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Bundesnetzagentur

BNetzA-CAB-02/21-102

# TEST REPORT

**Test report no.: 1-2685/21-03-14**

## Testing laboratory


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**Accredited Testing Laboratory:**
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate starting with the registration number: D-PL-12076-01.

## Applicant


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## Manufacturer


**Berlinger & Co.AG**
Mitteldorfstrasse 2
9608 Ganterschwil / SWITZERLAND


## Test standard/s

| | |
|---|---|
| FCC - Title 47 CFR Part 22 | FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 22 - Public mobile services |
| FCC - Title 47 CFR Part 24 | FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 24 - Personal communications services |

For further applied test standards please refer to section 3 of this test report.

## Test Item

| | |
|---|---|
| **Kind of test item:** | **SmartMonitor** |
| **Model name:** | **Shipment Logger L/M;** Site Logger |
| **FCC ID:** | **2AIEO-SMSHL,** 2AIEO-SMSIL |
| **ISED certification number:** | **21299-SMSHL,** 21299-SMSIL |
| Frequency: | LTE band 2; 4; 5; 12 and 13 |
| Technology tested: | LTE NB-IoT |
| Antenna: | Integrated antenna |
| Power supply: | 5 V DC by external mains adapter / 3.6 V DC by battery |
| Temperature range: | -30°C to +75°C |

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**Test report authorized:**

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Lab Manager
Radio Communications

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# 2 General information

## 2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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## 2.2 Application details

| | |
|---|---|
| Date of receipt of order: | 2021-10-19 |
| Date of receipt of test item: | 2022-02-04 |
| Start of test:* | 2022-02-04 |
| End of test:* | 2022-04-13 |
| Person(s) present during the test: | -/- |

*Date of each measurement, if not shown in the plot, can be requested. Dates are stored in the measurement software.

## 2.3 Test laboratories sub-contracted

None

## 3 Test standard/s, references and accreditations

| Test standard | Date | Description |
|---|---|---|
| FCC - Title 47 CFR Part 22 | -/- | FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 22 - Public mobile services |
| FCC - Title 47 CFR Part 24 | -/- | FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 24 - Personal communications services |
| FCC - Title 47 CFR Part 27 | -/-0 | FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 27 - Miscellaneous wireless communications services |
| RSS - 132 Issue 3 | January 2013 | Spectrum Management and Telecommunications Radio Standards Specification - Cellular Telephone Systems Operating in the Bands 824-849 MHz and 869-894 MHz |
| RSS - 133 Issue 6 | January 2018 | Spectrum Management and Telecommunications Policy - Radio Standards Specifications, 2 GHz Personal Communication Services |
| RSS - 130 Issue 2 | February 2019 | Equipment Operating in the Frequency Bands 617-652 MHz, 663-698 MHz, 698-756 MHz and 777-787 MHz |

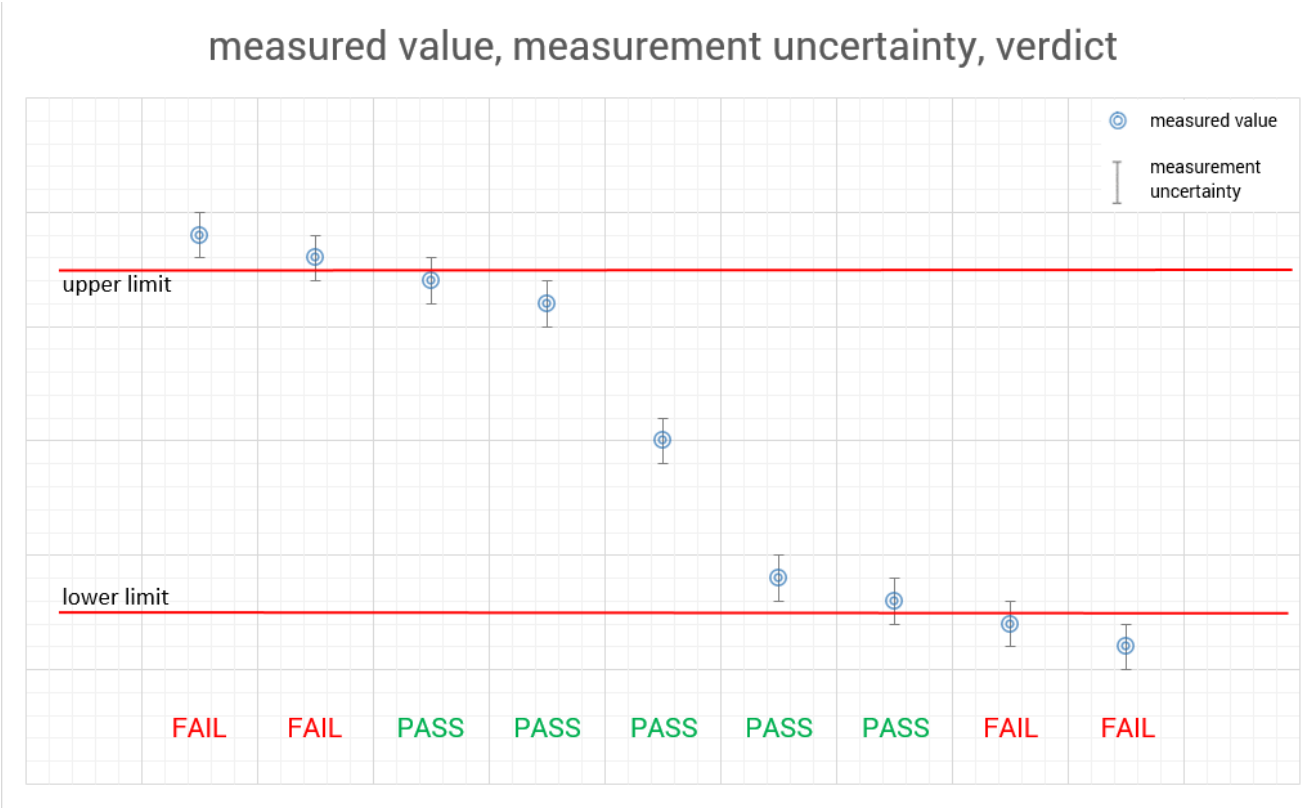
| Guidance | Version | Description |
|---|---|---|
| ANSI C63.4-2014 | -/- | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| ANSI C63.26-2015 | -/- | American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services |
| Power Meas License Systems: KDB 971168 D01 | v03r01 | Measurement Guidance for Certification of Licensed Digital Transmitters |

| Accreditation | Description |
|---|---|
| D-PL-12076-01-04 | Telecommunication and EMC Canada<br>https://www.dakks.de/as/ast/d/D-PL-12076-01-04e.pdf |
| D-PL-12076-01-05 | Telecommunication FCC requirements<br>https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf |

ISED Testing Laboratory Recognized Listing Number: DE0001
FCC designation number: DE0002

## 4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.
The measurement uncertainty is mentioned in this test report, see chapter 9, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."



# 5 Test environment

| | | | |
|---|---|---|---|
| Temperature | : | $T_{nom}$<br>$T_{max}$<br>$T_{min}$ | +20 °C during room temperature tests<br>+75 °C during high temperature tests<br>-30 °C during low temperature tests |
| Relative humidity content | : | | 42 % |
| Barometric pressure | : | | 1018 hpa |
| Power supply | : | $V_{nom}$<br><br>$V_{max}$<br>$V_{min}$ | 5 V DC by external mains adapter<br>3.6 V DC by battery<br>4.0<br>3.2 |

# 6 Test item

## 6.1 General description

| | | |
|---|---|---|
| Kind of test item | : | SmartMonitor |
| Model name | : | Shipment Logger L/M |
| HMN | : | -/- |
| PMN | : | SmartMonitor |
| HVIN | : | BE14002 / BE14003; BE14001 |
| FVIN | : | V01 |
| S/N serial number | : | Radiated unit: AL008<br>Conducted unit: AL010 |
| Hardware status | : | V3 |
| Software status | : | n.a. |
| Firmware status | : | V0.2.3 |
| Frequency band | : | LTE band 2; 4; 5; 12 and 13 |
| Type of radio transmission<br>Use of frequency spectrum | :<br>: | modulated carrier |
| Type of modulation | : | BPSK and QPSK |
| Antenna | : | Integrated antenna |
| Power supply | : | 5 V DC by external mains adapter<br>3.6 V DC by battery |
| Temperature range | : | -30°C to +75°C |

## 6.2 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup and EUT photos are included in test report: 1-2685/21-03-01_AnnexA
1-2685/21-03-01_AnnexB
1-2685/21-03-01_AnnexD

## 7 Description of the test setup

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

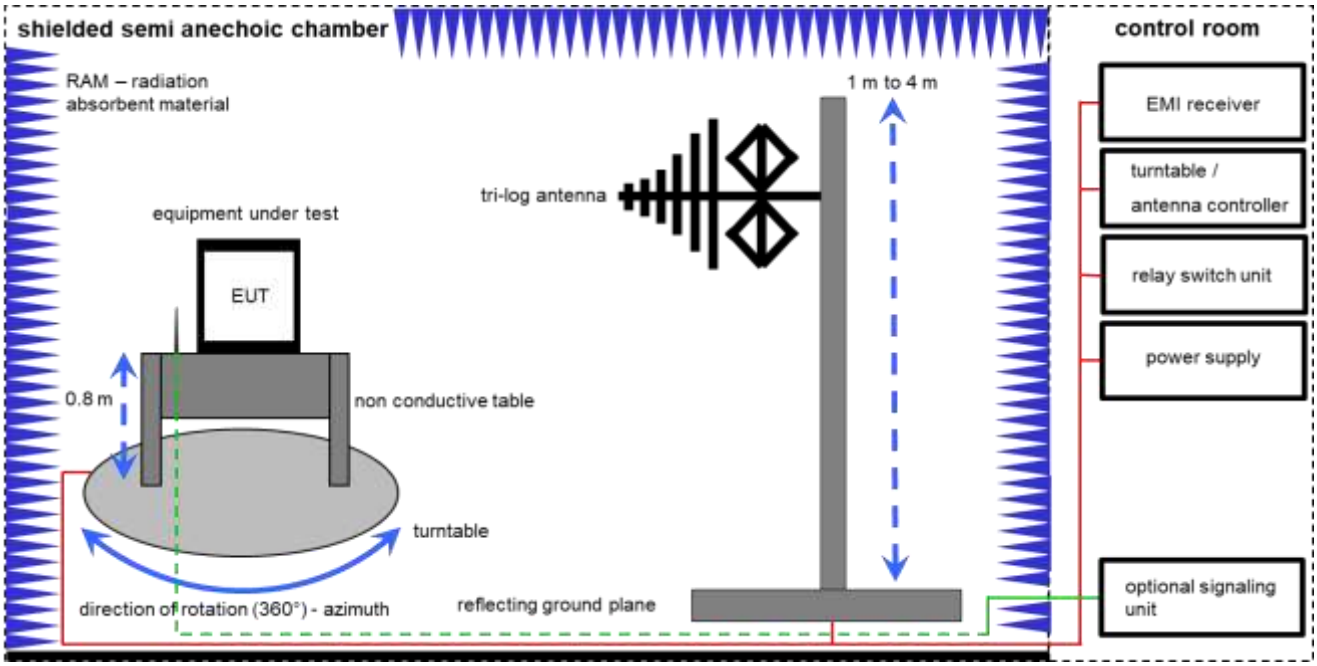
Each block diagram listed can contain several test setup configurations. All devices belonging to a test setup are identified with the same letter syntax. For example: Column Setup and all devices with an A.

**Agenda:** Kind of Calibration

| | | | |
|---|---|---|---|
| k | calibration / calibrated | EK | limited calibration |
| ne | not required (k, ev, izw, zw not required) | zw | cyclical maintenance (external cyclical maintenance) |
| ev | periodic self verification | izw | internal cyclical maintenance |
| Ve | long-term stability recognized | g | blocked for accredited testing |
| vlkl! | Attention: extended calibration interval | | |
| NK! | Attention: not calibrated | *) | next calibration ordered / currently in progress |

## 7.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 30 MHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are conform to specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.




Measurement distance: tri-log antenna 10 meter; EMC32 software version: 10.59.00

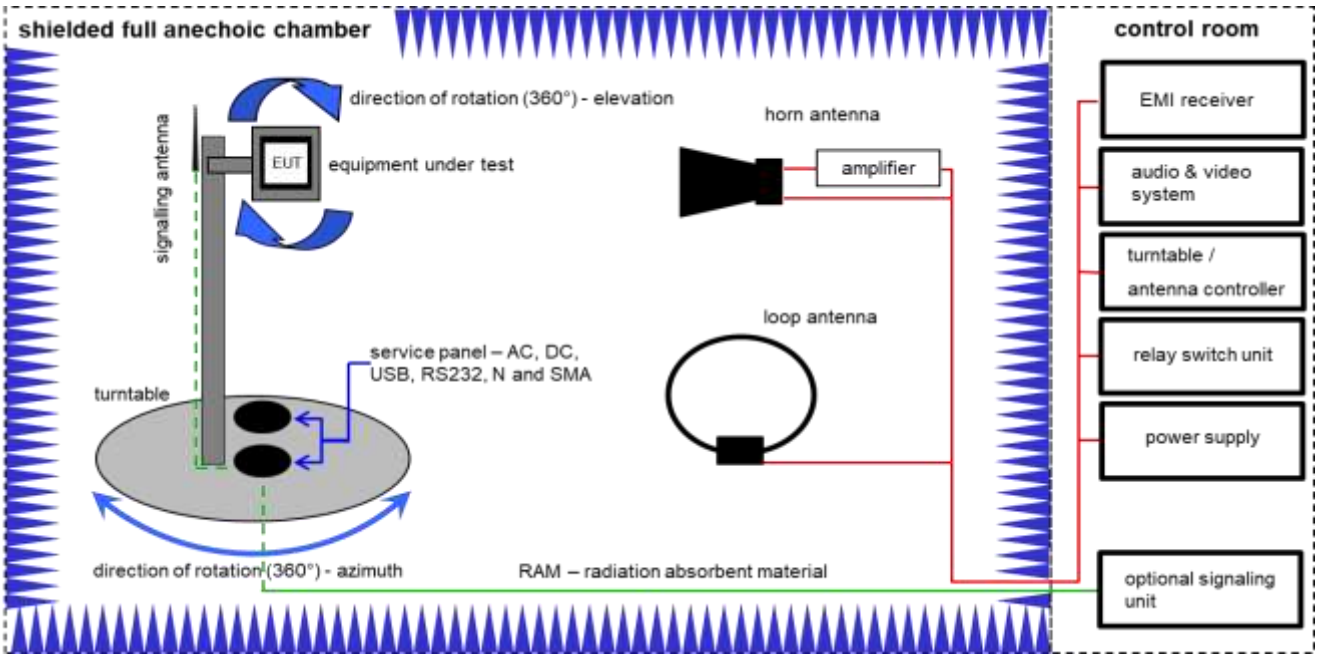
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

*Example calculation:*
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

**Equipment table:**

| No. | Setup | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | Switch-Unit | 3488A | HP | 2719A14505 | 300000368 | ev | -/- | -/- |
| 2 | A | Semi anechoic chamber | 3000023 | MWB AG | -/- | 300000551 | ne | -/- | -/- |
| 3 | A | Analyzer-Reference-System (Harmonics and Flicker) | ARS 16/1 | SPS | A3509 07/0 0205 | 300003314 | vIKI! | 29.12.2021 | 28.12.2023 |
| 4 | A | Antenna Tower | Model 2175 | ETS-Lindgren | 64762 | 300003745 | izw | -/- | -/- |
| 5 | A | Positioning Controller | Model 2090 | ETS-Lindgren | 64672 | 300003746 | izw | -/- | -/- |
| 6 | A | Turntable Interface-Box | Model 105637 | ETS-Lindgren | 44583 | 300003747 | izw | -/- | -/- |
| 7 | A | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163 | Schwarzbeck Mess - Elektronik | 318 | 300003696 | vIKI! | 30.09.2021 | 29.09.2023 |
| 8 | A | Turntable | 2089-4.0 | EMCO | -/- | 300004394 | ne | -/- | -/- |
| 9 | A | PC | TecLine | F+W | -/- | 300004388 | ne | -/- | -/- |
| 10 | A | EMI Test Receiver | ESR3 | Rohde & Schwarz | 102587 | 300005771 | k | 08.12.2021 | 07.12.2022 |
| 11 | A | Wideband radio communication tester | CMW500 | Rohde & Schwarz | 166977 | 300005718 | k | 30.09.2020 | 29.09.2022 |

## 7.2 Shielded fully anechoic chamber




Measurement distance: horn antenna 3 meter; loop antenna 3 meter

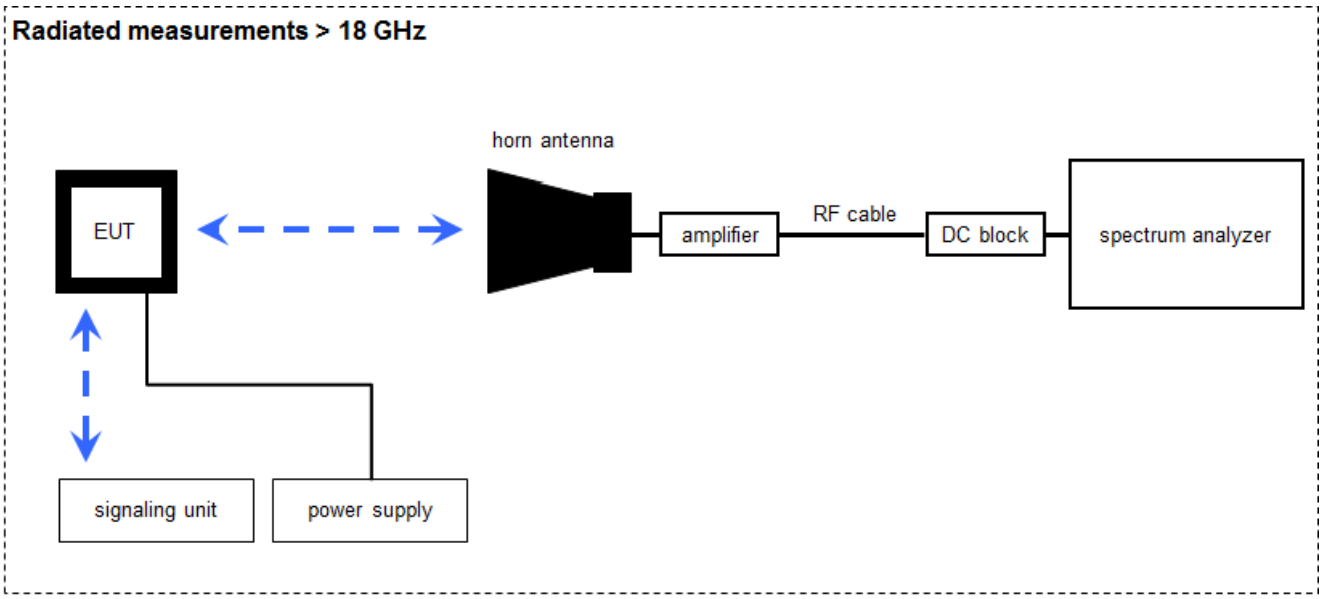
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

*Example calculation:*
OP [dBm] = -39.0 [dBm] + 57.0 [dB] - 12.0 [dBi] + (-36.0) [dB] = -30 [dBm] (1 µW)

**Equipment table:**

| No. | Setup | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A, B, C | Double-Ridged Waveguide Horn Antenna 1-18.0GHz | 3115 | EMCO | 9107-3696 | 300001604 | vIKI! | 12.03.2021 | 11.03.2023 |
| 2 | A, B | Highpass Filter | WHK1.1/15G-10SS | Wainwright | 37 | 400000148 | ne | -/- | -/- |
| 3 | B | Band Reject Filter | WRCG1850/1910-1835/1925-40/8SS | Wainwright | 23 | 400000149 | ne | -/- | -/- |
| 4 | A, B | Highpass Filter | WHKX7.0/18G-8SS | Wainwright | 18 | 300003789 | ne | -/- | -/- |
| 5 | A | Band Reject Filter | WRCG824/849-810/863-60/9SS | Wainwright | 6 | 300003791 | ne | -/- | -/- |
| 6 | A, B | Broadband Amplifier 0.5-18 GHz | CBLU5184540 | CERNEX | 22051 | 300004483 | ev | -/- | -/- |
| 7 | A, B, C | 4U RF Switch Platform | L4491A | Agilent Technologies | MY50000032 | 300004510 | ne | -/- | -/- |
| 8 | A, B, C | Computer | Intel Core i3 3220/3,3 GHz, Prozessor | -/- | 2V2403033A 5421 | 300004591 | ne | -/- | -/- |
| 9 | A, B, C | NEXIO EMV-Software | BAT EMC V3.21.0.27 | EMCO | -/- | 300004682 | ne | -/- | -/- |
| 10 | A, B, C | Anechoic chamber | -/- | TDK | -/- | 300003726 | ne | -/- | -/- |
| 11 | A, B, C | EMI Test Receiver 9kHz-26,5GHz | ESR26 | Rohde & Schwarz | 101376 | 300005063 | k | 15.12.2021 | 14.12.2022 |
| 12 | A, B | RF-Amplifier | AMF-6F06001800-30-10P-R | NARDA-MITEQ Inc | 2011571 | 300005240 | ev | -/- | -/- |
| 13 | A, B, C | Wideband radio communication tester | CMW500 | Rohde & Schwarz | 166977 | 300005718 | k | 30.09.2020 | 29.09.2022 |
| 14 | A, B | Active Loop Antenna 9 kHz to 30 MHz | 6502 | EMCO | 2210 | 300001015 | vIKI! | 01.07.2021 | 30.06.2023 |

## 7.3 Radiated measurements > 18 GHz




Measurement distance: horn antenna 50 cm

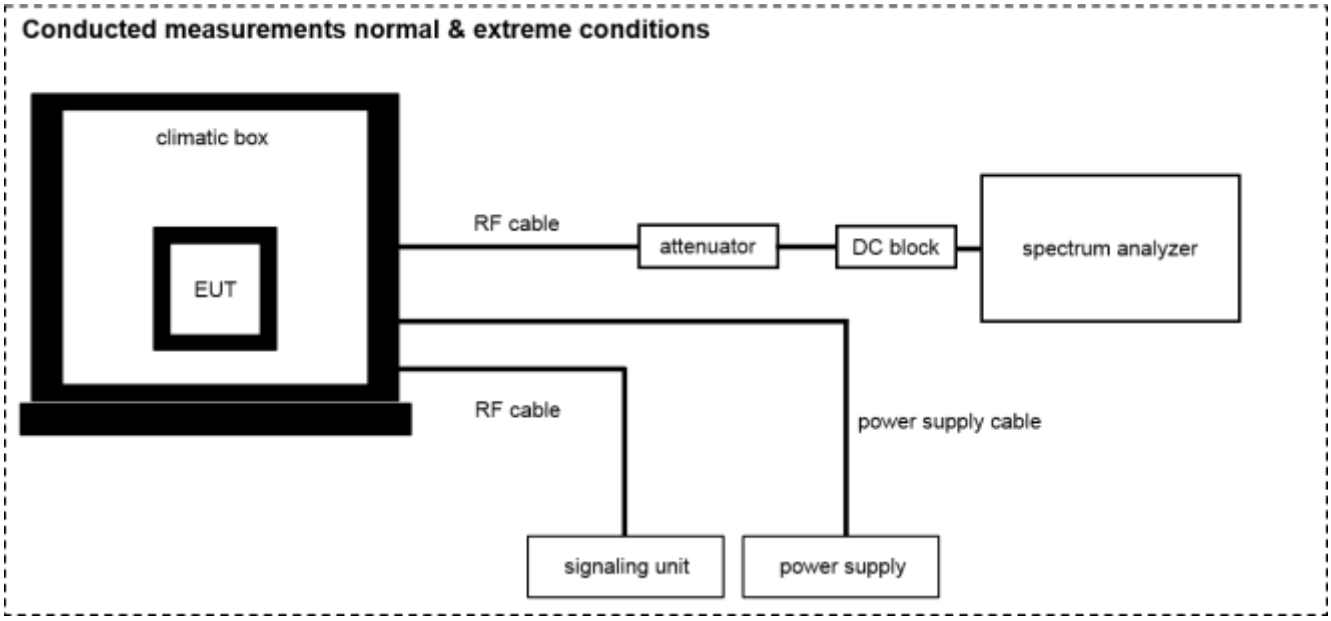
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

*Example calculation:*
OP [dBm] = -59.0 [dBm] + 44.0 [dB] - 20.0 [dBi] + 5.0 [dB] = -30 [dBm] (1 µW)

**Equipment table:**

| No. | Setup | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | Microwave System Amplifier, 0.5-26.5 GHz | 83017A | HP | 00419 | 300002268 | ev | -/- | -/- |
| 2 | A | Std. Gain Horn Antenna 18.0-26.5 GHz | 638 | Narda | 01096 | 300000486 | vlKl! | -/- | -/- |
| 3 | A | Signal analyzer | FSV40 | Rohde&Schwarz | 101042 | 300004517 | k | 25.01.2022 | 24.01.2023 |
| 4 | A | RF-Cable | ST18/SMAm/SMAm /48 | Huber & Suhner | Batch no. 127377 | 400001183 | ev | -/- | -/- |
| 5 | A | DC-Blocker 0.1-40 GHz | 8141A | Inmet | -/- | 400001185 | ev | -/- | -/- |
| 6 | A | Wideband radio communication tester | CMW500 | Rohde & Schwarz | 166977 | 300005718 | k | 30.09.2020 | 29.09.2022 |

## 7.4 Conducted measurements normal and extreme conditions




OP = AV + CA
(OP-output power; AV-analyzer value; CA-loss signal path)

*Example calculation:*
OP [dBm] = 6.0 [dBm] + 11.7 [dB] = 17.7 [dBm] (58.88 mW)

**Equipment table:**

| No. | Setup | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | Temperature Test Chamber | VT 4002 | Heraeus Voetsch | 521/83761 | 300002326 | g | -/- | -/- |
| 2 | A | Wideband radio communication tester | CMW500 | Rohde & Schwarz | 166977 | 300005718 | k | 30.09.2020 | 29.09.2022 |
| 3 | A | Hygro-Thermometer | -/-, 5-45°C, 20-100%rF | Thies Clima | -/- | 400000108 | ev | 13.08.2020 | 12.08.2022 |
| 4 | A | PC Tester R005 | Intel Core i3 3220/3,3 GHz, Prozessor | -/- | 2V2403033A4523 | 300004589 | ne | -/- | -/- |
| 5 | A | Teststand | Teststand Custom Sequence Editor | National Instruments GmbH | -/- | 300004590 | ne | -/- | -/- |
| 6 | A | Resistive Power Dividers, DC-40 GHz, 1W | 1575 | MRC COMPONENTS | -/- | 300004671 | ne | -/- | -/- |
| 7 | A | USB-GPIB-Adapter | GPIB-USB-HS | National Instruments | 1829974 | 400001136 | ne | -/- | -/- |
| 8 | A | RF-Cable | ST18/SMAm/SMAm/72 | Huber & Suhner | Batch no. 699714 | 400001184 | ev | -/- | -/- |
| 9 | A | Synchron Power Meter | SPM-4 | CTC | 1 | 300005580 | ev | -/- | -/- |
| 10 | A | Signal analyzer | FSV40 | Rohde&Schwarz | 101042 | 300004517 | k | 25.01.2022 | 24.01.2023 |
| 11 | A | RF-Cable | ST18/SMAm/SMAm/36 | Huber & Suhner | Batch no. 601494 | 400001309 | ev | -/- | -/- |
| 12 | A | DC-Blocker 0.1-40 GHz | 8141A | Inmet | -/- | 400001185 | ev | -/- | -/- |

# 8 Sequence of testing

## 8.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

**Setup**

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, it is placed on a table with 0.8 m height.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

**Premeasurement***

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

**Final measurement**

- Identified emissions during the pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

*)Note: The sequence will be repeated three times with different EUT orientations.

## 8.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

**Setup**

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

**Premeasurement**

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

**Final measurement**

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position ± 45° and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

## 8.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

**Setup**

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

**Premeasurement**

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height is 1.5 m.
- At each turntable position and antenna polarization the analyzer sweeps with positive peak detector to find the maximum of all emissions.

**Final measurement**

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximizes the peaks by rotating the turntable from 0° to 360°. This measurement is repeated for different EUT-table positions (0° to 150° in 30°-steps) and for both antenna polarizations.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

## 8.4 Sequence of testing radiated spurious above 18 GHz

**Setup**

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate (e.g. 0.5 m).
- The EUT is set into operation.

**Premeasurement**

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.

**Final measurement**

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

## 9 Measurement uncertainty

| Measurement uncertainty | | |
|---|---|---|
| **Test case** | **Uncertainty** | |
| Antenna gain | ± 3 dB | |
| 99 % bandwidth | ± RBW | |
| -26 dB bandwidth | ± RBW | |
| Frequency stability | $10^{-6}$ | |
| Maximum output power conducted | ± 1.56 dB | |
| Block edge compliance | ± 1.56 dB | |
| Spurious emissions conducted | > 3.6 GHz | ± 1.56 dB |
| | > 7 GHz | ± 1.56 dB |
| | > 18 GHz | ± 2.31 dB |
| | ≥ 40 GHz | ± 2.97 dB |
| Spurious emissions radiated below 30 MHz | ± 3 dB | |
| Spurious emissions radiated 30 MHz to 1 GHz | ± 3 dB | |
| Spurious emissions radiated 1 GHz to 12.75 GHz | ± 3.7 dB | |
| Spurious emissions radiated above 12.75 GHz | ± 4.5 dB | |

## 10 Additional information and comments

Reference documents: None

Special test descriptions: None

Configuration descriptions: None

EUT selection:

☐ Only one device available

☐ Devices selected by the customer

☒ Devices selected by the laboratory (Randomly)

## 11 Summary of measurement results

| | |
|---|---|
| ☒ | No deviations from the technical specifications were ascertained |
| ☐ | There were deviations from the technical specifications ascertained |
| ☐ | This test report is only a partial test report.<br>The content and verdict of the performed test cases are listed below. |

| TC identifier | Description | verdict | date | Remark |
|---|---|---|---|---|
| RF-Testing | FCC: CFR Part 2 & Part 22<br>ISED: RSS-Gen, Issue 5 & RSS 132, Issue 3 | See table! | 2022-04-14 | -/- |

### 11.1 Part 22/RSS-132: LTE band 5

| Test Case | temperature conditions | power source voltages | C | NC | NA | NP | Remark |
|---|---|---|---|---|---|---|---|
| RF Output Power | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |
| Frequency Stability | Extreme | Extreme | ☒ | ☐ | ☐ | ☐ | -/- |
| Spurious Emissions Radiated | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |
| Spurious Emissions Conducted | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |
| Block Edge Compliance | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |
| Occupied Bandwidth | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | -/- |

**Notes:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **C** | Compliant | **NC** | Not compliant | **NA** | Not applicable | **NP** | Not performed |

# 12 RF measurements

## 12.1 Description of test setup

For the spurious measurements we use the substitution method according TIA/EIA 603.

## 12.2 Results LTE band 5

The EUT was set to transmit the maximum power.

### 12.2.1 RF output power

**Description:**

This paragraph contains conducted average power, ERP and Peak-to-Average Power Ratio measurements for the mobile station.

**Measurement:**

The mobile was set up for the maximum output power with pseudo random data modulation.

