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# TEST REPORT

## MiMOMax MWL-Tornado - BCCA
## Digital Linking Radio

**Additional Variants:** MWL-TORNADO-ACAA, MWL-TORNADO-ACBA, MWL-TORNADO-ACCA, MWL-TORNADO-BCAA, MWL-TORNADO-BCBA, MWL-TORNADO-ACAB, MWL-TORNADO-ACBB, MWL-TORNADO-ACCB, MWL-TORNADO-BCAB, MWL-TORNADO-BCBB, MWL-TORNADO-BCCB

*tested to the*

## Code of Federal Regulations (CFR) 47

## Part 90 –Private Land Mobile Services

*for*

## MiMOMax Wireless Ltd

This Test Report is issued with the authority of:

**Andrew Cutler- General Manager**

ACCREDITED TESTING LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

# Table of Contents

# 1. COMPLIANCE STATEMENT

The **MiMOMax MWL-Tornado–BCCA Digital Linking Radio** complies with the limits defined in 47 CFR Part 90 and 47 CFR Part 2 when tested in-accordance with the test methods described in 47 CFR Part 2, ANSI / TIA-603-E: 2016 and ANSI C63.26: 2015.
The client has requested for the addition of variants to this test report based on their technical assessment. At the end of the test report, the request letter has been appended for reference.

The below models as per the client, are equivalent to the MWL-TORNADO-BCCA: MWL-TORNADO-ACAA, MWL-TORNADO-ACBA, MWL-TORNADO-ACCA, MWL-TORNADO-BCAA, MWL-TORNADO-BCBA, MWL-TORNADO-ACAB, MWL-TORNADO-ACBB, MWL-TORNADO-ACCB, MWL-TORNADO-BCAB, MWL-TORNADO-BCBB, MWL-TORNADO-BCCB

**RESULT SUMMARY**

The results of testing carried out between October 2023 and February 2024 are summarised below.

| Clause | Description | Result | Page no |
|---|---|---|---|
| 90.203 | Certification required | Noted. | 9 |
| 2.1046<br>90.205 | RF power output<br>Power and antenna height limits | Noted<br>Complies | 11 |
| 2.1049<br>2.202<br><br>90.207<br>90.209<br>90.210<br>90.221 | Occupied bandwidth<br>Bandwidths<br><br>Types of emissions<br>Bandwidth limitations<br>Emission masks<br>Adjacent channel power | Noted<br>Noted<br><br>Complies<br>Complies<br>Complies<br>Complies | <br><br><br>12<br>12<br>21<br>26 |
| 2.1051 | Spurious emissions at antenna terminals | Complies | 30 |
| 2.1053 | Field strength of spurious radiation | Complies | 33 |
| 2.1055<br><br>90.213 | Frequency stability<br><br>Frequency stability | Noted<br><br>Complies | 36 |
| 90.214 | Transient frequency behaviour | Complies | 38 |
| 1.1310 | Radio frequency exposure limits | Complies | 43 |

# 2. ATTESTATION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification.

**The client selected the test sample.**

**This report relates only to the sample tested.**

Measurement uncertainties with statistical confidence intervals of 95% are shown below test results. Both Class A and Class B uncertainties have been accounted for, as well as influence uncertainties where appropriate.

All compliance statements have been made with respect of the specification limit with no reference to the measurement uncertainty.

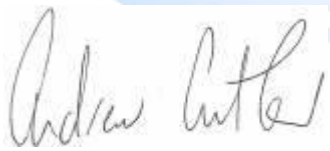
All testing was carried out as per the standard in the worst-case configuration with no deviations being applied.

In addition this equipment has been tested in accordance with the requirements contained in the appropriate Commission regulations.

All compliance statements have been made with respect of the specification limit with no reference to the measurement uncertainty.

To the best of my knowledge, these tests were performed using measurement procedures that are consistent with industry or Commission standards and demonstrate that the equipment complies with the appropriate standards.

I further certify that the necessary measurements were made by EMC Technologies NZ Ltd, 47 MacKelvie Street, Grey Lynn, Auckland, New Zealand.



Andrew Cutler
General Manager
EMC Technologies NZ Ltd

**Report Revision Table**

| Version | Change Made | Date |
|---|---|---|
| 230907.3 | Initial Issue. | 31/10/2023 |
| 230907.3b | FVIN added, Radiation hazard edited, 12.5 kHz transient plot added | 28/11/2023 |
| 230907.3c | Product photos excluded from Test report.<br>Editorial correction on page 3 | 15/12/2023 |
| 230907.3d | The antenna gain has been corrected on page 39 | 20/12/2023 |
| 230907.3e | The FCC certification range corrected | 21/12/2023 |
| 230907.3f | Test results for 450 MHz and 469.5 MHz have been added | 16/02/2024 |

# 3. CLIENT INFORMATION

**Company Name** MiMOMax Wireless Ltd

**Address** 540 Wairakei Rd
Burnside
Christchurch 8053

**Country** New Zealand

**Contact** James Dowle

# 4. TEST SAMPLE DESCRIPTION

**Brand Name** MiMOMax

**Model Number** MWL-Tornado-BCCA

**Product** Digital Linking Radio

**Manufacturer** MiMOMax Wireless Ltd

**Serial Number** UUT for Transmitter testing of 450.000 MHz: 23009502
UUT for Transmitter testing of 460.075 MHz: 23004571
UUT for Transmitter testing of 470.000 MHz: 23009503

**Firmware ID** 4.8.3

**RF Connectors** 2 X 50 Ohm N Type Connectors

**FCC ID** XMK-MMXTRNB007

**FCC Certification range** 450-470 MHz

**Rated Transmitter Output Power**

1 mW (0.0 dBm) to 0.25 watts (+24.0 dBm)
RMS power: +24.0 dBm (across all modulations)

The typical theoretical PARP (dB) for the modulations supported by the product is in the range of 6 dB to 8 dB. Testing has been carried out to ensure continued compliance as the transmitter power amplifier has been changed

**Product Description (From user manual):**

The MiMOMax Tornado Digital Link is an ultra-spectrally efficient, long range point to multipoint remote radio.

The radio unit has built in intelligent network features for Critical Network Infrastructure, providing economic SCADA and telemetry solutions for critical network infrastructure.

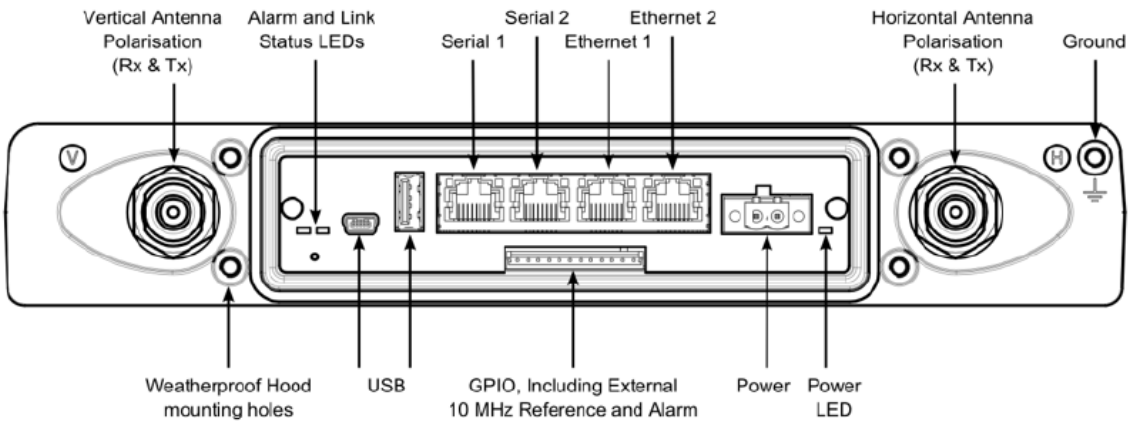
The MiMOMax Tornado utilises multiple input, multiple output technology (2X2 MIMO). The multiple input/ outputs consist of 2 or 4 antenna connections depending on the duplexer configuration.

Antenna connections provide simultaneous Tx/Rx on orthogonal antenna polarisations.

Tornado radios provide a radio wireless infrastructure for connecting devices used by various applications to form a network through which IP data, RS-232 serial data or RS485 synchronous serial data can seamlessly flow.

Features include isolated power supply with low power consumption, full duplex operation with built in duplexers and supporting a combination of interfaces, with very high scalable data rates, remote over the air network management, optional SNMP, ModBus and DNP3 support and a random-access protocol.






**Product connector diagram from the user manual**

**Test Power Source**

The test power source used for this report is identified in the equipment list at the end of this report. The test voltage was measured at the point of connection of the power cable to the test sample equipment.

**Normal test conditions**

**Normal Temperature and Humidity**

Temperature: +25 °C ± 4 °C maintained.
Relative Humidity: 60 % ± 10 % observed.

**Normal Test Power Source**

The equipment is powered using an external DC supply.

**Other Power Source**

Test Voltage: 24.0 V DC

**Extreme Test Conditions**

**Extreme Temperature**
High Temperature: + 50 °C maintained.
Low Temperature: - 30 °C maintained.

**Extreme Voltage (Noted as per the user manual)**

High Voltage: 60.0 VDC
Low Voltage: 10.5 VDC

**Test frequencies**

| Frequency (MHz) | Channel Spacing (kHz) | Modulation Type | Test Type | UUT ID |
|---|---|---|---|---|
| 450.000<br>460.075<br>469.500 | 12.5 & 25.0 kHz | QPSK | Transmit | 23009502<br>23004571<br>23009503 |
| | 12.5 & 25.0 kHz | 16QAM | Transmit | |
| | 12.5 & 25.0 kHz | 64QAM | Transmit | |
| | 12.5 & 25.0 kHz | 256QAM | Transmit | |

**Setup Description:**

**Transmitter Testing Setup:**

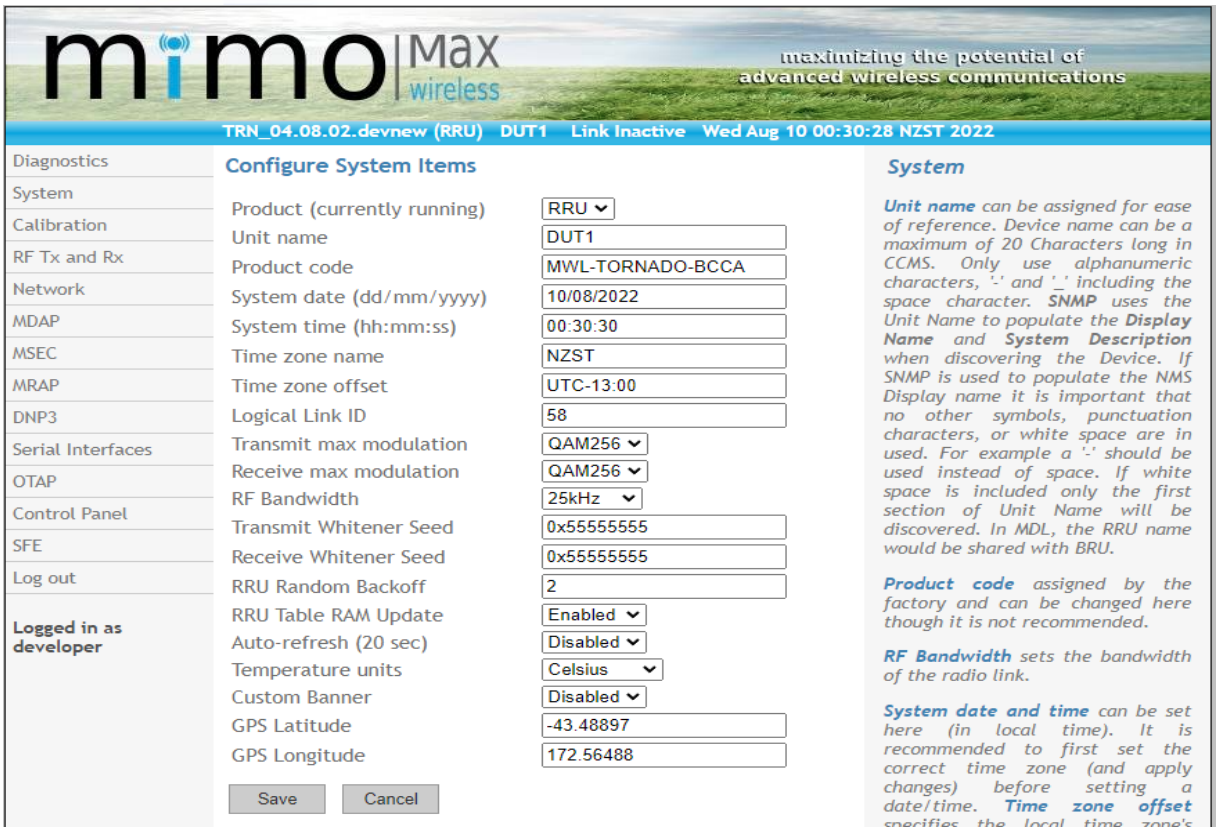
The UUT was connected to the laptop via an Ethernet cable. A static IP address was used to connect to the device.

Google chrome with this IP in the address bar was used to access the product setup.

For Transient Adjacent channel power test RRU style burst mode was selected.

The product has 2 antenna ports labelled as V and H. Both the ports were tested with one port terminated at a time by an attenuator capable of handling >20 Watt power.

Changing the modulation type and enabling/disabling the transmitter was performed remotely using the web server running the client application.




Snapshot of the software used to control the product

# 6. TEST RESULTS

**Certification required**

Part 90.203(j)

Except where otherwise specially provided for, transmitters operating on frequencies in the 150-174 MHz and 406-512 MHz bands must comply with the following:

(1) Applications for certification of mobile and portable equipment designed to transmit voice on public safety frequencies in the 150-174 MHz or 450-470 MHz band will be granted only if the mobile/portable equipment is capable of operating in the analog FM mode on the nationwide public safety interoperability channels in the 150-174 MHz band or 450-470 MHz band, as appropriate. (See § 90.20(c), (d)(80) of this part.)

**- The product is a base station transmitter. This clause is not applicable.**

(4) Applications for part 90 certification of transmitters designed to operate on frequencies in the 150.8-162.0125 MHz, 173.2-173.4 MHz, and/or 421-512 MHz bands, received on or after January 1, 2011, except for hand-held transmitters with an output power of two watts or less, will only be granted for equipment with the following channel bandwidths:

**- The product tested operates within 421.0-512.0 MHz band and hence certification is required.**

(i) 6.25 kHz or less for single bandwidth mode equipment;

(ii) 12.5 kHz for multi-bandwidth mode equipment with a maximum channel bandwidth of 12.5 kHz if it is capable of operating on channels of 6.25 kHz or less;

(iii) 25 kHz for multi-bandwidth mode equipment with a maximum channel bandwidth of 25 kHz if it is capable of operating on channels of 6.25 kHz or less; and

(iv) Up to 25 kHz if the equipment meets the efficiency standard of paragraph (j)(5) of this section.

**- The product is a base station transmitter which supports channel bandwidths of 12.5 kHz and 25.0 kHz. Spectrum efficiency details have been provided in this test report.**

(5) Applications for part 90 certification of transmitters designed to operate on frequencies in the 150.8-162.0125 MHz, 173.2-173.4 MHz, and/or 421-512 MHz bands, received on or after January 1, 2011, must include a certification that the equipment meets a spectrum efficiency standard of one voice channel per 6.25 kHz of channel bandwidth.

Additionally, if the equipment is capable of transmitting data, has transmitter output power greater than 500 mW, and has a channel bandwidth of more than 6.25 kHz, the equipment must be capable of supporting a minimum data rate of 4800 bits per second per 6.25 kHz of channel bandwidth.

**- The product does not support voice capability and 6.25 kHz channel bandwidth. Compliance to Part 90.203(j) (10) has been applied.**

(7) Transmitters designed only for one-way paging operations may be certified with up to a 25 kHz bandwidth and are exempt from the spectrum efficiency requirements of paragraphs (j)(3) and (j)(5) of this section.

**- Not applicable.**

(10) Except as provided in this paragraph, single-mode and multi-mode transmitters designed to operate in the 150-174 MHz and 421-512 MHz bands that operate with a maximum channel bandwidth greater than 12.5 kHz shall not be manufactured in, or imported into, the United States after January 1, 2011, except as follows:

(i) To the extent that the equipment meets the efficiency standard of paragraph (j)(3) of this section, or

(ii) Where operation with a bandwidth greater than 12.5 kHz is specified elsewhere.

**- Noted and Applied. Spectrum efficiency details have been provided in this test report.**

**§2.1046, § 90.205 RF power output**

Measurements were carried out at the RF output terminals of the transmitter using a 60 dB power attenuator and a 50 Ω dummy load.

Measurements were carried out when the transmitter was not being modulated.

Testing was carried out at maximum power output.

Maximum transmitter power (CW) - Rated 0.25W (+24.0 dBm)

**Frequency:** 450.000 MHz

| Port Tested | Temp (°C) | 10.5 VDC (dBm) | 24.0 VDC (dBm) | 60.0 VDC (dBm) |
|---|---|---|---|---|
| **V** | **+25** | 24.7 | 24.7 | 24.7 |
| **H** | **+25** | 24.7 | 24.7 | 24.7 |

**Frequency:** 460.075 MHz

| Port Tested | Temp (°C) | 10.5 VDC (dBm) | 24.0 VDC (dBm) | 60.0 VDC (dBm) |
|---|---|---|---|---|
| **V** | **+55** | 24.2 | 24.2 | 24.2 |
| | **+25** | 24.7 | 24.7 | 24.7 |
| | **-30** | 24.8 | 24.8 | 24.8 |
| **H** | **+55** | 24.1 | 24.1 | 24.1 |
| | **+25** | 24.6 | 24.6 | 24.6 |
| | **-30** | 24.7 | 24.7 | 24.7 |

**Frequency:** 469.500 MHz

| Port Tested | Temp (°C) | 10.5 VDC (dBm) | 24.0 VDC (dBm) | 60.0 VDC (dBm) |
|---|---|---|---|---|
| **V** | **+25** | 24.4 | 24.4 | 24.4 |
| **H** | **+25** | 24.4 | 24.4 | 24.4 |

**Limits:**

Part 90 does not specify the transmitter output power

**Result:** Complies.

**Measurement Uncertainty**: ± 0.5 dB

**§90.207 Emission types and bandwidth limitations:**

The following emission types are used: W1W, these have been elaborated as under:

The modulations tested are QPSK, 16QAM, 64QAM and 256 QAM for 12.5 kHz and 25.0 kHz channel bandwidths

The authorised bandwidth is taken to be the necessary bandwidth.

