

Test Report

HELEM2409000308-1 v1.1



INTENTIONAL RADIATOR TESTS ACCORDING TO FCC PART 90 AND ISED CANADA REQUIREMENTS

Equipment Under Test: Radio modem module

Model: SATEL-TR4+

Manufacturer: Satel Oy
P.O. Box 142 (Meriniitynkatu 17)
FI-24101, SALO
FINLAND

Customer: Satel Oy
P.O. Box 142 (Meriniitynkatu 17)
FI-24101, SALO
FINLAND

FCC Rule Part: 90: October 2019
IC Rule Part: RSS-119, Issue 12, May 2015
KDB: 971168 D01 Power Meas License Digital Systems v03r01
Measurement Guidance for Certification of Licensed Digital Transmitters
(April 9, 2018)

- *Partial testing; see Test Suite for details*

Date: 24 March 2025

Issued by:

A handwritten signature in blue ink, appearing to read 'R. Repo'.

Rauno Repo
Senior EMC Specialist

Date: 24 March 2025

Checked by:

A handwritten signature in blue ink, appearing to read 'Henri Mäki'.

Henri Mäki
Testing Engineer

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GENERAL REMARKS

Disclaimer

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Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.

RELEASE HISTORY

| Version | Changes | Issued |
|---------|--|-----------------|
| 1.0 | Initial release | 11 October 2024 |
| 1.1 | Maximum value of the input voltage fixed | 24 March 2025 |

PRODUCT DESCRIPTION**PRODUCT DESCRIPTION****Equipment Under Test**

Equipment Under Test: Radio modem module
Model: SATEL-TR4+
Type: SATEL-TA40
Trademark: Satel
Serial no: 2432000457 (radiated measurements)
2432000456 (conducted measurements)
FCC ID: MRBSATEL-TA40
IC: 2422A-SATELA40

General Description

SATEL-TR4+ is a radio modem module. It uses 400 MHz frequency band.

Classification

| | |
|--|-------------------------------------|
| Fixed device | <input checked="" type="checkbox"/> |
| Mobile Device (Human body distance > 20cm) | <input checked="" type="checkbox"/> |
| Portable Device (Human body distance < 20cm) | <input type="checkbox"/> |

Modifications Incorporated in the EUT

No modifications.

Specifications

| | |
|------------------|--------------------------------------|
| Frequency: | 410-430 MHz and 450-470 MHz |
| Channel width: | 12.5 kHz, 25 kHz |
| Channel spacing: | 12.5 kHz, 25 kHz |
| Modulation: | 4FSK, 8FSK, 16FSK, GMSK |
| Rated power: | 10 mW ... 1000 mW |
| Antenna type: | External, 50Ω TNC (female) connector |

Power Supply

Operating voltage range: 3.8 – 5.5 VDC

Mechanical Size of the EUT

| | | |
|--------------|--------------|---------------|
| Height: 6 mm | Width: 35 mm | Length: 56 mm |
|--------------|--------------|---------------|

SUMMARY OF TESTING

| Test Specification | Description of Test | Result |
|-----------------------|--------------------------------|--------|
| §90.205 / RSS-119 5.4 | Transmitter output power | PASS |
| §90.210 / RSS-119 5.5 | Occupied bandwidth | N/T |
| §90.210 / RSS-119 5.5 | Spectrum emission mask | N/T |
| §90.210 / RSS-119 5.8 | Spurious emissions (conducted) | PASS |
| §90.210 / RSS-119 5.8 | Spurious emissions (radiated) | PASS |
| §90.213 / RSS-119 5.3 | Frequency stability | N/T |
| §90.214 / RSS-119 5.9 | Transient frequency behaviour | N/T |

The decision rule applied for the tests results stated in this test report is according to the requirements of section 1.3 of ANSI C63.26-2015.

EUT Test Conditions

The EUT was in continuous transmit mode during all the tests. The EUT was configured into the wanted channel using software provided by the manufacturer. During the tests the EUT was mounted on an evaluation kit provided by the manufacturer (model M3-TR3 Evaluation kit).

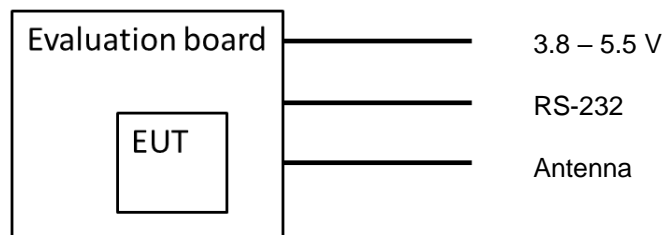


Figure 1: Test setup block diagram

Table 1: Transmission modes of the EUT

| Channel width (kHz) | Modulation |
|---------------------|------------|
| 12.5 | 4FSK |
| | 8FSK |
| | 16FSK |
| | GMSK |
| 25 | 4FSK |
| | 8FSK |
| | 16FSK |
| | GMSK |

Table 2: Test frequencies used in the tests

| Channel | Frequency (MHz) |
|---------|-----------------|
| LOW | 410.0 |
| MID 1 | 429.5 |
| MID 2 | 450.5 |
| HIGH | 469.5 |

Test Facility

| | |
|--|---|
| Testing Laboratory / address: FCC designation number: FI0002 ISED CAB identifier: T004 | SGS Fimko Ltd Takomotie 8 FI-00380, HELSINKI FINLAND |
| Test Site: | <input type="checkbox"/> K10LAB, ISED Canada registration number: 8708A-1 <input checked="" type="checkbox"/> K5LAB, ISED Canada registration number: 8708A-2 <input type="checkbox"/> T10LAB |

TEST RESULTS

Transmitter output power

Standard: ANSI C63.26 (2015)
Tested by: RRE
Date: 26 September 2024
Temperature: $23 \pm 3^{\circ}\text{C}$
Humidity: 20 - 60 % RH

Measurement uncertainty: ± 0.470 dB
Test result: **PASS**

Level of confidence 95.45 % (k = 2)

FCC Rule: 90.205
RSS-119 5.4

The output power shall be within ± 1 dB of the manufacturer's rated power listed in the equipment specifications.

The test was performed only at maximum power level, and with a spectrum analyser with the following settings:

Span: 200 kHz
RBW: 30 kHz
VBW: 100 kHz
Sweep points: 32001
Sweep time: Auto
Detector: Positive Peak

Transmitter output power
Test results
Table 3. Rated output power 1000 mW (30 dBm)

| Frequency (MHz) | Ch. Spacing (kHz) | Modulation | Measured Output Power (dBm) | Result |
|-----------------|-------------------|------------|-----------------------------|--------|
| 410.0 | 12.5 | 4FSK | 30.42 | PASS |
| 410.0 | 12.5 | 8FSK | 30.37 | PASS |
| 410.0 | 12.5 | 16FSK | 30.43 | PASS |
| 410.0 | 12.5 | GMSK | 30.45 | PASS |
| 410.0 | 25 | 4FSK | 30.43 | PASS |
| 410.0 | 25 | 8FSK | 30.39 | PASS |
| 410.0 | 25 | 16FSK | 30.43 | PASS |
| 410.0 | 25 | GMSK | 30.46 | PASS |
| 429.5 | 12.5 | 4FSK | 29.94 | PASS |
| 429.5 | 12.5 | 8FSK | 29.90 | PASS |
| 429.5 | 12.5 | 16FSK | 29.94 | PASS |
| 429.5 | 12.5 | GMSK | 29.96 | PASS |
| 429.5 | 25 | 4FSK | 29.94 | PASS |
| 429.5 | 25 | 8FSK | 29.94 | PASS |
| 429.5 | 25 | 16FSK | 29.94 | PASS |
| 429.5 | 25 | GMSK | 29.96 | PASS |
| 450.5 | 12.5 | 4FSK | 29.66 | PASS |
| 450.5 | 12.5 | 8FSK | 29.65 | PASS |
| 450.5 | 12.5 | 16FSK | 29.66 | PASS |
| 450.5 | 12.5 | GMSK | 29.68 | PASS |
| 450.5 | 25 | 4FSK | 29.67 | PASS |
| 450.5 | 25 | 8FSK | 29.67 | PASS |
| 450.5 | 25 | 16FSK | 29.68 | PASS |
| 450.5 | 25 | GMSK | 29.68 | PASS |
| 469.5 | 12.5 | 4FSK | 29.04 | PASS |
| 469.5 | 12.5 | 8FSK | 29.03 | PASS |
| 469.5 | 12.5 | 16FSK | 29.04 | PASS |
| 469.5 | 12.5 | GMSK | 29.05 | PASS |
| 469.5 | 25 | 4FSK | 29.47 | PASS |
| 469.5 | 25 | 8FSK | 29.05 | PASS |
| 469.5 | 25 | 16FSK | 29.03 | PASS |
| 469.5 | 25 | GMSK | 29.05 | PASS |