To determine the Peak-To-Average Power Ratio (PAPR) the measurement was performed with the Power Complementary Cumulative Distribution Function (CCDF).

| Measurement parameters | |
|---|---|
| Detector: | Sample |
| AQT: | See plot |
| Resolution bandwidth: | 1 MHz |
| Used equipment: | See chapter 7.1 setup A & 7.4 setup A |
| Measurement uncertainty: | see chapter 9 |
| Measurement procedure: | FCC: § 2.1046<br>ISED: RSS-Gen, 6.12 |

**Limits:**

| FCC | ISED |
|---|---|
| § 22.913(a)(5) & (d) | RSS-132, 5.4 |
| (a)(5) The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 W.<br>(d) The peak-to-average ratio (PAR) of the transmission must not exceed 13 dB. | The EIRP power for mobile equipment shall not exceed 11.5 W.<br>The peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB […]. |
| Power: **38.45 dBm ERP**<br>PAPR: **13 dB** | |

**Results:**

| Sub-Carrier Spacing [kHz] | Modulation | Number of Tones | Average Output Power [dBm] Channel No / Frequency [MHz] | | | Peak to Average Ratio [dB] Channel No / Frequency [MHz] | | |
|---|---|---|---|---|---|---|---|---|
| | | | 20401 / 824.1 | 20525 / 836.5 | 20649 / 848.9 | 20401 / 824.1 | 20525 / 836.5 | 20649 / 848.9 |
| 3.75 | BPSK | 1T0 | 19.34 | 19.35 | 19.10 | 1.94 | 1.91 | 1.88 |
| | | 1T47 | 19.25 | 19.32 | 19.02 | 0.29 | 1.88 | 1.86 |
| | QPSK | 1T0 | 19.31 | 19.38 | 19.11 | 0.29 | 0.29 | 0.26 |
| | | 1T47 | 19.29 | 19.35 | 19.09 | 1.62 | 1.62 | 1.59 |
| 15 | BPSK | 1T0 | 19.50 | 19.22 | 19.24 | 1.57 | 1.62 | 1.59 |
| | | 1T11 | 19.46 | 19.32 | 18.92 | 1.65 | 1.54 | 1.68 |
| | QPSK | 1T0 | 19.44 | 19.49 | 19.25 | 1.57 | 1.62 | 1.59 |
| | | 1T11 | 19.45 | 19.35 | 19.05 | 1.59 | 0.49 | 0.46 |
| | | 12T0 | 17.58 | 17.59 | 17.41 | 5.94 | 5.59 | 5.88 |

The radiated output power is measured in the mode with the highest conducted output power.

| Output Power (ERP) | | | |
|---|---|---|---|
| Sub-Carrier Spacing [kHz] | Frequency (MHz) | Average Output Power (dBm) BPSK | Average Output Power (dBm) QPSK |
| 3.75 | 824.1 | 16.44 | 16.41 |
| | 836.5 | 15.85 | 15.88 |
| | 848.9 | 16.00 | 16.01 |
| 15 | 824.1 | 16.60 | 16.55 |
| | 836.5 | 15.82 | 15.99 |
| | 848.9 | 16.14 | 16.15 |

## 12.2.2 Frequency stability

**Description:**

In order to measure the carrier frequency under normal conditions it is necessary to make measurements with the mobile station connected to a R&S CMW500 Wideband Radio Communication Tester.

1. Measure the carrier frequency at room temperature.
2. Subject the mobile station to overnight soak at -30 C.
3. With the mobile station, powered with $V_{nom}$, connected to the CMW500 on the center channel with channel bandwidth of 10 MHz, measure the carrier frequency. These measurements should be made within two minutes of powering up the mobile station, to prevent significant self warming.
4. Repeat the above measurements at 10°C increments from -30°C to +50°C. Allow at least 15 minutes at each temperature, unpowered, before making measurements.
5. Re-measure carrier frequency at room temperature with $V_{nom}$. Vary supply voltage to $V_{min}$ and measure the carrier frequency then setup $V_{max}$ and repeat the measurement.
6. At all temperature levels hold the temperature to +/- 0.5°C during the measurement procedure.

**Measurement:**

| Measurement parameters | |
|---|---|
| Detector: | Measured with CMW500 |
| Sweep time: | |
| Video bandwidth: | |
| Resolution bandwidth: | |
| Span: | |
| Trace-Mode: | |
| Test setup: | See chapter 7.4 setup A |
| Measurement uncertainty: | See chapter 9 |
| Measurement procedure: | FCC: § 2.1055<br>ISED: RSS-Gen, 6.11 |

**Limits:**

| FCC | ISED |
|---|---|
| § 22.355 (Mobile Station, 821 – 896 MHz) | RSS-132, 5.3 (Mobile Station) |
| The carrier frequency of each transmitter in the Public Mobile Services must be maintained within the tolerances given in Table C-1. | The carrier frequency shall not depart from the reference frequency in excess of ±2.5 ppm for mobile stations and ±1.5 ppm for base stations. |
| **± 2.5 ppm** | |

**Results:**

**AFC FREQ ERROR versus VOLTAGE**

| Voltage (V) | Frequency Error (Hz) | Frequency Error (ppm) |
|---|---|---|
| 3.2 | -18 | -0.0215 |
| 3.6 | -18 | -0.0215 |
| 4.0 | -18 | -0.0215 |

**AFC FREQ ERROR versus TEMPERATURE**

| Temperature (°C) | Frequency Error (Hz) | Frequency Error (ppm) |
|---|---|---|
| -30 | 22 | 0.0263 |
| -20 | 16 | 0.0191 |
| -10 | 10 | 0.0120 |
| ± 0 | 14 | 0.0167 |
| 10 | -17 | -0.0203 |
| 20 | -18 | -0.0215 |
| 30 | -24 | -0.0287 |
| 40 | -26 | -0.0311 |
| 50 | -35 | -0.0418 |

### 12.2.3 Spurious emissions radiated

**Description:**

The following steps outline the procedure used to measure the radiated emissions from the mobile station. The site is constructed in accordance with ANSI C63.4:2014 requirements and is recognized by the FCC to be in compliance for a 3 and a 10 meter site. The spectrum was scanned from 30 MHz to the 10th harmonic of the highest frequency generated within the equipment, which is the transmitted carrier that can be as high as 844 MHz. Measurement made up to 9 GHz. The resolution bandwidth is set as outlined in Part 22.917. The spectrum was scanned with the mobile station transmitting at carrier frequencies that pertain to low, mid and high channels of the LTE band V.

**Measurement:**

| Measurement parameters | |
|---|---|
| Detector: | Peak |
| Sweep time: | 2 s |
| Resolution bandwidth: | 100 kHz |
| Video bandwidth: | 300 kHz |
| Span: | 100 MHz Steps |
| Trace mode: | Max Hold |
| Used equipment: | See chapter 7.1 setup A & 7.2 setup A |
| Measurement uncertainty: | See chapter 9 |
| Measurement procedure: | FCC: § 2.1053<br>ISED: RSS-Gen, 6.13 |

**Limits:**

| FCC | ISED |
|---|---|
| § 22.917(a) & (b) | RSS-132, 5.5 |
| (a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.<br>(b)(1) In the spectrum below 1 GHz, instrumentation should employ a reference bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block, a RBW of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy, provided that the measured power is integrated over the full required reference bandwidth (i.e., 100 kHz or 1 percent of emission bandwidth, as specified). 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.<br>(b)(2) In the spectrum above 1 GHz, instrumentation should employ a reference bandwidth of 1 MHz. | i. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P ( dBW) by at least 43 + 10 log10(P) (watts).<br>ii. After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10(P) (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required. |
| **-13 dBm** | |

**Results:**

**BPSK:**

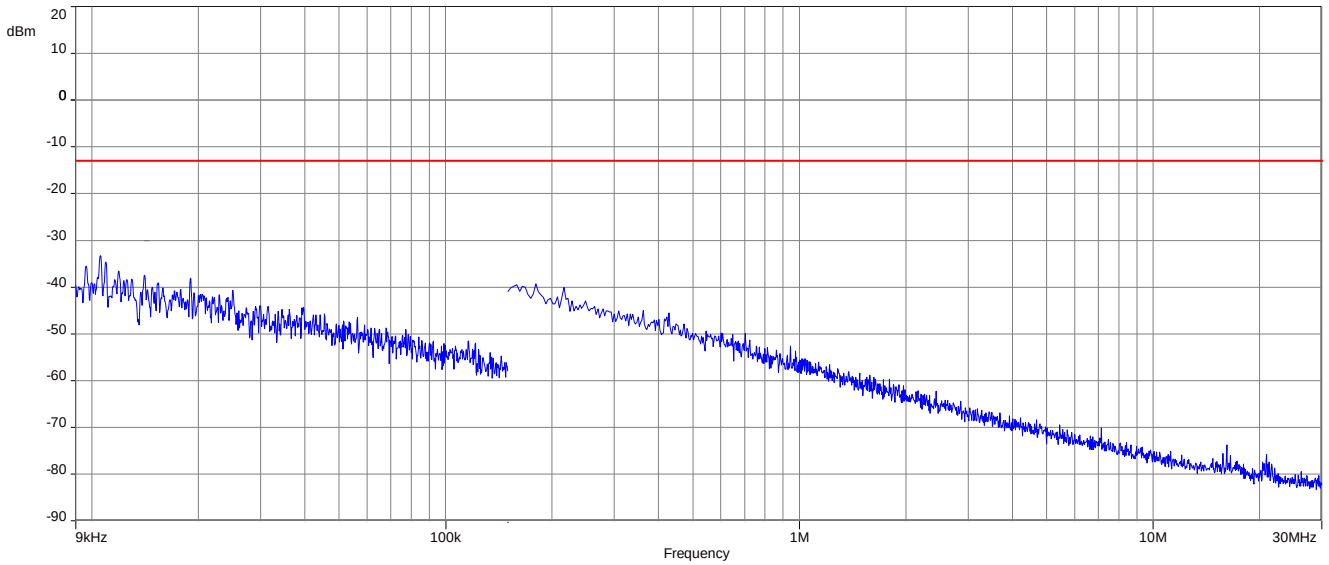
| SPURIOUS EMISSION LEVEL | | | | | |
|---|---|---|---|---|---|
| **LOWEST CHANNEL** | | **MIDDLE CHANNEL** | | **HIGHEST CHANNEL** | |
| Spurious emissions | Level [dBm] | Spurious emissions | Level [dBm] | Spurious emissions | Level [dBm] |
| -/- | | All detected emissions are more than 20 dB below the limit. | | -/- | |
| -/- | -/- | -/- | -/- | -/- | -/- |
| -/- | -/- | -/- | -/- | -/- | -/- |

**QPSK:**

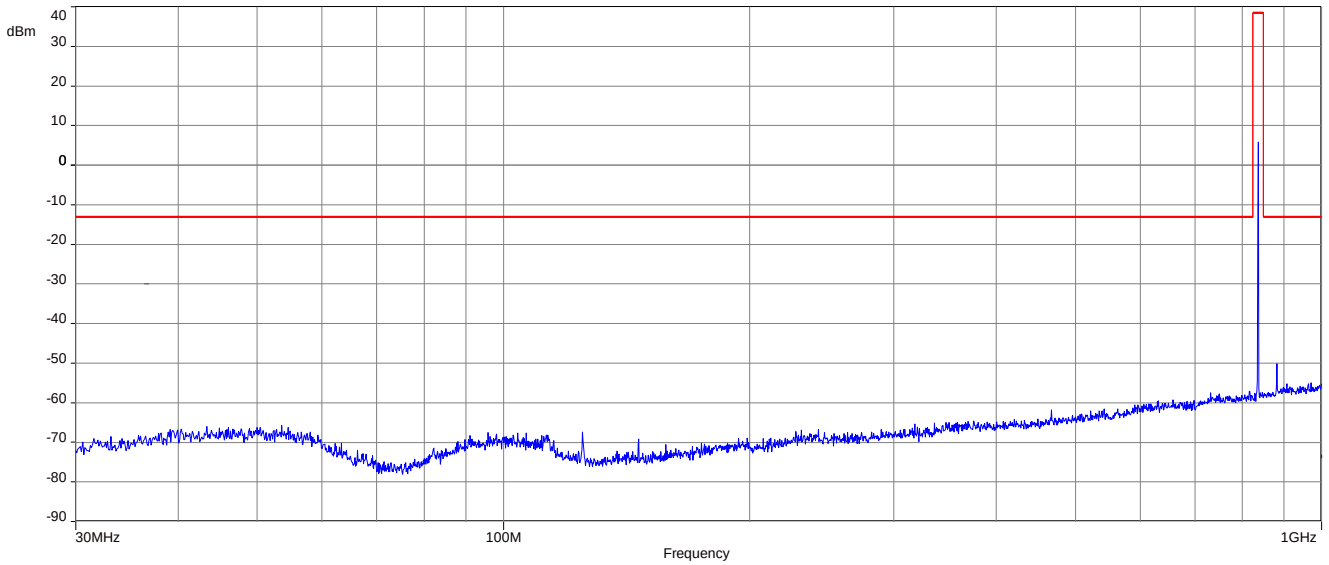
| SPURIOUS EMISSION LEVEL | | | | | |
|---|---|---|---|---|---|
| **LOWEST CHANNEL** | | **MIDDLE CHANNEL** | | **HIGHEST CHANNEL** | |
| Spurious emissions | Level [dBm] | Spurious emissions | Level [dBm] | Spurious emissions | Level [dBm] |
| -/- | | All detected emissions are more than 20 dB below the limit. | | -/- | |
| -/- | -/- | -/- | -/- | -/- | -/- |
| -/- | -/- | -/- | -/- | -/- | -/- |

**BPSK**

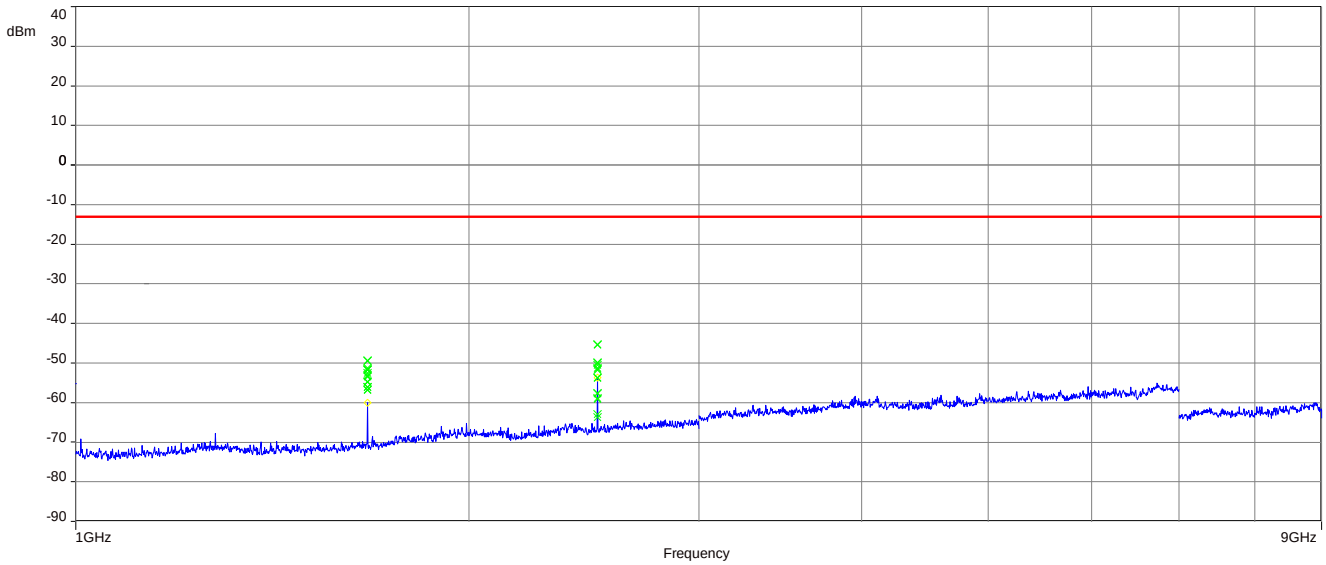
**Plot 1:** Mid channel (9 kHz - 30 MHz)




**Plot 2:** Mid channel (30 MHz – 1 GHz)

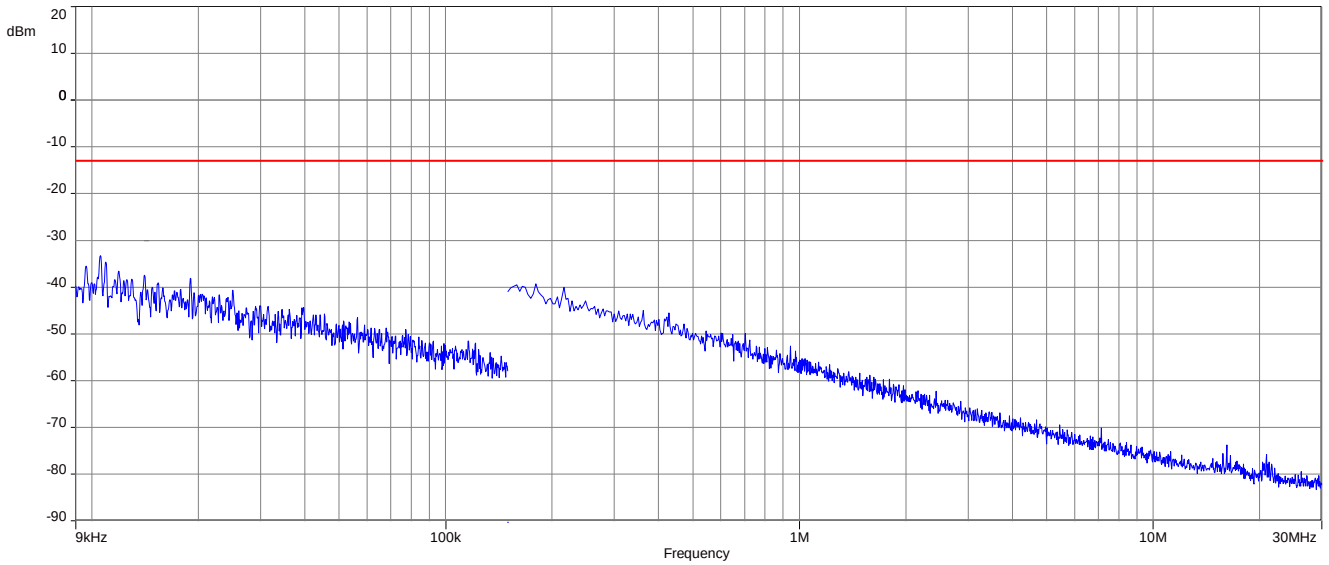


**Plot 3:** Mid channel (1 GHz – 9 GHz)

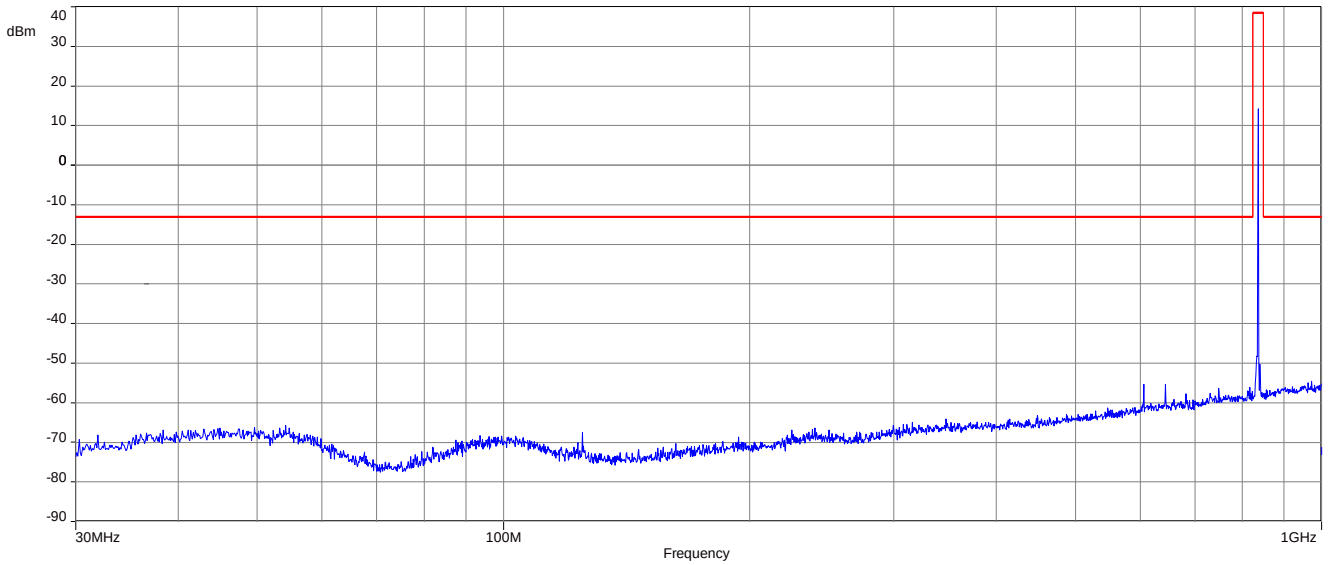


**QPSK**

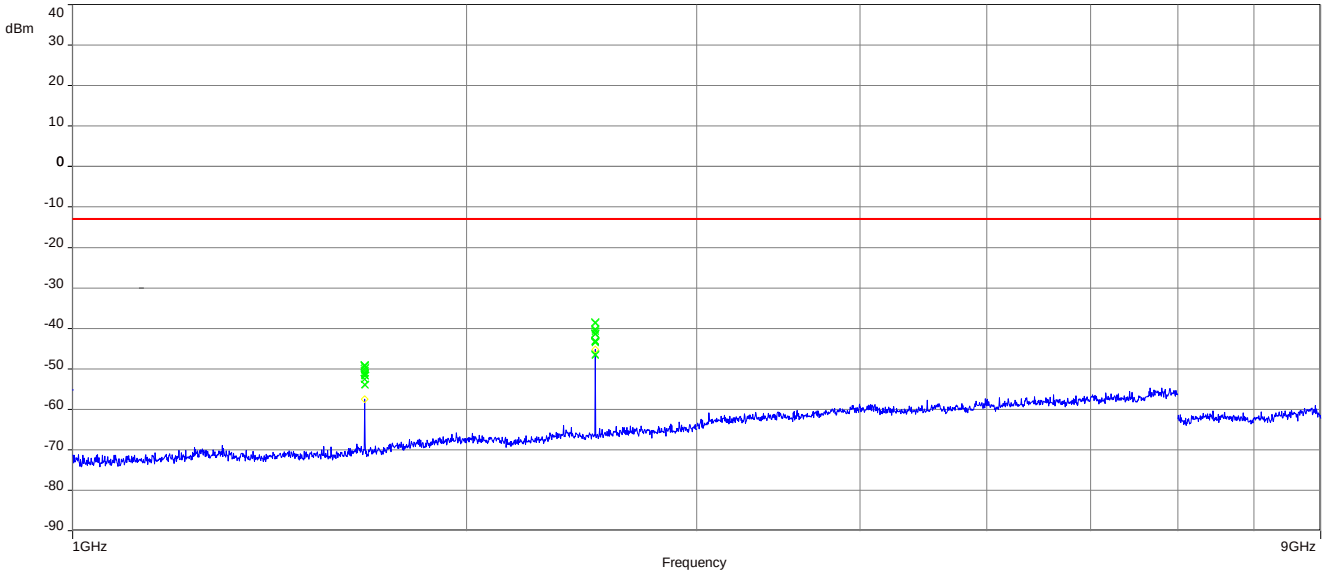
**Plot 1:** Mid channel (9 kHz - 30 MHz)




**Plot 2:** Mid channel (30 MHz – 1 GHz)



**Plot 3:** Mid channel (1 GHz – 9 GHz)



## 12.2.4 Spurious emissions conducted

**Description:**

The following steps outline the procedure used to measure the conducted emissions from the mobile station.
1. Determine frequency range for measurements: From § 2.1057 & RSS-Gen, 6.13.2 the spectrum should be investigated from the lowest radio frequency generated in the equipment up to at least the 10th harmonic of the carrier frequency.

2. Determine mobile station transmits frequencies: below outlines the band edge frequencies pertinent to conducted emissions testing.

**Measurement:**

| Measurement parameters | |
|---|---|
| Detector: | Peak |
| Sweep time: | Auto |
| Resolution bandwidth: | 100 kHz |
| Video bandwidth: | 300 kHz |
| Span: | 10 MHz – 8.5 GHz |
| Trace mode: | Max Hold |
| Used equipment: | See chapter 7.4 setup A |
| Measurement uncertainty: | See chapter 9 |
| Measurement procedure: | FCC: § 2.1051<br>ISED: RSS-Gen, 6.13 |

**Limits:**

| FCC | ISED |
|---|---|
| § 22.917(a) & (b) | RSS-132, 5.5 |
| (a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least **43 + 10 log(P) dB**.<br>(b)(1) In the spectrum below 1 GHz, instrumentation should employ a reference bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block, a RBW of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy, provided that the measured power is integrated over the full required reference bandwidth (i.e., 100 kHz or 1 percent of emission bandwidth, as specified). 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.<br>(b)(2) In the spectrum above 1 GHz, instrumentation should employ a reference bandwidth of 1 MHz. | i. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P ( dBW) by at least **43 + 10 log10(P) (watts)**.<br>ii. After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least **43 + 10 log10(P) (watts)**. If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required. |
| **-13 dBm** | |

**Results:**

**BPSK**

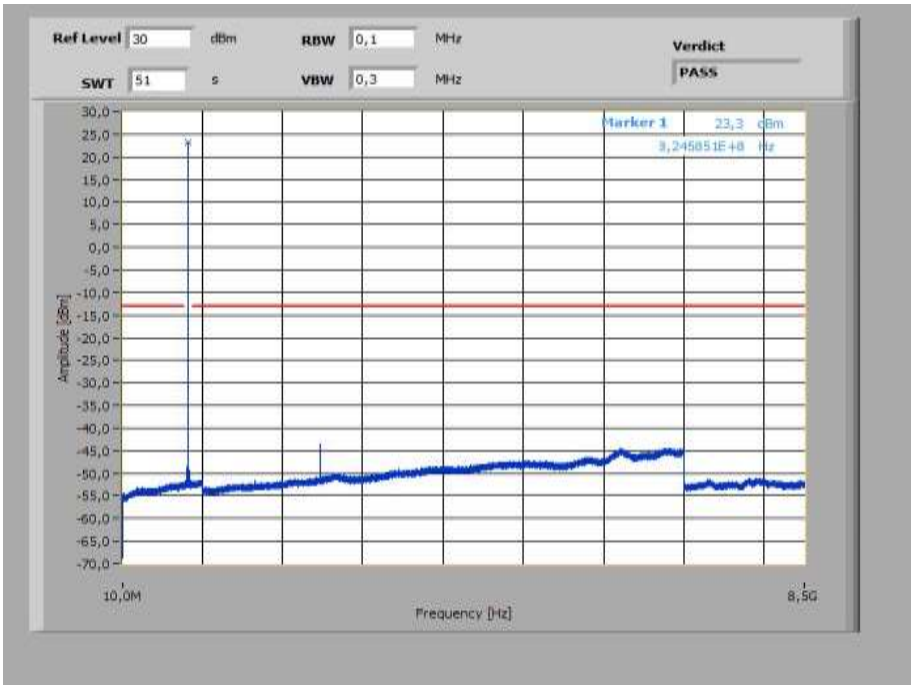
| SPURIOUS EMISSION LEVEL | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Harmonic | Lowest channel Freq. (MHz) | Level [dBm] | Harmonic | Middle channel Freq. (MHz) | Level [dBm] | Harmonic | Highest channel Freq. (MHz) | Level [dBm] |
| 2 | 1648.2 | -/- | 2 | 1673.0 | -/- | 2 | 1697.8 | -/- |
| 3 | 2472.3 | -/- | 3 | 2509.5 | -/- | 3 | 2446.7 | -/- |
| 4 | 3296.4 | -/- | 4 | 3346.0 | -/- | 4 | 3395.6 | -/- |
| 5 | 4120.5 | -/- | 5 | 4182.5 | -/- | 5 | 4244.5 | -/- |
| 6 | 4944.6 | -/- | 6 | 5019.0 | -/- | 6 | 5093.4 | -/- |
| 7 | 5768.7 | -/- | 7 | 5855.5 | -/- | 7 | 5942.3 | -/- |
| 8 | 6592.8 | -/- | 8 | 6692.0 | -/- | 8 | 6791.2 | -/- |
| 9 | 7416.9 | -/- | 9 | 7258.5 | -/- | 9 | 7640.1 | -/- |
| 10 | 8241.0 | -/- | 10 | 8365.0 | -/- | 10 | 8489.0 | -/- |

**QPSK**

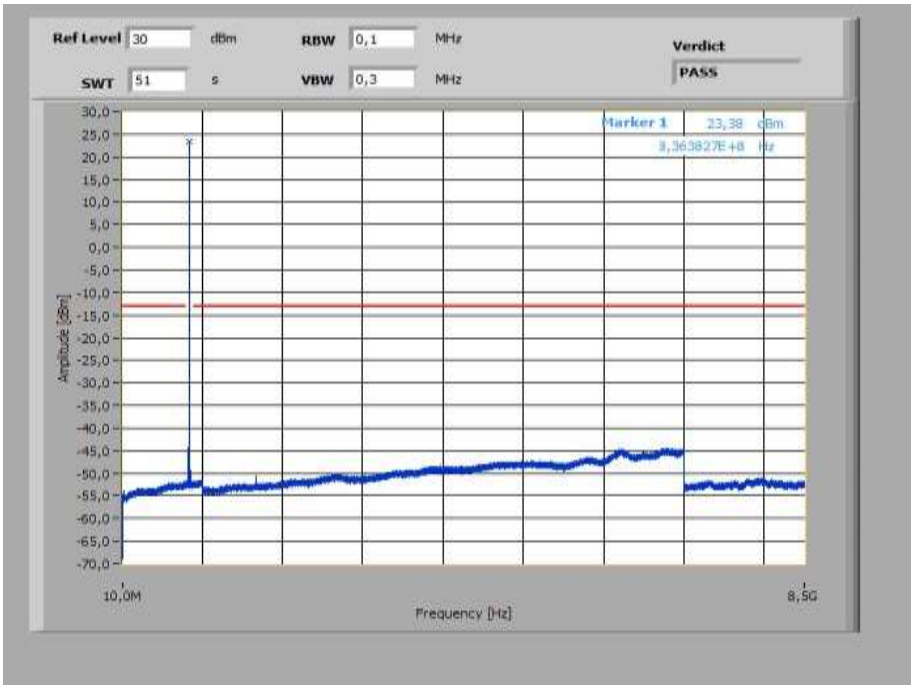
| SPURIOUS EMISSION LEVEL | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Harmonic | Lowest channel Freq. (MHz) | Level [dBm] | Harmonic | Middle channel Freq. (MHz) | Level [dBm] | Harmonic | Highest channel Freq. (MHz) | Level [dBm] |
| 2 | 1648.2 | -/- | 2 | 1673.0 | -/- | 2 | 1697.8 | -/- |
| 3 | 2472.3 | -/- | 3 | 2509.5 | -/- | 3 | 2446.7 | -/- |
| 4 | 3296.4 | -/- | 4 | 3346.0 | -/- | 4 | 3395.6 | -/- |
| 5 | 4120.5 | -/- | 5 | 4182.5 | -/- | 5 | 4244.5 | -/- |
| 6 | 4944.6 | -/- | 6 | 5019.0 | -/- | 6 | 5093.4 | -/- |
| 7 | 5768.7 | -/- | 7 | 5855.5 | -/- | 7 | 5942.3 | -/- |
| 8 | 6592.8 | -/- | 8 | 6692.0 | -/- | 8 | 6791.2 | -/- |
| 9 | 7416.9 | -/- | 9 | 7258.5 | -/- | 9 | 7640.1 | -/- |
| 10 | 8241.0 | -/- | 10 | 8365.0 | -/- | 10 | 8489.0 | -/- |

**Plots: BPSK**

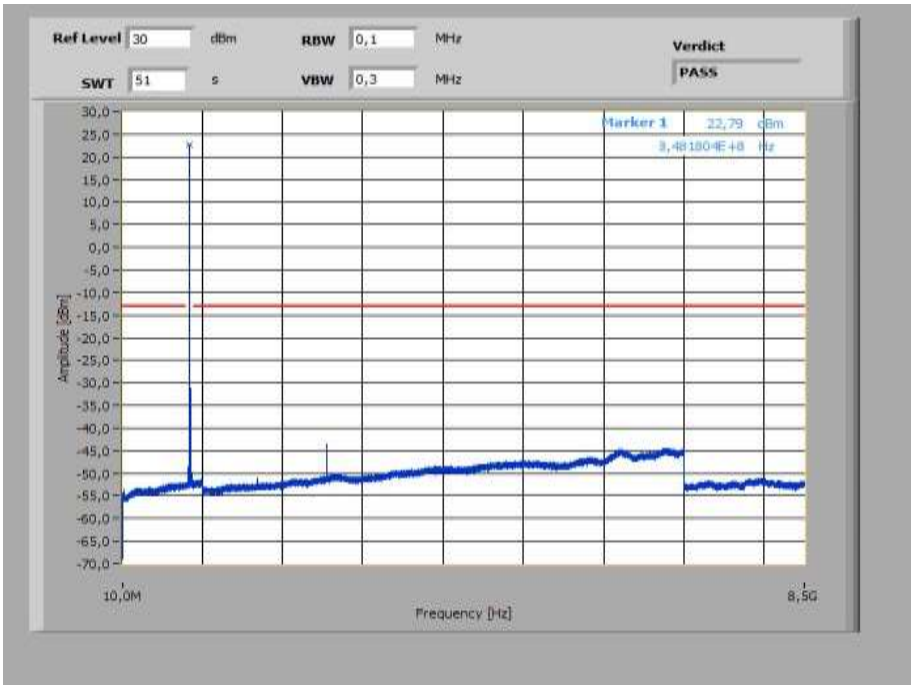
**Plot 1:** Lowest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@0 tones