Measurements have been made to verify this declared bandwidth using the various modulation types and data rates that the device under test can support at each test frequency.

Measurements were made using a spectrum analyser that was operating in occupied bandwidth mode with the 99% power points being determined automatically.

The analyser was set up with a resolution bandwidth video bandwidth as per 47 CFR Part 2, ANSI / TIA-603-E-2016 and ANSI C63.26: 2015.

Attached to the input of the spectrum analyser was an external high power attenuator.

All the measurements that have been tabulated were made but only the representative plots have been included in the test report in order to simplify the test report.

**Result:** Complies

**Measurement results:**

Ports V and Port H have shown identical measurements.

**Emission Type- 12.5 kHz spacing.**

| Modulation Type | Frequency (MHz) | Measured (kHz) | Authorised Bandwidth |
|---|---|---|---|
| 256QAM | 450.000 | 10.331 | 11.200 kHz |
| QPSK | 460.075 | 10.286 | |
| 16QAM | 460.075 | 10.271 | |
| 64QAM | 460.075 | 10.351 | |
| 256QAM | 460.075 | 10.441 | |
| 256QAM | 469.500 | 10.387 | |

**Emission Type- 25.0 kHz spacing.**

| Modulation Type | Frequency (MHz) | Measured (kHz) | Authorised Bandwidth |
|---|---|---|---|
| 256QAM | 450.000 | 20.802 | 22.000 kHz §90.209(b)(5) note 6 applied see below |
| QPSK | 460.075 | 20.655 | |
| 16QAM | 460.075 | 20.846 | |
| 64QAM | 460.075 | 20.739 | |
| 256QAM | 460.075 | 20.729 | |
| 256QAM | 469.500 | 20.379 | |

[6] Operations using equipment designed to operate with a 25 kilohertz channel bandwidth may be authorized up to a 20 kilohertz bandwidth unless the equipment meets the Adjacent Channel Power limits of § 90.221 in which case operations may be authorized up to a 22 kilohertz bandwidth. Operations using equipment designed to operate with a 12.5 kilohertz channel bandwidth may be authorized up to an 11.25 kilohertz bandwidth.

Table 1 to § 90.209(b)(5)—Standard Channel Spacing/Bandwidth

| Frequency band (MHz) | Channel spacing (kHz) | Authorized bandwidth (kHz) |
|---|---|---|
| Below 25[2] | | |
| 25–50 | 20 | 20 |
| 72–76 | 20 | 20 |
| 150–174 | [1]7.5 | [1 3] 20/11.25/6 |
| 216–220[5] | 6.25 | 20/11.25/6 |
| 220–222 | 5 | 4 |
| 406–512[2] | [1] 6.25 | [1 3 6] 20/11.25/6 |

[1] For stations authorized on or after August 18, 1995.

[2] Bandwidths for radiolocation stations in the 420–450 MHz band and for stations operating in bands subject to this footnote will be reviewed and authorized on a case-by-case basis.

[3] Operations using equipment designed to operate with a 25 kHz channel bandwidth will be authorized a 20 kHz bandwidth. Operations using equipment designed to operate with a 12.5 kHz channel bandwidth will be authorized a 11.25 kHz bandwidth. Operations using equipment designed to operate with a 6.25 kHz channel bandwidth will be authorized a 6 kHz bandwidth. All stations must operate on channels with a bandwidth of 12.5 kHz or less beginning January 1, 2013, unless the operations meet the efficiency standard of § 90.203(j)(3).

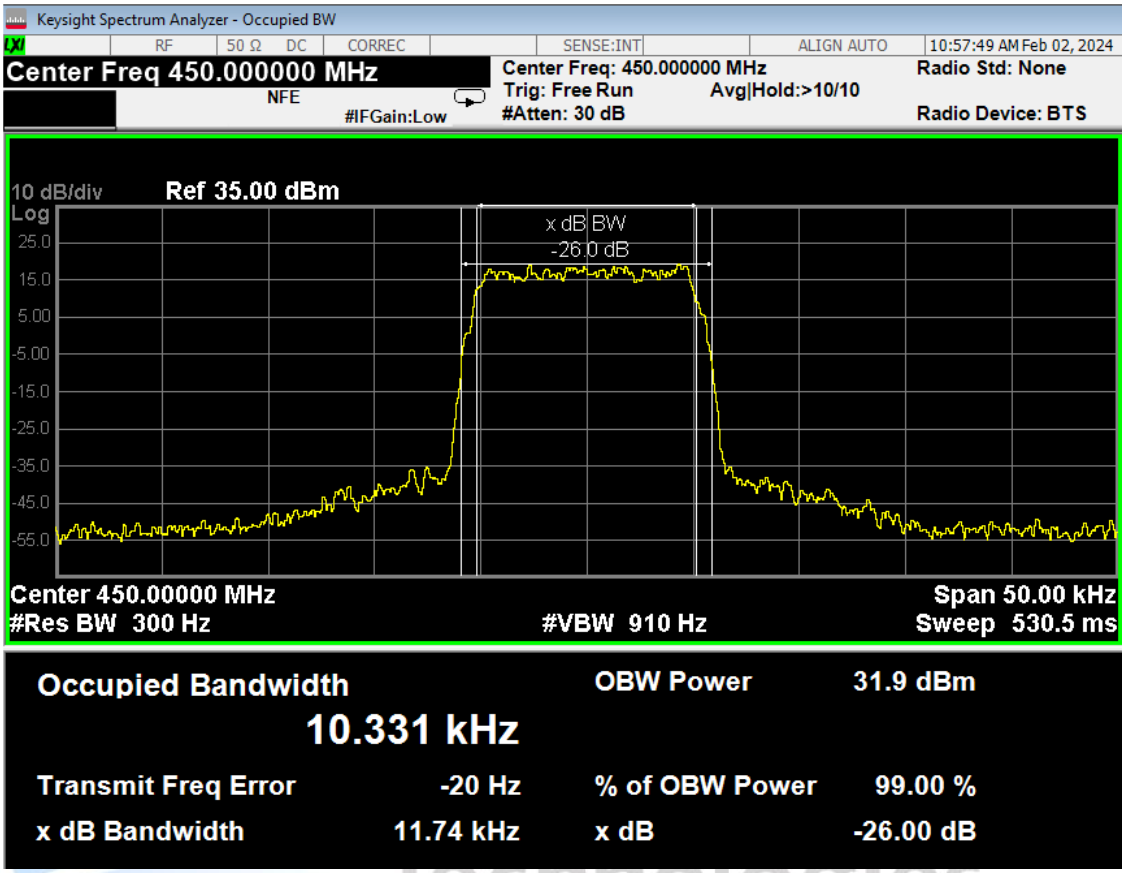
[4] The maximum authorized bandwidth shall be 12 MHz for non-multilateration LMS operations in the band 909.75–921.75 MHz and 2 MHz in the band 902.00–904.00 MHz. The maximum authorized bandwidth for multilateration LMS operations shall be 5.75 MHz in the 904.00–909.75 MHz band; 2 MHz in the 919.75–921.75 MHz band; 5.75 MHz in the 921.75–927.25 MHz band and its associated 927.25–927.50 MHz narrowband forward link; and 8.00 MHz if the 919.75–921.75 MHz and 921.75–927.25 MHz bands and their associated 927.25–927.50 MHz and 927.50–927.75 MHz narrowband forward links are aggregated.

[5] See § 90.259.

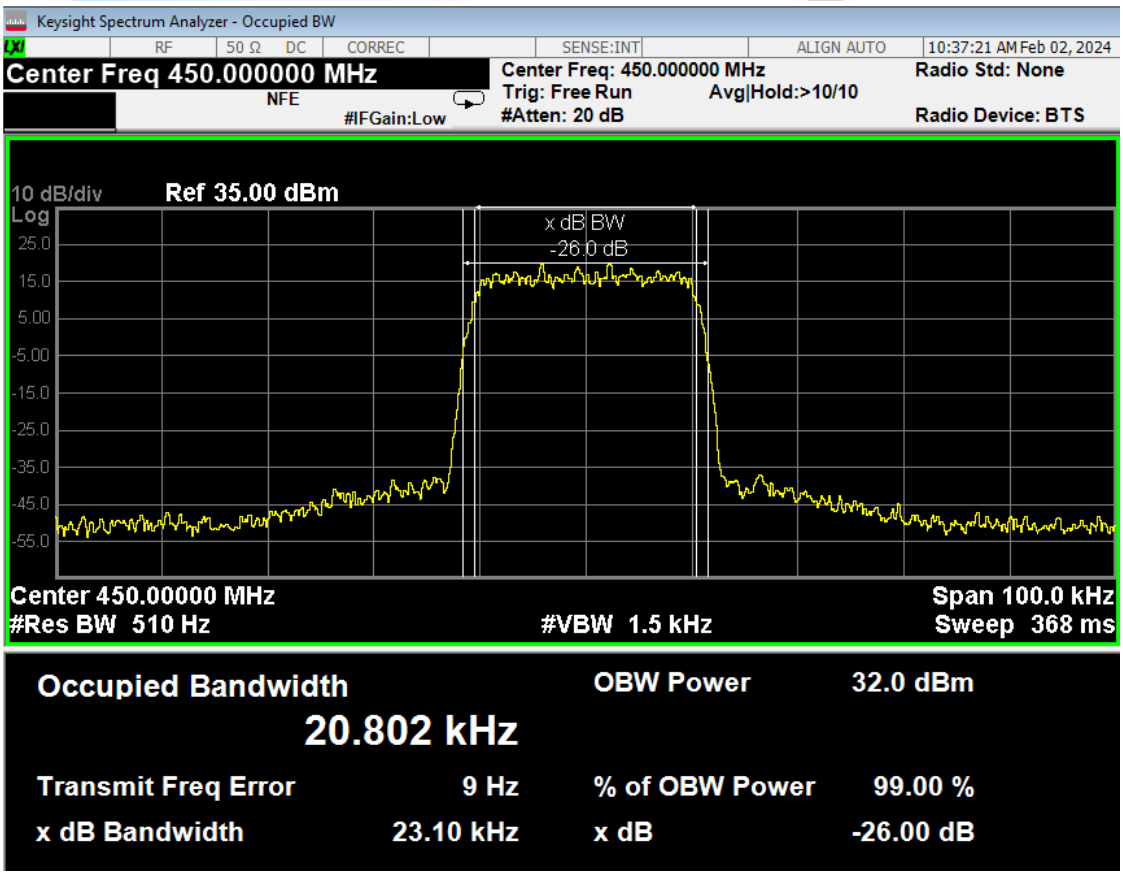
[6] Operations using equipment designed to operate with a 25 kilohertz channel bandwidth may be authorized up to a 20 kilohertz bandwidth unless the equipment meets the Adjacent Channel Power limits of § 90.221 in which case operations may be authorized up to a 22 kilohertz bandwidth. Operations using equipment designed to operate with a 12.5 kilohertz channel bandwidth may be authorized up to an 11.25 kilohertz bandwidth.