Transmitter output power

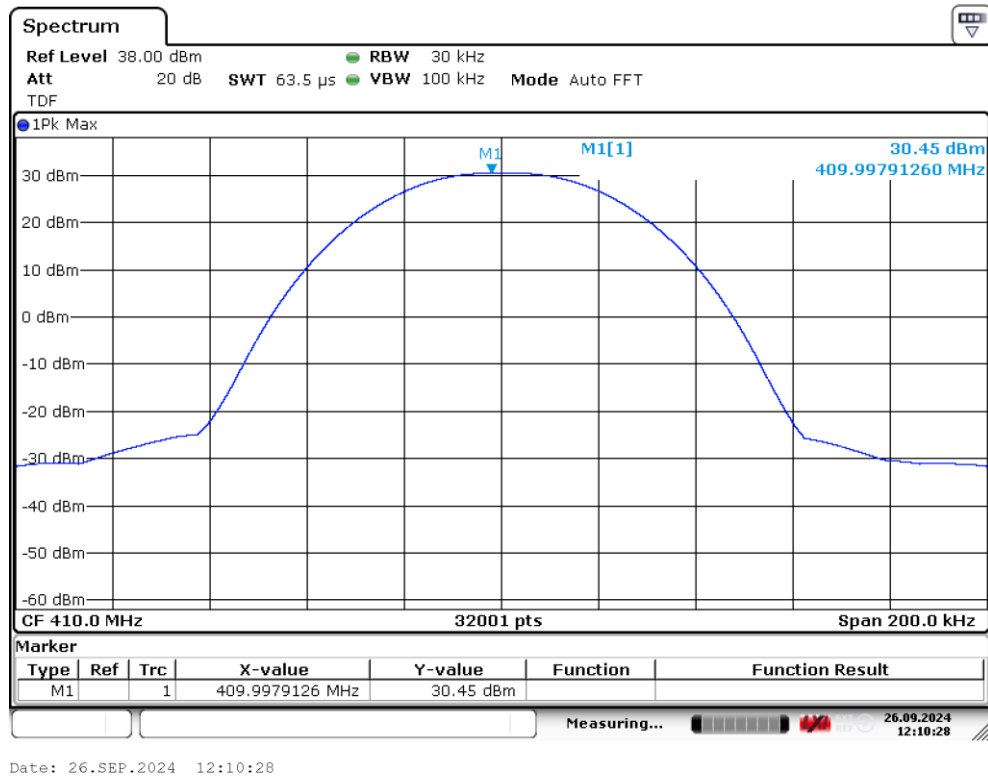


Figure 2: 410 MHz, GMSK, 12.5 kHz

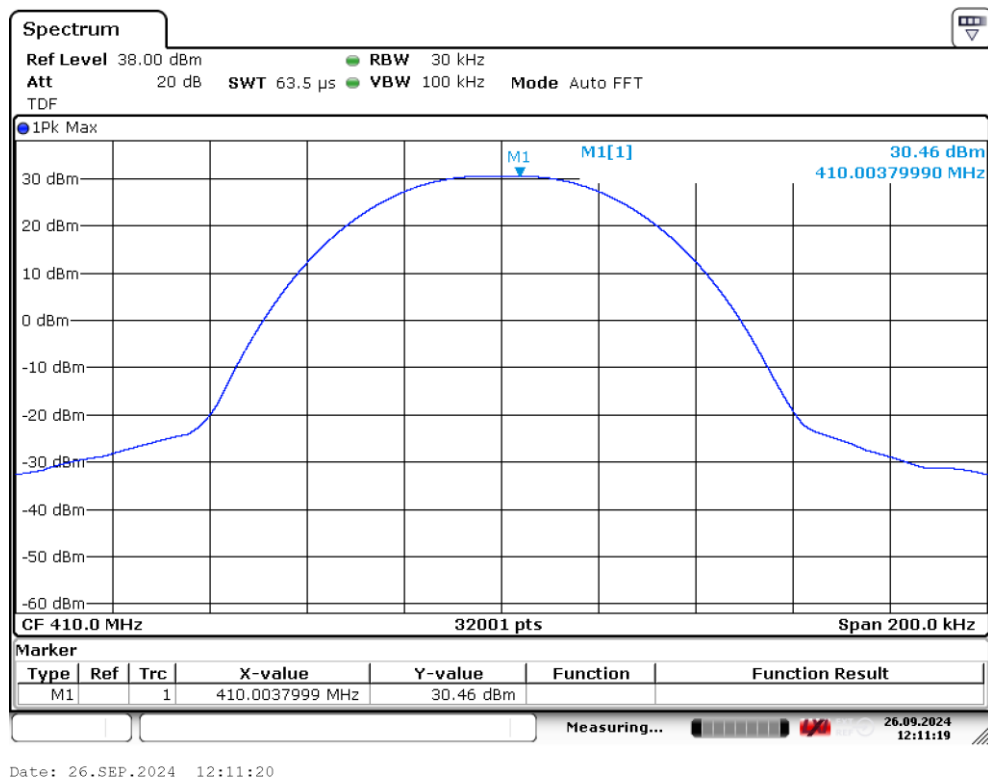


Figure 3: 410 MHz, GMSK, 25 kHz

Spurious emissions (conducted) 9 kHz – 5 GHz**Spurious emissions (conducted) 9 kHz – 5 GHz**

Standard: ANSI C63.26 (2015)
Tested by: RRE
Date: 26 September 2024 27 September 2024
Temperature: 23 ± 3°C
Humidity: 20 - 60 % RH

Measurement uncertainty: ± 2.90 dB Level of confidence 95.45 % (k = 2)
Test result: **PASS**

FCC Rule: 90.210**RSS-119 5.8**

For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows: on any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth; at least 43 + 10 log (P) dB.

For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows: on any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: at least 50 + 10 log (P) or 70 dB, whichever is the lesser attenuation.

| Frequency Band (MHz) | Channel Bandwidth (kHz) | Authorized Bandwidth (kHz) | Limit (dBm) |
|-----------------------|-------------------------|----------------------------|-------------|
| 406.1-430 and 450-470 | 12.5 | 11.25 | -20 |
| | 25 | 20 | -13 |

The test was performed at maximum power level, and with a spectrum analyser with following settings:

| | | | | |
|------------------|-----------------|------------------|----------------|---------------|
| Frequency range: | 9 kHz – 150 kHz | 150 kHz – 30 MHz | 30 MHz – 1 GHz | 1 GHz – 5 GHz |
| RBW: | 1 kHz | 10 kHz | 100 kHz | 1 MHz |
| VBW: | 3 kHz | 30 kHz | 300 kHz | 3 MHz |
| Sweep points: | 10001 | 10001 | 10001 | 10001 |
| Sweep time: | Auto | Auto | Auto | Auto |
| Detector: | Positive Peak | Positive Peak | Positive Peak | Positive Peak |

Test results

Worst case margins were more than 20 dB to the limits. Measurement results are presented in the following figures.

Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 410.0 MHz, 12.5 kHz, 4FSK

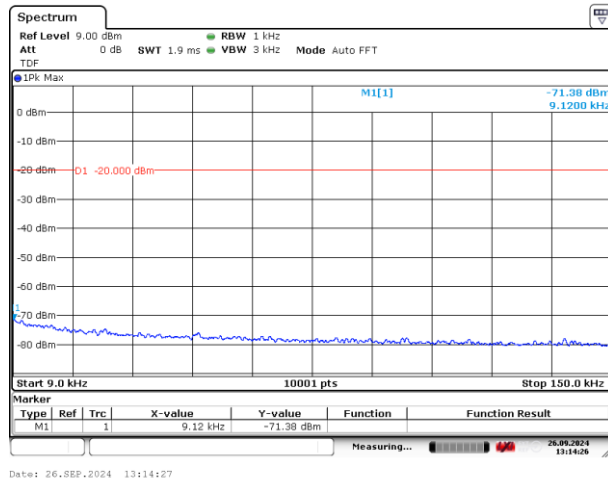


Figure 4: 9 – 150 kHz

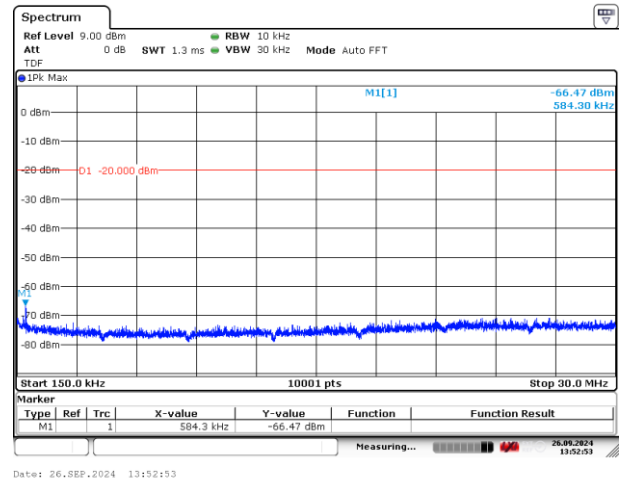


Figure 5: 150 kHz – 30 MHz

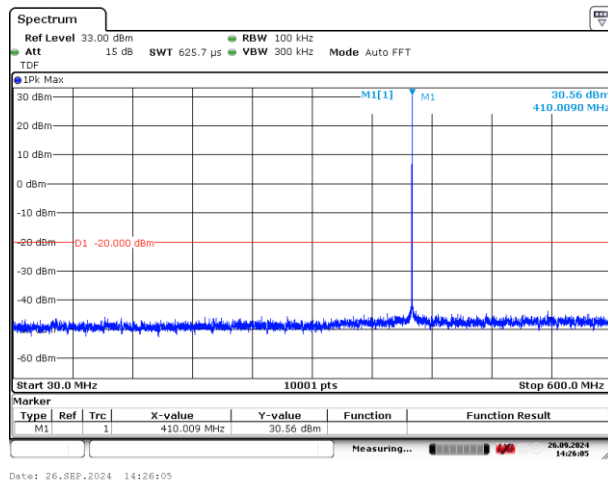


Figure 6: 30 – 600 MHz

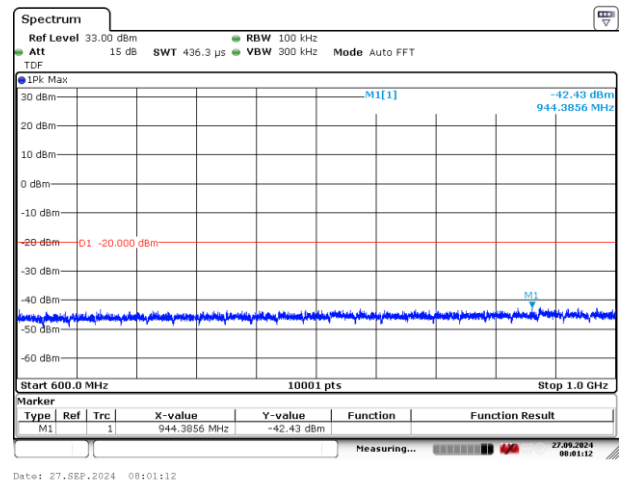


Figure 7: 600 – 1000 MHz

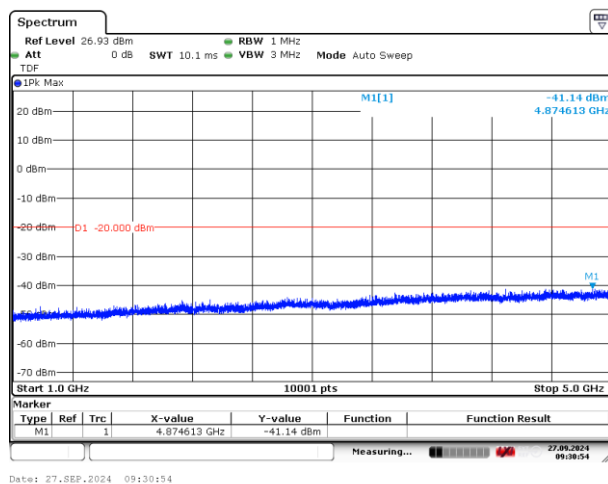


Figure 8: 1 – 5 GHz

Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 410.0 MHz, 25 kHz, 4FSK

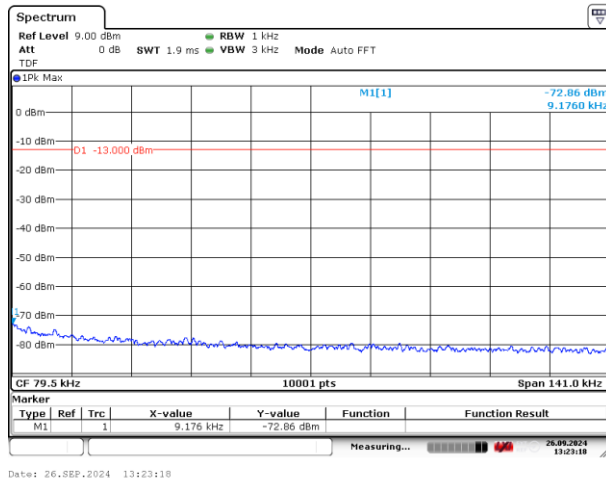


Figure 9: 9 – 150 kHz

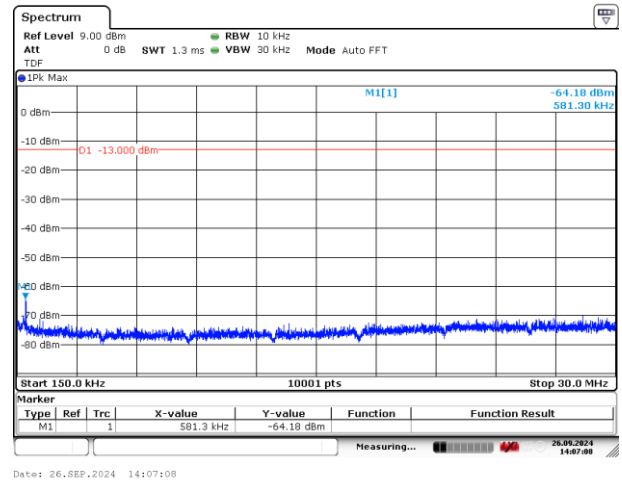


Figure 10: 150 kHz – 30 MHz

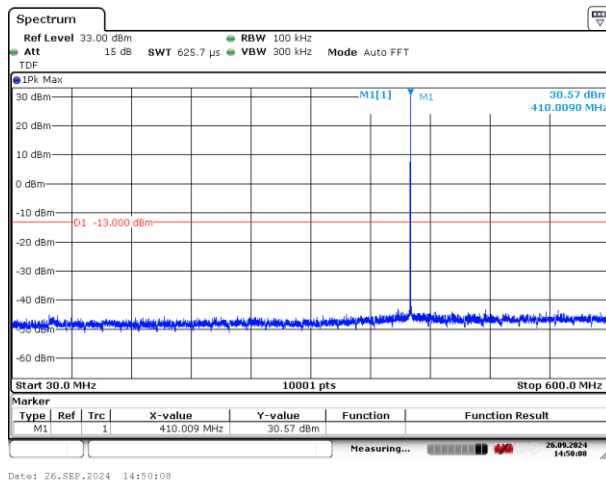


Figure 11: 30 – 600 MHz

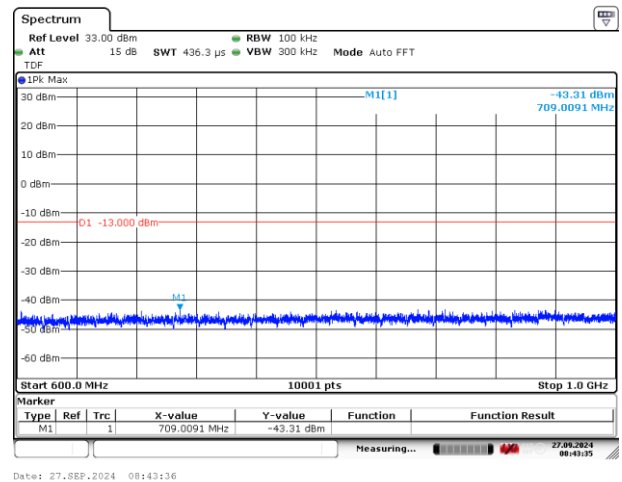


Figure 12: 600 – 1000 MHz

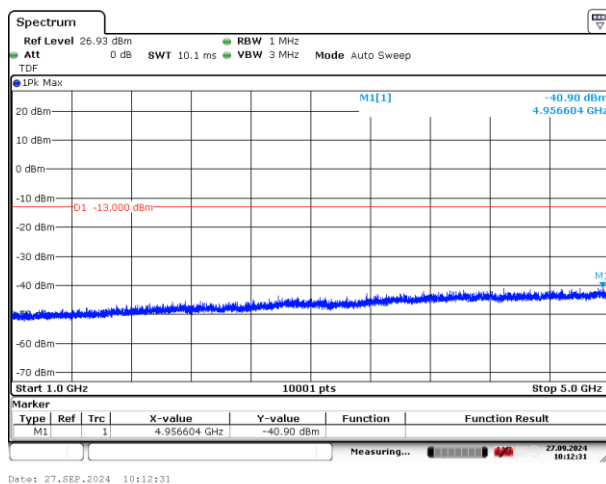
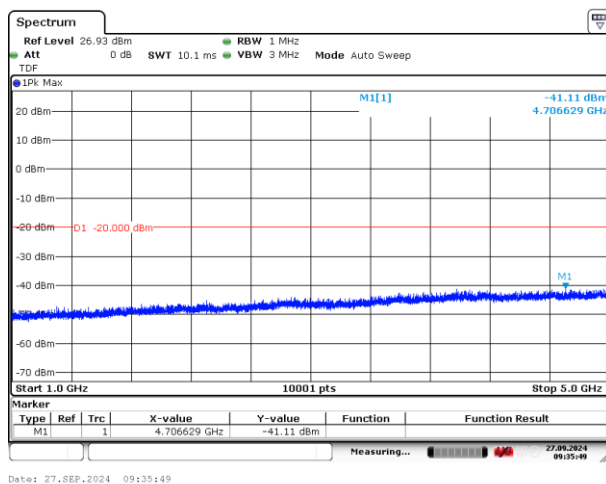
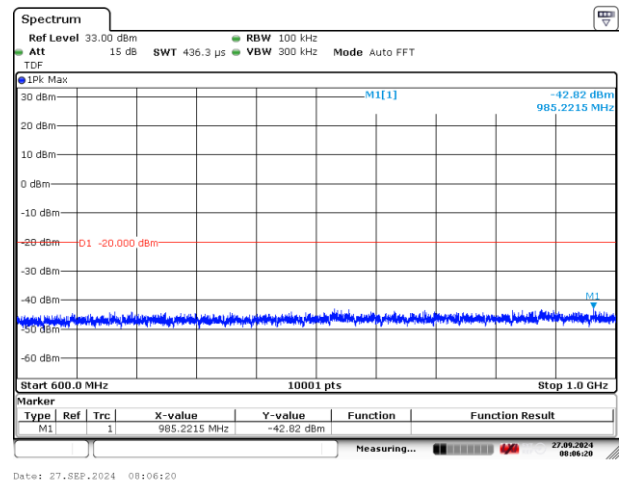
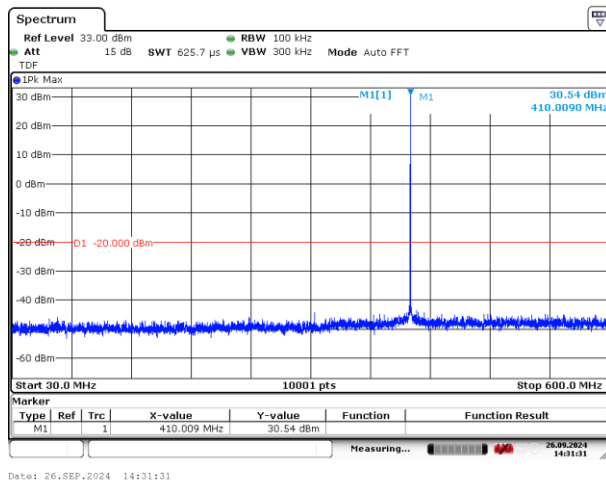
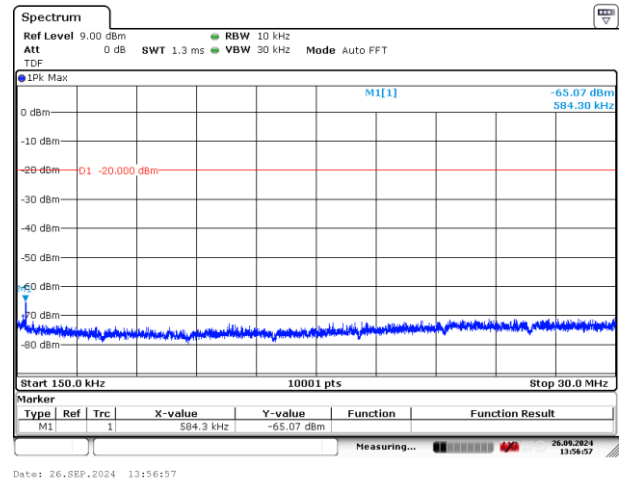
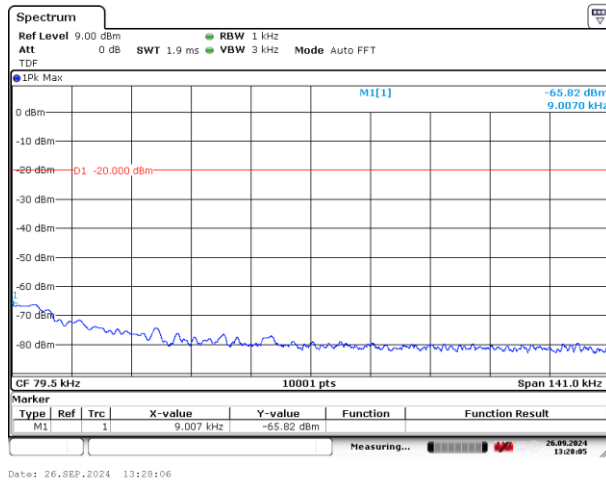