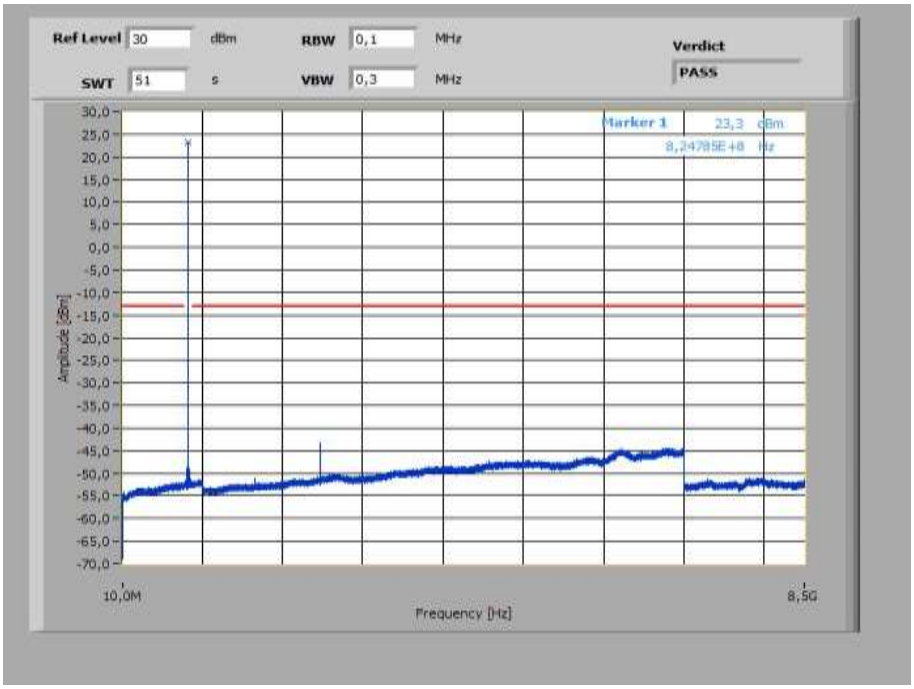

**Plot 2:** Middle Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@0 tones



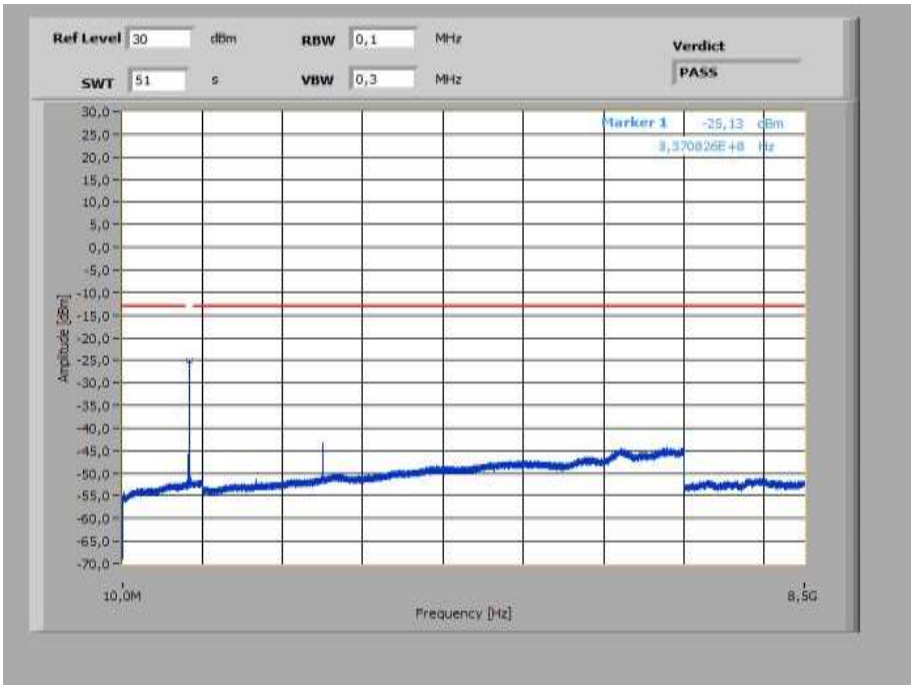
**Plot 3:** Highest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@0 tones



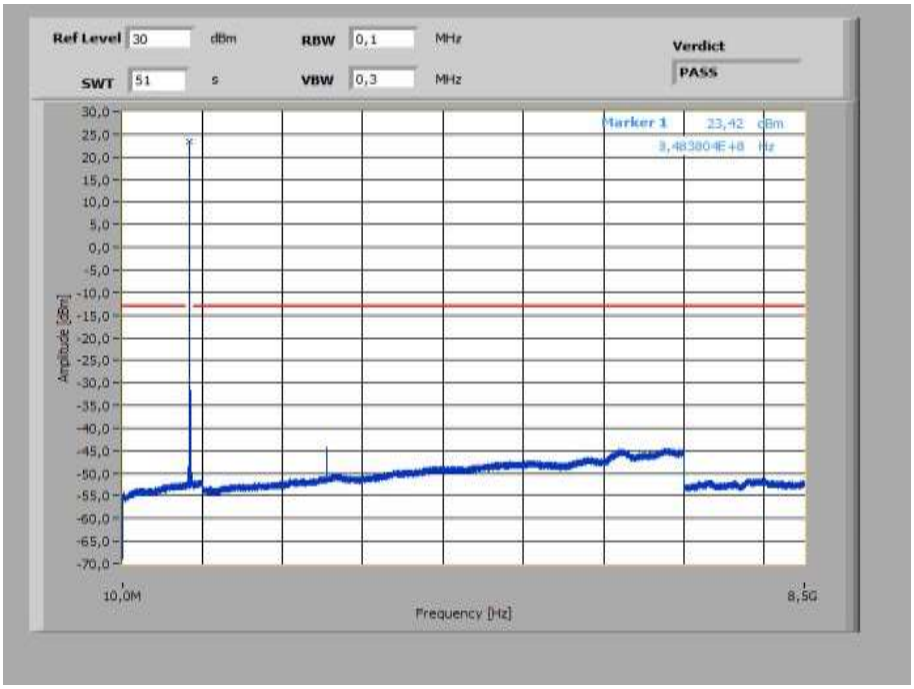

**Plot 4:** Lowest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@47 tones



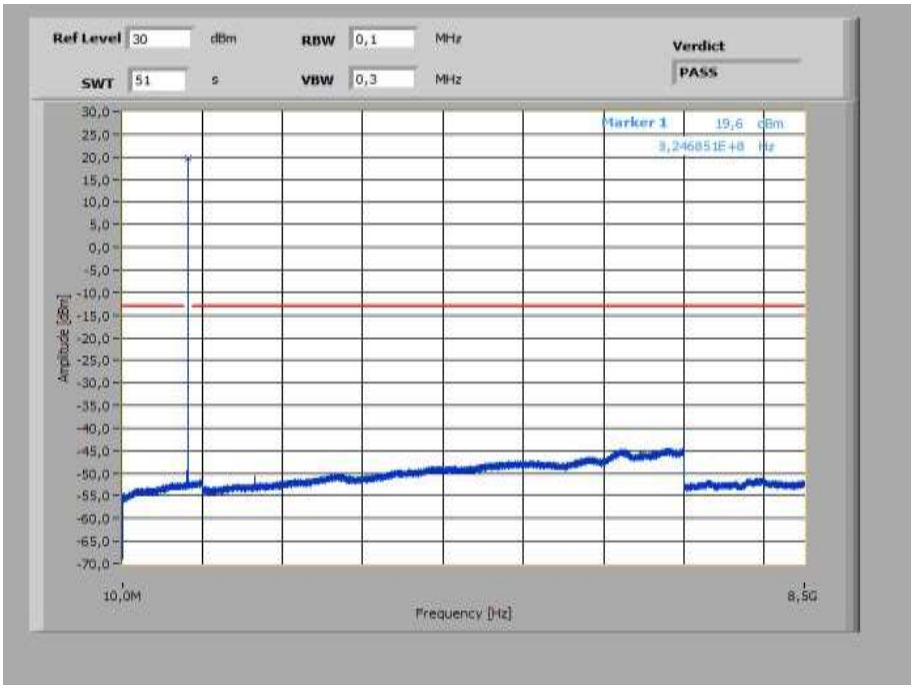
**Plot 5:** Middle Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@47 tones



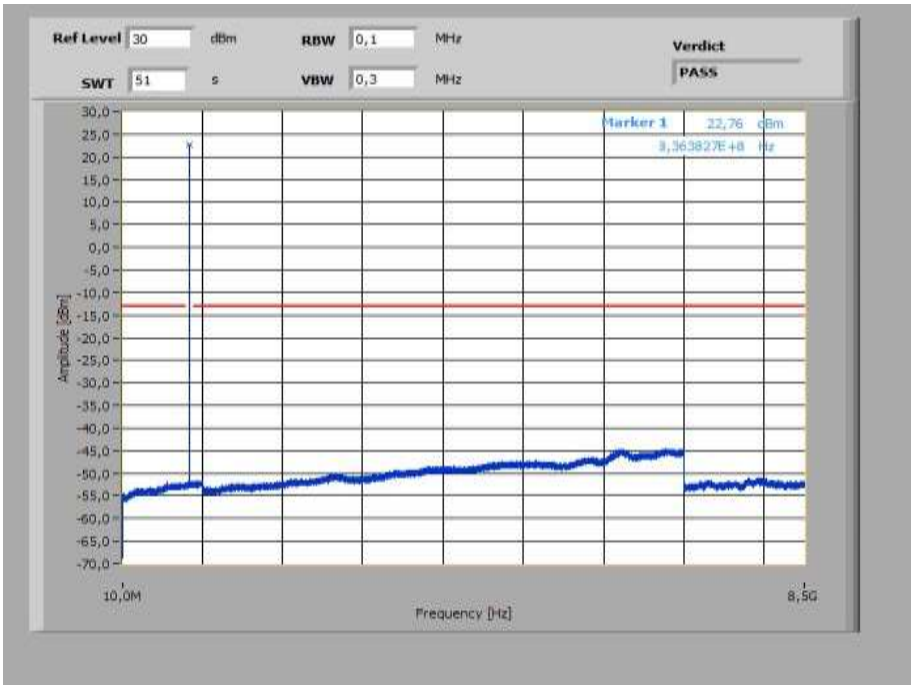

**Plot 6:** Highest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@47 tones



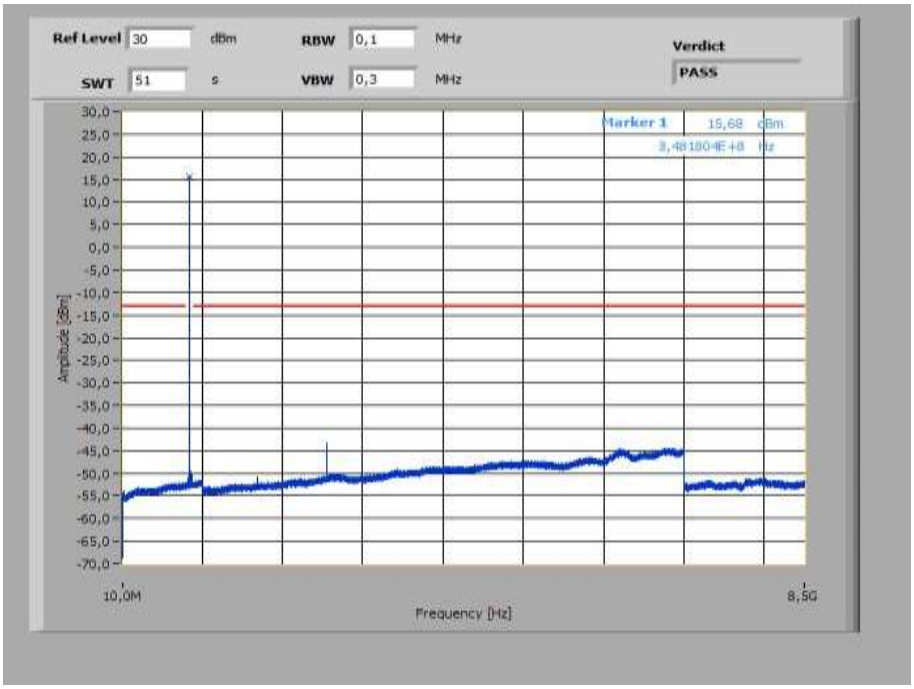
**Plot 7:** Lowest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@0 tones



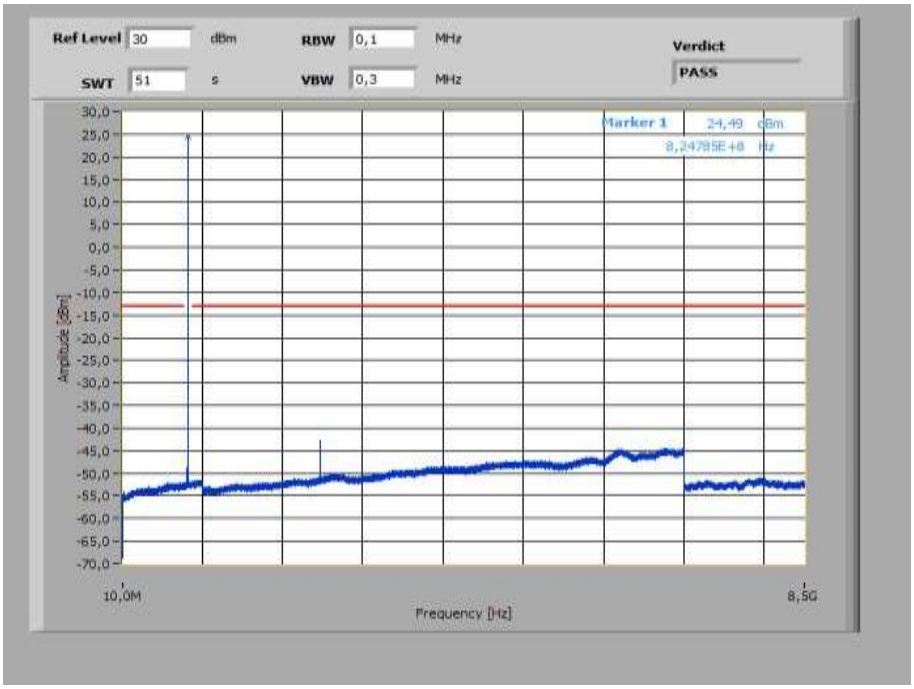

**Plot 8:** Middle Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@0 tones



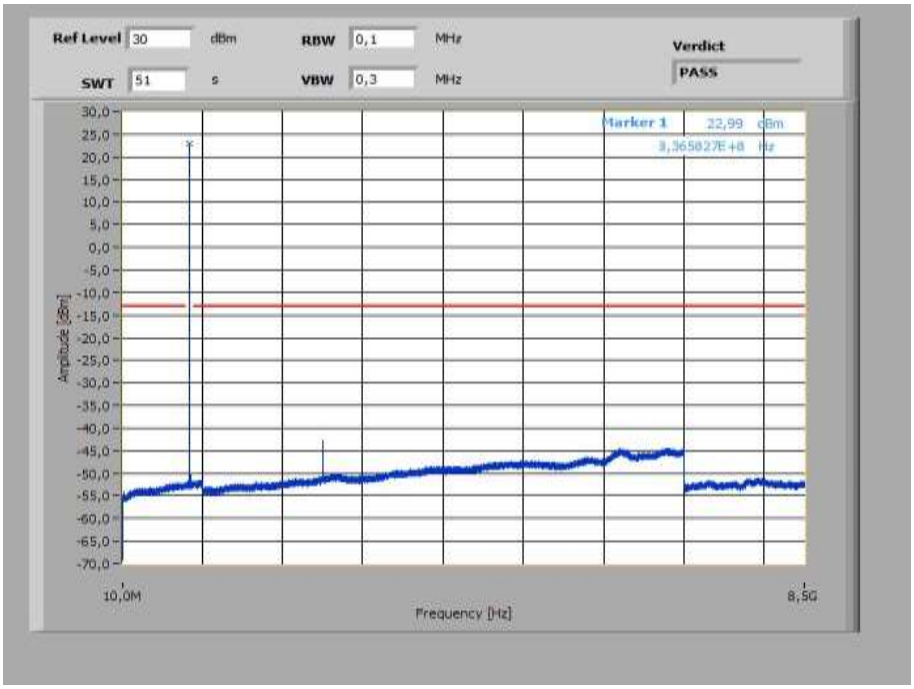
**Plot 9:** Highest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@0 tones



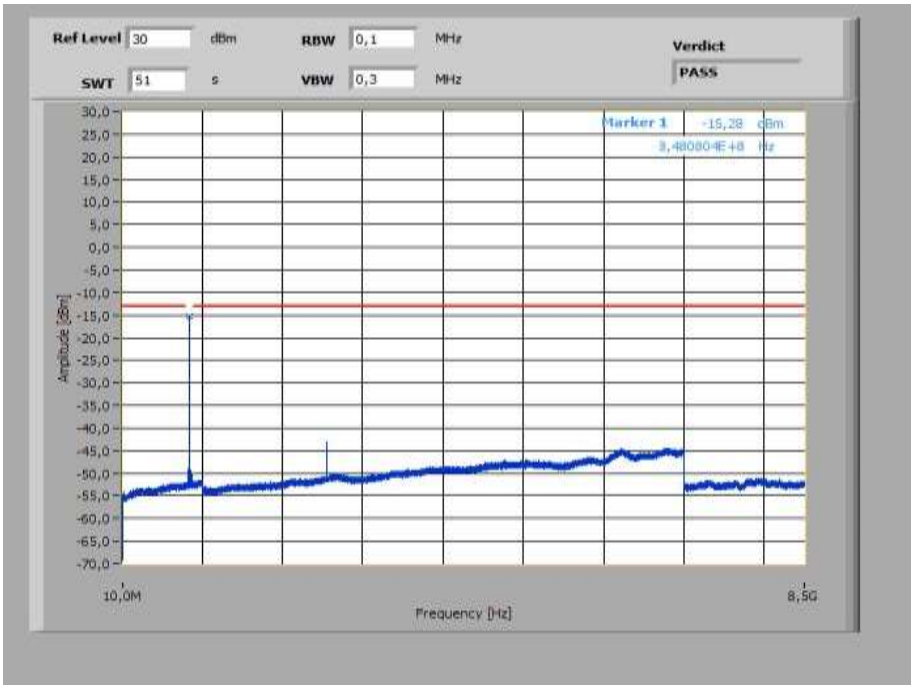

**Plot 10:** Lowest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@11 tones



**Plot 11:** Middle Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@11 tones

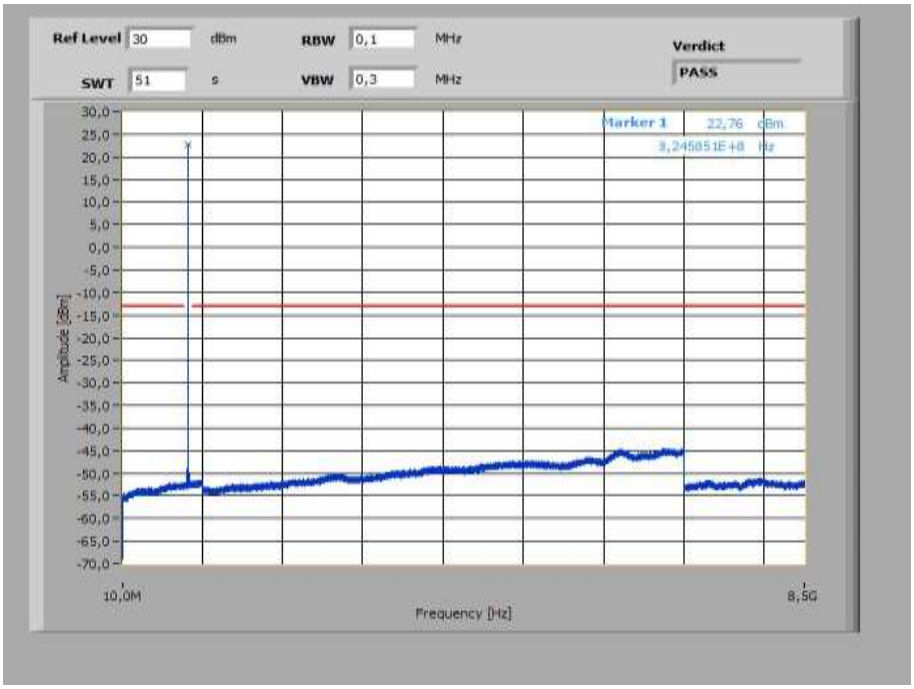



**Plot 12:** Highest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@11 tones

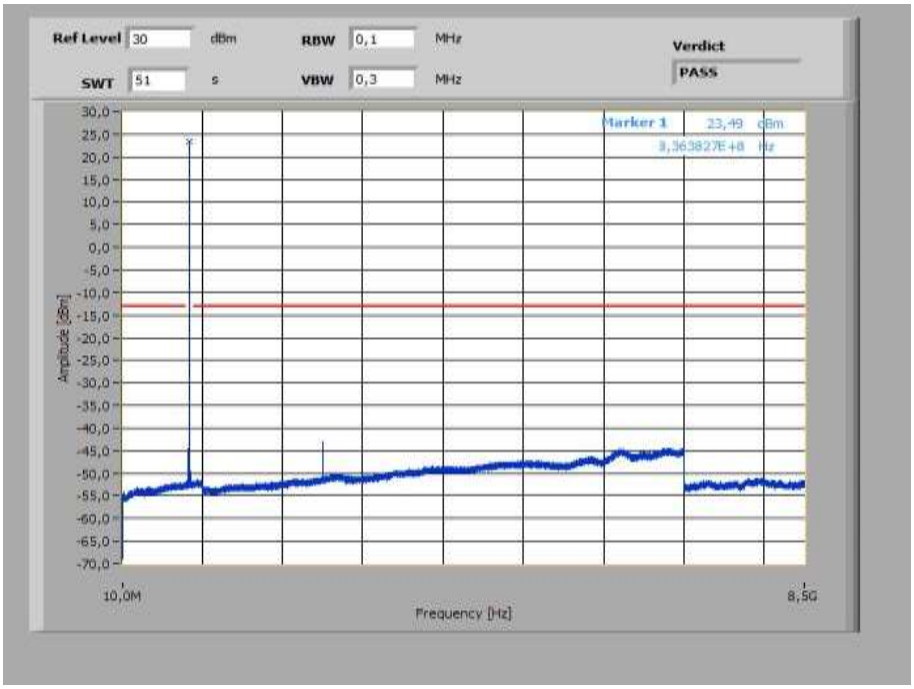


**Plots: QPSK**

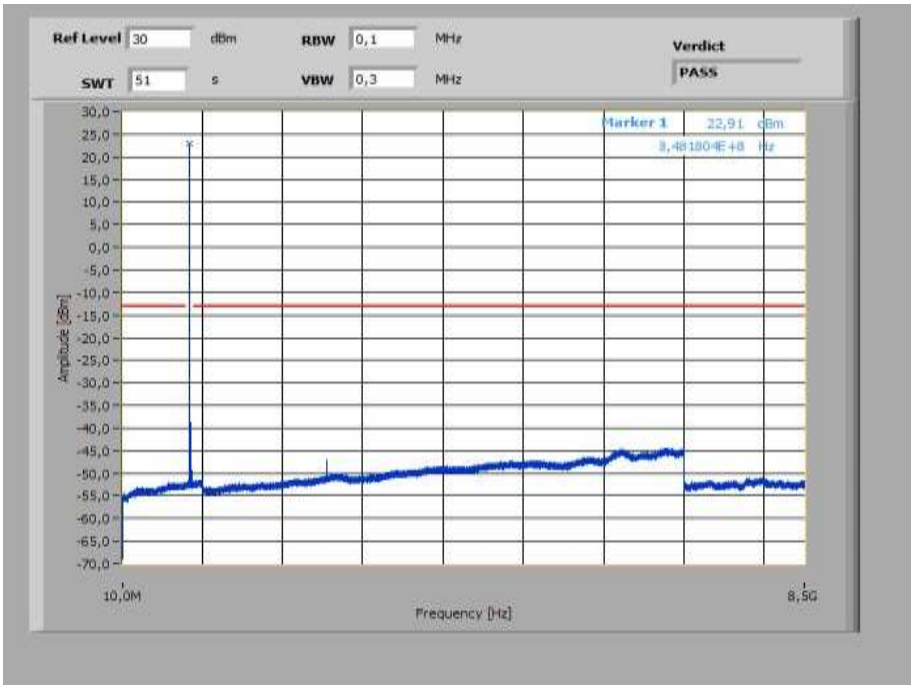
**Plot 1:** Lowest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@0 tones



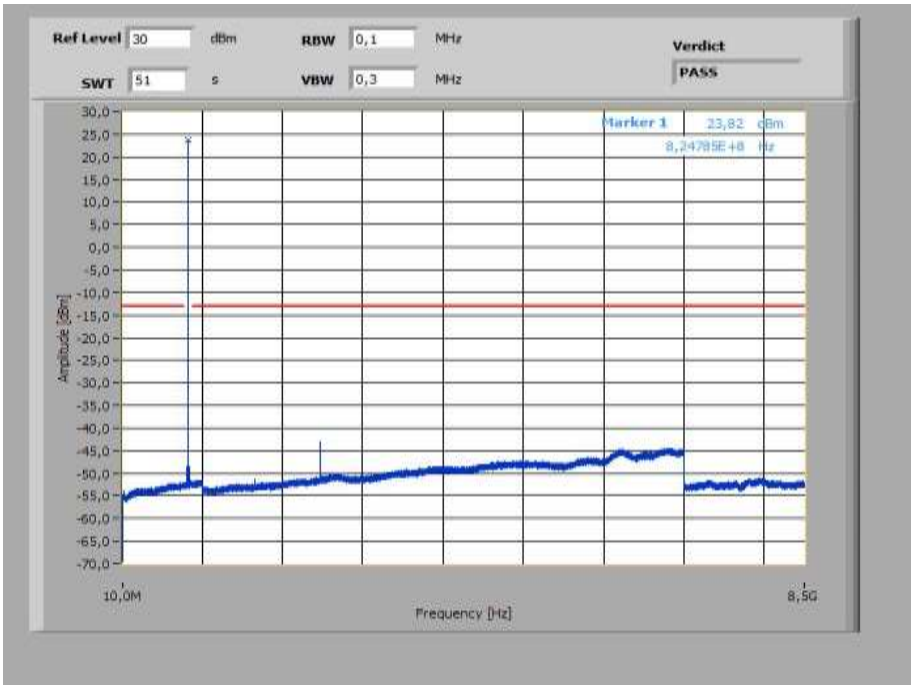

**Plot 2:** Middle Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@0 tones



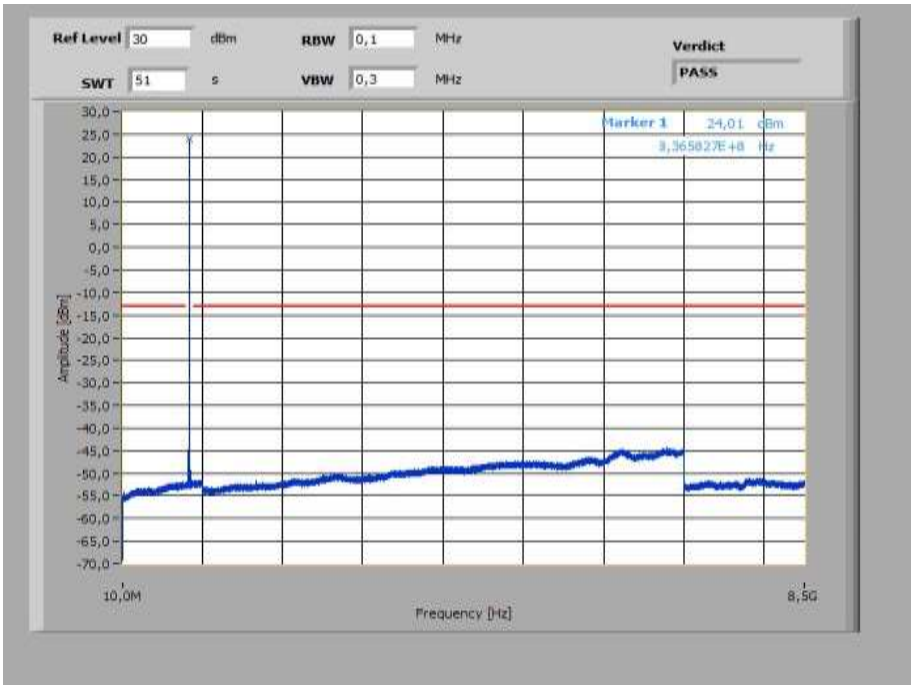
**Plot 3:** Highest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@0 tones



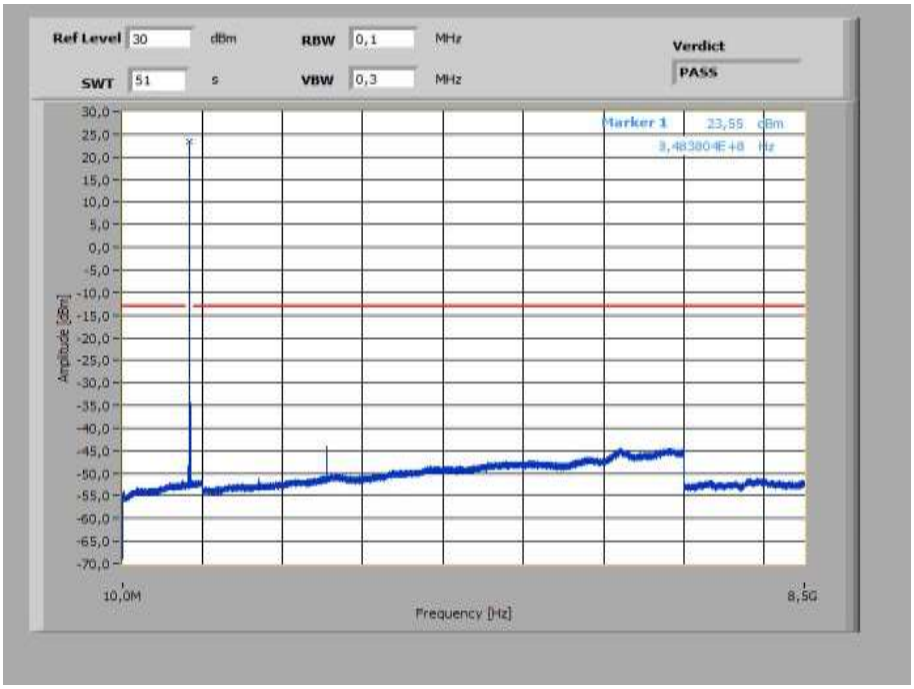

**Plot 4:** Lowest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@47 tones



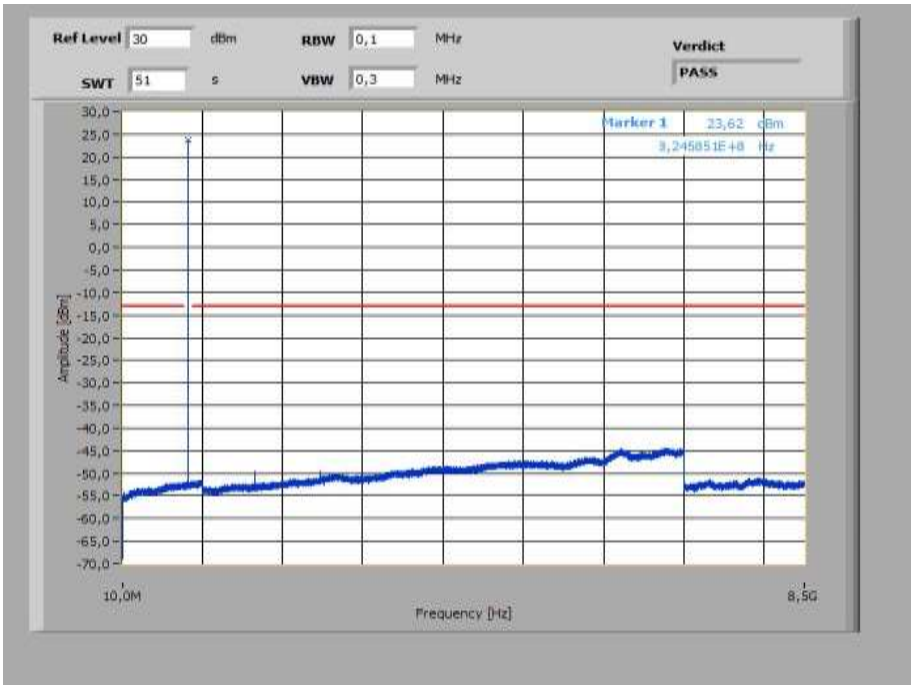
**Plot 5:** Middle Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@47 tones



