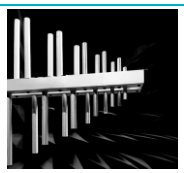
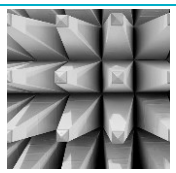



cetecom advanced

TEST REPORT

Test report no.: 1-6907-23-01-09_TR1-R01

DAkkS Deutsche Akkreditierungsstelle D-PL-12047-01-00

Testing laboratory

cetecom advanced GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
Internet: https://cetecomadvanced.com
e-mail: mail@cetecomadvanced.com

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 with the registration number: D-PL-12047-01-00.
ISED Testing Laboratory Recognized Listing Number: DE0001
FCC designation number: DE0002

Applicant

Swissphone Wireless AG
Fälmisstrasse 21
8833 Samstagern / SWITZERLAND
Phone: +41 4 47 86 77 70
Contact: Harald Pfurtscheller
e-mail: harald.pfurtscheller@swissphone.com

Manufacturer

Swissphone Wireless AG
Fälmisstrasse 21
8833 Samstagern / SWITZERLAND

Test standard/s

FCC - Title 47 CFR Part 90	FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 90 - Private Land Mobile Radio Services
RSS - 119 Issue 12	Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41-960 MHz
RSS - Gen Issue 5 incl. Amendment 1 & 2	Spectrum Management and Telecommunications Radio Standards Specification - General Requirements for Compliance of Radio Apparatus

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

Test Item

Kind of test item:	**Paging-Base Station**
Model name:	**ITC2800 UHF**
FCC ID:	**L3M-ITC2800UHF**
ISED certification number:	**4404A-ITC2800UHF**
Frequency:	421MHz – 430MHz | 450MHz – 470MHz
Technology tested:	POCSAG
Antenna:	external antenna
Power supply:	42.9 V to 58.1 V DC by external power supply
Temperature range:	-20°C to +55°C

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test report authorized:

Christoph Schneider
Lab Manager
Radio Labs

Test performed:

Hans-Joachim Wolsdorfer
Lab Manager
Radio Labs

1 Table of contents

1 Table of contents 2

2 General information 4

2.1 Notes and disclaimer 4
2.2 Application details 4
2.3 Test laboratories sub-contracted 4

3 Test standard/s, references and accreditations 5

4 Reporting statements of conformity – decision rule 6

5 Test environment 7

6 Test item 7

6.1 General description 7
6.2 Additional information 7
6.3 Modulation types and Emission designators 8

7 Description of the test setup 8

7.1 Shielded semi anechoic chamber 9
7.2 Shielded fully anechoic chamber 11
7.3 AC conducted 12
7.4 Conducted measurements normal and extreme conditions 13

8 Sequence of testing 14

8.1 Sequence of testing radiated spurious 9 kHz to 30 MHz 14
8.2 Sequence of testing radiated spurious 30 MHz to 1 GHz 15
8.3 Sequence of testing radiated spurious 1 GHz to 12 GHz 16

9 Measurement uncertainty 17

10 Additional comments 17

11 Summary of measurement results 18

12 RF measurements 20

13 Measurement results 20

13.1 Transmitter output power 20
13.2 Spectrum efficiency 23
13.3 Occupied bandwidth 24
13.3.1 Plots 6.25 kHz bandwidth 26
13.3.2 Plots 12.5 kHz bandwidth 40
13.3.3 Plots 20 kHz bandwidth 52
13.3.4 Plots 25 kHz bandwidth 64
13.4 Spectrum masks 76
13.4.1 Spectrum masks 6.25 kHz bandwidth (Emission mask E) 78
13.4.2 Spectrum masks 12.5 kHz bandwidth (Emission mask D) 102
13.4.3 Spectrum masks 20 kHz bandwidth (Emission mask G) 126
13.4.4 Spectrum masks 25 kHz bandwidth (Emission mask G) 150
13.5 Adjacent channel power 174
13.5.1 Plots 20 kHz bandwidth 175
13.5.2 Plots 25 kHz bandwidth 181
13.6 Transient frequency behavior 187
13.6.1 Transient frequency behavior 6.25 kHz bandwidth channels 187
13.6.2 Transient frequency behavior 25 kHz bandwidth channels 200
13.7 Frequency stability 213

13.8 Transmitter spurious emissions conducted 215
13.8.1 Plots 6.25 kHz bandwidth 217
13.8.2 Plots 12.5 kHz bandwidth 223
13.8.3 Plots 20 kHz bandwidth 229
13.8.4 Plots 25 kHz bandwidth 235
13.9 Transmitter spurious emissions (radiated) 241
13.10 Spurious emissions radiated < 30 MHz 254
13.11 Receiver spurious emissions (radiated) 279
13.12 Spurious emissions AC conducted < 30 MHz 282

14 Glossary 285

15 Document history 286

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. cetecom 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.
The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of cetecom advanced GmbH.
The testing service provided by cetecom advanced GmbH has been rendered under the current "General Terms and Conditions for cetecom advanced GmbH".
cetecom advanced GmbH will not be liable for any loss or damage resulting from false, inaccurate, inappropriate or incomplete product information provided by the customer.
Under no circumstances does the cetecom advanced GmbH test report include any endorsement or warranty regarding the functionality, quality or performance of any other product or service provided.
Under no circumstances does the cetecom advanced GmbH test report include or imply any product or service warranties from cetecom advanced GmbH, including, without limitation, any implied warranties of merchantability, fitness for purpose, or non-infringement, all of which are expressly disclaimed by cetecom advanced GmbH.
All rights and remedies regarding vendor's products and services for which cetecom advanced GmbH has prepared this test report shall be provided by the party offering such products or services and not by cetecom advanced GmbH.
In no case this test report can be considered as a Letter of Approval.

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

2.2 Application details

Date of receipt of order:	2023-11-29
Date of receipt of test item:	2024-02-06
Start of test:*	2024-07-25
End of test:*	2024-10-30
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

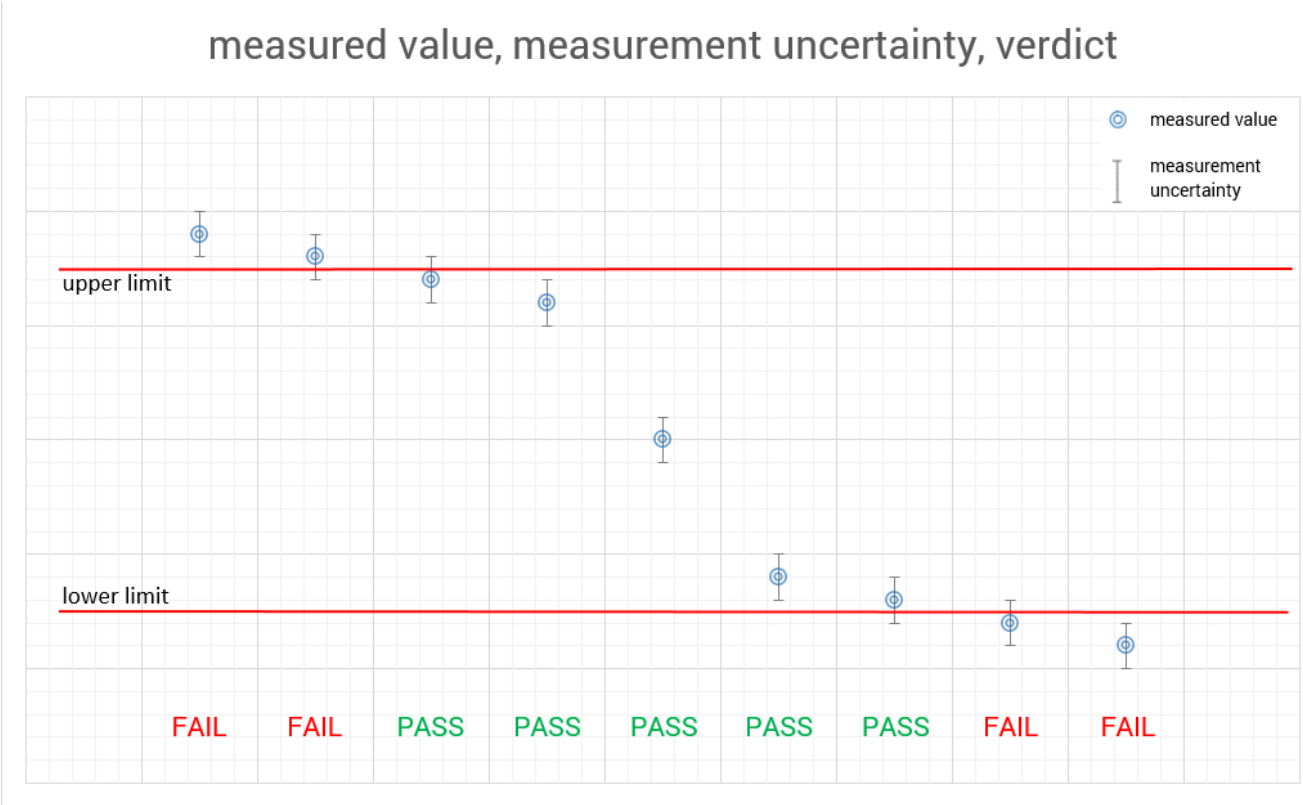
None

3 Test standard/s, references and accreditations

Test standard	Date	Description
FCC - Title 47 CFR Part 90		FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 90 - Private Land Mobile Radio Services
RSS - 119 Issue 12	01.05.2015	Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41-960 MHz
RSS - Gen Issue 5 incl. Amendment 1 & 2	February 2021	Spectrum Management and Telecommunications Radio Standards Specification - General Requirements for Compliance of Radio Apparatus
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

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} T_{max} T_{min}	+22 °C during room temperature tests +55 °C during high temperature tests -20 °C during low temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		1021 hpa
Power supply	:	V_{nom} V_{max} V_{min}	50.55 V DC by external power supply 58.1 V 42.9 V

6 Test item

6.1 General description

Kind of test item	:	Paging-Base Station
Model name	:	ITC2800 UHF
HMN	:	-/-
PMN	:	SWISSPHONE ITC2800
HVIN	:	ITC2800 40W UHF -48V
FVIN	:	-/-
S/N serial number	:	C202340.01000
Hardware status	:	-/-
Software status	:	-/-
Firmware status	:	itc-5.7.6-alpha51
Frequency band	:	421MHz – 430MHz | 450MHz – 470MHz
Type of radio transmission Use of frequency spectrum	: :	modulated carrier
Type of modulation	:	FSK
Antenna	:	external antenna
Power supply	:	42.9 V to 58.1 V DC by external power supply
Temperature range	:	-20°C to +55°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:

1-6907_23-01-09_TR1-A101-R1
1-6907_23-01-09_TR1-A102-R1
1-6907_23-01-09_TR1-A103-R1

6.3 Modulation types and Emission designators

	6.25 kHz	12.5 kHz	20 kHz	25 kHz
FSK – 512 bps	00k6F1D	05k3F1D	08k7F1D	09k5F1D
FSK – 1200 bps	01k3F1D	06k1F1D	10k8F1D	11k2F1D
FSK – 2400 bps	2k66F1D	07k4F1D	11k1F1D	12k2F1D
FSK – 4800 bps	5k06F1D	09k9F1D	14k5F1D	14k7F1D

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).