Figure 13: 1 – 5 GHz

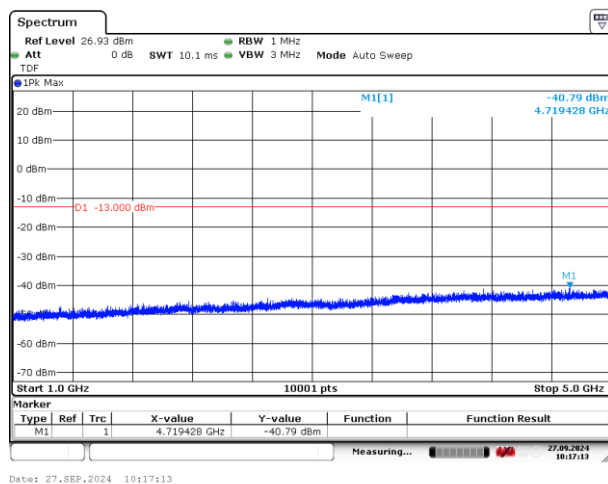
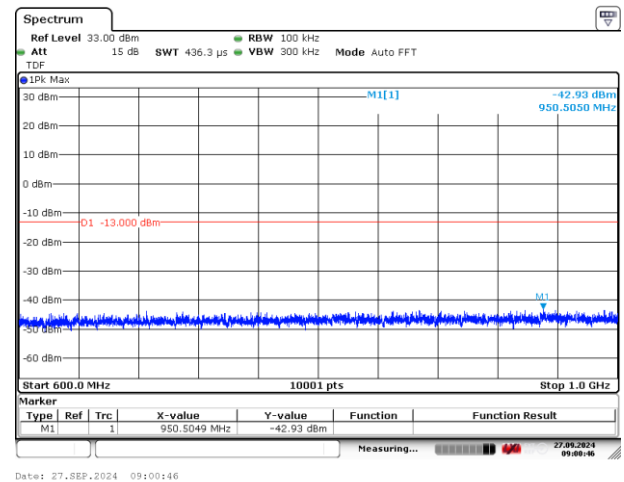
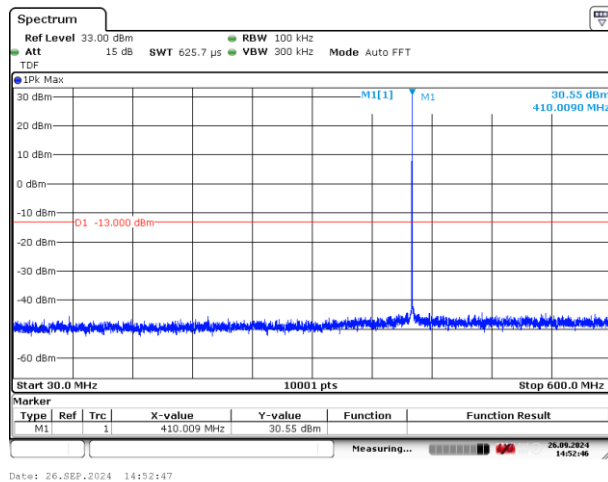
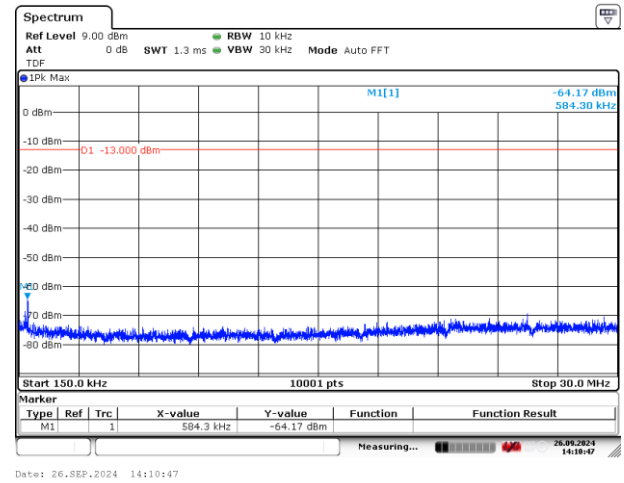
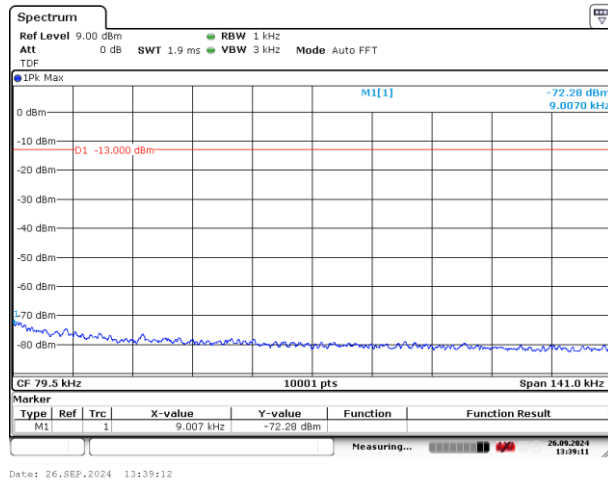
Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 410.0 MHz, 12.5 kHz, 8FSK



Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 410.0 MHz, 25 kHz, 8FSK



Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 410.0 MHz, 12.5kHz, 16FSK

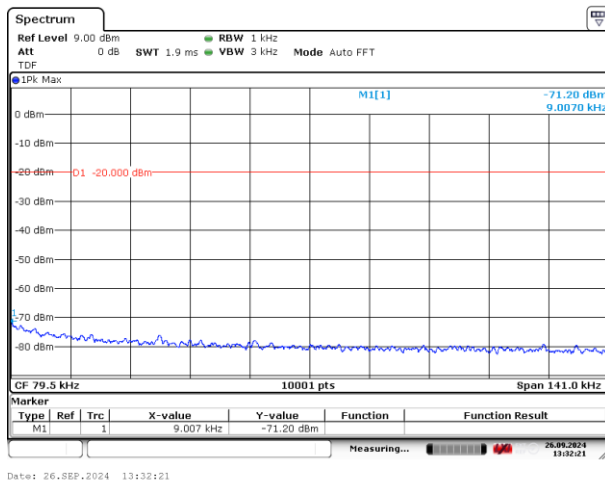


Figure 24: 9 – 150 kHz

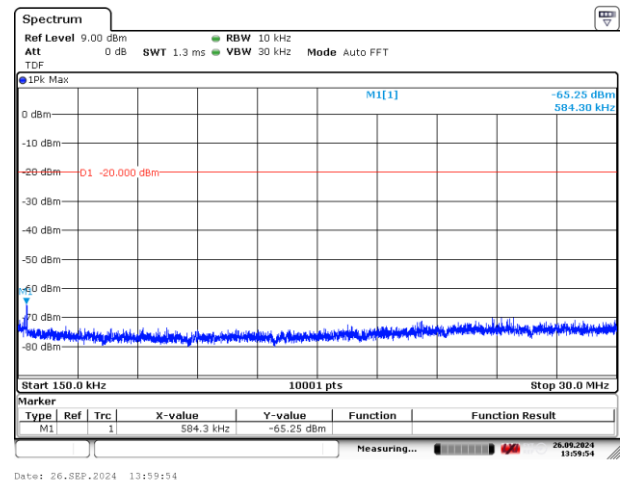


Figure 25: 150 kHz – 30 MHz

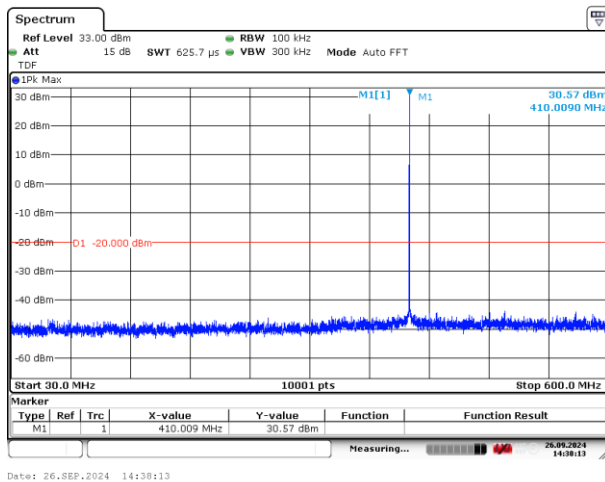


Figure 26: 30 – 600 MHz

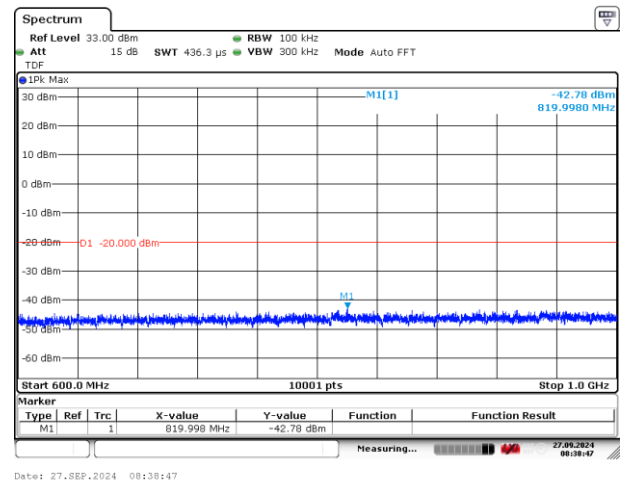


Figure 27: 600 – 1000 MHz

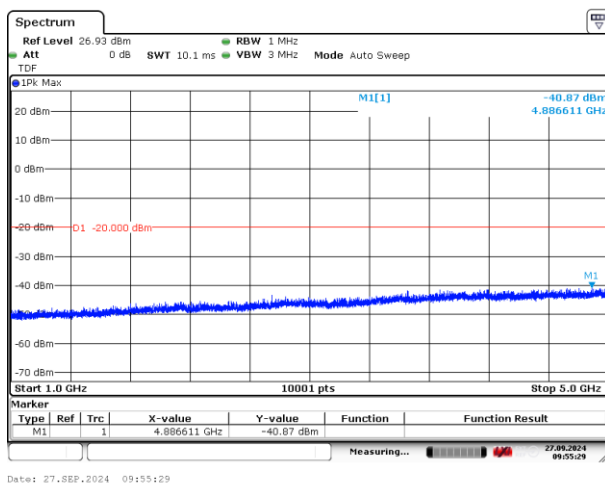


Figure 28: 1 – 5 GHz

Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 410.0 MHz, 25kHz, 16FSK

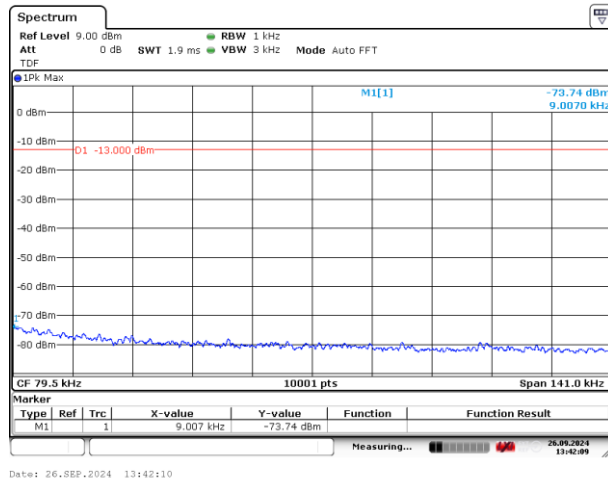


Figure 29: 9 – 150 kHz

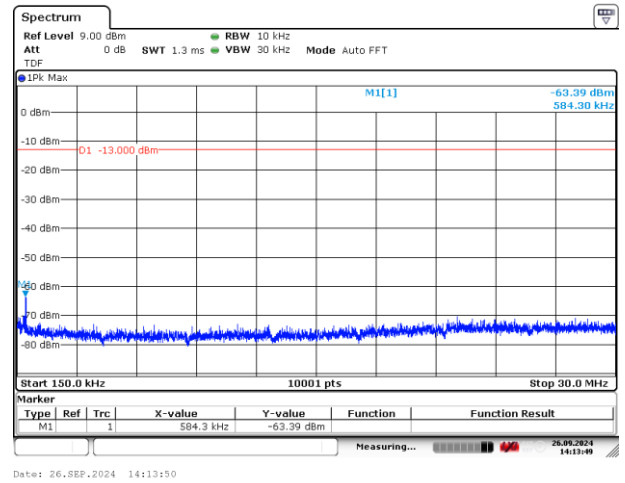


Figure 30: 150 kHz – 30 MHz

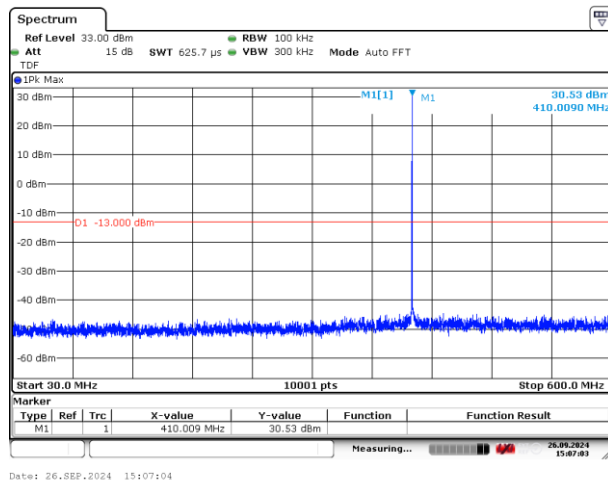


Figure 31: 30 – 600 MHz

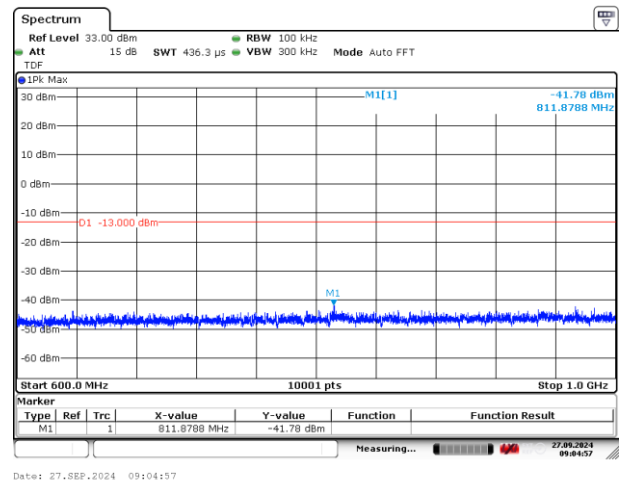


Figure 32: 600 – 1000 MHz

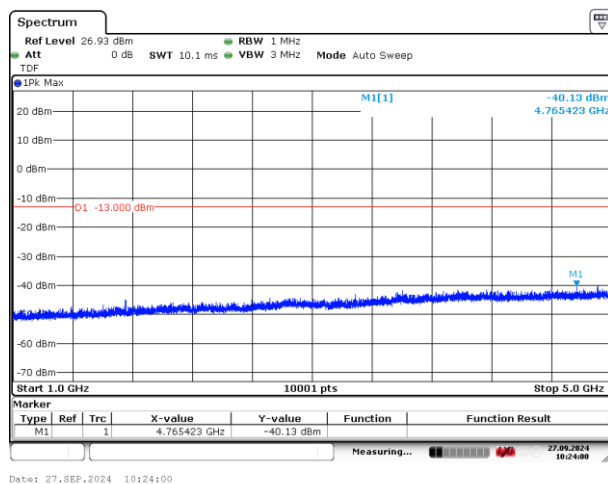


Figure 33: 1 – 5 GHz

Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 410.0 MHz, 12.5 kHz, GMSK

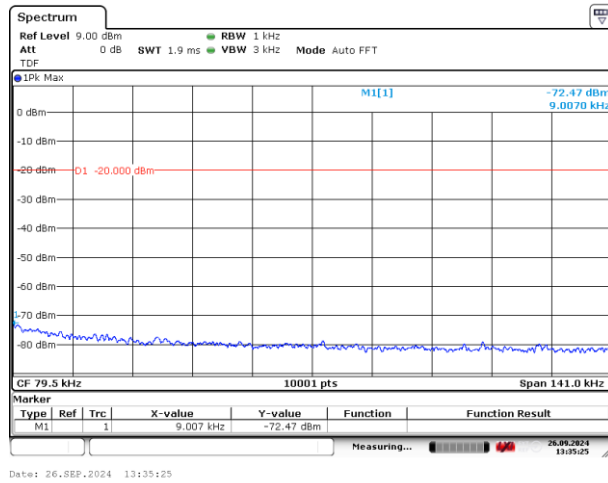


Figure 34: 9 – 150 kHz

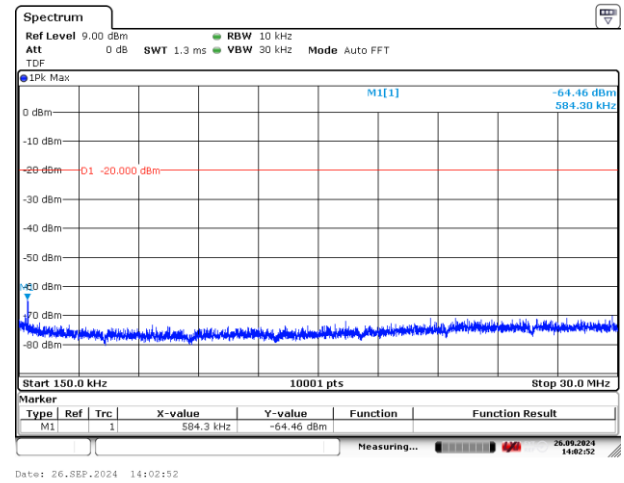


Figure 35: 150 kHz – 30 MHz

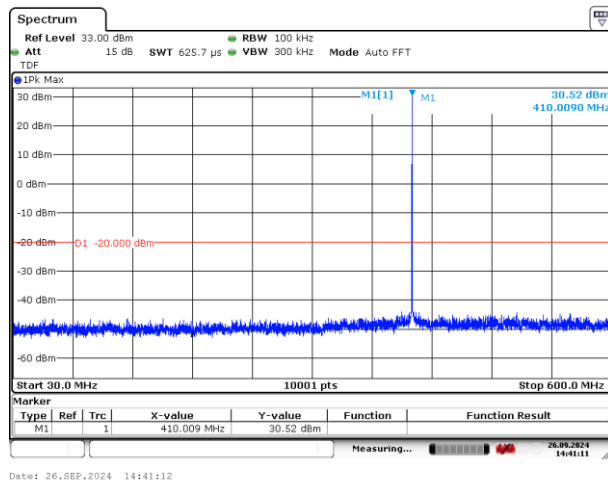


Figure 36: 30 – 600 MHz

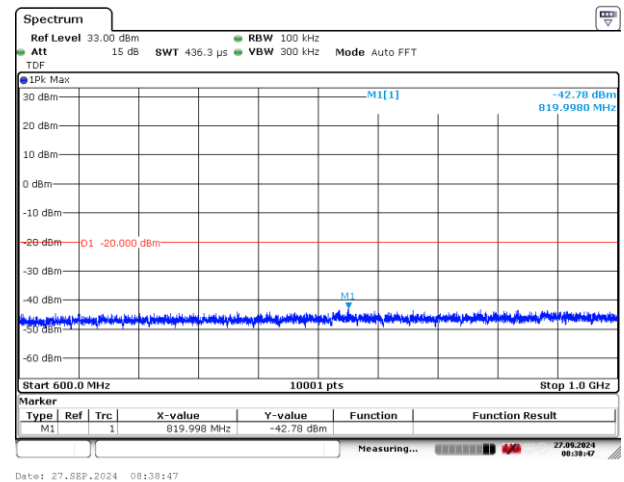


Figure 37: 600 – 1000 MHz

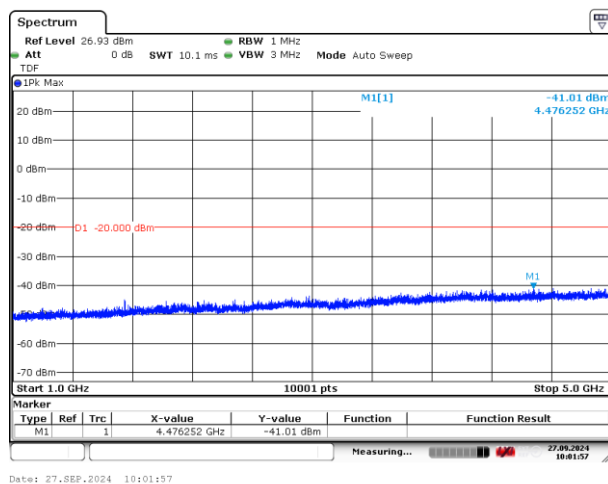
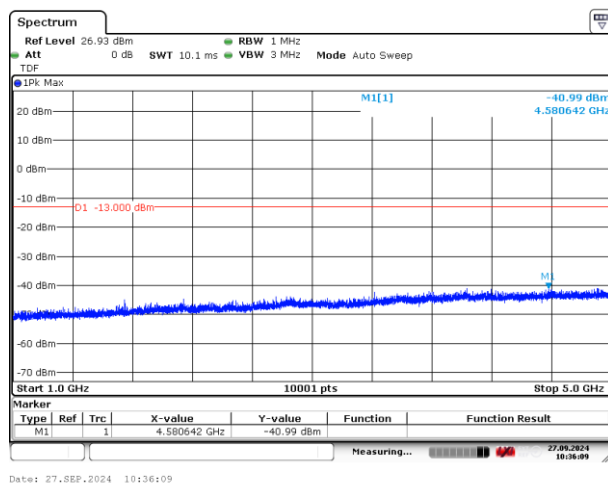
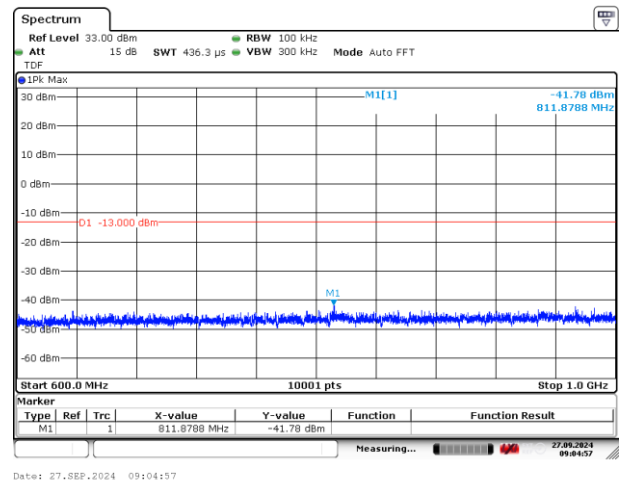
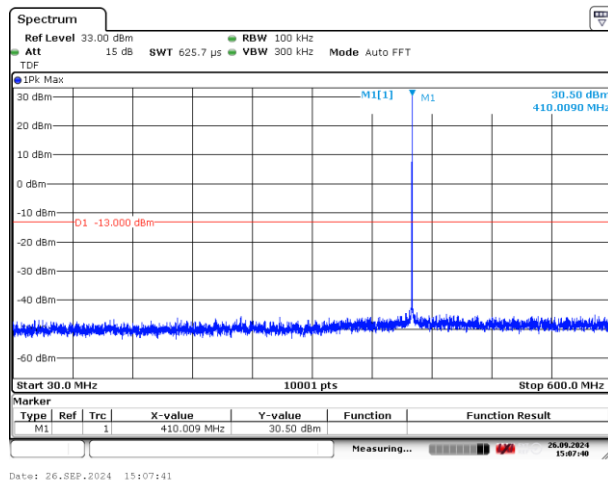
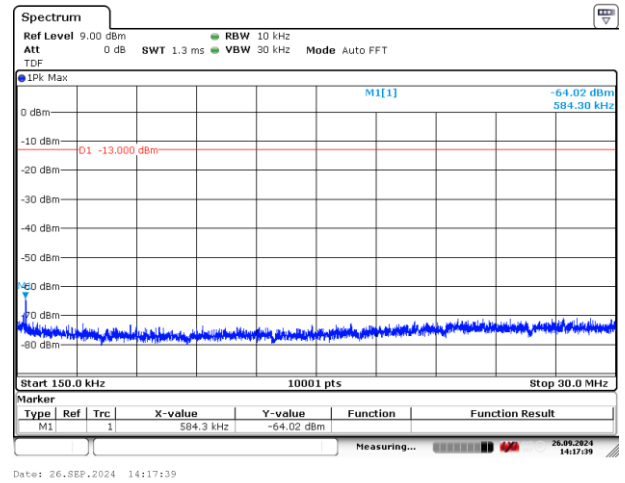
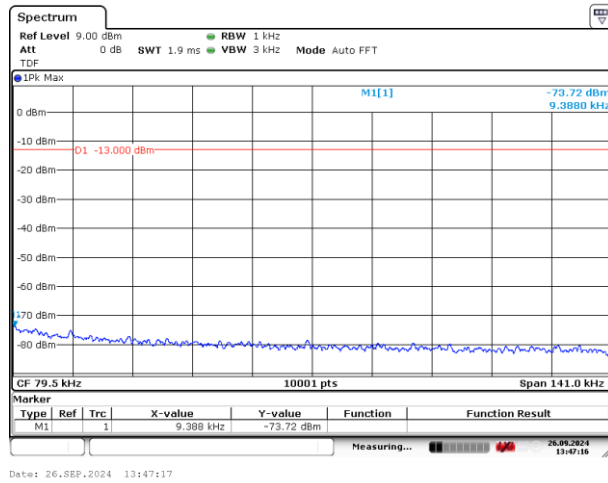