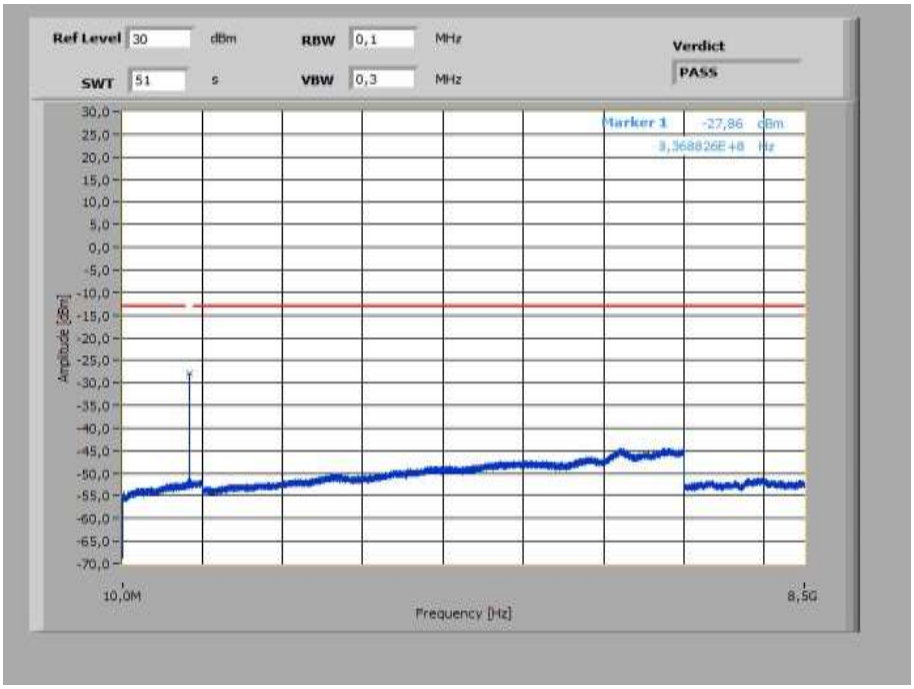

**Plot 6:** Highest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@47 tones



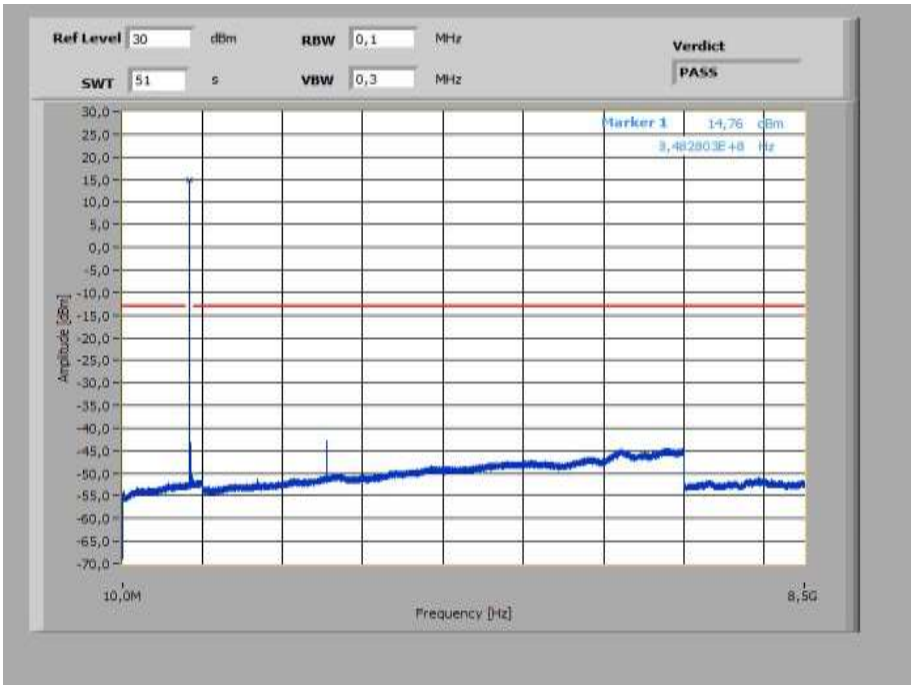
**Plot 7:** Lowest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@0 tones



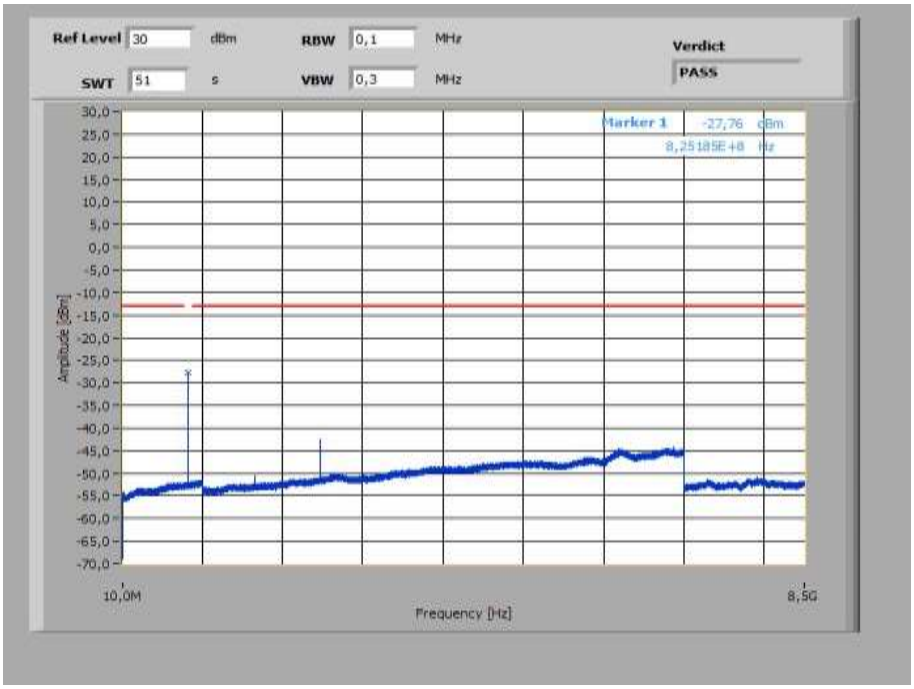

**Plot 8:** Middle Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@0 tones



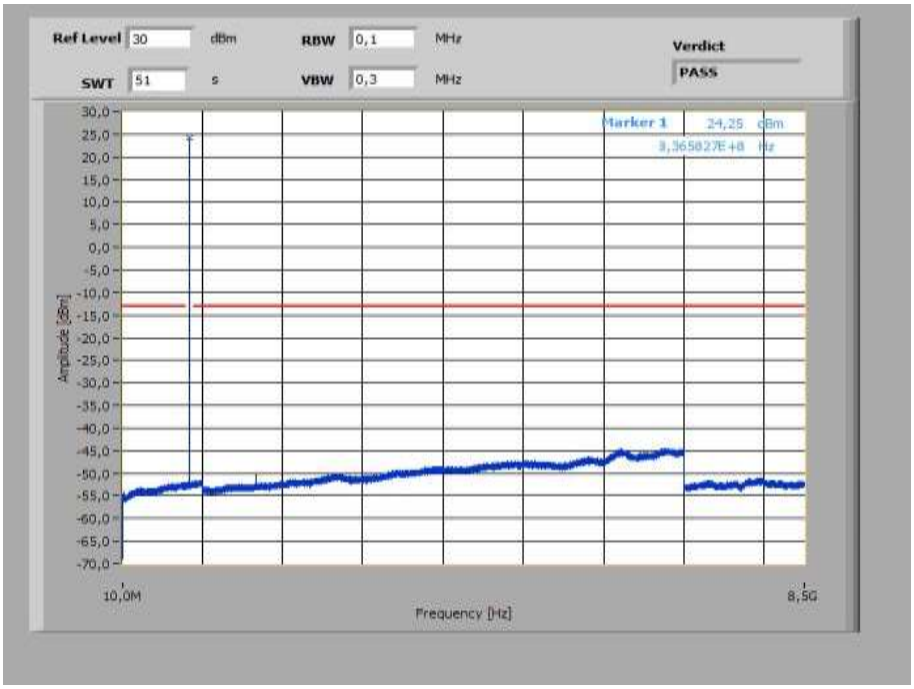
**Plot 9:** Highest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@0 tones



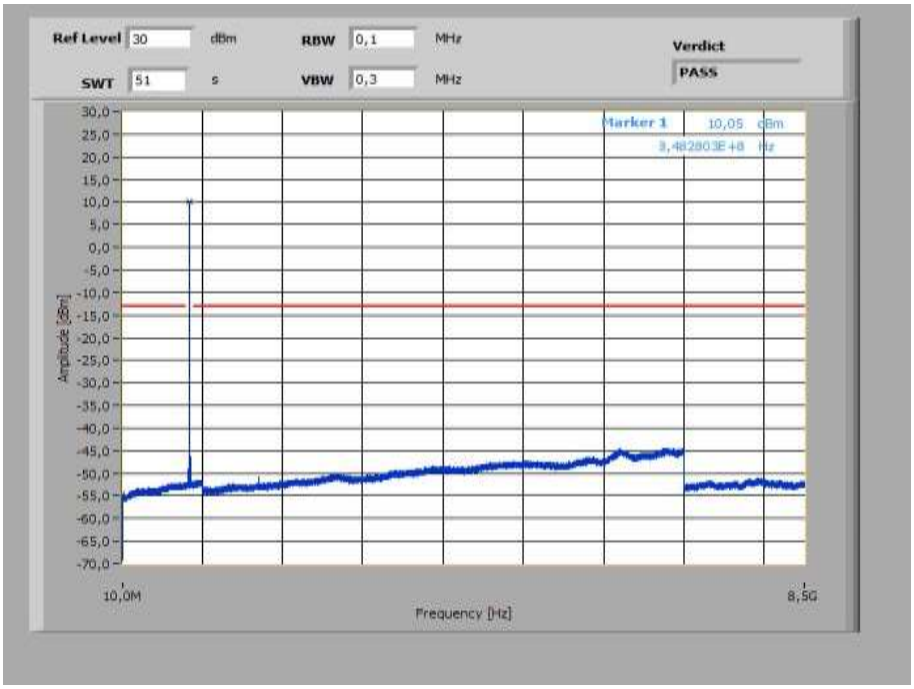

**Plot 10:** Lowest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@11 tones



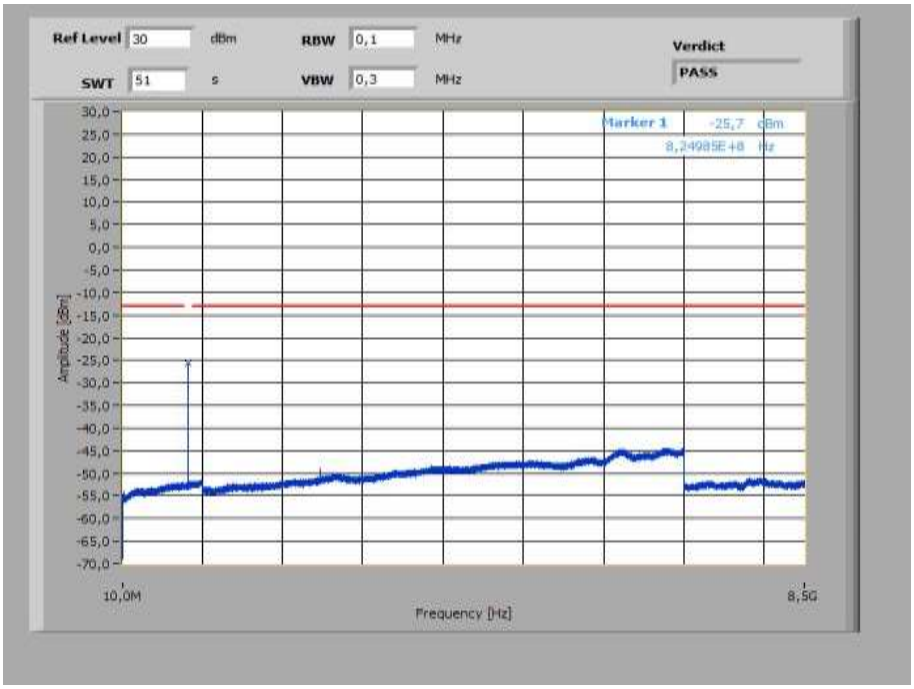
**Plot 11:** Middle Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@11 tones



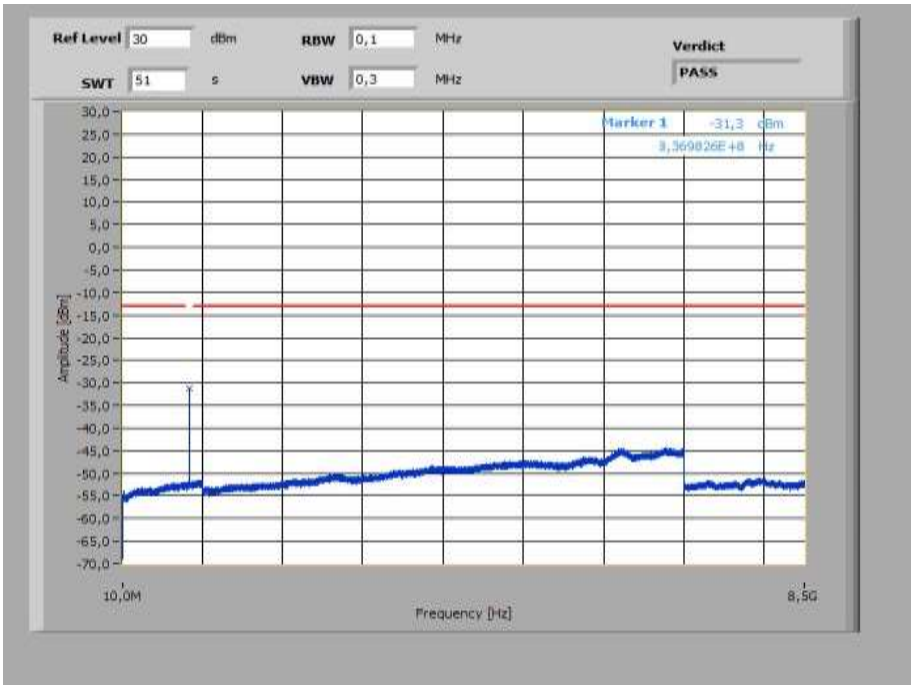

**Plot 12:** Highest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@11 tones



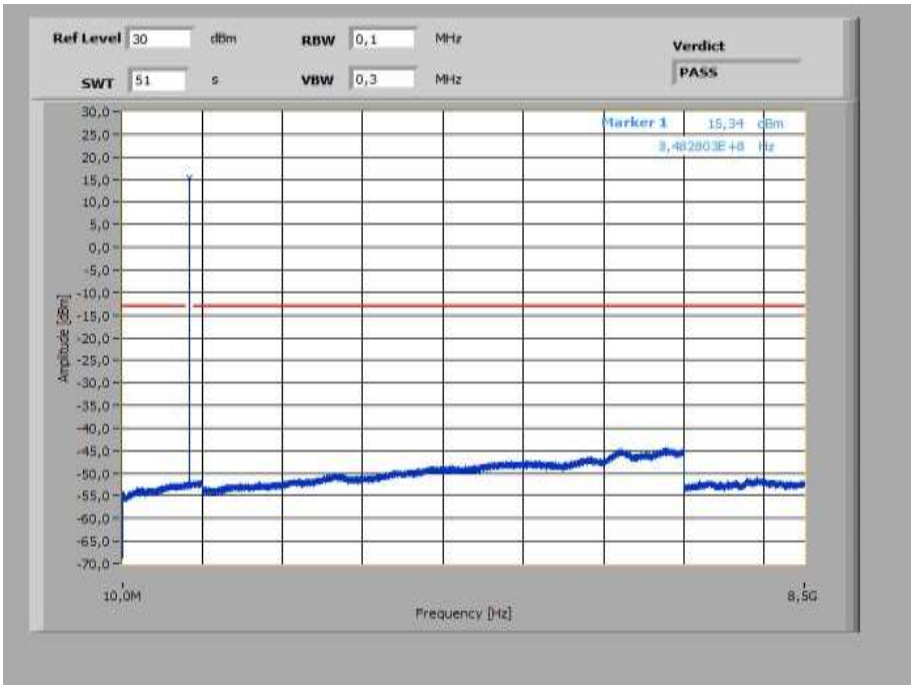
**Plot 13:** Lowest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 12@0 tones




**Plot 14:** Middle Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 12@0 tones



**Plot 15:** Highest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 12@0 tones



### 12.2.5 Block edge compliance

**Description:**

The spectrum at the band edges must comply with the spurious emissions limits.

**Measurement:**

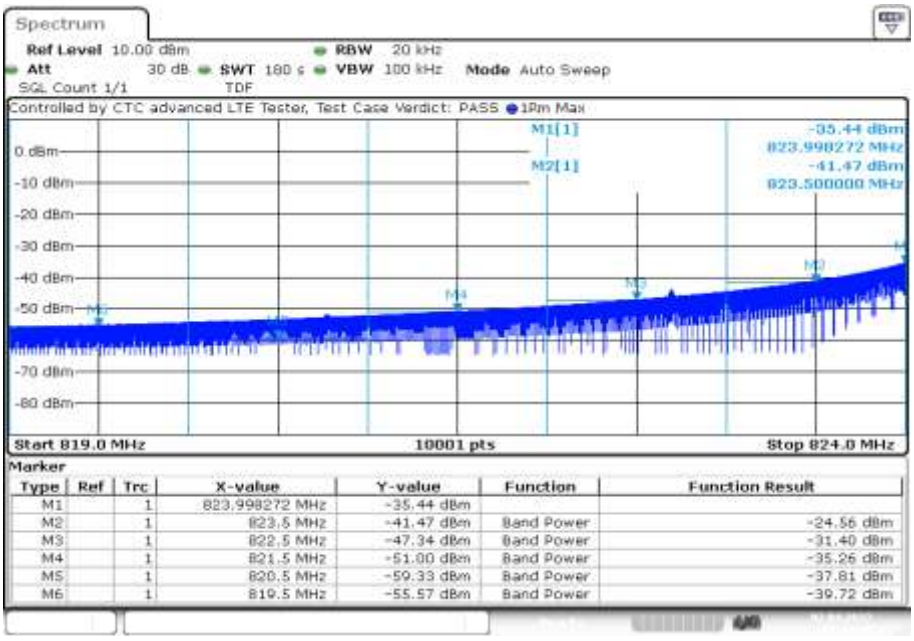
| Measurement parameters | |
|---|---|
| Detector: | RMS |
| Sweep time: | 180s |
| Video bandwidth: | 100 kHz |
| Resolution bandwidth: | 20 kHz |
| Span: | 1 MHz steps |
| Trace mode: | Max Hold |
| Used equipment: | See chapter 7.4 setup A |
| Measurement uncertainty: | See chapter 9 |
| Measurement procedure: | FCC: § 2.1051<br>ISED: RSS-Gen, 6.13 |

**Limits:**

| FCC | ISED |
|---|---|
| § 22.917(a) & (b) | RSS-132, 5.5 |
| (a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least **43 + 10 log(P) dB**.<br>(b)(1) In the spectrum below 1 GHz, instrumentation should employ a reference bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block, a RBW of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy, provided that the measured power is integrated over the full required reference bandwidth (i.e., 100 kHz or 1 percent of emission bandwidth, as specified). 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.<br>(b)(2) In the spectrum above 1 GHz, instrumentation should employ a reference bandwidth of 1 MHz. | i. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P ( dBW) by at least **43 + 10 log10(P) (watts)**.<br>ii. After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least **43 + 10 log10(P) (watts)**.<br>If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required. |
| **-13 dBm**<br><br>Correction factor according to KDB 890810 if RBW < 1 % emission bandwidth:<br>☒N/A here<br>☐10 log (RBW1/RBW2) = X dB; whereas: RBW1 = Y, RBW2 = Z | |

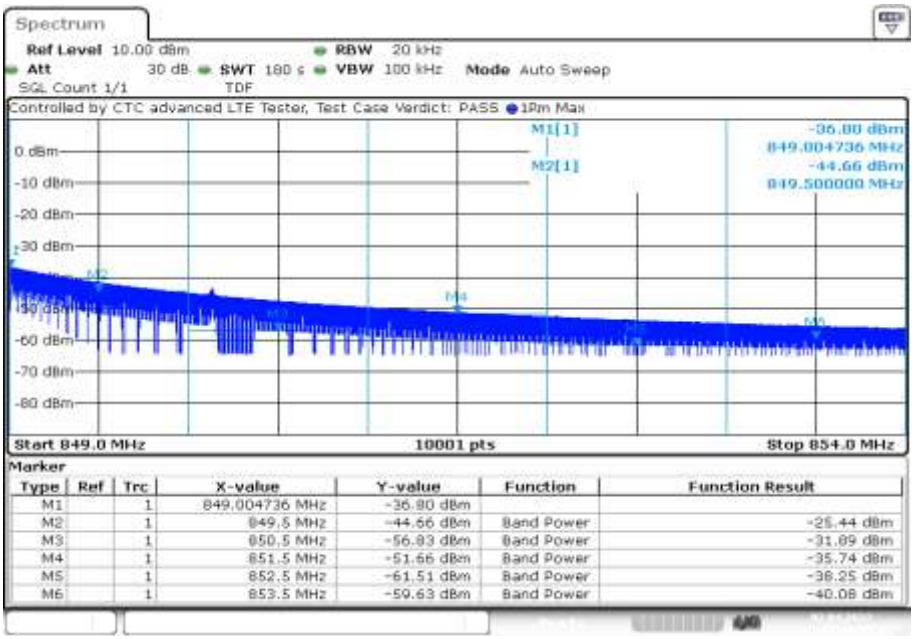
**Results:** **BPSK**

**Plot 1:** Lowest channel, spacing 3.75 kHz, 1@0 tones



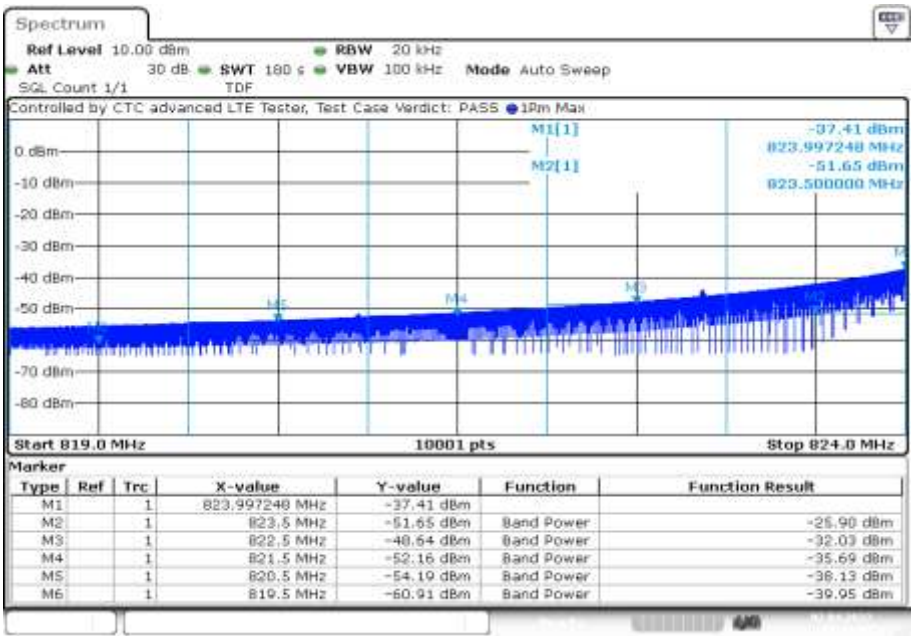

Date: 2.APR.2022 09:12:15

**Plot 2:** Highest channel, spacing 3.75 kHz, 1@0 tones



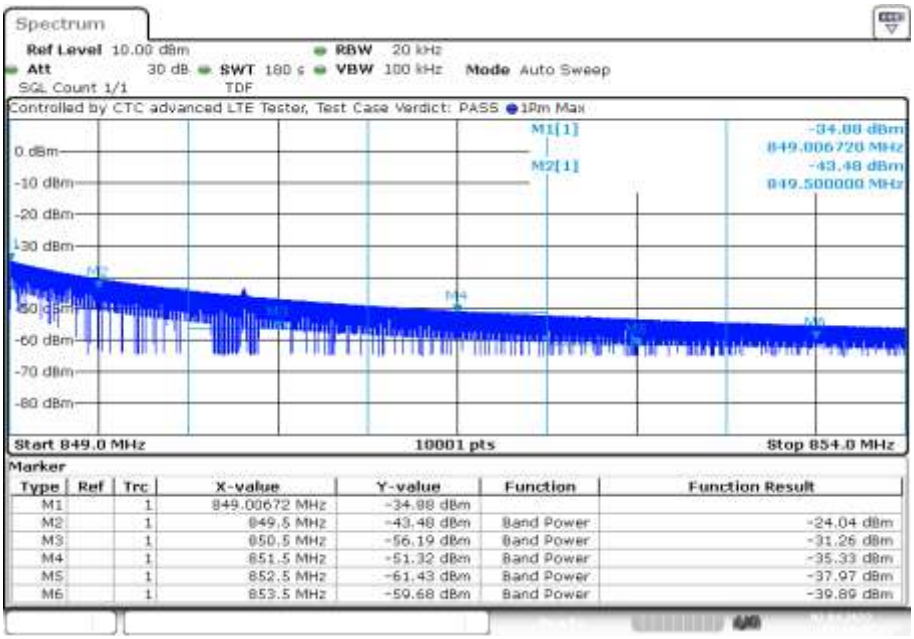

Date: 2.APR.2022 12:30:57

**Plot 3:** Lowest channel, spacing 3.75 kHz, 1@47 tones



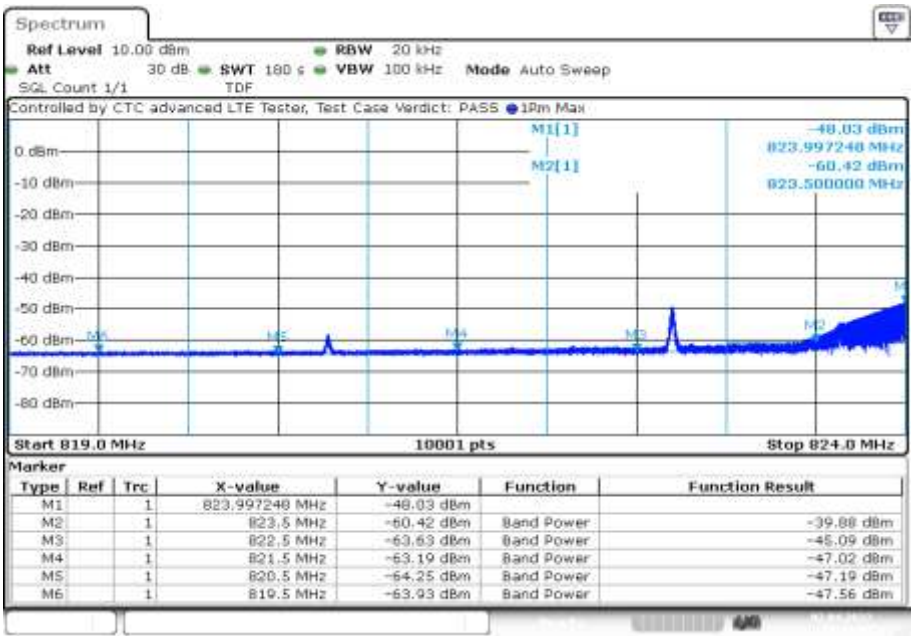

Date: 2.APR.2022 09:24:51

**Plot 4:** Highest channel, spacing 3.75 kHz, 1@47 tones



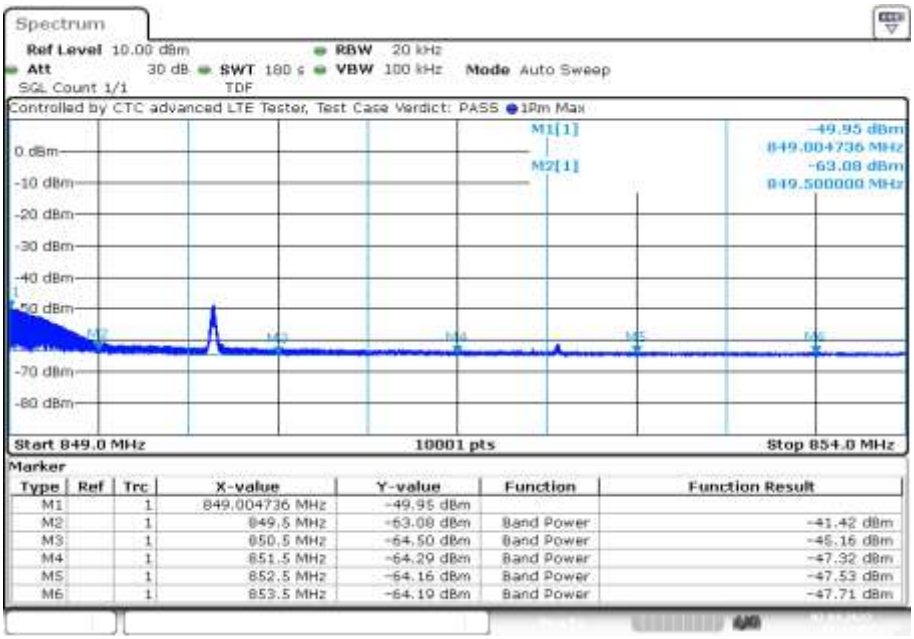

Date: 2.APR.2022 12:43:27

**Plot 5:** Lowest channel, spacing 15 kHz, 1@0 tones



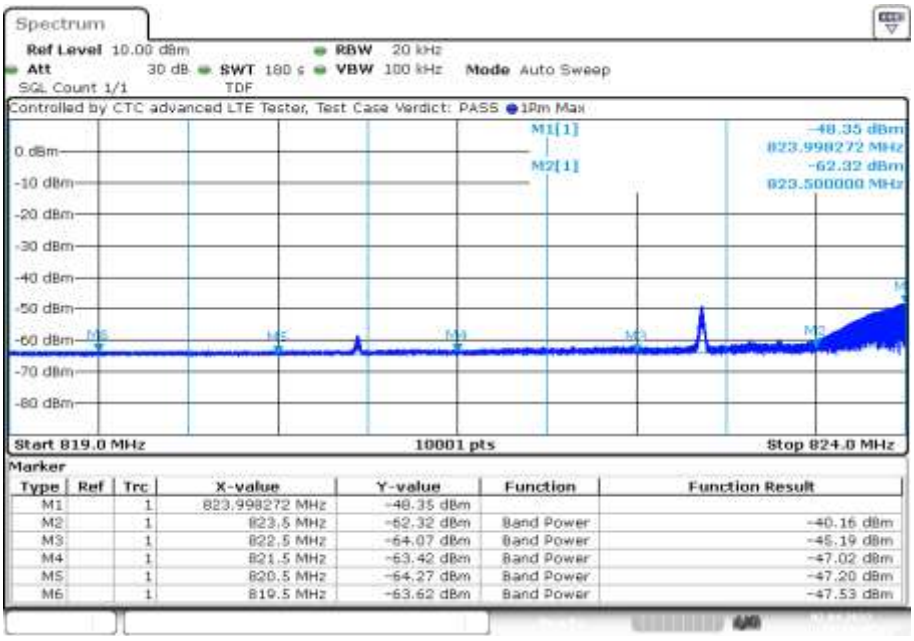

Date: 2.APR.2022 10:03:00

**Plot 6:** Highest channel, spacing 15 kHz, 1@0 tones



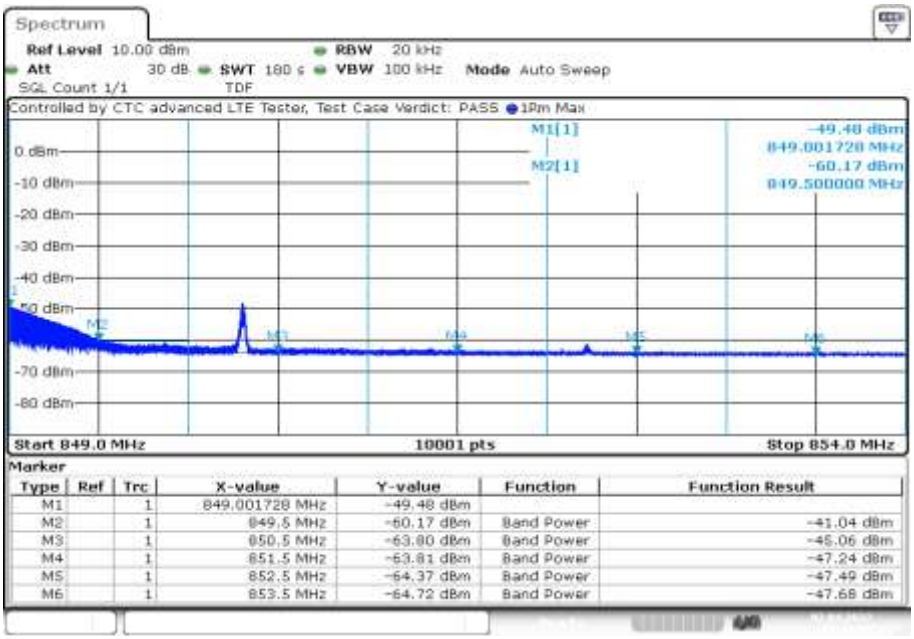

Date: 2.APR.2022 13:21:26

**Plot 7:** Lowest channel, spacing 15 kHz, 1@11 tones




Date: 2.APR.2022 10:15:37

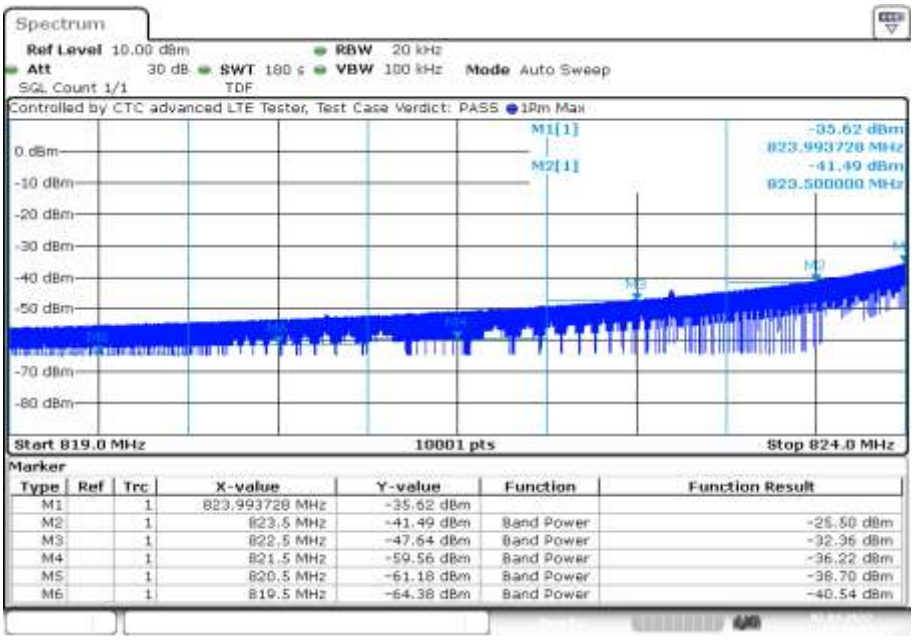
**Plot 8:** Highest channel, spacing 15 kHz, 1@11 tones




