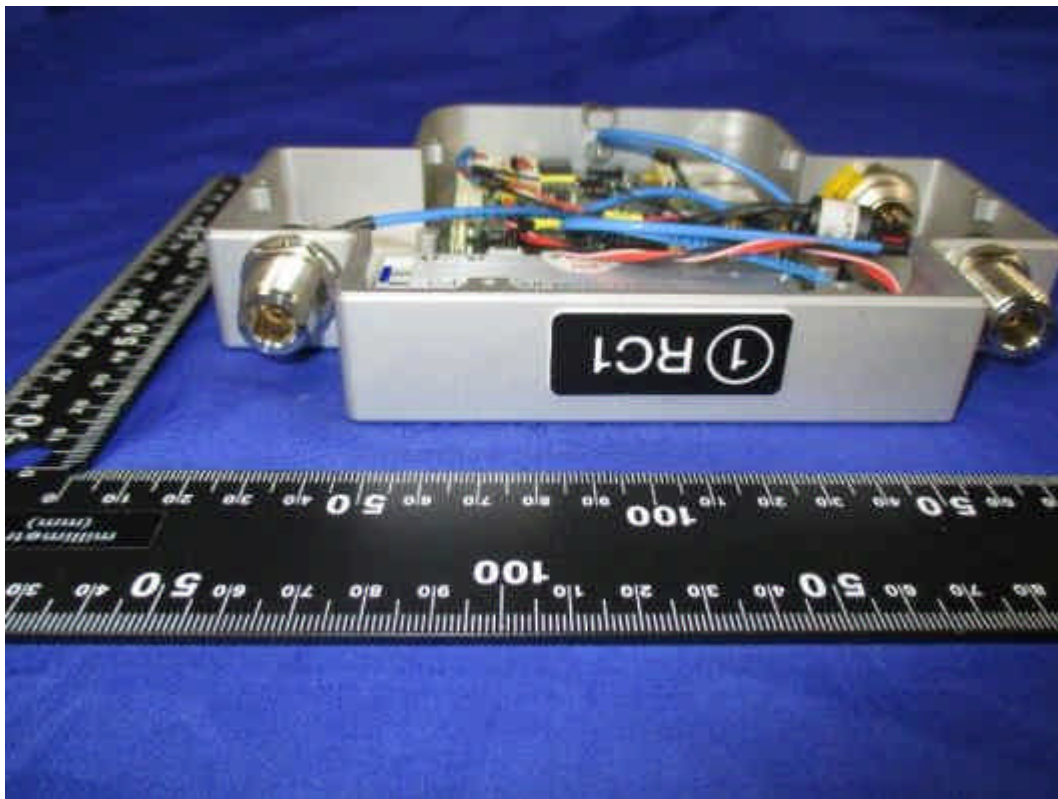
### 7.1 EUT Front View



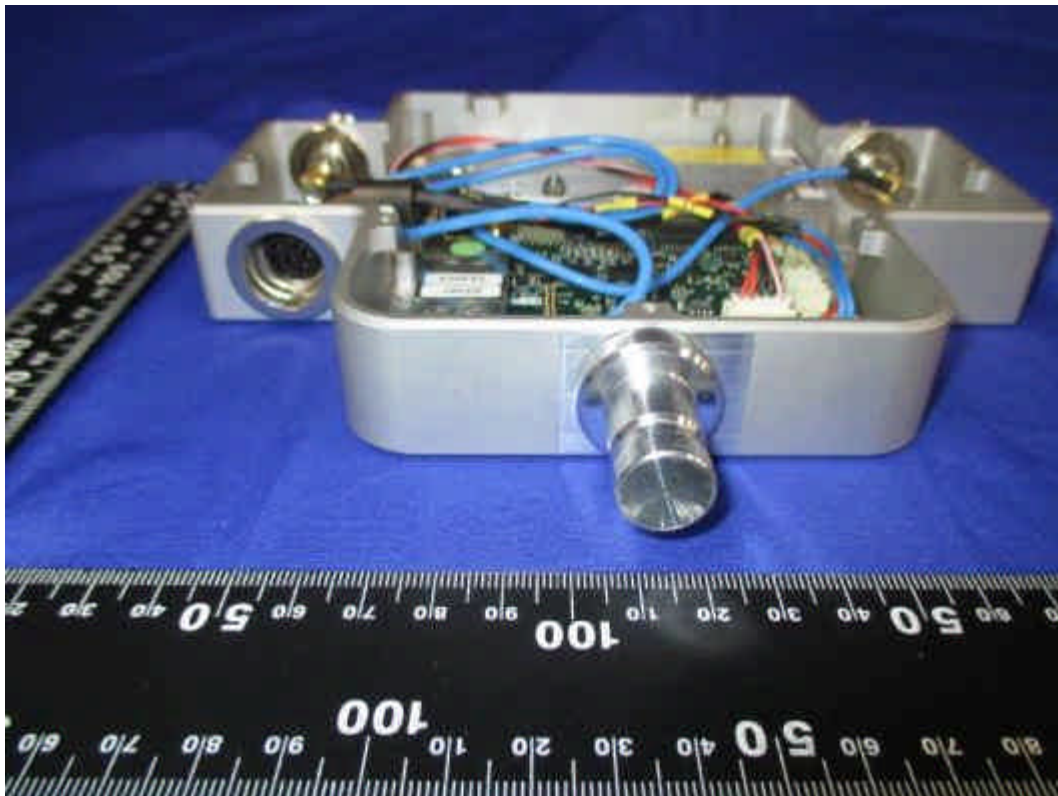
### 7.2 EUT Reverse Angle



### 7.3 EUT Left side View



### 7.4 EUT Right side View





## 7.5 EUT