Figure 38: 1 – 5 GHz

Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 410.0 MHz, 25 kHz, GMSK



Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 429.5 MHz, 12.5 kHz, 4FSK

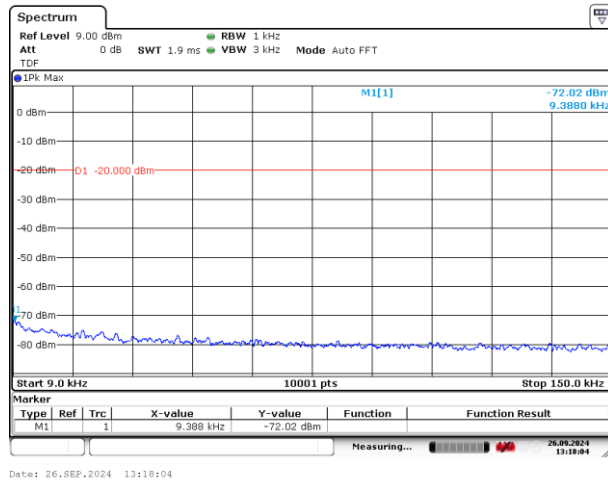


Figure 44: 9 – 150 kHz

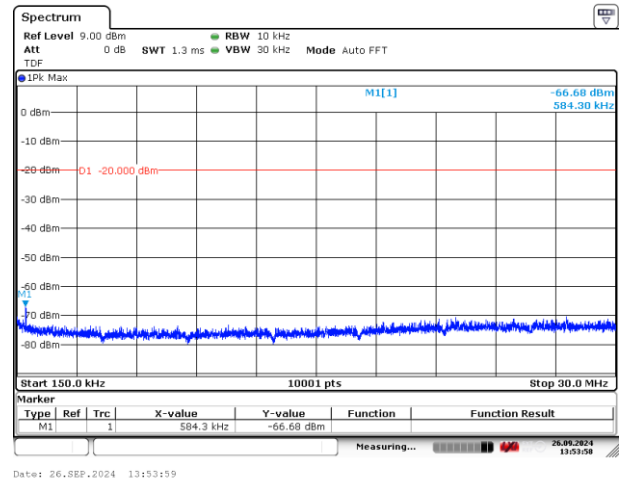


Figure 45: 150 kHz – 30 MHz

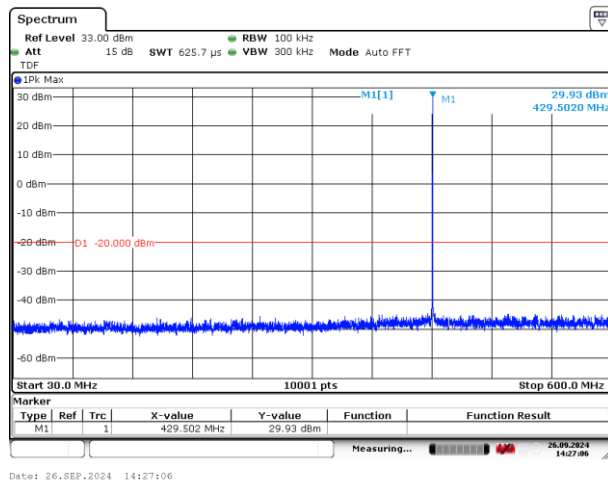


Figure 46: 30 – 600 MHz

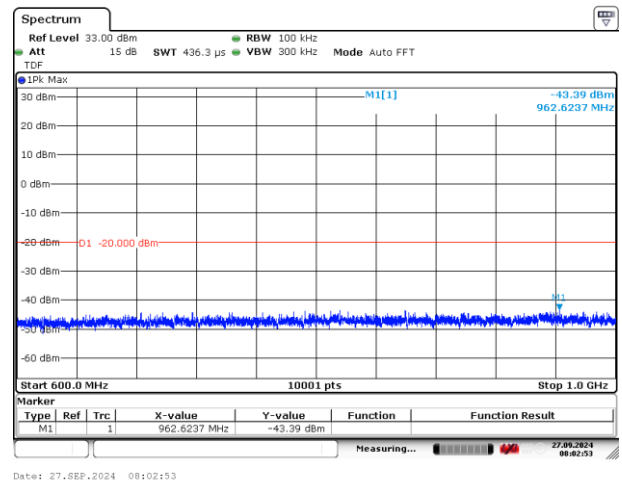


Figure 47: 600 – 1000 MHz

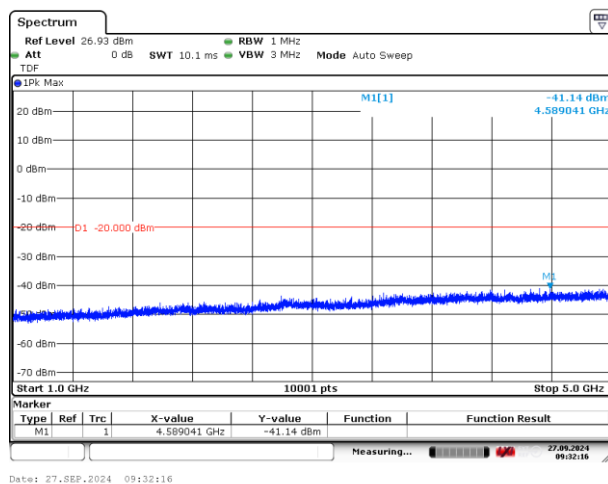


Figure 48: 1 – 5 GHz

Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 429.5 MHz, 25 kHz, 4FSK

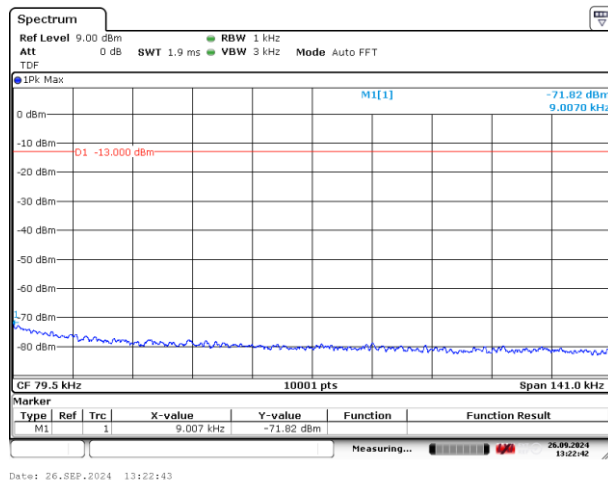


Figure 49: 9 – 150 kHz

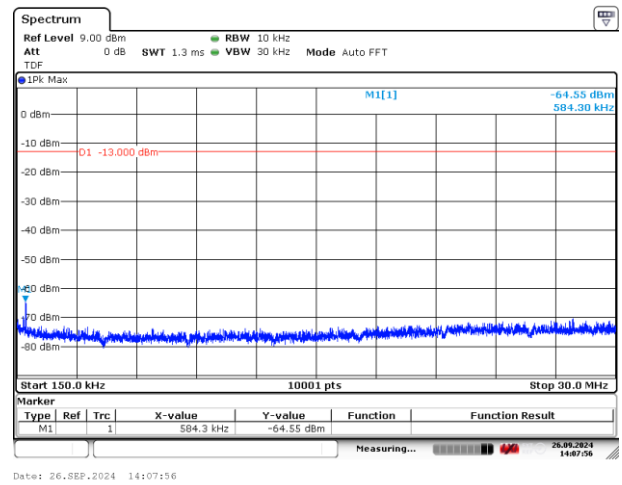


Figure 50: 150 kHz – 30 MHz

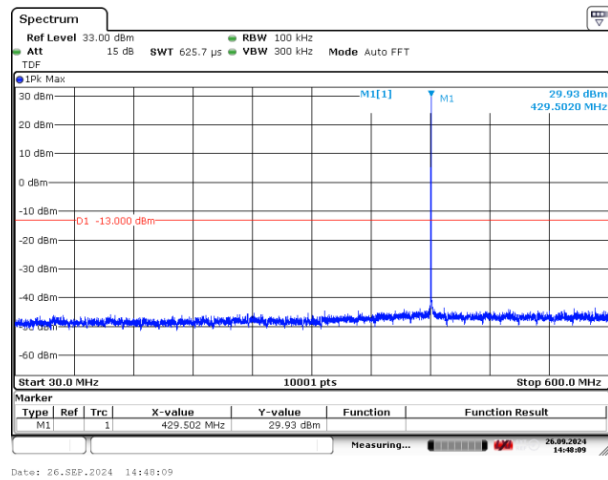


