Nemko

Choose Scandinavian trust

# RADIO TEST REPORT – 449941TRFWL

Type of assessment:

Final product testing

Applicant:

MIR Medical International Research

Product:

Spirometer and Oximeter

Model:

MIR065 – SPIROBANK OXI

Model variant(s):

--

FCC ID:

TUKMIR065

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247

Date of issue: October 15, 2021

G. Tepelena

Tested by

Signature

P. Barbieri

Reviewed by

Signature

## Lab locations

| | |
|---|---|
| Company name | Nemko Spa |
| Address | Via del Carroccio, 4 |
| City | Biassono |
| Province | MB |
| Postal code | 20853 |
| Country | Italy |
| Telephone | +39 039 220 12 01 |
| Facsimile | +39 039 220 12 21 |
| Website | www.nemko.com |
| Site number | 682159 (10 m semi anechoic chamber) |

## 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 contain in this report are within Nemko Spa ISO/IEC 17025 accreditation.

## Copyright notification

# Table of Contents

# Section 1 Report summary

## 1.1 Test specifications

| | |
|---|---|
| FCC 47 CFR Part 15, Subpart C, Clause 15.247 | Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–585 MHz |

## 1.2 Test methods

| | |
|---|---|
| 558074 D01 15.247 Meas Guidance v05r02 (April 2, 2019) | Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the FCC rules. |
| ANSI C63.10 v2013 | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices |

## 1.3 Exclusions

None

## 1.4 Statement of compliance

In the configuration tested, the EUT was found Choose an item.

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 Choose an item. 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 | October 15, 2021 | 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

None

## 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.

The following instruments are used to monitor the environmental conditions:

| Equipment | Manufacturer | Model no. | Asset no. | Cal date | Next cal. |
|---|---|---|---|---|---|
| Thermo-hygrometer data loggers | Testo | 175-H2 | 20012380/305 | 2020-12 | 2022-12 |
| Thermo-hygrometer data loggers | Testo | 175-H2 | 38203337/703 | 2020-12 | 2022-12 |
| Barometer | Castle | GPB 3300 | 072015 | 2021-04 | 2022-04 |

## 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

The measurement uncertainty was calculated for each test and quantity listed in this test report, according to CISPR 16-4-2 and other specific test standard and is documented in Nemko Spa working manual WML1002.

The assessment of conformity for each test performed on the equipment is performed not taking into account the measurement uncertainty. The two following possible verdicts are stated in the report:

P (Pass) - The measured values of the equipment respect the specification limit at the points tested. The specific risk of false accept is up to 50% when the measured result is close to the limit.

F (Fail) - One or more measured values of the equipment do not respect the specification limit at the points tested. The specific risk of false reject is up to 50% when the measured result is close to the limit.

Hereafter Nemko's measurement uncertainties are reported:

| EUT | Type | Test | Range | Measurement Uncertainty | Notes |
|---|---|---|---|---|---|
| Transmitter | Conducted | Frequency error | 0.001 MHz ÷ 40 GHz | 0.08 ppm | (1) |
| | | Carrier power<br>RF Output Power | 0.009 MHz ÷ 30 MHz | 1.1 dB | (1) |
| | | | 30 MHz ÷ 18 GHz | 1.5 dB | (1) |
| | | | 18 MHz ÷ 40 GHz | 3.0 dB | (1) |
| | | | 40 MHz ÷ 140 GHz | 5.0 dB | (1) |
| | | Adjacent channel power | 1 MHz ÷ 18 GHz | 1.4 dB | (1) |
| | | Conducted spurious emissions | 0.009 MHz ÷ 18 GHz | 3.0 dB | (1) |
| | | | 18 GHz ÷ 40 GHz | 4.2 dB | (1) |
| | | | 40 GHz ÷ 220 GHz | 6.0 dB | (1) |
| | | Intermodulation attenuation | 1 MHz ÷ 18 GHz | 2.2 dB | (1) |
| | | Attack time – frequency behaviour | 1 MHz ÷ 18 GHz | 2.0 ms | (1) |
| | | Attack time – power behaviour | 1 MHz ÷ 18 GHz | 2.5 ms | (1) |
| | | Release time – frequency behaviour | 1 MHz ÷ 18 GHz | 2.0 ms | (1) |
| | | Release time – power behaviour | 1 MHz ÷ 18 GHz | 2.5 ms | (1) |
| | | Transient behaviour of the transmitter– Transient frequency behaviour | 1 MHz ÷ 18 GHz | 0.2 kHz | (1) |
| | | Transient behaviour of the transmitter – Power level slope | 1 MHz ÷ 18 GHz | 9% | (1) |
| | | Frequency deviation - Maximum permissible frequency deviation | 0.001 MHz ÷ 18 GHz | 1.3% | (1) |
| | | Frequency deviation - Response of the transmitter to modulation frequencies above 3 kHz | 0.001 MHz ÷ 18 GHz | 0.5 dB | (1) |
| | | Dwell time | - | 3% | (1) |
| | | Hopping Frequency Separation | 0.01 MHz ÷ 18 GHz | 1% | (1) |
| | | Occupied Channel Bandwidth | 0.01 MHz ÷ 18 GHz | 2% | (1) |
| | | Modulation Bandwidth | 0.01 MHz ÷ 18 GHz | 2% | (1) |
| | Radiated | Radiated spurious emissions | 0.009 MHz ÷ 26.5 GHz | 6.0 dB | (1) |
| | | | 26.5 GHz ÷ 66 GHz | 8.0 dB | (1) |
| | | | 66 GHz ÷ 220 GHz | 10 dB | (1) |
| | | Effective radiated power transmitter | 10 kHz ÷ 26.5 GHz | 6.0 dB | (1) |
| | | | 26.5 GHz ÷ 66 GHz | 8.0 dB | (1) |
| | | | 66 GHz ÷ 220 GHz | 10 dB | (1) |

NOTES:
(1) The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95 %

# 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 | MIR Medical International Research |
| Applicant address | Via del Maggiolino 125  00155 Roma (RM) - Italy |
| Manufacture name | MIR Medical International Research |
| Manufacture address | Via del Maggiolino 125  00155 Roma (RM) - Italy |

## 5.3 EUT information

| | |
|---|---|
| Product | Spirometer and Oximeter |
| Model | MIR065 – SPIROBANK OXI |
| Model variant(s) | -- |
| Serial number | A23-E001546 |
| Part number | -- |
| Power supply requirements | Battery: 3 V(DC) |
| Product description and theory of operation | Spirobank Oxi, spirometer and pulse oximeter, is intended to be used by a physician or by a subject under the instruction of a physician or the patient to assess lung function. The device Spirobank Oxi is a pocket-sized system for measuring the respiratory parameters and SpO2 (percentage of oxygen saturation in the blood and BPM (Heart rate) The device connects to a smartphone via Bluetooth SMART technology. Connection is automatic once the MIR SPIROBANK application has been installed on the smartphone. |

## 5.4 Radio technical information

| | |
|---|---|
| Category of Wideband Data Transmission equipment | ☐ Frequency Hopping Spread Spectrum (FHSS) equipment<br>☒ Other types of Wideband Data Transmission equipment (e.g. DSSS, OFDM, etc.). |
| Frequency band | 2400–2483.5 MHz |
| Frequency Min (MHz) | 2402 |
| Frequency Max (MHz) | 2480 |
| Channel numbers | 1–39 |
| RF power Max (W), Conducted | N/A |
| Field strength, dBµV/m @ 3 m | 93.00 |
| Measured BW (kHz), 99% OBW | Ch Low: 2118 Ch Middle: 2131 Ch High: 2141 |
| Type of modulation | BLE (GFSK) |
| Emission classification | F1D |
| Transmitter spurious, dBµV/m @ 3 m | 50.6 @ 4.8 GHz |
| Antenna information | The EUT uses a unique antenna coupling/non detachable antenna to the interior radiator, Antenna Gain 0.6 dBi |

## 5.5 EUT setup details

### 5.5.1 Radio exercise details

| | |
|---|---|
| Operating conditions | The EUT operating on three frequencies using software Low ch = 2402 MHz Low channel 2440 MHz High channel 2480 MHz, level 0dBm , using dedicated software Nordic |
| Transmitter state | Transmitter set in to continuous mode. |
| Receiver state | -- |

### 5.5.2 EUT setup configuration

***Table 5.5-1:*** *EUT sub assemblies*

| Description | Brand name | Model, Part number, Serial number, Revision level |
|---|---|---|
| -- | -- | -- |
| -- | -- | -- |
| -- | -- | -- |
| -- | -- | -- |

***Table 5.5-2:*** *EUT interface ports*

| Description | Qty. |
|---|---|
| Enclosure | 1 |

***Table 5.5-3:*** *Support equipment*

| Description | Brand name | Model, Part number, Serial number, Revision level |
|---|---|---|
| -- | -- | -- |
| -- | -- | -- |
| -- | -- | -- |
| -- | -- | -- |

***Table 5.5-4:*** *Inter-connection cables*

| Cable description | From | To | Length (m) |
|---|---|---|---|
| -- | -- | -- | -- |
| -- | -- | -- | -- |
| -- | -- | -- | -- |
| -- | -- | -- | -- |

## EUT setup configuration, continued

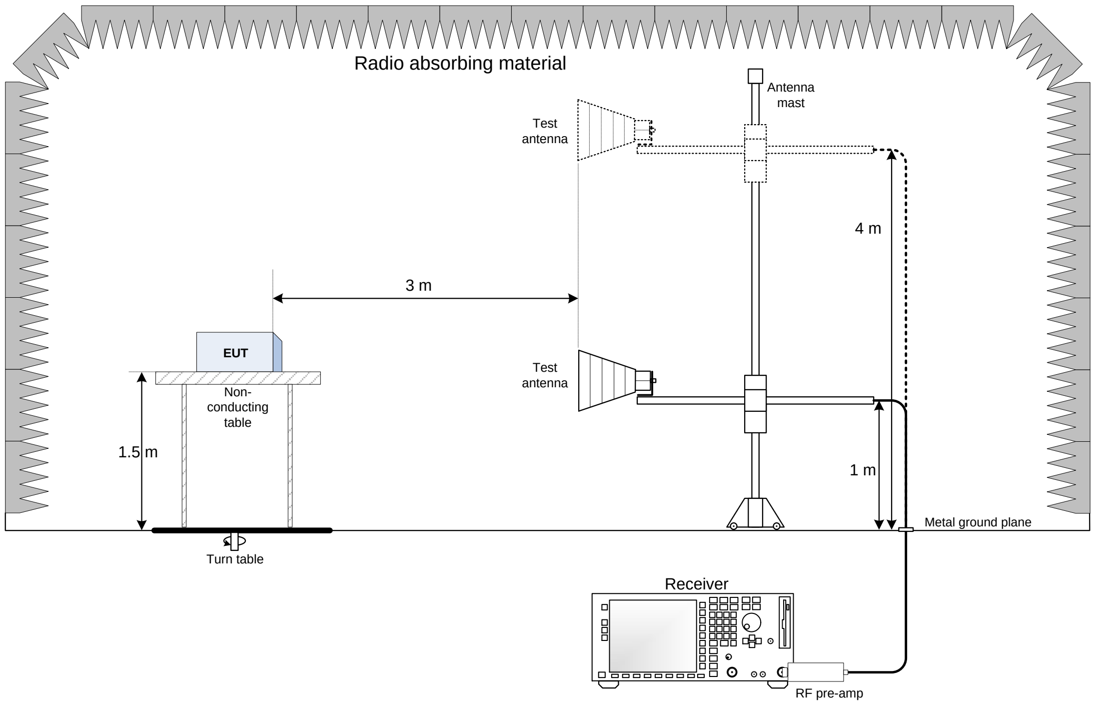



***Figure 5.5-1:*** *Radiated testing block diagram*

# Section 6 Summary of test results

## 6.1 Testing location

| | |
|---|---|
| Test location (s) | Nemko Biassono Italy |

## 6.2 Testing period

| | | | |
|---|---|---|---|
| Test start date | October 14, 2021 | Test end date | October 15, 2021 |

## 6.3 Sample information

| | | | |
|---|---|---|---|
| Receipt date | October 8, 2021 | Nemko sample ID number(s) | 4499410001 |

## 6.4 FCC Part 15 Subpart A and C, general requirements test results

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

| Part | Test description | Verdict |
|---|---|---|
| §15.207(a) | Conducted limits | Not applicable |
| §15.31l | Variation of power source | Pass |
| §15.31(m) | Number of tested frequencies | Pass |
| §15.203 | Antenna requirement | Pass |

Notes: EUT is a battery operated device, the testing was performed using fresh batteries.

## 6.5 FCC Part §15.247 test results for frequency hopping spread spectrum systems (FHSS)

***Table 6.5-1:*** *FCC FHSS requirements results*

| Part | Test description | Verdict |
|---|---|---|
| §15.247(a)(1)(i) | Requirements for operation in the 902–928 MHz band | Not applicable |
| §15.247(a)(1)(ii) | Requirements for operation in the 5725–5850 MHz band | Not applicable |
| §15.247(a)(1)(iii) | Requirements for operation in the 2400–2483.5 MHz band | Not applicable |
| §15.247(b)(1) | Maximum peak output power in the 2400–2483.5 MHz band and 5725–5850 MHz band | Not applicable |
| §15.247(b)(2) | Maximum peak output power in the 902–928 MHz band | Not applicable |
| §15.247I(1) | Fixed point-to-point operation with directional antenna gains greater than 6 dBi | Not applicable |
| §15.247I(2) | Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams | Not applicable |
| §15.247(d) | Spurious emissions | Not applicable |
| §15.247(f) | Time of occupancy for hybrid systems | Not applicable |
| §15.247(i) | Radiofrequency radiation exposure evaluation | Not applicable |

## 6.6 FCC Part §15.247 test results for digital transmission systems (DTS)

***Table 6.6-1:*** *FCC DTS requirements results*

| Part | Test description | Verdict |
|---|---|---|
| §15.247(a)(2) | Minimum 6 dB bandwidth | Pass |
| §15.247(b)(3) | Maximum peak output power in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands | Pass |
| §15.247I(1) | Fixed point-to-point operation with directional antenna gains greater than 6 dBi | Not applicable |
| §15.247I(2) | Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams | Not applicable |
| §15.247(d) | Spurious emissions | Pass |
| §15.247I | Power spectral density | Pass |
| §15.247(f) | Time of occupancy for hybrid systems | Not applicable |

# 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. |
|---|---|---|---|---|---|
| EMI receiver (20 Hz ÷ 8 GHz) | R&S | ESU8 | 100202 | 2021-01 | 2022-01 |
| EMI receiver (20 Hz ÷ 44 GHz) | R&S | ESW44 | 101620 | 2021-08 | 2022-08 |
| Trilog Antenna (30 MHz ÷ 7 GHz) | Schwarzbeck | VULB 9162 | 9162-025 | 2021-07 | 2024-07 |
| Bilog antenna (1 ÷ 18 GHz) | Schwarzbeck | STLP 9148 | 9148-123 | 2021-07 | 2024-07 |
| Horn antenna (4 ÷ 40 GHz) | RFSpin | DRH40 | 061106A40 | 2020-02 | 2023-02 |
| Preamplifier (1 ÷ 18 GHz) | Schwarzbeck | BBV 9718 | 9718-137 | 2021-09 | 2022-09 |
| Preamplifier (18 ÷ 40 GHz) | Miteq | JS44-18004000-35-8P-R | 1.627 | 2021-09 | 2022-09 |
| Controller | Maturo | FCU3.0 | 10041 | NCR | NCR |
| Tilt antenna mast | Maturo | TAM4.0-E | 10042 | NCR | NCR |
| Turntable | Maturo | TT4.0-5T | 2.527 | NCR | NCR |
| Semi-anechoic chamber | Nemko | 10m semi-anechoic chamber | 530 | 2021-09 | 2024-09 |
| Shielded room | Siemens | 10m control room | 1947 | NCR | NCR |

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

# Section 8 Testing data

## 8.1 Variation of power source

### 8.1.1 References, definitions and limits

**FCC §15.31 (e):**

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

### 8.1.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | G. Tepelena | Test date | October 14, 2021 |

### 8.1.3 Observations, settings and special notes

The testing was performed as per ANSI C63.10 Section 5.13.

a) Where the device is intended to be powered from an external power adapter, the voltage variations shall be applied to the input of the adapter provided with the device at the time of sale. If the device is not marketed or sold with a specific adapter, then a typical power adapter shall be used.

b) For devices, where operating at a supply voltage deviating ±15% from the nominal rated value may cause damages or loss of intended function, test to minimum and maximum allowable voltage per manufacturer's specification and document in the report.

c) For devices with wide range of rated supply voltage, test at 15% below the lowest and 15% above the highest declared nominal rated supply voltage.

d) For devices obtaining power from an input/output (I/O) port (USB, firewire, etc.), a test jig is necessary to apply voltage variation to the device from a support power supply, while maintaining the functionalities of the device.

For battery-operated equipment, the equipment tests shall be performed using a variable power supply.

### 8.1.4 Test data

| | | | |
|---|---|---|---|
| EUT Power requirements: | ☐ AC | ☐ DC | ☒ Battery |
| If EUT is an AC or a DC powered, was the noticeable output power variation observed? | ☐ YES | ☐ NO | ☐ N/A |
| If EUT is battery operated, was the testing performed using fresh batteries? | ☐ YES | ☐ NO | ☐ N/A |
| If EUT is rechargeable battery operated, was the testing performed using fully charged batteries? | ☐ YES | ☐ NO | ☐ N/A |

## 8.2 Number of frequencies

### 8.2.1 References, definitions and limits

**FCC §15.31:**

(m) Measurements on intentional radiators or receivers shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table.

***Table 8.2-1:*** *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.

### 8.2.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | G. Tepelena | Test date | October 14, 2021 |

### 8.2.3 Observations, settings and special notes

**ANSI C63.10, Clause 5.6.2.1:**

The number of channels tested can be reduced by measuring the center channel bandwidth first and then applying the following relaxations as appropriate:

a) For each operating mode, if the measured channel bandwidth on the middle channel is at least 150% of the minimum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.

b) For multiple-input multiple-output (MIMO) systems, if the measured channel bandwidth on testing the middle channel exceeds the minimum permitted bandwidth by more than 50% on one transmit chain, then it is not necessary to repeat testing on the other chains.

c) If the measured channel bandwidth on the middle channel is less than 50% of the maximum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.

**ANSI C63.10, Clause 5.6.2.2:**

For devices with multiple operating modes, measurements on the middle channel can be used to determine the worst-case mode(s). The worst-case modes are as follows:

a) Band edge requirements—Measurements on the mode with the widest bandwidth can be used to cover the same channel (center frequency) on modes with narrower bandwidth that have the same or lower output power for each modulation family (e.g., OFDM and direct sequence spread spectrum).

b) Spurious emissions—Measure the mode with the highest output power and the mode with the highest output power spectral density for each modulation family (e.g., OFDM and direct sequence spread spectrum).

c) In-band PSD—Measurements on the mode with the narrowest bandwidth can be used to cover all modes within the same modulation family of an equal or lower output power provided the result is less than 50% of the limit.

### 8.2.4 Test data

***Table 8.2-2:*** *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 |
|---|---|---|---|---|---|
| 2400 | 2483.5 | 83.5 | 2402 | 2440 | 2480 |

## 8.3 Antenna requirement

### 8.3.1 References, definitions and limits

**FCC §15.203:**

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

**FCC §15.247:**

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### 8.3.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | G. Tepelena | Test date | October 14, 2021 |

### 8.3.3 Observations, settings and special notes

None

### 8.3.4 Test data

| | | | |
|---|---|---|---|
| Must the EUT be professionally installed? | ☐ YES | ☒ NO | |
| Does the EUT have detachable antenna(s)? | ☐ YES | ☒ NO | |
| If detachable, is the antenna connector(s) non-standard? | ☐ YES | ☐ NO | ☒ N/A |

***Table 8.3-1:*** *Antenna information*

| Antenna type | Manufacturer | Model number | Maximum gain | Connector type |
|---|---|---|---|---|
| PCB internal | - | - | 0.6 dBi | - |

## 8.4 Minimum 6 dB bandwidth for DTS systems

### 8.4.1 References, definitions and limits

**FCC §15.247:**

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

### 8.4.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | G. Tepelena | Test date | October 14, 2021 |

### 8.4.3 Test equipment used

| Equipment | Manufacturer | Model no. | Asset no. | Cal cycle | Next cal. |
|---|---|---|---|---|---|
| EMI receiver (20 Hz ÷ 8 GHz) | R&S | ESU8 | 100202 | 2021-01 | 2022-01 |
| EMI receiver (20 Hz ÷ 44 GHz) | R&S | ESW44 | 101620 | 2021-08 | 2022-08 |
| Trilog Antenna (30 MHz ÷ 7 GHz) | Schwarzbeck | VULB 9162 | 9162-025 | 2021-07 | 2024-07 |
| Bilog antenna (1 ÷ 18 GHz) | Schwarzbeck | STLP 9148 | 9148-123 | 2021-07 | 2024-07 |
| Horn antenna (4 ÷ 40 GHz) | RFSpin | DRH40 | 061106A40 | 2020-02 | 2023-02 |
| Preamplifier (1 ÷ 18 GHz) | Schwarzbeck | BBV 9718 | 9718-137 | 2021-09 | 2022-09 |
| Preamplifier (18 ÷ 40 GHz) | Miteq | JS44-18004000-35-8P-R | 1.627 | 2021-09 | 2022-09 |
| Controller | Maturo | FCU3.0 | 10041 | NCR | NCR |
| Tilt antenna mast | Maturo | TAM4.0-E | 10042 | NCR | NCR |
| Turntable | Maturo | TT4.0-5T | 2.527 | NCR | NCR |
| Semi-anechoic chamber | Nemko | 10m semi-anechoic chamber | 530 | 2021-09 | 2024-09 |
| Shielded room | Siemens | 10m control room | 1947 | NCR | NCR |

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

### 8.4.4 Observations, settings and special notes

The test was performed as per KDB 558074, section 8.2 with reference to ANSI C63.10 subclause 11.8.
Spectrum analyser settings:

| | |
|---|---|
| Resolution bandwidth | 6 dB BW: 100 kHz; 99% OBW: 1–5% of OBW |
| Video bandwidth | ≥3 × RBW |
| Frequency span | 30 MHz for 20 MHz channel |
| Detector mode | Peak |
| Trace mode | Max Hold |

## 8.4.5 Test data

***Table 8.4-1:*** *99% occupied bandwidth results*

| Modulation | Frequency, MHz | 99% occupied bandwidth, kHz |
|---|---|---|
| GFSK | 2402 | 2118 |
| | 2440 | 2131 |
| | 2480 | 2141 |

Notes: There is no 99% occupied bandwidth limit in the standard's requirements, the measurement results provided for information purposes only.