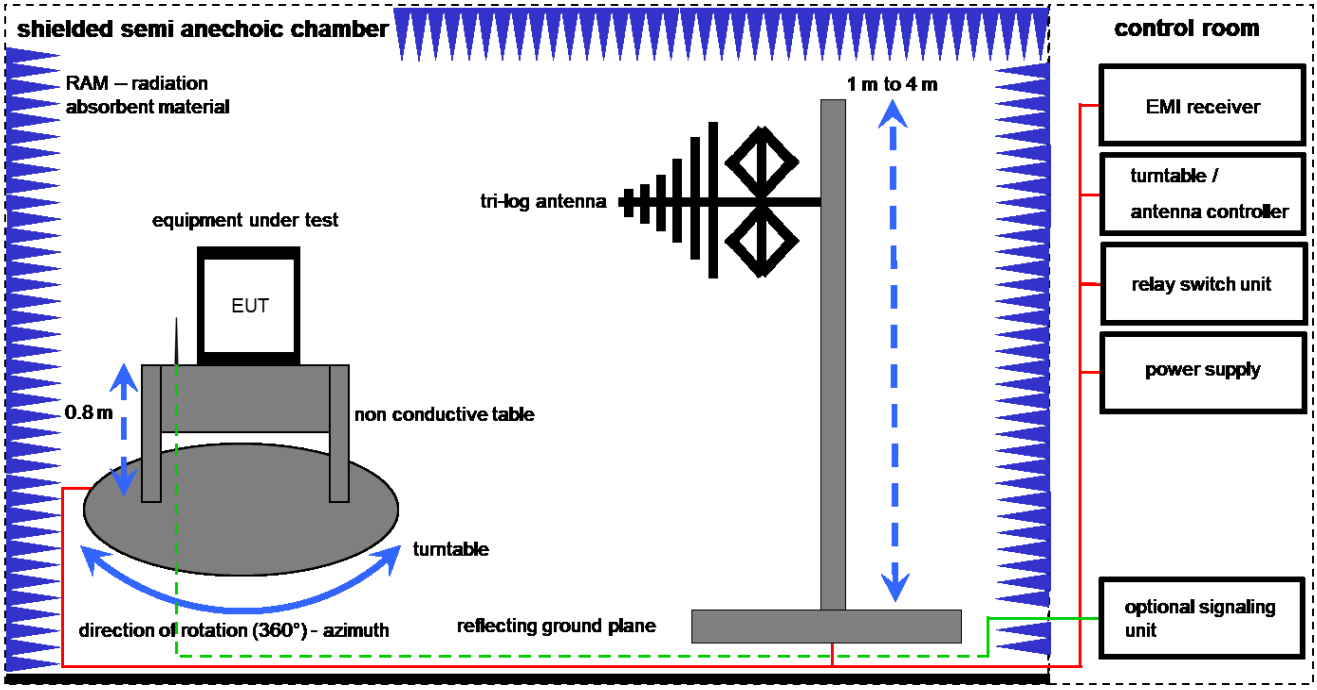
Each block diagram listed can contain several test setup configurations. All devices belonging to a test setup are identified with the same letter syntax. For example: Column Setup and all devices with an A.

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

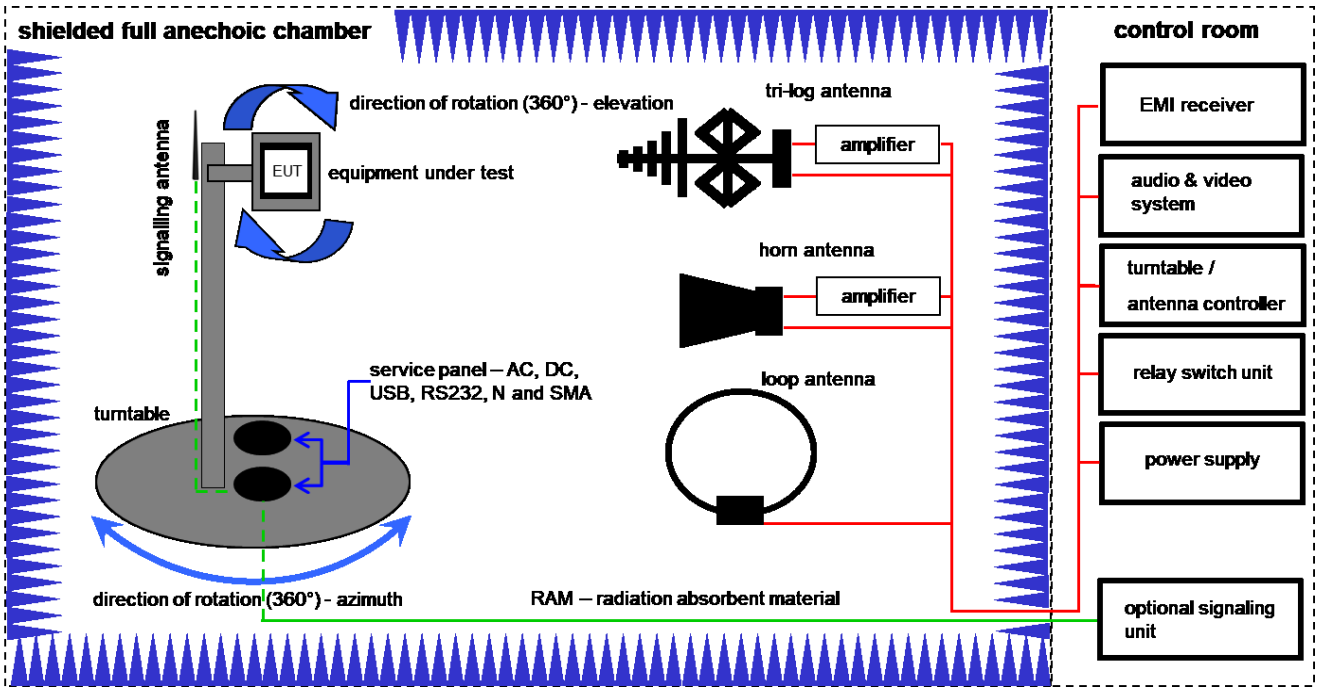
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
4	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
5	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
6	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	318	300003696	vlKl!	31.01.2024	30.01.2026
7	A	Turntable	2089-4.0	EMCO	-/-	300004394	ne	-/-	-/-
8	A	PC	TecLine	F+W	-/-	300004388	ne	-/-	-/-
9	A	EMI Test Receiver	ESR3	Rohde & Schwarz	102587	300005771	k	06.12.2023	31.12.2024
10	A	Attenuator	WA81-30-33	Weinschel Associates	A145	300005327	ev	-/-	-/-

7.2 Shielded fully anechoic chamber



Measurement distance: tri-log antenna and horn antenna 3 meter; loop antenna 3 meter

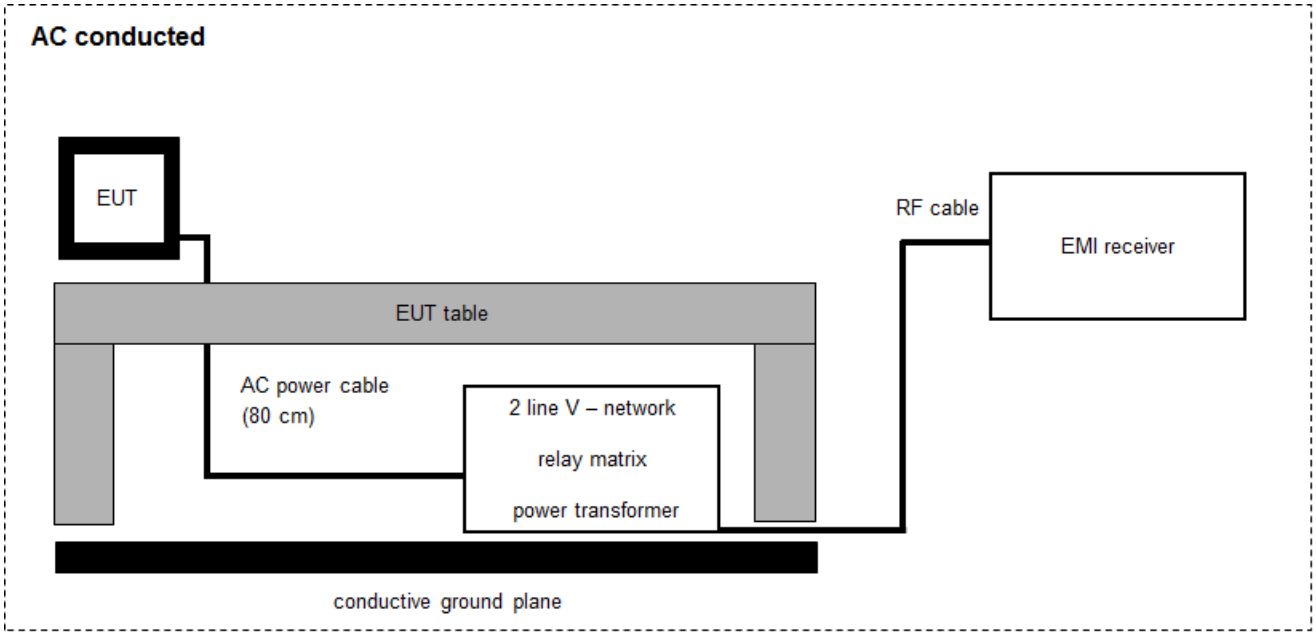
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	C	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3088	300001032	vIKI!	10.10.2023	31.10.2025
2	A,B,C	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
3	A,B,C	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	11.12.2023	31.12.2024
4	C	Highpass Filter	WHK1.1/15G-10SS	Wainwright	3	300003255	ev	-/-	-/-
5	B	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	01029	300005379	vIKI!	09.10.2023	31.10.2025
6	A	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vIKI!	02.08.2023	31.08.2025
7	C	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
8	A,B,C	NEXIO EMV-Software	BAT EMC V2022.0.22.0	Nexio	-/-	300004682	ne	-/-	-/-
9	A,B,C	Attenuator	WA81-30-33	Weinschel Associates	A145	300005327	ev	-/-	-/-

7.3 AC conducted



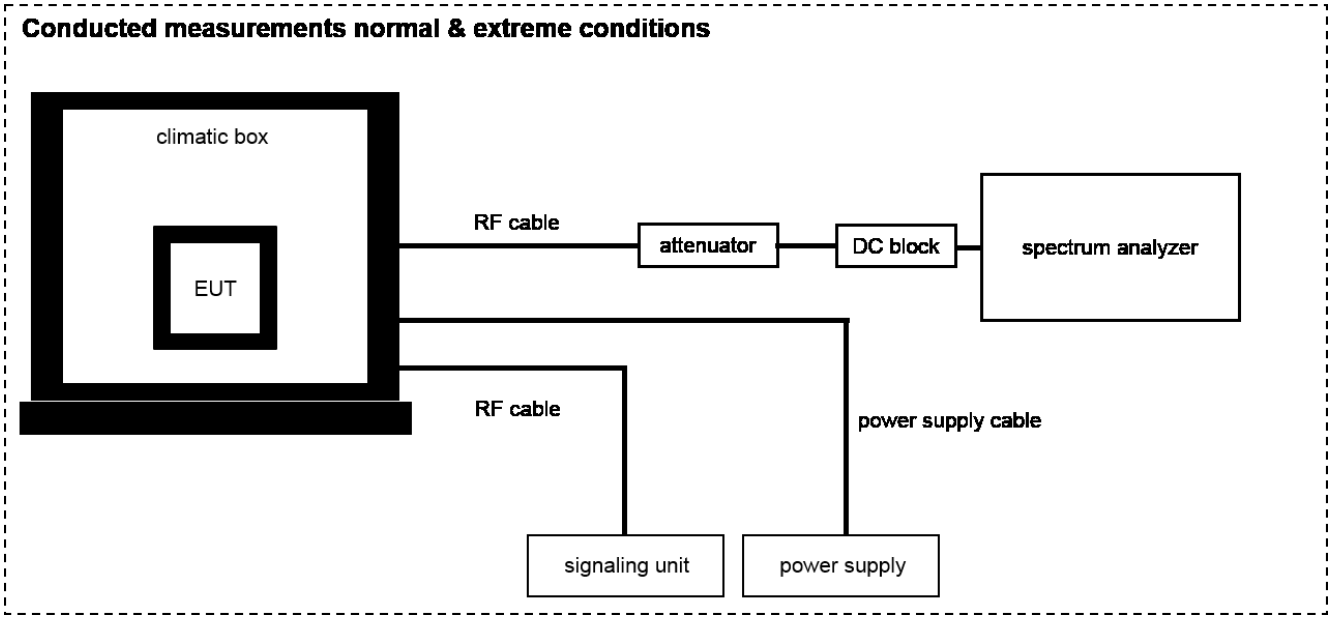
FS = UR + CF + VC
(FS-field strength; UR-voltage at the receiver; CR-loss of the cable and filter; VC-correction factor of the ISN)