Date: 2.APR.2022 13:33:56

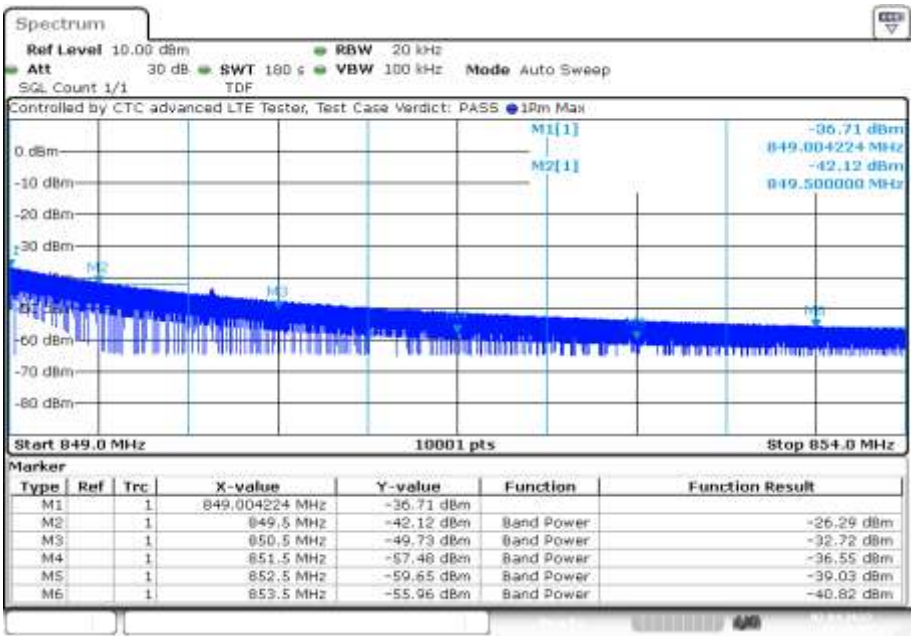
**Results:** **QPSK**

**Plot 1:** Lowest channel, spacing 3.75 kHz, 1@0 tones



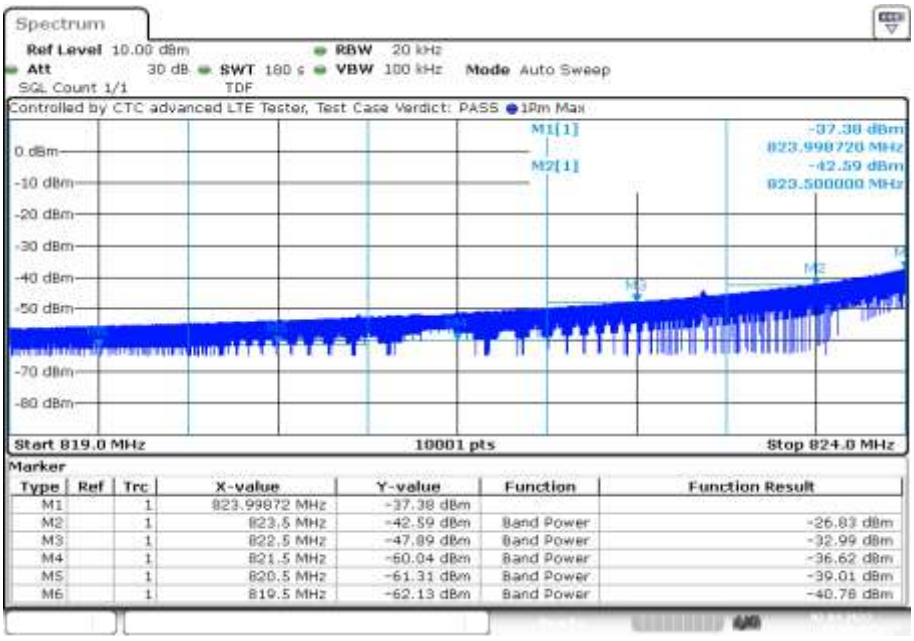

Date: 2.APR.2022 09:37:28

**Plot 2:** Highest channel, spacing 3.75 kHz, 1@0 tones



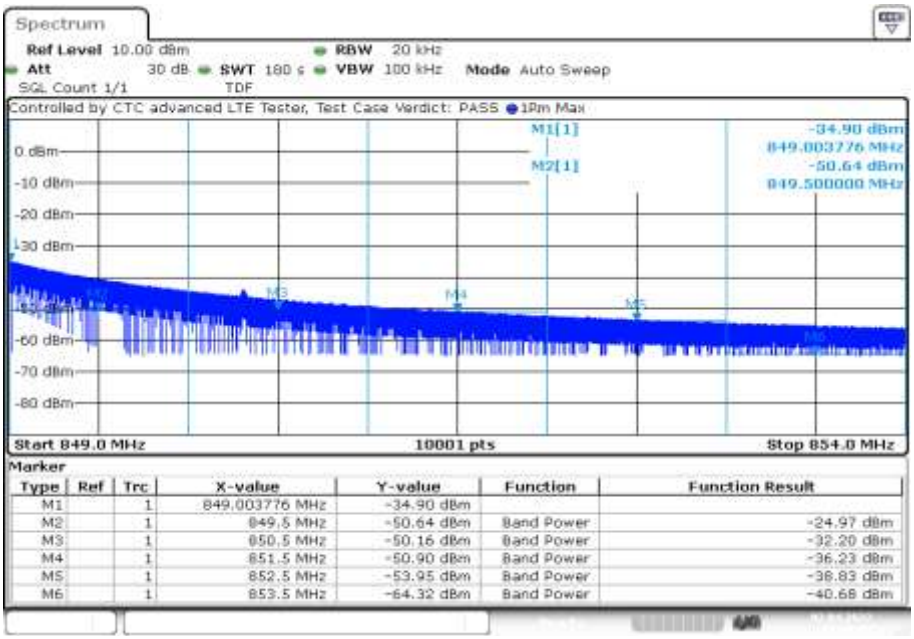

Date: 2.APR.2022 12:55:56

**Plot 3:** Lowest channel, spacing 3.75 kHz, 1@47 tones



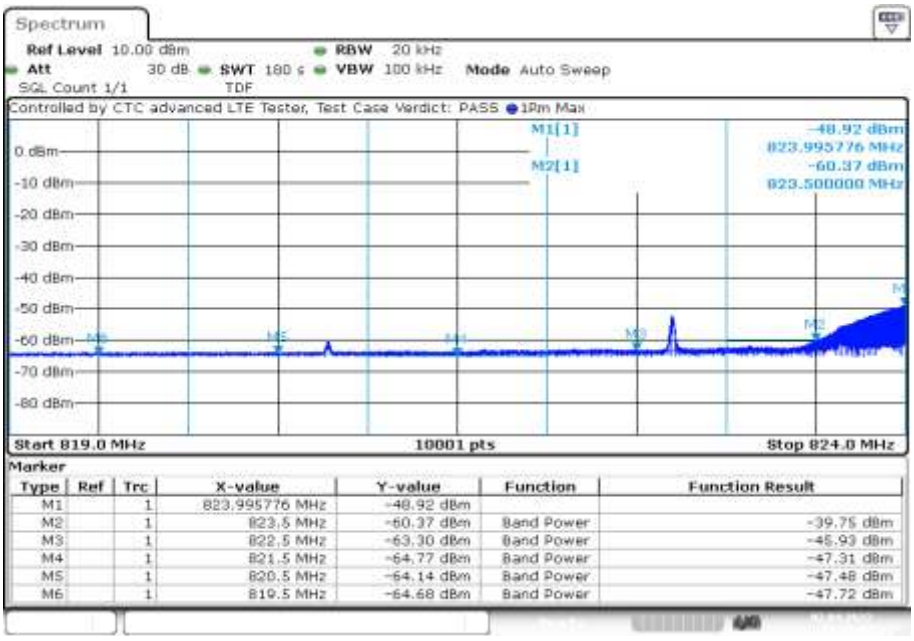

Date: 2.APR.2022 09:50:04

**Plot 4:** Highest channel, spacing 3.75 kHz, 1@47 tones



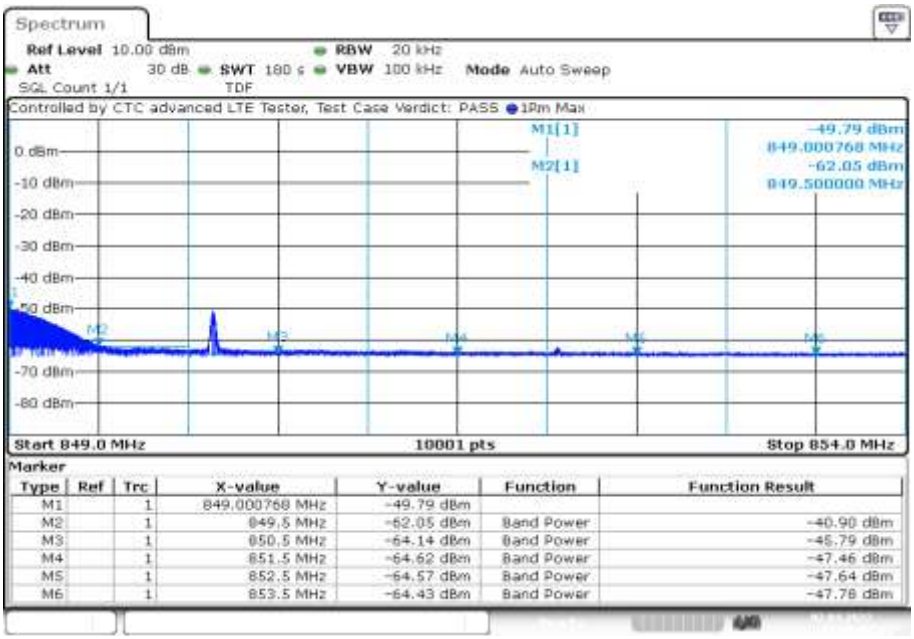

Date: 2.APR.2022 13:08:26

**Plot 5:** Lowest channel, spacing 15 kHz, 1@0 tones



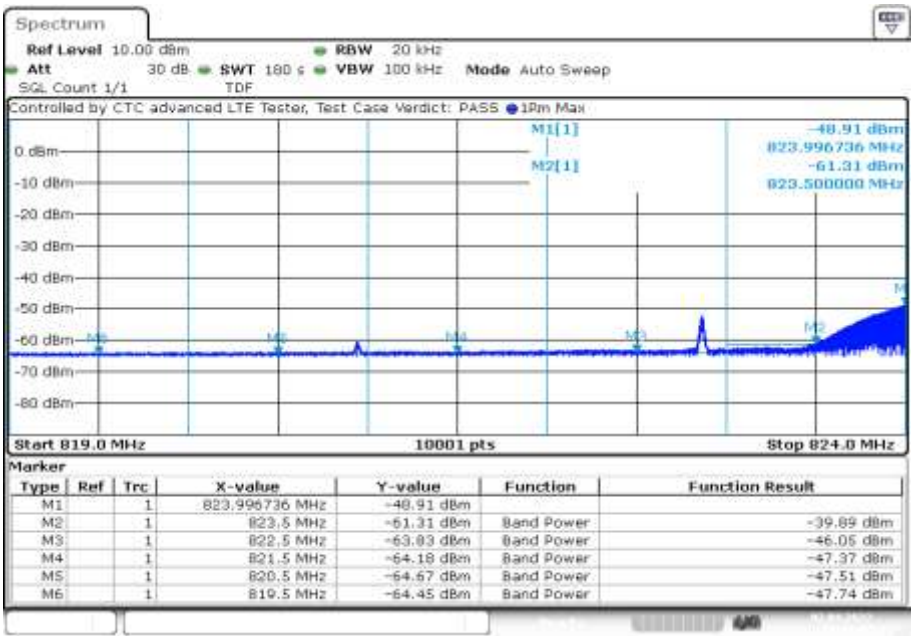

Date: 2.APR.2022 10:28:12

**Plot 6:** Highest channel, spacing 15 kHz, 1@0 tones




Date: 2.APR.2022 13:46:25

**Plot 7:** Lowest channel, spacing 15 kHz, 1@11 tones




Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 823.996736 MHz | -48.91 dBm | | |
| M2 | | 1 | 823.5 MHz | -61.31 dBm | Band Power | -39.89 dBm |
| M3 | | 1 | 822.5 MHz | -63.83 dBm | Band Power | -46.05 dBm |
| M4 | | 1 | 821.5 MHz | -64.18 dBm | Band Power | -47.37 dBm |
| M5 | | 1 | 820.5 MHz | -64.67 dBm | Band Power | -47.51 dBm |
| M6 | | 1 | 819.5 MHz | -64.45 dBm | Band Power | -47.74 dBm |

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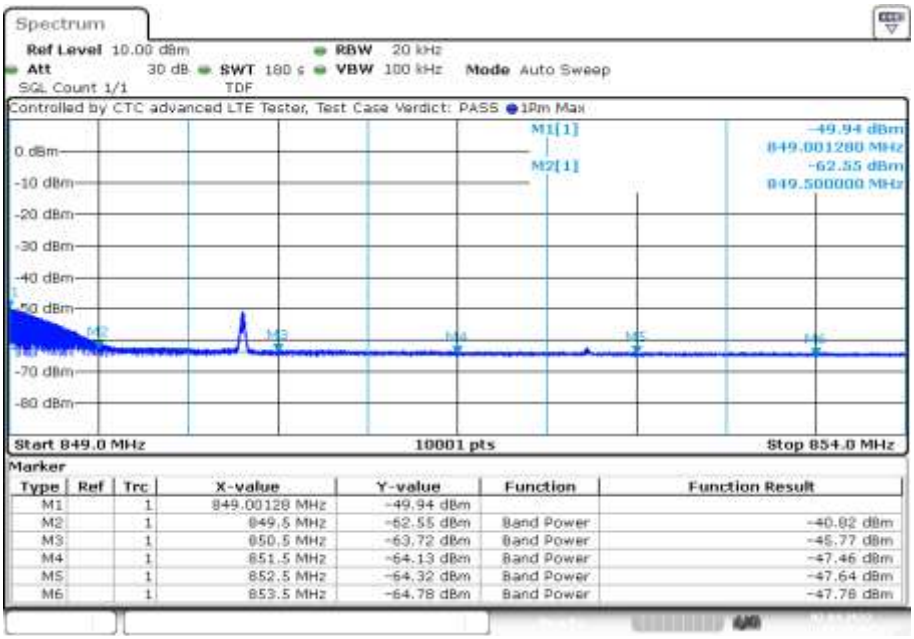
**Plot 8:** Highest channel, spacing 15 kHz, 1@11 tones




Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 849.00128 MHz | -49.94 dBm | | |
| M2 | | 1 | 849.5 MHz | -62.55 dBm | Band Power | -40.82 dBm |
| M3 | | 1 | 850.5 MHz | -63.72 dBm | Band Power | -45.77 dBm |
| M4 | | 1 | 851.5 MHz | -64.13 dBm | Band Power | -47.46 dBm |
| M5 | | 1 | 852.5 MHz | -64.32 dBm | Band Power | -47.64 dBm |
| M6 | | 1 | 853.5 MHz | -64.78 dBm | Band Power | -47.78 dBm |

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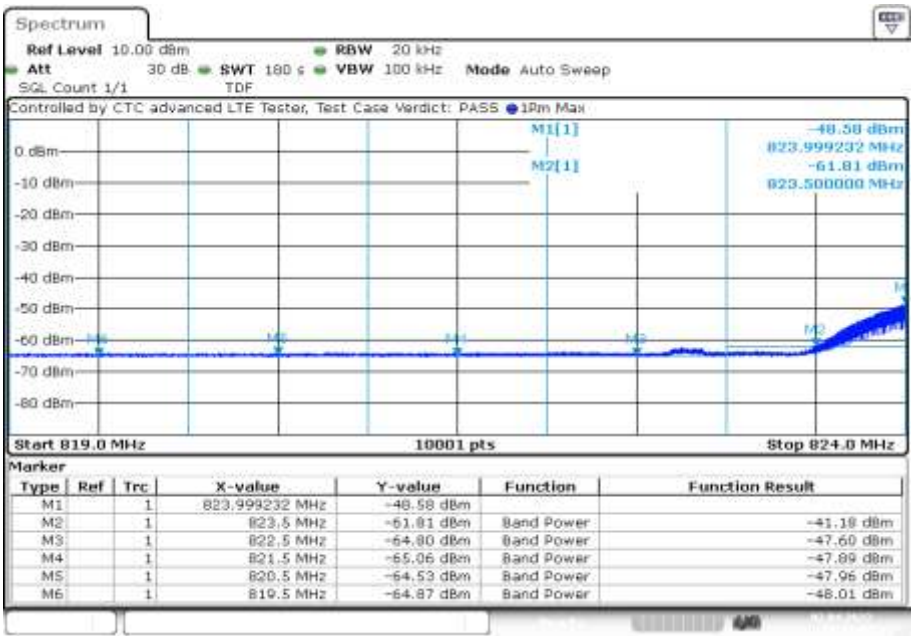
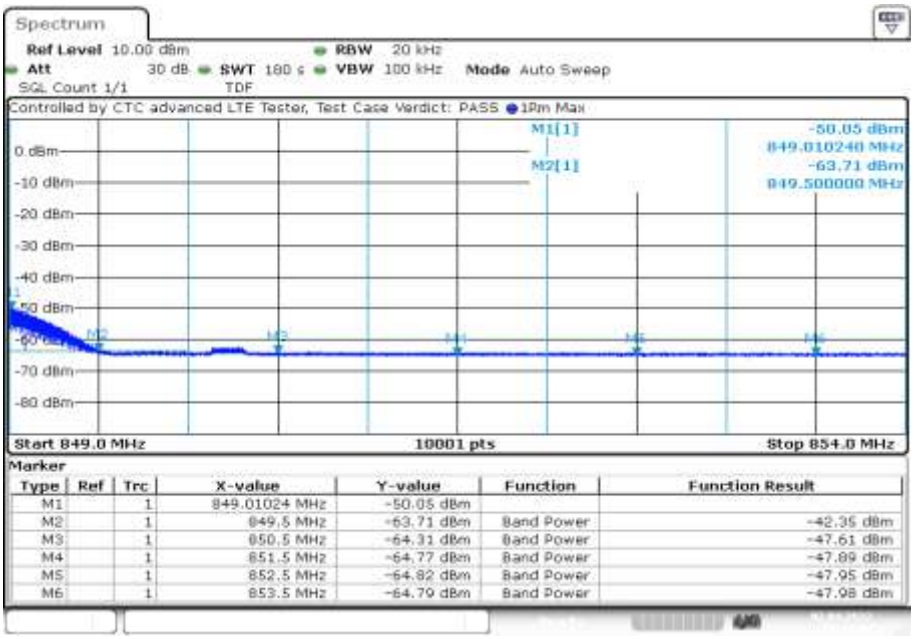
**Plot 7:** Lowest channel, spacing 15 kHz, 12@0 tones




Date: 2.APR.2022 10:53:23

**Plot 8:** Highest channel, spacing 15 kHz, 12@0 tones

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## 12.2.6 Occupied bandwidth

**Description:**

Measurement of the occupied bandwidth of the transmitted signal.

**Measurement:**

Similar to conducted emissions, occupied bandwidth measurements are only provided for selected frequencies in order to reduce the amount of submitted data. Data were taken at the extreme and mid frequencies of the LTE band V. The table below lists the measured 99% power and -26dBc occupied bandwidths. Spectrum analyzer plots are included on the following pages.

| Measurement parameters | |
|---|---|
| Detector: | Peak |
| Sweep time: | 180s |
| Resolution bandwidth: | 30 kHz |
| Video bandwidth: | 100 kHz |
| Span: | 2 x nominal BW |
| Trace mode: | Max Hold |
| Used equipment: | See chapter 7.4 setup A |
| Measurement uncertainty: | See chapter 9 |
| Measurement procedure: | FCC: § 2.1049<br>ISED: RSS-Gen, 6.7 |

**Limits:**

| FCC | ISED |
|---|---|
| § 2.1049 | RSS-Gen, 6.7 |
| Reporting only | |

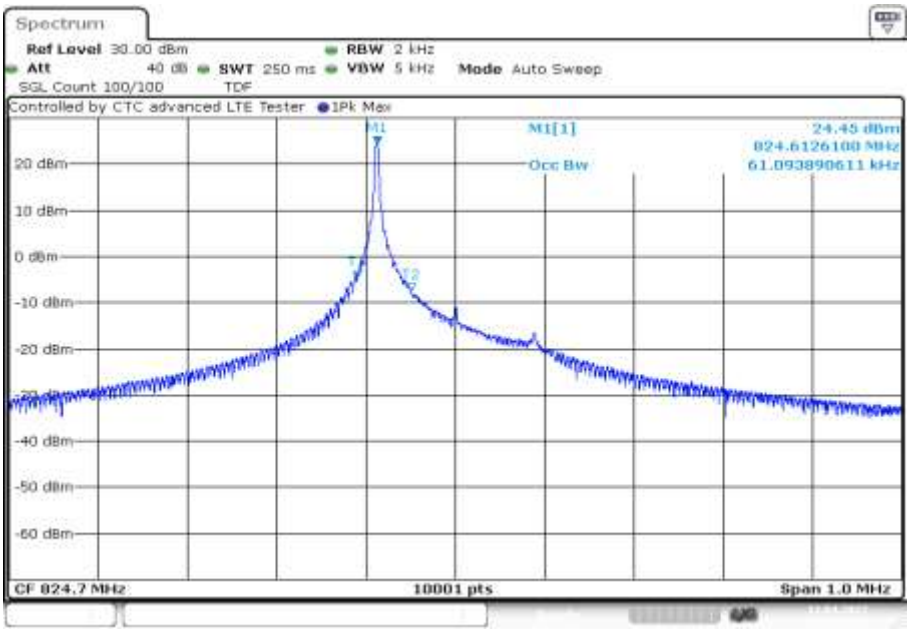
**Results:**

| Occupied Bandwidth – BPSK | | |
|---|---|---|
| **Mode** | **99% OBW (kHz)** | **-26 dBc BW (kHz)** |
| Low channel / spacing 3.75 kHz; 1@0 tones | 61 | 40 |
| Mid channel / spacing 3.75 kHz; 1@0 tones | 63 | 40 |
| High channel / spacing 3.75 kHz; 1@0 tones | 63 | 40 |
| Low channel / spacing 3.75 kHz; 1@47 tones | 62 | 38 |
| Mid channel / spacing 3.75 kHz; 1@47 tones | 62 | 38 |
| High channel / spacing 3.75 kHz; 1@47 tones | 62 | 38 |
| Low channel / spacing 15 kHz; 1@0 tones | 124 | 126 |
| Mid channel / spacing 15 kHz; 1@0 tones | 117 | 111 |
| High channel / spacing 15 kHz; 1@0 tones | 119 | 118 |
| Low channel / spacing 15 kHz; 1@11 tones | 127 | 105 |
| Mid channel / spacing 15 kHz; 1@11 tones | 117 | 100 |
| High channel / spacing 15 kHz; 1@11 tones | 120 | 103 |

| Occupied Bandwidth – QPSK | | |
|---|---|---|
| **Mode** | **99% OBW (kHz)** | **-26 dBc BW (kHz)** |
| Low channel / spacing 3.75 kHz; 1@0 tones | 68 | 41 |
| Mid channel / spacing 3.75 kHz; 1@0 tones | 70 | 39 |
| High channel / spacing 3.75 kHz; 1@0 tones | 70 | 39 |
| Low channel / spacing 3.75 kHz; 1@47 tones | 68 | 38 |
| Mid channel / spacing 3.75 kHz; 1@47 tones | 66 | 38 |
| High channel / spacing 3.75 kHz; 1@47 tones | 66 | 38 |
| Low channel / spacing 15 kHz; 1@0 tones | 116 | 131 |
| Mid channel / spacing 15 kHz; 1@0 tones | 119 | 114 |
| High channel / spacing 15 kHz; 1@0 tones | 117 | 115 |
| Low channel / spacing 15 kHz; 1@11 tones | 129 | 112 |
| Mid channel / spacing 15 kHz; 1@11 tones | 127 | 131 |
| High channel / spacing 15 kHz; 1@11 tones | 120 | 117 |
| Low channel / spacing 15 kHz; 12@0 tones | 185 | 248 |
| Mid channel / spacing 15 kHz; 12@0 tones | 184 | 234 |
| High channel / spacing 15 kHz; 12@0 tones | 187 | 248 |