Figure 51: 30 – 600 MHz

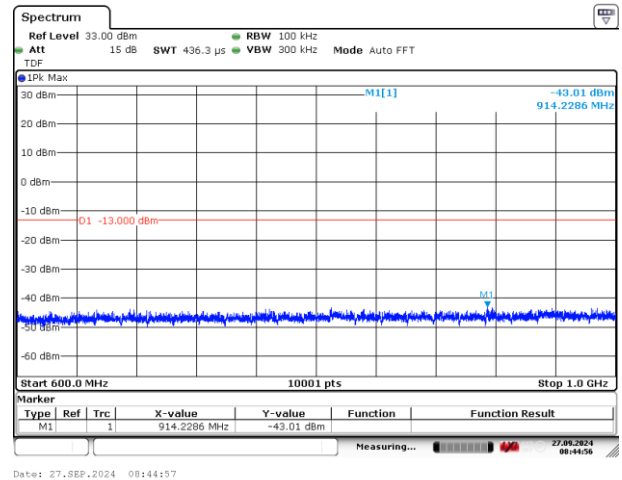


Figure 52: 600 – 1000 MHz

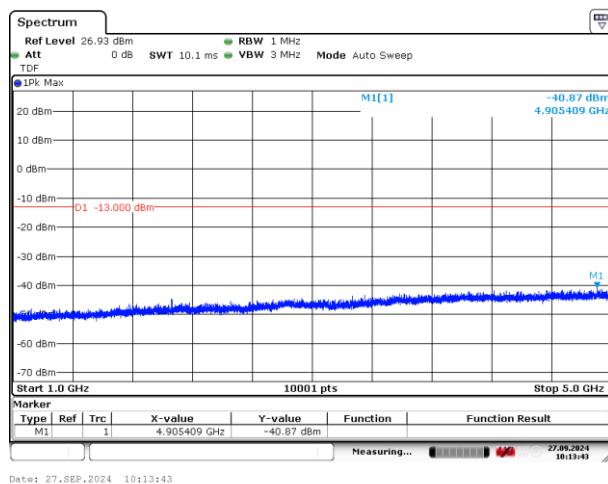


Figure 53: 1 – 5 GHz

Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 429.5 MHz, 12.5 kHz, 8FSK

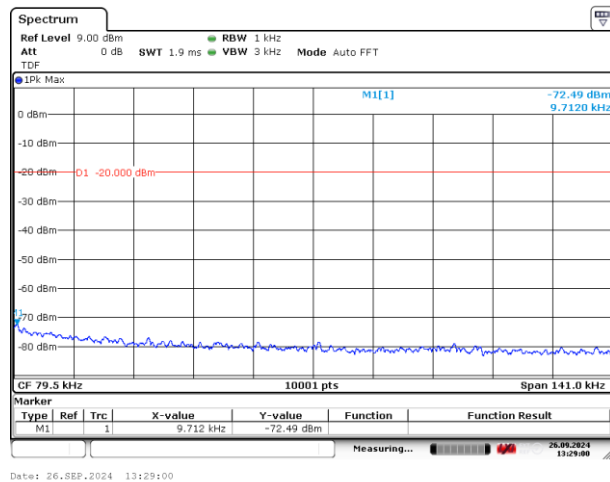


Figure 54: 9 – 150 kHz

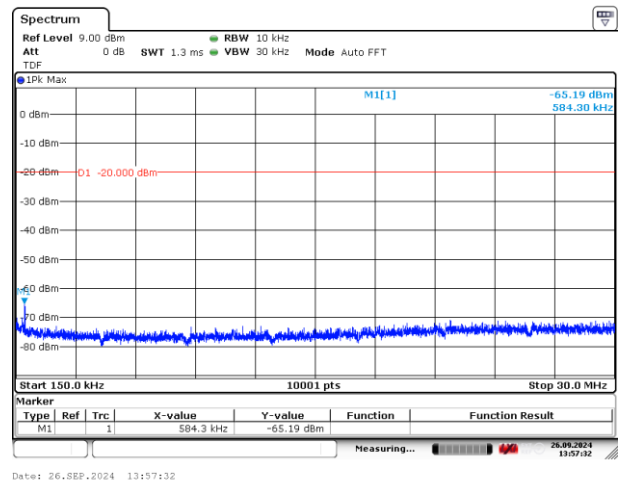


Figure 55: 150 kHz – 30 MHz

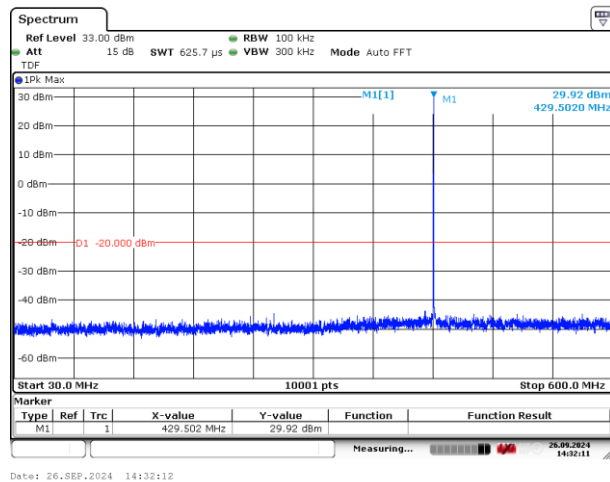


Figure 56: 30 – 600 MHz

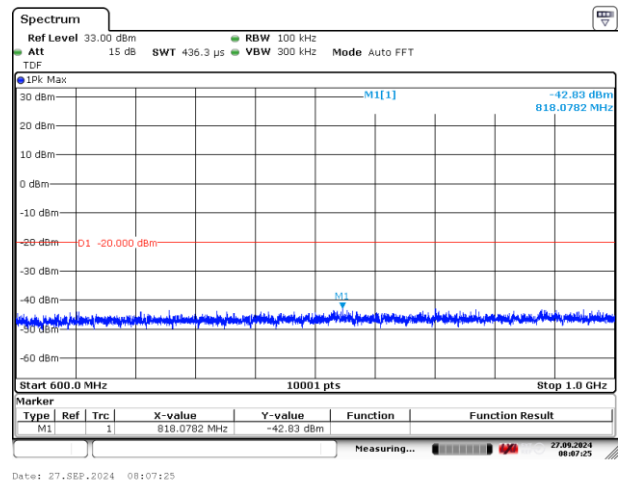


Figure 57: 600 – 1000 MHz

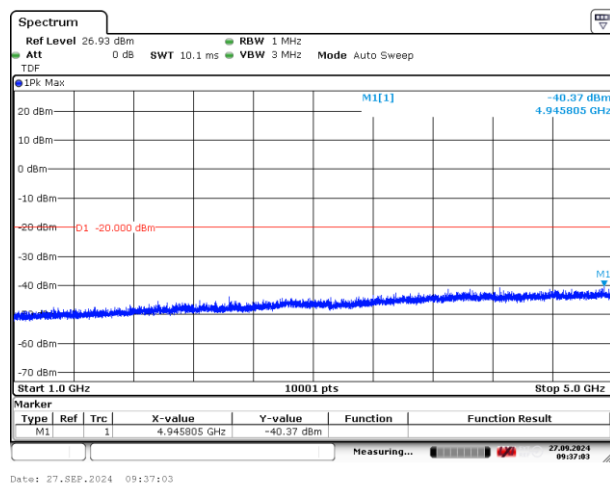
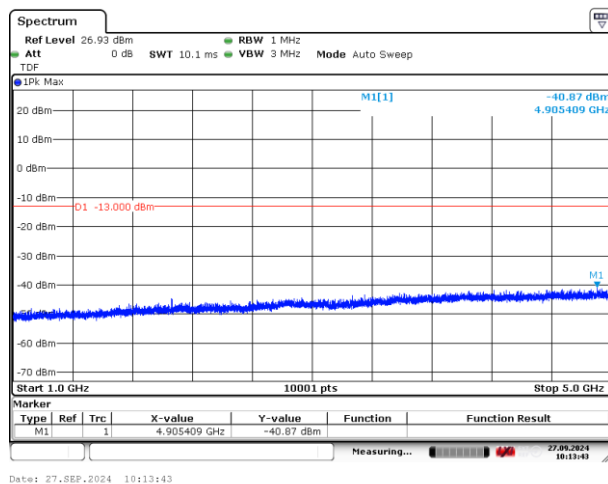
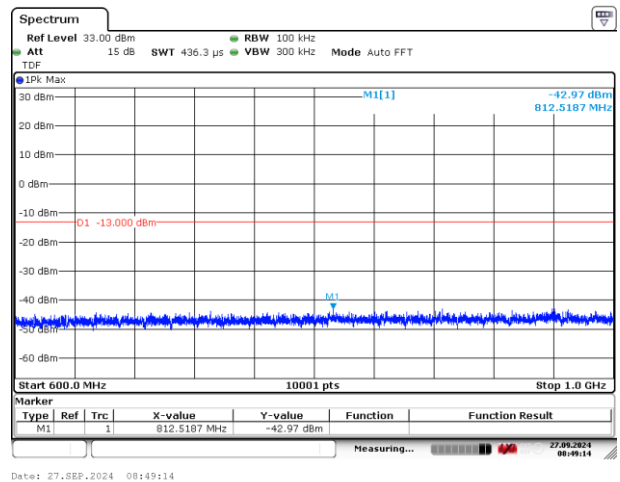
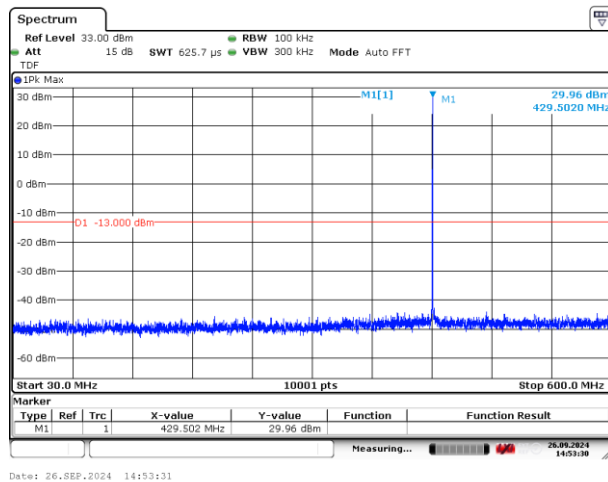
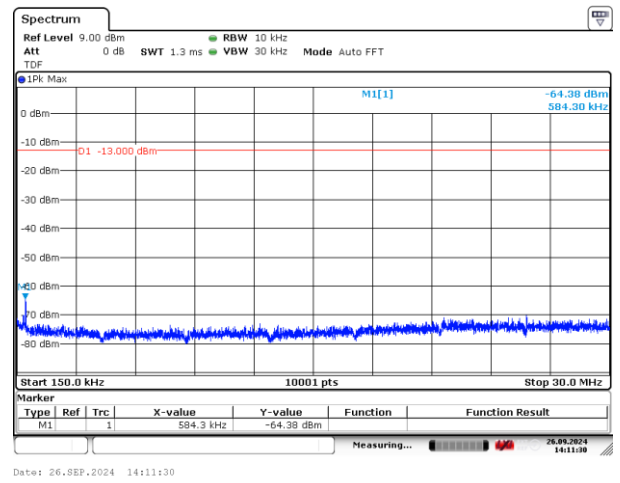
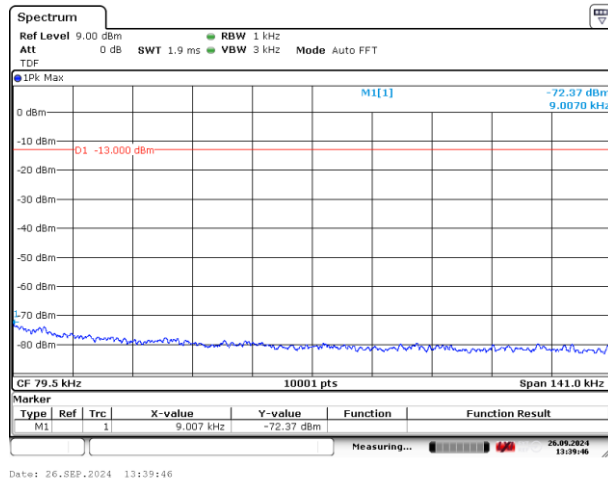