Example calculation:
FS [dBµV/m] = 37.62 [dBµV/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dBµV/m] (244.06 µV/m)

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	Rohde & Schwarz	892475/017	300002209	vIKI!	12.12.2023	31.12.2025
2	A	RF-Filter-section	85420E	HP	3427A00162	300002214	NK!	-/-	-/-
3	A	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	-/-	-/-
4	A	PC	TecLine	F+W		300003532	ne	-/-	-/-
5	A	Analyzer-Impedence-System	AIS16/1	Spitzenberger + Spies GmbH & Co. KG	UO2076 07/0 1023	400001751	k	19.10.2023	31.10.2025
6	A	EMI Test Receiver 3.6 GHz	ESR3	Rohde & Schwarz	102981	300006318	k	08.12.2023	31.12.2024
7	A	Attenuator	WA81-30-33	Weinschel Associates	A145	300005327	ev	-/-	-/-

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	Signal analyzer	FSW26	Rohde&Schwarz	101455	300004528	k	14.12.2023	31.12.2024
2	A	Temperature Test Chamber	VT 4011	Voetsch Industrietechnik	585662306000 10	300005363	ev	11.07.2024	31.07.2026
3	A	Attenuator	WA81-30-33	Weinschel Associates	A145	300005327	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 12 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.

9 Measurement uncertainty

Measurement uncertainty	
Test case	**Uncertainty**
Antenna gain	± 3 dB
Carrier frequency separation	± 21.5 kHz
Number of hopping channels	-/-
Spectrum bandwidth	± 21.5 kHz absolute; ± 15.0 kHz relative
Maximum output power	± 1 dB
Detailed conducted spurious emissions @ the band edge	± 1 dB
Band edge compliance radiated	± 3 dB
Spurious emissions conducted	± 3 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

10 Additional comments

Reference documents: Customer_Questionnaire_ITC2800UHF
ITC2800_UHF_Operational Description_Rev5.pdf

Special test descriptions: Kurzanleitung_FCC_ITC2800

Configuration descriptions: All radiated measurements have been performed with a terminated antenna output.
Channel mask measurements with 12.5kHz Bandwidth have been tested with a 300 Hz frequency offset, enabled in the user GUI.

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. The content and verdict of the performed test cases are listed below.

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	47 CFR Part 2 47 CFR Part 90 C RSS Gen Issue 5 RSS 119 Issue 12	Passed	2024-11-04	-/-

Test Specification Clause	Test Case	Temperature Conditions	Power Source Voltages	Pass	Fail	NA	NP	Remark
FCC 47 CFR § 2.1046 § 90.205 RSS 119 Issue 12 5.4	Transmitter output power	Nominal	Nominal	☒	☐	☐	☐	complies
FCC 47 CFR § 2.1047 § 90.211 (a) RSS 119 Issue 12 5.8.1	Audio frequency filter response	Nominal	Nominal	☐	☐	☒	☐	Only for analog modulated systems
FCC 47 CFR § 2.1047 (b) § 90.211 (a) RSS 119 Issue 12 5.8	Transmitter modulation limiting	Nominal	Nominal	☐	☐	☒	☐	Only for analog modulated systems
FCC 47 CFR § 90.20 (j)(3)	Spectrum efficiency	Nominal	Nominal	☐	☐	☒	☐	excepted according §90.203(j)(7)
FCC 47 CFR § 2.1049 (c) § 90.210 (d) RSS 119 Issue 12 5.8	Occupied bandwidth	Nominal	Nominal	☒	☐	☐	☐	complies
FCC 47 CFR § 90.214 RSS 119 Issue 11 5.9	Transient frequency behaviour	Nominal	Nominal	☒	☐	☐	☐	complies
FCC 47 CFR § 2.1055 (a)(1) § 90.213 RSS 119 Issue 12 5.3	Frequency stability	Nominal	Extreme	☒	☐	☐	☐	complies
		Extreme	Nominal	☒	☐	☐	☐	
FCC 47 CFR § 90.221	Adjacent channel power limits	Nominal	Nominal	☒	☐	☐	☐	complies

FCC 47 CFR § 2.1051 § 90.210 RSS 119 Issue 12 5.8.9.2	Transmitter spurious emissions conducted	Nominal	Nominal	☒	☐	☐	☐	complies
FCC 47 CFR § 2.1051 § 90.210 RSS 119 Issue 12 5.8.9.2	Transmitter spurious emissions (radiated)	Nominal	Nominal	☒	☐	☐	☐	complies
FCC 47 CFR § 15.209 RSS Gen Issue 5 Section 7	Receiver spurious emissions (radiated)	Nominal	Nominal	☒	☐	☐	☐	complies
§15.107(a) §15.207	Conducted emissions < 30 MHz	Nominal	Nominal	☒	☐	☐	☐	complies

Note: NA = Not Applicable; NP = Not Performed

12 RF measurements

13 Measurement results

13.1 Transmitter output power

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Span:	5 MHz
Trace-Mode:	Max. hold

Limits:

FCC
CFR § 2.1046 47 CFR § 90.205 47 CFR § 90.279

§ 90.205 Power and antenna height limits.

(g) ***421-430 MHz.*** Limitations on power and antenna heights are specified in § 90.279.

(h) 450 MHz – 470 MHz

(1) The maximum allowable station effective radiated power (ERP) is dependent upon the station's antenna HAAT and required service area and will be authorized in accordance with table 2. Applicants requesting an ERP in excess of that listed in table 2 must submit an engineering analysis based upon generally accepted engineering practices and standards that includes coverage contours to demonstrate that the requested station parameters will not produce coverage in excess of that which the applicant requires.

(2) Applications for stations where special circumstances exist that make it necessary to deviate from the ERP and antenna heights in Table 2 will be submitted to the frequency coordinator accompanied by a technical analysis, based upon generally accepted engineering practices and standards, that demonstrates that the requested station parameters will not produce a signal strength in excess of 39 dBu at any point along the edge of the requested service area. The coordinator may then recommend any ERP appropriate to meet this condition.

(3) An applicant for a station with a service area radius greater than 32 km (20 mi) must justify the requested service area radius, which may be authorized only in accordance with table 2, note 4. For base stations with service areas greater than 80 km, all operations 80 km or less from the base station will be on a primary basis and all operations outside of 80 km from the base station will be on a secondary basis and will be entitled to no protection from primary operations.

	Service area radius (km)									
	3	8	13	16	24	32	40[4]	48[4]	64[4]	80[4]
max. ERP (W)[1]	2	100	[2] 500	[2] 500	[2] 500	[2] 500	[2] 500	[2] 500	[2] 500	[2] 500
up to reference HAAT (m) [3]	15	15	15	27	63	125	250	410	950	2700

[1] Maximum ERP indicated provides for a 39 dBu signal strength at the edge of the service area per FCC Report R-6602, Fig. 29 (See § 73.699, Fig. 10 b).
[2] Maximum ERP of 500 watts allowed. Signal strength at the service area contour may be less than 39 dBu.

[3] When the actual antenna HAAT is greater than the reference HAAT, the allowable ERP will be reduced in accordance with the following equation: ERPallow = ERPmax × (HAATref / HAATactual)2.
[4] Applications for this service area radius may be granted upon specific request with justification and must include a technical demonstration that the signal strength at the edge of the service area does not exceed 39 dBu.

§ 90.279 Power limitations in the frequency range 421 MHz – 430 MHz

(a) Base station authorizations in the 421-430 MHz band will be subject to Effective Radiated Power (ERP) and Effective Antenna Height (EAH) limitations as shown in the table below. ERP is defined as the product of the power supplied to the antenna and its gain relative to a half-wave dipole in a given direction. EAH is calculated by subtracting the Assumed Average Terrain Elevation (AATE) as listed in table 7 of § 90.619 from the antenna height above mean sea level.

Limits of Effective Radiated Power (ERP) Corresponding to Effective Antenna Heights (EAH) of Base Stations in the 421-430 MHz Band

Effective antenna height (EAH) in meters (feet)	Maximum effective radiated power (ERP) (watts)
0-152 (0-500)	250
above 152-305 (above 500-1000)	150
above 305-457 (above 1000-1500)	75
above 457-610 (above 1500-2000)	40
above 610-762 (above 2000-2500)	20
above 762-914 (above 2500-3000)	15
above 914-1219 (above 3000-4000)	10
above 1219 (above 4000)	5

(b) The maximum transmitter power output that will be authorized for control stations is 20 watts.

IC
RSS 119 Issue 12 5.4
Maximum transmitter power shall be within ± 1.0 dB of the manufacturer's rated power 406.1 MHz – 430 MHz and 450 MHz – 470 MHz: 110 W (Base/Fixed Equipment) / 60 W (Mobile Equipment)

Result:

6.25 kHz Bandwidth

Frequency (channel)	output power	
Rated output power by manufacturer	40 dBm / 10 W nominal	46 dBm / 40 W nominal
421.2150 MHz	39.41 dBm / 8.72 W	45.40 dBm / 34.67 W
425.6125 MHz	39.52 dBm / 8.95 W	45.38 dBm / 34.51 W
429.9875 MHz	39.27 dBm / 8.45 W	45.30 dBm / 33.88 W
450.0125 MHz	39.21 dBm / 8.33 W	45.37 dBm / 34.43 W
460.0000 MHz	39.38 dBm / 8.66 W	45.61 dBm / 36.39 W
469.9875 MHz	39.32 dBm / 8.55 W	45.60 dBm / 36.30 W

12.5 kHz Bandwidth

Frequency (channel)	output power	
Rated output power by manufacturer	40 dBm / 10 W nominal	46 dBm / 40 W nominal
421.2150 MHz	39.42 dBm / 8.74 W	45.43 dBm / 34.91 W
425.6125 MHz	39.52 dBm / 8.95 W	45.38 dBm / 34.51 W
429.9875 MHz	39.28 dBm / 8.47 W	45.33 dBm / 34.11 W
450.0125 MHz	39.23 dBm / 8.37 W	45.37 dBm / 34.43 W
460.0000 MHz	39.39 dBm / 8.68 W	45.59 dBm / 36.22 W
469.9875 MHz	39.33 dBm / 8.57 W	45.40 dBm / 34.67 W

