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# RADIO TEST REPORT – 397888-1TRFWL

Type of assessment:

Final product testing

Applicant:

Intracom S.A. Telecom Solutions

Product:

Point-to-Multipoint Gigabit Radio 28 GHz

Model:

OSDR-28-H-1008-02

Model variant:

OSDR-28

FCC ID:

2AHZC-OSDR28H100802

Brand:

WiBAS

Specifications:

- FCC 47 CFR Part 101, Subpart C

Date of issue: July 27, 2020

Andrey Adelberg, Senior EMC/RF Specialist
Tested by

Signature

David Duchesne, EMC/RF Lab Manager
Reviewed by

Signature

| | | | | |
|---|---|---|---|---|
| Company name | Nemko Canada Inc. | | | |
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| Test site identifier | **Organization** | **Ottawa/Almonte** | **Montreal** | **Cambridge** |
| | FCC: | CA2040 | CA2041 | CA0101 |
| | ISED: | 2040ª-4 | 2040G-5 | 24676 |
| Website | www.nemko.com | | | |

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

# Table of contents

# Section 1. Report summary

## 1.1 Test specifications

| | |
|---|---|
| FCC 47 CFR Part 101, Subpart C | Fixed Microwave Services |

## 1.2 Test methods

| | |
|---|---|
| ANSI C63.26-2015 | American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services |
| FCC 47 CFR Part 2, Subpart J | Equipment authorization procedures |
| KDB 971168 D01 | Power Meas License Digital Systems v03r01 |

## 1.3 Exclusions

None

## 1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.3 above. Results obtained indicate that the product under test complies In full with the requirements tested. The test results relate only to the items tested.

*See "Summary of test results" for full details.*

## 1.5 Test report revision history

***Table 1.5-1:*** *Test report revision history*

| Revision # | Date of issue | Details of changes made to test report |
|---|---|---|
| TRF | July 27, 2020 | Original report issued |

# **Section 2.** Engineering considerations

## 2.1 Modifications incorporated in the EUT for compliance

There were no modifications performed to the EUT during this assessment.

## 2.2 Technical judgment

EUT can operate with modulations up to 1024-QAM. However everything was tested with 4-QAM operation, which was verified as a worst case in respect to the performance, power and emissions

## 2.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

# **Section 3.** Test conditions

## 3.1 Atmospheric conditions

| | |
|---|---|
| Temperature | 15 °C – 35 °C |
| Relative humidity | 20 % – 75 % |
| Air pressure | 86 kPa (860 mbar) – 106 kPa (1060 mbar) |

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

## 3.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

# **Section 4.** Measurement uncertainty

## 4.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

***Table 4.1-1:*** *Measurement uncertainty calculations*

| Test name | Measurement uncertainty, ±dB |
|---|---|
| All antenna port measurements | 0.55 |
| Occupied bandwidth | 4.45 |
| Conducted spurious emissions | 1.13 |
| Radiated spurious emissions | 3.78 |
| AC power line conducted emissions | 3.55 |

# **Section 5.** Information provided by the applicant

## 5.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results contained within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

## 5.2 Applicant/Manufacture

| | |
|---|---|
| Applicant name | Intracom S.A. Telecom Solutions |
| Applicant address | 19.7 km Markopoulou Ave., Peania, Athens GR-19002 Greece |
| Manufacture name and address | Same as applicant |

## 5.3 EUT information

| | |
|---|---|
| Product | Point-to-Multipoint Gigabit Radio 28 GHz (BS or HUB) |
| Model | OSDR-28-H-1008-02 |
| Model variant | OSDR-28 |
| Brand | WiBAS |
| Serial number | 321907296635 |
| Part number | KZ00-659/85.33 |
| Power supply requirements | AC: 90–240 $V_{AC}$ 50/60 Hz (via PoE) or DC: −48 $V_{DC}$ (via PONE) |
| Product description and theory of operation | WiBAS™-OSDR is an all-outdoor hub radio operating at area-licensed band (28 GHz) offering the highest capacity and the most dense PtMP deployment available in the market. This radio delivers state-of-the-art IP connectivity for Fixed Wireless Access (FWA) networks and perfectly suits the operator needs for zero-footprint installations at homes and business subscriber locations. It is based on a software defined radio platform, which provides future-proof deployments and feature enhancements through software licensing. WiBAS™-OSDR combines sophisticated QoS features and robust performance with a highly-efficient operation. The electronics – baseband unit / modem / controller and radio circuitry – are all securely accommodated in a lightweight, environmentally hardened housing that is directly coupled to the antenna. Service area can extend more than 10 km from the hub location (clear sky conditions). |

## 5.4 Radio technical information

| | |
|---|---|
| Operating band | 29.10–29.25 GHz |
| Frequency Min (MHz) | 29,130.50 |
| Frequency Max (MHz) | 29,221.50 |
| RF power Max (W), Conducted | 0.148 (21.7 dBm) |
| Field strength, dBµV/m @ 3 m | N/A |
| Measured BW (kHz), 99% OBW | 53526 |
| Type of modulation | Up to 1024-QAM |
| Emission classification | W7D |
| Transmitter spurious, dBµV/m @ 3 m | 70.23 at 98.8 GHz |
| Antenna information | Sectoral 90° MN: SEC90-28G-HG-VPOL by faini telecommunication systems with 19 dBi maximum gain<br>Sectoral 90° MN: SEC90-28G-HG-HPOL by faini telecommunication systems with 19 dBi maximum gain<br>Sectoral 90° MN: SEC90-28G-SG-VPOL by faini telecommunication systems with 15 dBi maximum gain<br>Sectoral 90° MN: SEC90-28G-SG-HPOL by faini telecommunication systems with 15 dBi maximum gain |

## 5.5 EUT setup details

### 5.5.1 Radio exercise details

| | |
|---|---|
| Operating conditions | EUT was controlled from external PC using WebGUI. Channel BW of 56 MHz, Power setting of 18 dBm<br>System SW Release: 7.1.0_2302_B.3.2.0.build_07<br>Use a PC to manage the equipment, for specific tests, the low-level telnet is required.<br>The PC must have an IP (for example)<br>10.10.10.200<br>255.255.255.0<br>Use of a telnet: PuTTY or other software for telnet using the equipment IP<br>Username: admin<br>Password: admin<br>The units have the following IP addresses:<br>High Unit: BS (Hub): 10.10.10.100<br>Commands (tx freq value, tx power value, mute on/off):<br>modify wphy rfuconf rfuid 1 txfreq 29228000 txpower 18 mute off<br>for freq_stability test:<br>!!shell sudo mdmtest setup test cw |

### 5.5.2 EUT setup configuration

***Table 5.5-1:*** *EUT interface ports*

| Description | Qty. |
|---|---|
| GbE (RJ-45) Traffic / inband NMS / PoE input | 1 |
| GbE (SFP) Traffic / inband NMS | 1 |
| GbE (RJ-45) OSDR protection | 1 |
| FE (RJ-45) Outband NMS / PoE input | 1 |
| GbE (RJ-45) Reserved | 1 |

***Table 5.5-2:*** *Support equipment*

| Description | Brand name | Model, Part number, Serial number, Revision level |
|---|---|---|
| POE | Intracom | SN: PT1936210309, MN: PT-PSE106GWN-AR, Ver. 5.0, OC: POE-ID-AC72 |
| PONE injector, outdoor | Intracom | SN: 321904188530; MN: PONE-OD-DC; PN: KZ00-65A/60.39 |
| Laptop | Dell | Nemko Asset: FA002852 |

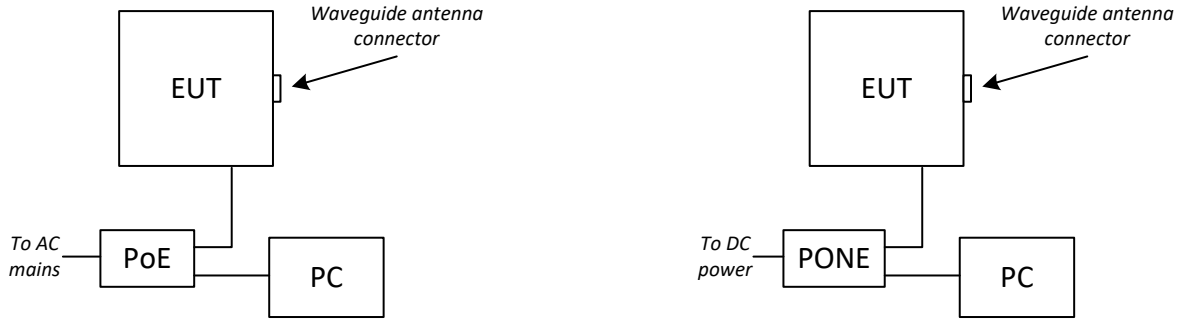



***Figure 5.5-1:*** *Setup block diagram*

# **Section 6.** Summary of test results

## 6.1 Testing location

| | |
|---|---|
| Test location (s) | Ottawa |

## 6.2 Testing period

| | | | |
|---|---|---|---|
| Test start date | May 25, 2020 | Test end date | May 29, 2020 |