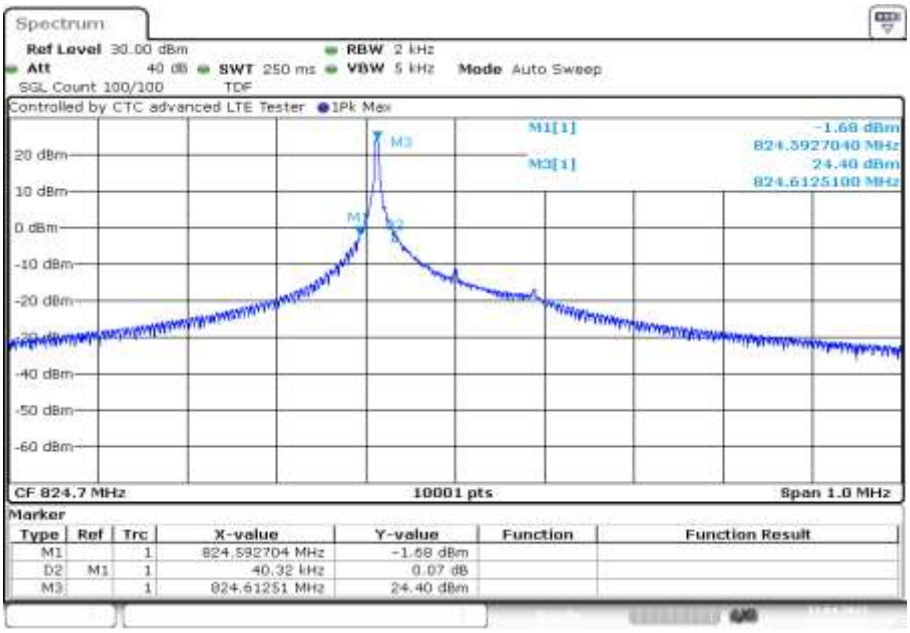
## Plots: BPSK

**Plot 1:** low channel (99% - OBW), spacing 3.75 kHz, 1@0 tones



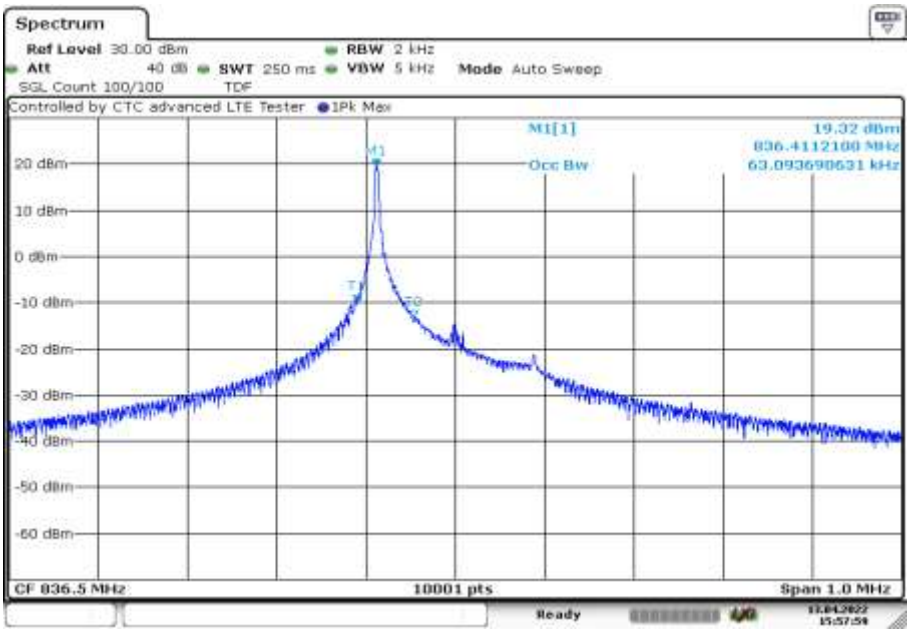

Date: 13.APR.2022 08:49:53

**Plot 2:** low channel (-26 dBc BW), spacing 3.75 kHz, 1@0 tones



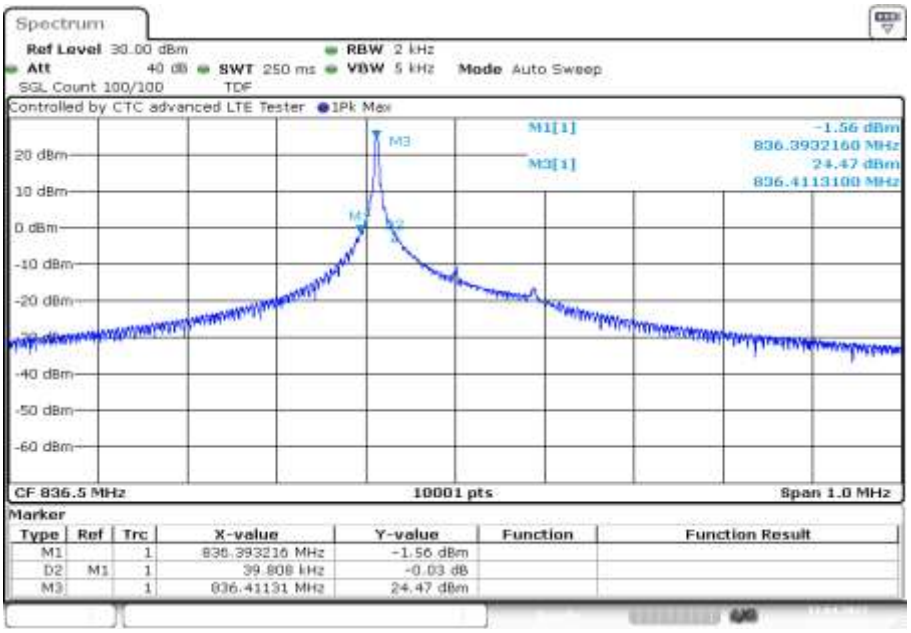

Date: 13.APR.2022 08:50:22

**Plot 3:** mid channel (99% - OBW), spacing 3.75 kHz, 1@0 tones



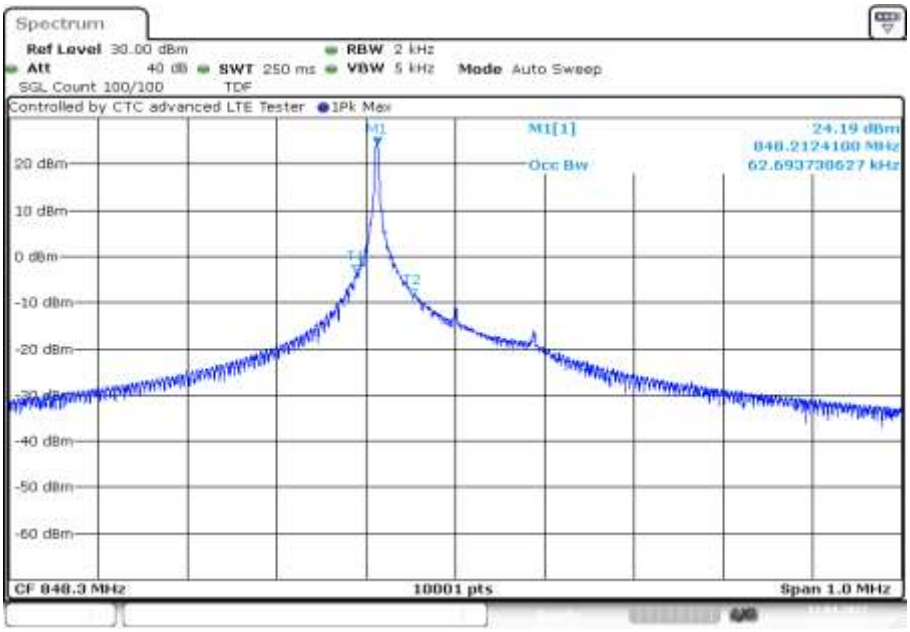

Date: 13.APR.2022 15:57:59

**Plot 4:** mid channel (-26 dBc BW), spacing 3.75 kHz, 1@0 tones



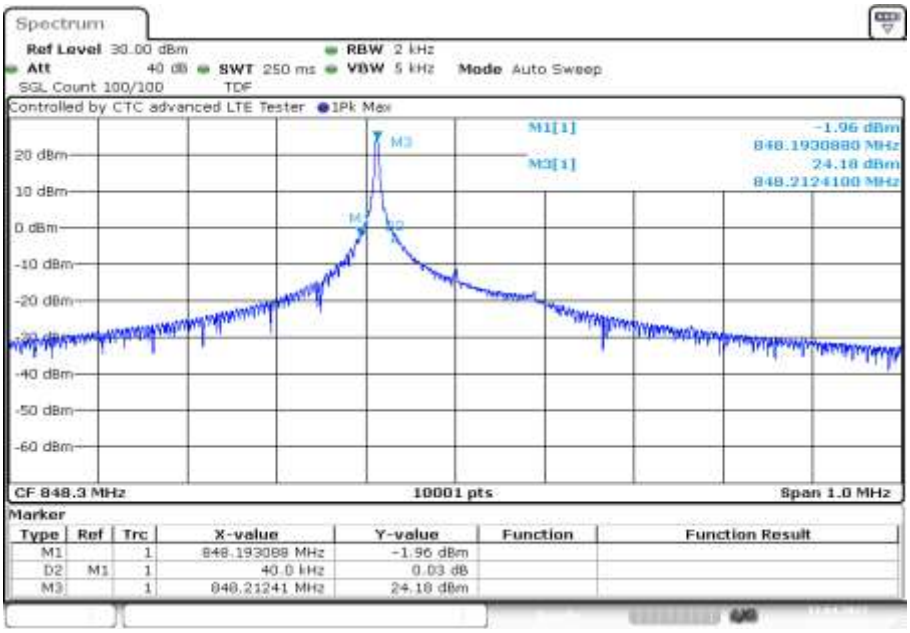

Date: 13.APR.2022 09:00:44

**Plot 5:** high channel (99% - OBW), spacing 3.75 kHz, 1@0 tones



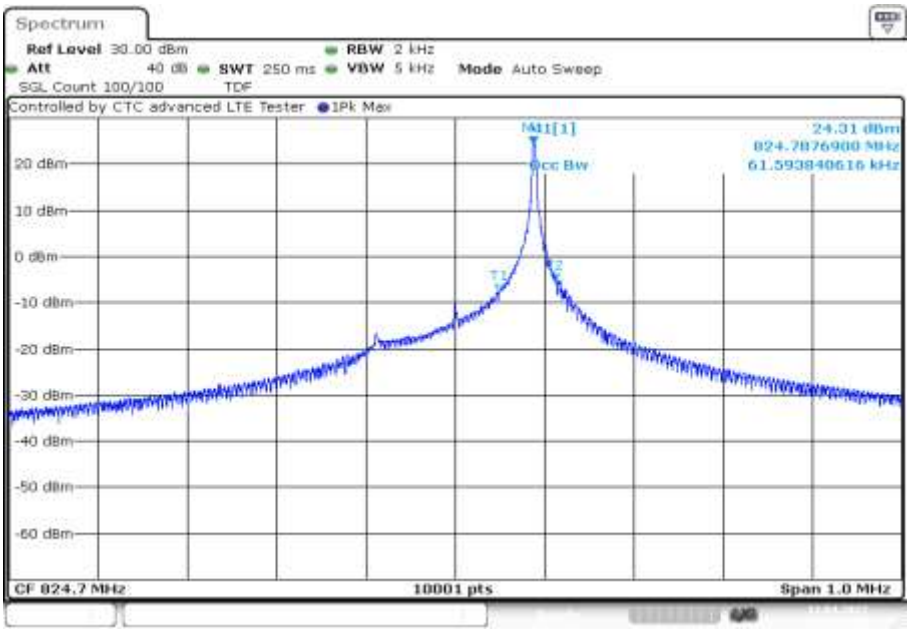

Date: 13.APR.2022 09:10:41

**Plot 6:** high channel (-26 dBc BW), spacing 3.75 kHz, 1@0 tones



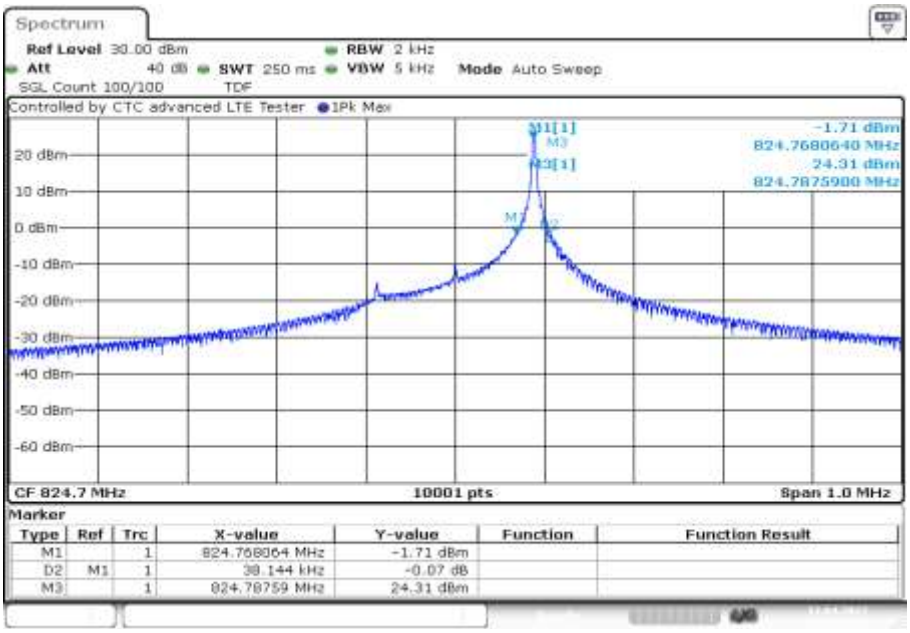

Date: 13.APR.2022 09:11:09

**Plot 7:** low channel (99% - OBW), spacing 3.75 kHz, 1@47 tones



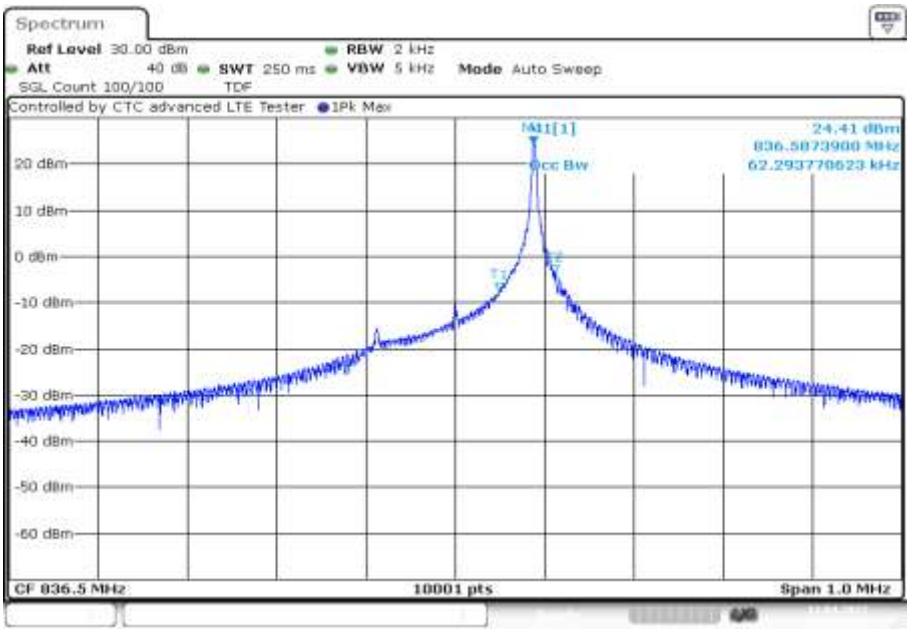

Date: 13.APR.2022 08:51:00

**Plot 8:** low channel (-26 dBc BW), spacing 3.75 kHz, 1@47 tones



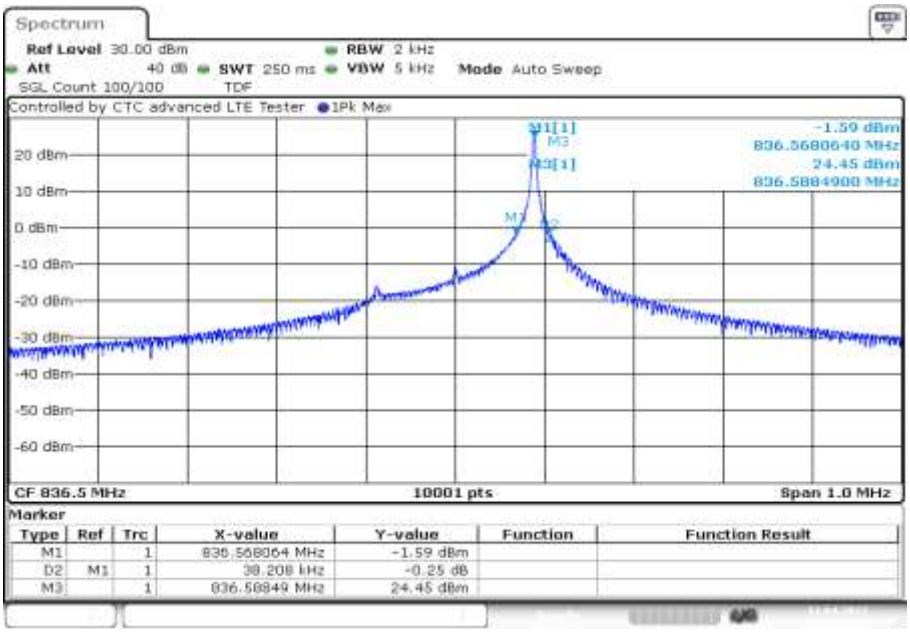

Date: 13.APR.2022 08:51:29

**Plot 9:** mid channel (99% - OBW), spacing 3.75 kHz, 1@47 tones



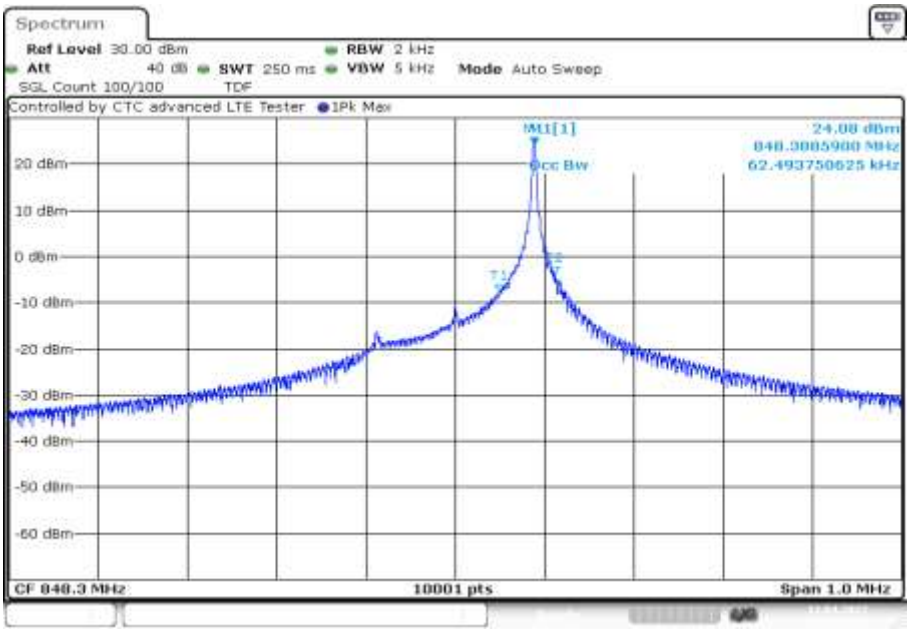

Date: 13.APR.2022 09:01:22

**Plot 10:** mid channel (-26 dBc BW), spacing 3.75 kHz, 1@47 tones



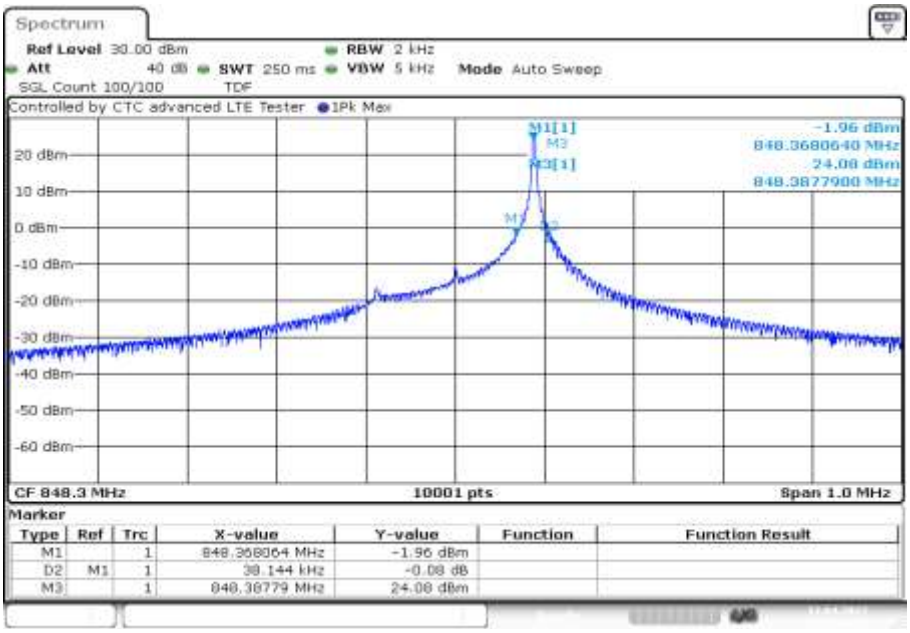

Date: 13.APR.2022 09:01:51

**Plot 11:** high channel (99% - OBW), spacing 3.75 kHz, 1@47 tones



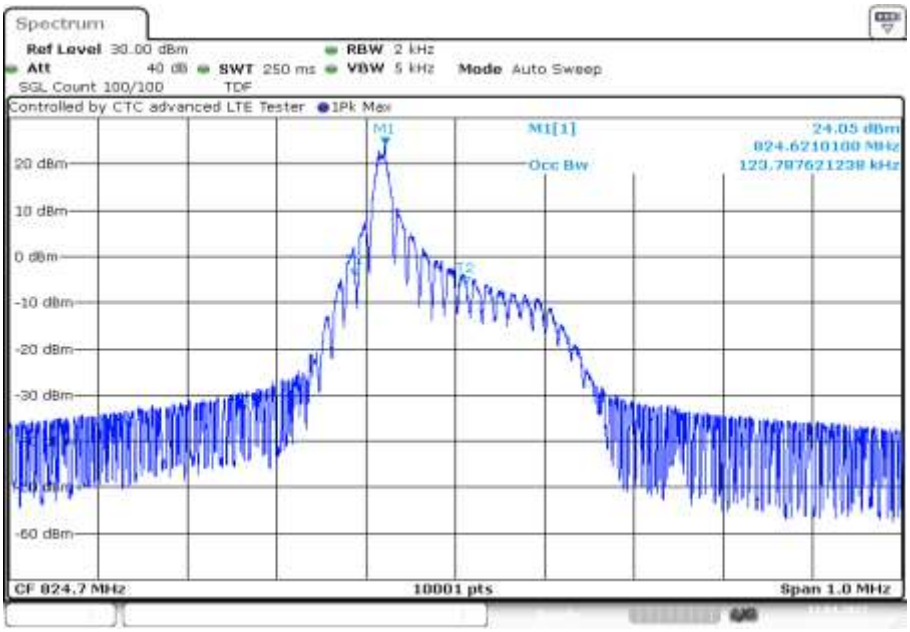

Date: 13.APR.2022 09:11:47

**Plot 12:** high channel (-26 dBc BW), spacing 3.75 kHz, 1@47 tones



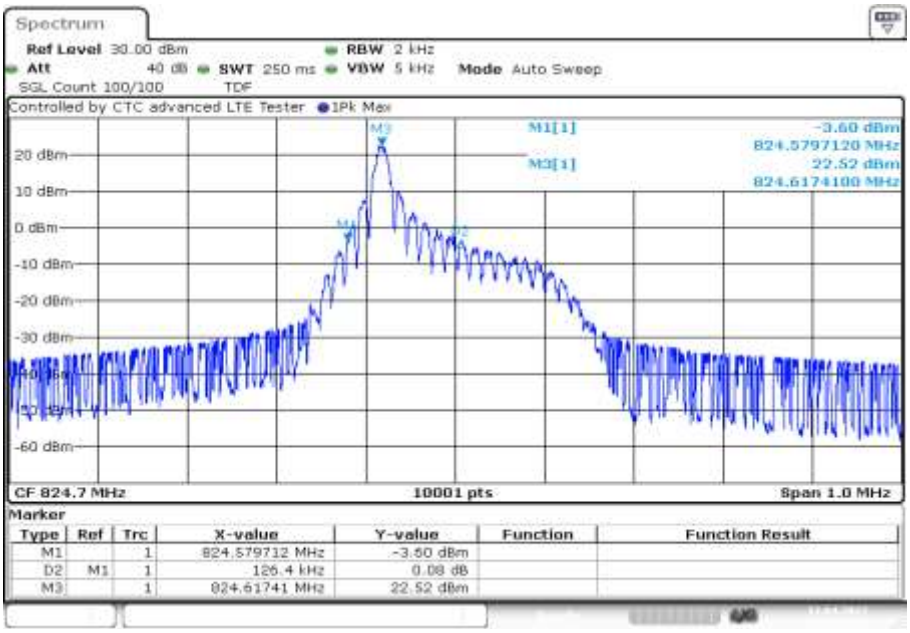

Date: 13.APR.2022 09:12:16

**Plot 13:** low channel (99% - OBW), spacing 15 kHz, 1@0 tones



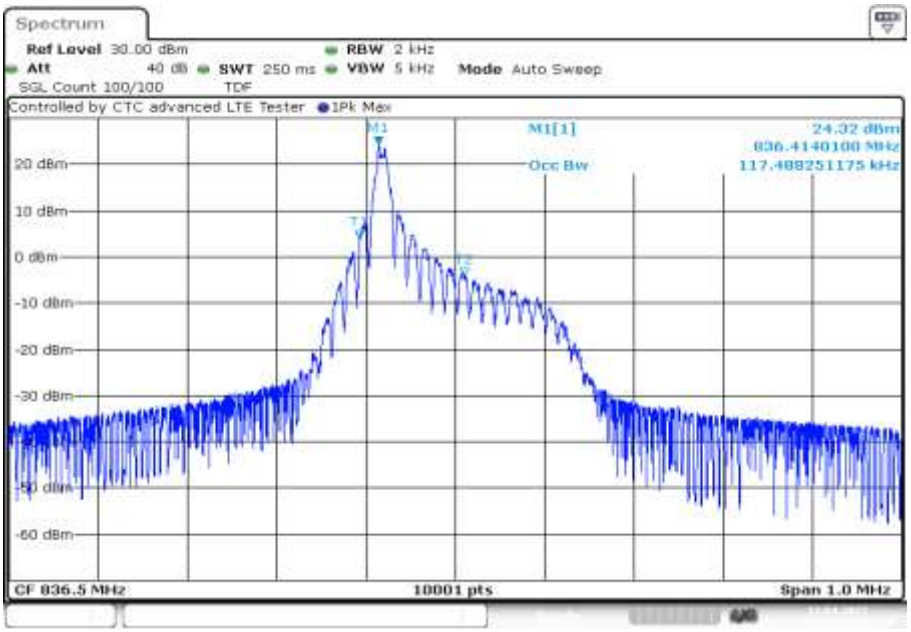

Date: 13.APR.2022 08:54:29

**Plot 14:** low channel (-26 dBc BW), spacing 15 kHz, 1@0 tones



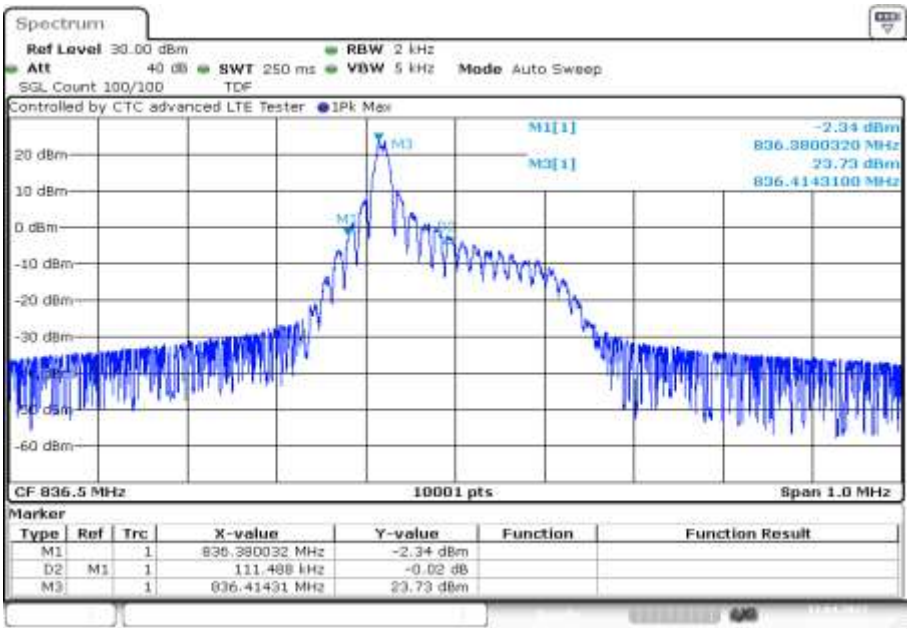

Date: 13.APR.2022 08:54:57

**Plot 15:** mid channel (99% - OBW), spacing 15 kHz, 1@0 tones



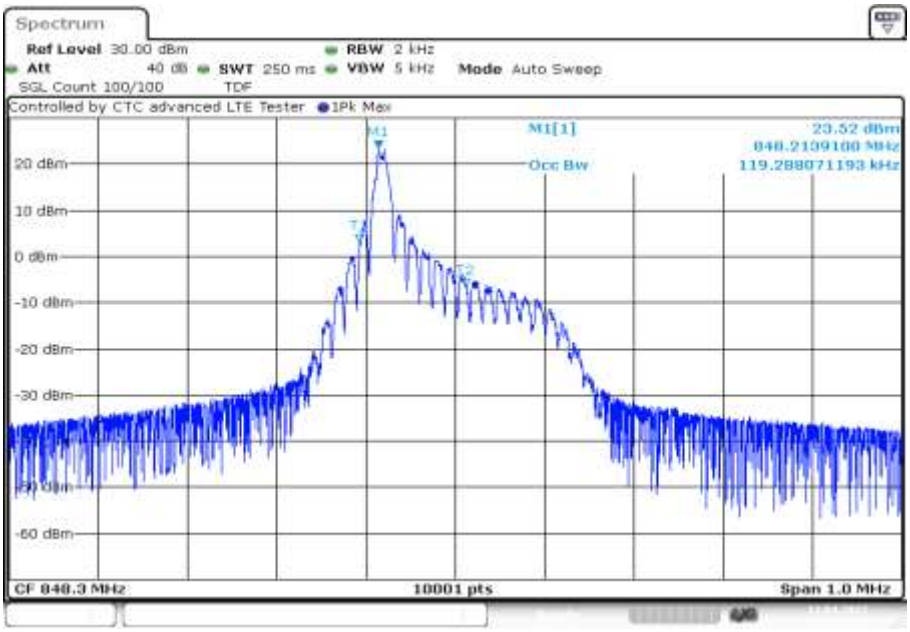

Date: 13.APR.2022 09:04:47

**Plot 16:** mid channel (-26 dBc BW), spacing 15 kHz, 1@0 tones



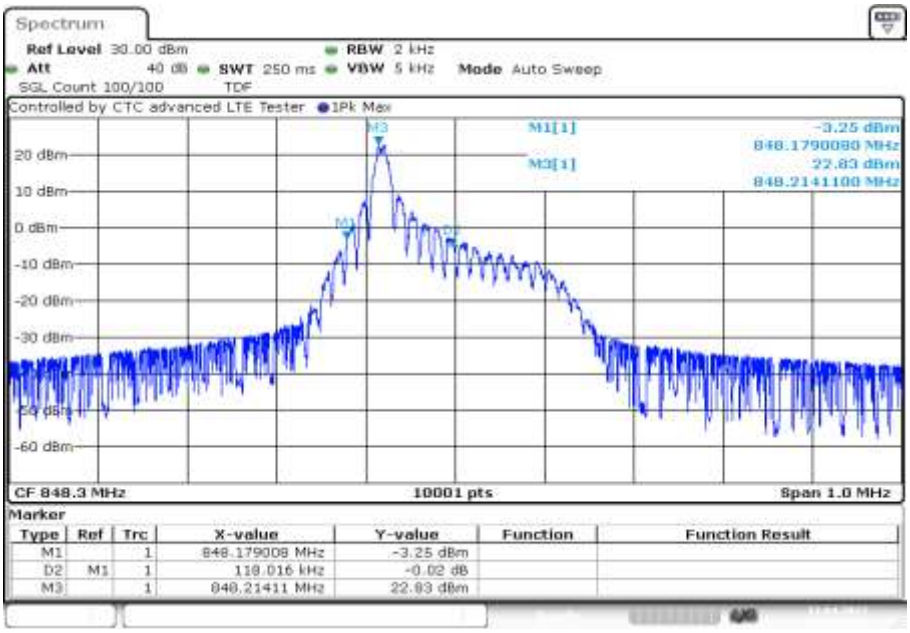

Date: 13.APR.2022 09:05:15

**Plot 17:** high channel (99% - OBW), spacing 15 kHz, 1@0 tones



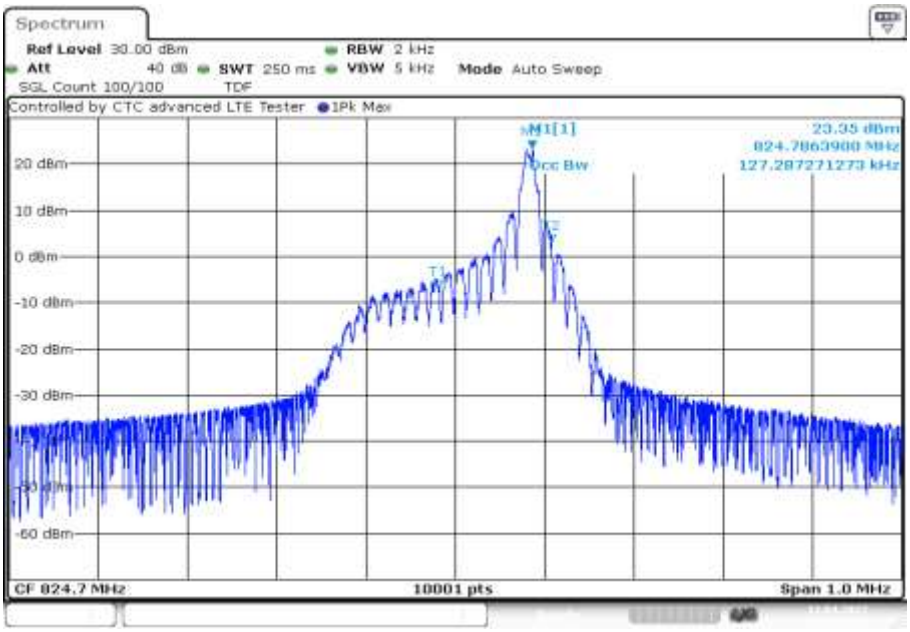

Date: 13.APR.2022 09:15:13

**Plot 18:** high channel (-26 dBc BW), spacing 15 kHz, 1@0 tones



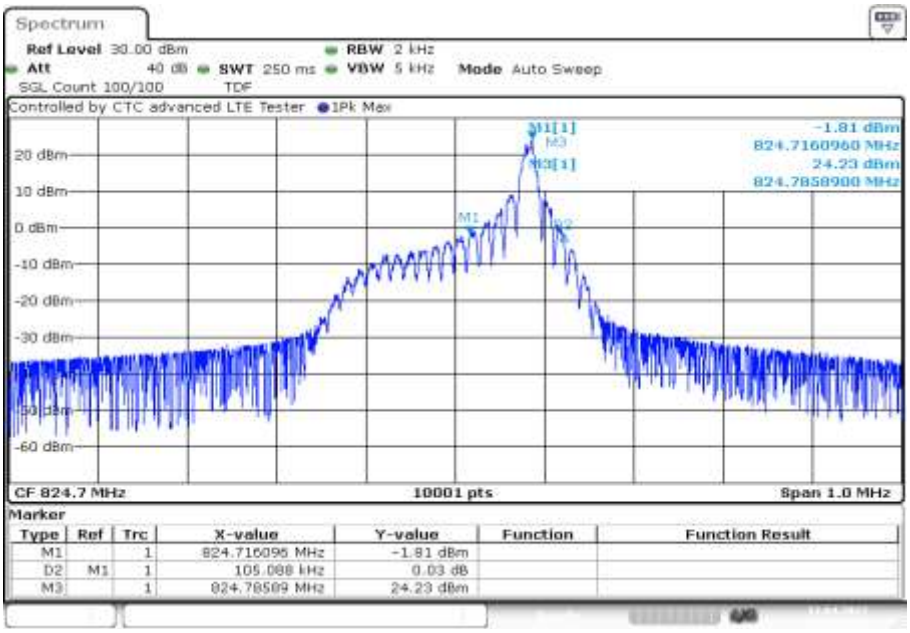

Date: 13.APR.2022 09:15:41

**Plot 19:** low channel (99% - OBW), spacing 15 kHz, 1@11 tones



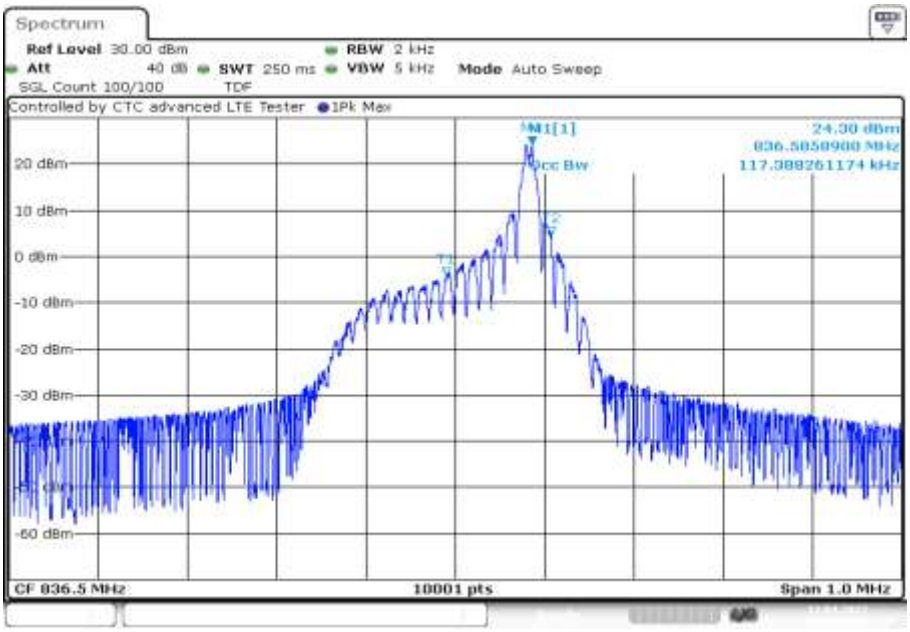

Date: 13.APR.2022 08:55:35

**Plot 20:** low channel (-26 dBc BW), spacing 15 kHz, 1@11 tones



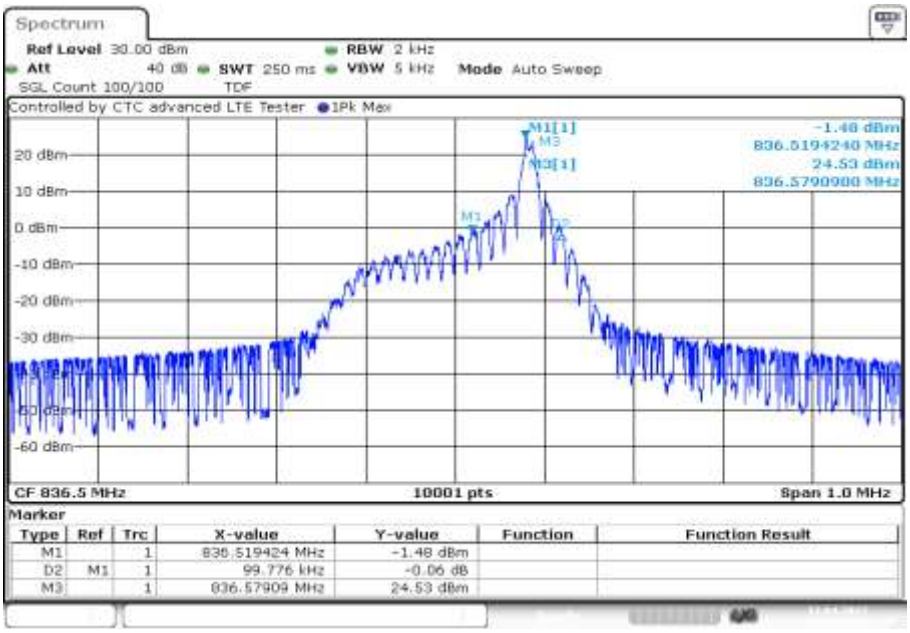

Date: 13.APR.2022 08:56:04

**Plot 21:** mid channel (99% - OBW), spacing 15 kHz, 1@11 tones



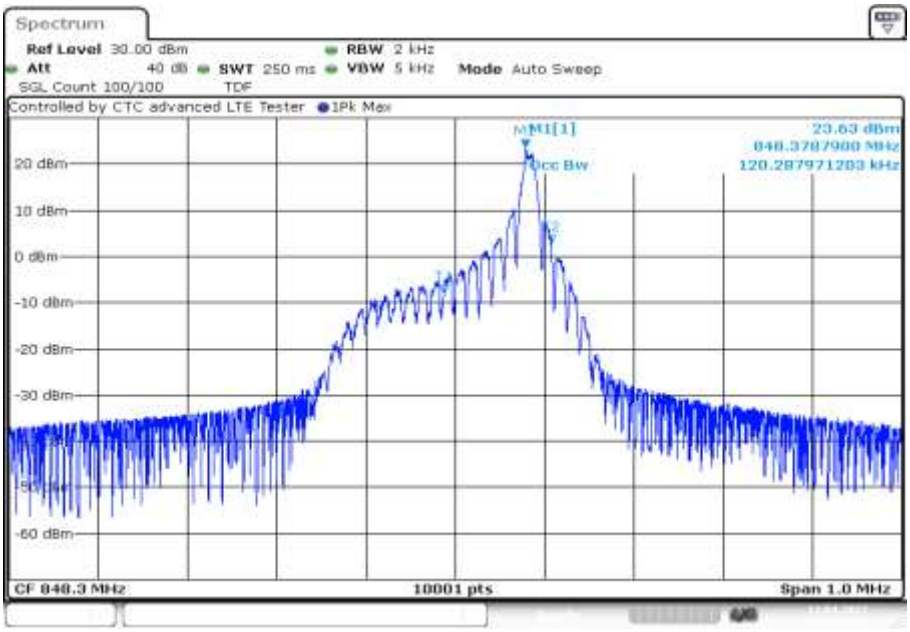

Date: 13.APR.2022 09:05:53

**Plot 22:** mid channel (-26 dBc BW), spacing 15 kHz, 1@11 tones



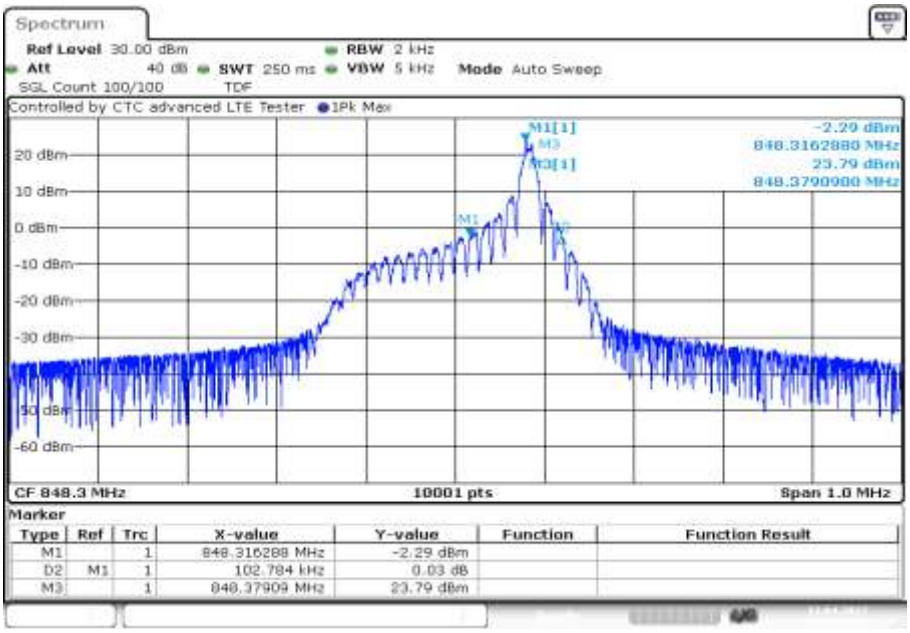

Date: 13.APR.2022 09:06:22

**Plot 23:** high channel (99% - OBW), spacing 15 kHz, 1@11 tones




Date: 13.APR.2022 09:16:19

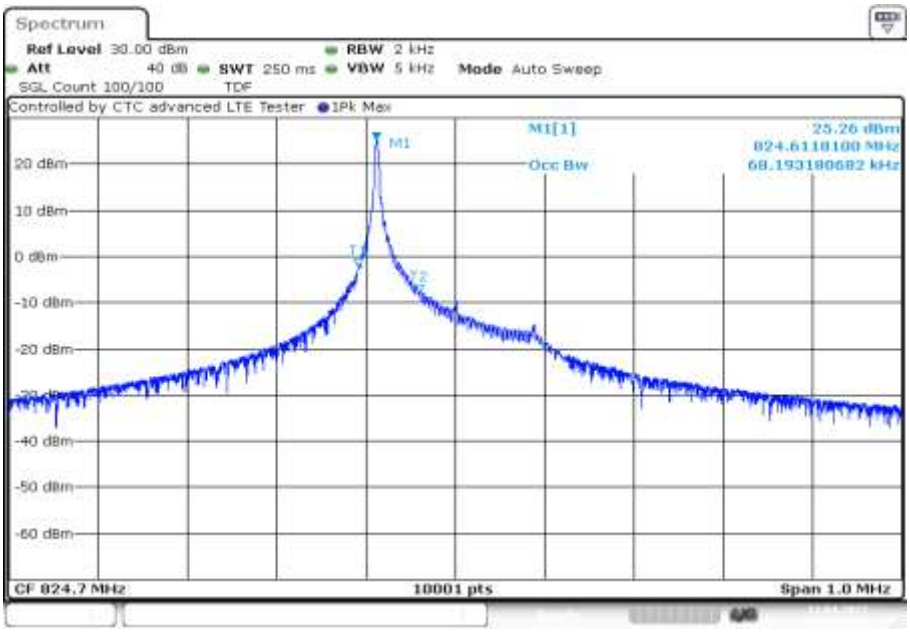
**Plot 24:** high channel (-26 dBc BW), spacing 15 kHz, 1@11 tones