20 kHz Bandwidth

Frequency (channel)	output power	
Rated output power by manufacturer	40 dBm / 10 W nominal	46 dBm / 40 W nominal
421.2150 MHz	39.44 dBm / 8.79 W	45.40 dBm / 34.67 W
425.6125 MHz	39.52 dBm / 8.95 W	45.41 dBm / 34.75 W
429.9875 MHz	39.30 dBm / 8.51 W	45.29 dBm / 33.80 W
450.0125 MHz	39.24 dBm / 8.39 W	45.36 dBm / 34.35 W
460.0000 MHz	39.41 dBm / 8.72 W	45.57 dBm / 36.05 W
469.9875 MHz	39.33 dBm / 8.57 W	45.41 dBm / 34.75 W

25 kHz Bandwidth

Frequency (channel)	output power	
Rated output power by manufacturer	40 dBm / 10 W nominal	46 dBm / 40 W nominal
421.2150 MHz	39.44 dBm / 8.79 W	45.39 dBm / 34.59 W
425.6125 MHz	39.53 dBm / 8.97 W	45.37 dBm / 34.43 W
429.9875 MHz	39.31 dBm / 8.53 W	45.28 dBm / 33.72 W
450.0125 MHz	39.25 dBm / 8.41 W	45.37 dBm / 34.43 W
460.0000 MHz	39.42 dBm / 8.74 W	45.57 dBm / 36.05 W
469.9875 MHz	39.33 dBm / 8.57 W	45.40 dBm / 34.67 W

13.2 Spectrum efficiency

Limits:

FCC	IC
FCC 47 CFR § 90.203 (j)(3)	RSS 119 Issue 12
If the equipment is capable of transmitting data, has transmitter power greater than 500 mW, and has a channel bandwidth of more than 6.25 kHz, the equipment must be capable of supporting a minimum data rate of 4800 bits per second (bps) per 6.25 kHz of channel bandwidth.	

Result:

According §90.203(j)(7) the EUT is excepted from this rule as it supports only one way paging operations

Supported channel bandwidth	Supported data rates
6.25 kHz, 12.5 kHz, 20 kHz, 25 kHz	512, 1200, 2400, 4800 bps

13.3 Occupied bandwidth

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	see plots
Video bandwidth:	see plots
Span:	see plots
Trace-Mode:	max. hold

Limits:

FCC	IC
FCC 47 CFR § 2.1049 (c) § 90.209 (b) (5)	RSS 119 Issue 12 5.5
Channel bandwidth	**Authorized bandwidth**
6.25 kHz	6 kHz
12.5 kHz	11.25 kHz
20 kHz	20 kHz
25 kHz	20 kHz

Result: 99%-bandwidth

6.25 kHz Bandwidth

	99%-bandwidth			
Data rate / bits per second	512	1200	2400	4800
421.2125 MHz	528.7 Hz	1.202 kHz	*	*
425.6125 MHz	528.7 Hz	1.202 kHz	*	*
429.9875 MHz	530.1 Hz	1.202 kHz	*	*
450.0125 MHz	531.8 Hz	1.203 kHz	*	*
460.0000 MHz	531.6 Hz	1.202 kHz	*	*
469.9875 MHz	532.0 Hz	1.200 kHz	*	*

* due to signal (occupied bandwidth changes with the used resolution bandwidth)
the 1% to 5% rule couldn't be fulfilled with the data rates 2400 bps and 4800 bps see additional plots on page 27 + 28.

12.5 kHz Bandwidth

	99%-bandwidth			
Data rate / bits per second	512	1200	2400	4800
421.2125 MHz	5.180 kHz	5.951 kHz	7.233 kHz	9.628 kHz
425.6125 MHz	5.190 kHz	5.846 kHz	7.232 kHz	9.632 kHz
429.9875 MHz	5.187 kHz	5.948 kHz	7.230 kHz	9.634 kHz
450.0125 MHz	5.191 kHz	5.903 kHz	7.230 kHz	9.635 kHz
460.0000 MHz	5.188 kHz	5.907 kHz	7.227 kHz	9.632 kHz
469.9875 MHz	5.191 kHz	5.963 kHz	7.231kHz	9.625 kHz

20 kHz Bandwidth

	99%-bandwidth			
Data rate / bits per second	512	1200	2400	4800
421.2125 MHz	8.531 kHz	10.344 kHz	10.878 kHz	14.410 kHz
425.6125 MHz	8.501 kHz	10.361 kHz	10.872 kHz	14.414 kHz
429.9875 MHz	8.496 kHz	10.335 kHz	10.859 kHz	14.422 kHz
450.0125 MHz	8.489 kHz	10.261 kHz	10.872 kHz	14.422 kHz
460.0000 MHz	8.485 kHz	10.279 kHz	10.867 kHz	14.420 kHz
469.9875 MHz	8.508 kHz	10.548 kHz	10.873 kHz	14.399 kHz

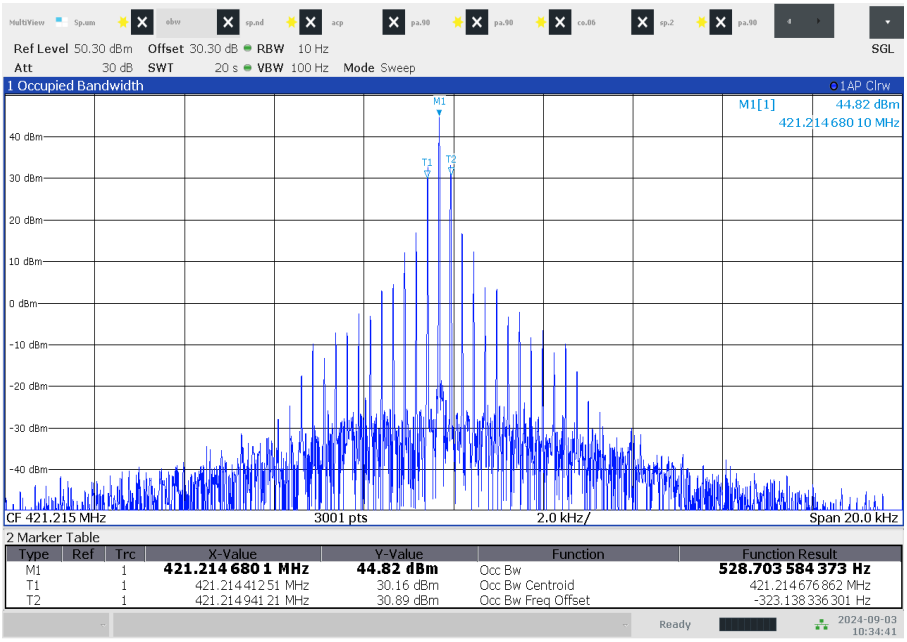
25 kHz Bandwidth

	99%-bandwidth			
Data rate / bits per second	512	1200	2400	4800
421.2125 MHz	9.337 kHz	10.998 kHz	12.089 kHz	14.547 kHz
425.6125 MHz	9.336 kHz	10.990 kHz	12.088 kHz	14.550 kHz
429.9875 MHz	9.335 kHz	11.005 kHz	12.084 kHz	14.555 kHz
450.0125 MHz	9.339 kHz	10.981 kHz	12.086 kHz	14.557 kHz
460.0000 MHz	9.336 kHz	10.989 kHz	12.086 kHz	14.552 kHz
469.9875 MHz	9.329 kHz	11.010 kHz	12.091 kHz	14.540 kHz

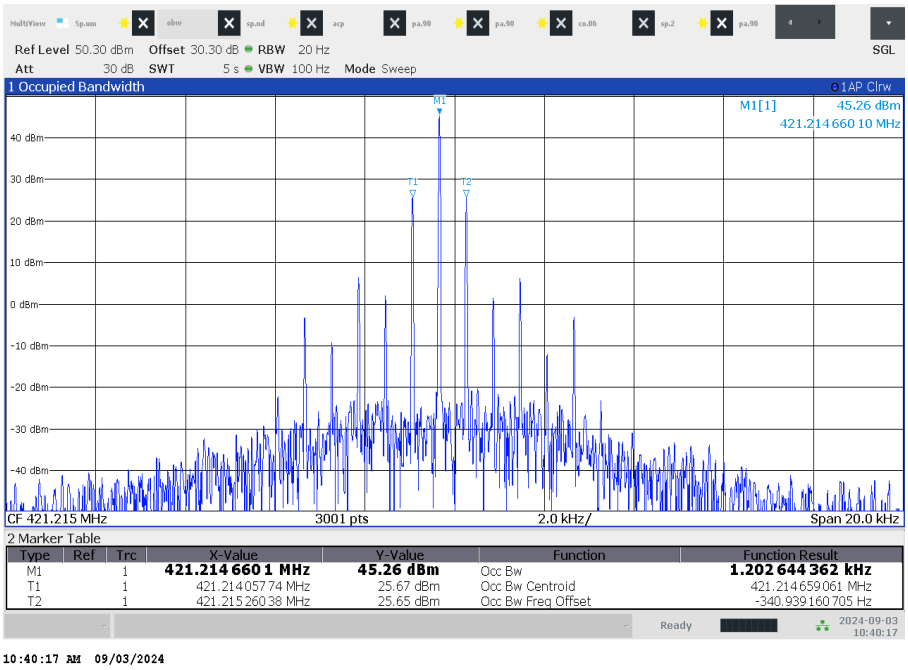
13.3.1 Plots 6.25 kHz bandwidth

Plots 421.2125 MHz

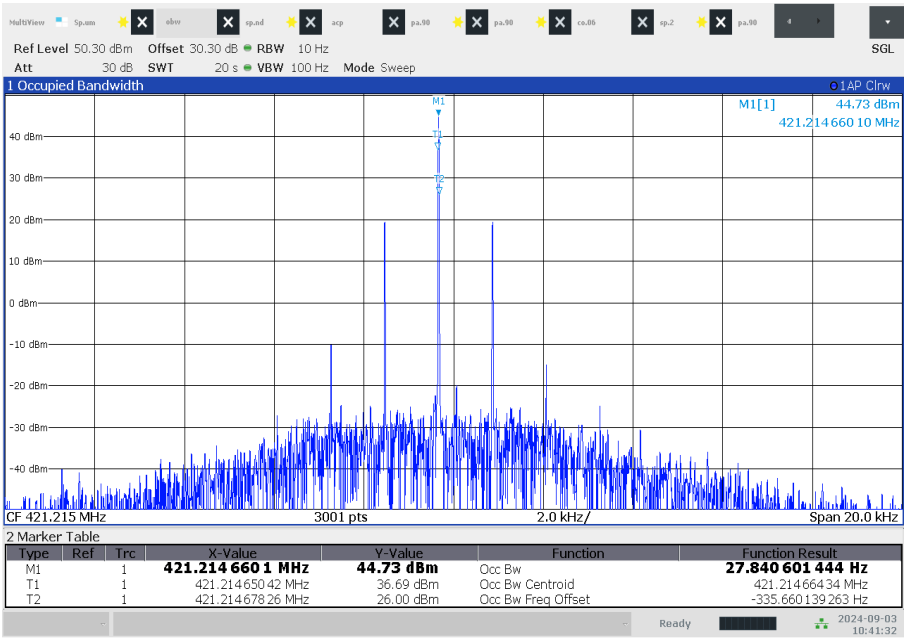
Plot 1: 421.2125 MHz / 512 bits per second