## 6.3 Sample information

| | | | |
|---|---|---|---|
| Receipt date | May 21, 2020 | Nemko sample ID number(s) | 1 |

## 6.4 FCC Part 101 requirements test results

***Table 6.4-1:*** *FCC requirements results*

| FCC P1001 Paragraph | FCC P2 Paragraph | Test description | Verdict |
|---|---|---|---|
| §101.107(a) | §2.1055 | Frequency stability | Pass |
| §101.109(c) | §2.1049 | Occupied Bandwidth | Pass |
| §101.111(a)(2) | §2.1053 | Band edge / spectrum mask additional emissions limitations | Pass |
| §101.111(a)(2) | §2.1053 | Spurious Emissions | Pass |
| §101.113(a) | §2.1051 | RF Power Output | Pass |
| §101.113(a) | §2.1051 | Spectral Density | Pass |

# **Section 7.** Test equipment

## 7.1 Test equipment list

***Table 7.1-1:*** *Equipment list*

| Equipment | Manufacturer | Model no. | Asset no. | Cal cycle | Next cal. |
|---|---|---|---|---|---|
| 3 m EMI test chamber | TDK | SAC-3 | FA002047 | 1 year | January 24, 2021 |
| Flush mount turntable | Sunol | FM2022 | FA002082 | — | NCR |
| Controller | Sunol | SC104V | FA002060 | — | NCR |
| Antenna mast | Sunol | TLT2 | FA002061 | — | NCR |
| 61505 AC source | Chroma | 61509 | FA003036 | — | VOU |
| DC Power source | Ametek | SGA80X125C-0AAA | FA002737 | — | VOU |
| Receiver/spectrum analyzer | Rohde & Schwarz | ESU 26 | FA002043 | 1 year | November 8, 2020 |
| Spectrum analyzer | Rohde & Schwarz | FSU | FA001877 | 1 year | October 31, 2020 |
| Horn (1–18 GHz) | ETS Lindgren | 3117 | FA002840 | 1 year | January 25, 2021 |
| Preamp (1–18 GHz) | ETS Lindgren | 124334 | FA002873 | 1 year | November 4, 2020 |
| Bilog antenna (20–3000 MHz) | Sunol | JB3 | FA002108 | 1 year | January 14, 2021 |
| Horn antenna (18–40 GHz) | EMCO | 3116 | FA001847 | 1 year | November 7, 2020 |
| Pre-amplifier (18–26 GHz) | Narda | BBS-1826N612 | FA001550 | — | VOU |
| Pre-amplifier (26–40 GHz) | Narda | DBL-2640N610 | FA001556 | — | VOU |
| 40–60 GHz Harmonic mixer | OML | WR19 M19HWD | FA002322 | 3 year | July 29, 2022 |
| 40–60 GHz Standard gain horn | Millitech | U SGH-19 | FA002322a | — | VOU |
| 60–90 GHz Harmonic mixer | OML | WR12 M12HWD | FA001524 | 3 year | July 29, 2022 |
| 60–90 GHz Standard gain horn | Millitech | U SGH-12 | FA001524a | — | VOU |
| 90–140 GHz Harmonic mixer | OML | WR08 M08HWD | FA001525 | 3 year | July 29, 2022 |
| 90–140 GHz Standard gain horn | Millitech | U SGH-08 | FA001525a | — | VOU |
| Temperature chamber | Thermotron | SM-16C | FA001030 | 1 year | January 7, 2021 |

Note: NCR - no calibration required, VOU - verify on use

# Section 8. Testing data

## 8.1 Number of frequencies

### 8.1.1 References, definitions and limits

**ANSI C63.26, Clause 5.1.2:**

Measurements of transmitters shall be performed and, if required, reported for each frequency band in which the EUT can be operated with the device transmitting at the number of frequencies in each band specified in table below.

***Table 8.1-1:*** *Frequency Range of Operation*

| Frequency range over which the device operates (in each band) | Number of test frequencies required | Location of measurement frequency inside the operating frequency range |
|---|---|---|
| 1 MHz or less | 1 | Center (middle of the band) |
| 1–10 MHz | 2 | 1 near high end, 1 near low end |
| Greater than 10 MHz | 3 | 1 near high end, 1 near center and 1 near low end |

Notes: "near" means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

### 8.1.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | Andrey Adelberg | Test date | May 29, 2020 |

### 8.1.3 Observations, settings and special notes

None

### 8.1.4 Test data

***Table 8.1-2:*** *Test channels selection*

| Start of Frequency range, MHz | End of Frequency range, MHz | Frequency range bandwidth, MHz | Low channel, MHz | Mid channel, MHz | High channel, MHz |
|---|---|---|---|---|---|
| 29100 | 29250 | 150 | 29130.50 | 29179.50 | 29221.50 |

## 8.2 Transmitter power limitations

### 8.2.1 References, definitions and limits

**FCC §101.113:**

(a) On any authorized frequency, the average power delivered to an antenna in this service must be the minimum amount of power necessary to carry out the communications desired. Application of this principle includes, but is not to be limited to, requiring a licensee who replaces one or more of its antennas with larger antennas to reduce its antenna input power by an amount appropriate to compensate for the increased primary lobe gain of the replacement antenna(s). In no event shall the average equivalent isotropically radiated power (EIRP), as referenced to an isotropic radiator, exceed the values specified below. In cases of harmful interference, the Commission may, after notice and opportunity for hearing, order a change in the effective radiated power of this station. Further, the output power of a transmitter on any authorized frequency in this service may not exceed the following.

(c)(1) Transmitter power limitations. Point-to-point stations in the 29.1–29.25 GHz band for the LMDS backbone between LMDS hubs shall be limited to a maximum allowable e.i.r.p. density per carrier of 23 dBW/MHz (53 dBm/MHz) in any one megahertz in clear air, and may exceed this limit by employment of adaptive power control in cases where link propagation attenuation exceeds the clear air value due to precipitation and only to the extent that the link is impaired.

(2) Hub transmitter EIRP spectral area, density limit. LMDS applicants shall demonstrate that, under clear air operating conditions, the maximum aggregate of LMDS transmitting hub stations in a Basic Trading Area in the 29.1–29.25 GHz band will not transmit a co-frequency hub-to-subscriber e.i.r.p. spectral area density in any azimuthal direction in excess of X dBW/(MHz-km$^2$) when averaged over any 4.375 MHz band, where X is defined in Table 1. Individual hub stations may exceed their clear air e.i.r.p.s by employment of adaptive power control in cases where link propagation attenuation exceeds the clear air value and only to the extent that the link is impaired.

***Table 1***

| Climate zone | e.i.r.p. Spectral Density *(Clear Air)* (dBW/MHz-km$^2$) |
|---|---|
| 1 | -23 |
| 2 | -25 |
| 3,4,5 | -26 |

LMDS system licensees in two or more BTAs may individually or collectively deviate from the spectral area density computed above by averaging the power over any 200 km by 400 km area, provided that the aggregate interference to the satellite receiver is no greater than if the spectral area density were as specified in Table 1. A showing to the Commission comparing both methods of computation is required and copies shall be served on any affected non-GSO 20/30 GHz MSS providers.

(3) Hub transmitter e.i.r.p. spectral area density limit at elevation angles above the horizon. LMDS applicants shall demonstrate that, under clear air operating conditions, the maximum aggregate of LMDS transmitting hub stations in a Basic Trading Area in the 29.1–29.25 GHz band will not transmit a co-frequency hub-to-subscriber e.i.r.p. spectral area density in any azimuthal direction in excess of X dBW/(MHz-km$^2$) when averaged over any 4.375 MHz band where X is defined in Table 2. Individual hub stations may exceed their clear air e.i.r.p.s by employment of adaptive power control in cases where link propagation attenuation exceeds the clear air value and only to the extent that the link is impaired.

***Table 2***

| Elevation angle (a) | Relative e.i.r.p. density (dBW/MHz-km$^2$) |
|---|---|
| 0° ≤a ≤4.0° | e.i.r.p.(a) = e.i.r.p.(0°) + 20 log (sinΠ x)(1/Π x) where x = (a + 1)/7.5°. |
| 4.0° <a ≤7.7° | e.i.r.p.(a) = e.i.r.p.(0°) − 3.85a + 7.7. |
| a >7.7° | e.i.r.p.(a) = e.i.r.p.(0°) − 22. |

(ii) LMDS system licensees in two or more BTAs may individually or collectively deviate from the spectral area density computed above by averaging the power over any 200 km by 400 km area, provided that the aggregate interference to the satellite receiver is no greater than if the spectral area density were as specified in Table 1. A showing to the Commission comparing both methods of computation is required and copies shall be served on any affected non-GSO MSS providers.