## Occupied Bandwidth Measurement Plots:

Port V/ 256QAM/12.5 kHz/450.000 MHz

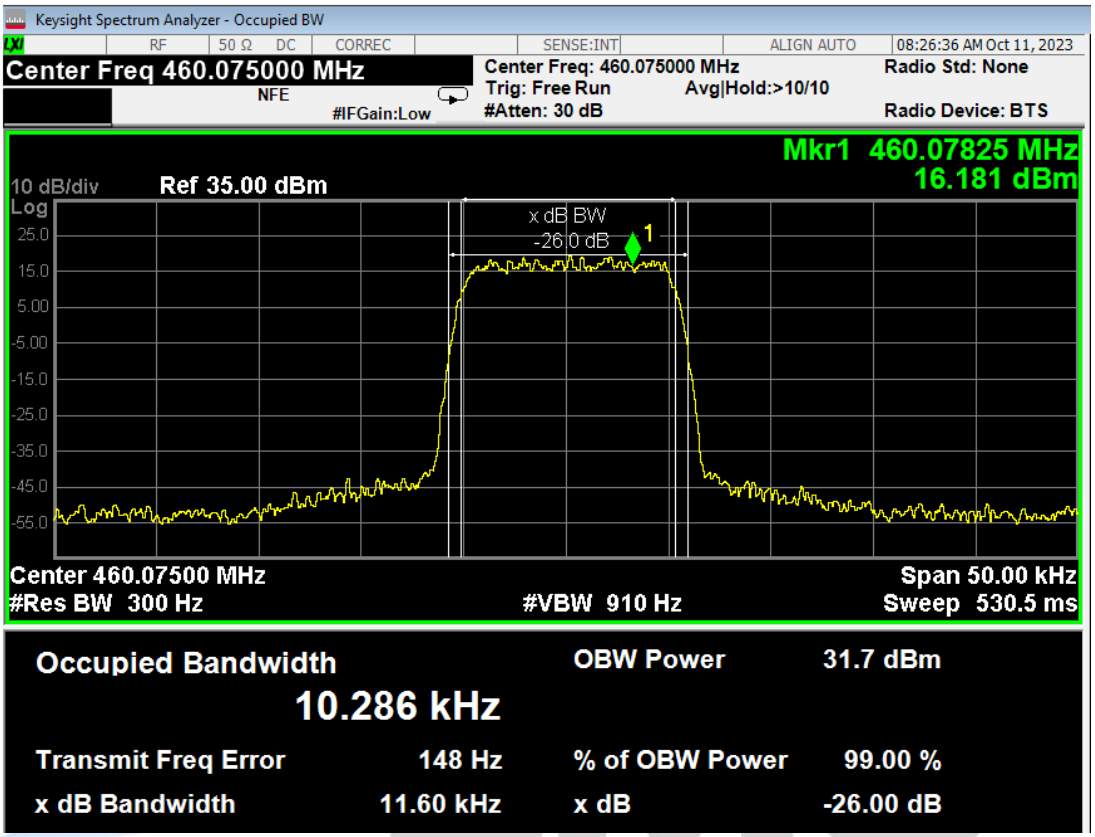



Port V/ 256QAM/25.0 kHz/450.000 MHz

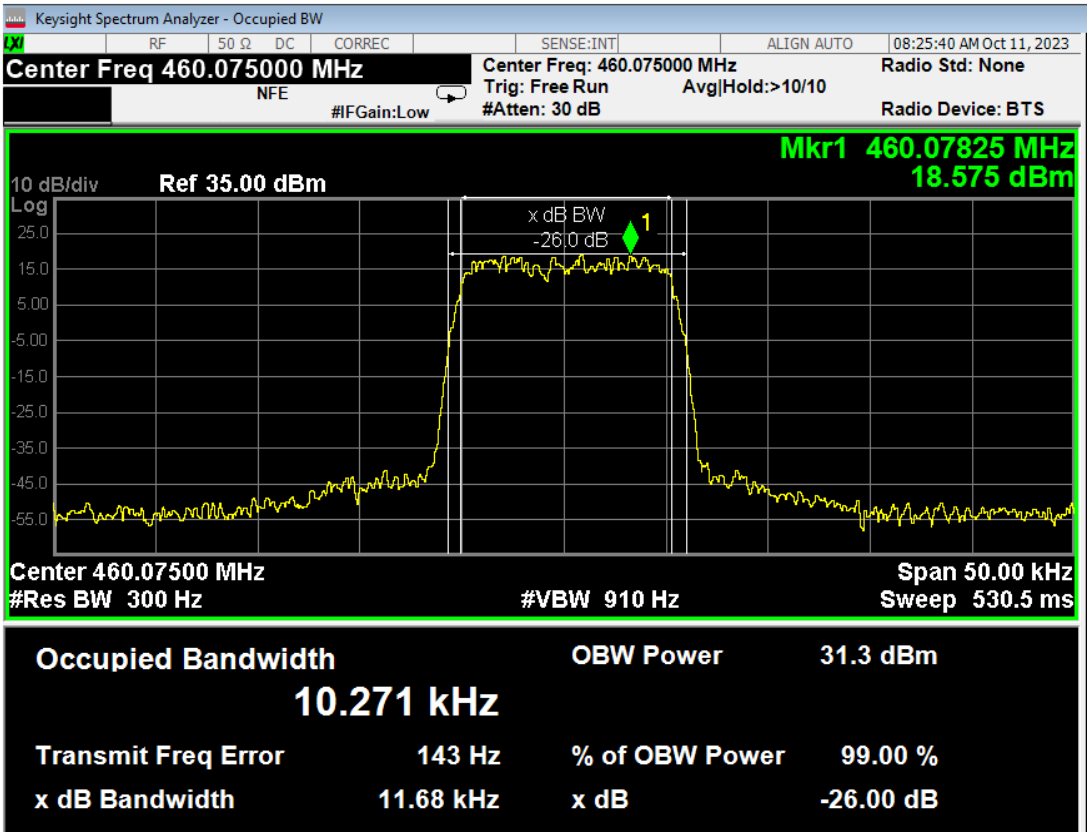


## Occupied Bandwidth Measurement Plots:

Port V/ QPSK/12.5 kHz

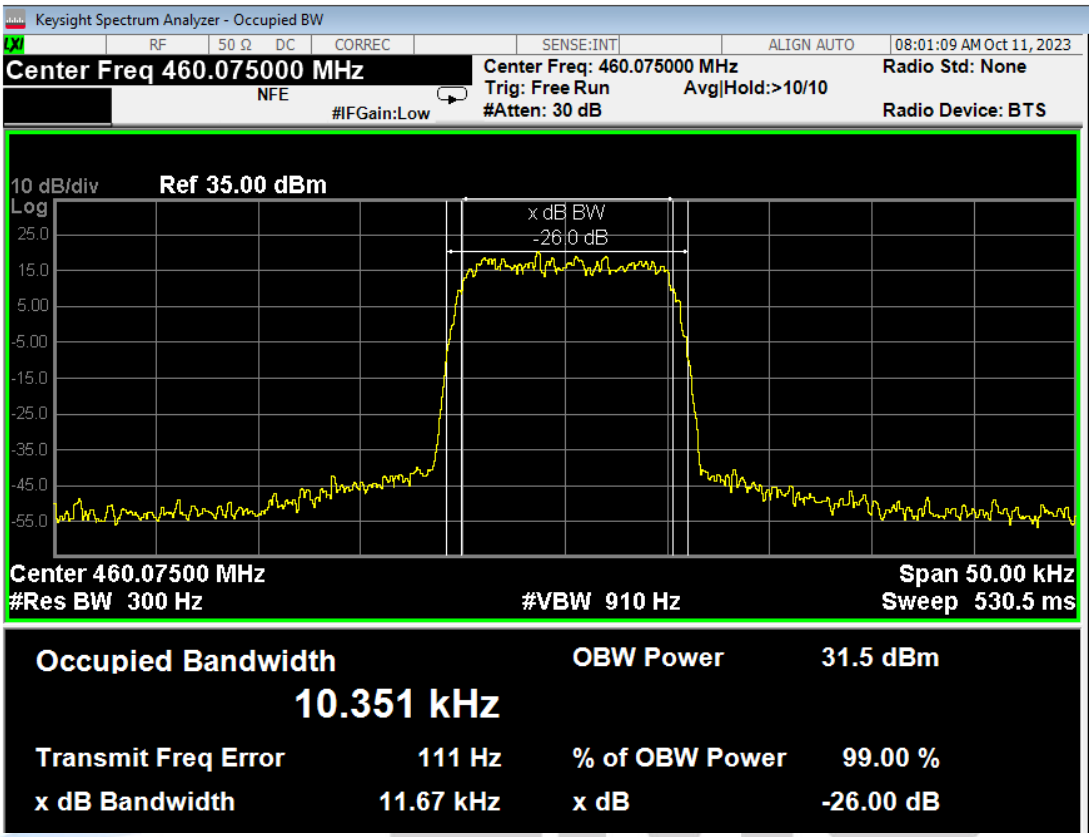



Port V/ 16QAM/12.5 kHz

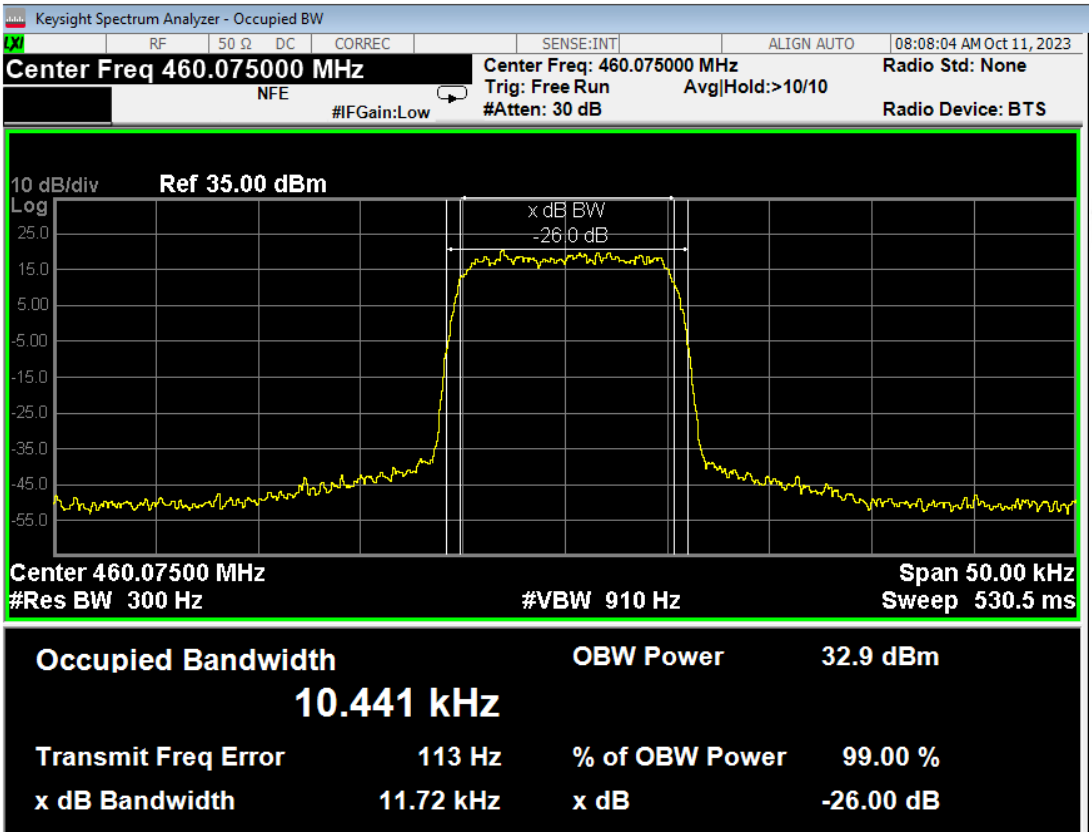


## Occupied Bandwidth Measurement Plots:

Port V/ 64QAM/12.5 kHz

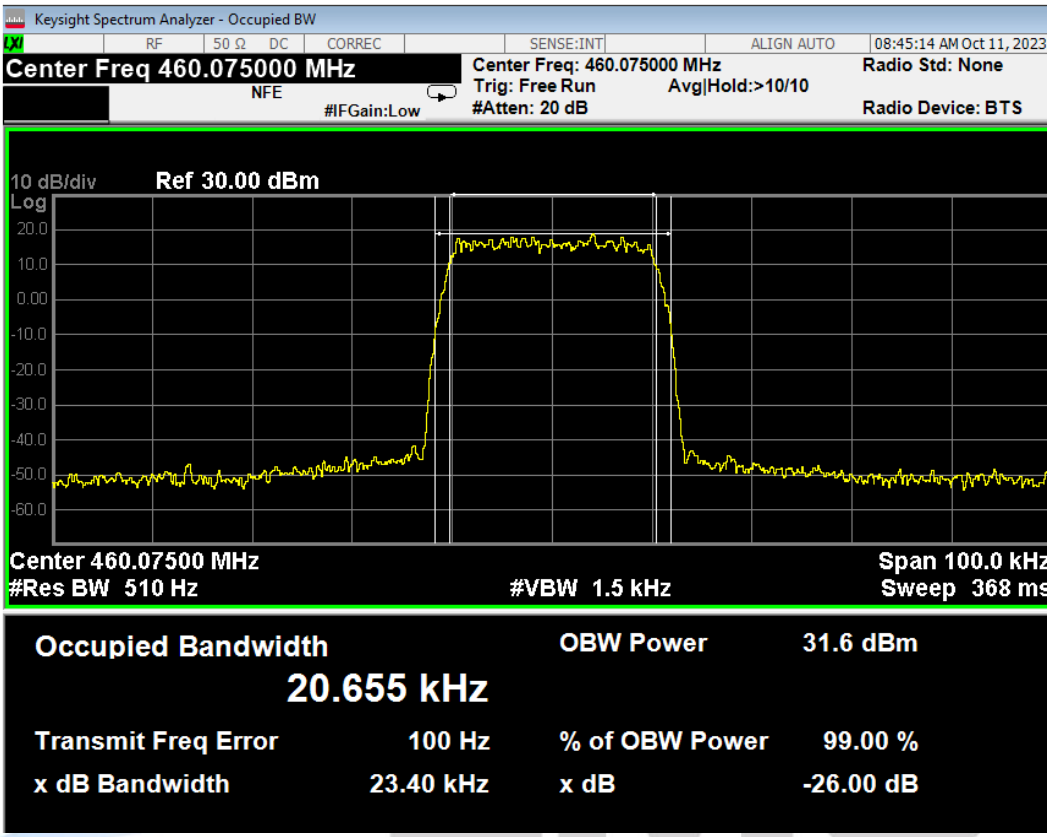



Port V/ 256QAM/12.5 kHz

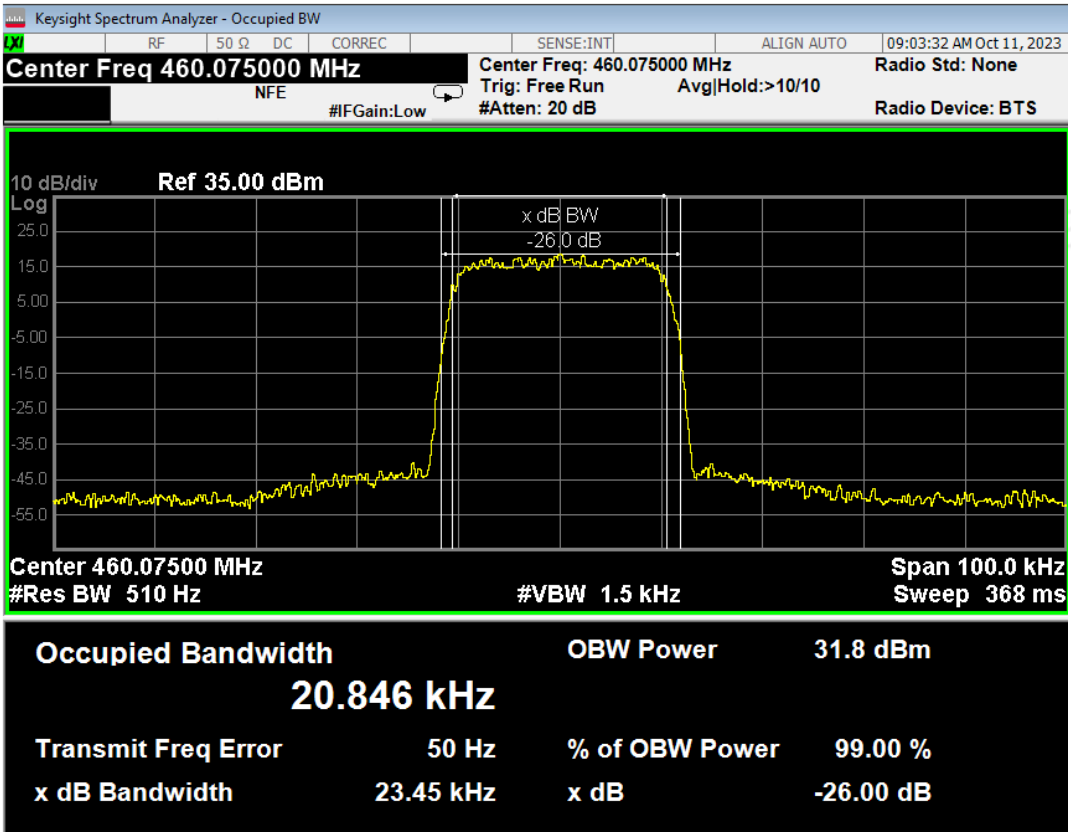


## Occupied Bandwidth Measurement Plots:

Port V/ QPSK/25.0 kHz

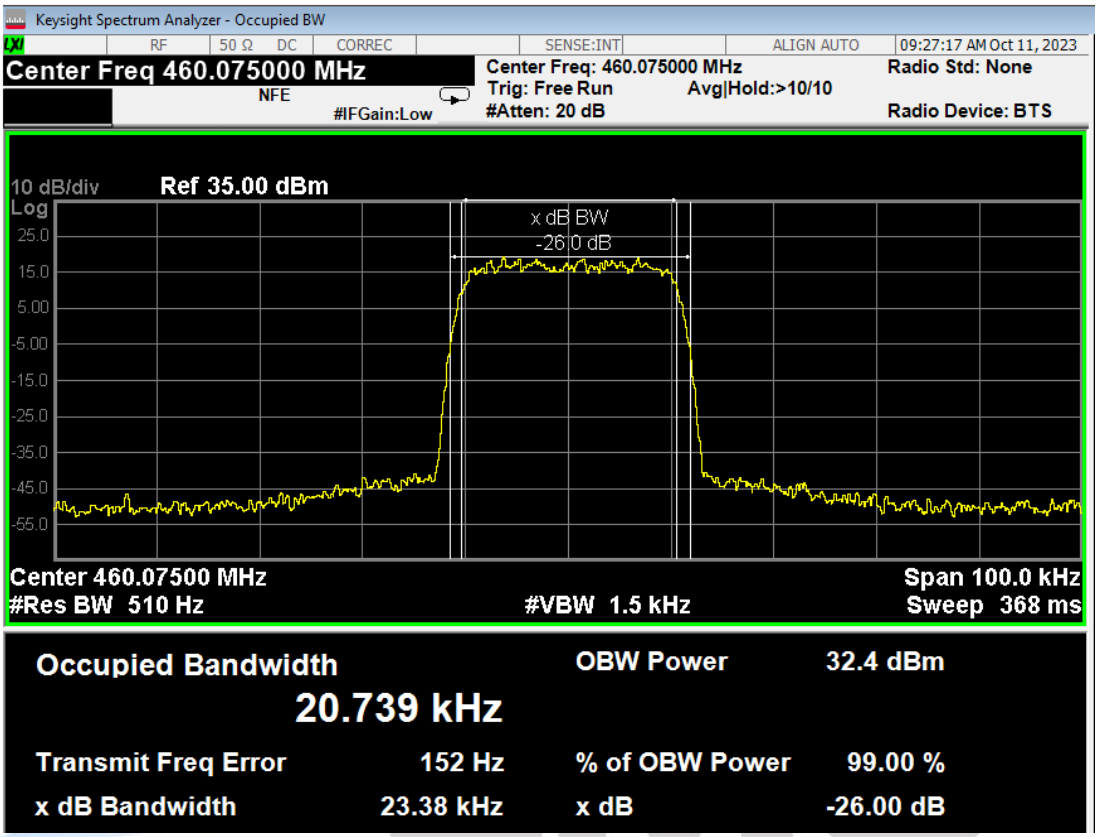



Port V/ 16QAM/25.0 kHz

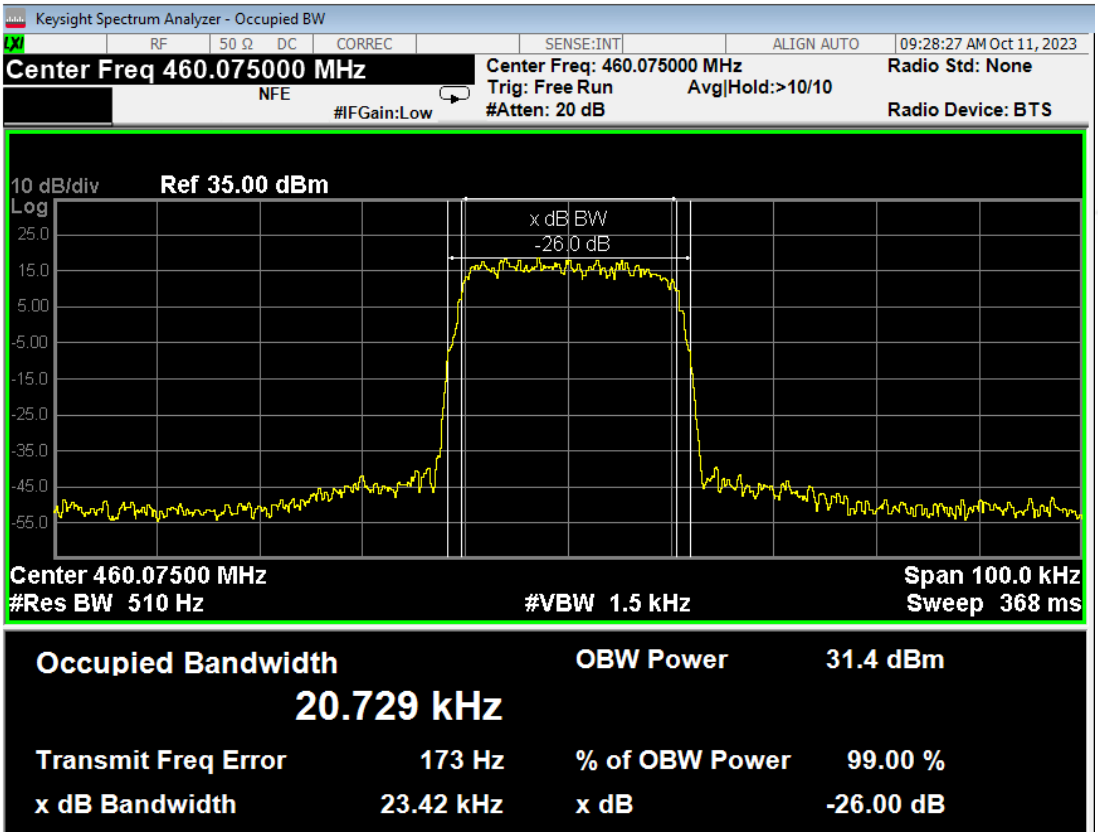


## Occupied Bandwidth Measurement Plots:

Port V/ 64QAM/25.0 kHz

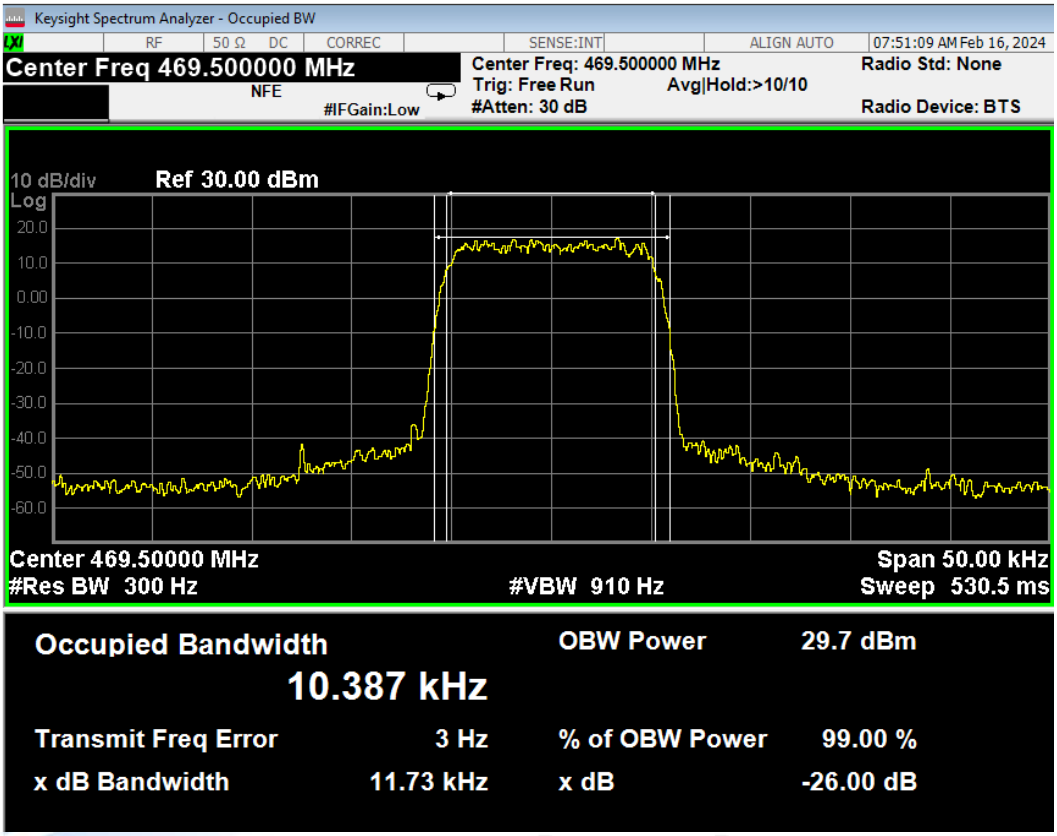



Port V/ 256QAM/25.0 kHz

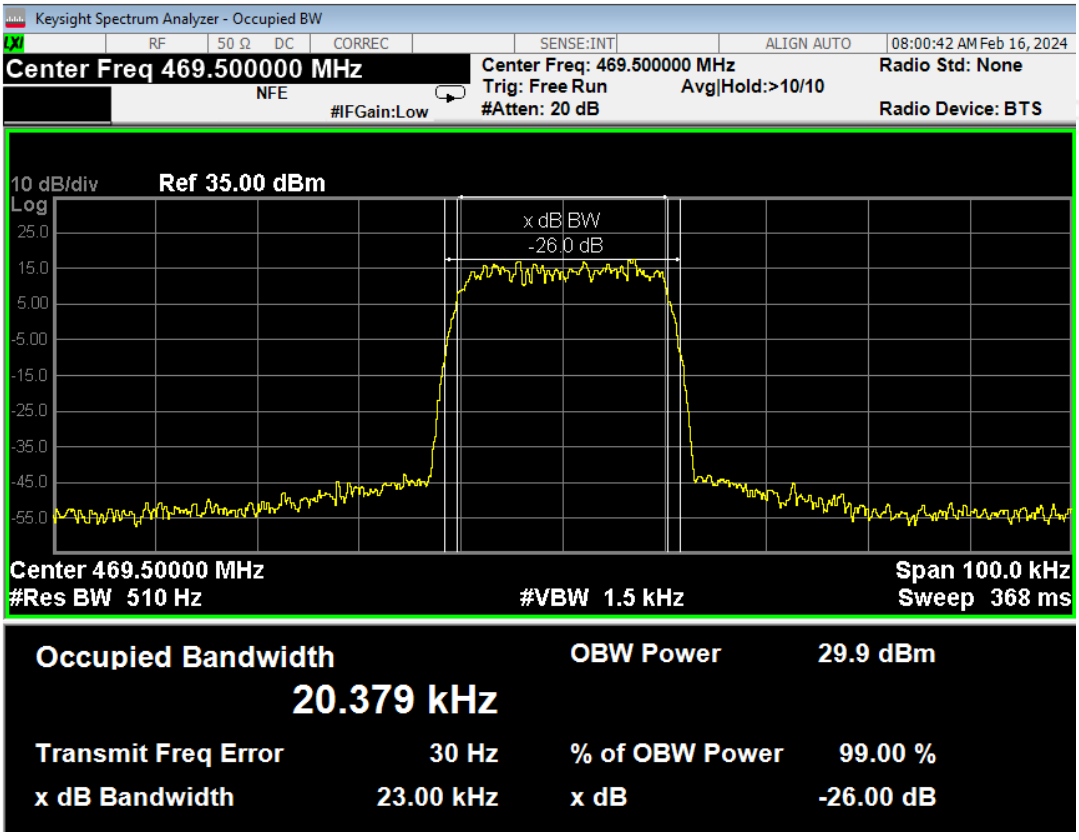


## Occupied Bandwidth Measurement Plots:

Port V/ 256QAM/12.5 kHz/469.500 MHz




Port V/ 256QAM/25.0 kHz/469.500 MHz



## §90.210 Spectrum Emission Masks

As per the client, the product does not have audio filters, Section 90.210(d) – Mask D have been applied as the transmitter can operate in the band 450.000-470.000 MHz using an authorised bandwidth of 12.5 kHz as per Section 90.209(b)(5).

For all measurements a high power attenuator is placed between the transmitter and the spectrum analyser. Measurements were made in peak hold.

For showing compliance of the product to emission masks plots at various modulation and channel bandwidths when the product was operating on 460.075 MHz have been presented in the test report.

All the measurements were performed when the product was operating at a high power setting (0.25 Watts)

For 25 kHz channel bandwidth, following notes have been applied and compliance to Adjacent channel power measurements have been shown in this test report.

[5] Equipment designed to operate on 25 kilohertz bandwidth channels must meet the requirements of either Emission Mask B or G, whichever is applicable, while equipment designed to operate on 12.5 kilohertz bandwidth channels must meet the requirements of Emission Mask D. Equipment designed to operate on 25 kilohertz bandwidth channels may alternatively meet the Adjacent Channel Power limits of § 90.221.