## Test data, continued

***Table 8.4-2:*** *6 dB bandwidth results*

| Modulation | Frequency, MHz | 6 dB bandwidth, MHz | Minimum limit, MHz | Margin, MHz |
|---|---|---|---|---|
| GFSK | 2402 | 1.569 | 0.500 | 1.069 |
| | 2440 | 1.482 | 0.500 | 0.982 |
| | 2480 | 1.369 | 0.500 | 0.869 |

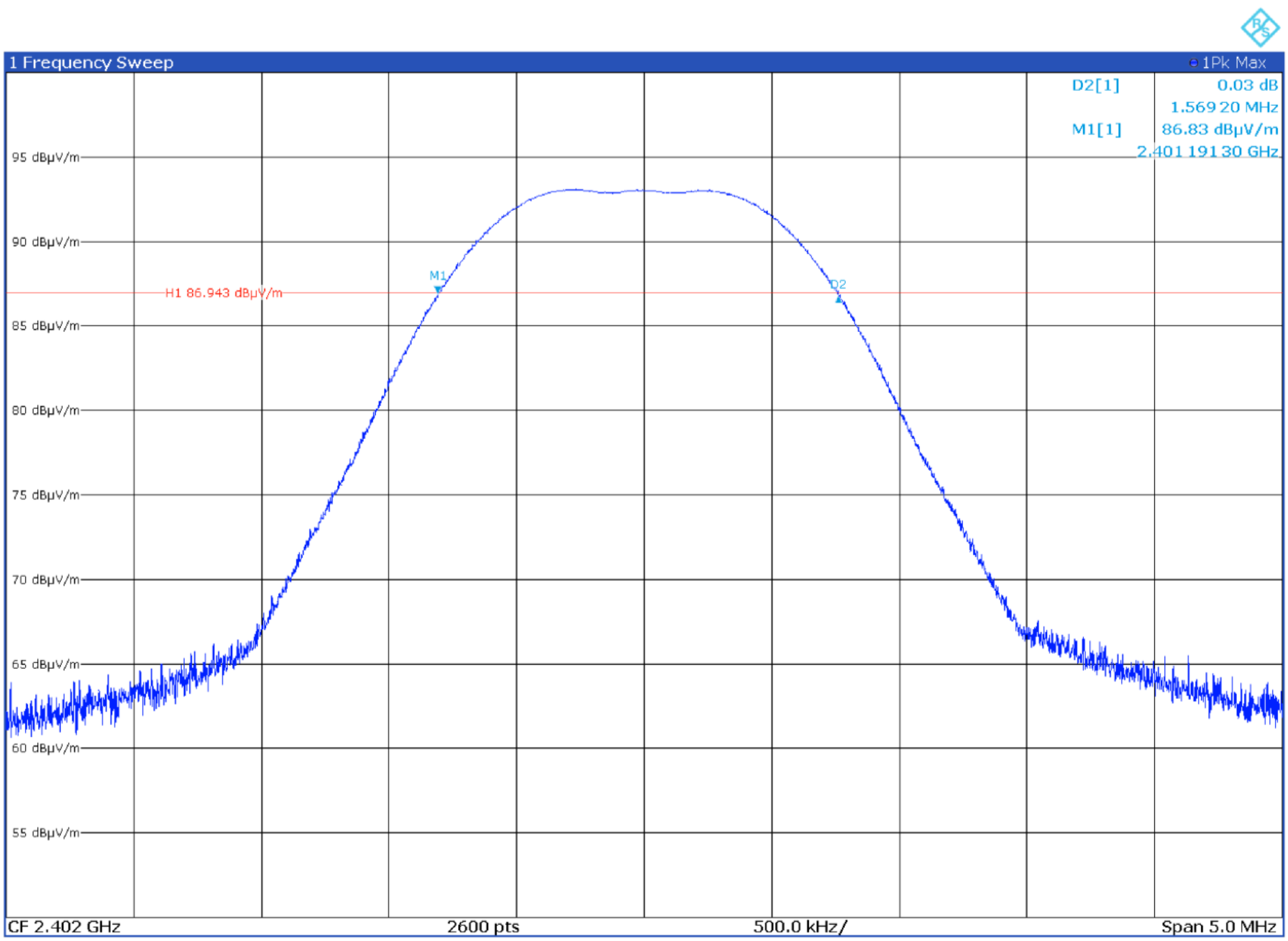



Figure 8.4-1: 6 dB bandwidth on Low channel

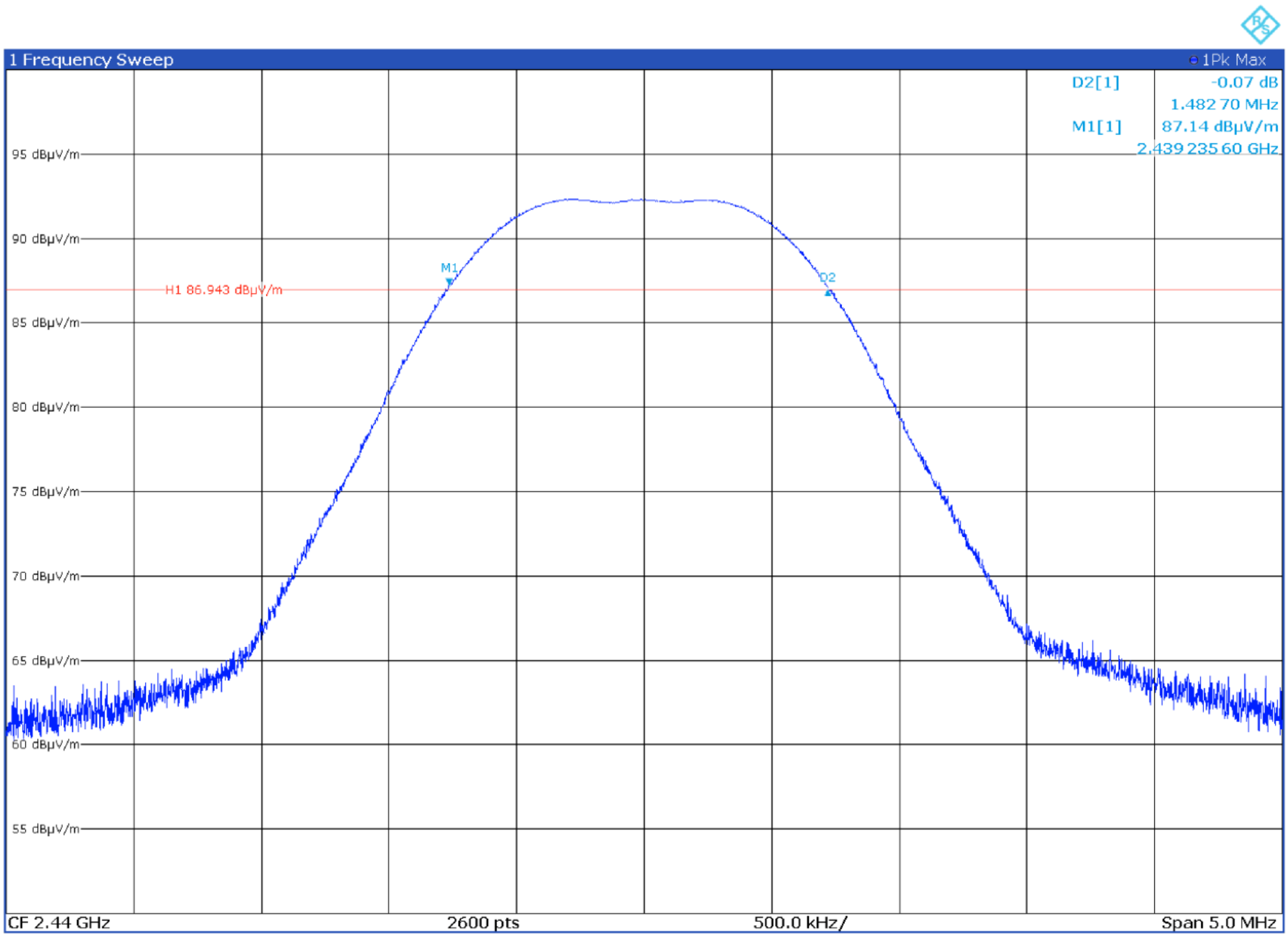



Figure 8.4-2: 6 dB bandwidth on Middle channel

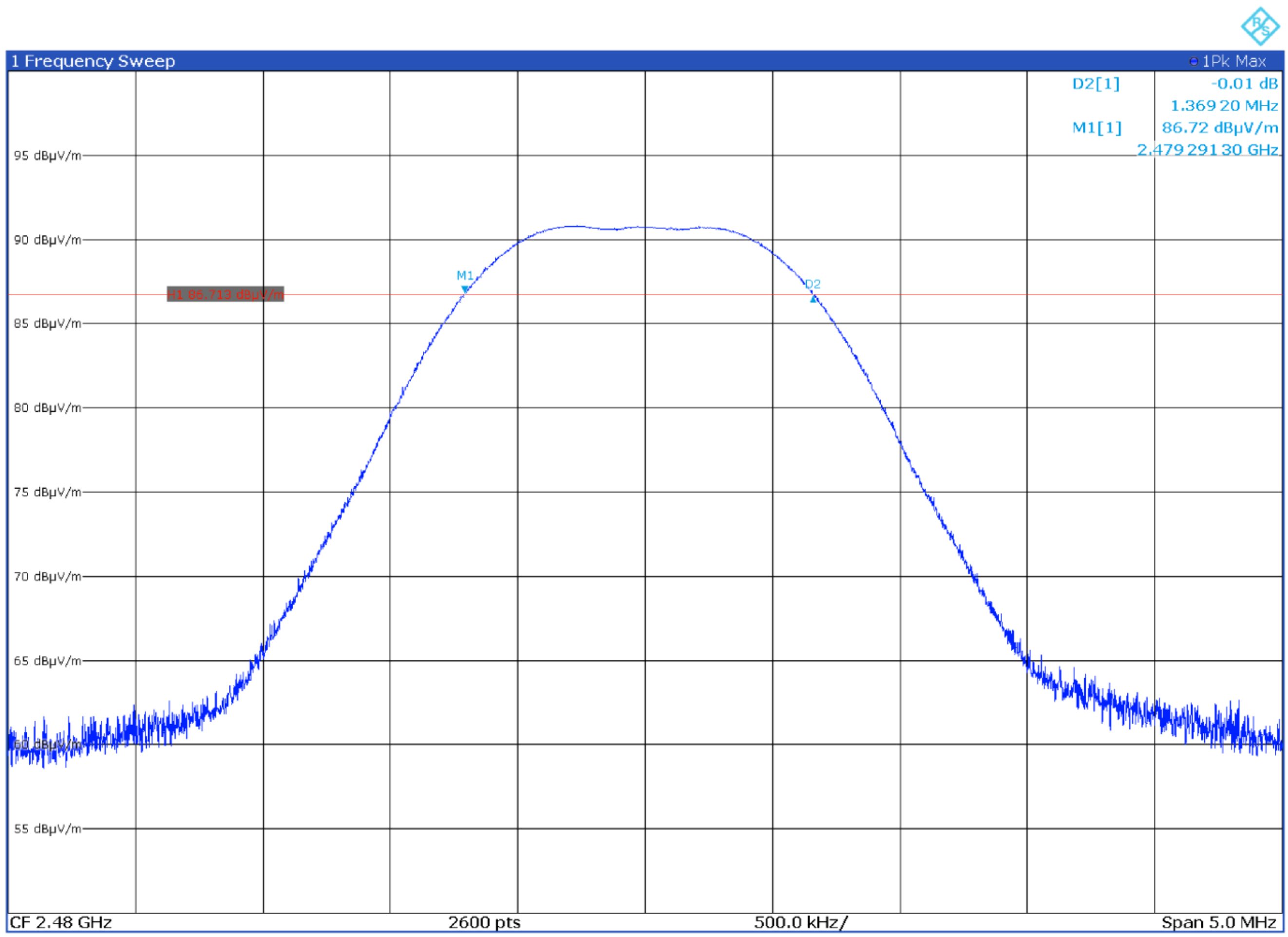
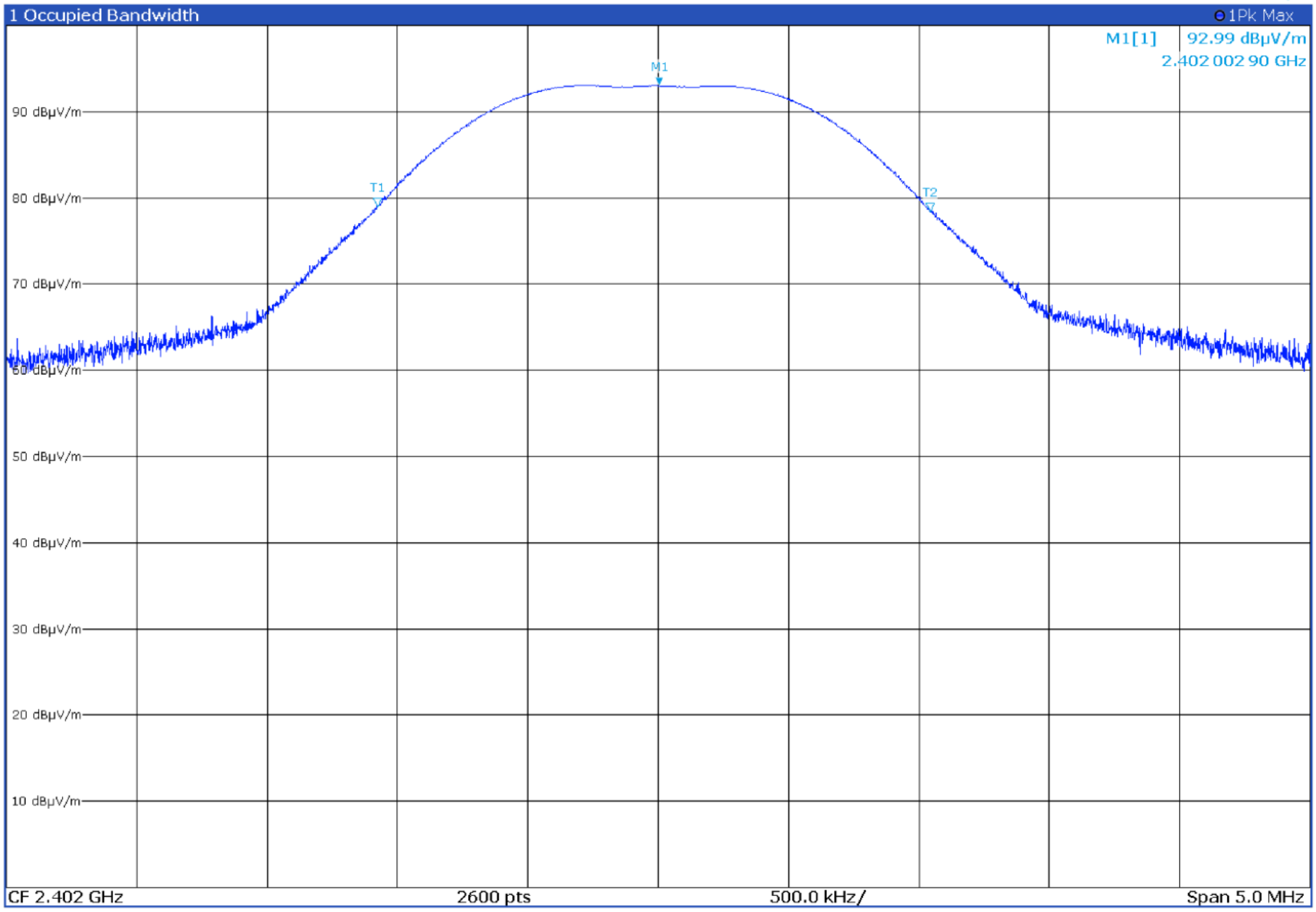
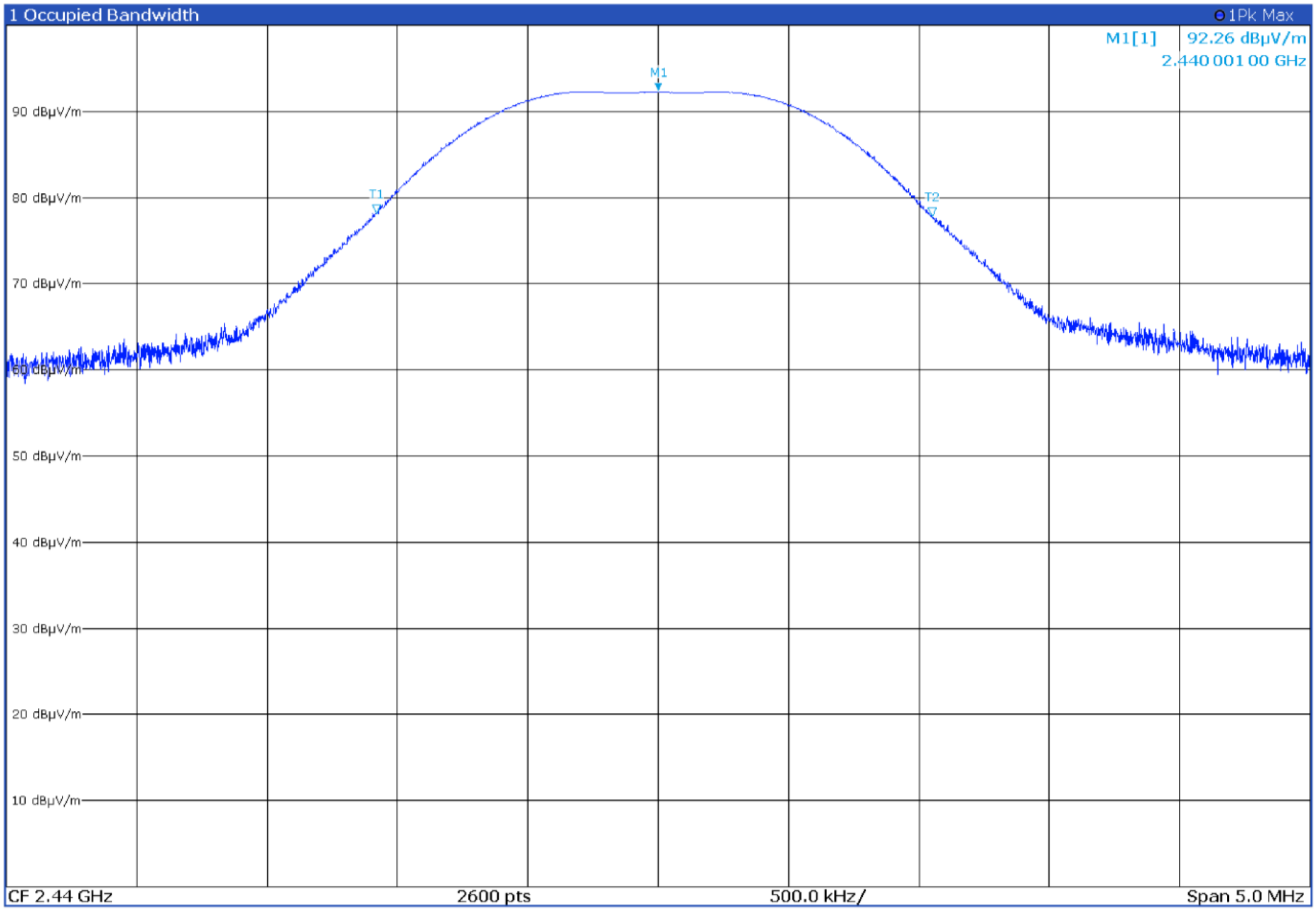



***Figure 8.4-3:*** *6 dB bandwidth on High channel BW=1.369 MHz*



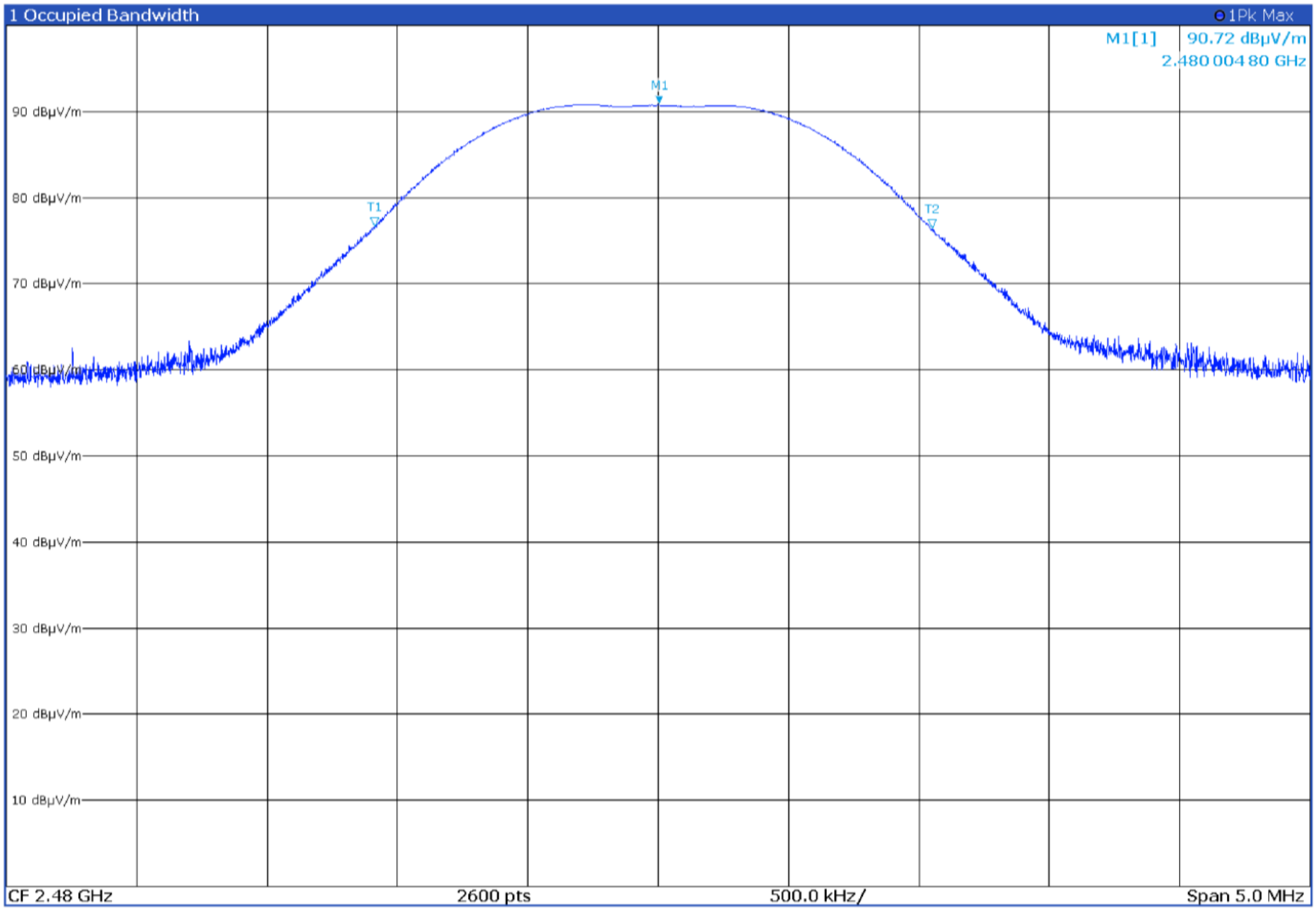

| Type | Ref | Trc | X-Value | Y-Value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | **2.402 002 9 GHz** | **92.99 dBµV/m** | Occ Bw | **2.118 280 537 MHz** |
| T1 | | 1 | 2.400 924 08 GHz | 78.96 dBµV/m | Occ Bw Centroid | 2.401 983 225 GHz |
| T2 | | 1 | 2.403 042 37 GHz | 78.36 dBµV/m | Occ Bw Freq Offset | -16.774 966 743 kHz |

***Figure 8.4-4:*** *99% occupied bandwidth on low channel BW=2.118 MHz*




| Type | Ref | Trc | X-Value | Y-Value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | **2.440 001 GHz** | **92.26 dBµV/m** | Occ Bw | **2.131 790 413 MHz** |
| T1 | | 1 | 2.438 918 9 GHz | 78.18 dBµV/m | Occ Bw Centroid | 2.439 984 8 GHz |
| T2 | | 1 | 2.441 050 7 GHz | 77.77 dBµV/m | Occ Bw Freq Offset | -15.200 103 783 kHz |

***Figure 8.4-5:*** *99% occupied bandwidth on middle channel BW=2.131 MHz*




| | | | | | | |
|---|---|---|---|---|---|---|
| M1 | | 1 | **2.480 004 8 GHz** | **90.72 dBµV/m** | Occ Bw | **2.141 308 905 MHz** |
| T1 | | 1 | 2.478 910 5 GHz | 76.70 dBµV/m | Occ Bw Centroid | 2.479 981 154 GHz |
| T2 | | 1 | 2.481 051 81 GHz | 76.40 dBµV/m | Occ Bw Freq Offset | -18.846 175 632 kHz |

***Figure 8.4-6:*** *99% occupied bandwidth on high channel BW=2.141 MHz*

## 8.5 Transmitter output power and e.i.r.p. requirements for DTS in 2.4 GHz

### 8.5.1 References, definitions and limits

**FCC §15.247:**

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(3) For systems using digital modulation in the 2400–2483.5 MHz band: 1 W (30 dBm). As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(c) Operation with directional antenna gains greater than 6 dBi.