### 8.2.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | Andrey Adelberg | Test date | May 26, 2020 |

### 8.2.3 Observations, settings and special notes

EUT is a Point-to-multipoint radio (HUB/Base station).
Power spectral density was done using the following settings:

| | |
|---|---|
| Resolution bandwidth: | 1 MHz |
| Video bandwidth: | 10 MHz |
| Frequency span: | 200 MHz |
| Detector mode: | RMS |
| Trace mode: | Power average |

### 8.2.4 Test data

***Table 8.2-1:*** *EIRP measurements results for EC90-28G-HG antenna*

| Frequency, GHz | Conducted power density, dBm/MHz | Antenna gain, dBi | EIRP, dBm/MHz | EIRP, dBW/MHz | EIRP limit, dBW/MHz | EIRP margin, dB |
|---|---|---|---|---|---|---|
| 29.1305 | 6.03 | 19.00 | 25.03 | -4.97 | 23.00 | 27.97 |
| 29.1795 | 4.86 | 19.00 | 23.86 | -6.14 | 23.00 | 29.14 |
| 29.2215 | 5.47 | 19.00 | 24.47 | -5.53 | 23.00 | 28.53 |

***Table 8.2-2:*** *EIRP measurements results for EC90-28G-SG antenna*

| Frequency, GHz | Conducted power density, dBm/MHz | Antenna gain, dBi | EIRP, dBm/MHz | EIRP, dBW/MHz | EIRP limit, dBW/MHz | EIRP margin, dB |
|---|---|---|---|---|---|---|
| 29.1305 | 6.03 | 15.00 | 21.03 | -8.97 | 23.00 | 31.97 |
| 29.1795 | 4.86 | 15.00 | 19.86 | -10.14 | 23.00 | 33.14 |
| 29.2215 | 5.47 | 15.00 | 20.47 | -9.53 | 23.00 | 32.53 |

***Table 8.2-3:*** *EIRP measurements results at elevation angles for EC90-28G-HG antenna*

| Frequency, GHz | Conducted Power density, dBm/MHz | Max antenna gain at >7.7° elevation*, dBi | EIRP, dBm/MHz | EIRP, dBW/MHz | EIRP limit**, dBW/MHz | EIRP margin, dB |
|---|---|---|---|---|---|---|
| 29.1305 | 6.03 | 10.50 | 16.53 | -13.47 | 1.00 | 14.47 |
| 29.1795 | 4.86 | 10.50 | 15.36 | -14.64 | 1.00 | 15.64 |
| 29.2215 | 5.47 | 10.50 | 15.97 | -14.03 | 1.00 | 15.03 |

Note: * antenna elevation gain was taken from antenna documentation

** The EIRP limit at elevation angle above 7.7 degrees is: e.i.r.p.(0°) – 22 dB.

The limit at climate zone 1 (based on table 1) is −23 dBW/MHz, therefore the elevation limit was calculated as follows: 23 – 22 = 1 dBW/MHz

***Table 8.2-4:*** *EIRP measurements results at elevation angles for EC90-28G-SG antenna*

| Frequency, GHz | Conducted Power density, dBm/MHz | Max antenna gain at >7.7° elevation*, dBi | EIRP, dBm/MHz | EIRP, dBW/MHz | EIRP limit**, dBW/MHz | EIRP margin, dB |
|---|---|---|---|---|---|---|
| 29.1305 | 6.03 | 4.00 | 10.03 | -19.97 | 1.00 | 20.97 |
| 29.1795 | 4.86 | 4.00 | 8.86 | -21.14 | 1.00 | 22.14 |
| 29.2215 | 5.47 | 4.00 | 9.47 | -20.53 | 1.00 | 21.53 |

Note: * antenna elevation gain was taken from antenna documentation

** The EIRP limit at elevation angle above 7.7 degrees is: e.i.r.p.(0°) – 22 dB.

The limit at climate zone 1 (based on table 1) is −23 dBW/MHz, therefore the elevation limit was calculated as follows: 23 – 22 = 1 dBW/MHz

Test data, continued

***Table 8.2-5:*** *Total channel power*

| Frequency, GHz | Conducted channel power, dBm | Conducted channel power, W |
|---|---|---|
| 29.1305 | 21.70 | 0.148 |
| 29.1795 | 21.05 | 0.127 |
| 29.2215 | 21.48 | 0.141 |

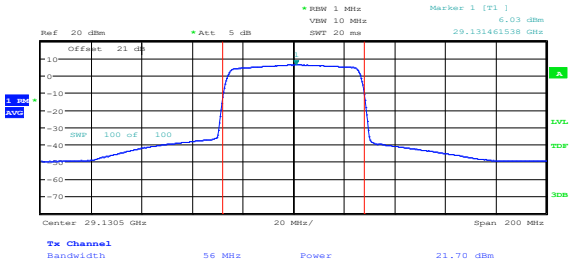



***Figure 8.2-1:*** *Power and PSD on low channel*

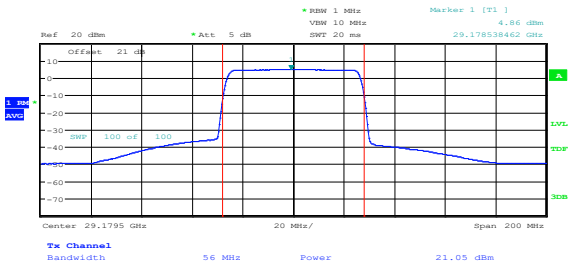



***Figure 8.2-2:*** *Power and PSD on mid channel*

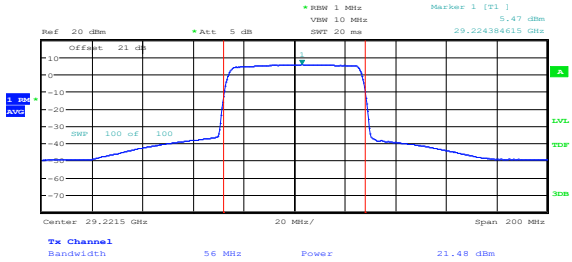



***Figure 8.2-3:*** *Power and PSD on high channel*

## 8.3 Emission limitations

### 8.3.1 References, definitions and limits

**FCC §101.111:**

(a) The mean power of emissions must be attenuated below the mean output power of the transmitter in accordance with the following schedule:

(2) When using transmissions employing digital modulation techniques (see §101.141(b)) in situations not covered in this section:

(ii) For operating frequencies above 15 GHz, in any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 250 percent of the authorized bandwidth: As specified by the following equation but in no event less than 11 decibels:

$A = 11 + 0.4(P-50) + 10\times\text{Log}_{10} B$. (Attenuation greater than 56 decibels or to an absolute power of less than −13 dBm/1MHz is not required.)

(iii) In any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least $43 + 10\ \text{Log}_{10}$ (the mean output power in watts) decibels, or 80 decibels, whichever is the lesser attenuation. The authorized bandwidth includes the nominal radio frequency bandwidth of an individual transmitter/modulator in block-assigned bands.

(iv) The emission mask for LMDS shall use the equation in paragraph (a)(2)(ii) of this section and apply it only to the band edge of each block of spectrum, but not to subchannels established by licensees. The value of P in the equation is the percentage removed from the carrier frequency and assumes that the carrier frequency is the center of the actual bandwidth used. The emission mask can be satisfied by locating a carrier of the subchannel sufficiently far from the channel edges so that the emission levels of the mask are satisfied. The LMDS emission mask shall use a value B (bandwidth) of 40 MHz, for all cases even in the case where a narrower subchannel is used (for instance the actual bandwidth is 10 MHz) and the mean output power used in the calculation is the sum of the output power of a fully populated channel. For block assigned channels, the out-of-band emission limits apply only outside the assigned band of operation and not within the band.

### 8.3.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | Andrey Adelberg | Test date | May 27, 2020 |

### 8.3.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to 100 GHz. No unintentional emissions were detected.
Measurement distances used were: 1–18 GHz at 3 m, 18–40 GHz at 1 m, 40–100 GHz at 0.03 m.
A 50-ohm matching impedance network and attenuation was used during testing. Cabinet radiation was done with antenna port terminated with 50-ohm load.
Authorized channel bandwidth is 56 MHz. 250% of the authorized bandwidth is 56 × 2.5 = 140 MHz.
OOB frequencies calculation:
29.100 GHz − 140 MHz = 28.960 GHz.
29.250 GHz + 140 MHz = 29.390 GHz

Spectrum analyser settings for radiated measurements within restricted bands below 1 GHz:

| | |
|---|---|
| Resolution bandwidth: | 100 kHz |
| Video bandwidth: | 300 kHz |
| Detector mode: | Peak |
| Trace mode: | Max Hold |

Spectrum analyser settings for peak radiated measurements within restricted bands above 1 GHz:

| | |
|---|---|
| Resolution bandwidth: | 1 MHz |
| Video bandwidth: | 3 MHz |
| Detector mode: | Peak |
| Trace mode: | Max Hold |