**Result:** Complies.

## §90.210- Applicable Emission Masks

| Frequency band (MHz) | Mask for equipment with audio low pass filter | Mask for equipment without audio low pass filter |
|---|---|---|
| Below 25[1] | A or B | A or C |
| 25–50 | B | C |
| 72–76 | B | C |
| 150–174[2] | B, D, or E | C, D or E |
| 150 paging only | B | C |
| 220–222 | F | F |
| 421–512[2 5] | B, D, or E | C, D, or E |
| 450 paging only | B | G |
| 806–809/851–854[6] | B | H |
| 809–824/854–869[35] | B, D | D, G. |
| 896–901/935–940 | I | J |

[1] Equipment using single sideband J3E emission must meet the requirements of Emission Mask A. Equipment using other emissions must meet the requirements of Emission Mask B or C, as applicable.

[2] Equipment designed to operate with a 25 kHz channel bandwidth must meet the requirements of Emission Mask B or C, as applicable. Equipment designed to operate with a 12.5 kHz channel bandwidth must meet the requirements of Emission Mask D, and equipment designed to operate with a 6.25 kHz channel bandwidth must meet the requirements of Emission Mask E.

[3] Equipment used in this licensed to EA or non-EA systems shall comply with the emission mask provisions of § 90.691 of this chapter.

[4] DSRCS Roadside Units in the 5895–5925 MHz band are governed under subpart M of this part.

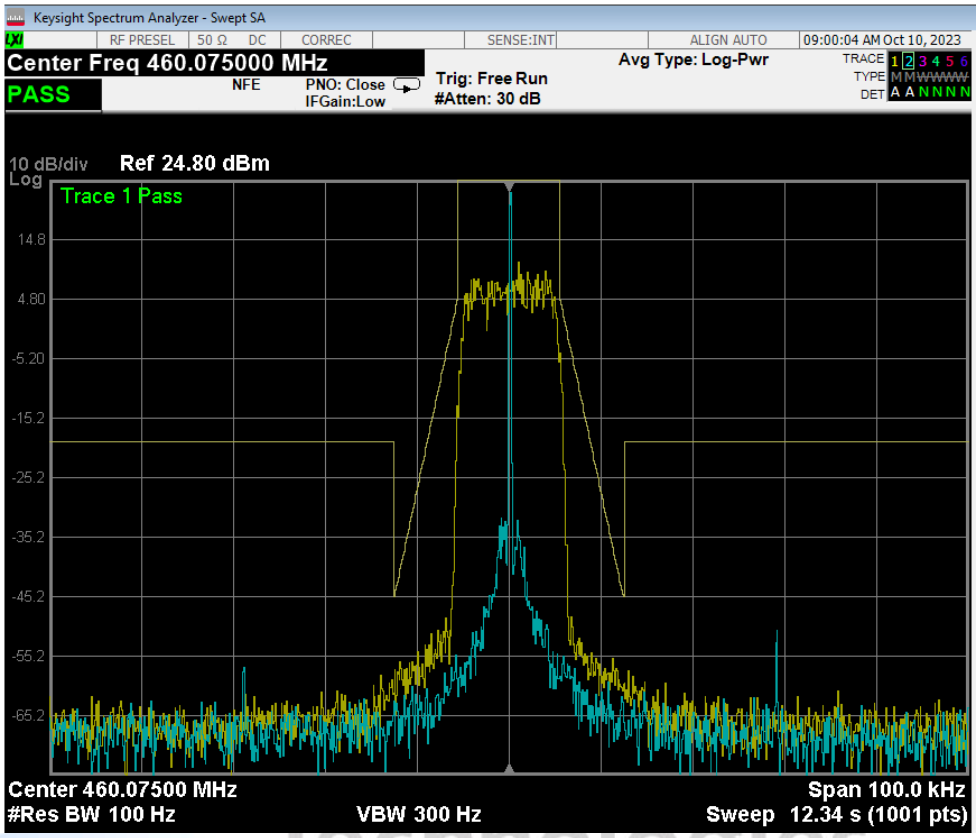
[5] Equipment designed to operate on 25 kilohertz bandwidth channels must meet the requirements of either Emission Mask B or G, whichever is applicable, while equipment designed to operate on 12.5 kilohertz bandwidth channels must meet the requirements of Emission Mask D. Equipment designed to operate on 25 kilohertz bandwidth channels may alternatively meet the Adjacent Channel Power limits of § 90.221.

[6] Transmitters utilizing analog emissions that are equipped with an audio low-pass filter must meet Emission Mask B. All transmitters utilizing digital emissions and those transmitters using analog emissions without an audio low-pass filter must meet Emission Mask H.

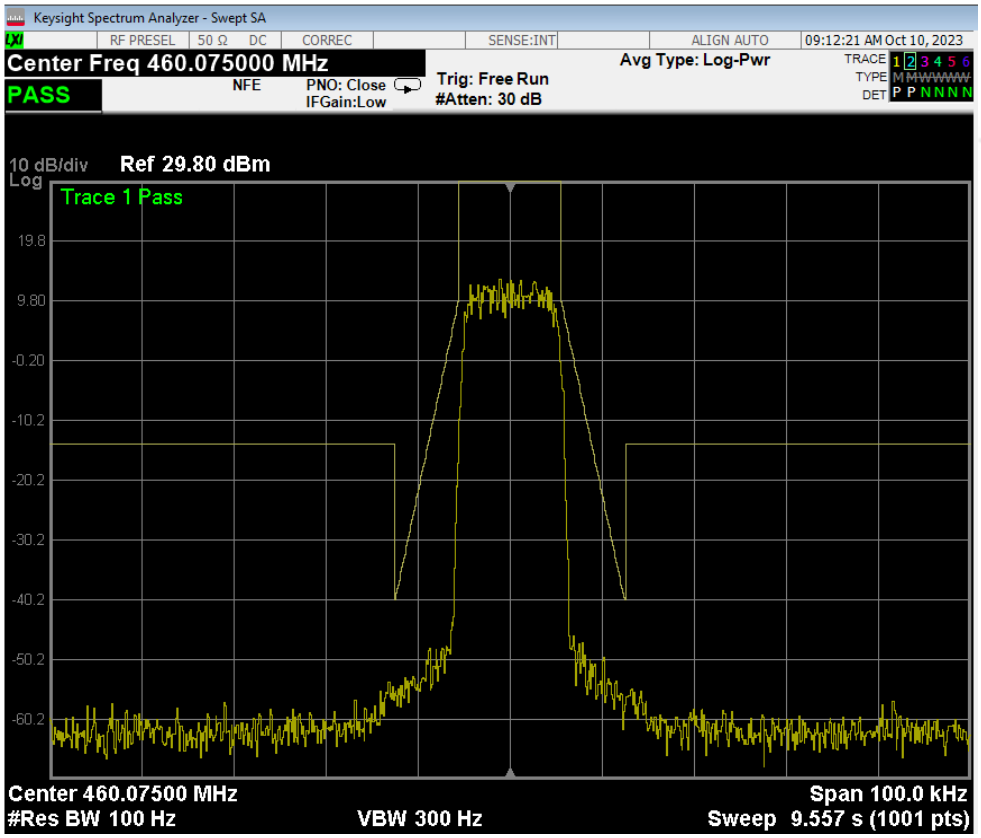
## 12.5 kHz Channel bandwidth emission mask-D

The measurements using peak and average detector methods have shown similar results for compliance