Antenna Port



## 7.6 EUT Display & Controls

The unit does not have any displays or controls.

## 7.7 EUT Internal photos

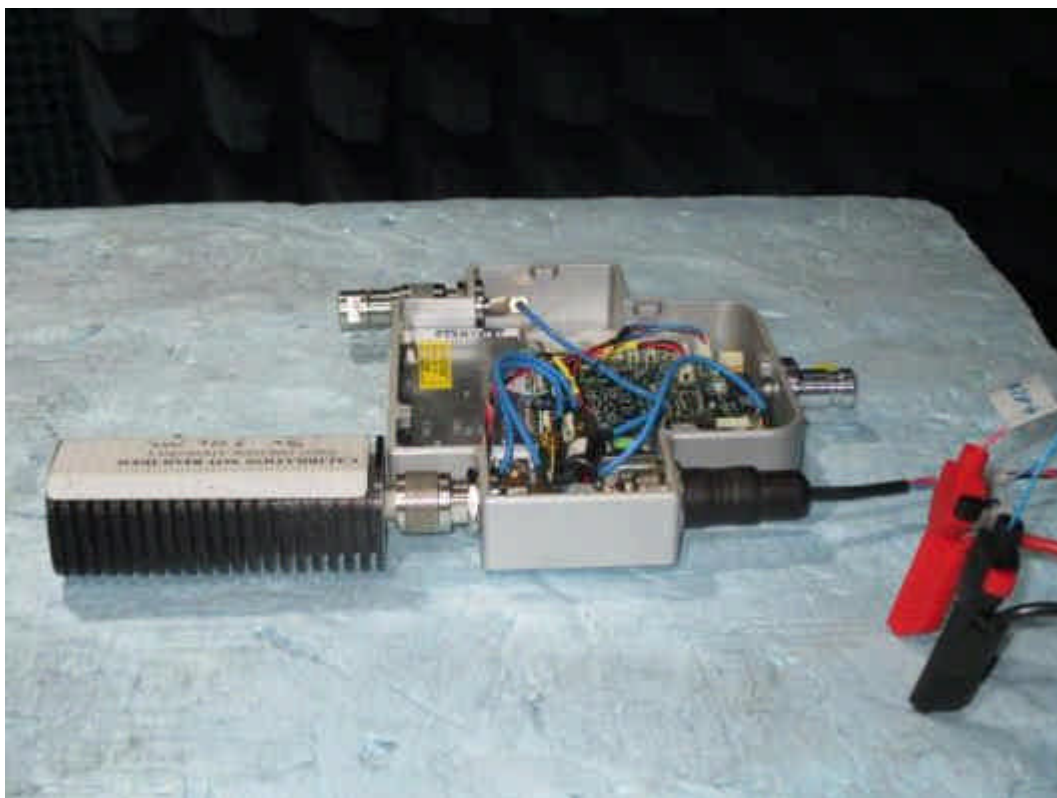
Photos not included at request of applicant.