## 8.3.4 Test data

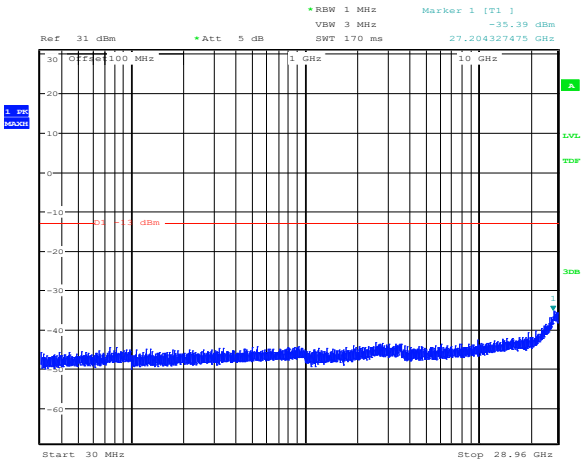



***Figure 8.3-1:*** *Conducted spurious emissions 30 MHz to 28.96 GHz at low channel*

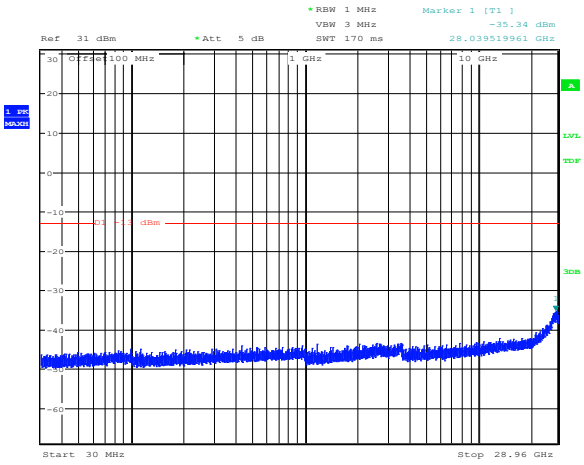



***Figure 8.3-2:*** *Conducted spurious emissions 30 MHz to 28.96 GHz at mid channel*

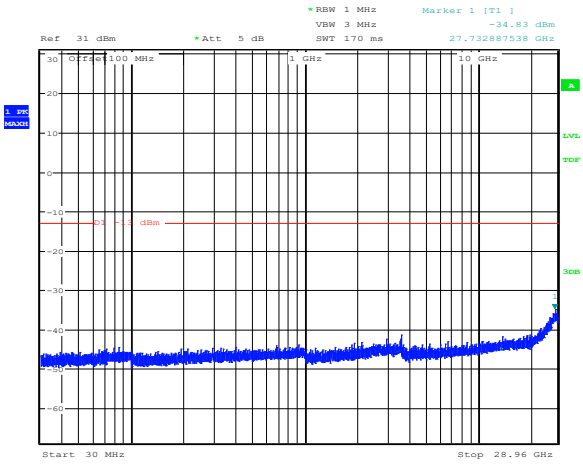



***Figure 8.3-3:*** *Conducted spurious emissions 30 MHz to 28.96 GHz at high channel*

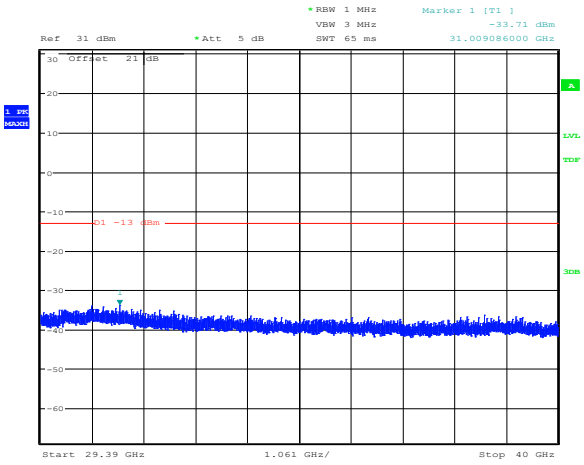



***Figure 8.3-4:*** *Conducted spurious emissions 29.39–40 GHz at low channel*

Test data, continued

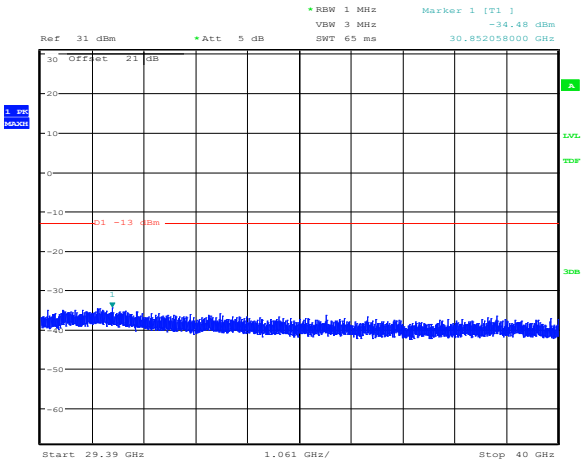



***Figure 8.3-5:*** *Conducted spurious emissions 29.39–40 GHz at mid channel*

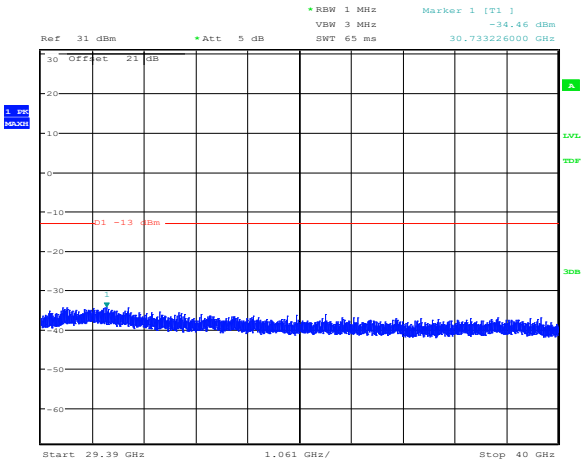



***Figure 8.3-6:*** *Conducted spurious emissions 29.39–40 GHz at high channel*

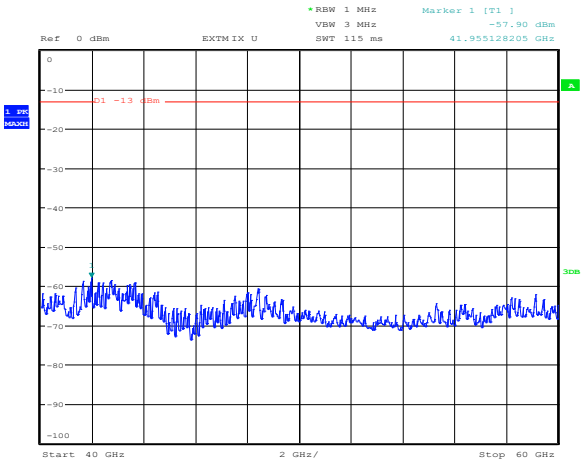



***Figure 8.3-7:*** *Conducted spurious emissions 40–60 GHz at low channel*

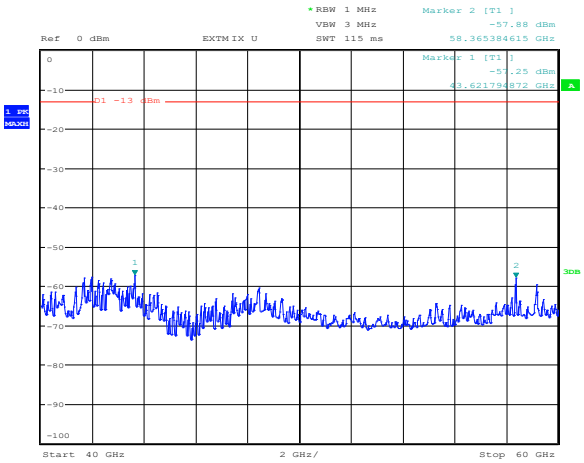



***Figure 8.3-8:*** *Conducted spurious emissions 40–60 GHz at mid channel*

Test data, continued

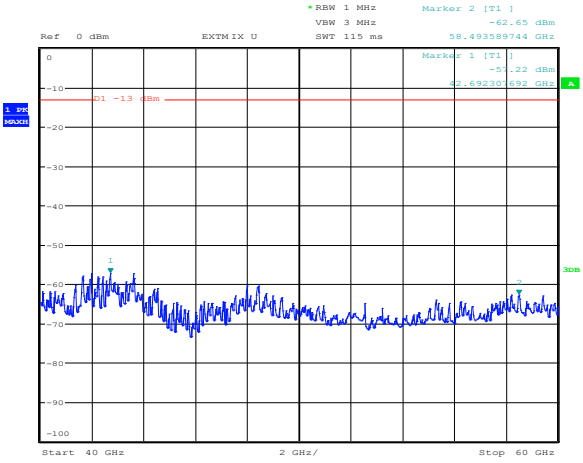



***Figure 8.3-9:*** *Conducted spurious emissions 40–60 GHz at high channel*

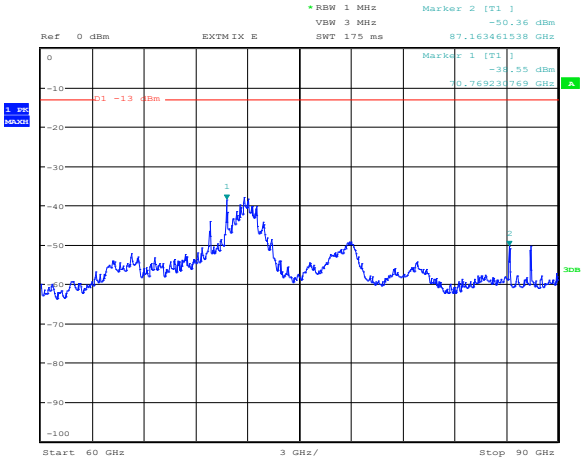



***Figure 8.3-10:*** *Conducted spurious emissions 60–90 GHz at low channel*

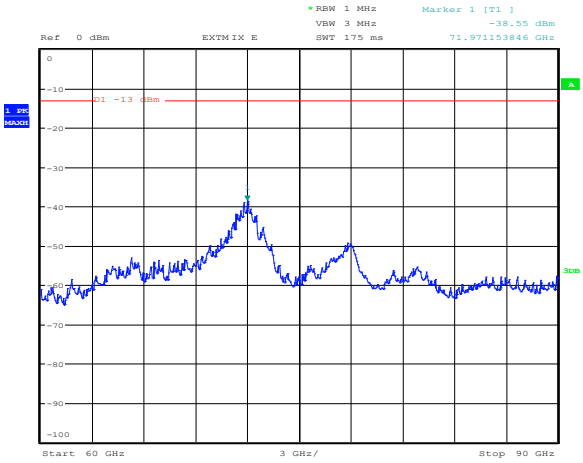



***Figure 8.3-11:*** *Conducted spurious emissions 60–90 GHz at mid channel*

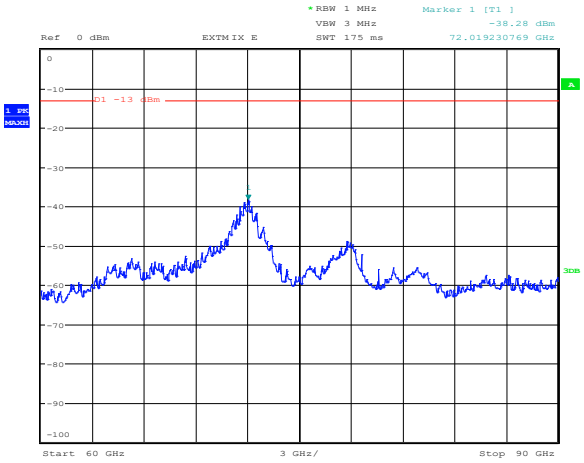



***Figure 8.3-12:*** *Conducted spurious emissions 60–90 GHz at high channel*

Test data, continued

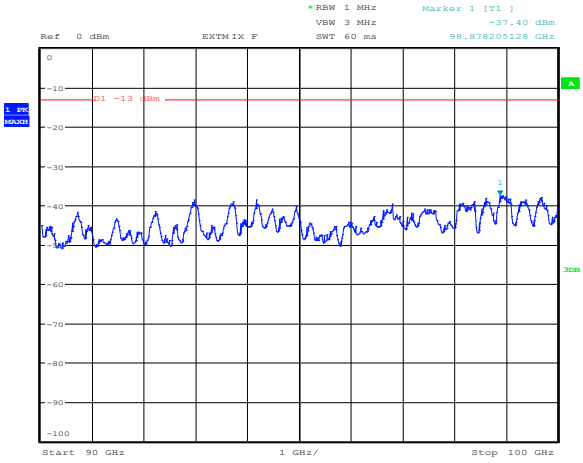



***Figure 8.3-13:*** *Conducted spurious emissions 90–100 GHz at low channel*

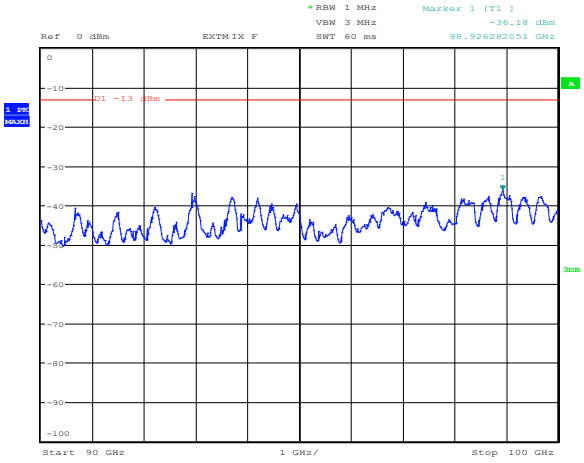