Port-V/QPSK/12.5 kHz/Mask D/RMS mode

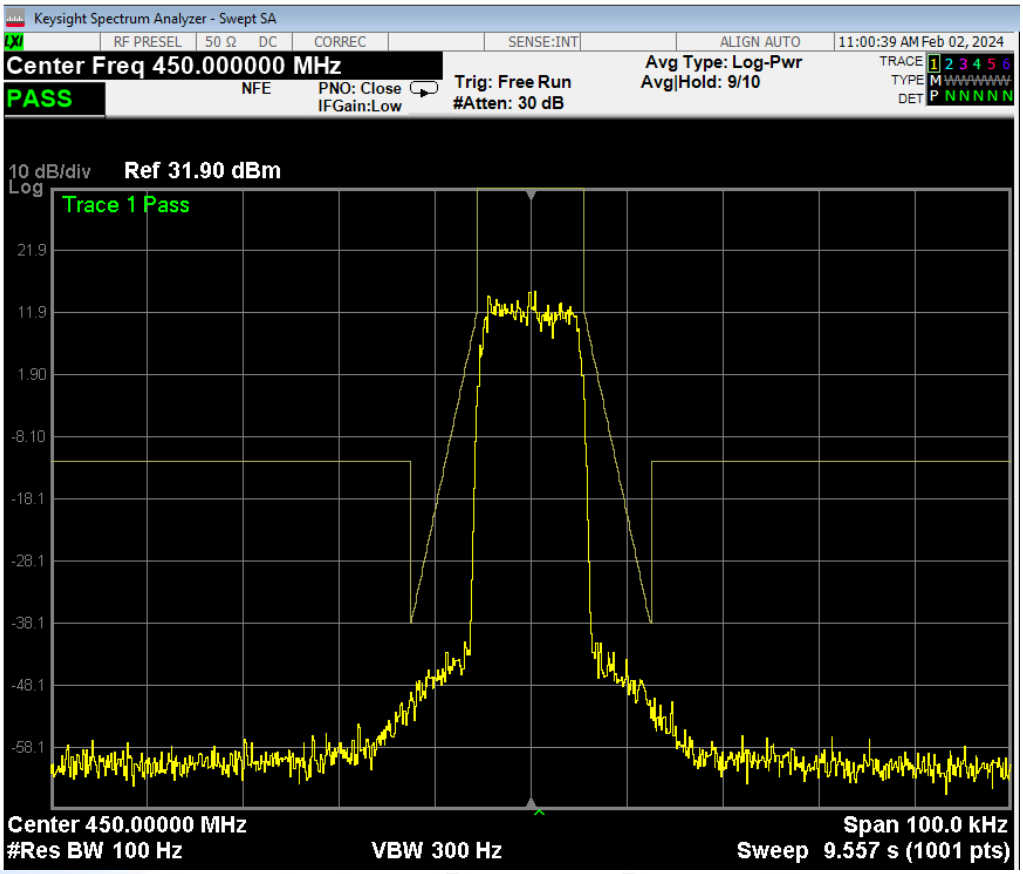



Port-V/QPSK/12.5 kHz/Mask D/Peak mode

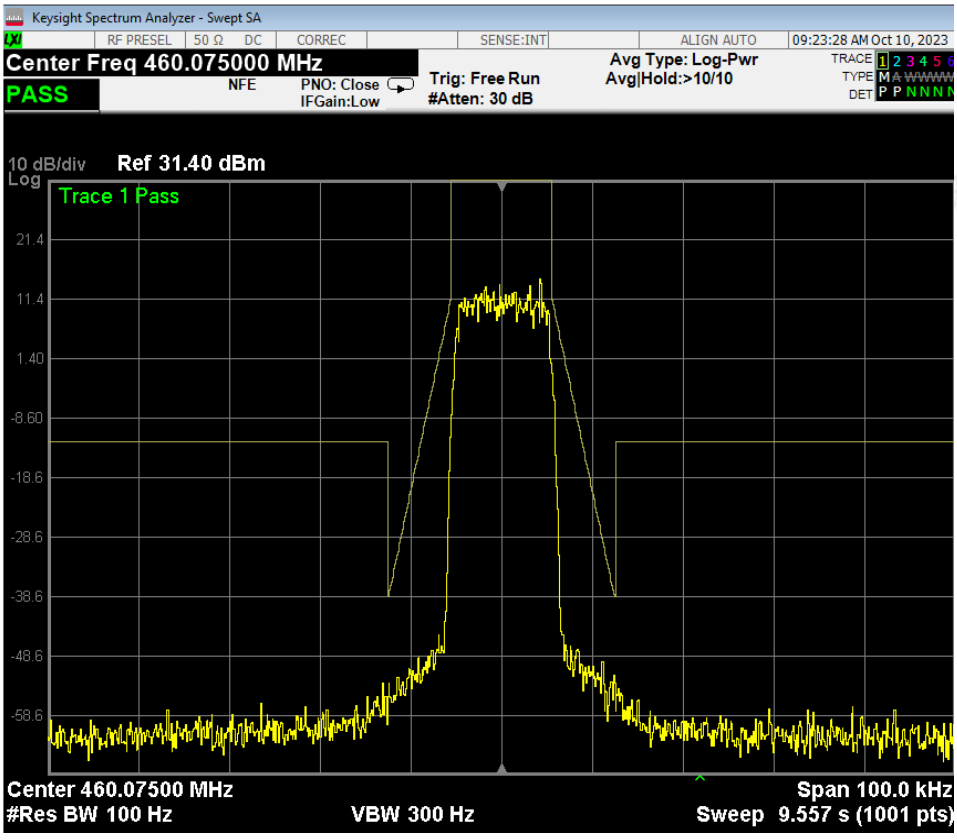


## 12.5 kHz Channel bandwidth emission mask-D

Port-H/256QAM/12.5 kHz/Mask D/450.000 MHz

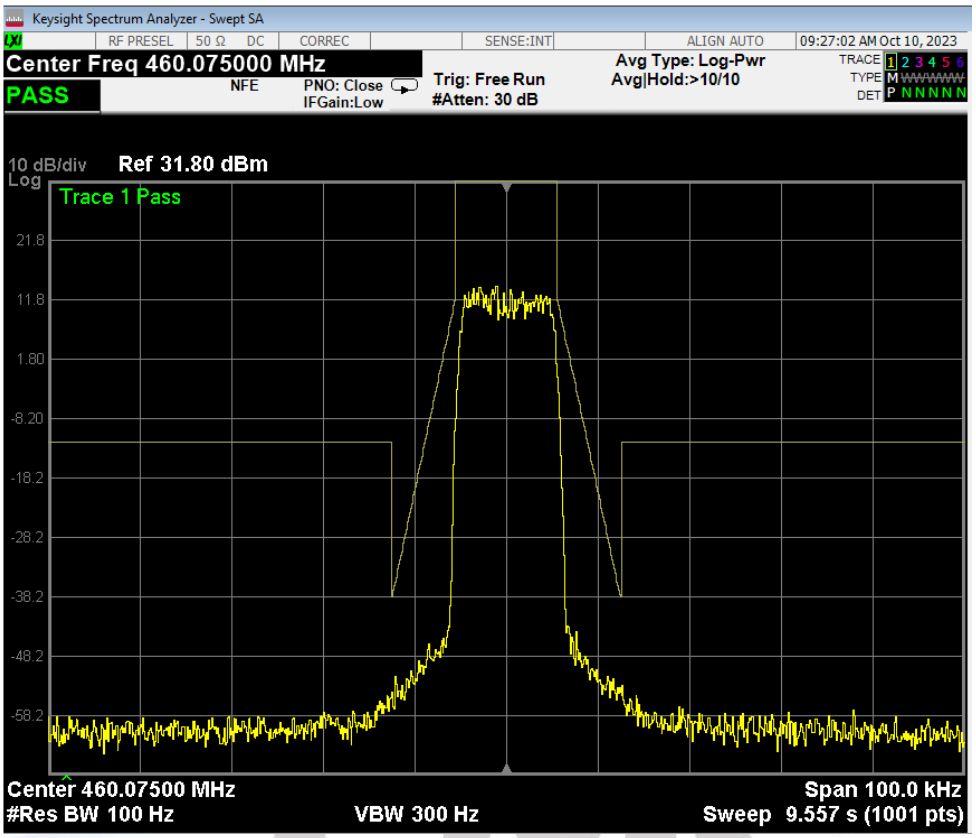



Port-V/16QAM/12.5 kHz/Mask D

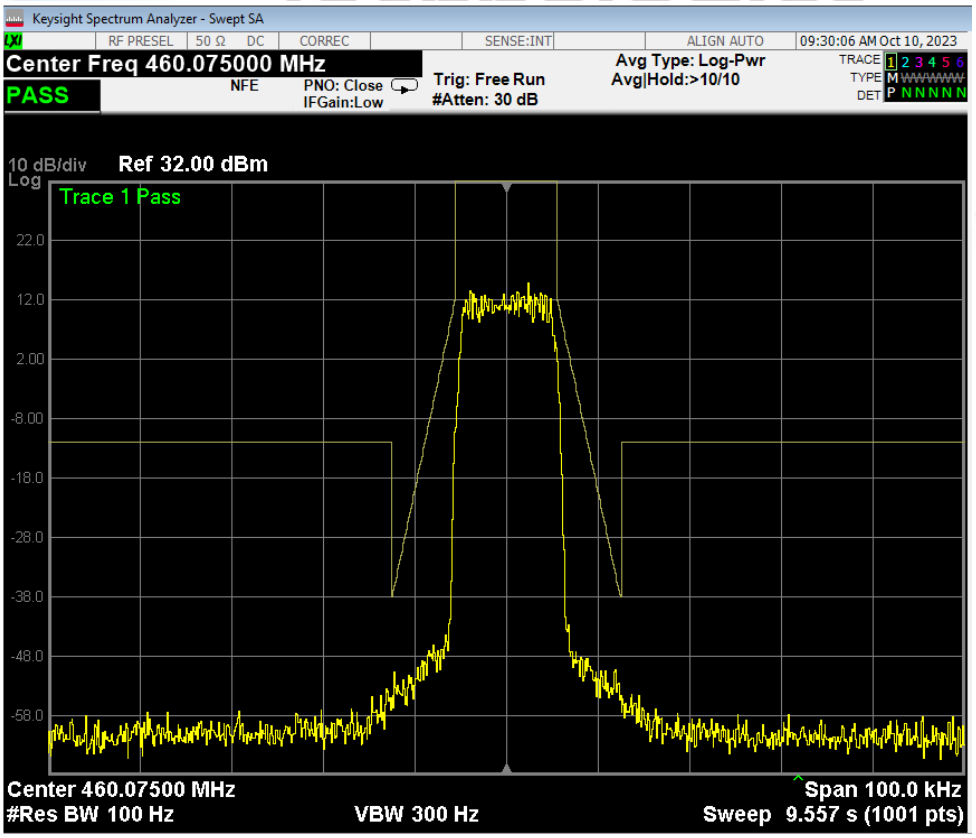


## 12.5 kHz Channel bandwidth emission mask-D

Port-V/64QAM/12.5 kHz/Mask D

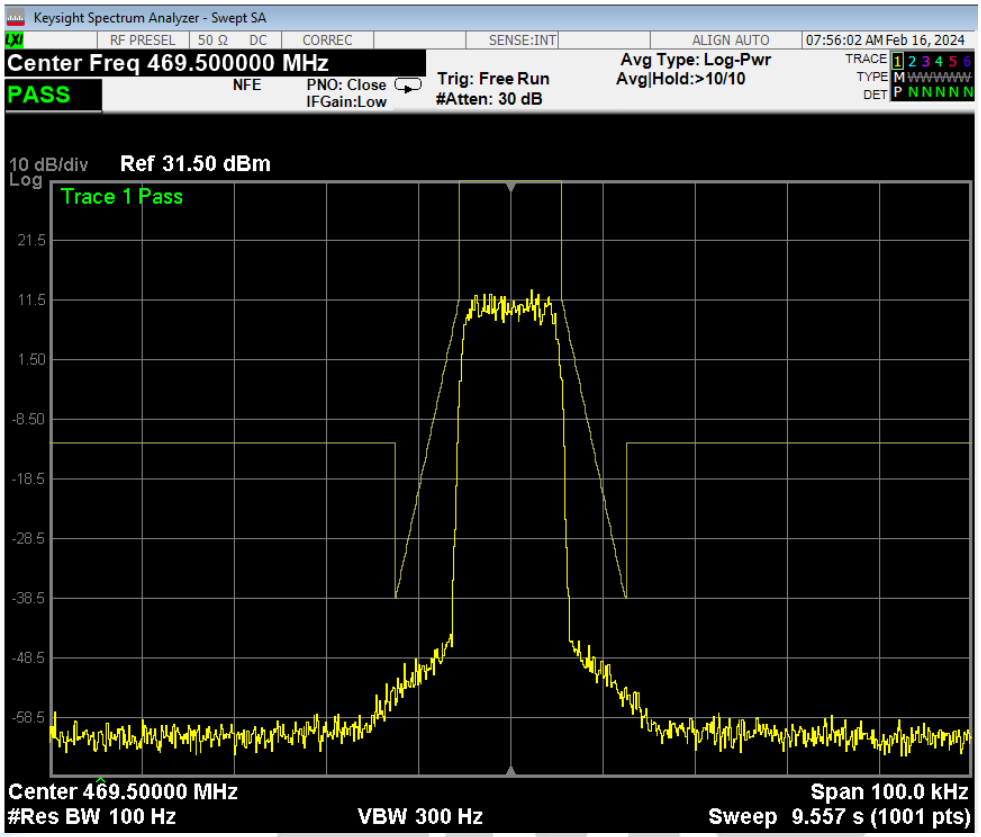



Port-V/256QAM/12.5 kHz/Mask D



## 12.5 kHz Channel bandwidth emission mask-D

Port-V/256QAM/12.5 kHz/Mask D




## 25.0 kHz Channel bandwidth- Adjacent channel power results

- The Adjacent channel power measurements have been performed as per §90.221 which in the 450-470 MHz band states as follows:

For the frequency bands indicated below, operations using equipment designed to operate with a 25 kHz channel bandwidth may be authorized up to a 22 kHz bandwidth if the equipment meets the adjacent channel power (ACP) limits below. The table specifies a value for the ACP as a function of the displacement from the channel center frequency and a measurement bandwidth of 18 kHz.

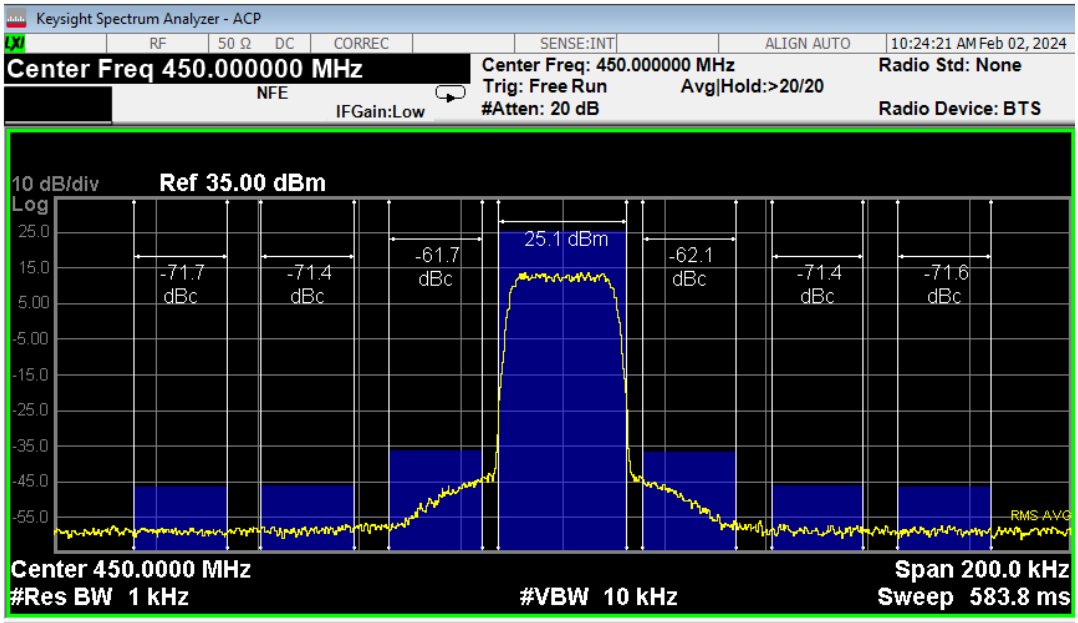
| Frequency offset | Maximum ACP (dBc) for devices 1 watt and less | Maximum ACP (dBc) for devices above 1 watt |
|---|---|---|
| 25 kHz | −55 dBc | −60 dBc |
| 50 kHz | −70 dBc | −70 dBc |
| 75 kHz | −70 dBc | −70 dBc |

In any case, no requirement in excess of −36 dBm shall apply.

On any frequency removed from the assigned frequency by more than 75 kHz, the attenuation of any emission must be at least 43 + 10 log ($P_{watts}$) dB.

## 25.0 kHz Channel bandwidth- Adjacent channel power results

Port-H/256QAM/25.0 kHz/ACP/450.000 MHz

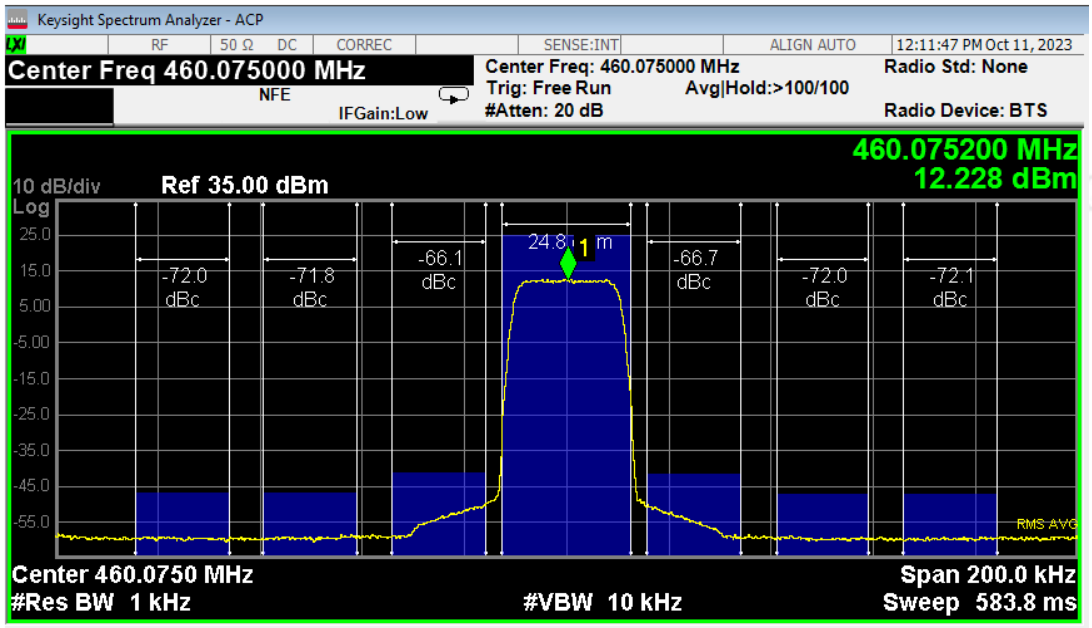



Total Carrier Power 25.104 dBm/ 25.00 kHz ACP-IBW

| Carrier Power | | | Filter |
|---|---|---|---|
| 1 | 25.104 dBm / | 25.00 kHz | -3 dB |

| Offset Freq | Integ BW | Lower dBc | Lower dBm | Upper dBc | Upper dBm | Filter |
|---|---|---|---|---|---|---|
| 25.00 kHz | 18.00 kHz | -61.75 | -36.64 | -62.07 | -36.97 | -3 dB |
| 50.00 kHz | 18.00 kHz | -71.37 | -46.26 | -71.40 | -46.30 | -3 dB |
| 75.00 kHz | 18.00 kHz | -71.66 | -46.56 | -71.65 | -46.54 | -3 dB |

Port-V/QPSK/25.0 kHz/ACP



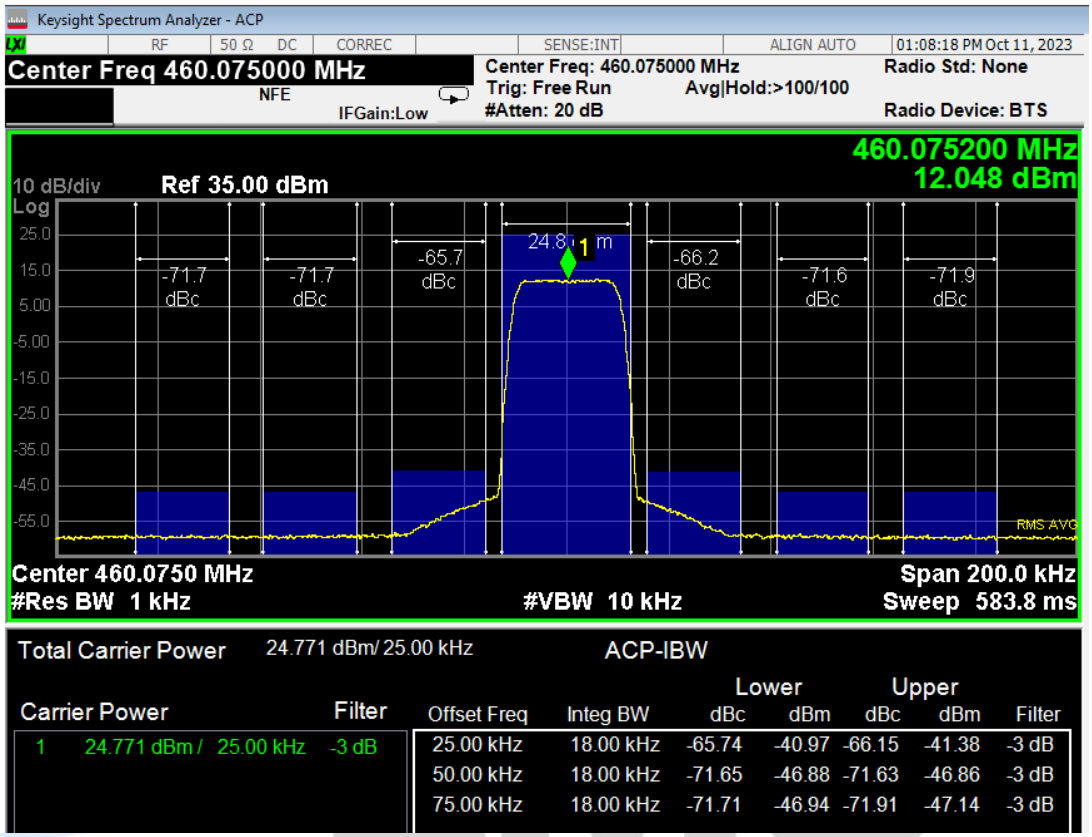

Total Carrier Power 24.812 dBm/ 25.00 kHz ACP-IBW

| Carrier Power | | | Filter |
|---|---|---|---|
| 1 | 24.812 dBm / | 25.00 kHz | -3 dB |

| Offset Freq | Integ BW | Lower dBc | Lower dBm | Upper dBc | Upper dBm | Filter |
|---|---|---|---|---|---|---|
| 25.00 kHz | 18.00 kHz | -66.11 | -41.30 | -66.69 | -41.88 | -3 dB |
| 50.00 kHz | 18.00 kHz | -71.82 | -47.01 | -72.01 | -47.20 | -3 dB |
| 75.00 kHz | 18.00 kHz | -71.97 | -47.16 | -72.10 | -47.29 | -3 dB |