(1) Fixed point-to-point operation:

(i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(iii) Fixed, point-to-point operation, as used in paragraphs (c)(1)(i) and (c)(1)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

(B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

(iii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

(iv) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

References, definitions and limits, continued

### 8.5.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | G. Tepelena | Test date | October 15, 2021 |

### 8.5.3 Test equipment used

| Equipment | Manufacturer | Model no. | Asset no. | Cal cycle | Next cal. |
|---|---|---|---|---|---|
| EMI receiver (20 Hz ÷ 8 GHz) | R&S | ESU8 | 100202 | 2021-01 | 2022-01 |
| EMI receiver (20 Hz ÷ 44 GHz) | R&S | ESW44 | 101620 | 2021-08 | 2022-08 |
| Trilog Antenna (30 MHz ÷ 7 GHz) | Schwarzbeck | VULB 9162 | 9162-025 | 2021-07 | 2024-07 |
| Bilog antenna (1 ÷ 18 GHz) | Schwarzbeck | STLP 9148 | 9148-123 | 2021-07 | 2024-07 |
| Horn antenna (4 ÷ 40 GHz) | RFSpin | DRH40 | 061106A40 | 2020-02 | 2023-02 |
| Preamplifier (1 ÷ 18 GHz) | Schwarzbeck | BBV 9718 | 9718-137 | 2021-09 | 2022-09 |
| Preamplifier (18 ÷ 40 GHz) | Miteq | JS44-18004000-35-8P-R | 1.627 | 2021-09 | 2022-09 |
| Controller | Maturo | FCU3.0 | 10041 | NCR | NCR |
| Tilt antenna mast | Maturo | TAM4.0-E | 10042 | NCR | NCR |
| Turntable | Maturo | TT4.0-5T | 2.527 | NCR | NCR |
| Semi-anechoic chamber | Nemko | 10m semi-anechoic chamber | 530 | 2021-09 | 2024-09 |
| Shielded room | Siemens | 10m control room | 1947 | NCR | NCR |

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

### 8.5.4 Observations, settings and special notes

The test was performed as per KDB 558074, section 8.3 with reference to ANSI C63.10 subclause 11.9.1 (peak power) using method RBW≥DTS bandwidth (Maximum peak conducted output power).
Spectrum analyser settings:

| | |
|---|---|
| Resolution bandwidth | > DTS bandwidth |
| Video bandwidth | ≥3 × RBW |
| Frequency span | 2.5 MHz |
| Detector mode | Peak |
| Trace mode | Max Hold |

### 8.5.5 Test data

***Table 8.5-1:*** *Output power and EIRP results (radiated measurement)*

| Frequency, MHz | Field strength, dBµV/m | EIRP, dBm | EIRP limit, dBm | EIRP margin, dB | Antenna gain, dBi | Output power, dBm | Output power limit, dBm | Output power margin, dB |
|---|---|---|---|---|---|---|---|---|
| 2402 | 93.00 | -2.23 | 36.00 | 38.23 | 0.60 | -2.83 | 30.00 | 32.83 |
| 2440 | 92.22 | -3.01 | 36.00 | 39.01 | 0.60 | -3.61 | 30.00 | 33.61 |
| 2480 | 90.70 | -4.53 | 36.00 | 40.53 | 0.60 | -5.13 | 30.00 | 35.13 |

Note: EIRP [dBm] = Field Strength [dBµV/m] – 95.23 [dB]; Output power [dBm] = EIRP [dBm] – Antenna gain [dBi]

Test data, continued

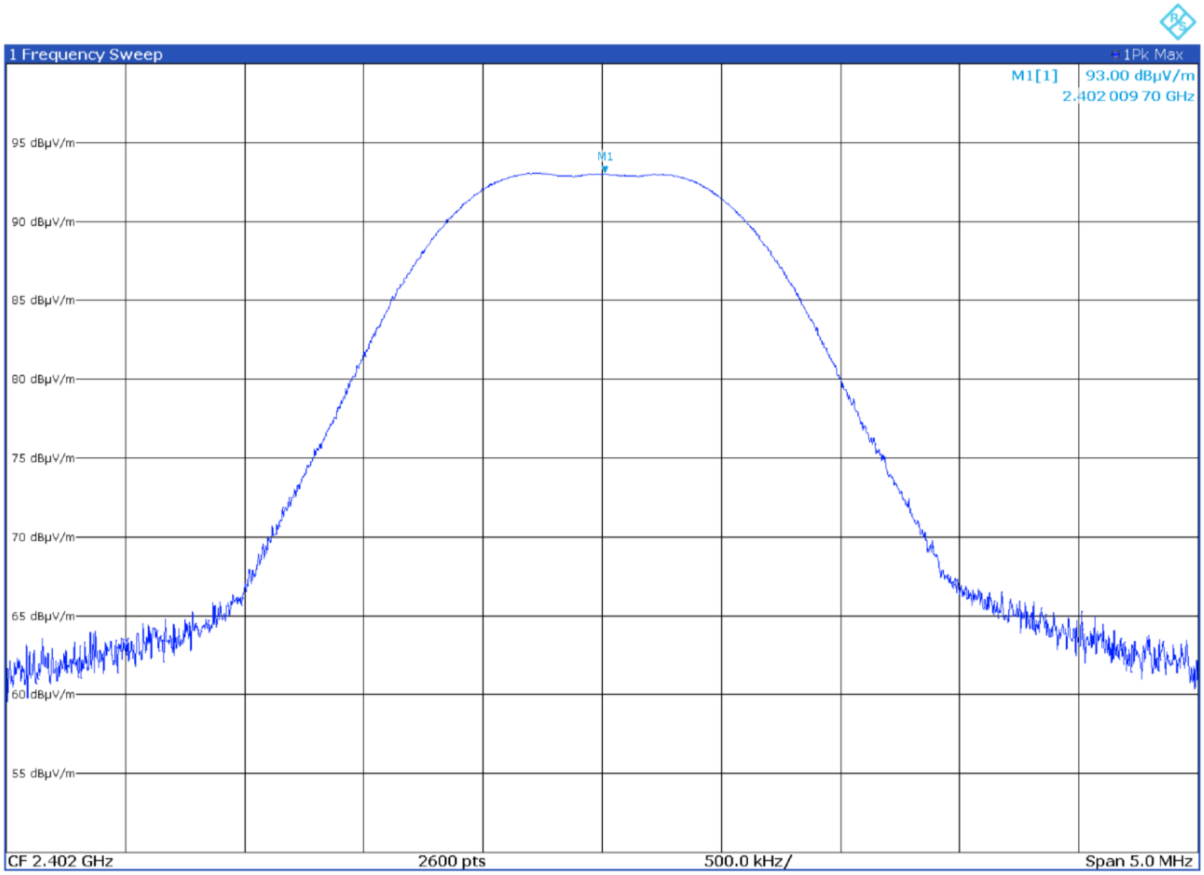



***Figure 8.5-1:*** *Output power on low channel*

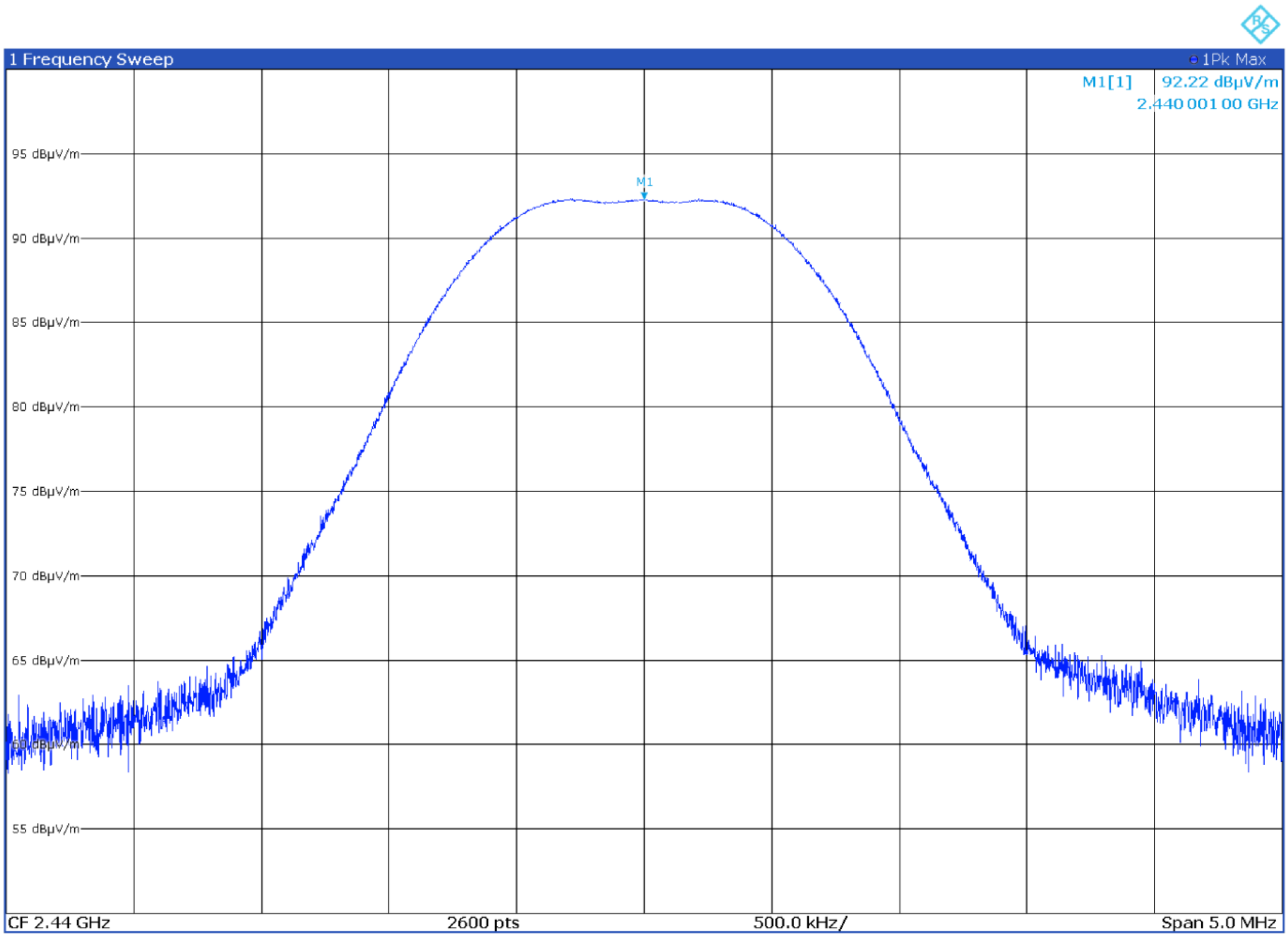



***Figure 8.5-2:*** *Output power on mid channel*

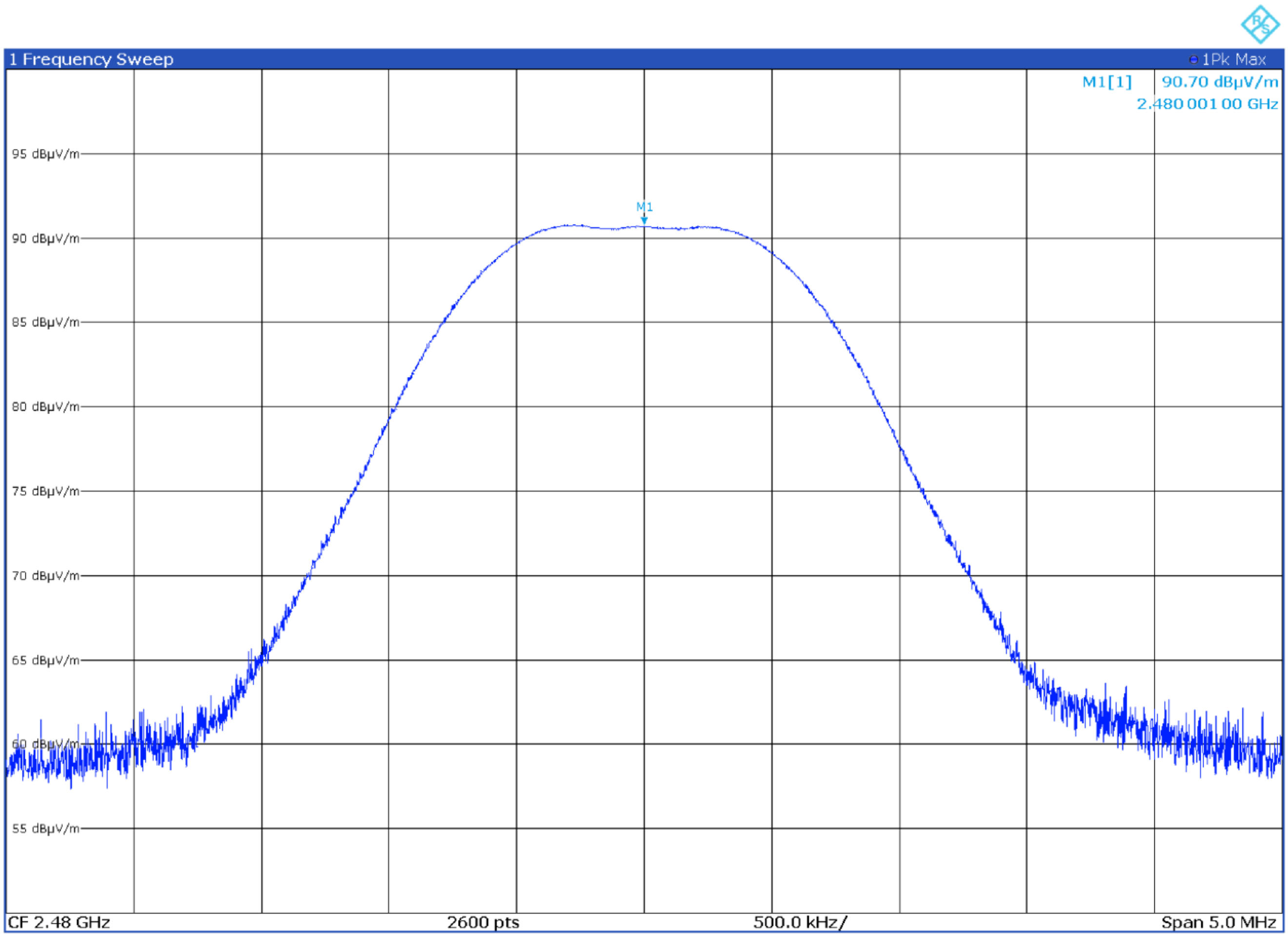



***Figure 8.5-3:*** *Output power on high channel*

## 8.6 Spurious (out-of-band) unwanted emissions

### 8.6.1 References, definitions and limits

**FCC §15.247:**

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

***Table 8.6-1:*** *FCC §15.209– Radiated emission limits*

| | Field strength of emissions | | |
|---|---|---|---|
| **Frequency, MHz** | **µV/m** | **dBµV/m** | **Measurement distance, m** |
| 0.009–0.490 | 2400/F | 67.6 – 20 × $\log_{10}$(F) | 300 |
| 0.490–1.705 | 24000/F | 87.6 – 20 × $\log_{10}$(F) | 30 |
| 1.705–30.0 | 30 | 29.5 | 30 |
| 30–88 | 100 | 40.0 | 3 |
| 88–216 | 150 | 43.5 | 3 |
| 216–960 | 200 | 46.0 | 3 |
| above 960 | 500 | 54.0 | 3 |

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

***Table 8.6-2:*** *FCC restricted frequency bands*

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090–0.110 | 16.42–16.423 | 399.9–410 | 4.5–5.15 |
| 0.495–0.505 | 16.69475–16.69525 | 608–614 | 5.35–5.46 |
| 2.1735–2.1905 | 16.80425–16.80475 | 960–1240 | 7.25–7.75 |
| 4.125–4.128 | 25.5–25.67 | 1300–1427 | 8.025–8.5 |
| 4.17725–4.17775 | 37.5–38.25 | 1435–1626.5 | 9.0–9.2 |
| 4.20725–4.20775 | 73–74.6 | 1645.5–1646.5 | 9.3–9.5 |
| 6.215–6.218 | 74.8–75.2 | 1660–1710 | 10.6–12.7 |
| 6.26775–6.26825 | 108–121.94 | 1718.8–1722.2 | 13.25–13.4 |
| 6.31175–6.31225 | 123–138 | 2200–2300 | 14.47–14.5 |
| 8.291–8.294 | 149.9–150.05 | 2310–2390 | 15.35–16.2 |
| 8.362–8.366 | 156.52475–156.52525 | 2483.5–2500 | 17.7–21.4 |
| 8.37625–8.38675 | 156.7–156.9 | 2690–2900 | 22.01–23.12 |
| 8.41425–8.41475 | 162.0125–167.17 | 3260–3267 | 23.6–24.0 |
| 12.29–12.293 | 167.72–173.2 | 3332–3339 | 31.2–31.8 |
| 12.51975–12.52025 | 240–285 | 3345.8–3358 | 36.43–36.5 |
| 12.57675–12.57725 | 322–335.4 | 3600–4400 | Above 38.6 |
| 13.36–13.41 | | | |

## 8.6.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | G. Tepelena | Test date | October 15, 2021 |

## 8.6.3 Test equipment used

| Equipment | Manufacturer | Model no. | Asset no. | Cal cycle | Next cal. |
|---|---|---|---|---|---|
| EMI receiver (20 Hz ÷ 8 GHz) | R&S | ESU8 | 100202 | 2021-01 | 2022-01 |
| EMI receiver (20 Hz ÷ 44 GHz) | R&S | ESW44 | 101620 | 2021-08 | 2022-08 |
| Trilog Antenna (30 MHz ÷ 7 GHz) | Schwarzbeck | VULB 9162 | 9162-025 | 2021-07 | 2024-07 |
| Bilog antenna (1 ÷ 18 GHz) | Schwarzbeck | STLP 9148 | 9148-123 | 2021-07 | 2024-07 |
| Horn antenna (4 ÷ 40 GHz) | RFSpin | DRH40 | 061106A40 | 2020-02 | 2023-02 |
| Preamplifier (1 ÷ 18 GHz) | Schwarzbeck | BBV 9718 | 9718-137 | 2021-09 | 2022-09 |
| Preamplifier (18 ÷ 40 GHz) | Miteq | JS44-18004000-35-8P-R | 1.627 | 2021-09 | 2022-09 |
| Controller | Maturo | FCU3.0 | 10041 | NCR | NCR |
| Tilt antenna mast | Maturo | TAM4.0-E | 10042 | NCR | NCR |
| Turntable | Maturo | TT4.0-5T | 2.527 | NCR | NCR |
| Semi-anechoic chamber | Nemko | 10m semi-anechoic chamber | 530 | 2021-09 | 2024-09 |
| Shielded room | Siemens | 10m control room | 1947 | NCR | NCR |

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

## 8.6.4 Observations, settings and special notes

- As part of the current assessment, the test range of 9 kHz to 10th harmonic has been fully considered and compared to the actual frequencies utilized within the EUT. Since the EUT contains a transmitter in the GHz range, the EUT has been deemed compliant without formal testing in the 9 kHz to 30 MHz test range, therefore formal test results (tabular data and/or plots) are not provided within this test report.
- EUT was set to transmit with 100 % duty cycle.
- Radiated measurements were performed at a distance of 3 m.
- DTS emissions in non-restricted frequency bands test was performed as per KDB 558074, section 8.5 with reference to ANSI C63.10 subclause 11.11.
- Since fundamental power was tested using Choose an item.
- DTS emissions in restricted frequency bands test was performed as per KDB 558074, section 8.6 with reference to ANSI C63.10 subclause 11.12.
- DTS band-edge emission measurements test was performed as per KDB 558074, section 8.7 with reference to ANSI C63.10 subclause 11.13.
- Average was calculated from peak results using duty cycle correction factor (DCCF).
- Pulse width = xxx ms, Pulse repetition = every yyy ms (Z pulses within 100 ms) DCCF = 20 × Log10 ((xxx × Z) / 100) = −AAA dB

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 |

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

| | |
|---|---|
| Resolution bandwidth: | 1 MHz |
| Video bandwidth: | 10 Hz |

| | |
|---|---|
| Detector mode: | Peak |
| Trace mode: | Max Hold |

Spectrum analyser settings for conducted spurious emissions measurements:

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

## 8.6.5 Test data

***Table 8.6-3:*** *Radiated field strength measurement results*

| Channel | Frequency, MHz | Peak Field strength, dBµV/m | | Margin, dB | Average Field strength, dBµV/m | | Margin, dB |
|---|---|---|---|---|---|---|---|
| | | Measured | Limit | | Measured | Limit | |
| Low | 2390.0 | 58.20 | 74.00 | 15.80 | 47.31 | 54.00 | 6.69 |
| Low | 2824.0 | 58.69 | 74.00 | 15.31 | 47.77 | 54.00 | 6.23 |
| High | 2874.0 | 58.62 | 74.00 | 15.38 | 47.67 | 54.00 | 6.33 |
| High | 2483.5 | 59.02 | 74.00 | 14.80 | 47.47 | 54.00 | 6.53 |