Plot 2: 421.2125 MHz / 1200 bits per second

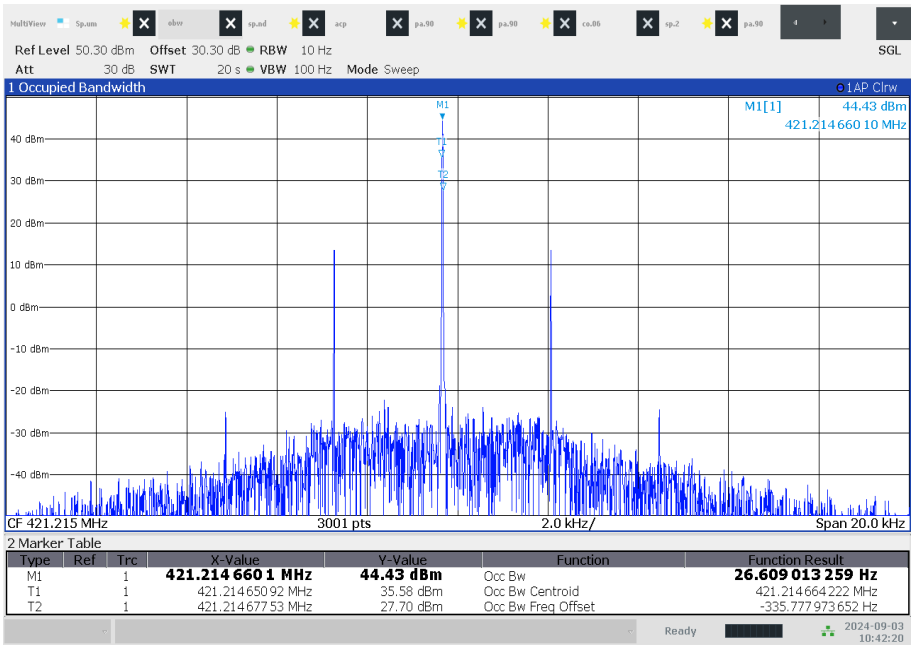


Plot 3: 421.2125 MHz / 2400 bits per second



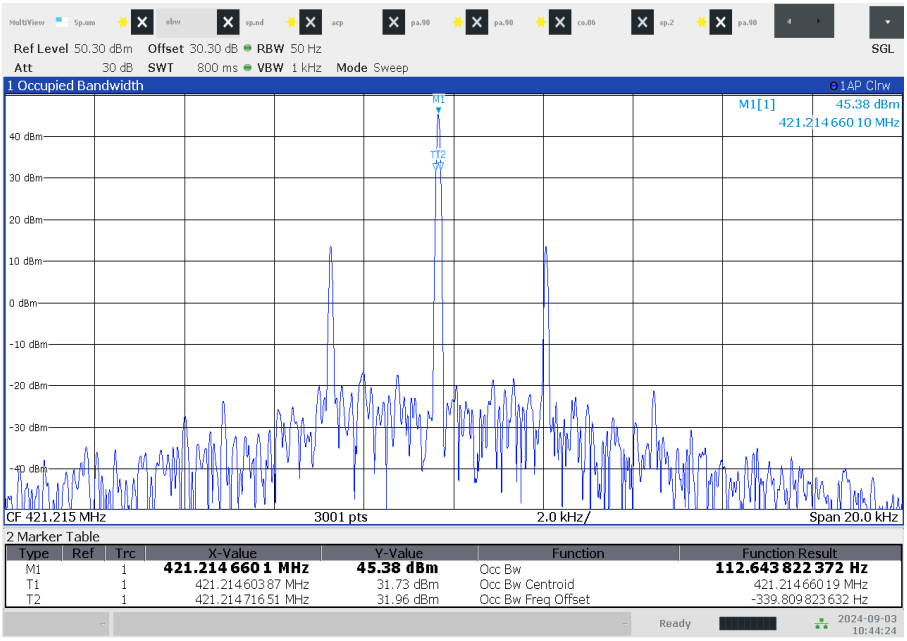
10:41:33 AM 09/03/2024

Plot 4: 421.2125 MHz / 4800 bits per second



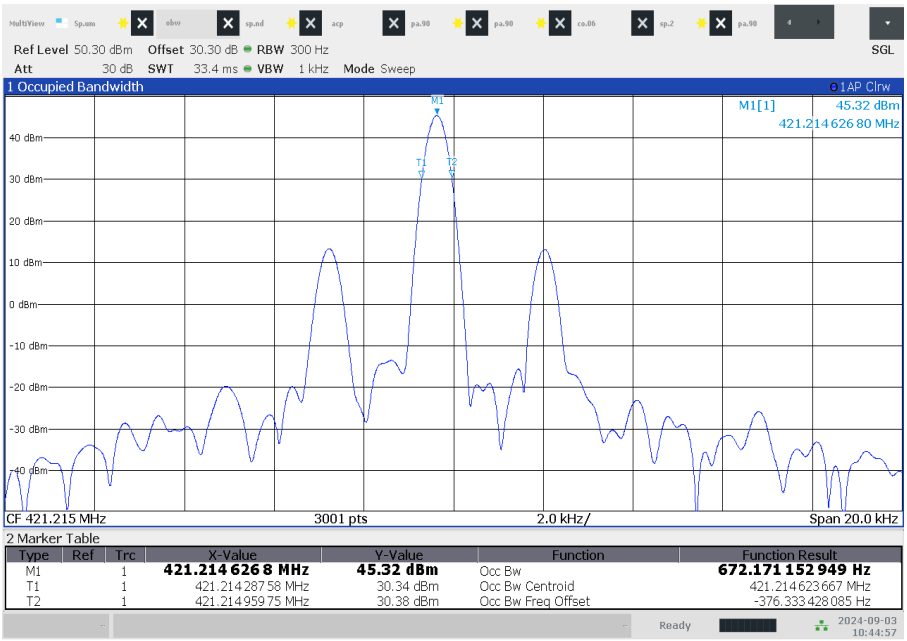
10:42:21 AM 09/03/2024

Plot 5: 421.2125 MHz / 4800 bits per second, 50Hz RBW



10:44:24 AM 09/03/2024

Plot 6: 421.2125 MHz / 4800 bits per second, 300Hz RBW



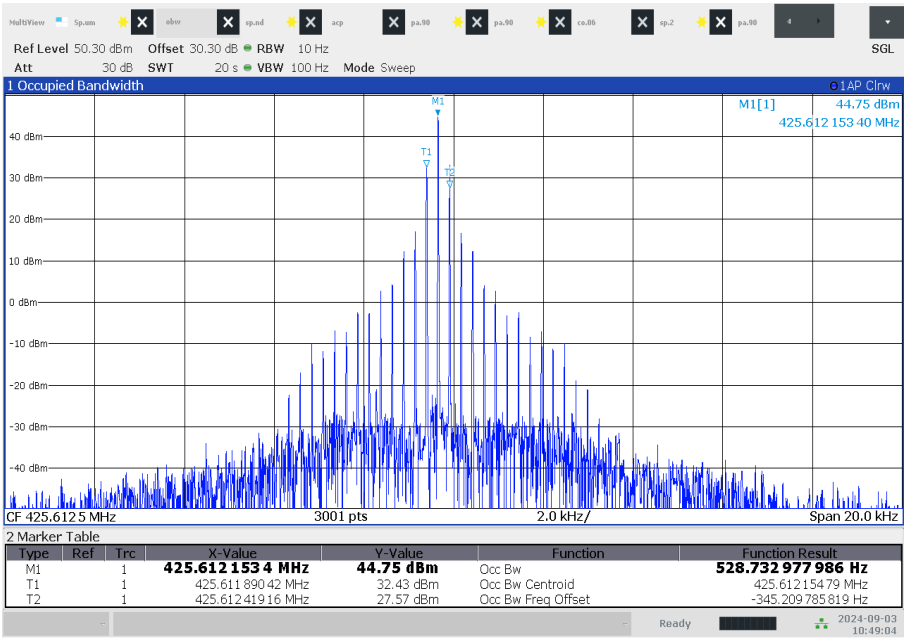
10:44:58 AM 09/03/2024

Plot 7: 421.2125 MHz / 4800 bits per second, 1 kHz RBW

10:45:30 AM 09/03/2024

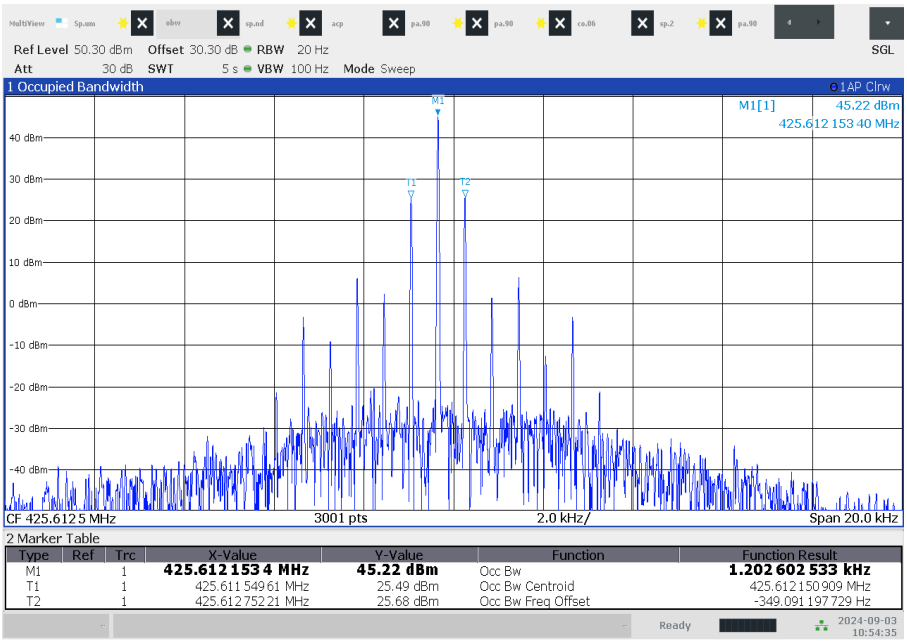
Plots 425.6125 MHz

Plot 1: 425.6125 MHz / 512 bits per second



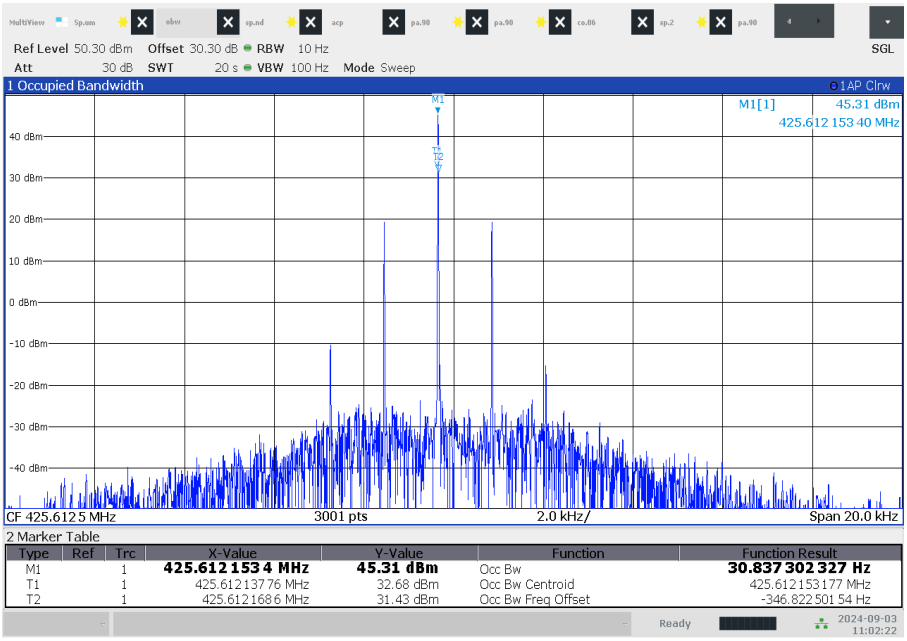