Date: 13.APR.2022 09:16:47

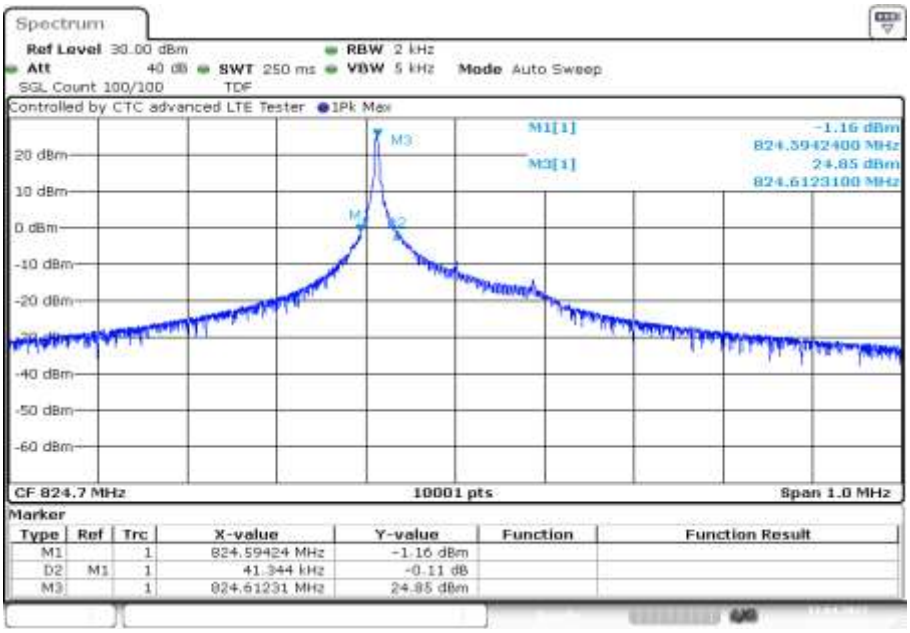
**Plots: QPSK**

**Plot 1:** low channel (99% - OBW), spacing 3.75 kHz, 1@0 tones



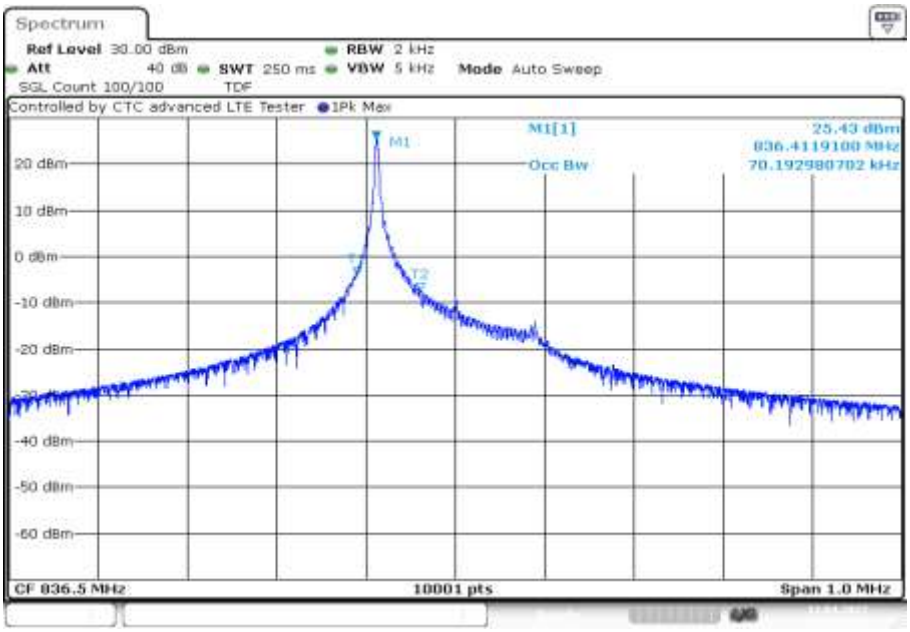

Date: 13.APR.2022 08:52:07

**Plot 2:** low channel (-26 dBc BW), spacing 3.75 kHz, 1@0 tones



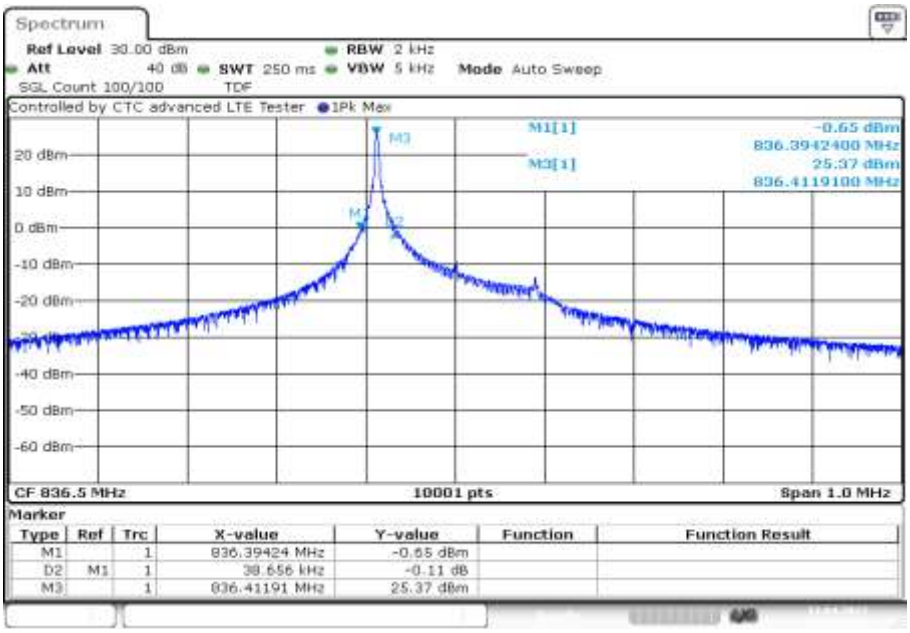

Date: 13.APR.2022 08:52:35

**Plot 3:** mid channel (99% - OBW), spacing 3.75 kHz, 1@0 tones



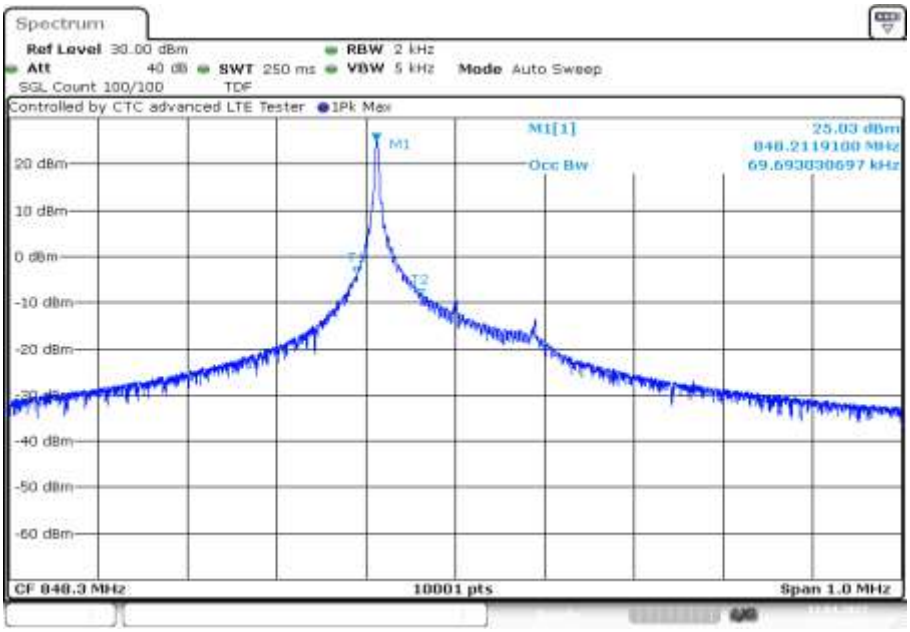

Date: 13.APR.2022 09:02:29

**Plot 4:** mid channel (-26 dBc BW), spacing 3.75 kHz, 1@0 tones



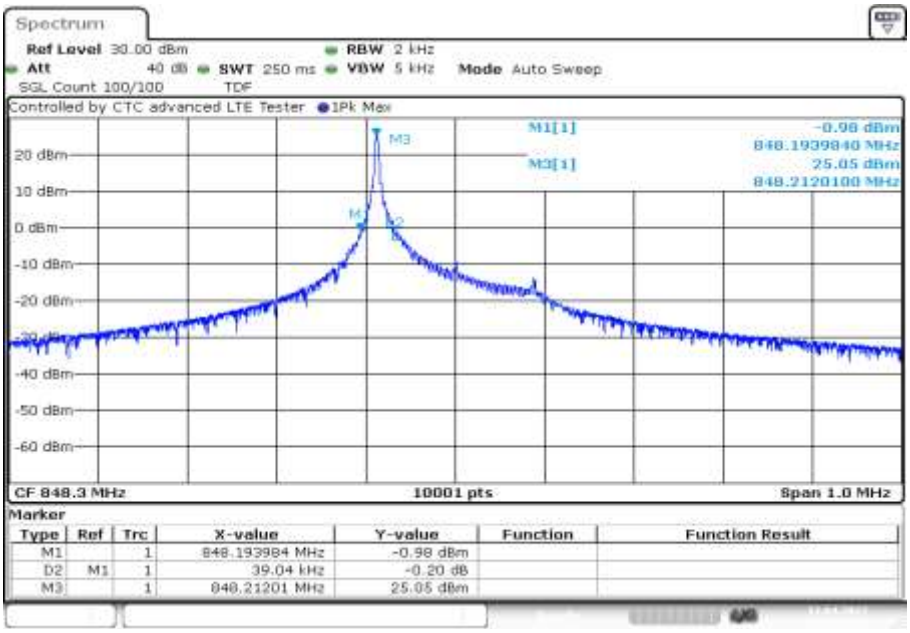

Date: 13.APR.2022 09:02:57

**Plot 5:** high channel (99% - OBW), spacing 3.75 kHz, 1@0 tones



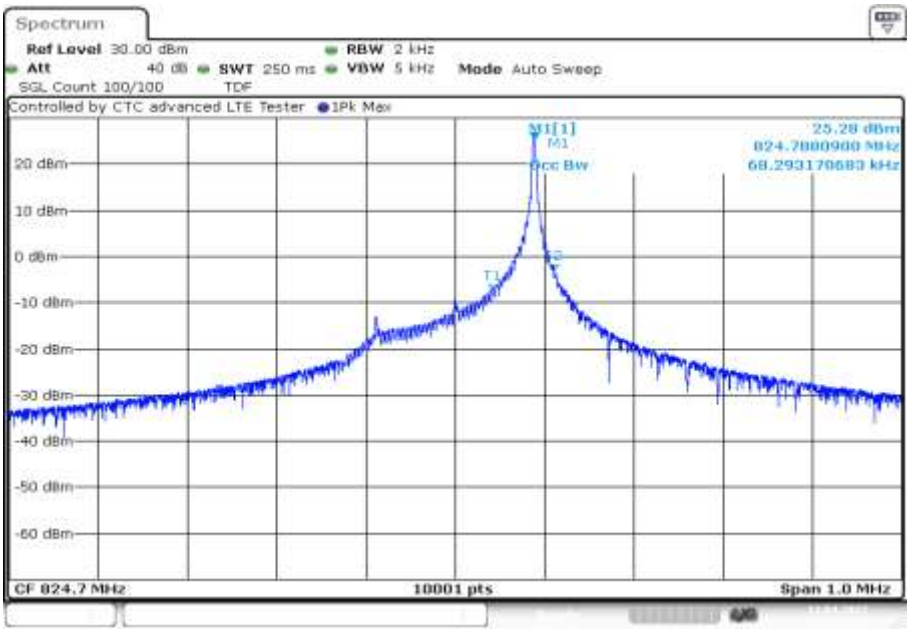

Date: 13.APR.2022 09:12:54

**Plot 6:** high channel (-26 dBc BW), spacing 3.75 kHz, 1@0 tones



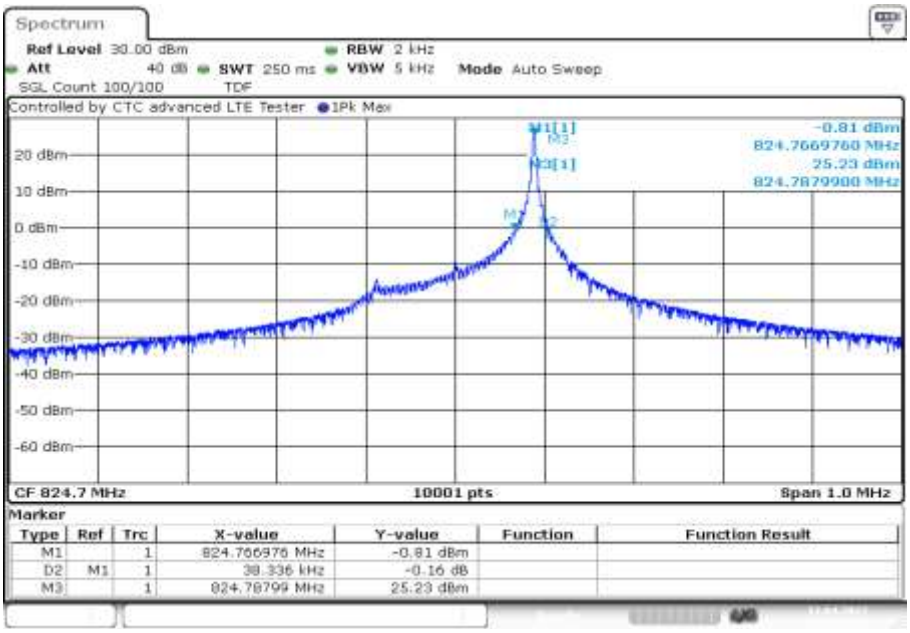

Date: 13.APR.2022 09:13:22

**Plot 7:** low channel (99% - OBW), spacing 3.75 kHz, 1@47 tones



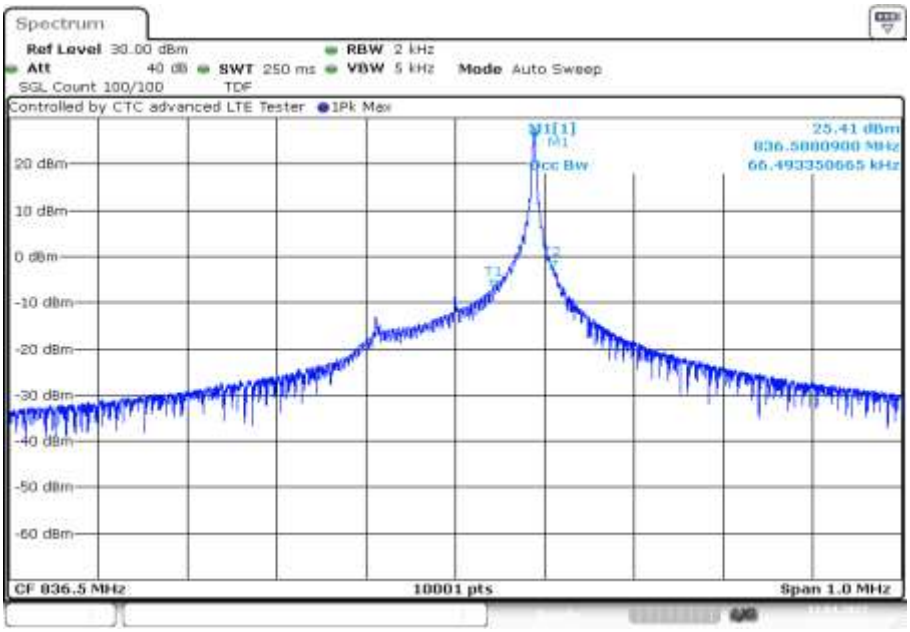

Date: 13.APR.2022 08:53:14

**Plot 8:** low channel (-26 dBc BW), spacing 3.75 kHz, 1@47 tones



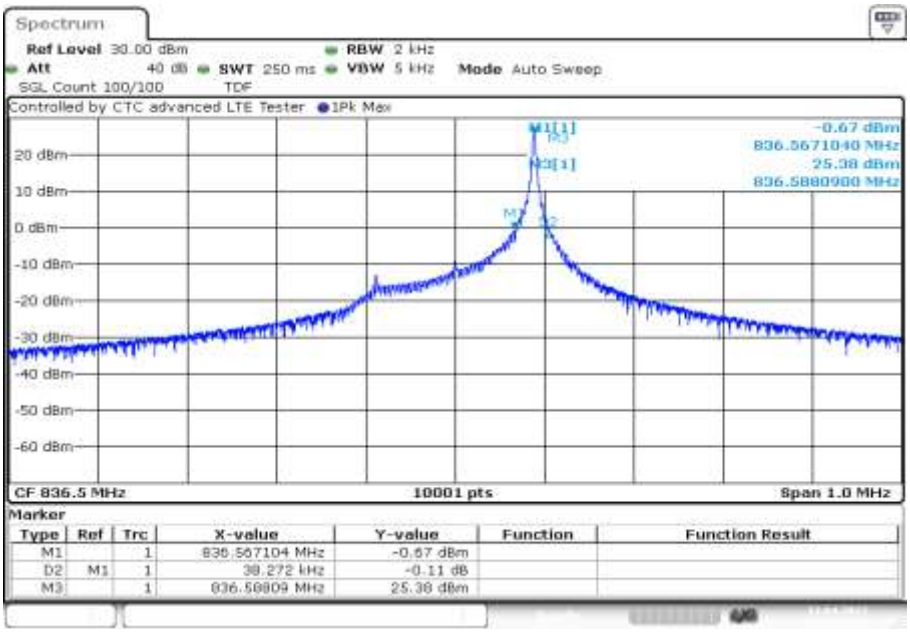

Date: 13.APR.2022 08:53:42

**Plot 9:** mid channel (99% - OBW), spacing 3.75 kHz, 1@47 tones



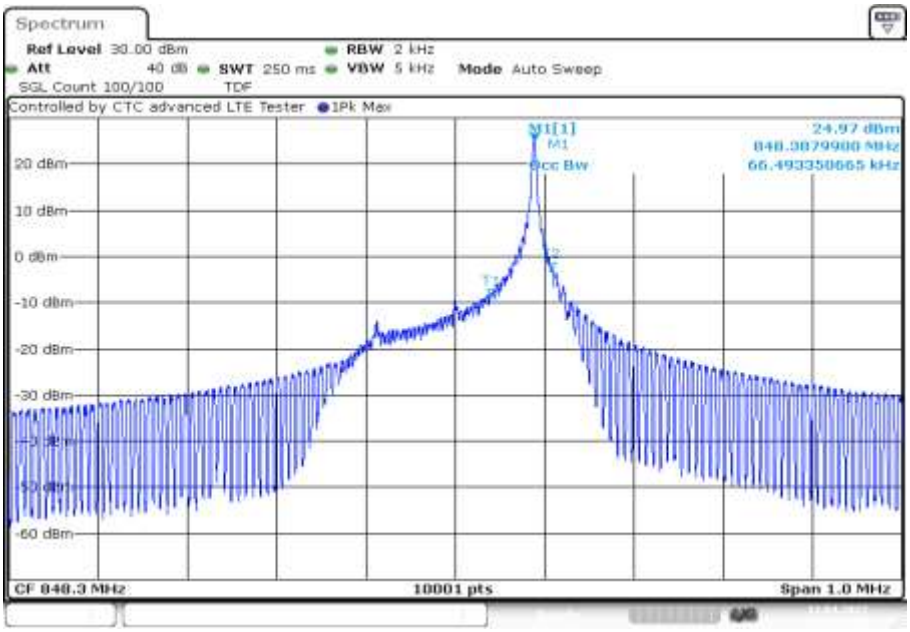

Date: 13.APR.2022 09:03:35

**Plot 10:** mid channel (-26 dBc BW), spacing 3.75 kHz, 1@47 tones



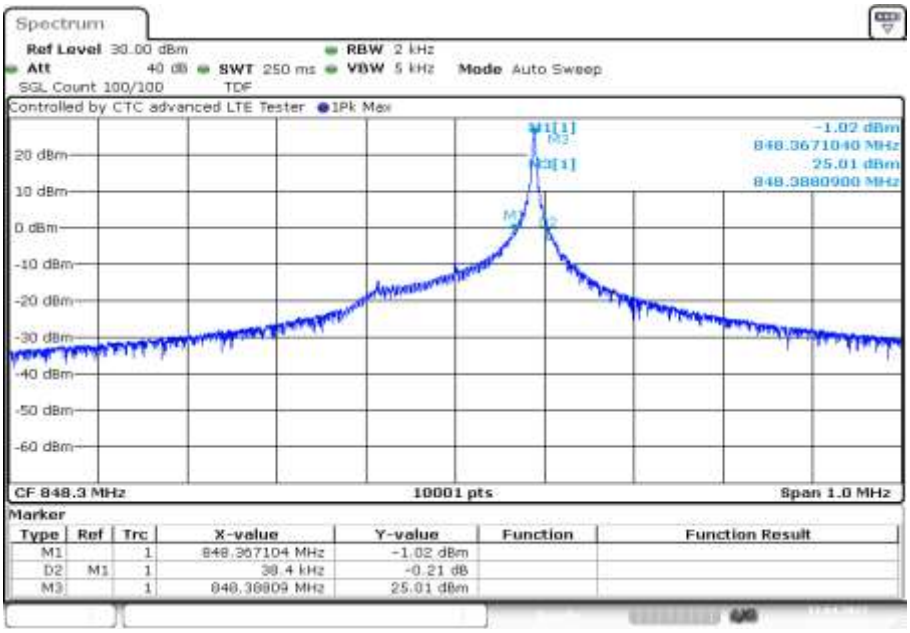

Date: 13.APR.2022 09:04:03

**Plot 11:** high channel (99% - OBW), spacing 3.75 kHz, 1@47 tones



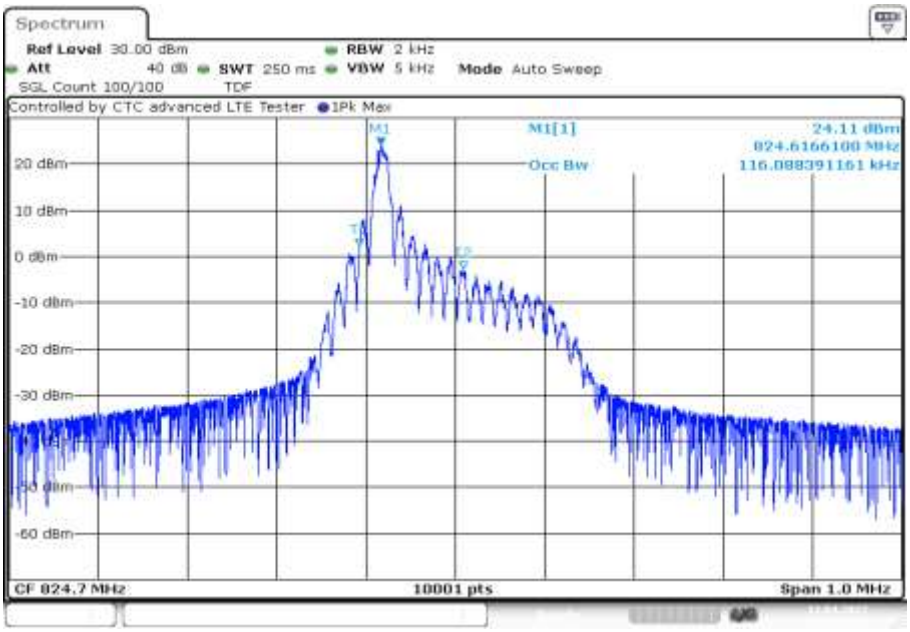

Date: 13.APR.2022 09:14:00

**Plot 12:** high channel (-26 dBc BW), spacing 3.75 kHz, 1@47 tones



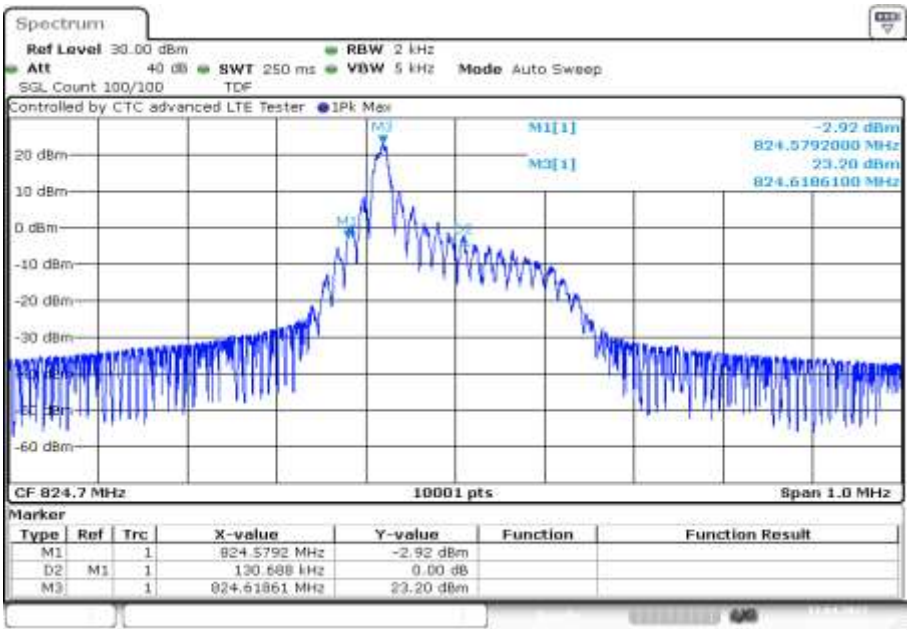

Date: 13.APR.2022 09:14:29

**Plot 13:** low channel (99% - OBW), spacing 15 kHz, 1@0 tones



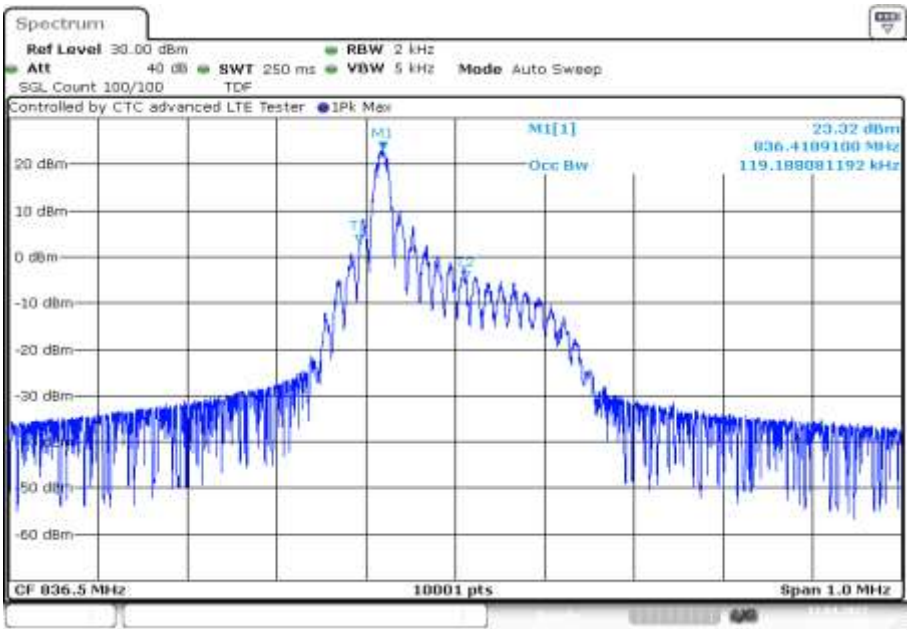

Date: 13.APR.2022 08:56:42

**Plot 14:** low channel (-26 dBc BW), spacing 15 kHz, 1@0 tones



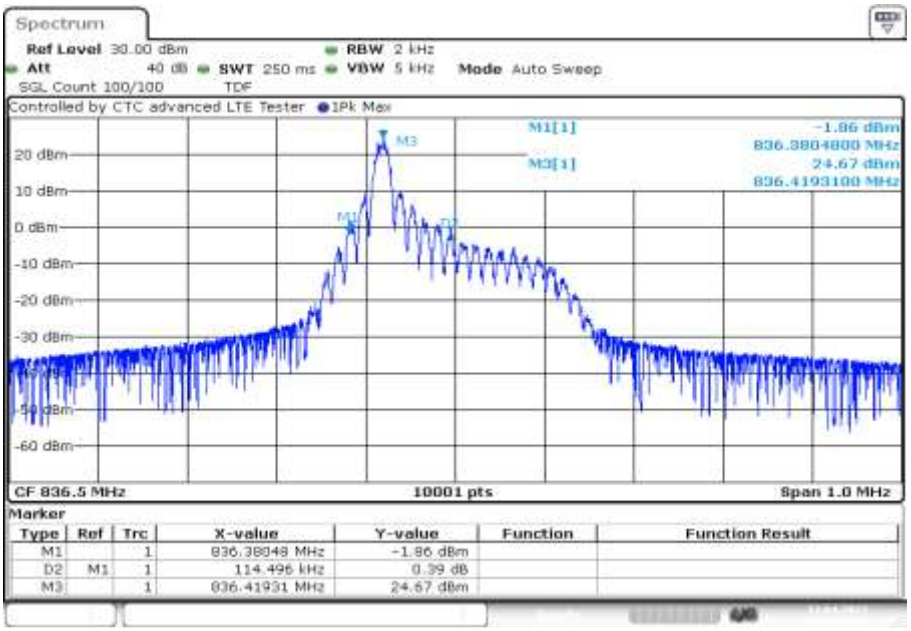

Date: 13.APR.2022 08:57:11