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

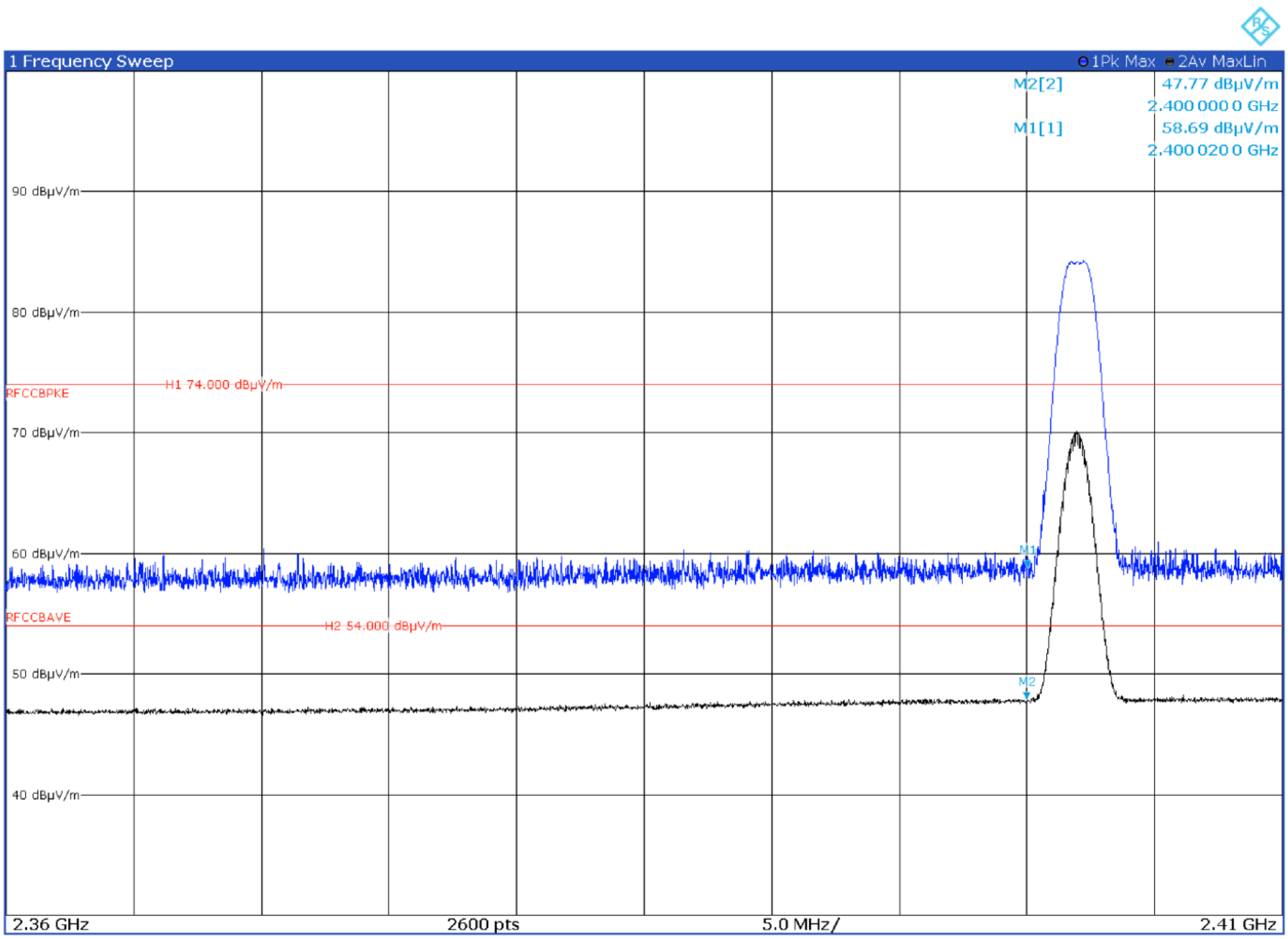



***Figure 8.6-1:*** *Band edge spurious emissions at 2400 MHz vertical polarization*

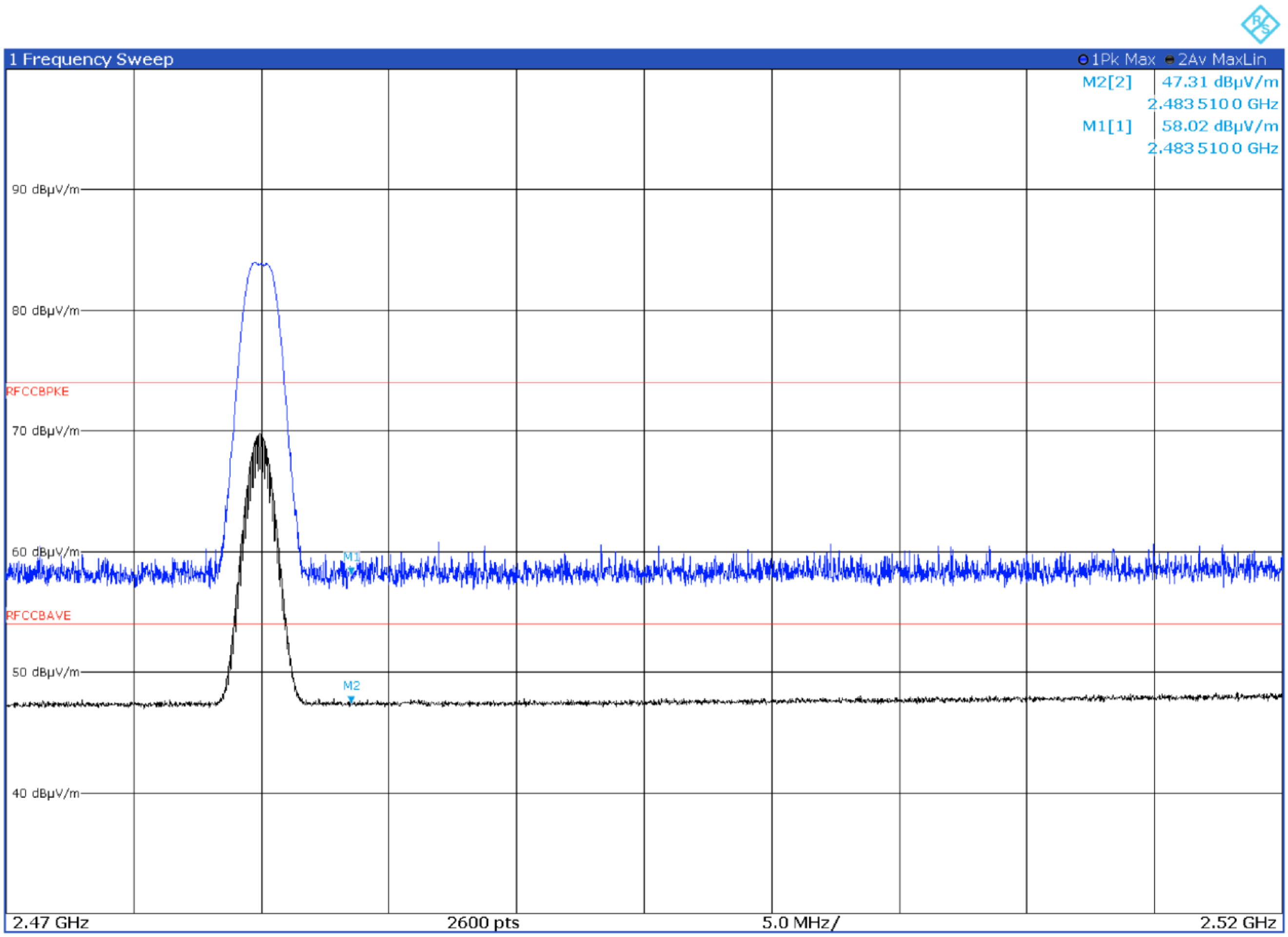



***Figure 8.6-2:*** *Band edge spurious emissions at 2483.5 MHz vertical polarization*

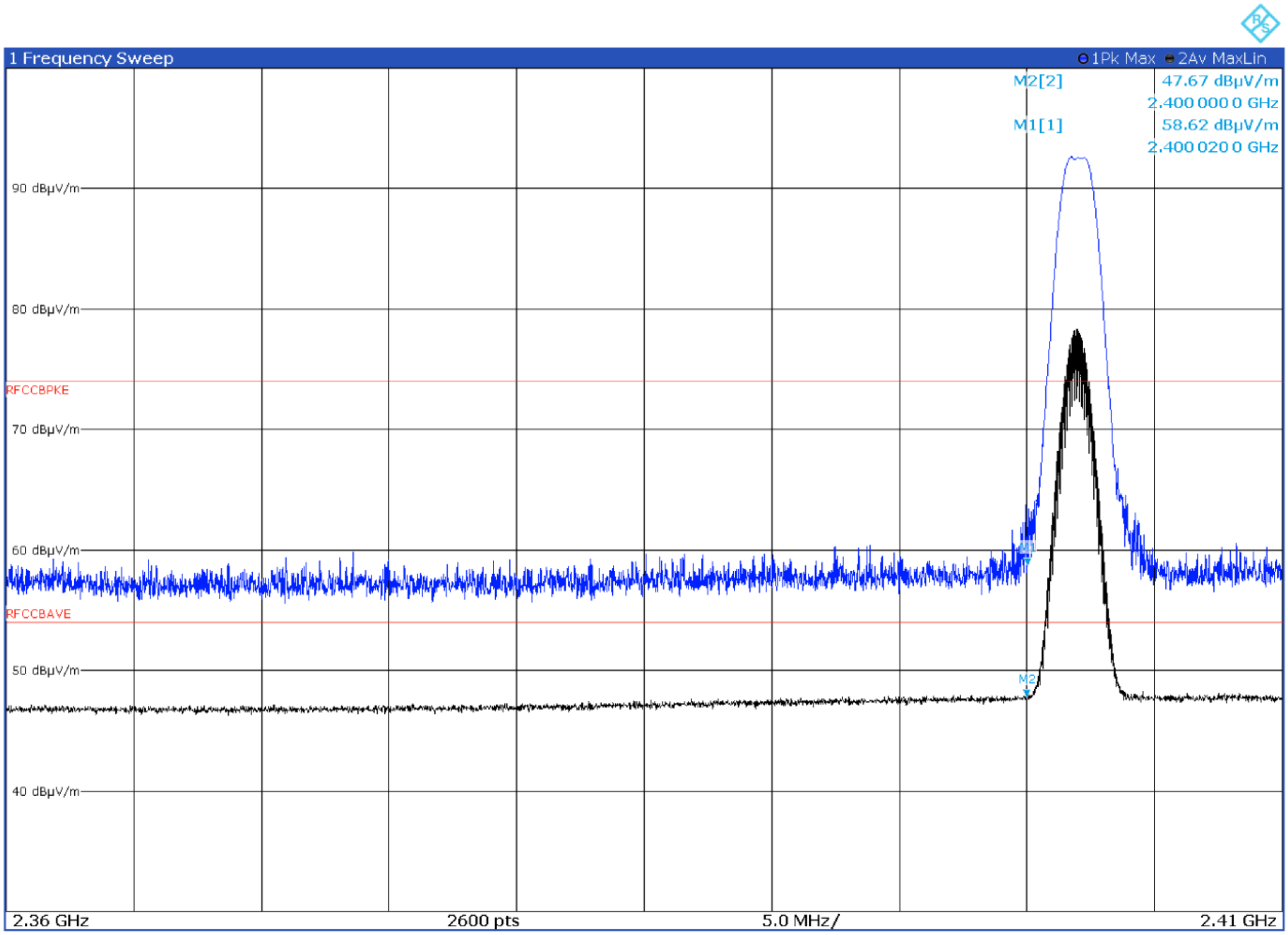



***Figure 8.6-3:*** *Band edge spurious emissions at 2400 MHz horizontal polarization.*

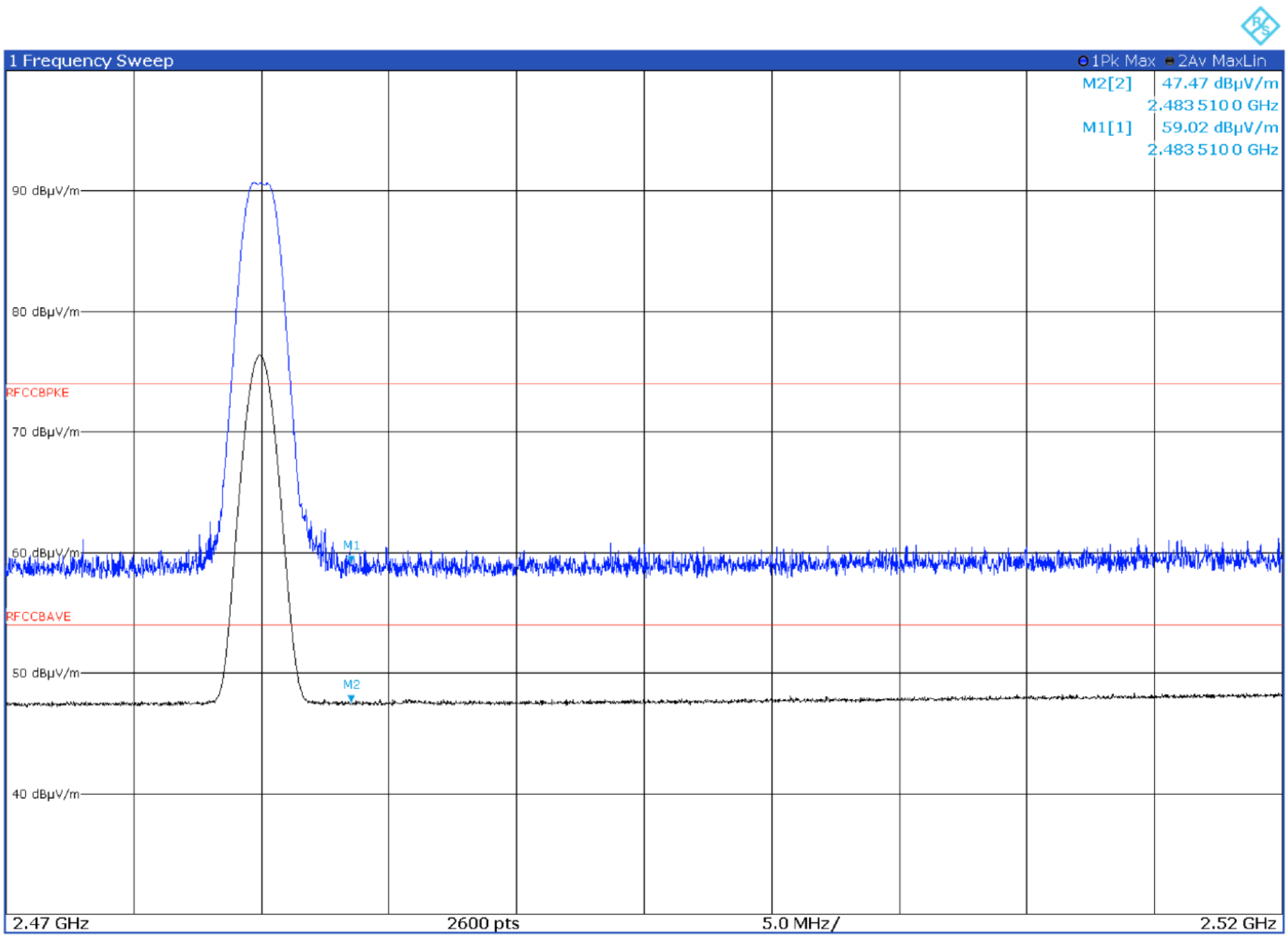



***Figure 8.6-4:*** *Band edge spurious emissions at 2483.5 MHz horizontal polarization*

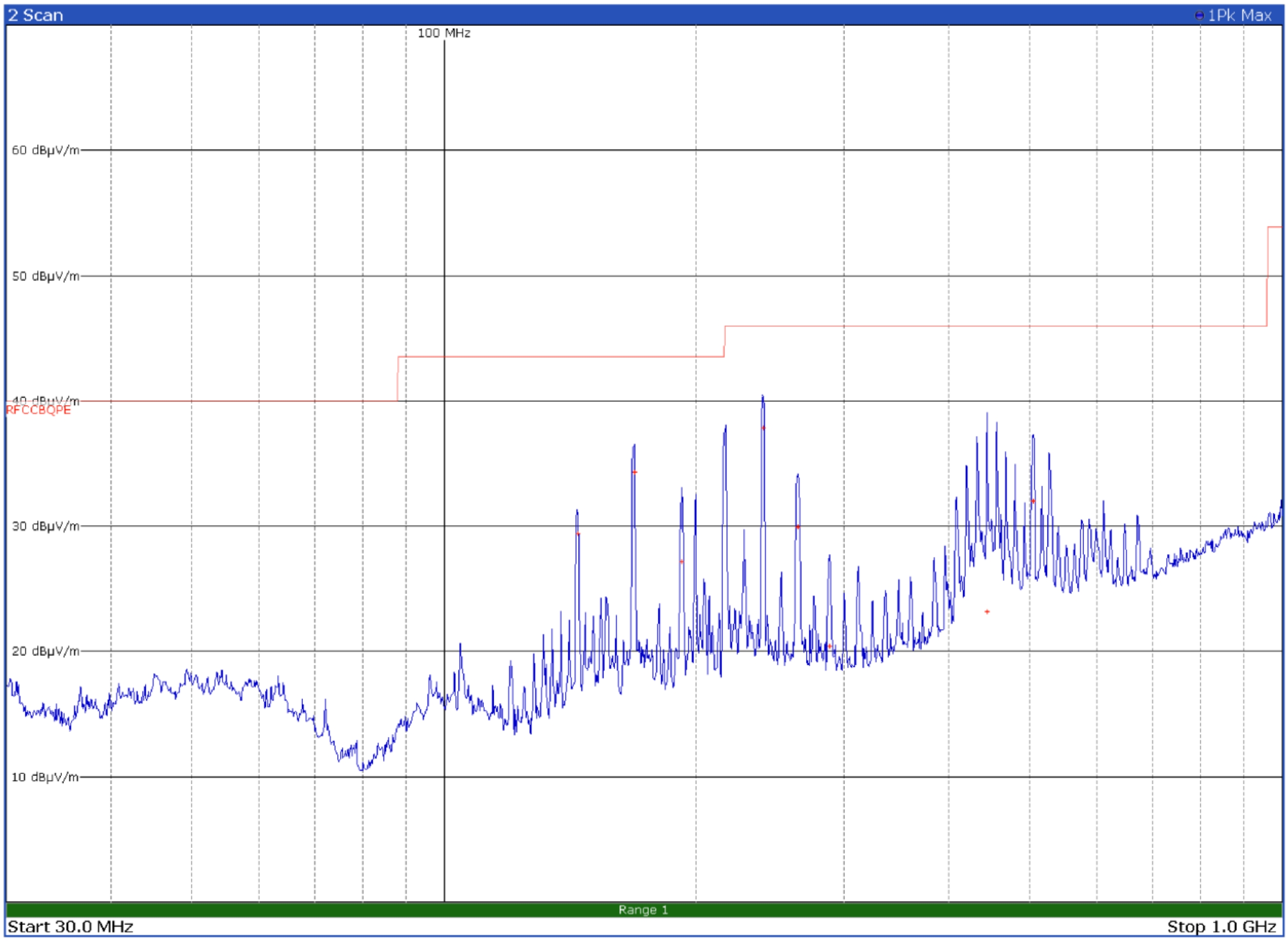



***Figure 8.6-3:*** *Radiated spurious emissions with antenna in horizontal polarization, low channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 144.2100 | 29.4 | 43.5 | -14.1 | QP |
| 168.5400 | 34.4 | 43.5 | -9.1 | QP |
| 192.0000 | 27.2 | 43.5 | -16.3 | QP |
| 240.0000 | 37.9 | 46.0 | -8.1 | QP |
| 264.0900 | 30.0 | 46.0 | -16.0 | QP |
| 288.0900 | 20.5 | 46.0 | -25.5 | QP |
| 444.1500 | 23.2 | 46.0 | -22.8 | QP |
| 504.0000 | 32.0 | 46.0 | -14.0 | QP |

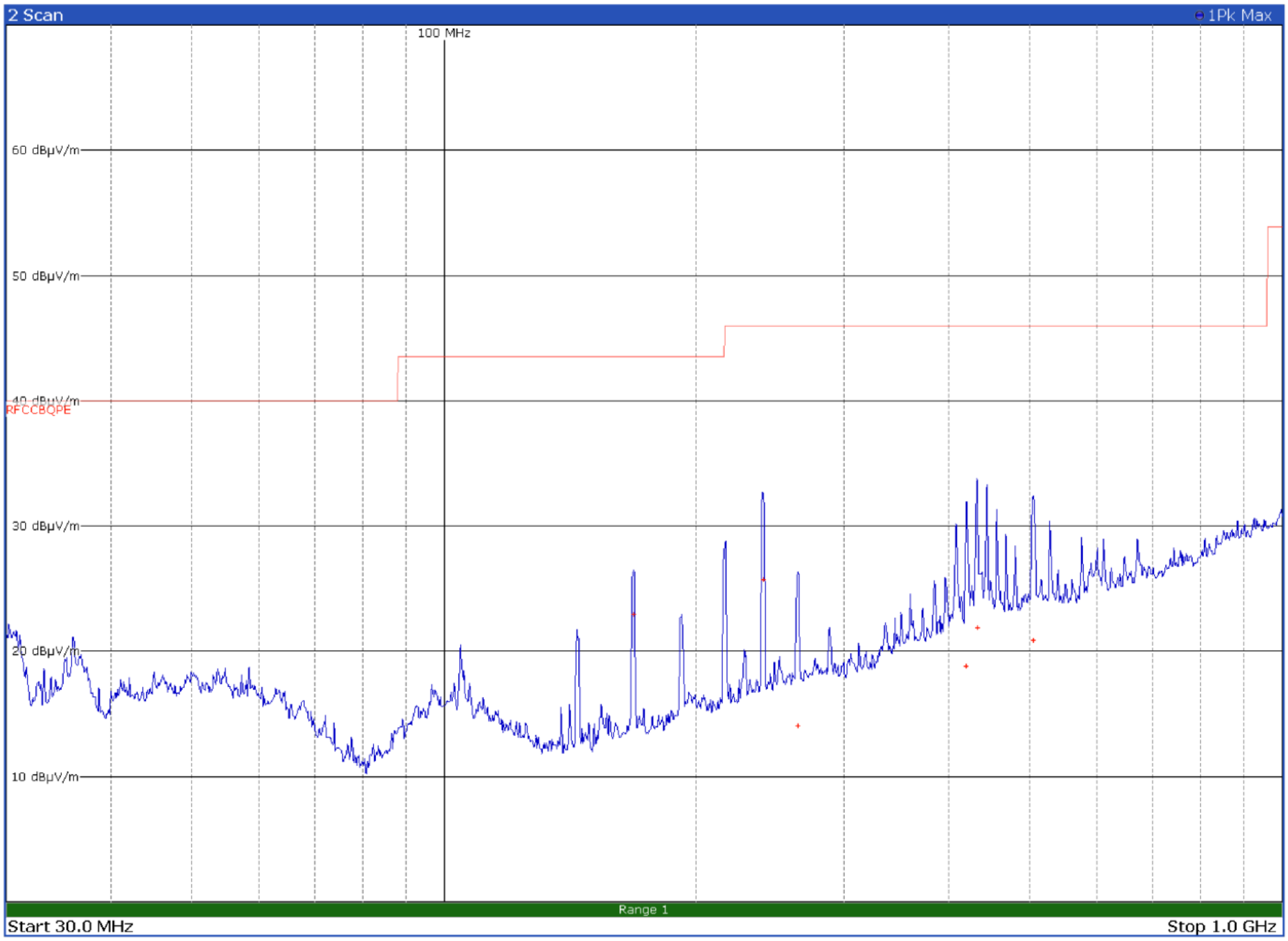



***Figure 8.6-4:*** *Radiated spurious emissions with antenna in vertical polarization, low channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 168.3600 | 23.0 | 43.5 | -20.5 | QP |
| 240.0000 | 25.8 | 46.0 | -20.2 | QP |
| 264.2400 | 14.1 | 46.0 | -31.9 | QP |
| 420.0300 | 18.8 | 46.0 | -27.2 | QP |
| 432.4500 | 21.9 | 46.0 | -24.1 | QP |
| 504.0000 | 21.0 | 46.0 | -25.0 | QP |

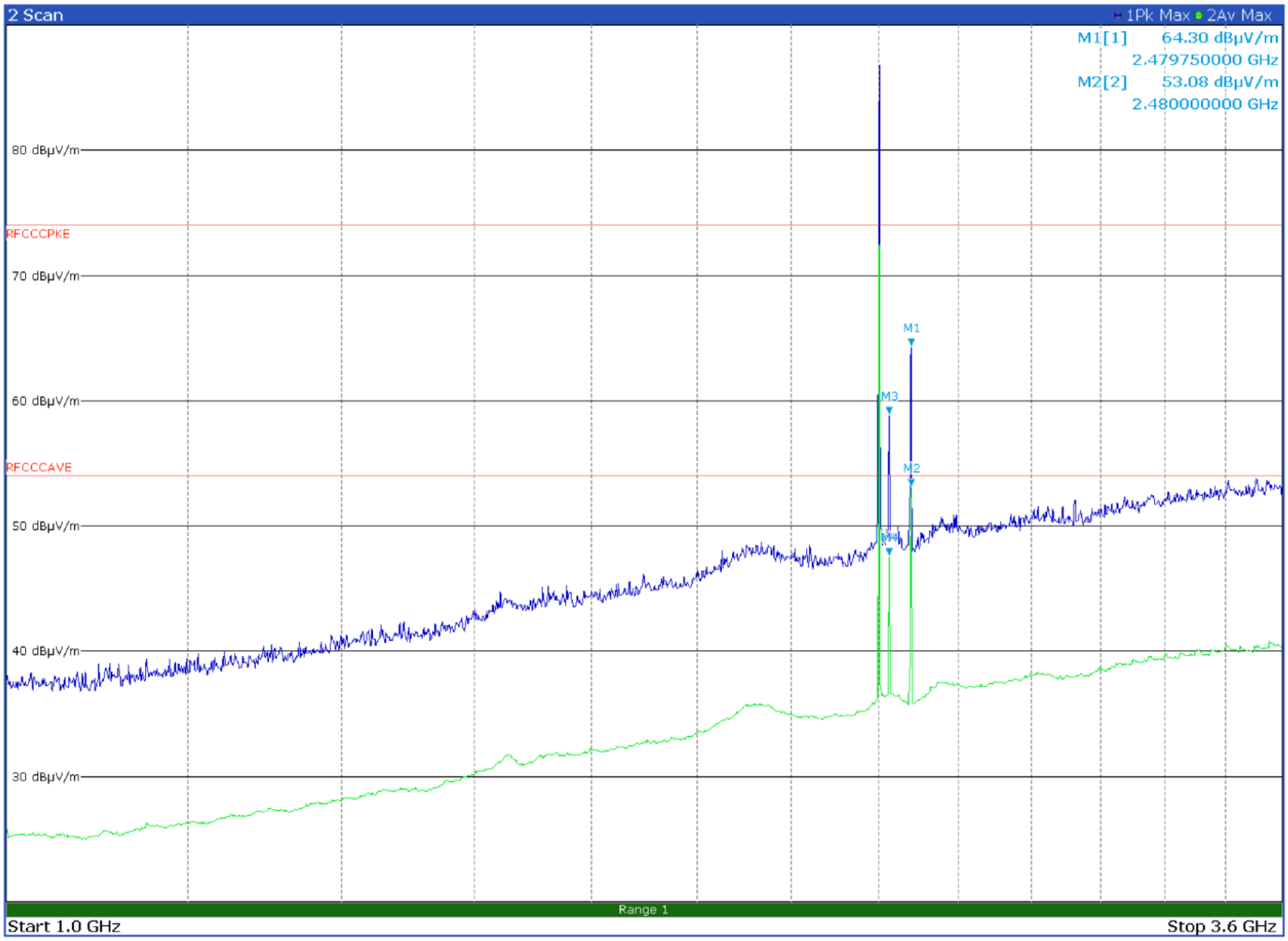



***Figure 8.6-5:*** *Radiated spurious emissions with antenna in horizontal polarization, low channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 2479.7500 | 64.30 | 74.00 | -5.70 | Pk |
| 2480.0000 | 53.08 | 54.00 | -0.92 | Av |