10:49:04 AM 09/03/2024

Plot 2: 425.6125 MHz / 1200 bits per second



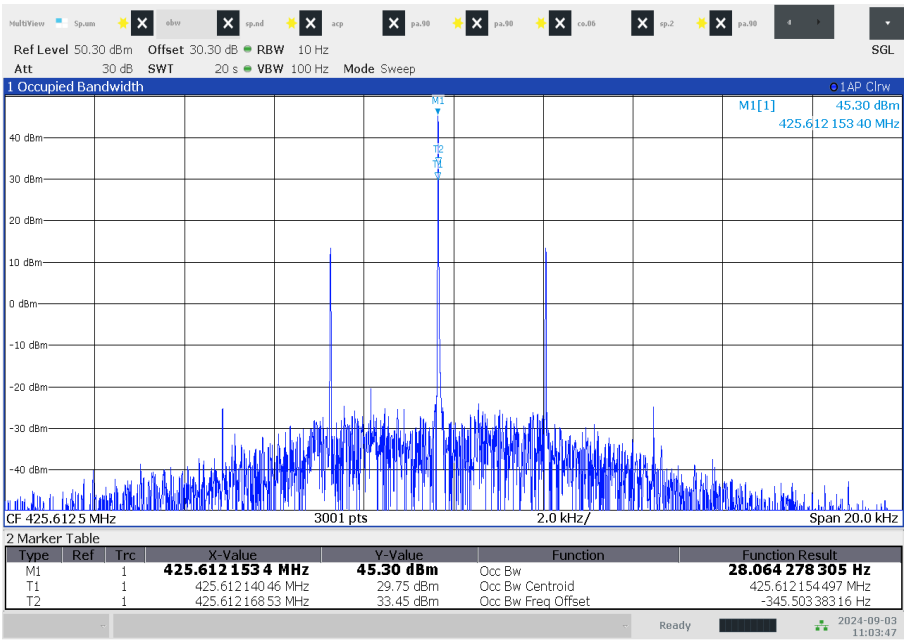
10:54:36 AM 09/03/2024

Plot 3: 425.6125 MHz / 2400 bits per second



11:02:23 AM 09/03/2024

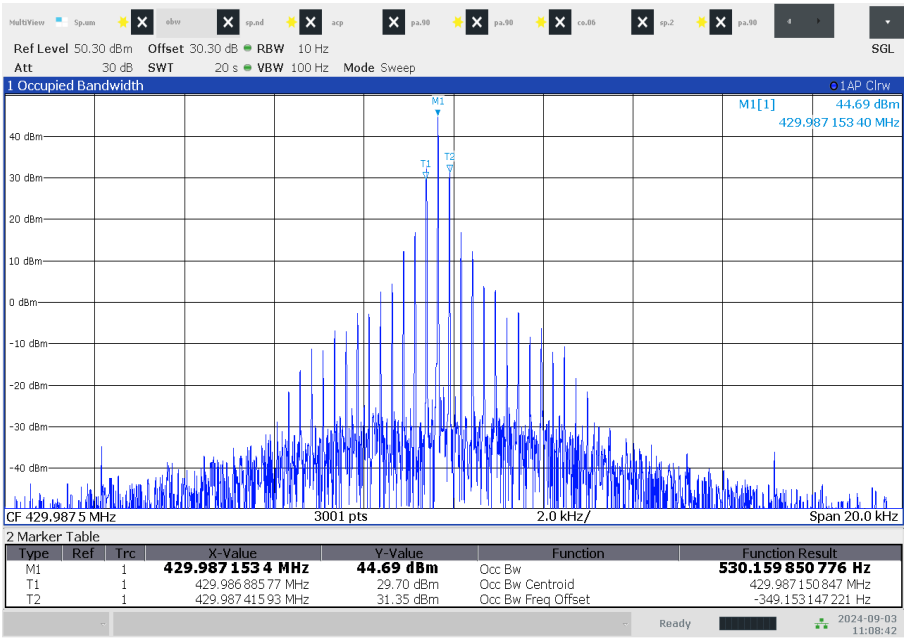
Plot 4: 425.6125 MHz / 4800 bits per second



11:03:47 AM 09/03/2024

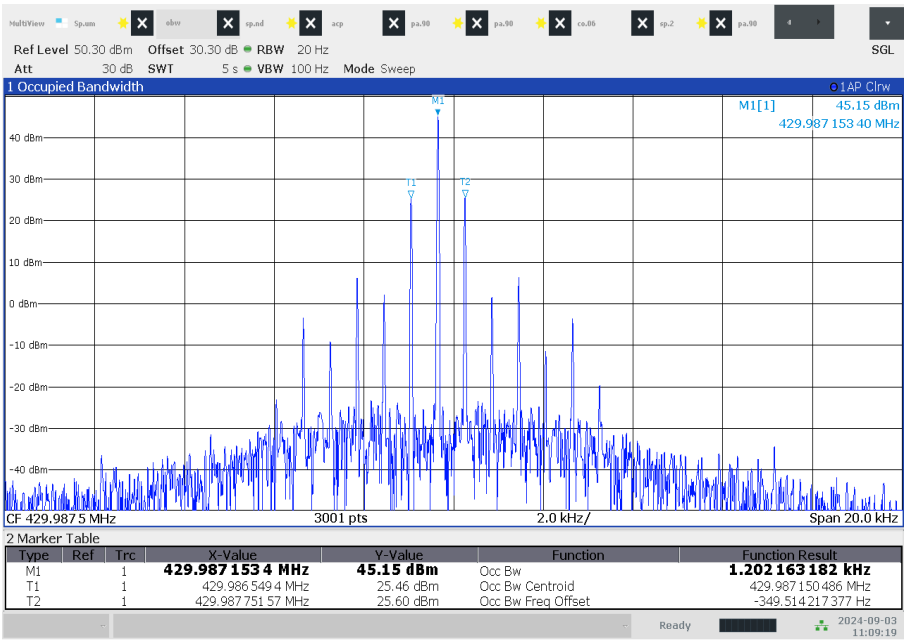
Plots 429.9875 MHz

Plot 1: 429.9875 MHz / 512 bits per second



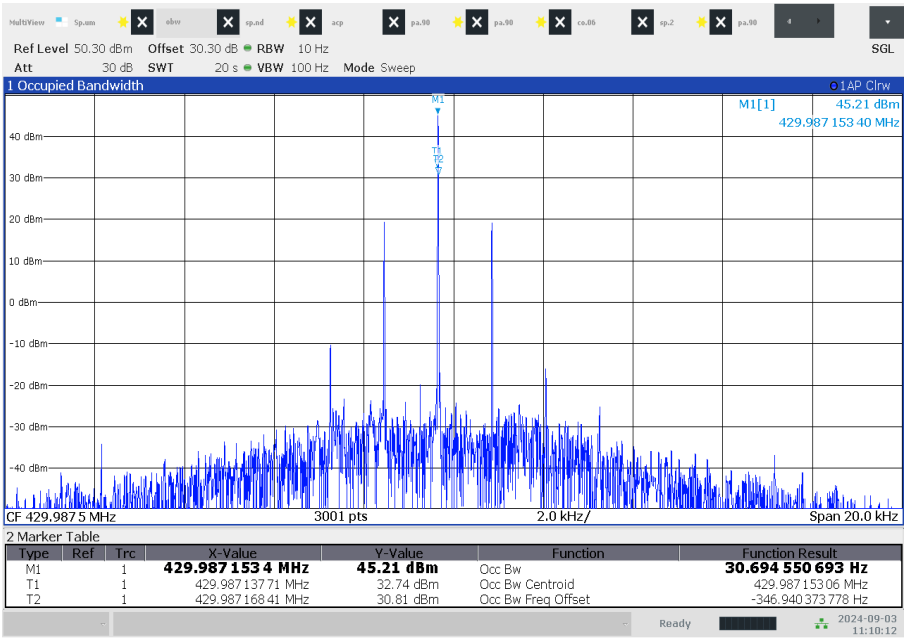
11:08:43 AM 09/03/2024

Plot 2: 429.9875 MHz / 1200 bits per second



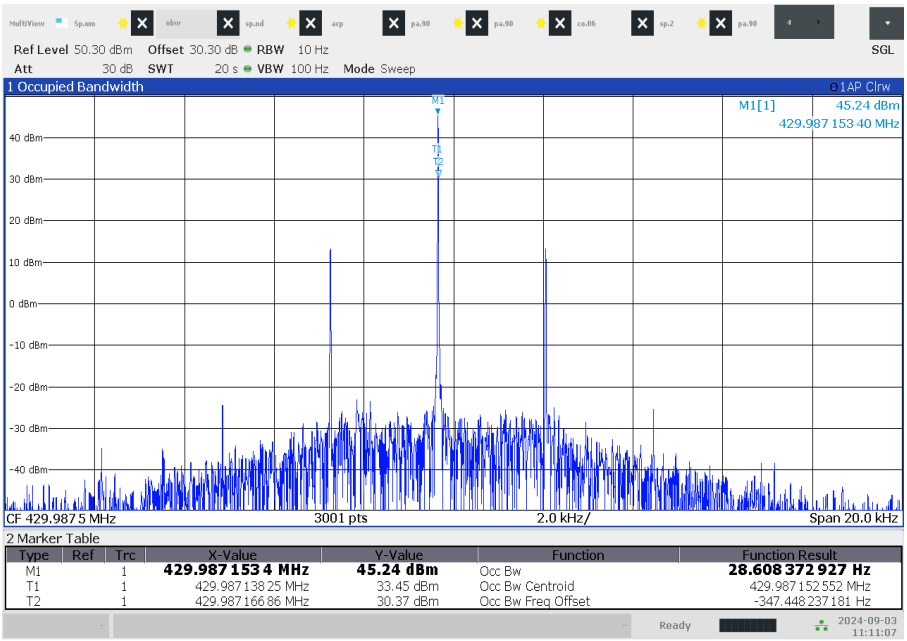
11:09:19 AM 09/03/2024

Plot 3: 429.9875 MHz / 2400 bits per second



11:10:13 AM 09/03/2024

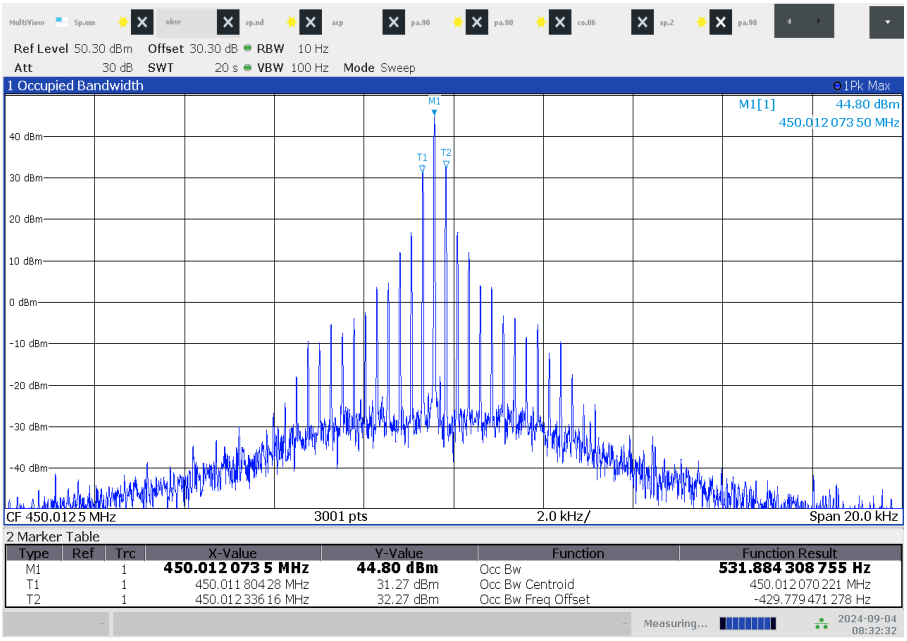
Plot 4: 429.9875 MHz / 4800 bits per second