## 25.0 kHz Channel bandwidth- Adjacent channel power results

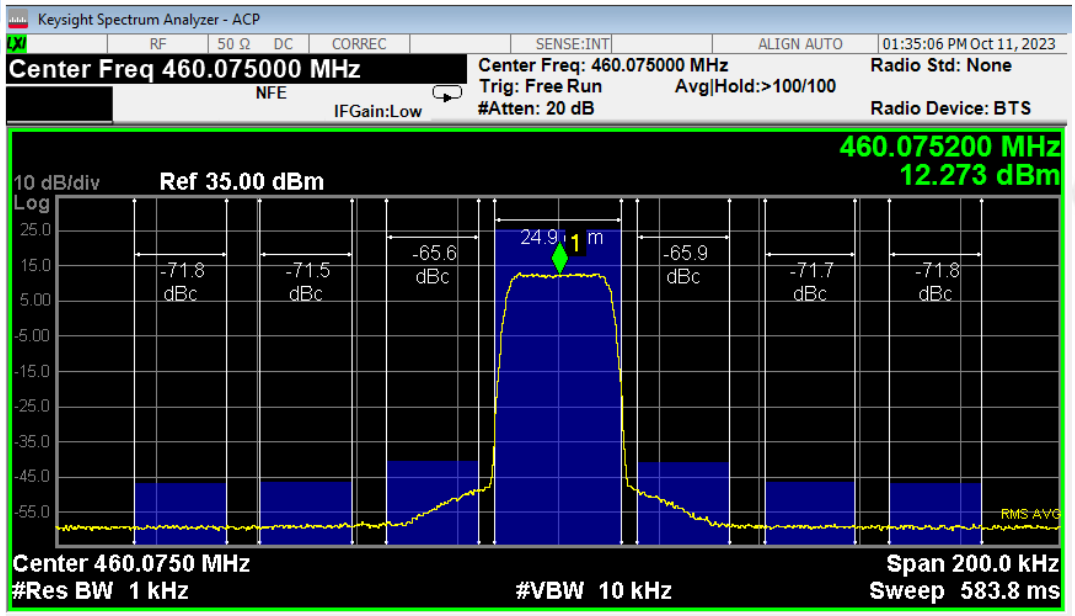
Port-V/16QAM/25.0 kHz/ACP




Total Carrier Power 24.771 dBm/ 25.00 kHz ACP-IBW

| Carrier Power | | | Filter | Offset Freq | Integ BW | Lower dBc | Lower dBm | Upper dBc | Upper dBm | Filter |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 24.771 dBm / | 25.00 kHz | -3 dB | 25.00 kHz | 18.00 kHz | -65.74 | -40.97 | -66.15 | -41.38 | -3 dB |
| | | | | 50.00 kHz | 18.00 kHz | -71.65 | -46.88 | -71.63 | -46.86 | -3 dB |
| | | | | 75.00 kHz | 18.00 kHz | -71.71 | -46.94 | -71.91 | -47.14 | -3 dB |

Port-V/64QAM/25.0 kHz/ACP

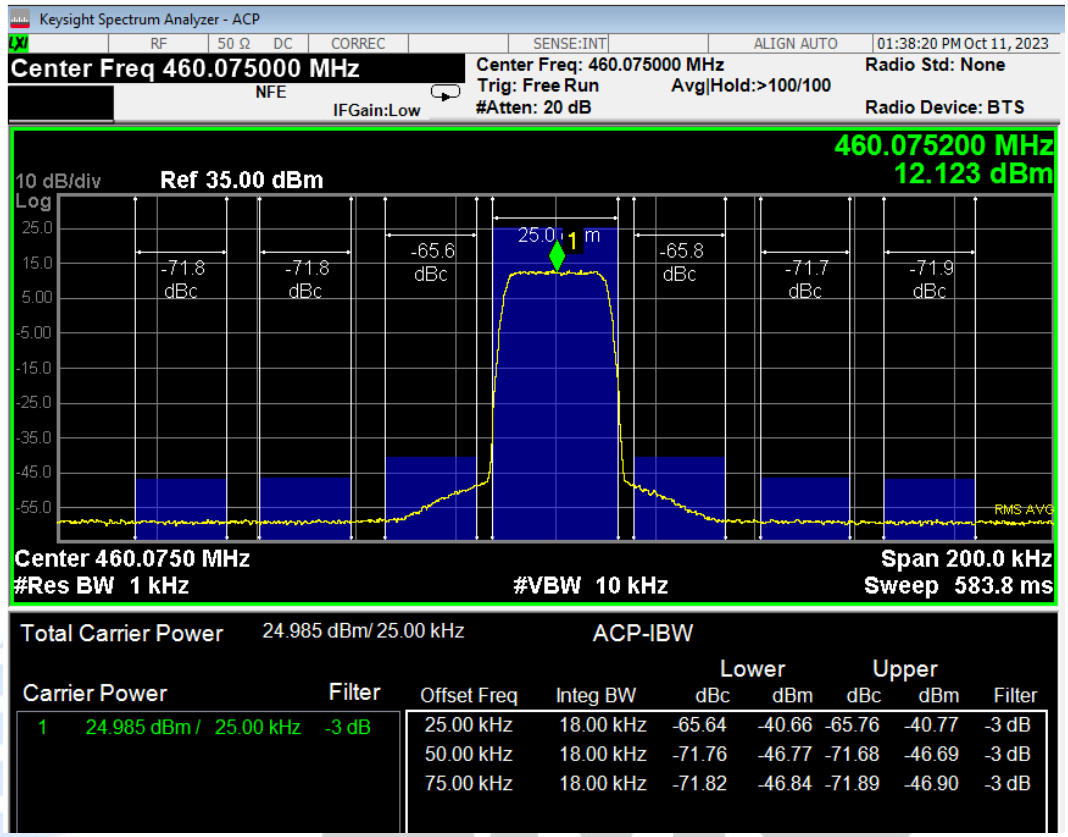



Total Carrier Power 24.894 dBm/ 25.00 kHz ACP-IBW

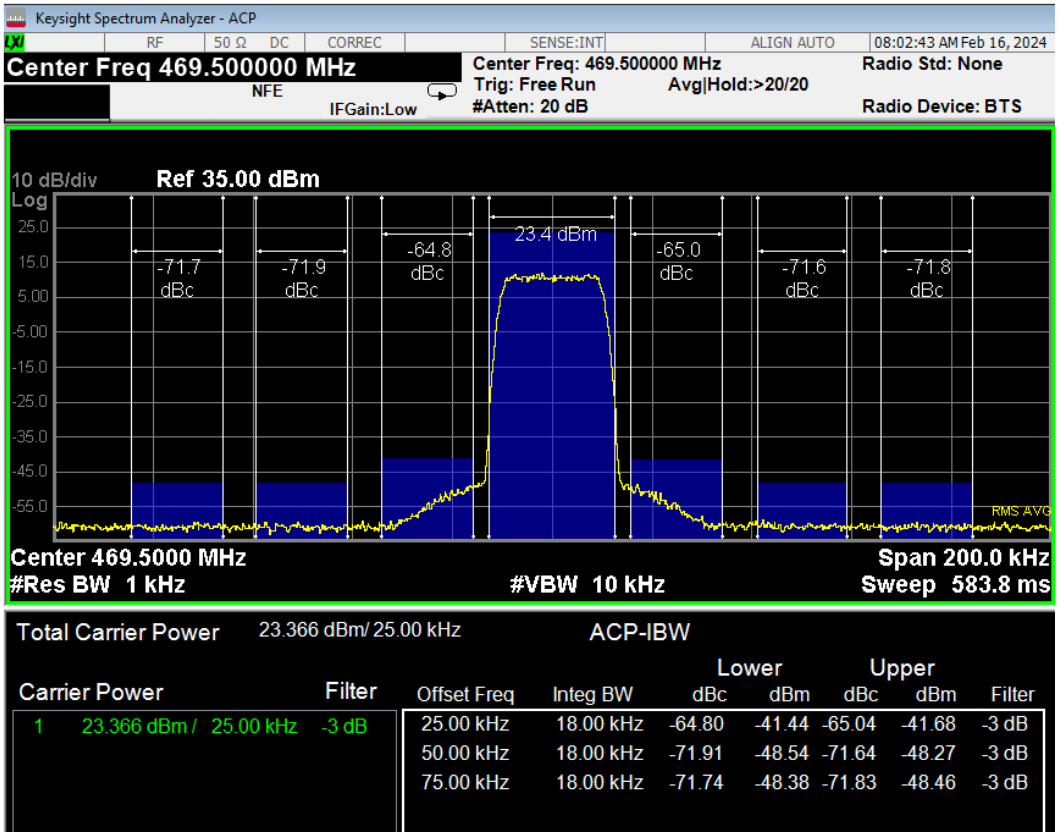
| Carrier Power | | | Filter | Offset Freq | Integ BW | Lower dBc | Lower dBm | Upper dBc | Upper dBm | Filter |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 24.894 dBm / | 25.00 kHz | -3 dB | 25.00 kHz | 18.00 kHz | -65.61 | -40.71 | -65.88 | -40.99 | -3 dB |
| | | | | 50.00 kHz | 18.00 kHz | -71.54 | -46.65 | -71.65 | -46.76 | -3 dB |
| | | | | 75.00 kHz | 18.00 kHz | -71.82 | -46.92 | -71.82 | -46.93 | -3 dB |

## 25.0 kHz Channel bandwidth- Adjacent channel power results

Port-V/256QAM/25.0 kHz/ACP




Port-V/256QAM/25.0 kHz/ACP



**§2.1051 Transmitter spurious emissions at the antenna terminals**

The test was conducted at standard and extreme test conditions and the worst case has been tabulated as below:

**Rated output power level:** +24 dBm

**Frequency:** 450.000 MHz/256QAM

| Spurious emission (MHz) | Emission level (dBm) | | Limit (dBm) |
|---|---|---|---|
| | V | H | |
| 900.000 | <-45.0 | <-45.0 | -20.0 |
| 1350.000 | <-45.0 | <-45.0 | -20.0 |
| 1800.000 | <-45.0 | <-45.0 | -20.0 |
| 2250.000 | <-45.0 | <-45.0 | -20.0 |

**Frequency:** 460.075 MHz/QPSK

| Spurious emission (MHz) | Emission level (dBm) | | Limit (dBm) |
|---|---|---|---|
| | V | H | |
| 920.150 | <-45.0 | <-45.0 | -20.0 |
| 1380.225 | <-45.0 | <-45.0 | -20.0 |
| 1840.300 | <-45.0 | <-45.0 | -20.0 |
| 2300.375 | <-45.0 | <-45.0 | -20.0 |

**Frequency:** 460.075 MHz /16QAM

| Spurious emission (MHz) | Emission level (dBm) | | Limit (dBm) |
|---|---|---|---|
| | V | H | |
| 920.150 | <-45.0 | <-45.0 | -20.0 |
| 1380.225 | <-45.0 | <-45.0 | -20.0 |
| 1840.300 | <-45.0 | <-45.0 | -20.0 |
| 2300.375 | <-45.0 | <-45.0 | -20.0 |

**Frequency:** 460.075 MHz /64QAM

| Spurious emission (MHz) | Emission level (dBm) | | Limit (dBm) |
|---|---|---|---|
| | V | H | |
| 920.150 | <-45.0 | <-45.0 | -20.0 |
| 1380.225 | <-45.0 | <-45.0 | -20.0 |
| 1840.300 | <-45.0 | <-45.0 | -20.0 |
| 2300.375 | <-45.0 | <-45.0 | -20.0 |

**Frequency:** 460.075 MHz /256QAM

| Spurious emission (MHz) | Emission level (dBm) | | Limit (dBm) |
|---|---|---|---|
| | V | H | |
| 920.150 | <-45.0 | <-45.0 | -20.0 |
| 1380.225 | <-45.0 | <-45.0 | -20.0 |
| 1840.300 | <-45.0 | <-45.0 | -20.0 |
| 2300.375 | <-45.0 | <-45.0 | -20.0 |

**Frequency:** 469.500 MHz/256 QAM

| Spurious emission (MHz) | Emission level (dBm) | | Limit (dBm) |
|---|---|---|---|
| | V | H | |
| 939.000 | <-45.0 | <-45.0 | -20.0 |
| 1408.500 | <-45.0 | <-45.0 | -20.0 |
| 1878.000 | <-45.0 | <-45.0 | -20.0 |
| 2347.500 | <-45.0 | <-45.0 | -20.0 |

When operating in transmit mode no other emissions were detected between the harmonic emissions.

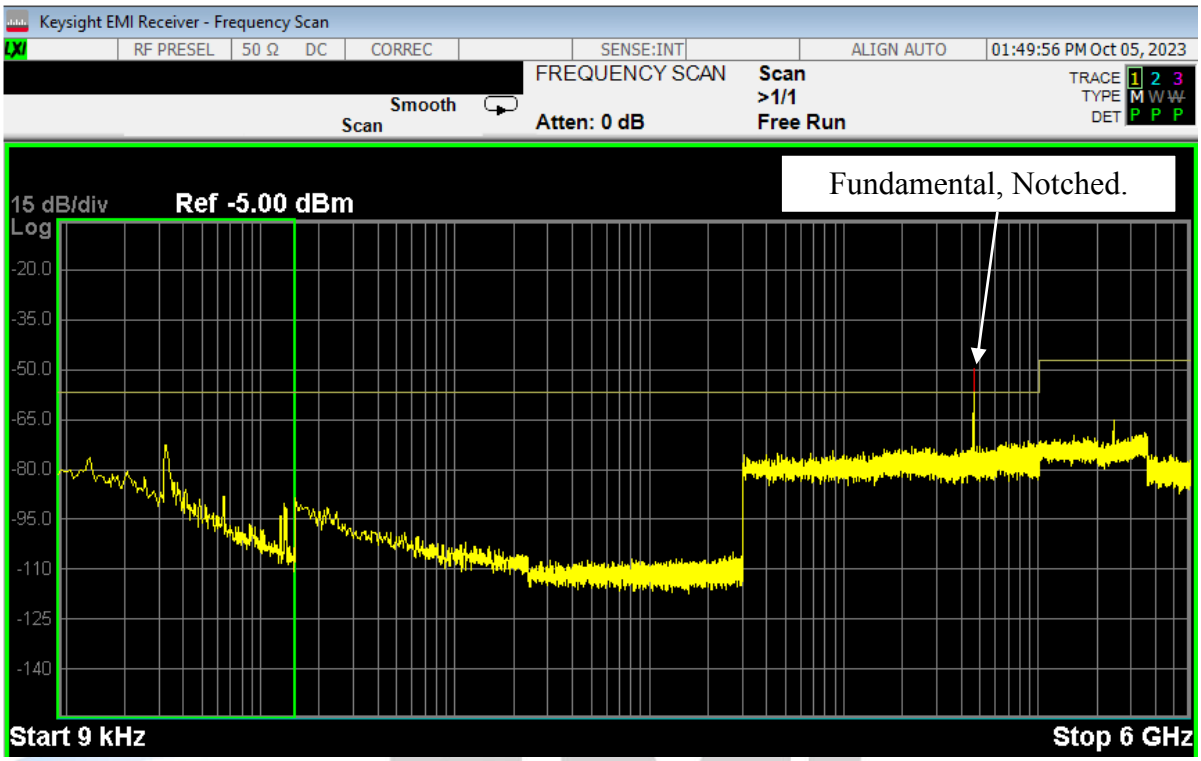
**Limit:**

The limit of 50+10 log (P) attenuation from unmodulated power has been applied, which calculates to (+24 dBm -44 dB) = -20.0 dBm

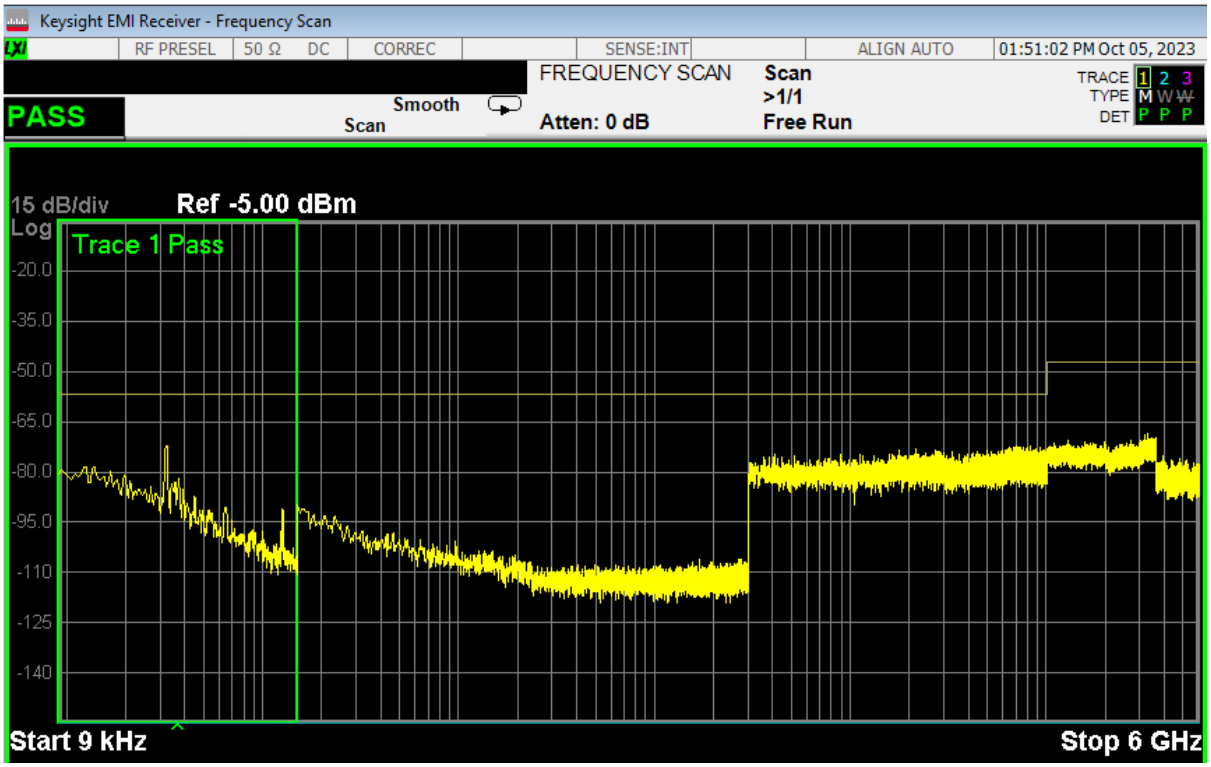
No measurements were made above the 10$^{th}$ harmonic.

**Result:** Complies.
**Measurement Uncertainty**: ± 1.5 dB

**H port Transmit emission plot with carrier frequency notched.**




**H port receive/standby emission plot**



## §2.1053 Field strength of the transmitter spurious emissions

Field strength transmitter spurious emission testing was carried out over the range of 30 – 6000 MHz which covered the 10th harmonic of the transmitter fundamental emission.

Before testing was carried out a receiver self-calibration was undertaken along with a check of all cables and programmed antenna factors was carried out.