Av detector measured as state in clause 8.5.3

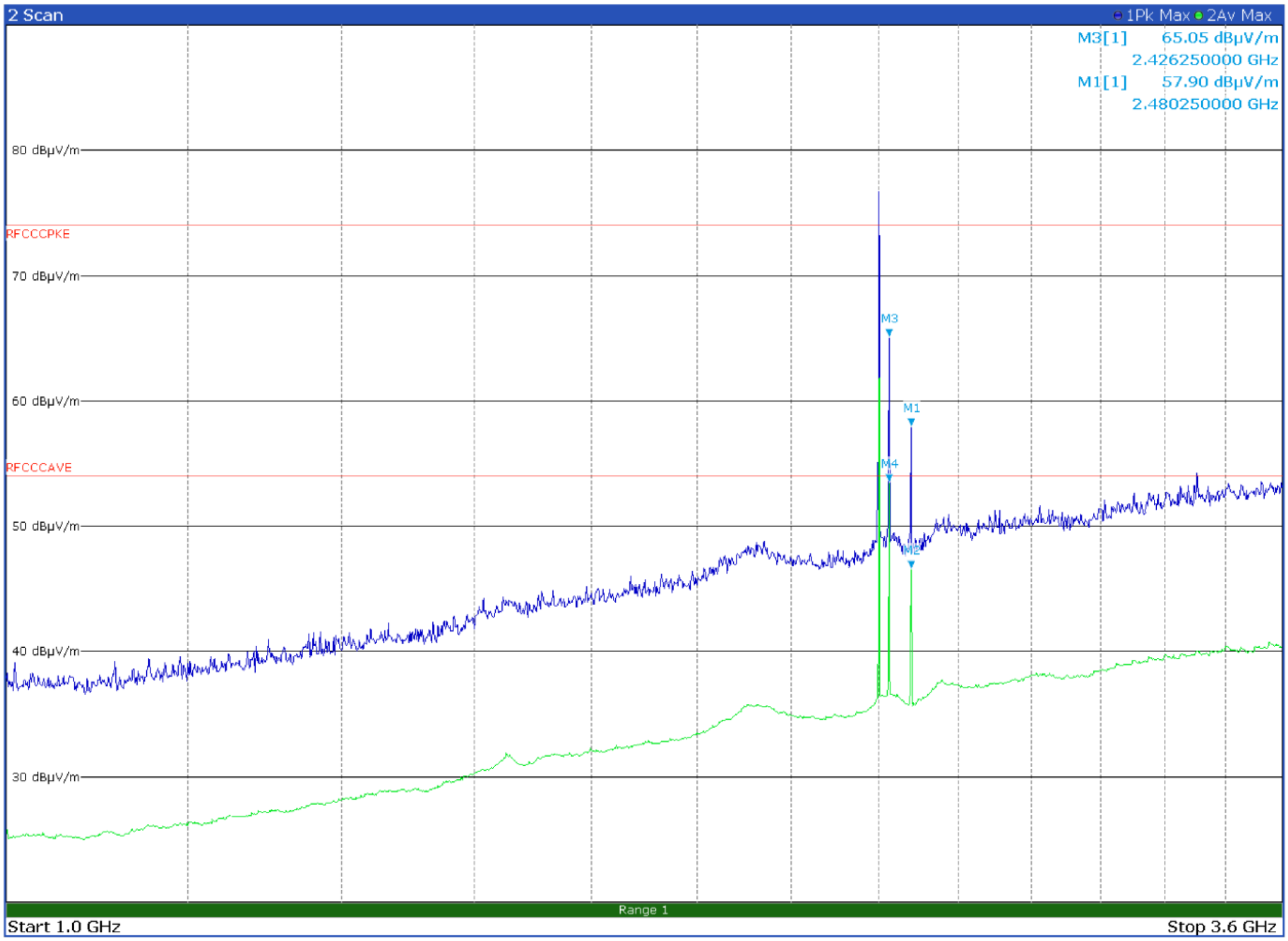



***Figure 8.6-6:*** *Radiated spurious emissions with antenna in vertical polarization, low channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 2426.0000 | 65.05 | 74.00 | -4.95 | Pk |
| 2426.0000 | 53.85 | 54.00 | -0.15 | Av |

Av detector measured as state in clause 8.5.3

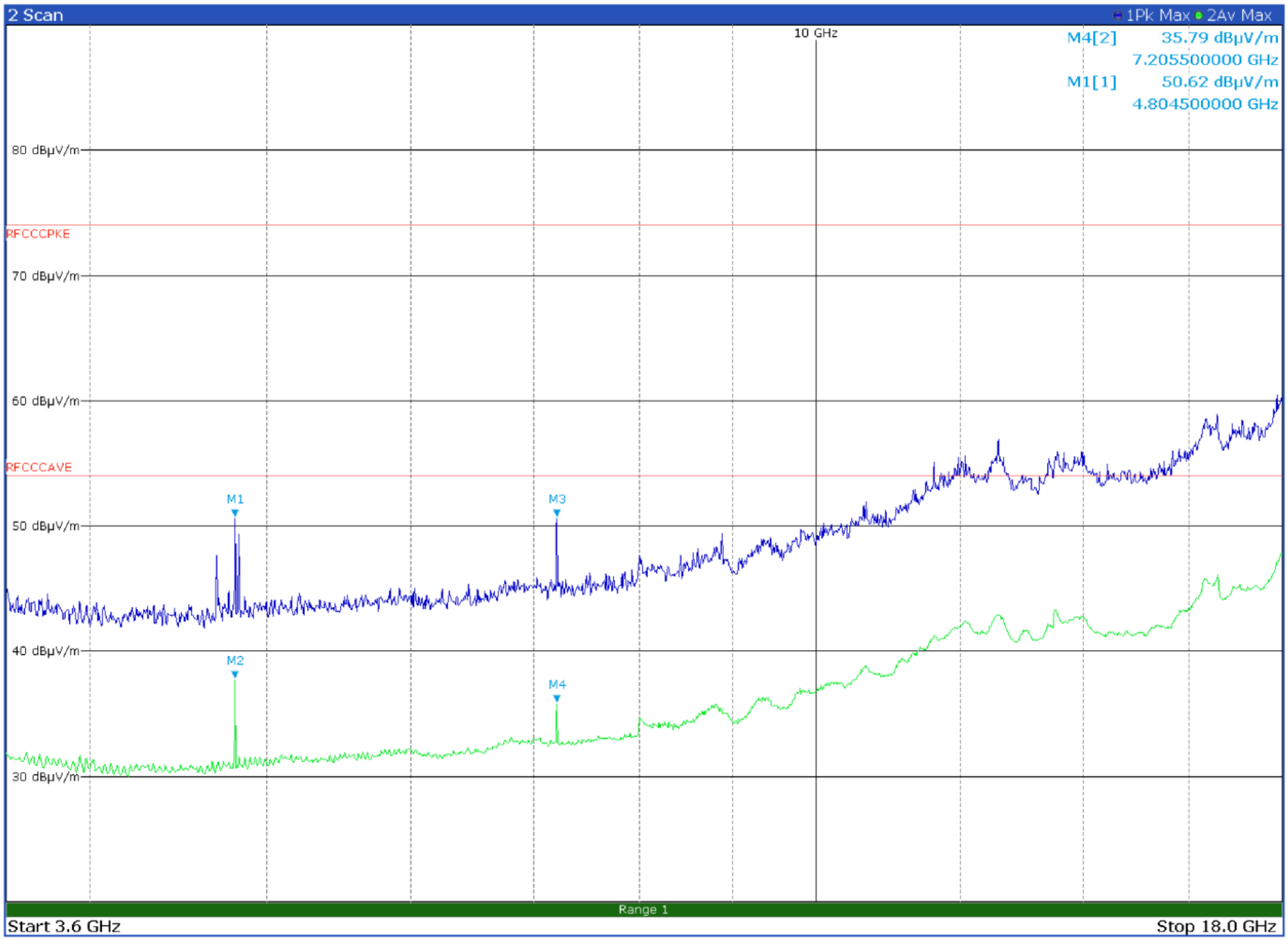



***Figure 8.6-11:*** *Radiated spurious emissions with antenna in horizontal polarization, low channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 4804.5000 | 50.62 | 74.00 | -23.38 | Pk |
| 7205.5000 | 35.79 | 54.00 | -10.21 | Av |

Av detector measured as state in clause 8.5.3

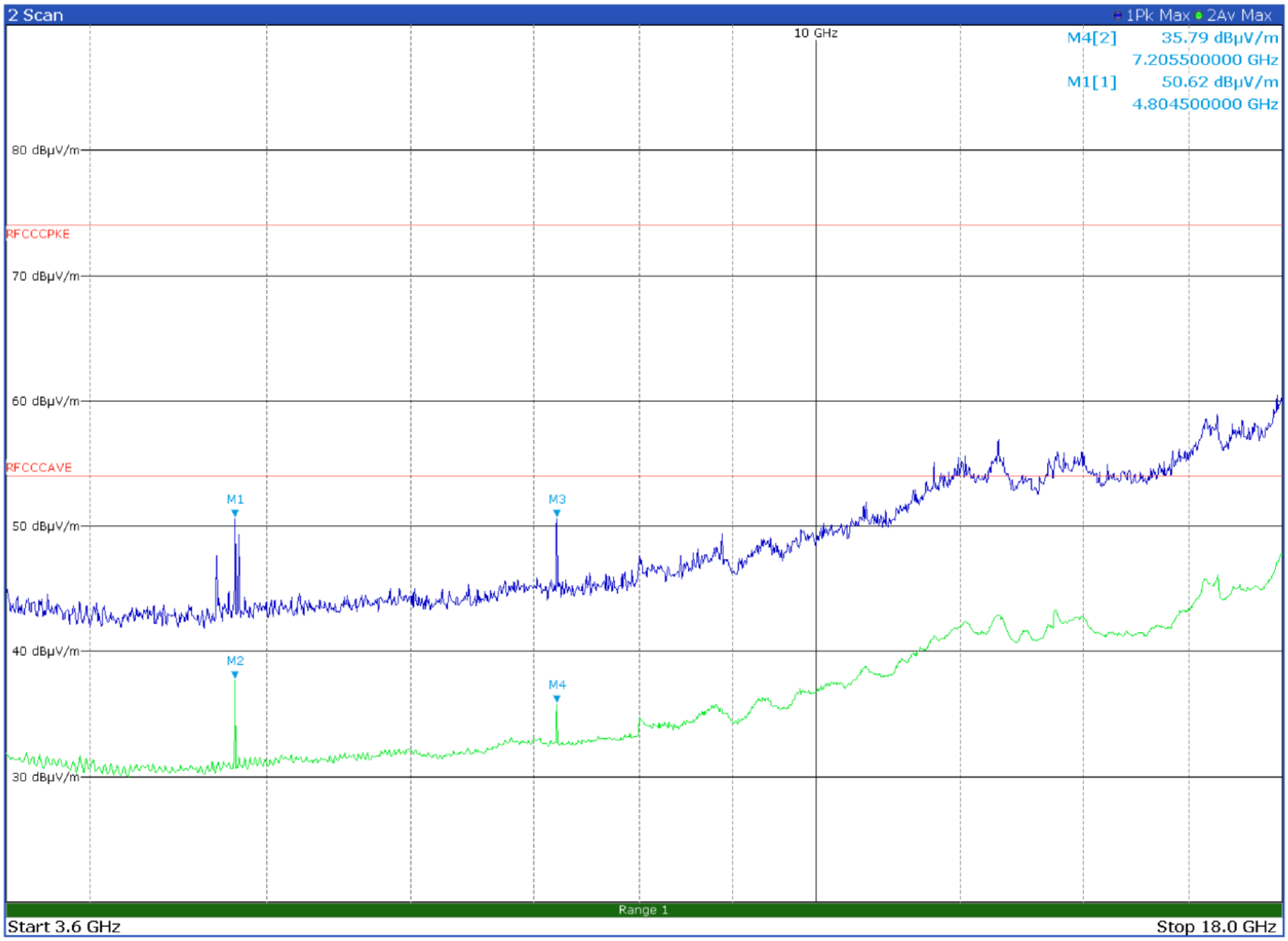



***Figure 8.6-12:** Radiated spurious emissions with antenna in horizontal polarization, low channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 4804.5000 | 50.62 | 74.00 | -23.38 | Pk |
| 7205.5000 | 35.79 | 54.00 | -10.21 | Av |

Av detector measured as state in clause 8.5.3

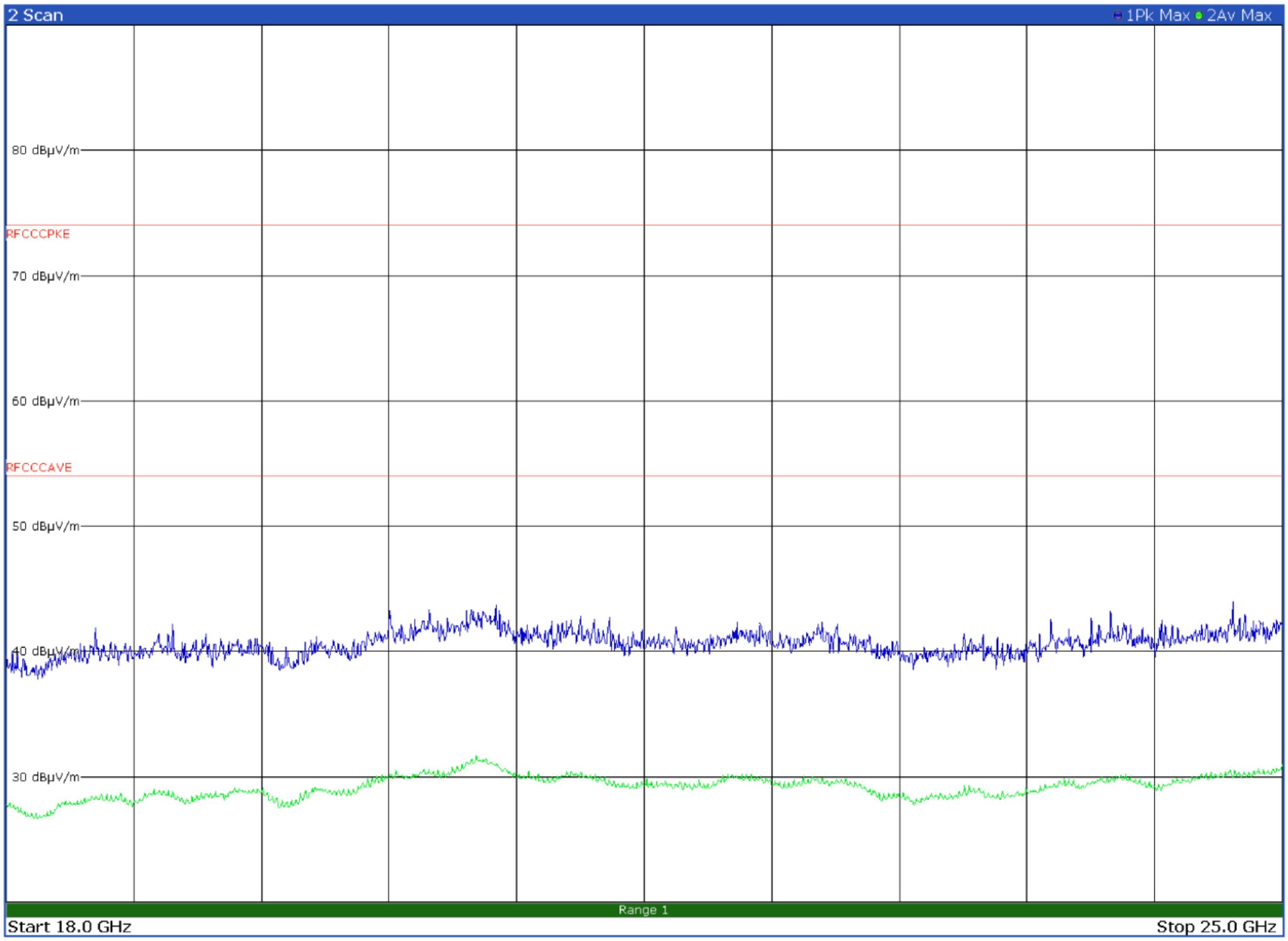



***Figure 8.6-13:*** *Radiated spurious emissions with antenna in horizontal polarization, low channel*

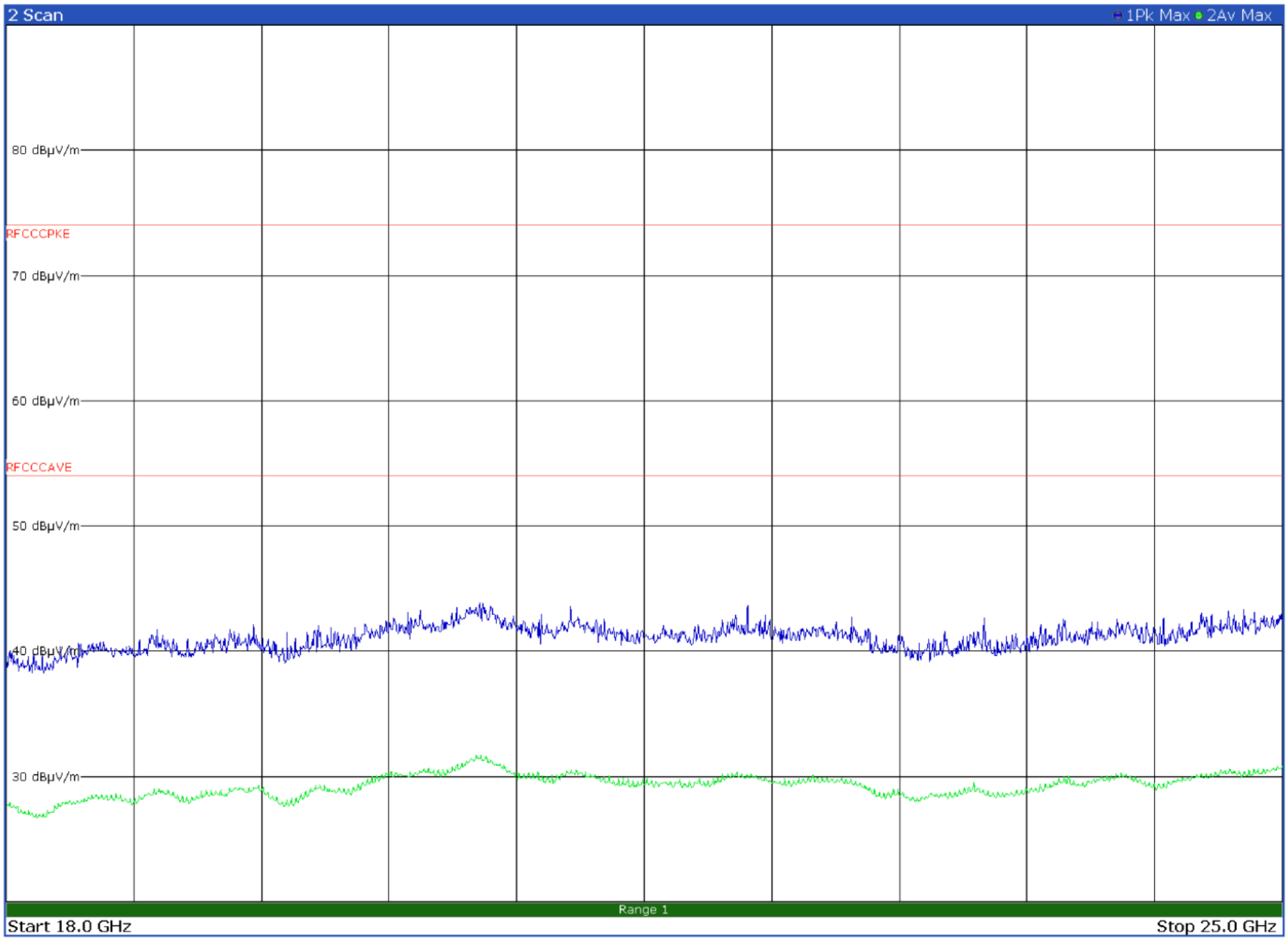



***Figure 8.6-14:*** *Radiated spurious emissions with antenna in horizontal polarization, low channel*

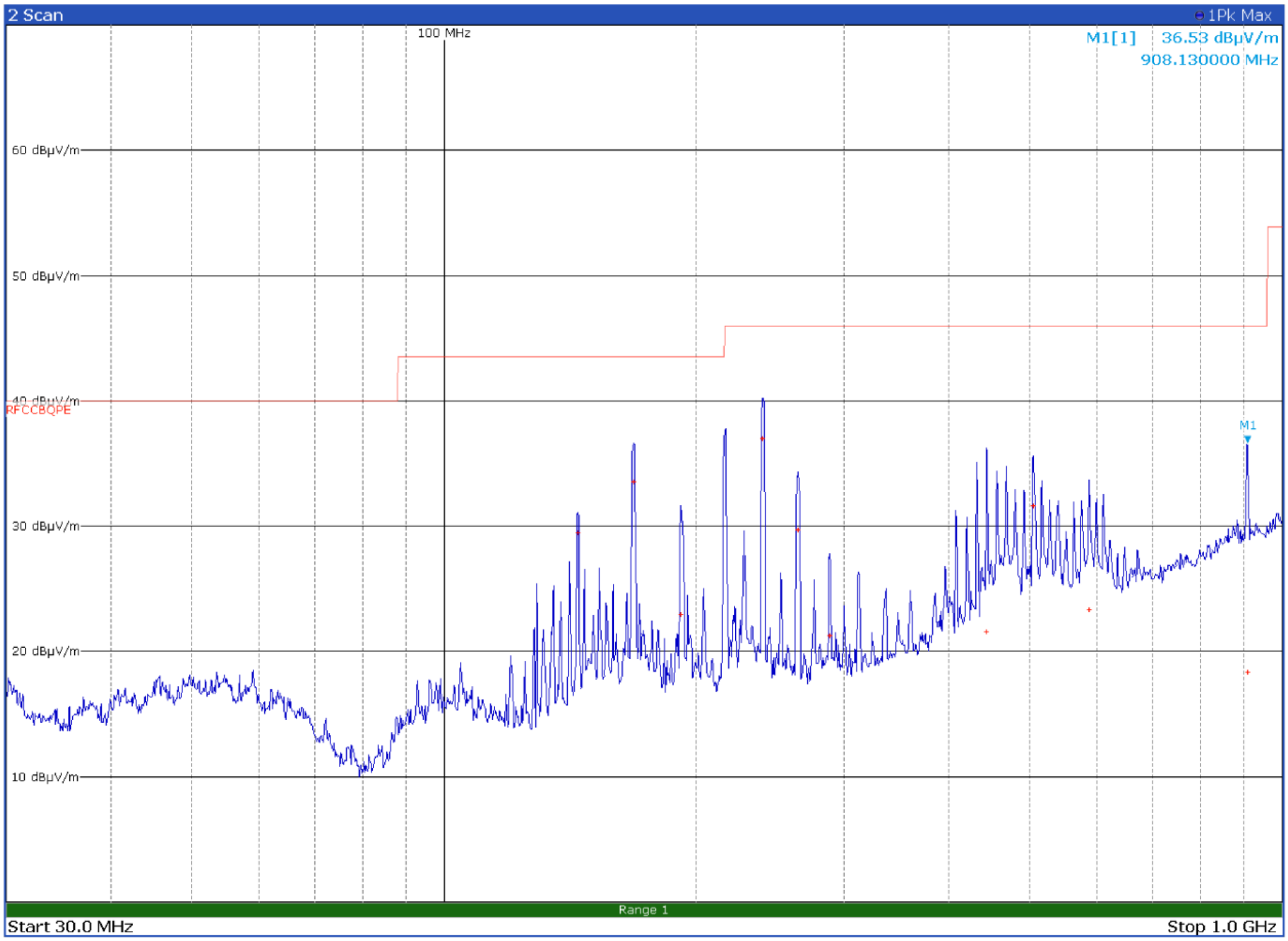



***Figure 8.6-15:*** *Radiated spurious emissions with antenna in horizontal polarization, middle channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 144.2400 | 29.5 | 43.5 | -14.0 | QP |
| 168.0600 | 33.6 | 43.5 | -9.9 | QP |
| 191.4600 | 23.0 | 43.5 | -20.5 | QP |
| 239.9100 | 37.0 | 46.0 | -9.0 | QP |
| 264.1500 | 29.7 | 46.0 | -16.3 | QP |
| 288.0300 | 21.3 | 46.0 | -24.7 | QP |
| 443.7600 | 21.6 | 46.0 | -24.4 | QP |
| 504.0300 | 31.7 | 46.0 | -14.3 | QP |
| 588.3600 | 23.4 | 46.0 | -22.6 | QP |
| 908.1300 | 18.4 | 46.0 | -27.6 | QP |