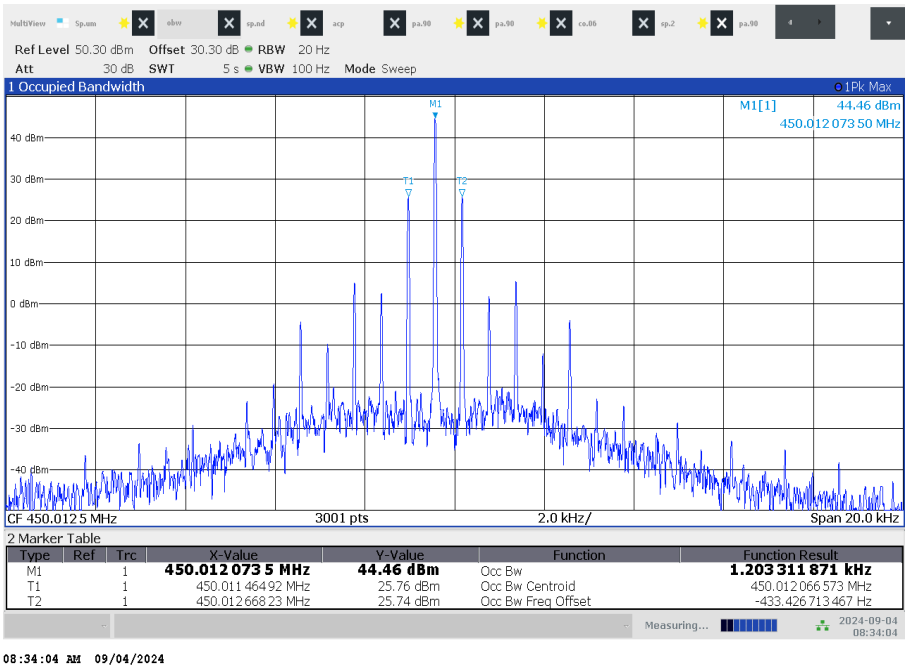
11:11:07 AM 09/03/2024

Plots 450.0125 MHz

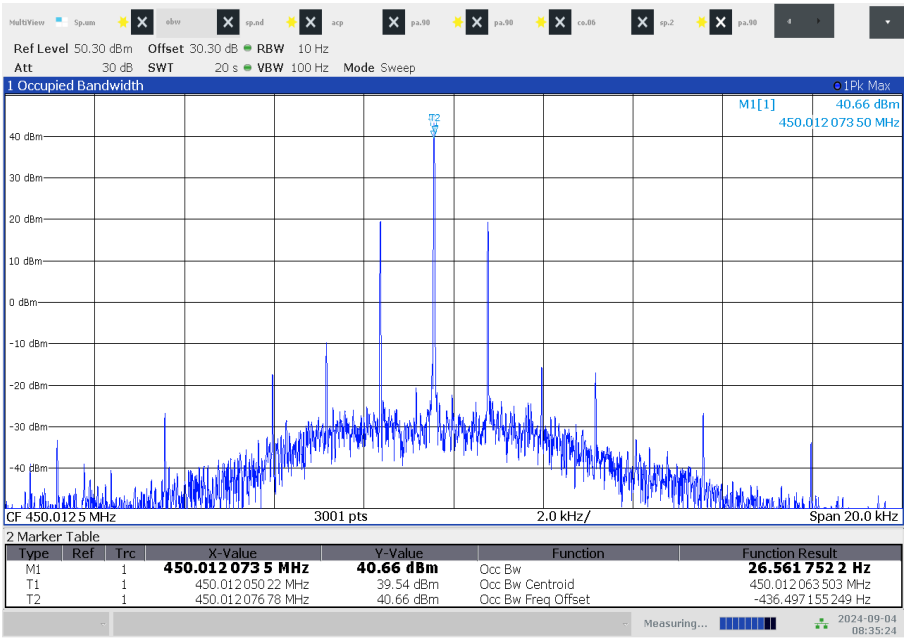
Plot 1: 450.0125 MHz / 512 bits per second



Plot 2: 450.0125 MHz / 1200 bits per second

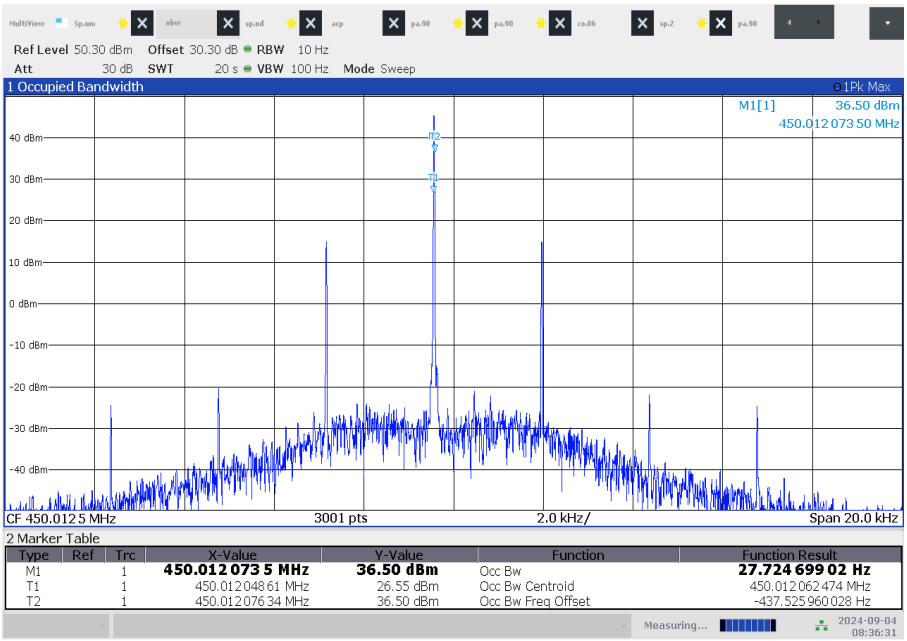


Plot 3: 450.0125 MHz / 2400 bits per second



08:35:24 AM 09/04/2024

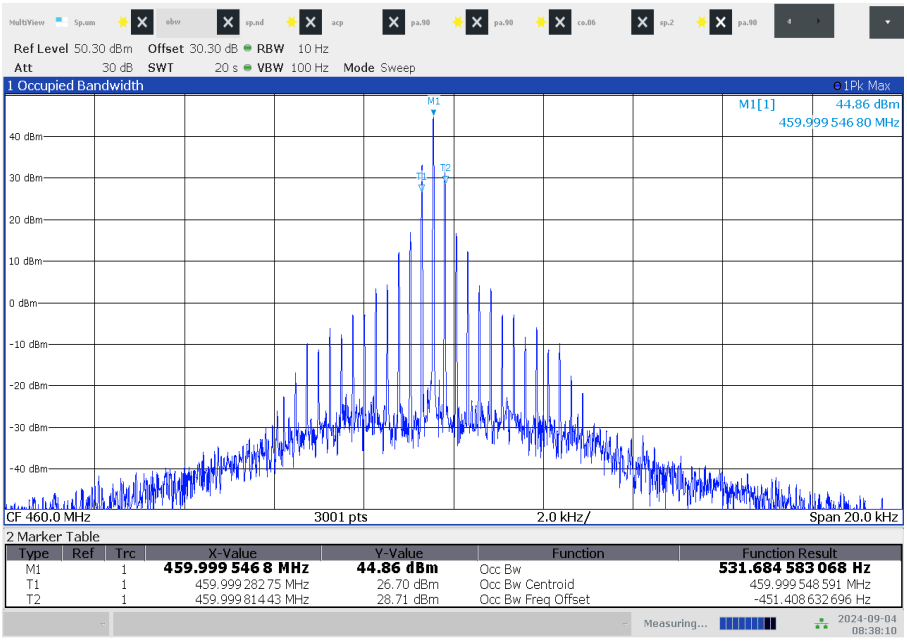
Plot 4: 450.0125 MHz / 4800 bits per second