***Figure 8.3-14:*** *Conducted spurious emissions 90–100 GHz at mid channel*

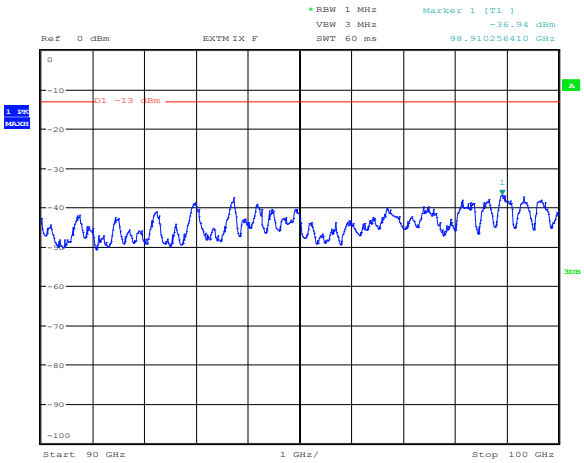



***Figure 8.3-15:*** *Conducted spurious emissions 90–100 GHz at high channel*

Test data, continued

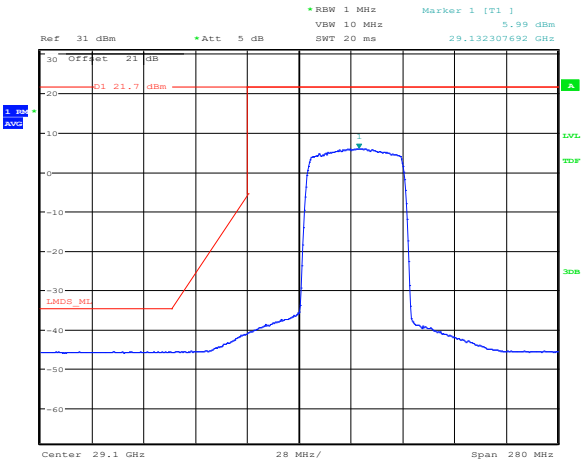



***Figure 8.3-16:*** *Emission mask at low channel*

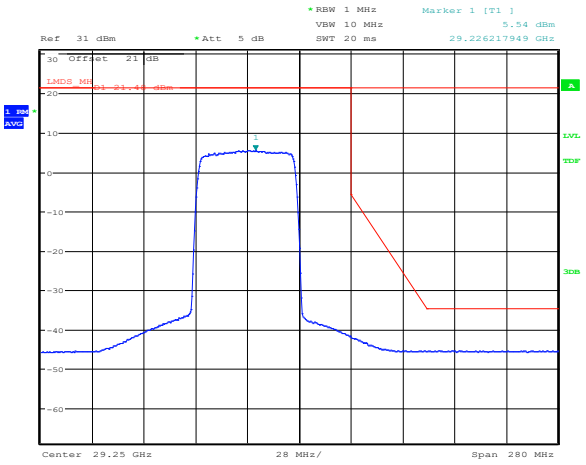



***Figure 8.3-17:*** *Emission mask at high channel*

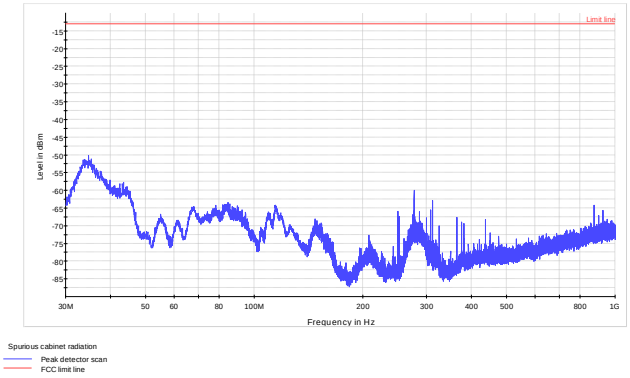



***Figure 8.3-18:*** *Radiated spurious emissions 30–1000 MHz, low channel*

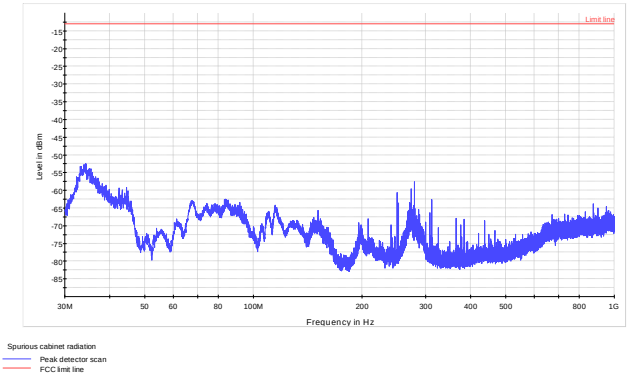



***Figure 8.3-19:*** *Radiated spurious emissions 30–1000 MHz, mid channel*

Test data, continued

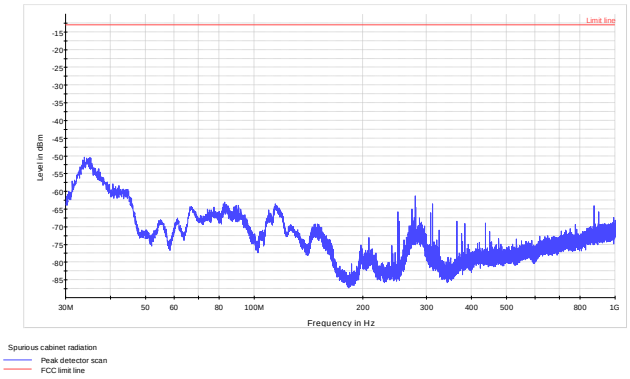



***Figure 8.3-20:*** *Radiated spurious emissions 30–1000 MHz, high channel*

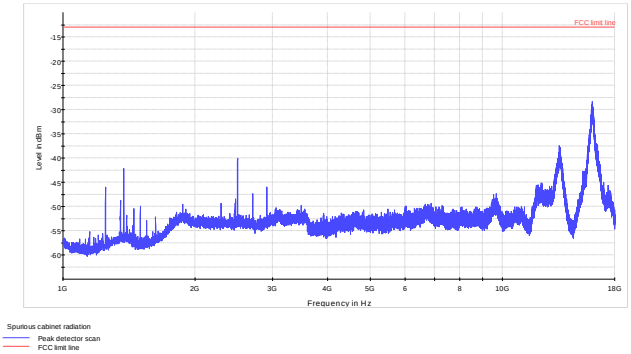



***Figure 8.3-21:*** *Radiated spurious emissions 1–18 GHz, low channel*

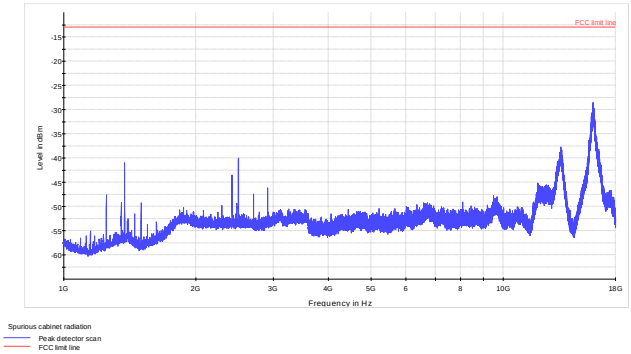



***Figure 8.3-22:*** *Radiated spurious emissions 1–18 GHz, mid channel*

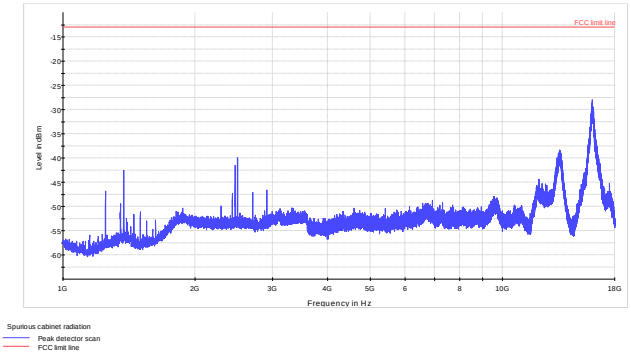



***Figure 8.3-23:*** *Radiated spurious emissions 1–18 GHz, high channel*

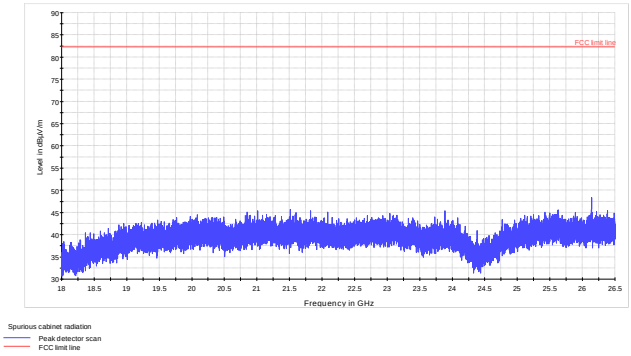



***Figure 8.3-24:*** *Radiated spurious emissions 18–26.5 GHz, low channel*

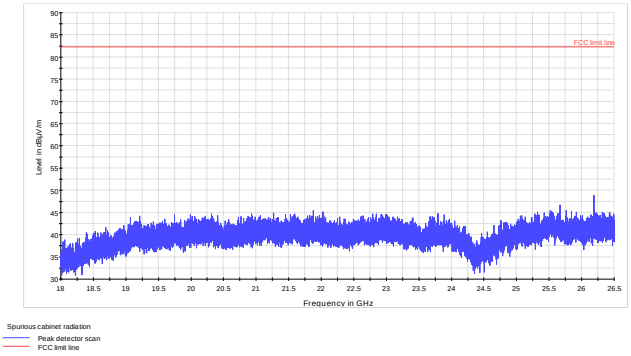



***Figure 8.3-25:*** *Radiated spurious emissions 18–26.5 GHz, mid channel*

Test data, continued

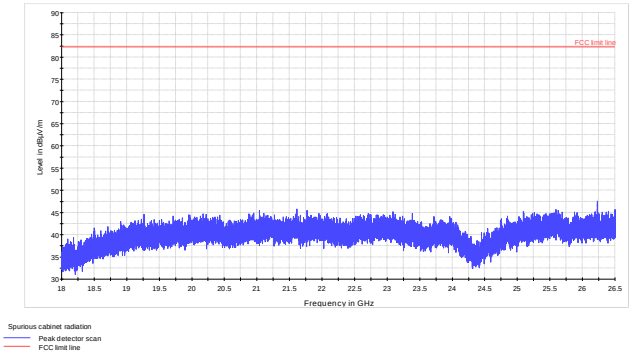



***Figure 8.3-26:*** *Radiated spurious emissions 18–26.5 GHz, high channel*

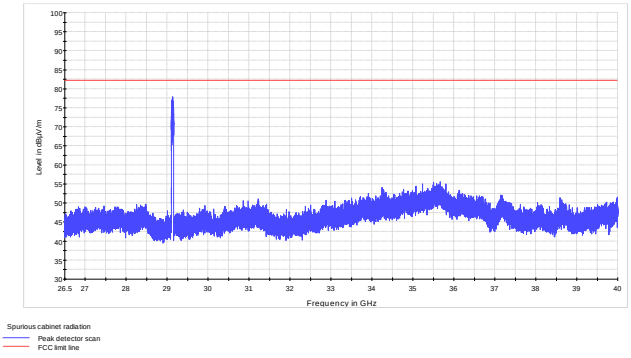



***Figure 8.3-27:*** *Radiated spurious emissions 26.5–40 GHz, low channel*

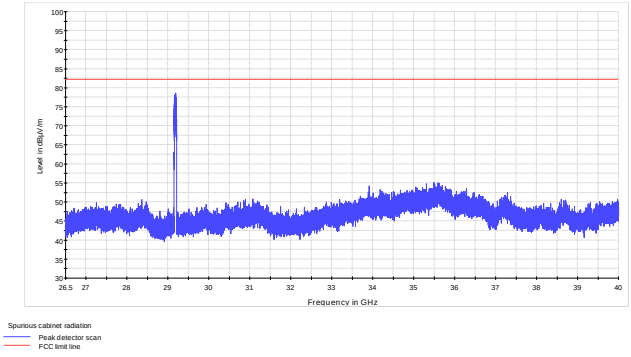



***Figure 8.3-28:*** *Radiated spurious emissions 26.5–40 GHz, mid channel*

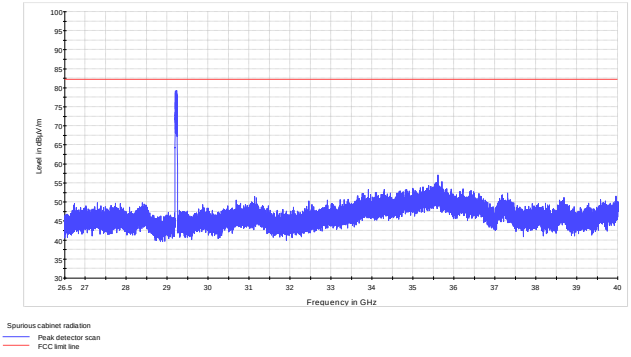