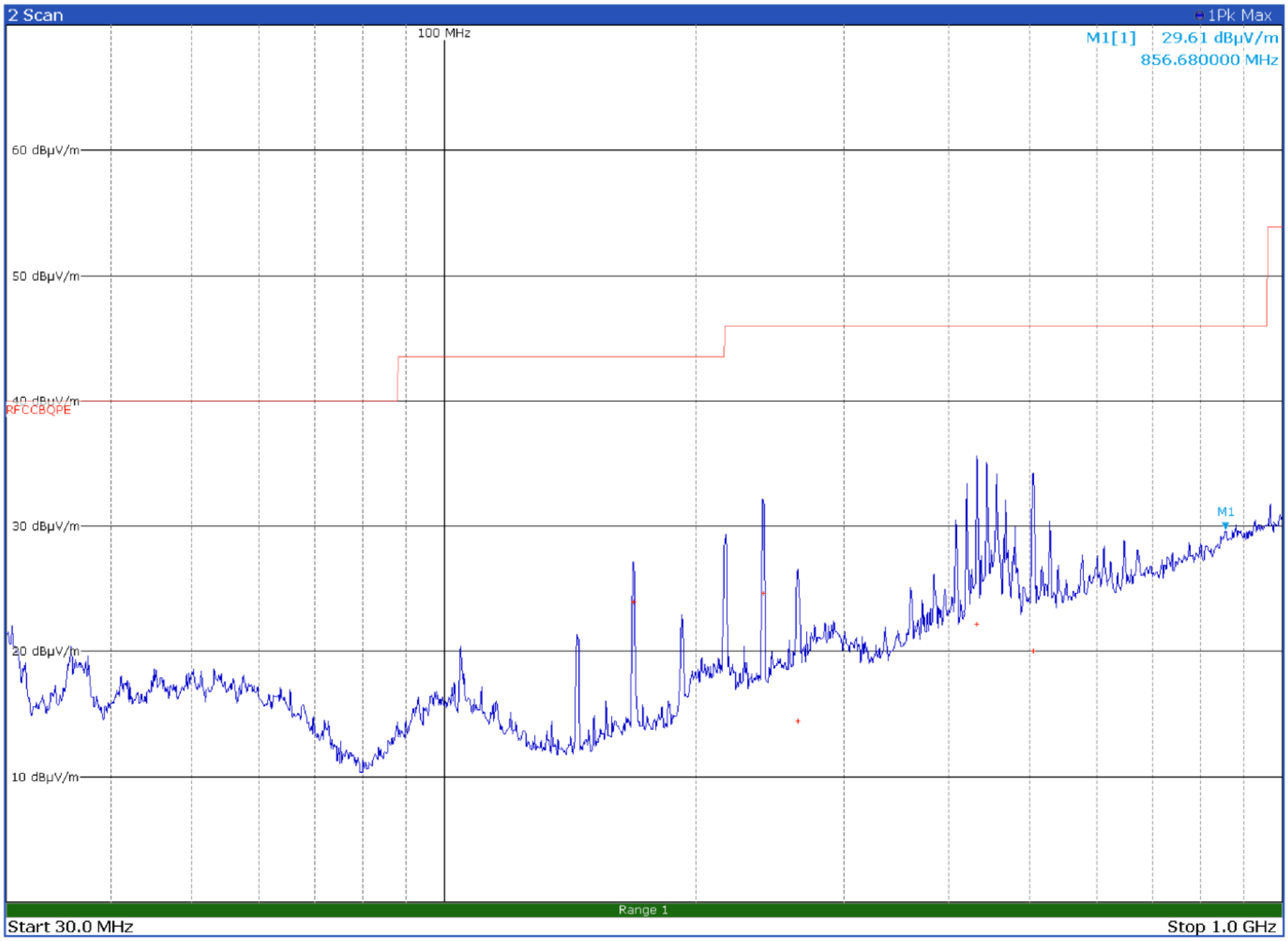



***Figure 8.6-16:*** *Radiated spurious emissions with antenna in vertical polarization, middle channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 168.0300 | 24.0 | 43.5 | -19.5 | QP |
| 240.2100 | 24.7 | 46.0 | -21.3 | QP |
| 263.9700 | 14.5 | 46.0 | -31.5 | QP |
| 432.3600 | 22.2 | 46.0 | -23.8 | QP |
| 504.0300 | 20.1 | 46.0 | -25.9 | QP |

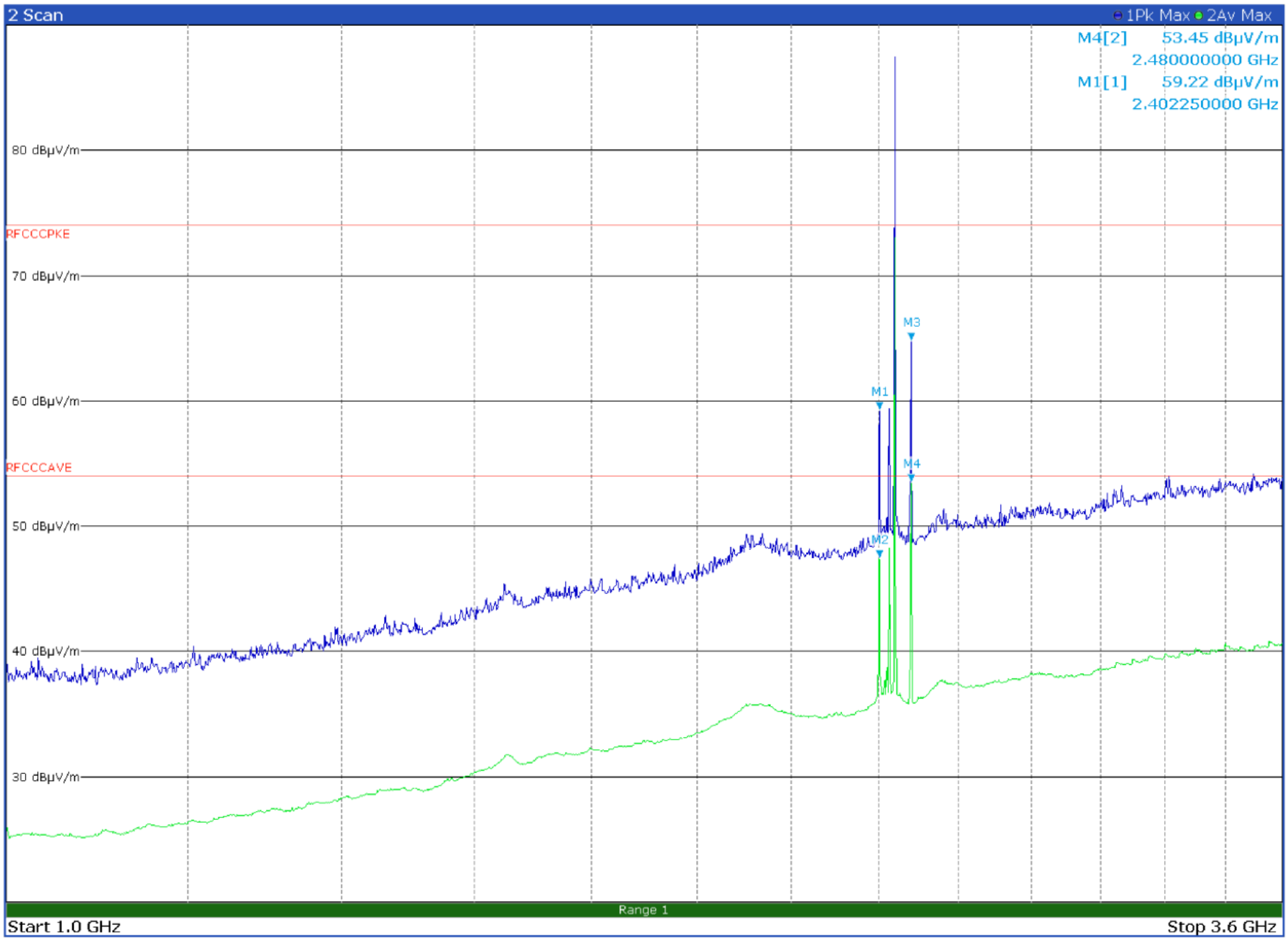



***Figure 8.6-17:*** *Radiated spurious emissions with antenna in horizontal polarization, middle channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 2402.2000 | 58.23 | 74.00 | -15.77 | Pk |
| 2402.2500 | 46.66 | 54.00 | -7.34 | Av |

Av detector measured as state in clause 8.5.3

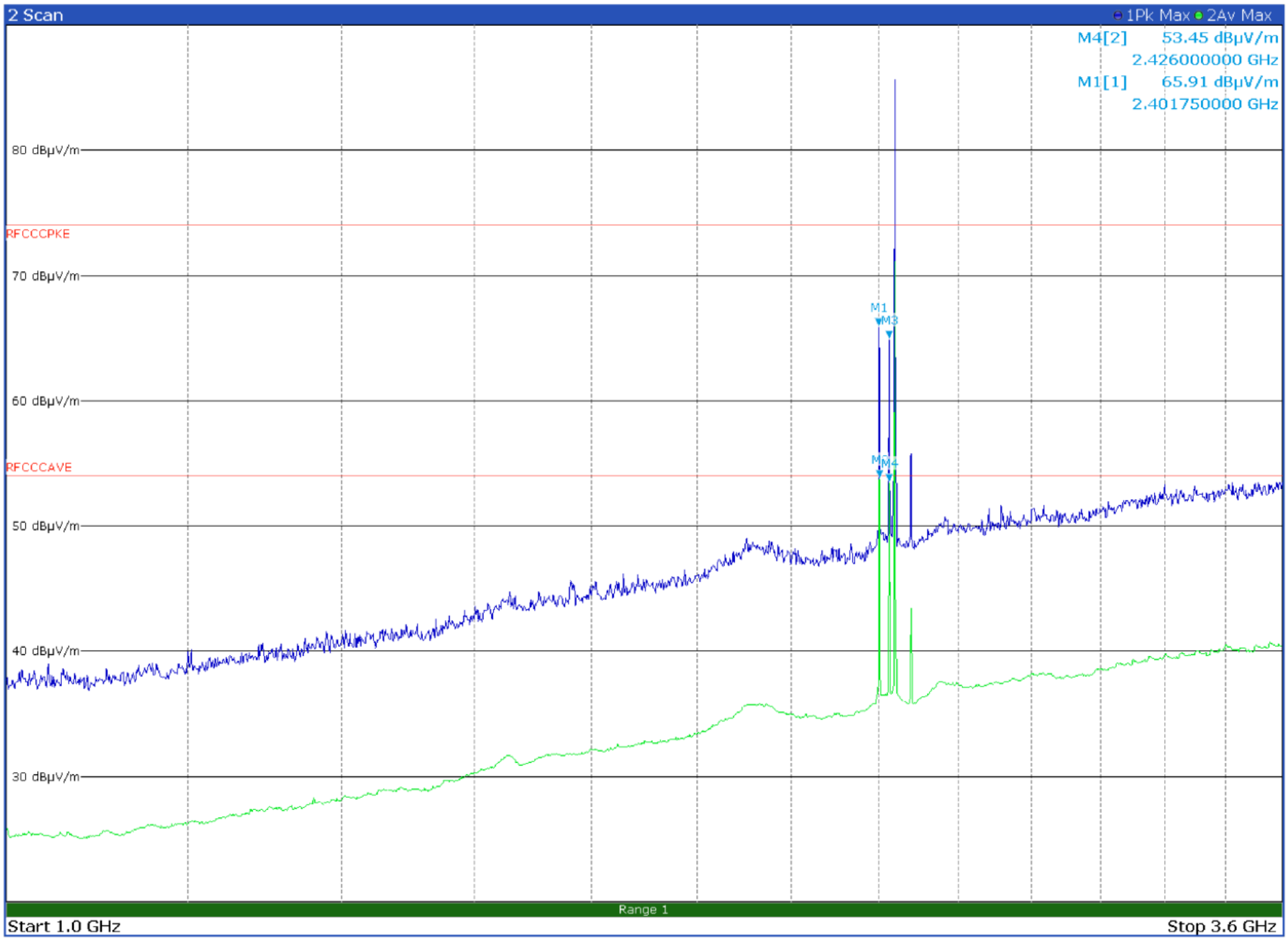



***Figure 8.6-17:*** *Radiated spurious emissions with antenna in vertical polarization, middle channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 2402.2000 | 58.23 | 74.00 | -15.77 | Pk |
| 2402.2500 | 46.66 | 54.00 | -7.34 | Av |

Av detector measured as state in clause 8.5.3

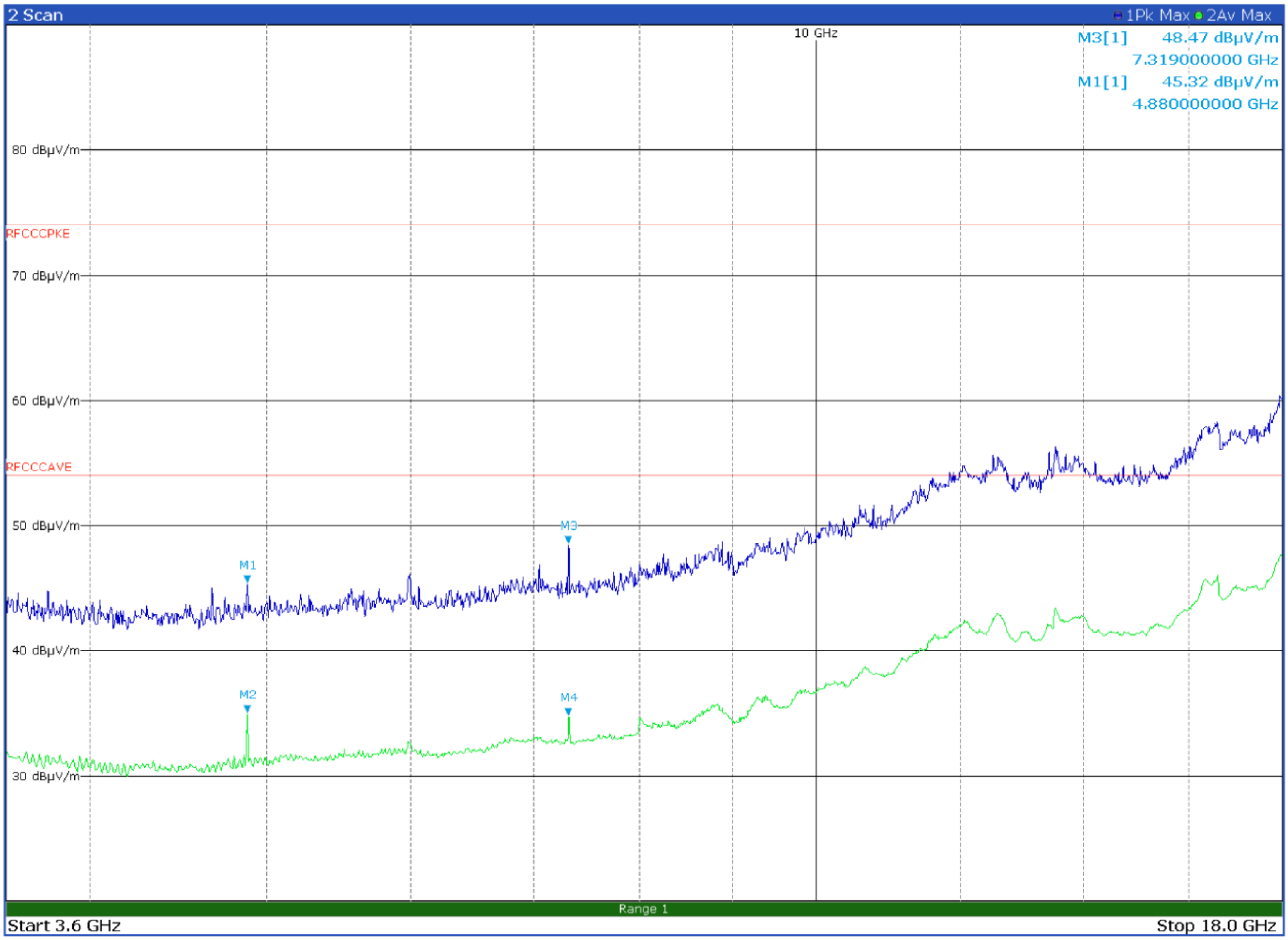



***Figure 8.6-18:*** *Radiated spurious emissions with antenna in horizontal polarization, middle channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 4880.0000 | 45.32 | 74.00 | -28.66 | Pk |
| 7319.0000 | 48.47 | 74.00 | -25.53 | Pk |

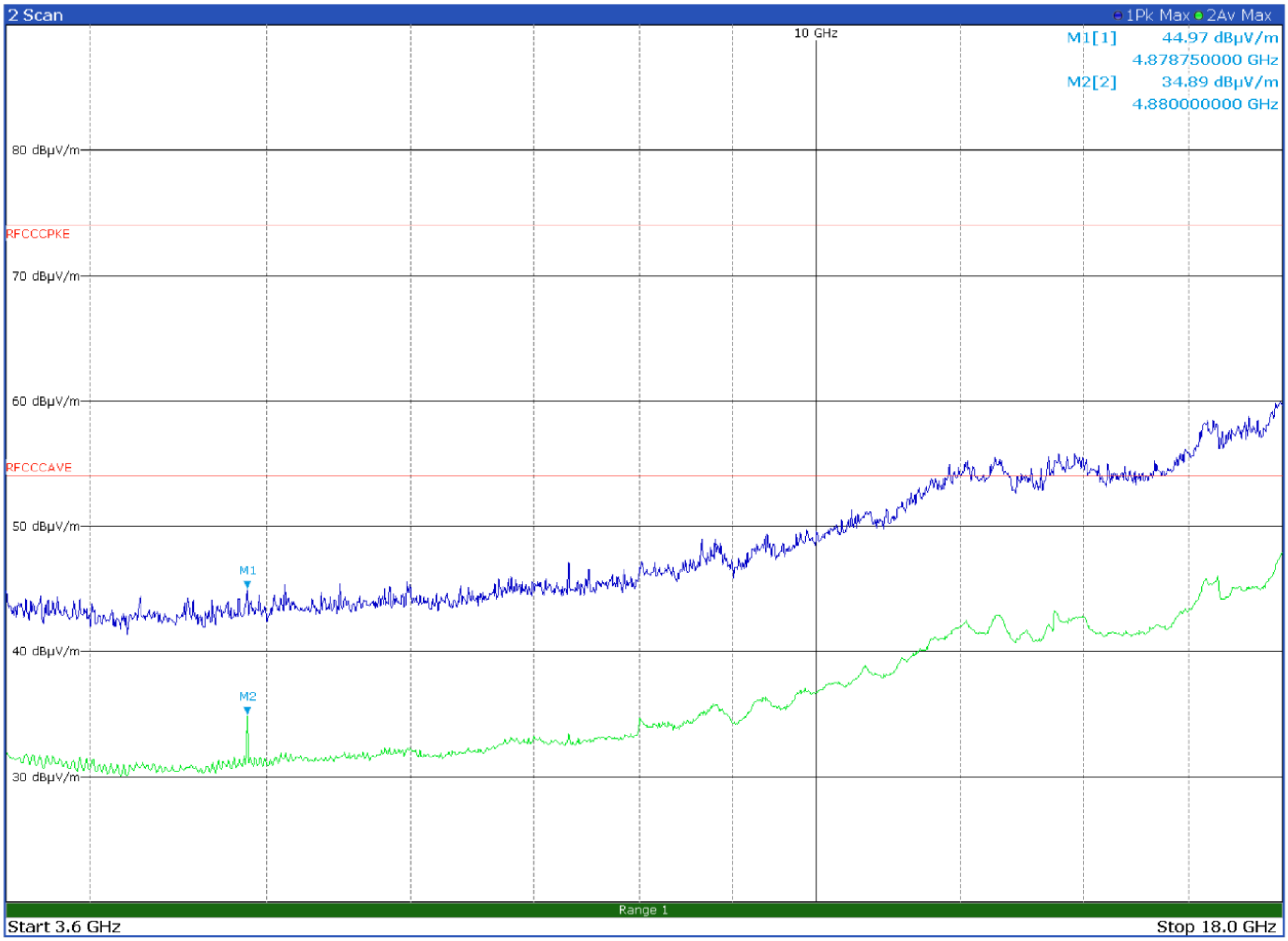



***Figure 8.6-19:*** *Radiated spurious emissions with antenna in horizontal polarization, middle channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 4878.7500 | 44.97 | 74.00 | -29.03 | Pk |
| 4878.7500 | 34.89 | 54.00 | -19.11 | Av |