The device tested when placed in the centre of the test table flat 0.8 m above the test site ground plane.

All interconnecting cables were bundled in 40 cm long bundles.

The device was powered at 24 Vdc using lead acid batteries.

Attached to the device was a test laptop using a 2 meter long Ethernet cable that facilitated product control using software.

When operating in transmit mode no significant emissions were detected between the harmonic emissions that were detected.

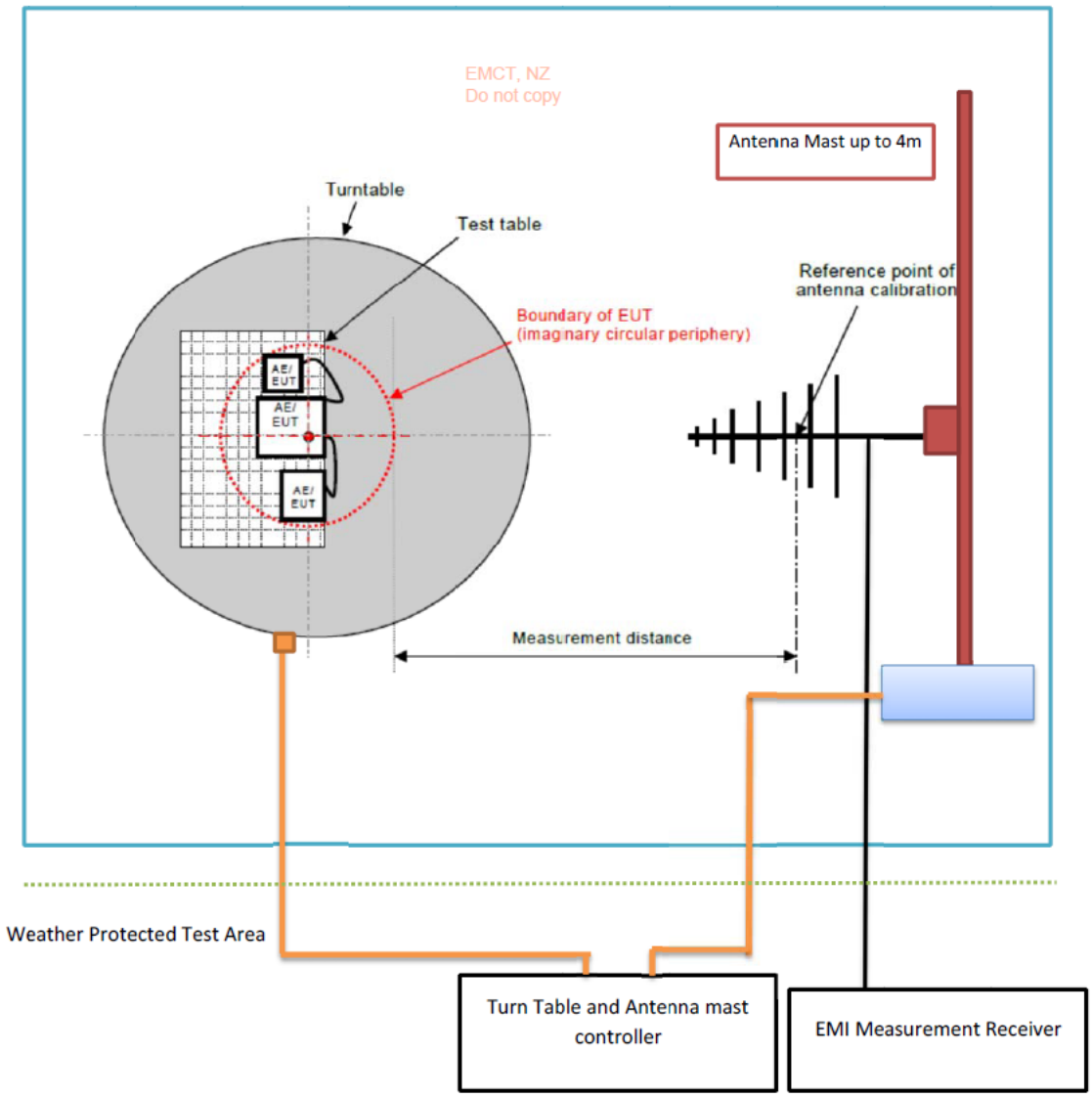
The transmitter was tested while transmitting continuously on high power (0.25 watts) while attached to a dummy load.

The device was tested on an open area test site at a distance of 3 metres.

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site which is located at Driving Creek, Orere Point, Auckland.

The level recorded is the signal generator output level in dBm less any gains / losses due to the coax cable and the dipole antenna.

**Radiated Emissions Test setup at Open area test site**






30 MHz-300 MHz: Bi conical Antenna; Measurement distance: 3 m

300 MHz- 1000 MHz: Log Periodic Antenna; Measurement distance: 3 m

Above 1 GHz: Horn Antenna; Measurement distance: 3 m

EMI Receiver Used: ESIB40

**Nominal Frequency:** 460.075 MHz

| Frequency (MHz) | Level (dBuV/m) | Level (dBm) | Limit (dBm) | Polarity | Margin (dB) | Result |
|---|---|---|---|---|---|---|
| 920.150 | 36.0 | -61.4 | -20.0 | Vertical | 41.4 | Pass |
| 920.150 | 37.3 | -60.1 | -20.0 | Horizontal | 40.1 | Pass |
| 1380.225 | 53.6 | -43.8 | -20.0 | Vertical | 23.8 | Pass |
| 1380.225 | 48.0 | -49.4 | -20.0 | Horizontal | 29.4* | Pass |
| 1840.300 | 48.0 | -49.4 | -20.0 | Vertical | 29.4* | Pass |
| 1840.300 | 48.0 | -49.4 | -20.0 | Horizontal | 29.4* | Pass |
| 2300.375 | 48.0 | -49.4 | -20.0 | Vertical | 29.4* | Pass |
| 2300.375 | 52.0 | -45.4 | -20.0 | Horizontal | 25.4* | Pass |
| 2760.450 | 52.0 | -45.4 | -20.0 | Vertical | 25.4* | Pass |
| 2760.450 | 52.0 | -45.4 | -20.0 | Horizontal | 25.4* | Pass |
| 3220.525 | 52.0 | -45.4 | -20.0 | Vertical | 25.4* | Pass |
| 3220.525 | 53.0 | -44.4 | -20.0 | Horizontal | 24.4* | Pass |
| 3680.600 | 53.0 | -44.4 | -20.0 | Vertical | 24.4* | Pass |
| 3680.600 | 54.0 | -43.4 | -20.0 | Horizontal | 23.4* | Pass |
| 4140.675 | 54.0 | -43.4 | -20.0 | Vertical | 23.4* | Pass |
| 4140.675 | 54.0 | -43.4 | -20.0 | Horizontal | 23.4* | Pass |
| 4600.750 | 54.0 | -43.4 | -20.0 | Vertical | 23.4* | Pass |
| 4600.750 | 54.0 | -43.4 | -20.0 | Horizontal | 23.4* | Pass |
| 5060.825 | 54.0 | -43.4 | -20.0 | Vertical | 23.4* | Pass |
| 5060.825 | 54.0 | -43.4 | -20.0 | Horizontal | 23.4* | Pass |
| 5520.900 | 54.0 | -43.4 | -20.0 | Vertical | 23.4* | Pass |
| 5520.900 | 54.0 | -43.4 | -20.0 | Horizontal | 23.4* | Pass |

* Noise floor measurement.

**Limit:**

A limit of -20 dBm has been applied to the measurements.

No measurements were made above the 10th harmonic.

**Result:** Complies.
**Measurement Uncertainty**: ± 4.1 dB

**§90.213 Frequency Stability**

Frequency stability measurements were between - 30 °C and + 50°C in 10°C increments.

At each temperature the transmitter was given a period of 30 minutes to stabilise.

The transmitter was then turned on and the frequency error measured after a period of 1 minute.

**Ambient Temperature measurement:**

| Frequency (MHz) | Low (Vdc) Error (Hz) | Nominal (Vdc) Error (Hz) | High (Vdc) Error (Hz) |
|---|---|---|---|
| 450.000 MHz | -30 | -30 | -30 |
| 469.500 MHz | -30 | -30 | -30 |

**Test Frequency:** 460.075 MHz

| Temperature (°C) | Low (Vdc) Error (Hz) | Nominal (Vdc) Error (Hz) | High (Vdc) Error (Hz) |
|---|---|---|---|
| **+50** | +130 | +130 | +130 |
| **+40** | +150 | +150 | +150 |
| **+30** | +160 | +160 | +160 |
| **+20** | +120 | +120 | +120 |
| **+10** | +70 | +70 | +70 |
| **0** | +20 | +20 | +20 |
| **-10** | -10 | -10 | -10 |
| **-20** | -30 | -30 | -30 |
| **-30** | -10 | -10 | -10 |

**Limits:**

Part 90.213 states that fixed station transmitters operating between 421.000-512.000 MHz are required to have a frequency tolerance of 1.5 ppm, note 7, 11 and 14 have been applied.

Note 7: In the 421-512 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 1.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 0.5 ppm.

Note 11: Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150-174 MHz band and 2.5 ppm in the 421-512 MHz band.

Note 14: Control stations may operate with the frequency tolerance specified for associated mobile frequencies.

A worst case error of 0.34 ppm (+160 Hz / 460.075 MHz) was observed.

**Result:** Complies.

**Measurement Uncertainty:** ± 30 Hz

**§90.214 Transient frequency behaviour**

Measurements were carried out using the method described in TIA-603 and EN 300-086.

The modulation analyser produces an amplitude difference signal and a frequency difference signal, which are applied to the input of a storage oscilloscope.

The unmodulated transmitter is then keyed which produces a trigger pulse that is AC coupled to the oscilloscope that produces a display on the screen.

The result of the change in the ratio of power between the test signal from the signal generator and the transmitter output will produce 2 separate sides on the oscilloscope picture. One will show the 1000 Hz test modulation and the other will be the frequency difference of the transmitter versus time.

| Channel Spacing (kHz) | Transient Period $t_1$ | Frequency Period $t_2$ | Deviation (kHz) Period $t_3$ |
|---|---|---|---|
| 6.25 | Nil | Nil | Nil |
| 12.5 | Nil | Nil | Nil |
| 25.0 | Nil | Nil | Nil |

**Limits:** For 421.000 to 512.000 MHz Band, the limits are

| Time Interval | Period (ms) VHF | Period (ms) UHF | 6.25 kHz Deviation (kHz) | 12.5 kHz Deviation (kHz) | 25 kHz Deviation (kHz) |
|---|---|---|---|---|---|
| $t_1$ | 10 | 5 | ± 6.25 | ± 12.5 | ± 25.0 |
| $t_2$ | 25 | 20 | ± 3.125 | ± 6.25 | ± 12.5 |
| $t_3$ | 10 | 5 | ± 6.25 | ± 12.5 | ± 25.0 |

**Result:** Complies.

**Measurement Uncertainty**: Frequency difference ± 1.6 kHz,
Time period ±1 ms.

**12.5 kHz transmitter turn on (460.075 MHz)**

Trace = 1 kHz tone with FM deviation of 12.5 kHz.

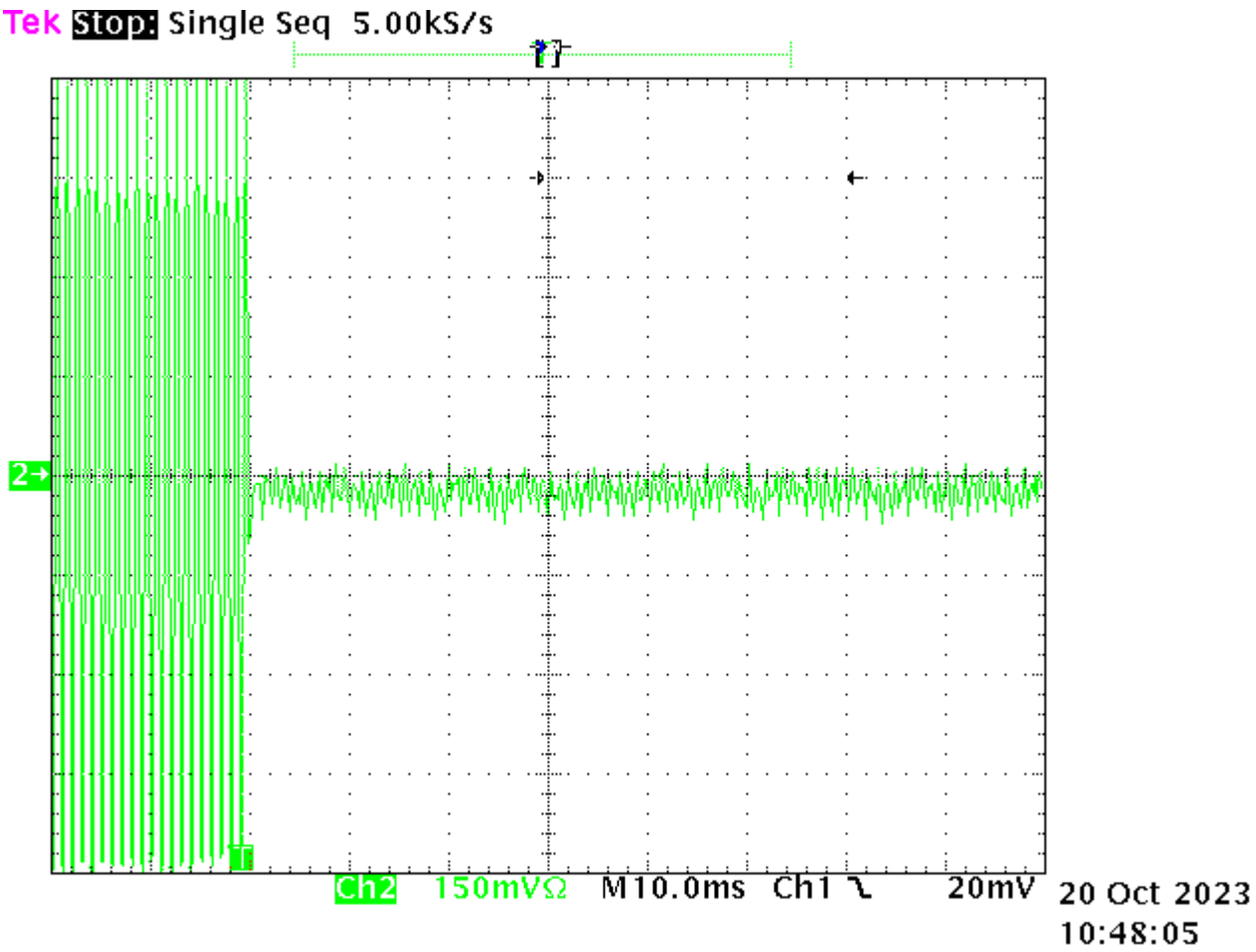
The trace has been maximised to give full screen indication of +/- 12.5 kHz.
The X axis has been set to a sweep rate of 10 ms/division.

Triggering has been set to occur 2 divisions from the left hand edge (20 ms).

*t*on occurs at 20 ms.

*t*1 occurs between 2.0 and 3.0 divisions from the left hand edge.
*t*2 occurs between 3.0 and 5.5 divisions from the left hand edge.

Transient response can be observed during t1 and t2.



**12.5 kHz transmitter turn off (460.075 MHz)**

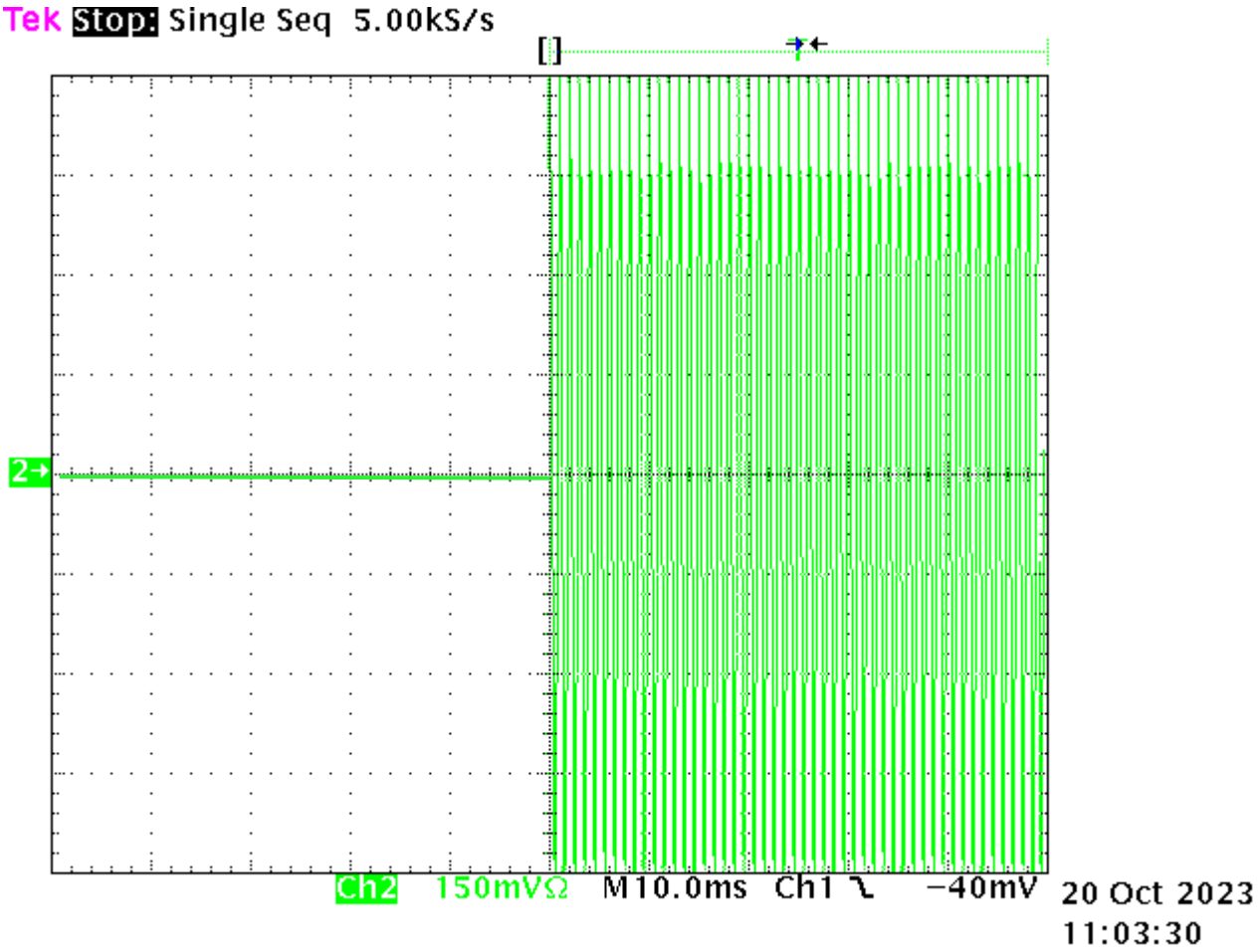
Trace = 1 kHz tone with FM deviation of 12.5 kHz.