***Figure 8.3-29:*** *Radiated spurious emissions 26.5–40 GHz, high channel*

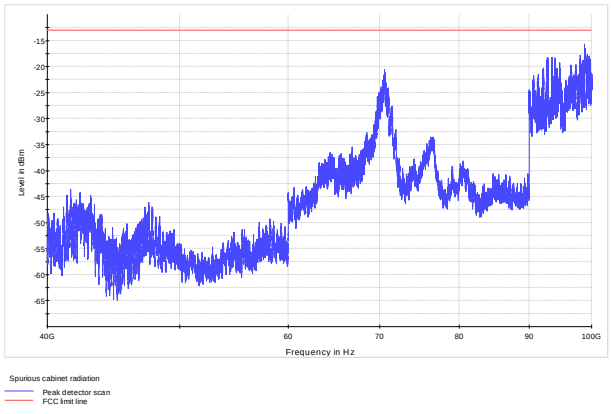



***Figure 8.3-30:*** *Radiated spurious emissions 40–100 GHz, low channel*

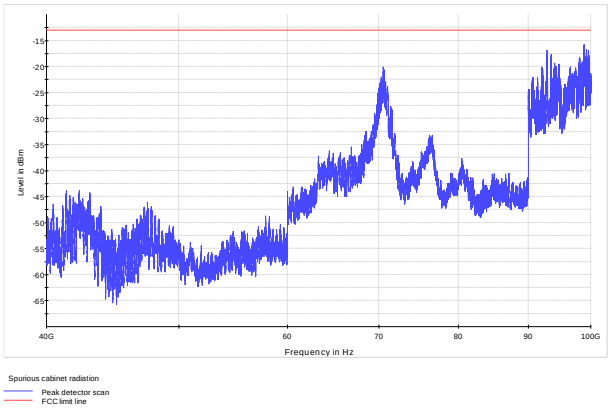



***Figure 8.3-31:*** *Radiated spurious emissions 40–100 GHz, mid channel*

Test data, continued

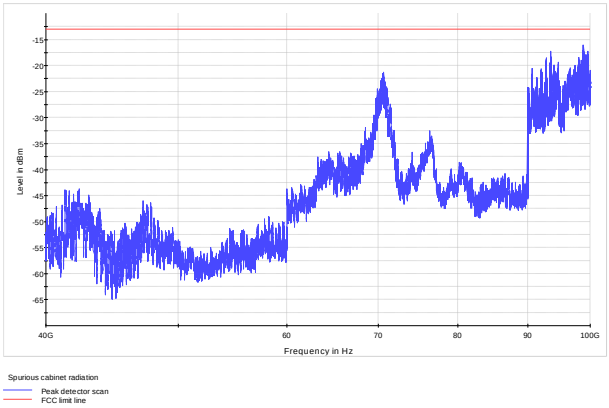



***Figure 8.3-32:*** *Radiated spurious emissions 40–100 GHz, high channel*

## 8.4 Occupied bandwidth

### 8.4.1 References, definitions and limits

**FCC §2.1049:**

The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

**FCC §101.109:**

(a) Each authorization issued pursuant to these rules will show, as the emission designator, a symbol representing the class of emission which must be prefixed by a number specifying the necessary bandwidth. This figure does not necessarily indicate the bandwidth actually occupied by the emission at any instant. In those cases where part 2 of this chapter does not provide a formula for the computation of the necessary bandwidth, the occupied bandwidth may be used in the emission designator.

(b) Stations in this service will be authorized any type of emission, method of modulation, and transmission characteristic, consistent with efficient use of the spectrum and good engineering practice, except that Type B, damped-wave emission will not be authorized.

(c) The maximum bandwidth which will be authorized per 29.100 to 29.250 GHz frequency band is 150 MHz. Regardless of the maximum authorized bandwidth specified for each frequency band, the Commission reserves the right to issue a license for less than the maximum bandwidth if it appears that a lesser bandwidth would be sufficient to support an applicant's intended communications.