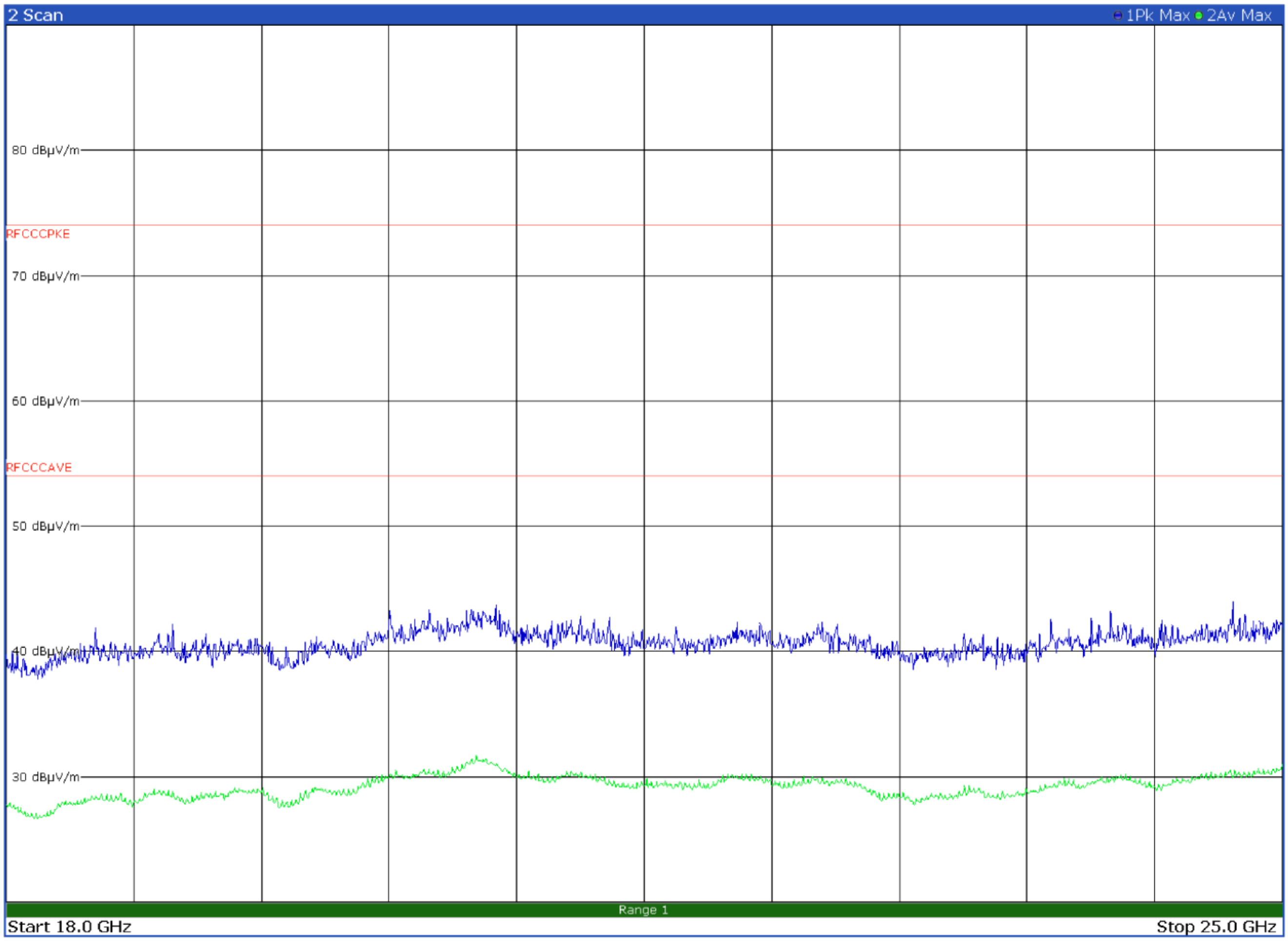



***Figure 8.6-20:*** *Radiated spurious emissions with antenna in horizontal polarization, middle channel*

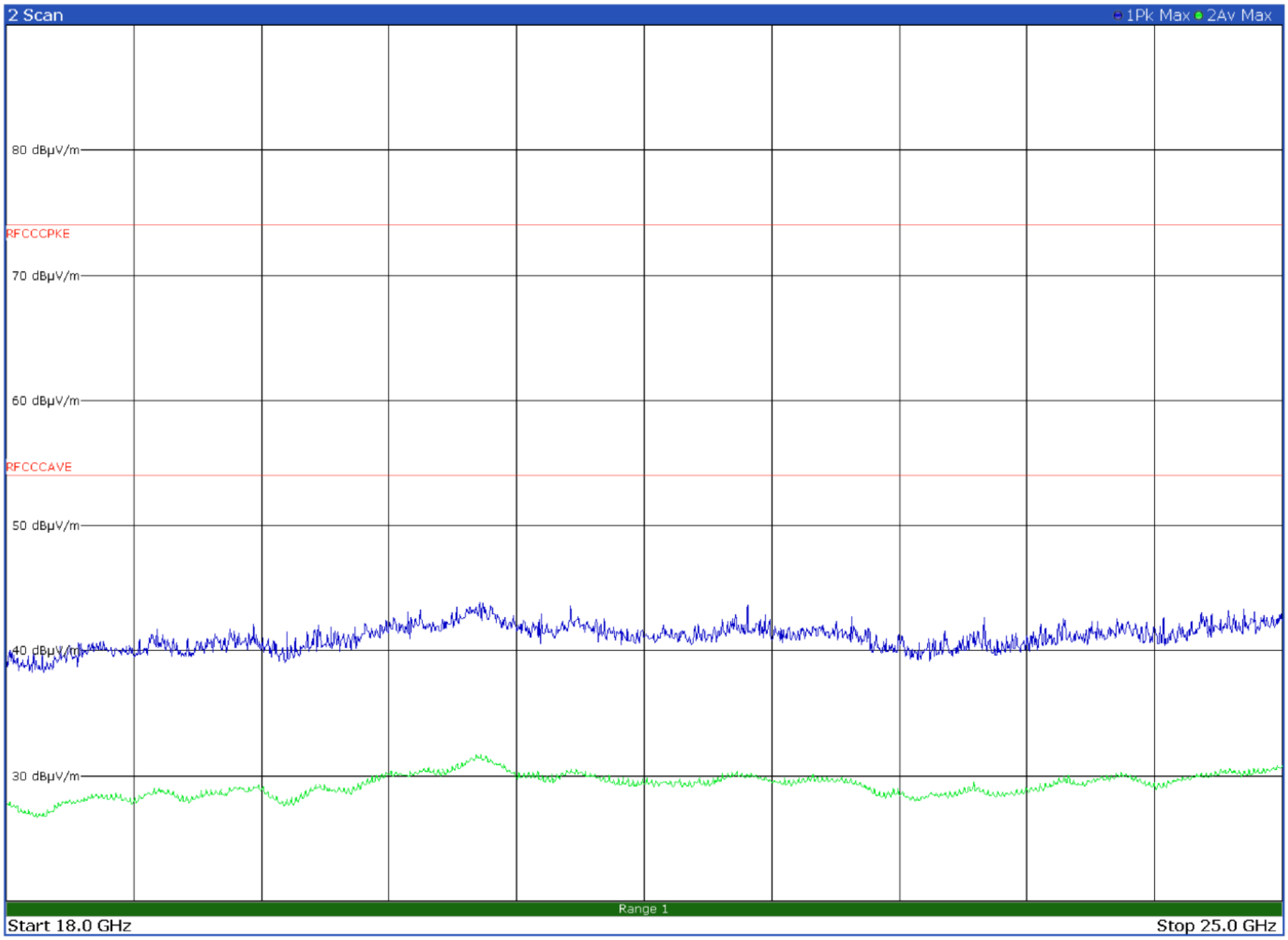



***Figure 8.6-21:*** *Radiated spurious emissions with antenna in horizontal polarization, middle channel*

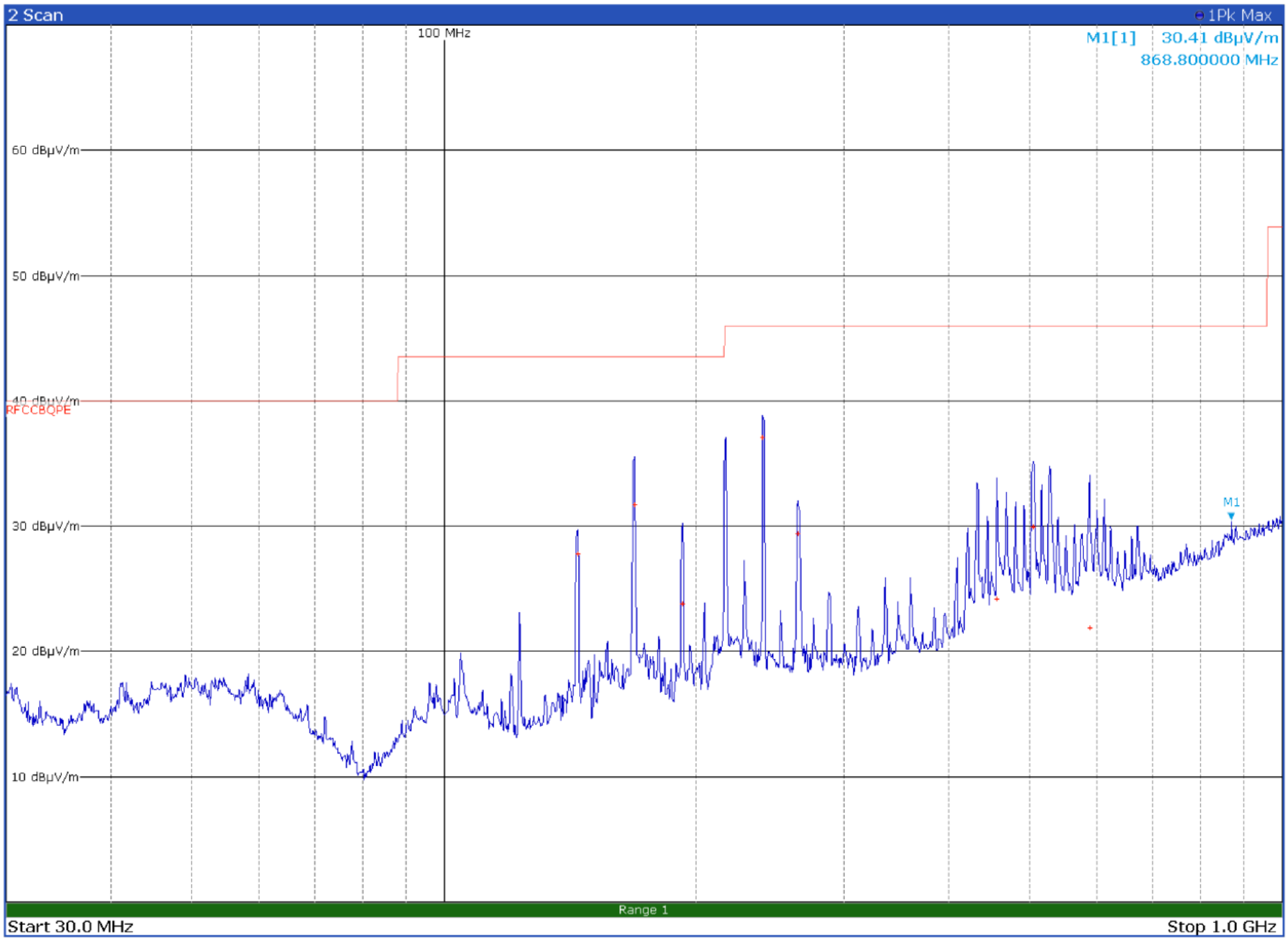



***Figure 8.6-22:*** *Radiated spurious emissions with antenna in horizontal polarization, high channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 144.2400 | 29.5 | 43.5 | -14.0 | QP |
| 168.0600 | 33.6 | 43.5 | -9.9 | QP |
| 191.4600 | 23.0 | 43.5 | -20.5 | QP |
| 239.9100 | 37.0 | 46.0 | -9.0 | QP |
| 264.1500 | 29.7 | 46.0 | -16.3 | QP |
| 288.0300 | 21.3 | 46.0 | -24.7 | QP |
| 443.7600 | 21.6 | 46.0 | -24.4 | QP |
| 504.0300 | 31.7 | 46.0 | -14.3 | QP |
| 588.3600 | 23.4 | 46.0 | -22.6 | QP |
| 908.1300 | 18.4 | 46.0 | -27.6 | QP |

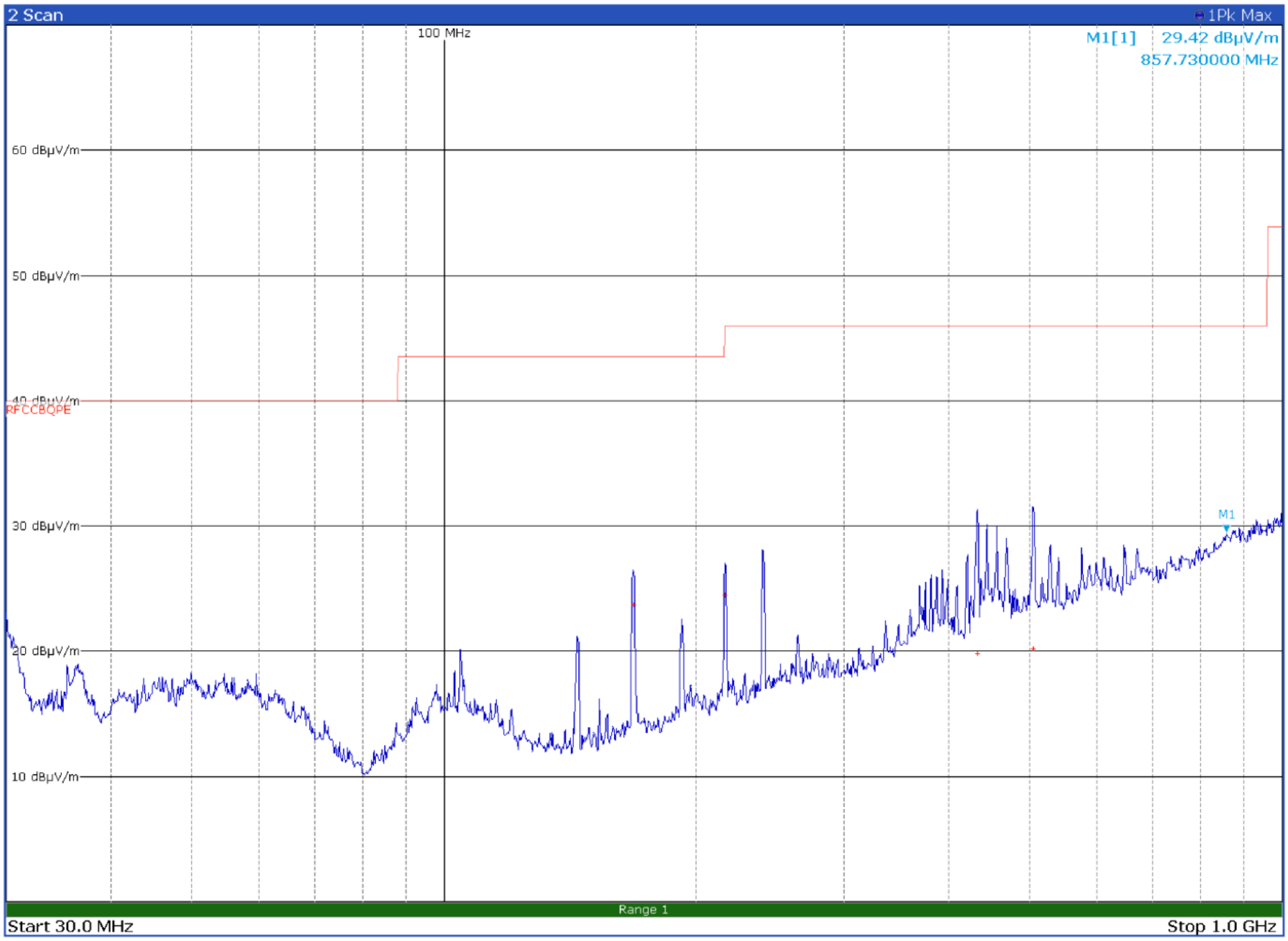



***Figure 8.6-23:*** *Radiated spurious emissions with antenna in vertical polarization, high channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 168.0600 | 23.8 | 43.5 | -19.7 | QP |
| 216.0000 | 24.5 | 46.0 | -21.5 | QP |
| 433.3500 | 19.9 | 46.0 | -26.1 | QP |
| 504.0000 | 20.2 | 46.0 | -25.8 | QP |

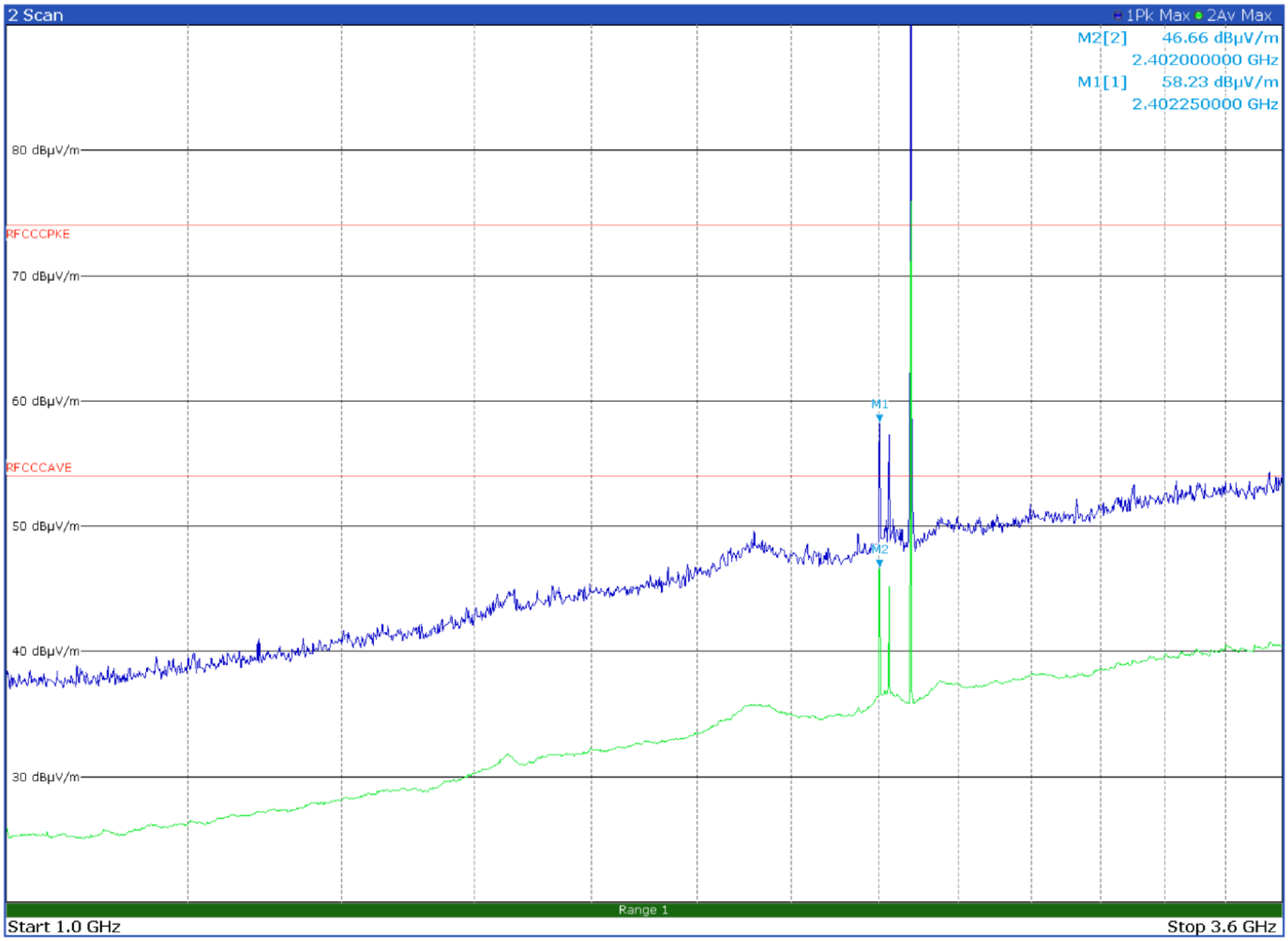



***Figure 8.6-24:*** *Radiated spurious emissions with antenna in horizontal polarization, high channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 2402.2000 | 58.23 | 74.00 | -15.77 | Pk |
| 2402.2500 | 46.66 | 54.00 | -7.34 | Av |

Av detector measured as state in clause 8.5.3

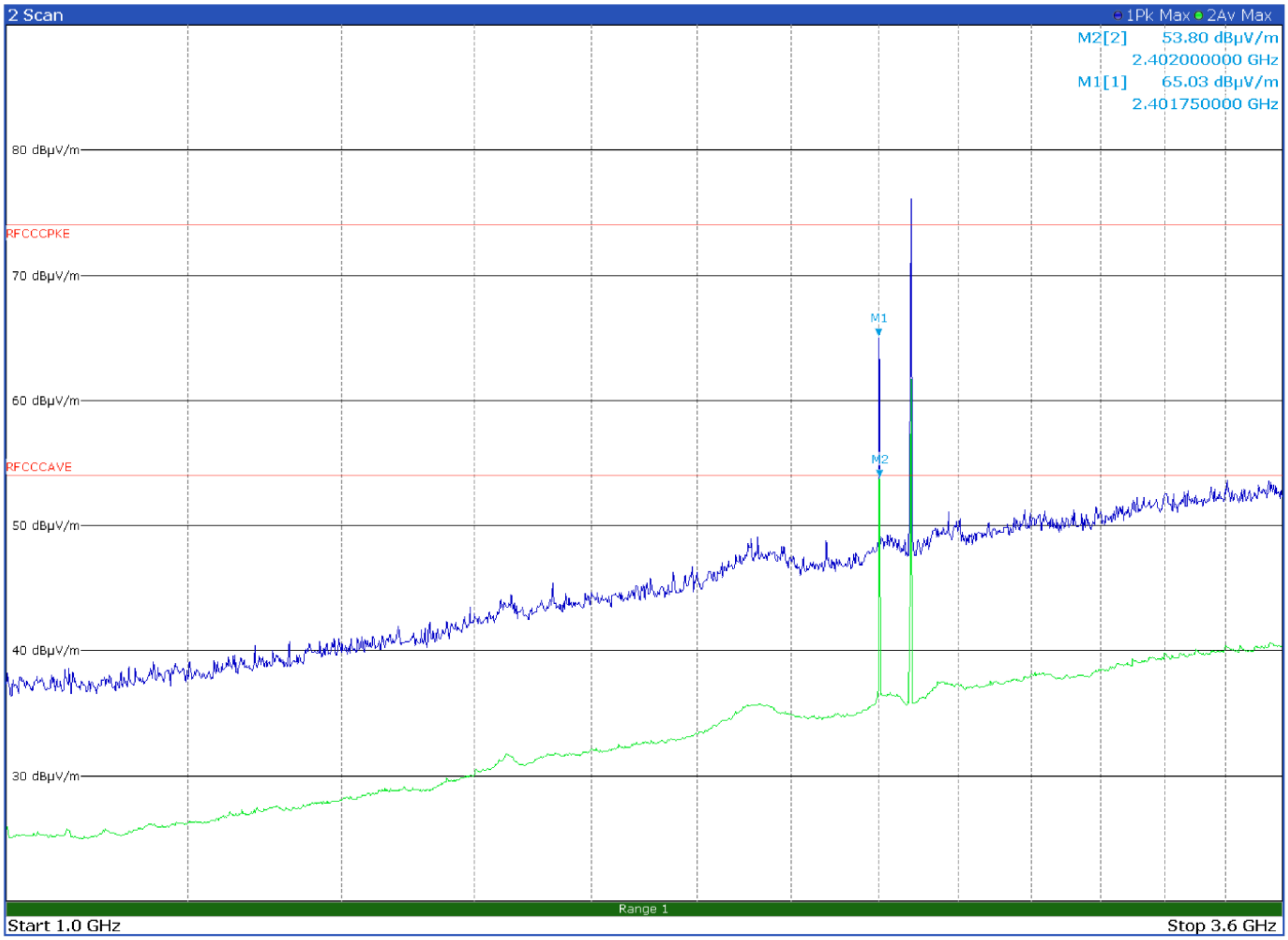



***Figure 8.6-25:*** *Radiated spurious emissions with antenna in vertical polarization, high channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 2402.0000 | 65.03 | 74.00 | -4.97 | Pk |
| 2401.7500 | 53.80 | 54.00 | -0.02 | Av |

Av detector measured as state in clause 8.5.3

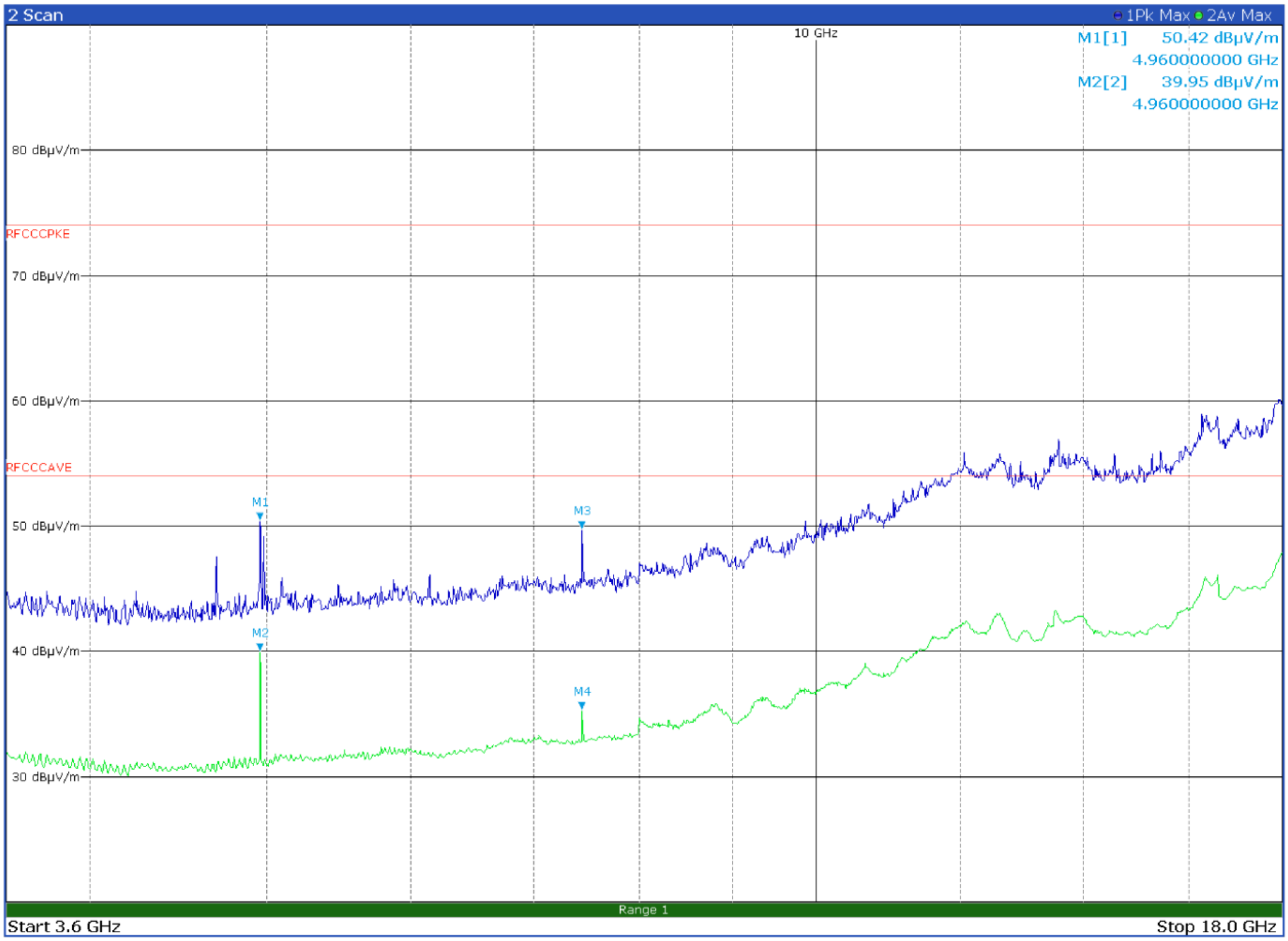



***Figure 8.6-26:*** *Radiated spurious emissions with antenna in horizontal polarization, high channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 4960.0000 | 50.42 | 74.00 | -23.58 | Pk |
| 4960.0000 | 39.95 | 54.00 | -14.05 | Av |