Figure 58: 1 – 5 GHz

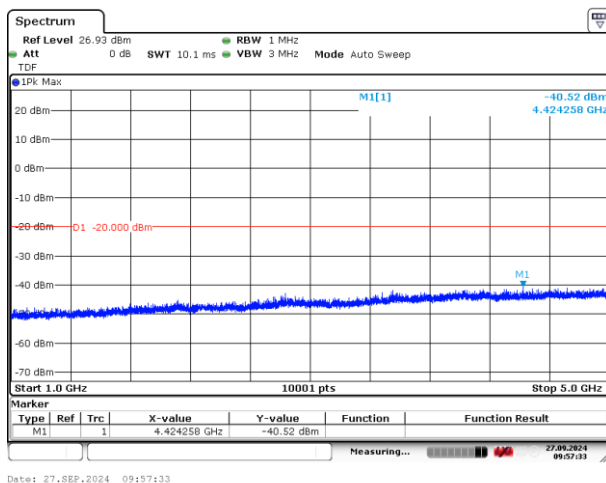
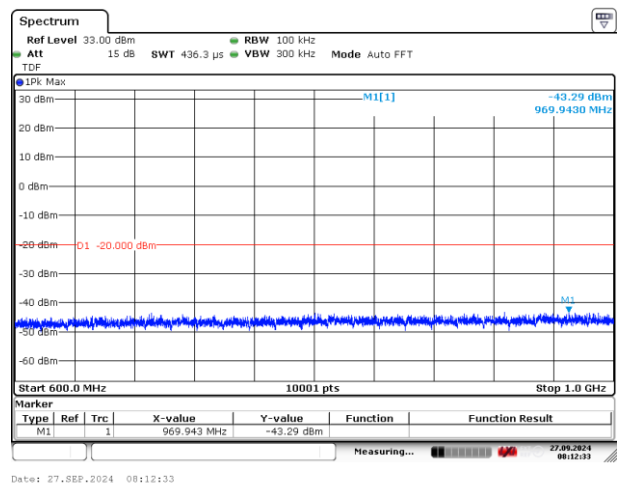
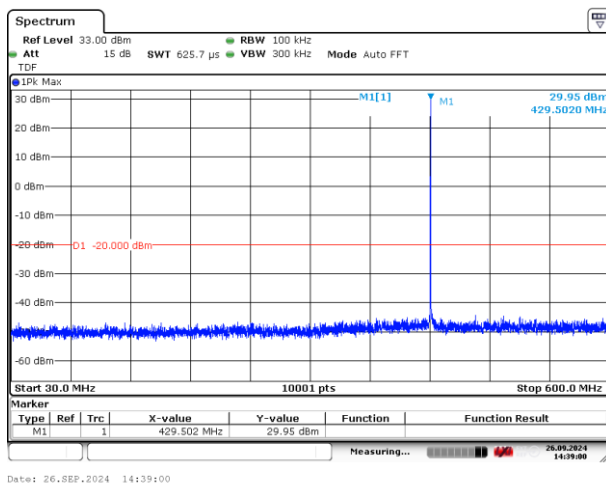
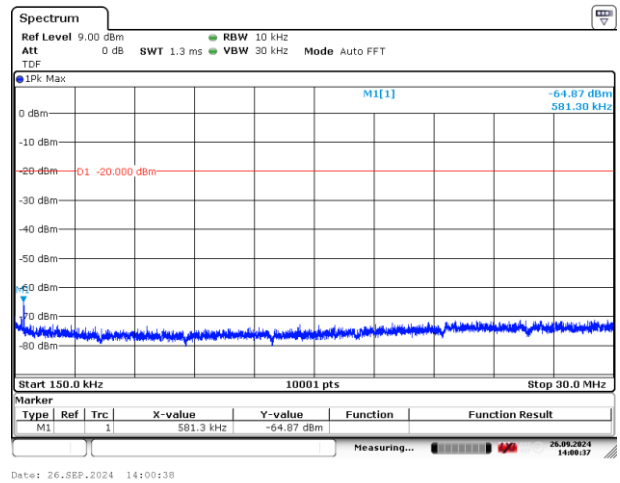
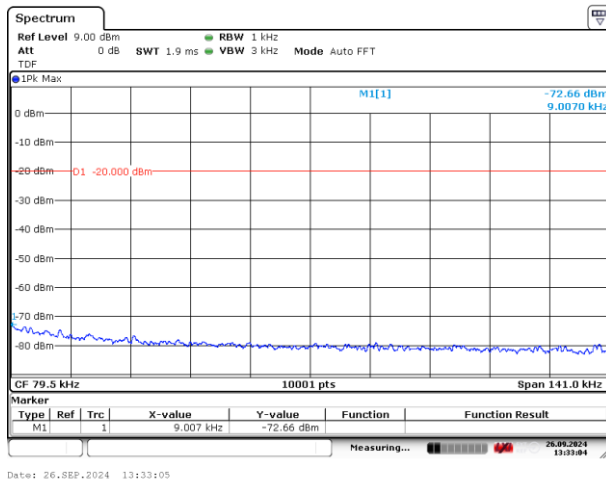
Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 429.5 MHz, 25 kHz, 8FSK



Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 429.5 MHz, 12.5 kHz, 16FSK



Spurious emissions (conducted) 9 kHz – 5 GHz

Spurious emissions TX 429.5 MHz, 25 kHz, 16FSK

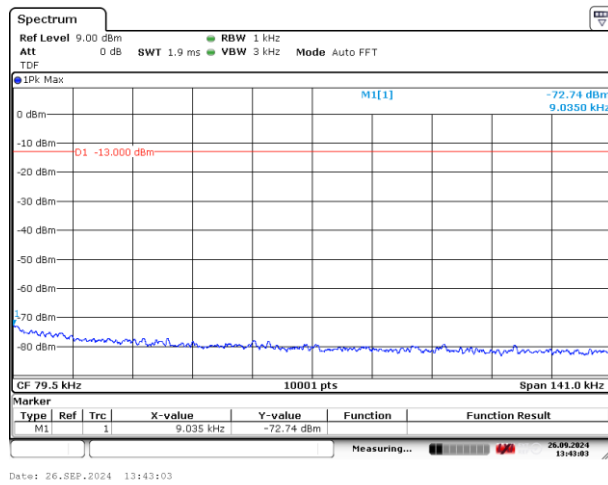


Figure 69: 9 – 150 kHz

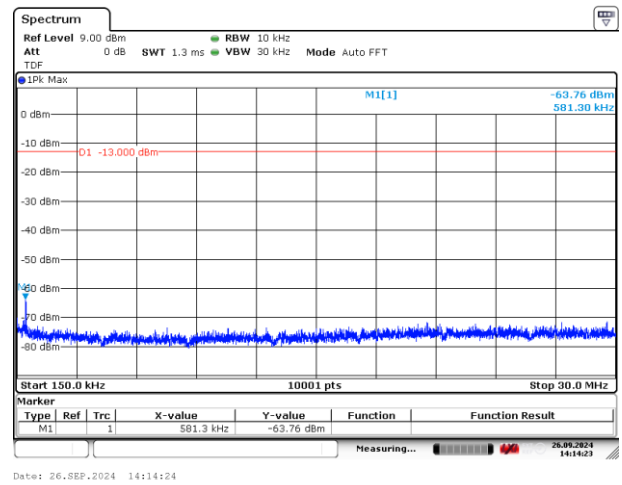


Figure 70: 150 kHz – 30 MHz

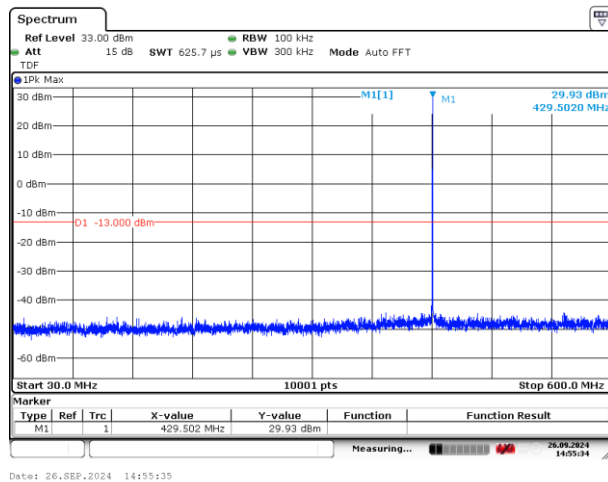


Figure 71: 30 – 600 MHz

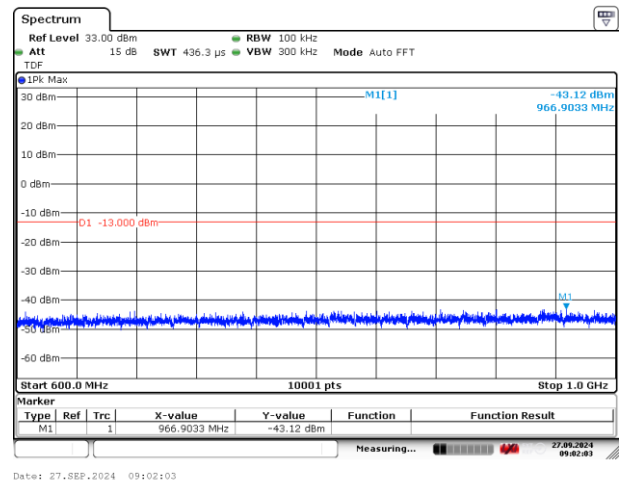


Figure 72: 600 – 1000 MHz

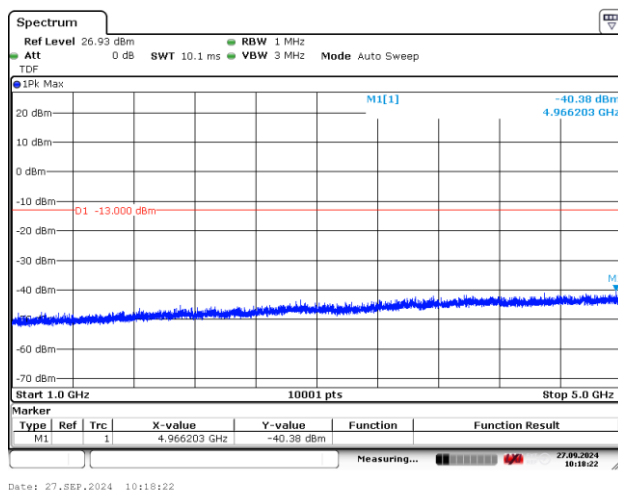


Figure 73: 1 – 5 GHz