### 8.4.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | Andrey Adelberg | Test date | May 26, 2020 |

### 8.4.3 Observations, settings and special notes

Spectrum analyzer settings:

| | |
|---|---|
| Detector mode | Peak |
| Resolution bandwidth | ≥1 % of span |
| Video bandwidth | RBW × 3 |
| Trace mode | Max Hold |

### 8.4.4 Test data

***Table 8.4-1:*** *Occupied Bandwidth results*

| Frequency, MHz | 99% OBW, MHz | Limit, MHz | Margin, MHz |
|---|---|---|---|
| 29130.500 | 52.885 | 150.000 | 97.115 |
| 29179.500 | 53.526 | 150.000 | 96.474 |
| 29221.500 | 53.205 | 150.000 | 96.795 |

***Table 8.4-2:*** *Emission Bandwidth results*

| Frequency, MHz | 26 dB BW, MHz |
|---|---|
| 29130.500 | 59.615 |
| 29179.500 | 59.936 |
| 29221.500 | 59.615 |

Test data, continued

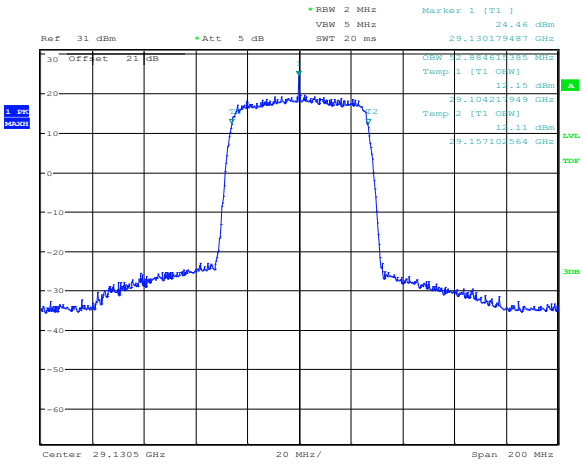



***Figure 8.4-1:*** *99% OBW on low channel*

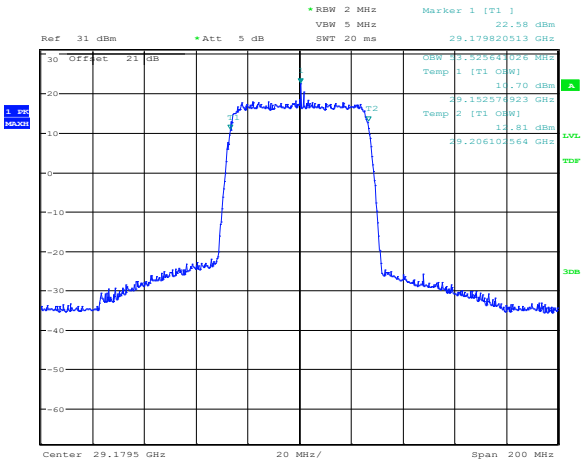



***Figure 8.4-2:*** *99% OBW on mid channel*

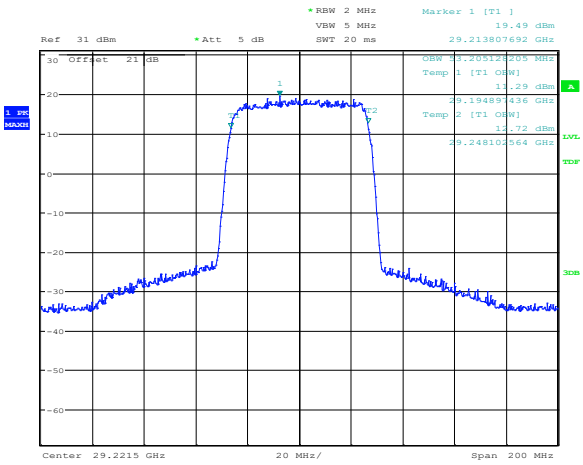



***Figure 8.4-3:*** *99% OBW on high channel*

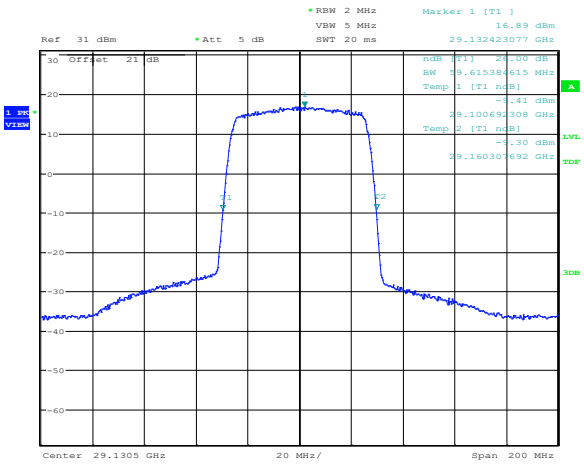



***Figure 8.4-4:*** *26 dB BW on low channel*

Test data, continued

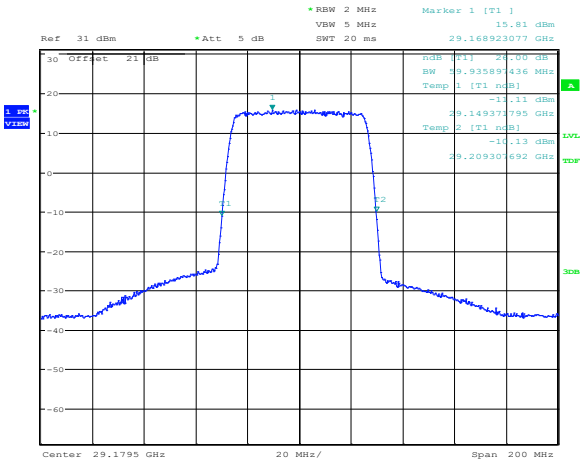



***Figure 8.4-5:*** *26 dB BW on mid channel*

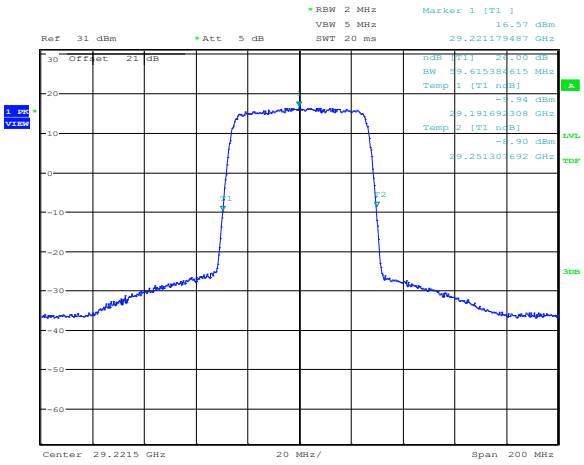



***Figure 8.4-6:*** *26 dB BW on high channel*

## 8.5 Frequency stability

### 8.5.1 References, definitions and limits

**FCC §101.107:**

(a) The carrier frequency of each transmitter authorized in these services must be maintained within the following percentage of the reference frequency except as otherwise provided in paragraph (b) of this section or in the applicable subpart of this part (unless otherwise specified in the instrument of station authorization the reference frequency will be deemed to be the assigned frequency): 29.1–29.25 GHz is 0.001%