Av detector measured as state in clause 8.5.3

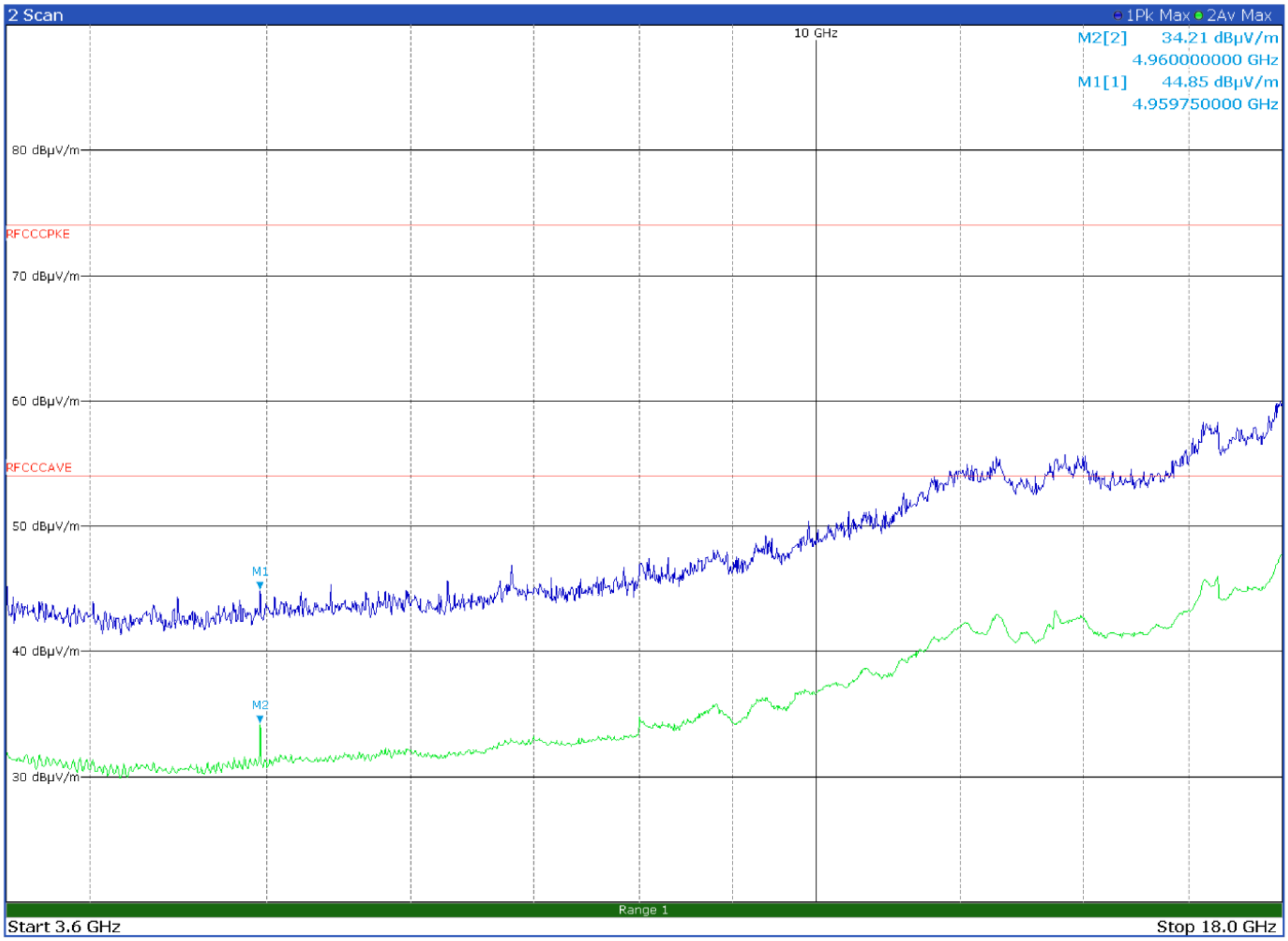



***Figure 8.6-27:*** *Radiated spurious emissions with antenna in horizontal polarization, high channel*

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector |
|---|---|---|---|---|
| 4960.0000 | 44.85 | 74.00 | -29.15 | Pk |
| 4960.0000 | 34.21 | 54.00 | -19.79 | Av |

Av detector measured as state in clause 8.5.3

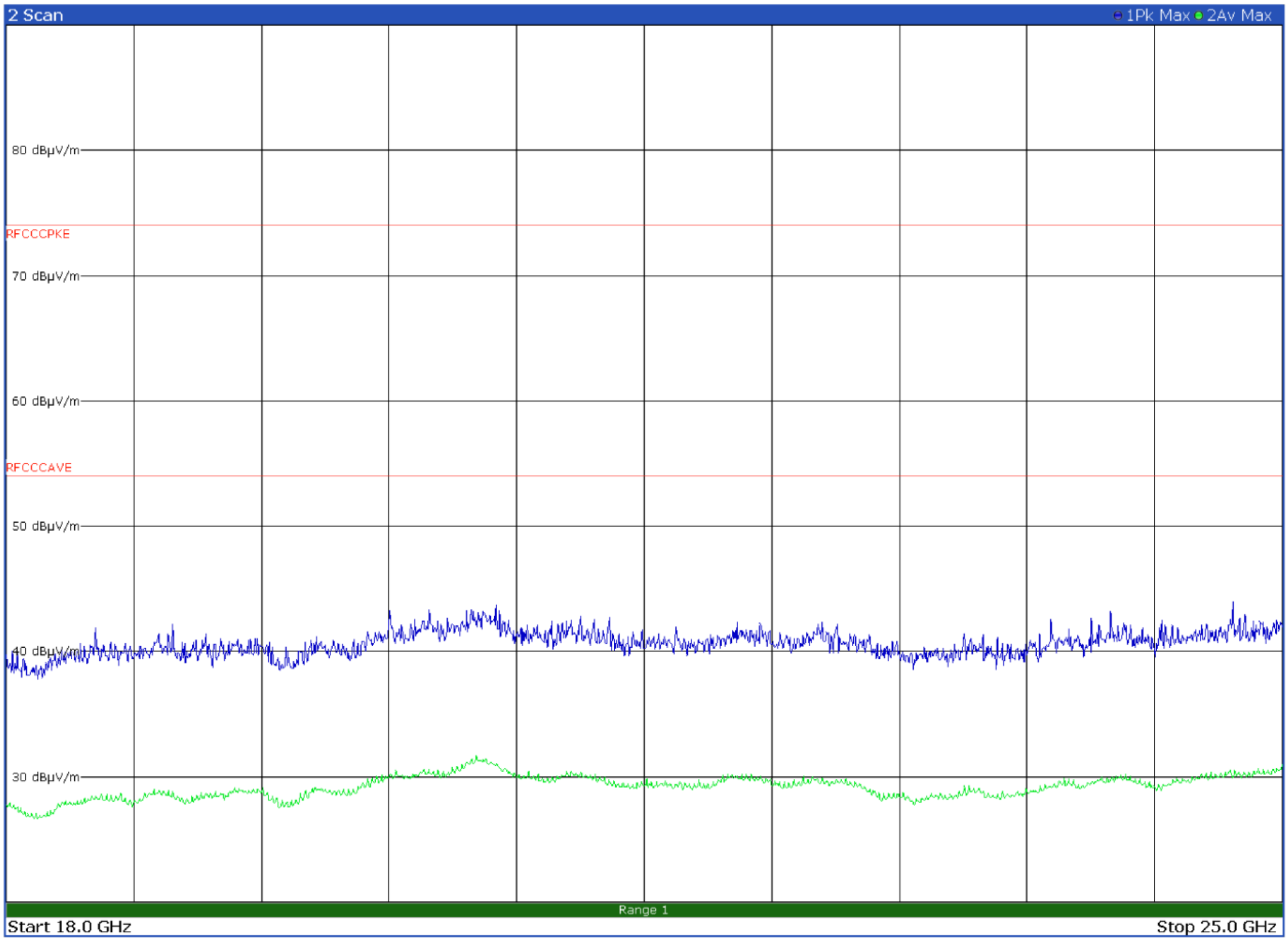



***Figure 8.6-28:*** *Radiated spurious emissions with antenna in horizontal polarization, high channel*

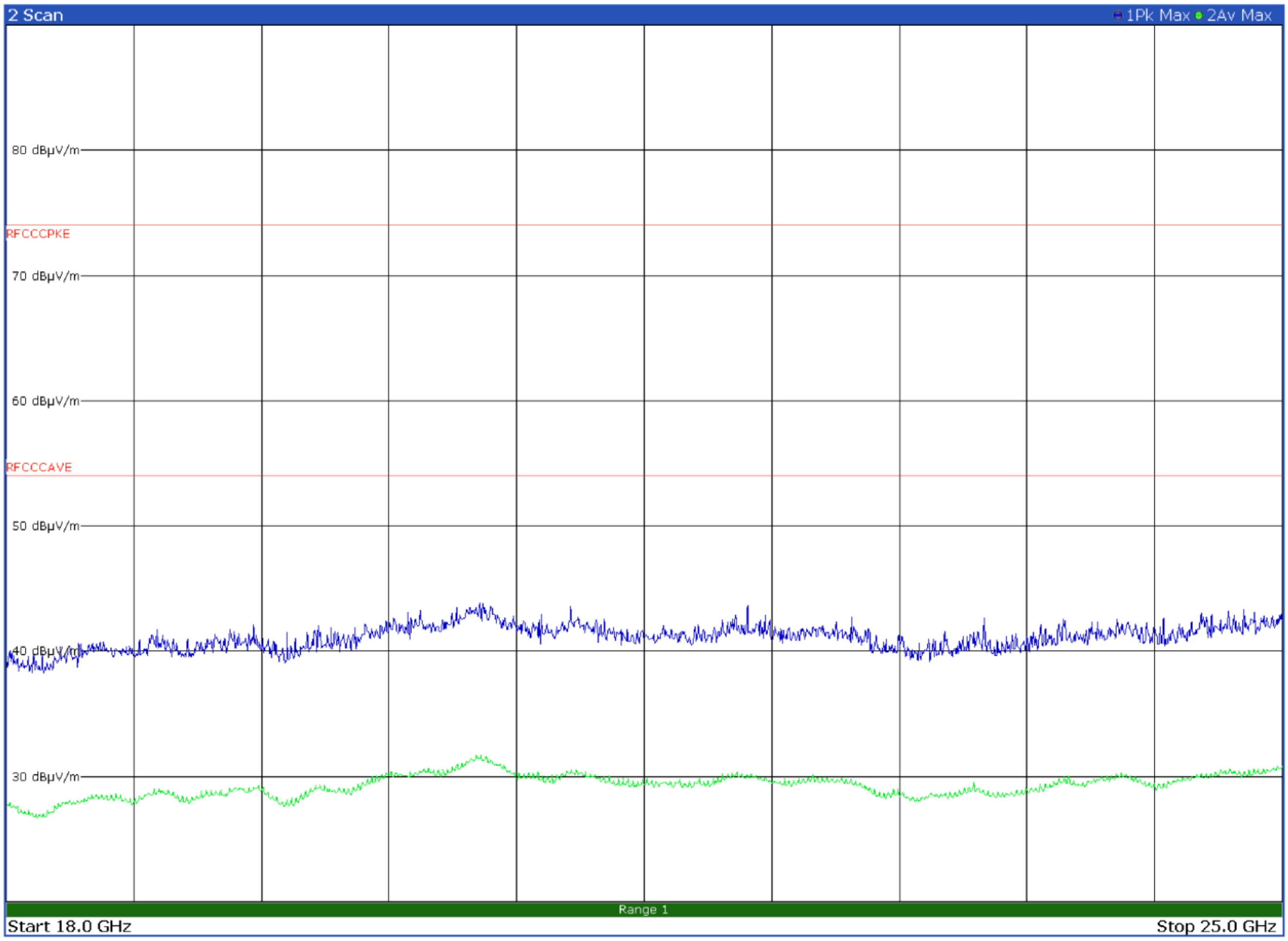



***Figure 8.6-29:*** *Radiated spurious emissions with antenna in horizontal polarization, high channel*

## 8.7 Power spectral density for digitally modulated devices

### 8.7.1 References, definitions and limits

**FCC §15.247:**

(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

(f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### 8.7.2 Test summary

| | | | |
|---|---|---|---|
| Verdict | Pass | | |
| Tested by | G. Tepelena | Test date | October 15, 2021 |

### 8.7.3 Test equipment used

| Equipment | Manufacturer | Model no. | Asset no. | Cal cycle | Next cal. |
|---|---|---|---|---|---|
| EMI receiver (20 Hz ÷ 8 GHz) | R&S | ESU8 | 100202 | 2021-01 | 2022-01 |
| EMI receiver (20 Hz ÷ 44 GHz) | R&S | ESW44 | 101620 | 2021-08 | 2022-08 |
| Trilog Antenna (30 MHz ÷ 7 GHz) | Schwarzbeck | VULB 9162 | 9162-025 | 2021-07 | 2024-07 |
| Bilog antenna (1 ÷ 18 GHz) | Schwarzbeck | STLP 9148 | 9148-123 | 2021-07 | 2024-07 |
| Horn antenna (4 ÷ 40 GHz) | RFSpin | DRH40 | 061106A40 | 2020-02 | 2023-02 |
| Preamplifier (1 ÷ 18 GHz) | Schwarzbeck | BBV 9718 | 9718-137 | 2021-09 | 2022-09 |
| Preamplifier (18 ÷ 40 GHz) | Miteq | JS44-18004000-35-8P-R | 1.627 | 2021-09 | 2022-09 |
| Controller | Maturo | FCU3.0 | 10041 | NCR | NCR |
| Tilt antenna mast | Maturo | TAM4.0-E | 10042 | NCR | NCR |
| Turntable | Maturo | TT4.0-5T | 2.527 | NCR | NCR |
| Semi-anechoic chamber | Nemko | 10m semi-anechoic chamber | 530 | 2021-09 | 2024-09 |
| Shielded room | Siemens | 10m control room | 1947 | NCR | NCR |

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

### 8.7.4 Observations, settings and special notes

Power spectral density test was performed as per KDB 558074, section 8.4 with reference to ANSI C63.10 subclause 11.10.
The test was performed using Choose an item.
Spectrum analyser settings:

| | |
|---|---|
| Resolution bandwidth: | 3 kHz |
| Video bandwidth: | 10 kHz |
| Frequency span: | 1.5 times the OBW (Average) |
| Detector mode: | Peak |
| Trace mode: | Max Hold |
| Averaging sweeps number: | 100 |

## 8.7.5 Test data

***Table 8.7-1:*** *PSD results (radiated measurement)*

| Frequency, MHz | Field strength, dBµV/m/3 kHz | EIRPSD, dBm/3 kHz | Antenna gain, dBi | PSD, dBm/3 kHz | PSD limit, dBm/3 kHz | Margin, dB |
|---|---|---|---|---|---|---|
| 2402 | 79.12 | -13.38 | 0.6 | -12.78 | 8.00 | 20.78 |
| 2440 | 78.73 | -13.77 | 0.6 | -13.17 | 8.00 | 21.17 |
| 2480 | 77.29 | -15.21 | 0.6 | -14.61 | 8.00 | 22.61 |

Note: EIRPSD [dBm/3 kHz] = Field Strength [dBµV/m/3 kHz] – 95.23 [dB]; PSD [dBm/3 kHz] = EIRP [dBm/3 kHz] – Antenna gain [dBi]

Test data, continued

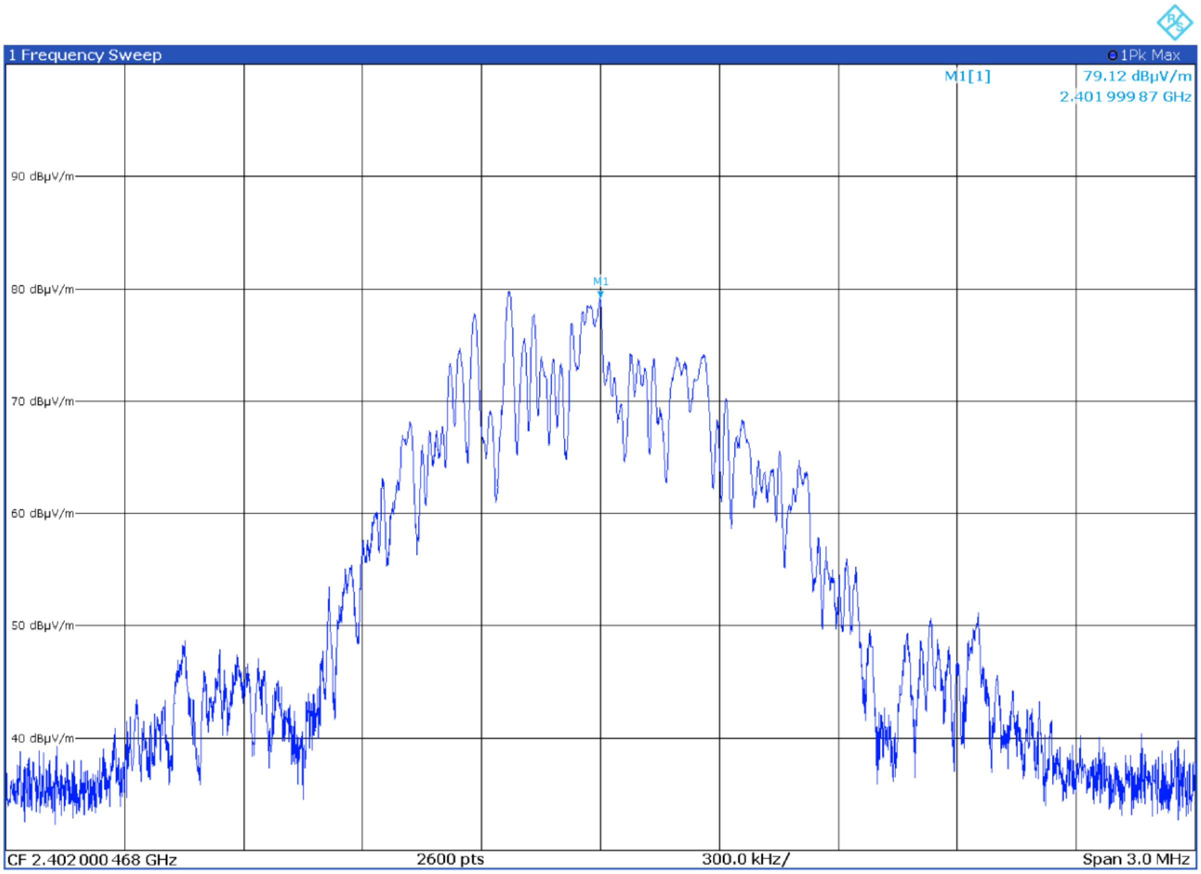



***Figure 8.7-1:*** *PSD on low channel*

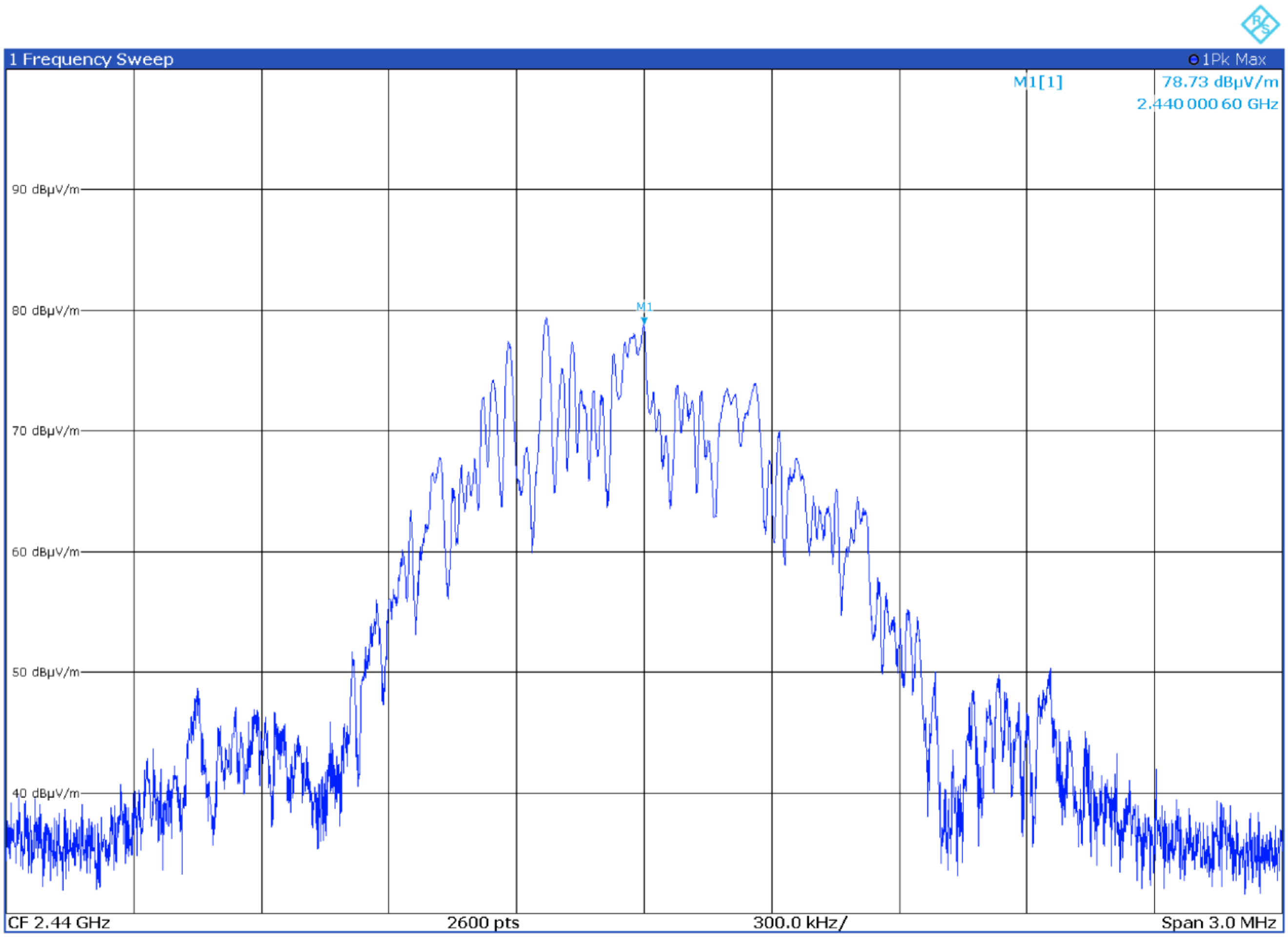



***Figure 8.7-2:*** *PSD on mid channel*

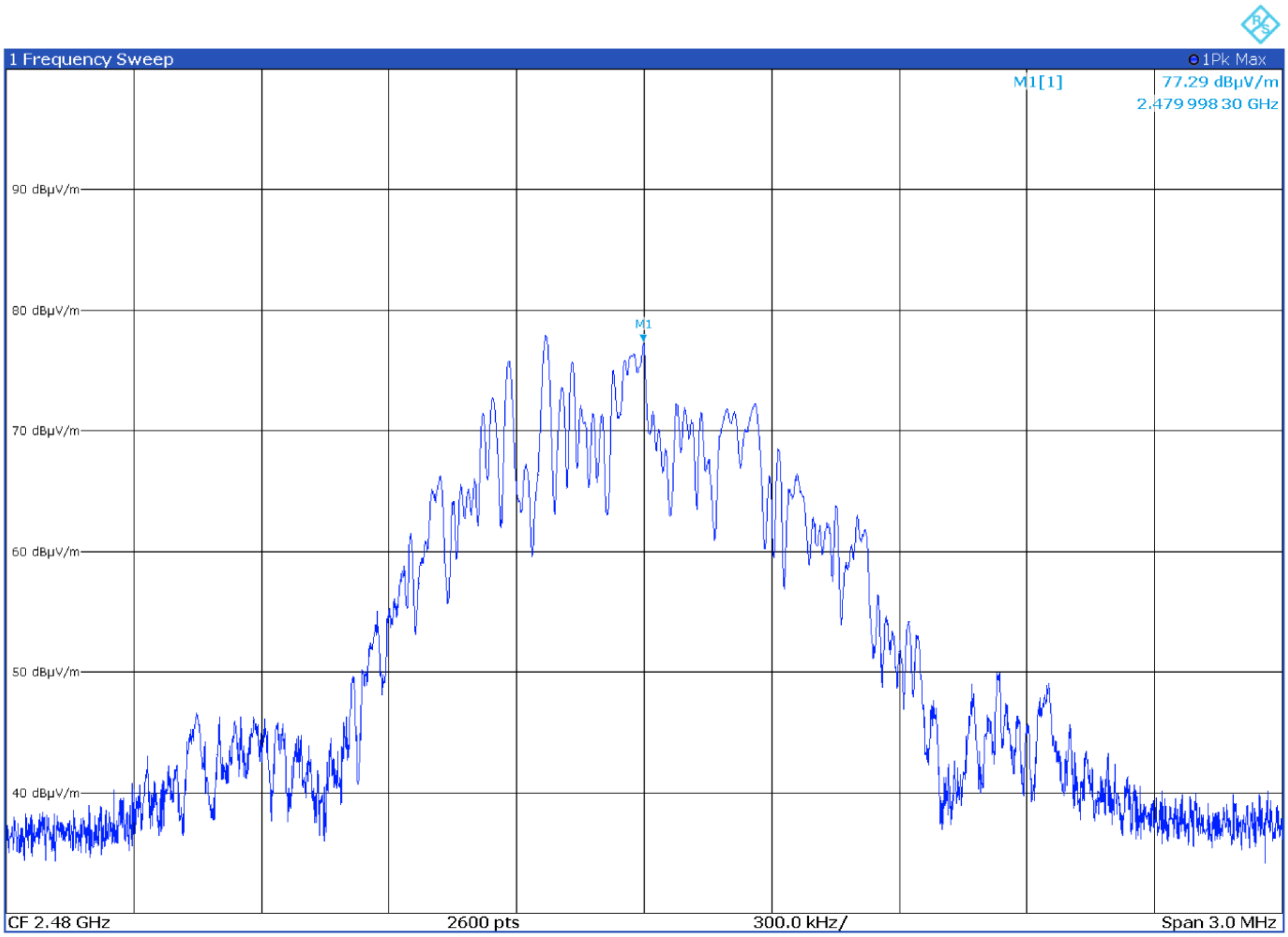



***Figure 8.7-3:*** *PSD on high channel*

# Section 9 EUT photos

## 9.1 External photos


***Figure 9.1-1:*** *Front view photo*


***Figure 9.1-2:*** *Rear view photo*


***Figure 9.1-3:*** *Side view photo*

***Figure 9.1-4:*** *Side view photo*

***Figure 9.1-5:*** *Top view photo*


***Figure 9.1-6:*** *Bottom view photo*

**End of the test report**