**Plot 15:** mid channel (99% - OBW), spacing 15 kHz, 1@0 tones



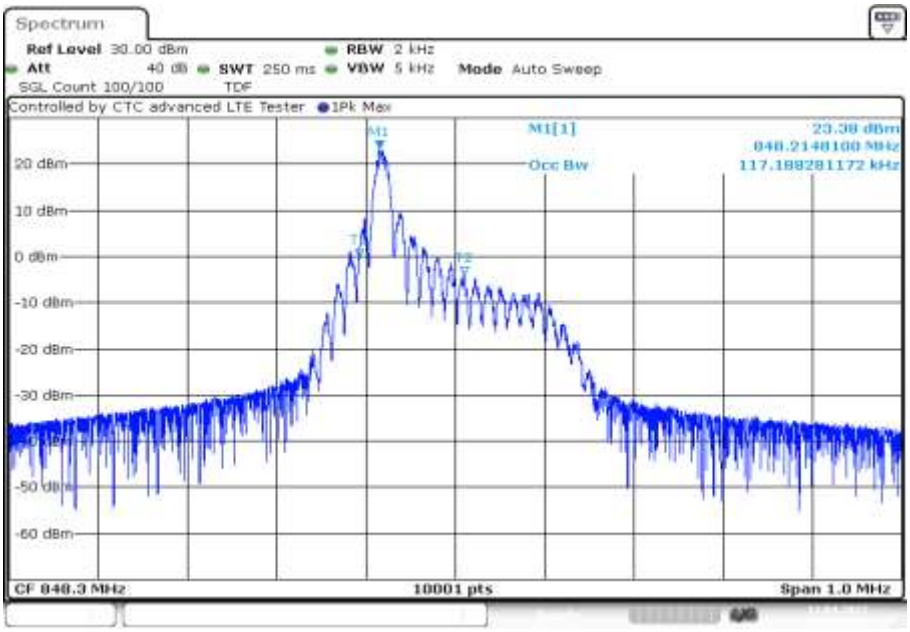

Date: 13.APR.2022 09:07:00

**Plot 16:** mid channel (-26 dBc BW), spacing 15 kHz, 1@0 tones



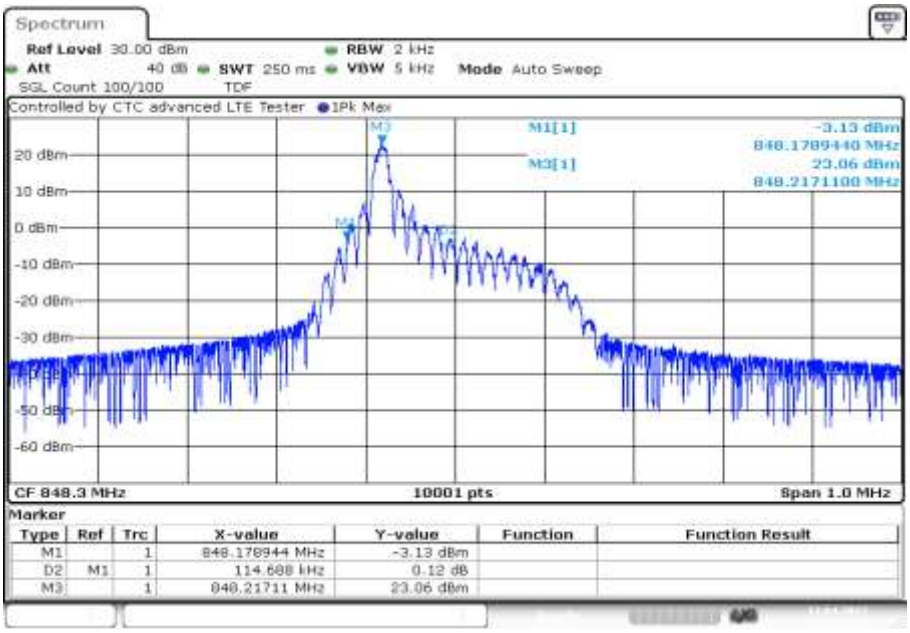

Date: 13.APR.2022 09:07:28

**Plot 17:** high channel (99% - OBW), spacing 15 kHz, 1@0 tones



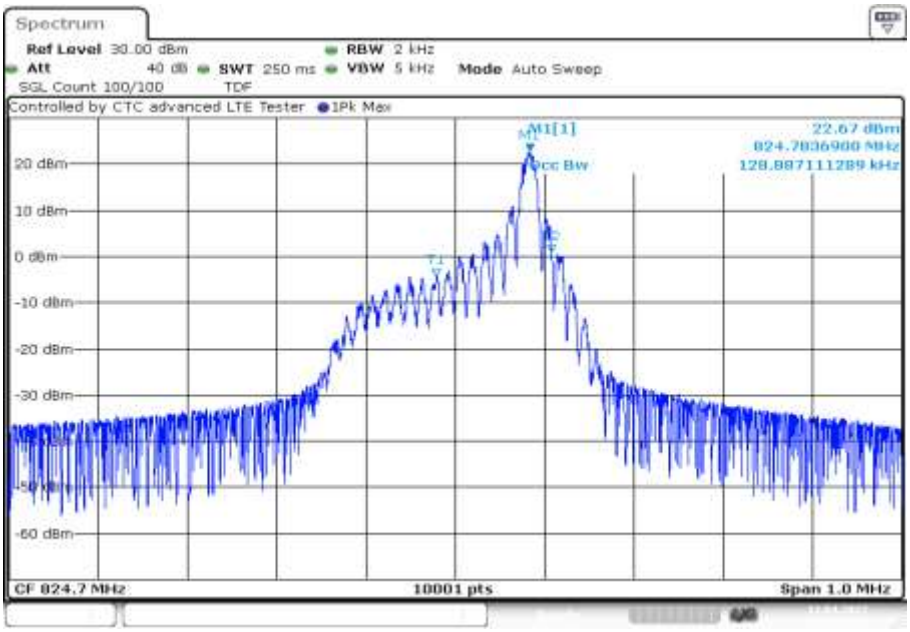

Date: 13.APR.2022 09:17:25

**Plot 18:** high channel (-26 dBc BW), spacing 15 kHz, 1@0 tones



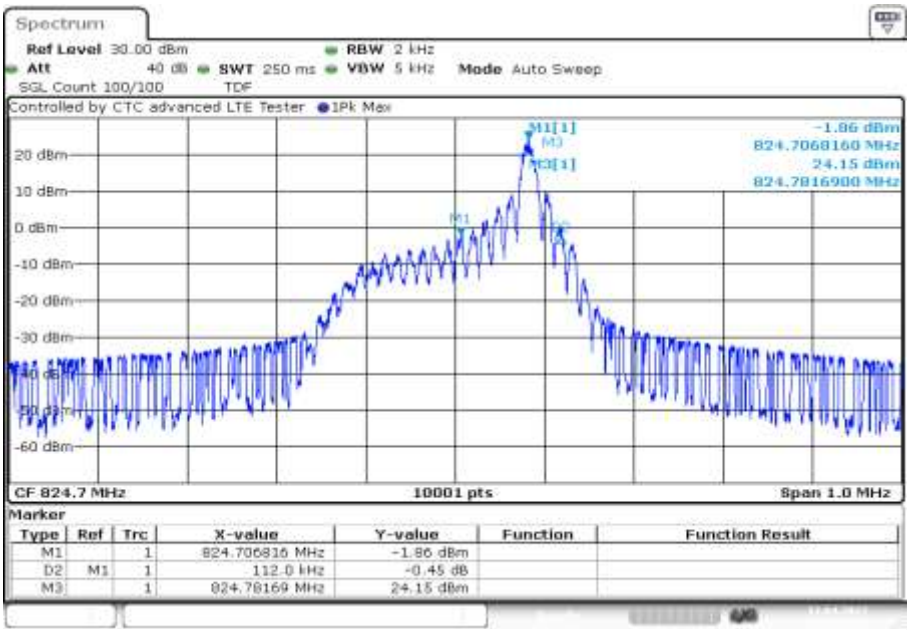

Date: 13.APR.2022 09:17:54

**Plot 19:** low channel (99% - OBW), spacing 15 kHz, 1@11 tones



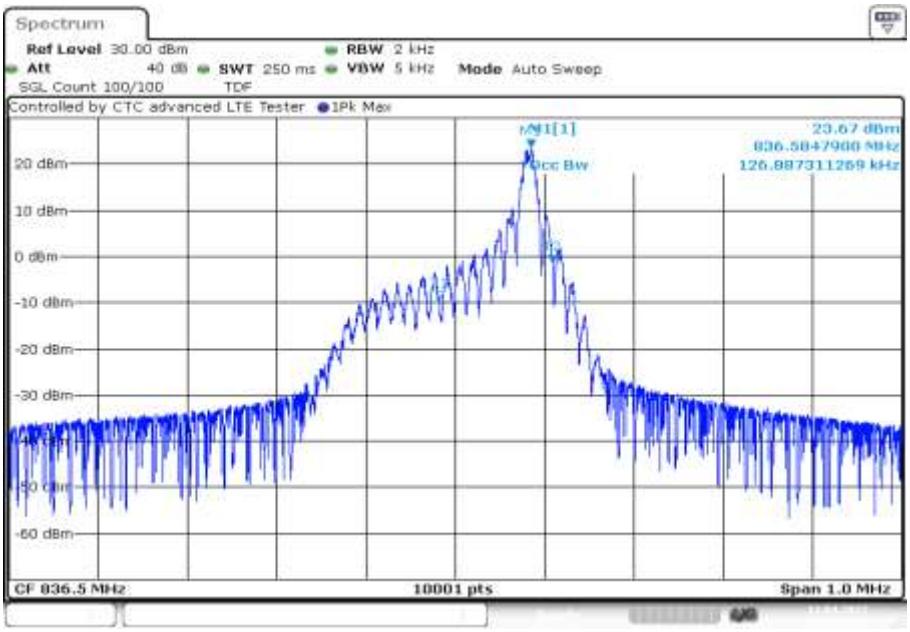

Date: 13.APR.2022 08:57:49

**Plot 20:** low channel (-26 dBc BW), spacing 15 kHz, 1@11 tones



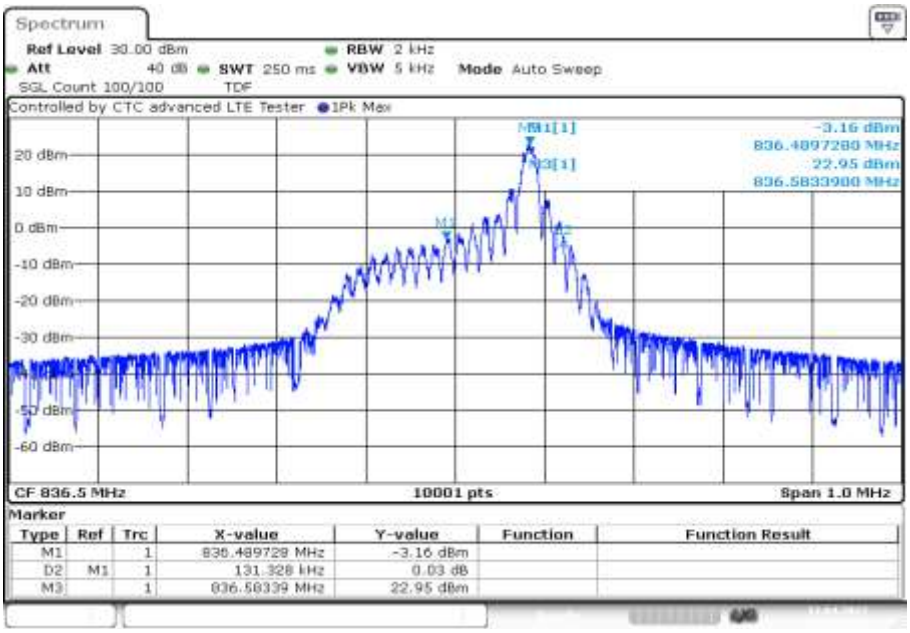

Date: 13.APR.2022 08:58:17

**Plot 21:** mid channel (99% - OBW), spacing 15 kHz, 1@11 tones



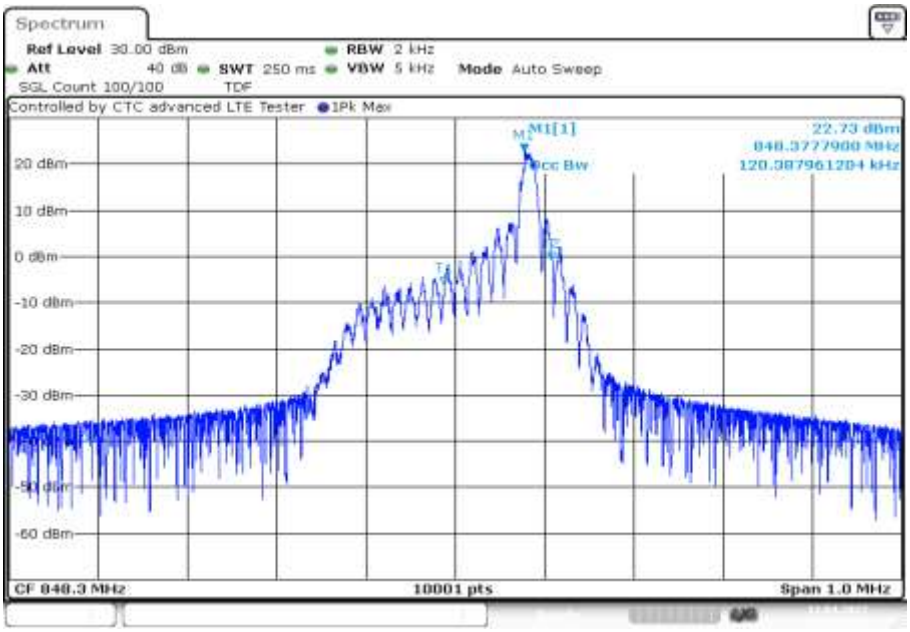

Date: 13.APR.2022 09:08:07

**Plot 22:** mid channel (-26 dBc BW), spacing 15 kHz, 1@11 tones



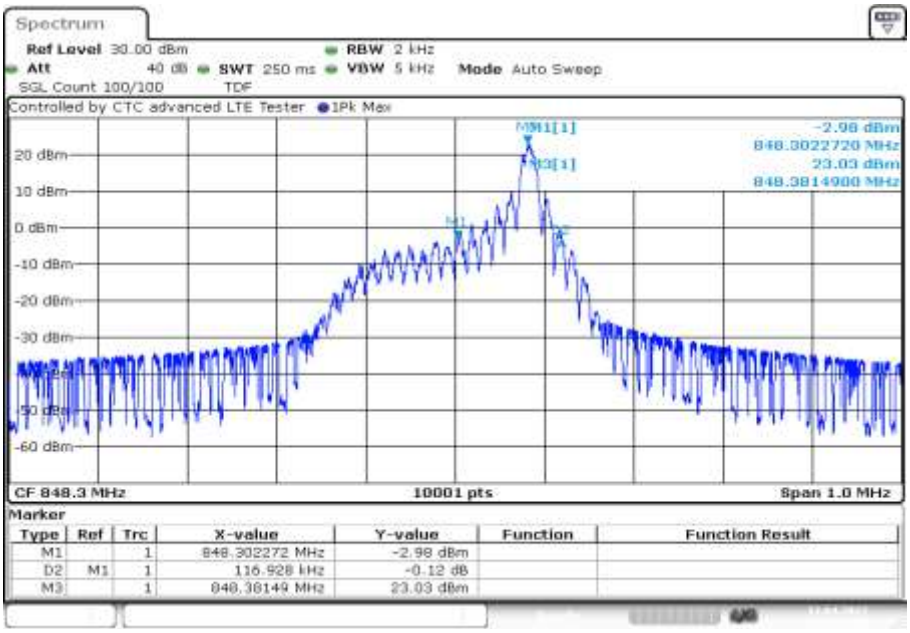

Date: 13.APR.2022 09:08:35

**Plot 23:** high channel (99% - OBW), spacing 15 kHz, 1@11 tones



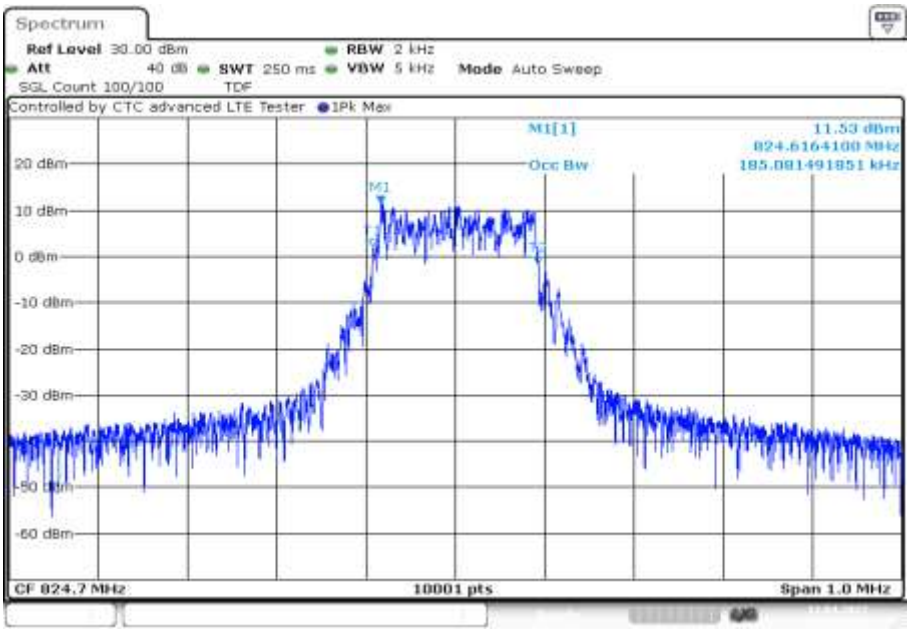

Date: 13.APR.2022 09:18:32

**Plot 24:** high channel (-26 dBc BW), spacing 15 kHz, 1@11 tones



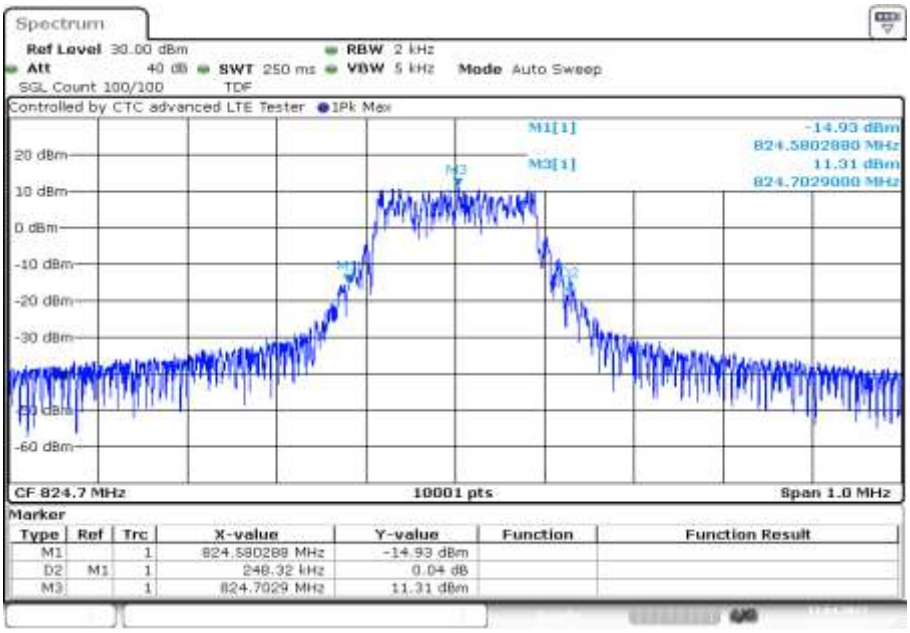

Date: 13.APR.2022 09:19:00

**Plot 25:** low channel (99% - OBW), spacing 15 kHz, 12@0 tones



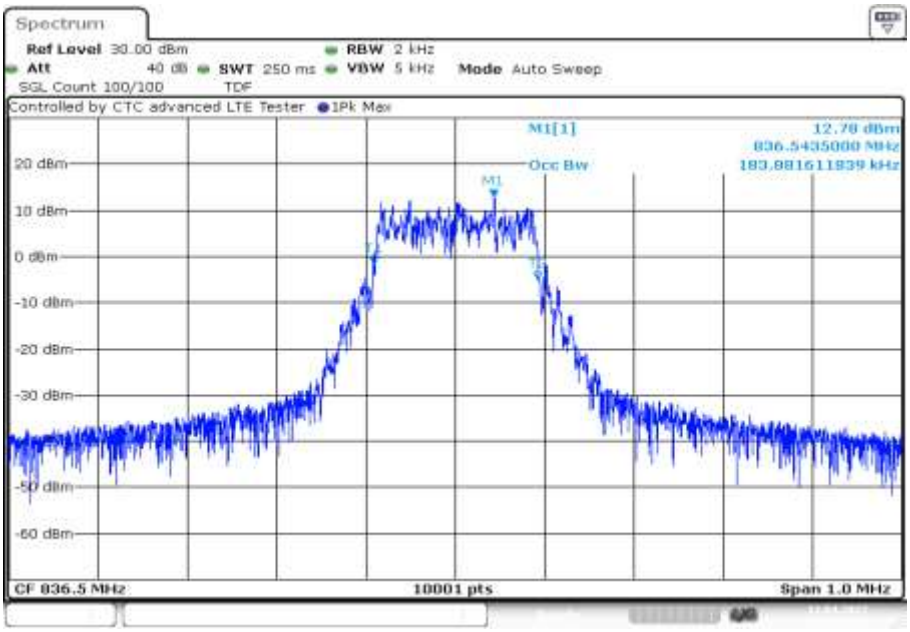

Date: 13.APR.2022 08:58:55

**Plot 26:** low channel (-26 dBc BW), spacing 15 kHz, 12@0 tones



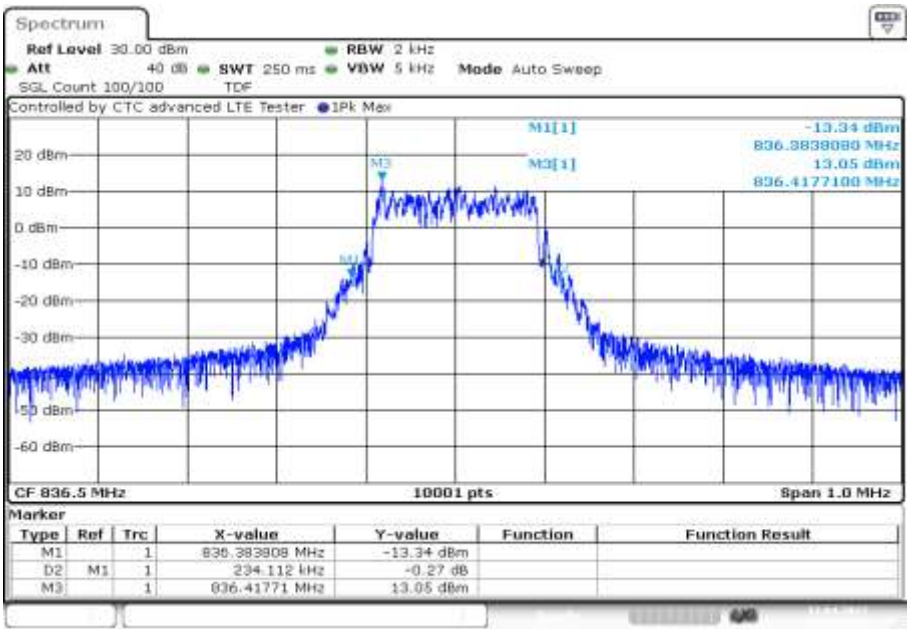

Date: 13.APR.2022 08:59:24

**Plot 27:** mid channel (99% - OBW), spacing 15 kHz, 12@0 tones



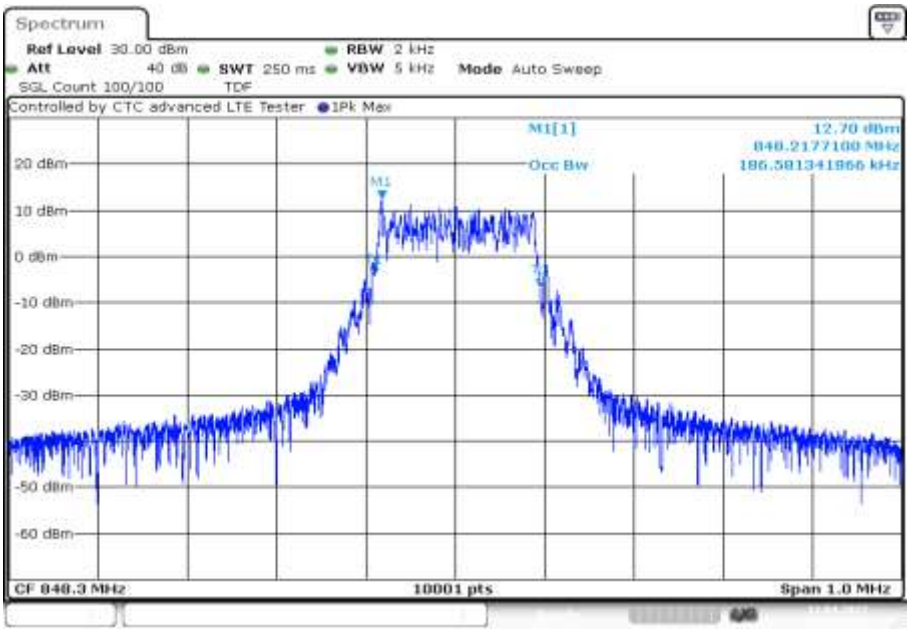

Date: 13.APR.2022 09:09:14

**Plot 28:** mid channel (-26 dBc BW), spacing 15 kHz, 12@0 tones



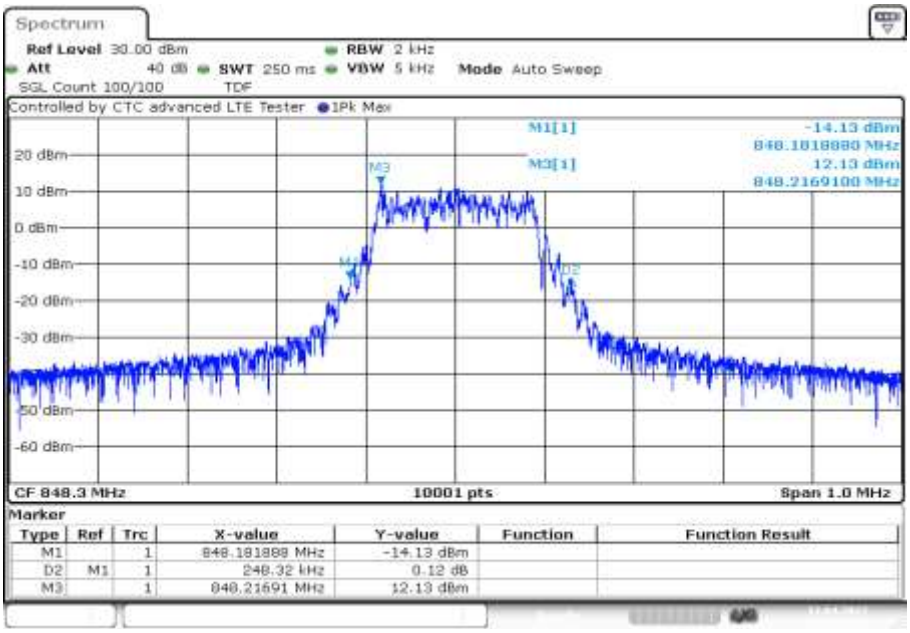

Date: 13.APR.2022 09:09:42

**Plot 29:** high channel (99% - OBW), spacing 15 kHz, 12@0 tones




Date: 13.APR.2022 09:19:38

**Plot 30:** high channel (-26 dBc BW), spacing 15 kHz, 12@0 tones




Date: 13.APR.2022 09:20:07