## 7.8 EUT ID Label





## 7.9 30-1000MHz Spurious emissions test set-up



## 7.10 Above 1GHz Spurious emissions test set-up







## 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                     | 10-Jan-2020      | 6 months   |
| E005   | 8447F       | Pre-Amplifier 10MHz to 1000MHz  | MCL Microwave+Mini-circuits | 19-Jun-2019      | 12 months  |
| E136   | 3105        | Horn Antenna 1-12.5GHz          | EMCO                        | 27-Apr-2019      | 12 months  |
| E268   | BHA 9118    | Horn Antenna 1-18GHz            | Schaffner                   | 27-Apr-2019      | 12 months  |
| E411   | N9039A      | 9 kHz - 1 GHz RF Filter Section | Agilent Technologies        | 11-Jul-2019      | 12 months  |
| E453   | 20240-20-AA | Horn Std Gain 17.6 - 26.7GHz    | Flann (FMI)                 | 26-Jul-2019      | 12 months  |
| E454   | 18240-20    | Horn Std Gain 11.9 - 18.0GHz    | Flann (FMI)                 | 24-Jul-2019      | 12 months  |
| E602   | MG3692A     | Signal Generator 10MHz - 20GHz  | Anritsu                     | 04-Feb-2019      | 24 months  |
| E624   | E4440A      | PSA 3 Hz - 26.5 GHz             | Agilent Technologies        | 10-Jan-2020      | 24 months  |
| E743   | 2017 4/2dB  | Attenuator 4/2dB 30-1000MHz     | RN Electronics              | 11-Feb-2019      | 12 months  |
| E755   | N9030B      | PXA 3Hz to 50GHz                | Keysight Technologies       | 11-May-2019      | 12 months  |
| E866   | 42N50A-30   | Attenuator 18GHz 50W N-type     | Anritsu                     | #30-Jan-2020     | 12 months  |
| E874   | M0del2-20   | Attenuator N type 20dB 18GHz    | Weinschel                   | 06-Feb-2019      | 12 months  |
| LPE364 | CBL6112A    | Antenna BiLog 30MHz - 2GHz      | Chase Electronics Ltd       | 21-Mar-2018      | 24 months  |
| P270   | 610-451     | PSU 30V 2A                      | Thurlby                     | 11-Apr-2019      | 12 months  |
| TMS38  | VMT04/140   | Environmental Oven              | Heraeus Votsch              | N/A              | N/A        |
| TMS57  | PM2534      | Digital Multimeter              | Philips                     | 20-Mar-2019      | 24 months  |
| TMS78  | 3160-08     | Horn Std Gain 12.4-18 GHz       | ETS Systems                 | 24-Jul-2019      | 12 months  |
| TMS80  | 206-3722    | Digital Thermometer & K Probe   | RS Components Ltd           | 20-Nov-2019      | 12 months  |
| TMS814 | MP627A      | Antenna Doublet 200-1700 MHz    | Anritsu                     | 30-May-2019      | 12 months  |
| TMS82  | 8449B       | Pre-Amplifier 1GHz - 26.5GHz    | Agilent Technologies        | 18-Dec-2019      | 12 months  |

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

## 9 Auxiliary and peripheral equipment

### 9.1 Customer supplied equipment

No customer equipment was supplied.

### 9.2 RN Electronics supplied equipment

| RN No. | Model No. | Description                    | Manufacturer | Serial No     |
|--------|-----------|--------------------------------|--------------|---------------|
| N484   | GS605     | 5-Port Gigabit Ethernet Switch | Netgear      | 1FE1795S009BD |
| P270   | 610-451   | PSU 30V 2A                     | Thurlby      | 35821         |
| P281   | L30-2     | PSU 30V 2A                     | Farnell      | 3888          |

## 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<br>FCC Registration No. 293246<br>IC 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)<br>FCC Registration No. 293246<br>IC Registration No. 5612A-2 |
| Site J                                   | Transient Laboratory                                                                                 |
| Site K                                   | Screened Room (Control Room for Site M)                                                              |
| Site M                                   | 3m Semi-Anechoic Chamber (indoor OATS)<br>FCC Registration No. 293246<br>IC 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<br>IC Registration No. 5612A-1                                           |
| Site R                                   | Screened Room (Conducted Immunity)                                                                   |
| Site S                                   | Safety Laboratory                                                                                    |
| Site T                                   | Transient Laboratory                                                                                 |

## 12 Abbreviations and units

|        |                                                                      |        |                                                |
|--------|----------------------------------------------------------------------|--------|------------------------------------------------|
| %      | Percent                                                              | LBT    | Listen Before Talk                             |
| μA/m   | microAmps per metre                                                  | LO     | Local Oscillator                               |
| μV     | microVolts                                                           | mA     | milliAmps                                      |
| μW     | microWatts                                                           | max    | maximum                                        |
| AC     | Alternating Current                                                  | kPa    | Kilopascal                                     |
| ALSE   | Absorber Lined Screened Enclosure                                    | Mbit/s | MegaBits per second                            |
| AM     | Amplitude Modulation                                                 | MHz    | MegaHertz                                      |
| Amb    | Ambient                                                              | mic    | Microphone                                     |
| ATPC   | Automatic Transmit Power Control                                     | min    | minimum                                        |
| BER    | Bit Error Rate                                                       | mm     | milliMetres                                    |
| °C     | Degrees Celsius                                                      | ms     | milliSeconds                                   |
| C/I    | Carrier / Interferer                                                 | mW     | milliWatts                                     |
| CEPT   | European Conference of Postal and Telecommunications Administrations | NA     | Not Applicable                                 |
| COFDM  | Coherent OFDM                                                        | nom    | Nominal                                        |
| CS     | Channel Spacing                                                      | nW     | nanoWatt                                       |
| CW     | Continuous Wave                                                      | OATS   | Open Area Test Site                            |
| dB     | decibel                                                              | OFDM   | Orthogonal Frequency Division Multiplexing     |
| dBμA/m | decibel relative to 1μA/m                                            | ppm    | Parts per million                              |
| dBμV   | decibel relative to 1μV                                              | PRBS   | Pseudo Random Bit Sequence                     |
| dBc    | decibel relative to Carrier                                          | QAM    | Quadrature Amplitude Modulation                |
| dBm    | decibel 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                                                            |        |                                                |