### 8.5.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | Andrey Adelberg | Test date | May 28, 2020 |

### 8.5.3 Observations, settings and special notes

None

### 8.5.4 Test data

***Table 8.5-1:*** *Frequency drift*

| Test conditions | Frequency, Hz | Drift, % | Limit, ±% | Margin, % |
|---|---|---|---|---|
| +50 °C, Nominal voltage | 29.220936218 | 0.000007515 | 0.001000000 | -99.248 |
| +40 °C, Nominal voltage | 29.220934319 | 0.000001016 | 0.001000000 | -99.898 |
| +30 °C, Nominal voltage | 29.220934054 | 0.000000110 | 0.001000000 | -99.989 |
| +20 °C, Nominal voltage +15 % | 29.220934025 | 0.000000010 | 0.001000000 | -99.999 |
| +20 °C, Nominal voltage | 29.220934022 | | *Reference* | |
| +20 °C, Nominal voltage −15 % | 29.220934039 | 0.000000058 | 0.001000000 | -99.994 |
| +10 °C, Nominal voltage | 29.220934872 | 0.000002909 | 0.001000000 | -99.709 |
| 0 °C, Nominal voltage | 29.220953357 | 0.000066168 | 0.001000000 | -93.383 |
| −10 °C, Nominal voltage | 29.220885378 | -0.000166470 | 0.001000000 | -83.353 |
| −20 °C, Nominal voltage | 29.220860553 | -0.000251426 | 0.001000000 | -74.857 |

Notes: Drift percentage calculation:

$(F_M - F_R) / F_R \times 100\%$ where $F_M$ is measured frequency, $F_R$ is a reference frequency at 20 °C and nominal voltage.

Margin calculation:

$(\%_D - \%_L) / \%_L \times 100\%$ where $\%_D$ is a frequency drift percentage, $\%_L$ is a limit.

# 8.6 Modulation characteristics

## 8.6.1 References, definitions and limits

**FCC §2.1047:**

(d) Other types of equipment. A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

## 8.6.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | Andrey Adelberg | Test date | May 26, 2020 |

## 8.6.3 Observations, settings and special notes

Spectrum analyser settings:

| | |
|---|---|
| Resolution bandwidth | 1 MHz |
| Video bandwidth | > RBW |
| Detector | Peak, max-hold |

## 8.6.4 Test data

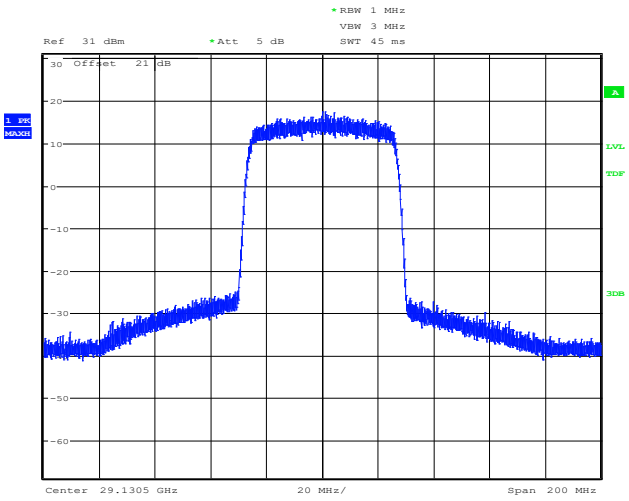
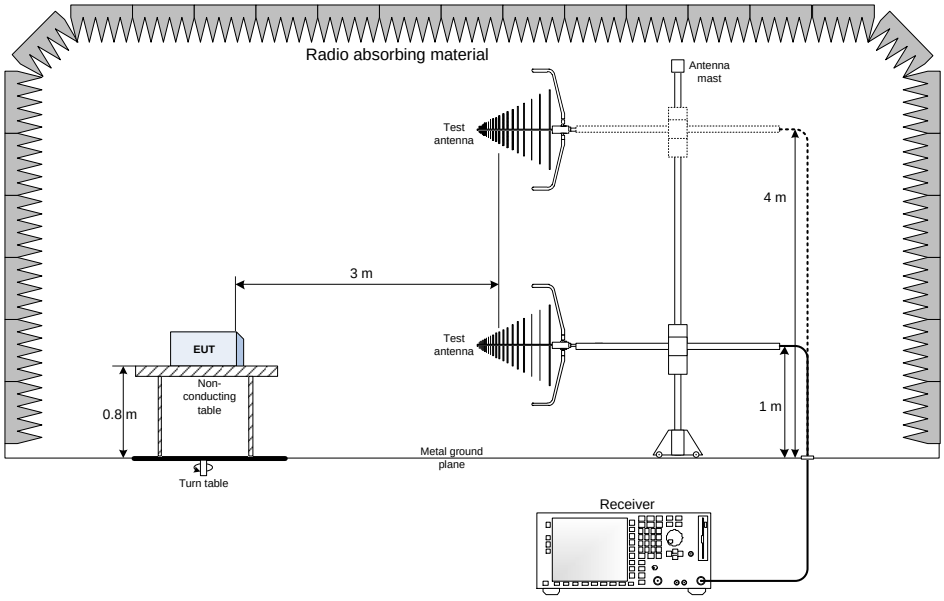


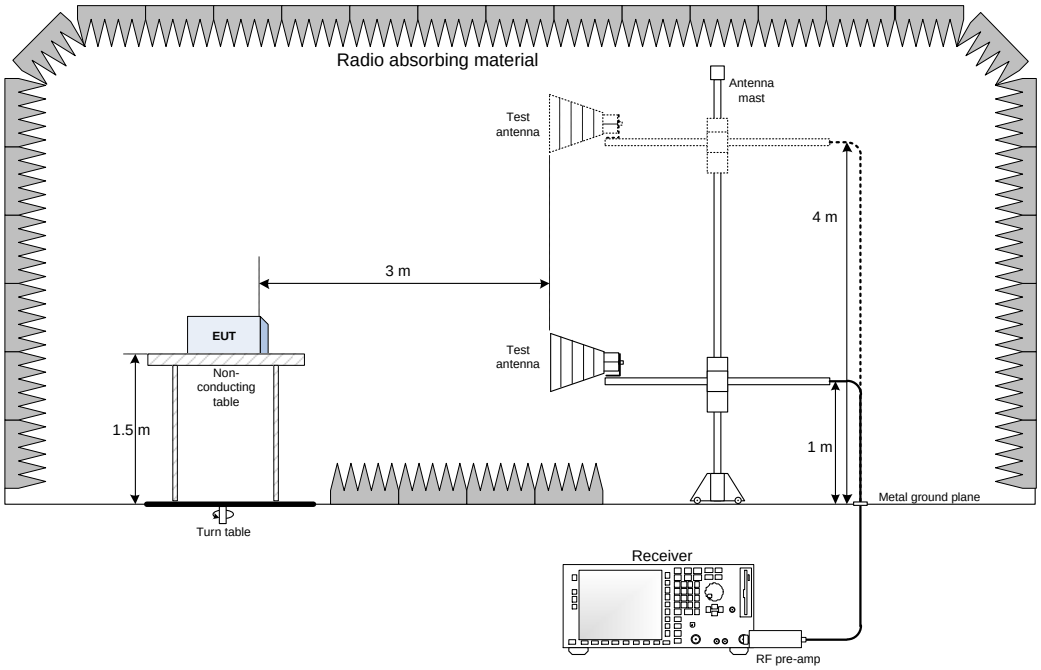

***Figure 8.6-1:*** *Plot showing envelope of a digital modulation*

# **Section 9.** Block diagrams of test set-ups

## 9.1 Radiated emissions set-up for frequencies below 1 GHz




## 9.2 Radiated emissions set-up for frequencies above 1 GHz



## 9.3 Antenna port set-up