The trace has been maximised to give full screen indication of +/- 12.5 kHz.
The X axis has been set to a sweep rate of 10 ms/division

The display of the 1 kHz signal rising has been positioned 5 divisions from the left hand edge (50 ms). This is position *t*off.

*t*3 occurs between 4.0 and 5.0 divisions from the left hand edge.

Transient response can be observed before *t*off.



**25.0 kHz Transmitter turn on (460.075 MHz)**

Green Trace = 1 kHz tone with FM deviation of 25.0 kHz.

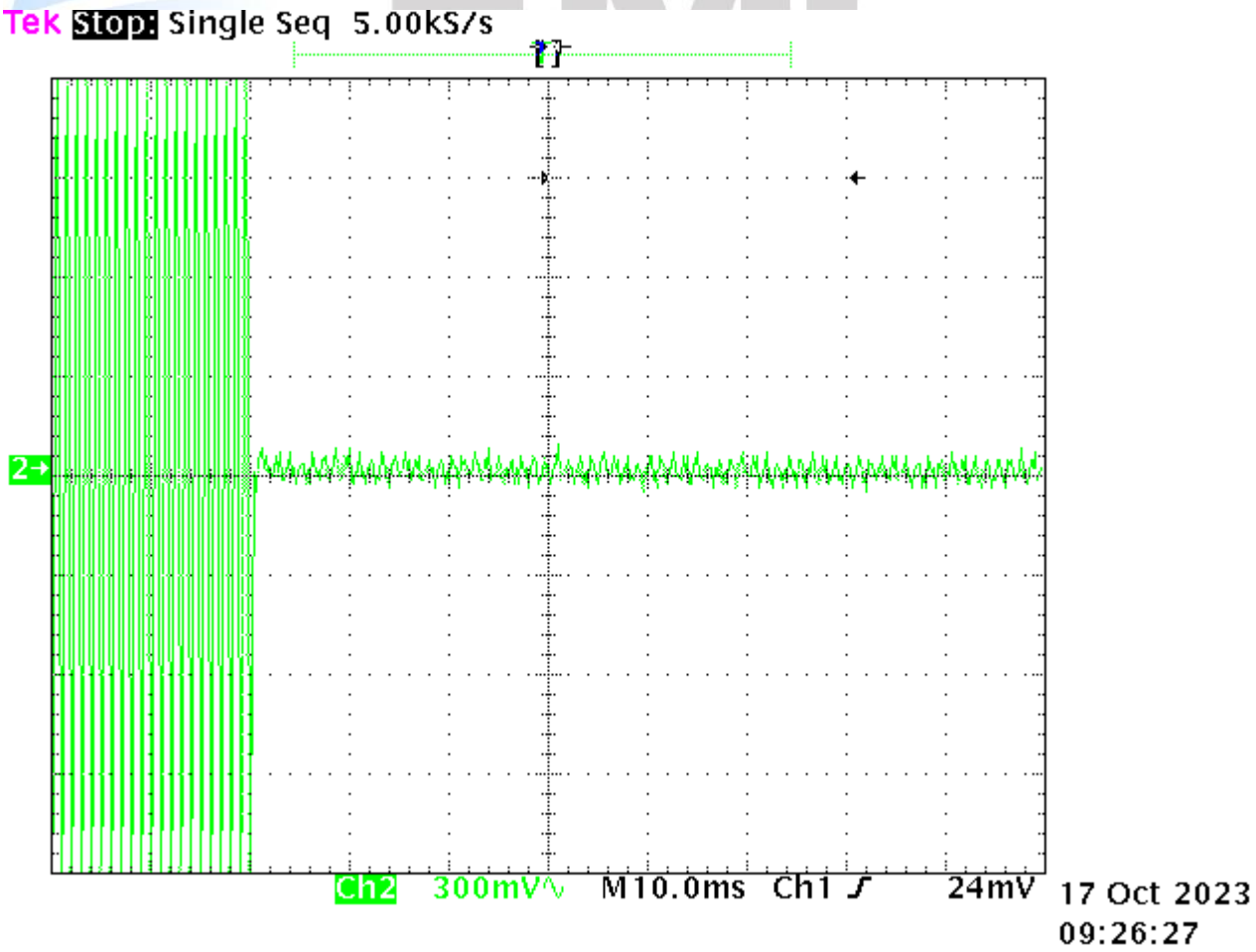
Green trace has been maximised to give full screen indication of +/- 25.0 kHz.
The X axis has been set to a sweep rate of 10 ms/division.

Triggering has been set to occur 2 divisions from the left hand edge (20 ms).

*t*on occurs at 20 ms

*t*1 occurs between 2.0 and 2.5 divisions from the left hand edge.
*t2* occurs between 2.5 and 4.5 divisions from the left hand edge.

Transient response can be observed during *t*1 and *t*2.



**25.0 kHz transmitter turn off (460.075 MHz)**

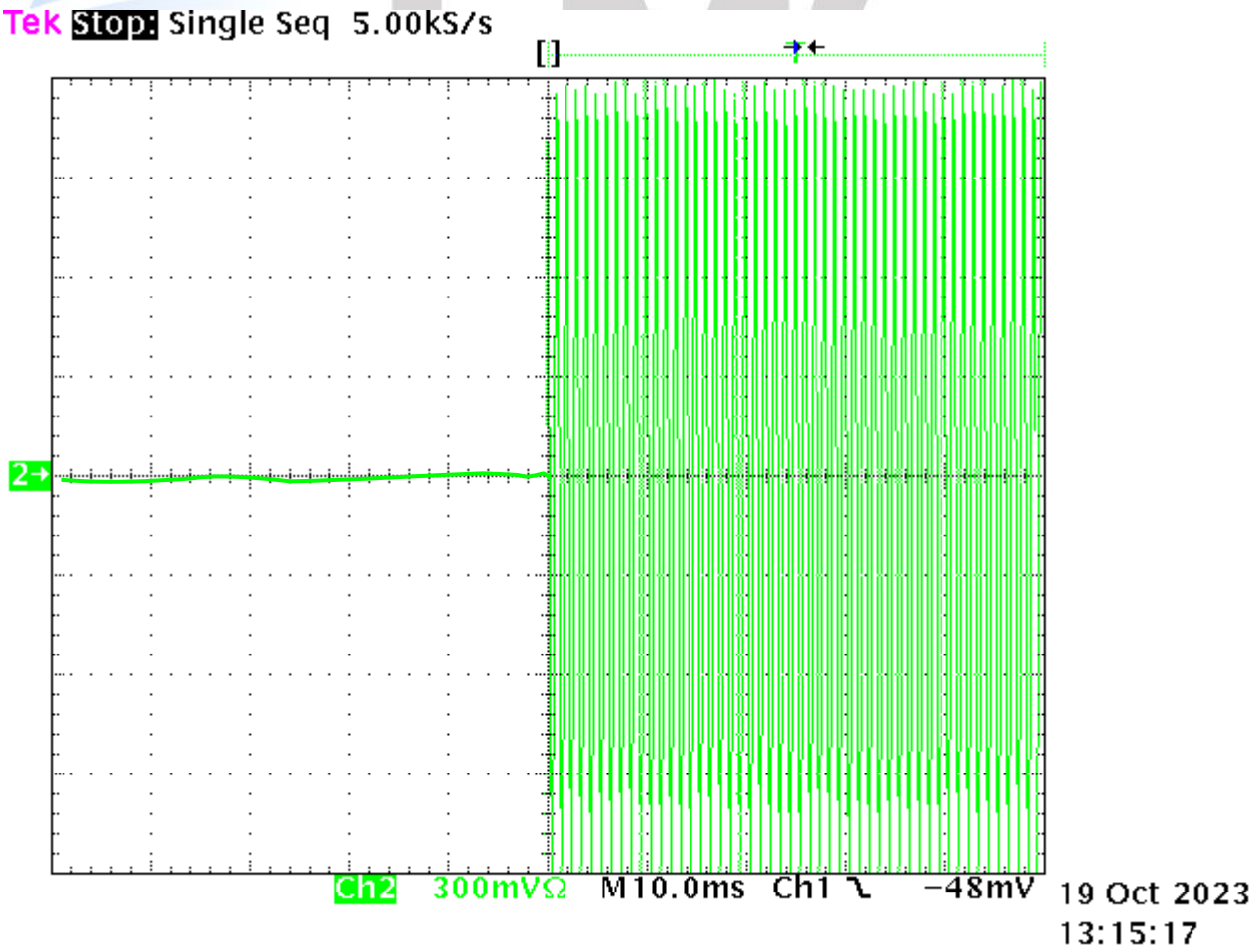
Green Trace = 1 kHz tone with FM deviation of 25.0 kHz.

Green trace has been maximised to give full screen indication of +/- 25.0 kHz.
The X axis has been set to a sweep rate of 10 ms/division

The display of the 1 kHz signal rising has been positioned 5 divisions from the left hand edge (50 ms). This is position *t*off.

*t*3 occurs between 4.5 and 5.0 divisions from the left hand edge.

A transient response can be observed before *t*off.



**Exposure of humans to RF fields**

As per FCC KDB 447498 D01 and Section 2.1091 radio frequency transmitters are required to be operated in a manner that ensures the public is not exposed to RF energy levels.

Calculations have been made using the General Public/Uncontrolled Exposure limits that are defined in Section 1.1310.

For worst case MPE calculations, 460.075 MHz has been selected.

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density ($mW/cm^2$) | Averaging time (minutes) |
|---|---|---|---|---|
| **(A) Limits for Occupational/Controlled Exposure** | | | | |
| 0.3–3.0 | 614 | 1.63 | *100 | 6 |
| 3.0–30 | 1842/f | 4.89/f | *900/$f^2$ | 6 |
| 30–300 | 61.4 | 0.163 | 1.0 | 6 |
| 300–1,500 | | | f/300 | 6 |
| 1,500–100,000 | | | 5 | 6 |
| **(B) Limits for General Population/Uncontrolled Exposure** | | | | |
| 0.3–1.34 | 614 | 1.63 | *100 | 30 |
| 1.34–30 | 824/f | 2.19/f | *180/$f^2$ | 30 |
| 30–300 | 27.5 | 0.073 | 0.2 | 30 |
| 300–1,500 | | | f/1500 | 30 |
| 1,500–100,000 | | | 1.0 | 30 |

f = frequency in MHz * = Plane-wave equivalent power density

**Limits for maximum permissible exposure (MPE)**

- General Population / Uncontrolled exposure is f/1500. At 460.075 MHz, the calculated limit is 0.3 $mW/cm^2$

- Occupational /Controlled exposure is f/300. At 460.075 MHz, the calculated limit is 1.53 $mW/cm^2$

Minimum safe distances have been calculated below.

**For Uncontrolled Environment**

At 460.075 MHz, Power Density = (460.075/1500)=0.30 $mW/cm^2 = E^2/3770$

$E = \sqrt{0.3*3770}$

E = 33.6 V/m

**For Controlled Environment**

At 460.075 MHz, Power Density = (460.075/300)=1.53 mW/cm$^2$ = E$^2$/3770

E= √ 1.53*3770

E = 75.9 V/m

The rated maximum transmitter power = 0.25 W (+24 dBm).

A worst case scenario duty cycle of 100% has been used for the calculations.

The following information about the antenna type and gain has been obtained from the client:

| Antenna Type | Gain (dBi) |
|---|---|
| Omni | 10 dBi |
| Panel | 10 dBi |
| Panel | 15 dBi |

The minimum distance from the antenna at which the MPE is met is calculated from the following

Field strength in V/m (FS),
Transmit power in watts (P)
Transmit antenna gain (G)
Transmitter duty cycle (DC)
Separation distance in metres (D)

The calculation is as follows:

FS = (√ (30 * P * G * DC)) / D

The calculations have been shown with following scenarios:

- MPE calculations for the product with both ports terminated in a 50 Ohm load
- Using 10 dBi gain antenna
- Using 15 dBi gain antenna

a) For Uncontrolled environments, the minimum distance is:

D = (√ (30 * P * G * DC)) / FS

P = 0.25 W

FS = 33.6 V/m

| Frequency (MHz) | Antenna Gain (dBi) | Antenna Gain Numeric | Duty cycle | Safe distance (metres) |
|---|---|---|---|---|
| 460.075 | No gain (0) | 1.0 | 100% | 0.08 |
| 460.075 | 10.0 | 10.0 | 100% | 0.26 |
| 460.075 | 15.0 | 31.6 | 100% | 0.46 |

a) For Controlled environments, the minimum distance is:

D = (√ (30 * P * G * DC)) / FS

P = 0.25 W

FS = 75.9 V/m

| Frequency (MHz) | Antenna Gain (dBi) | Antenna Gain Numeric | Duty cycle | Safe distance (metres) |
|---|---|---|---|---|
| 460.075 | No gain (0) | 1.0 | 100% | 0.04 |
| 460.075 | 10.0 | 10.0 | 100% | 0.11 |
| 460.075 | 15.0 | 31.6 | 100% | 0.20 |



**Result:** Complies if a safe distance shown in the calculations above is followed.

# 7. TEST EQUIPMENT USED

| Instrument | Manufacturer | Model | Serial/ID # | Cal Due | Interval |
|---|---|---|---|---|---|
| Aerial Controller | EMCO | 1090 | 9112-1062 | N/a | N/a |
| Aerial Mast | EMCO | 1070-1 | 9203-1661 | N/a | N/a |
| Biconical Antenna | Schwarzbeck | BBA 9106 | 9594 | 23/11/23 | 2.0 years |
| Log Periodic Antenna | Schwarzbeck | VUSLP 91111 | 9111-112 | 16/11/23 | 2.0 years |
| Horn Antenna | EMCO | 3115 | 9511-4629 | 03/03/25 | 3.0 years |
| Modulation Analyzer | Rohde & Schwarz | FMA | 837807/020 | 13/04/25 | 3.0 year |
| Power Attenuator | Tenuline | 8322 | - | N/a | N/a |
| Power Attenuator | DTS | - | - | N/a | N/a |
| Modulation Analyser | Hewlett Packard | 8901B | SN2608A00782 | 30/04/25 | 2.0 years |
| Level Generator | Anritsu | MG443B | M61689 | 7/08/2025 | 2.0 years |
| Power meter | Hewlett Packard | 436A | 2512A22439 | 19/04/25 | 2.0 years |
| Power Sensor | Hewlett Packard | 8482A | 2237A07036 | 19/04/25 | 2.0 years |
| Oscilloscope | Tektronics | 745A | B010643 | 4/10/24 | 2.0 Years |
| Signal Generator | Agilent | E4433B | ESG-D | 28/02/24 | 2.0 Years |
| Signal Generator | Rohde & Schwarz | SMHU | E1493 | 27/05/24 | 2.0 Years |
| Heliax Cable | L6PNM-RPD | OATS | 22869 | 23/12/23 | 1.0 Years |
| Receiver | Rohde & Schwarz | ESIB-40 | 100295 | 06/10/24 | 2.0 years |
| Spectrum Analyzer | Keysight | N9038A | MY57290153 | 21/11/24 | 1.0 year |
| Thermal chamber | Contherm | M180F | 86025 | N/a | N/a |
| Thermometer | DSIR | RT200 | 35 | 11/04/27 | 5.0 years |
| Turntable | EMCO | 1080-1-2.1 | 9109-1578 | N/a | N/a |
| VHF Balun | Schwarzbeck | VHA9103 | - | N/a | N/a |

At the time of testing all test equipment was within calibration.

# 8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies NZ Ltd designation as a FCC Accredited Laboratory by International Accreditation New Zealand, designation number: NZ0002 under the APEC TEL MRA.

All testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025.

All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025.

International Accreditation New Zealand has International Laboratory Accreditation Council (ILAC) Mutual Recognition Arrangements for testing and calibration with various accreditation bodies in a number of economies.

This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied on request.

Letter supplied by the client for addition of Variants:

Mimomax Wireless Ltd
540 Wairakei Road
PO Box 1645
Christchurch, New Zealand

13 November 2023

To whom it may concern

Equivalence for FCC-ID: XMK-MMXTRNB007

Mimomax 440-470 MHz Tornado radios have been certification tested with during October/November 2023, Testing was carried out on an Encryption capable radio fitted with internal duplexers and 50kHz receiver filters. Equivalent radios with and without encryption capability, with internal vs external duplexers and with different bandwidth receiver filters are available in the Tornado Radios.

Encryption capability or lack of encryption capability makes no impact on the signal transmitted from the Radio. Internal duplexers radios have less rejection of unwanted signals and are consequently the worst case for the signals out of the radio. A radio with a 50 kHz receiver filter was tested as it can support all the bandwidths required for testing and the receiver filter bandwidth has no impact on the signals out of the radio.

Certification testing was complete on a MWL-TORNADO-BCCA model radio.

The below models are equivalent to the MWL-TORNADO-BCCA:

MWL-TORNADO-ACAA, MWL-TORNADO-ACBA, MWL-TORNADO-ACCA, MWL-TORNADO-BCAA,

MWL-TORNADO-BCBA, MWL-TORNADO-ACAB, MWL-TORNADO-ACBB, MWL-TORNADO-ACCB,

MWL-TORNADO-BCAB, MWL-TORNADO-BCBB, MWL-TORNADO-BCCB

Model numbering follows the format

MWL-TORNADO-1234

Where 1 = A for non-encryption capable radios, and B for encryption capable radios.

Where 2 = C for 440-470 MHz Frequency band radios.

Where 3 = A for 12.5kHz bandwidth Receiver filters, B for 25kHz bandwidth receiver filters and C for 50kHz bandwidth receiver filters.

Where 4 = A for internal duplexer radios and B for external duplexer radios.

Regards

James Dowle, Development Manager