08:36:31 AM 09/04/2024

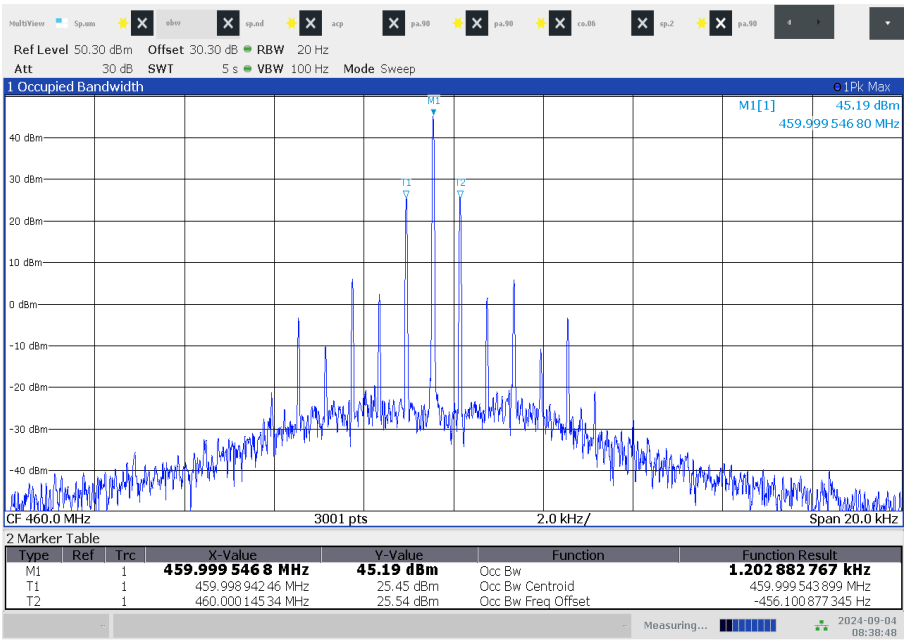
Plots 460.0 MHz

Plot 1: 460.0 MHz / 512 bits per second



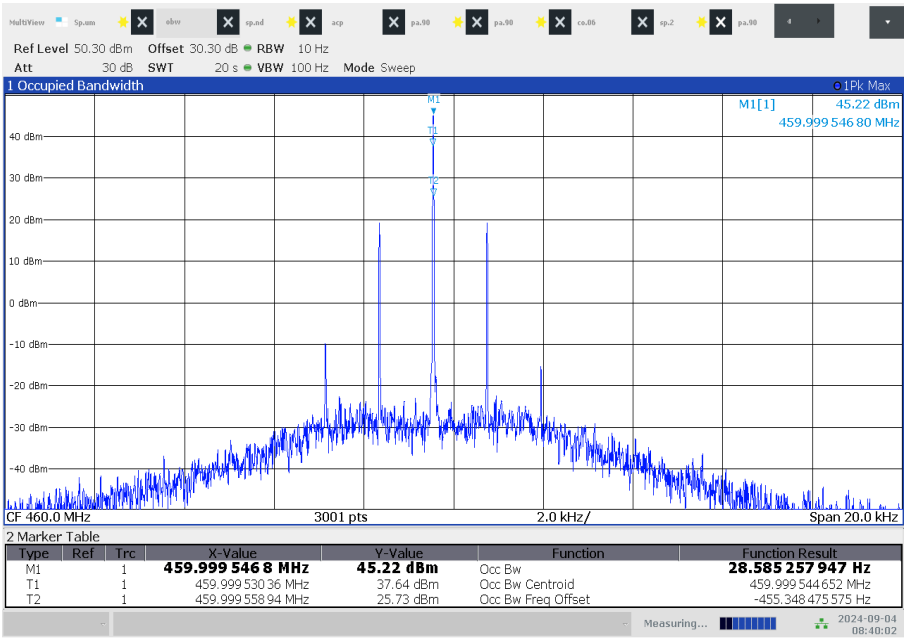
08:38:11 AM 09/04/2024

Plot 2: 460.0 MHz / 1200 bits per second



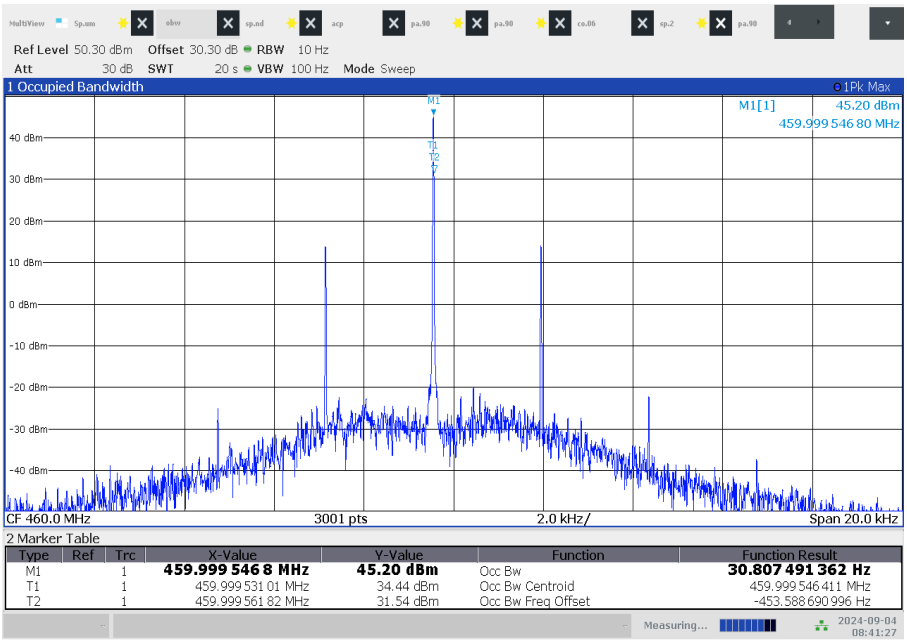
08:38:48 AM 09/04/2024

Plot 3: 460.0 MHz / 2400 bits per second



08:40:03 AM 09/04/2024

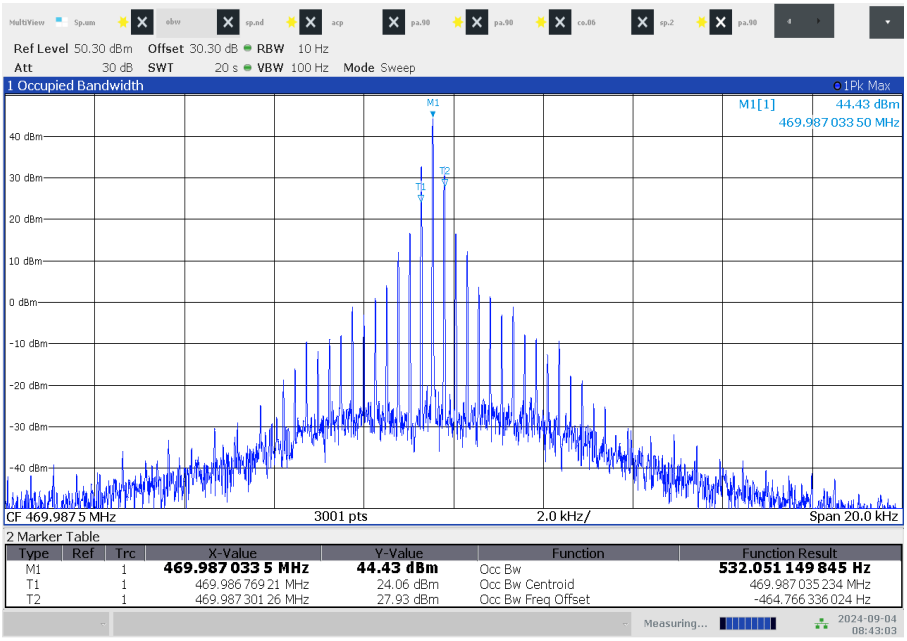
Plot 4: 460.0 MHz / 4800 bits per second



08:41:27 AM 09/04/2024

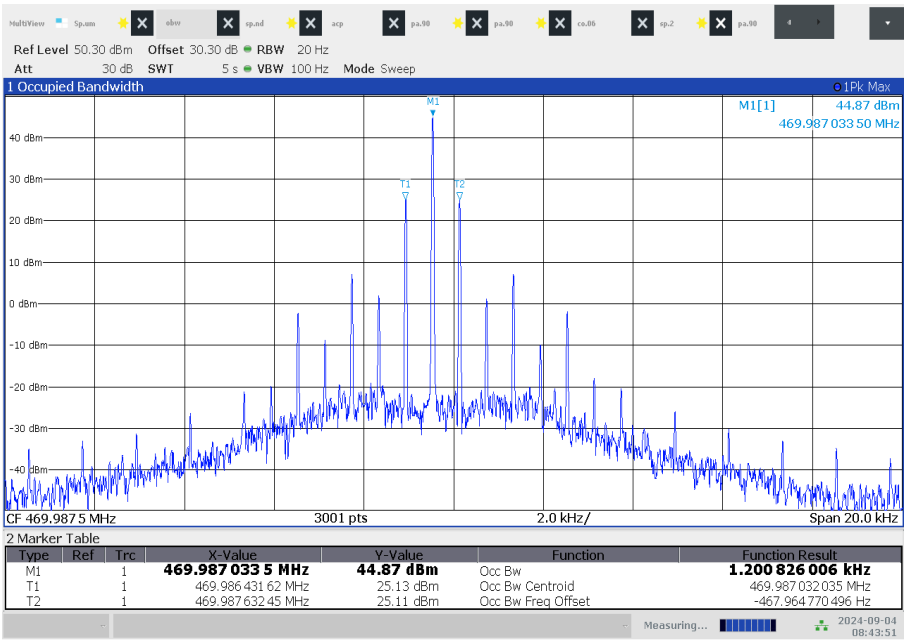
Plots 469.9875 MHz

Plot 1: 469.9875 MHz / 512 bits per second



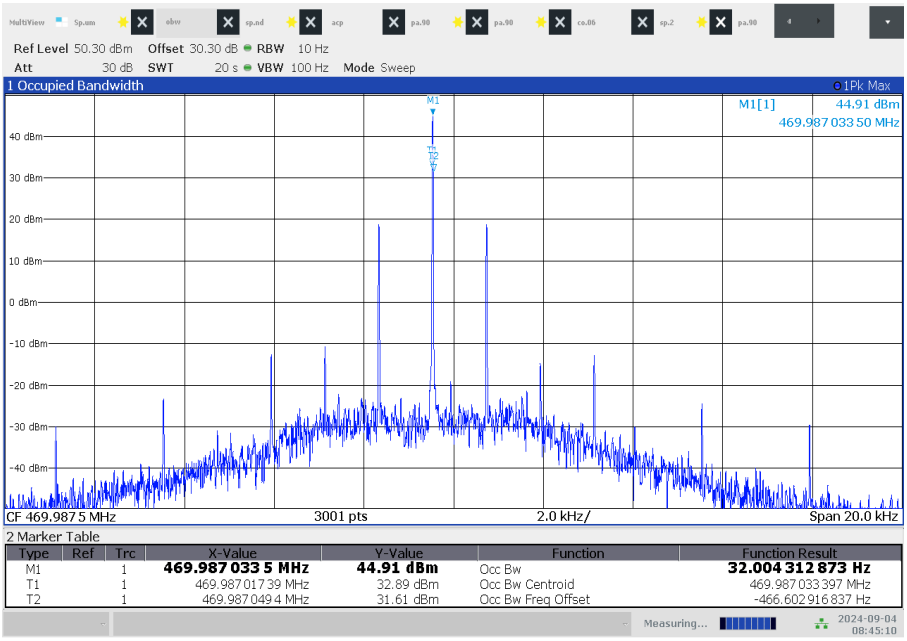
08:43:04 AM 09/04/2024

Plot 2: 469.9875 MHz / 1200 bits per second



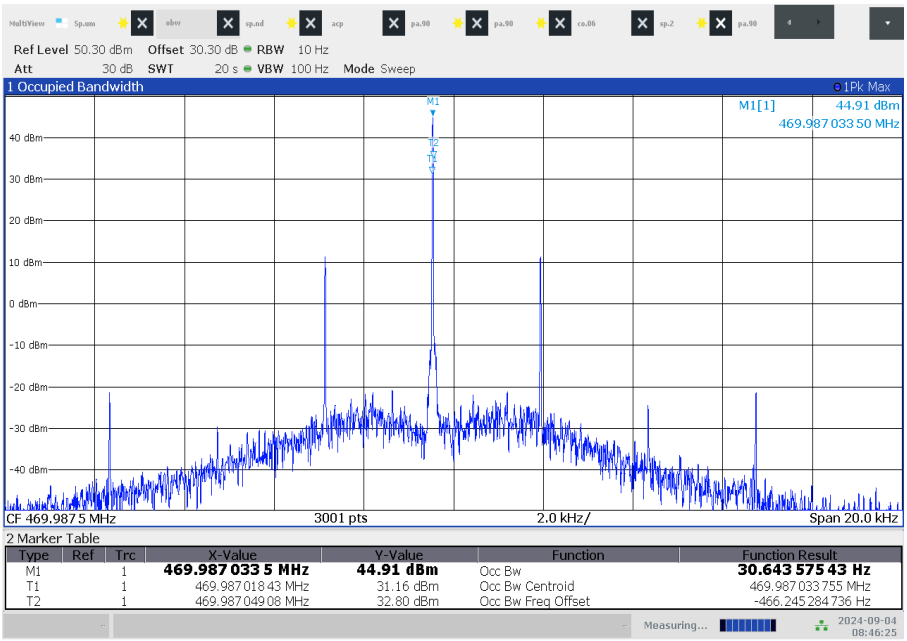
08:43:51 AM 09/04/2024

Plot 3: 469.9875 MHz / 2400 bits per second



08:45:11 AM 09/04/2024

Plot 4: 469.9875 MHz / 4800 bits per second

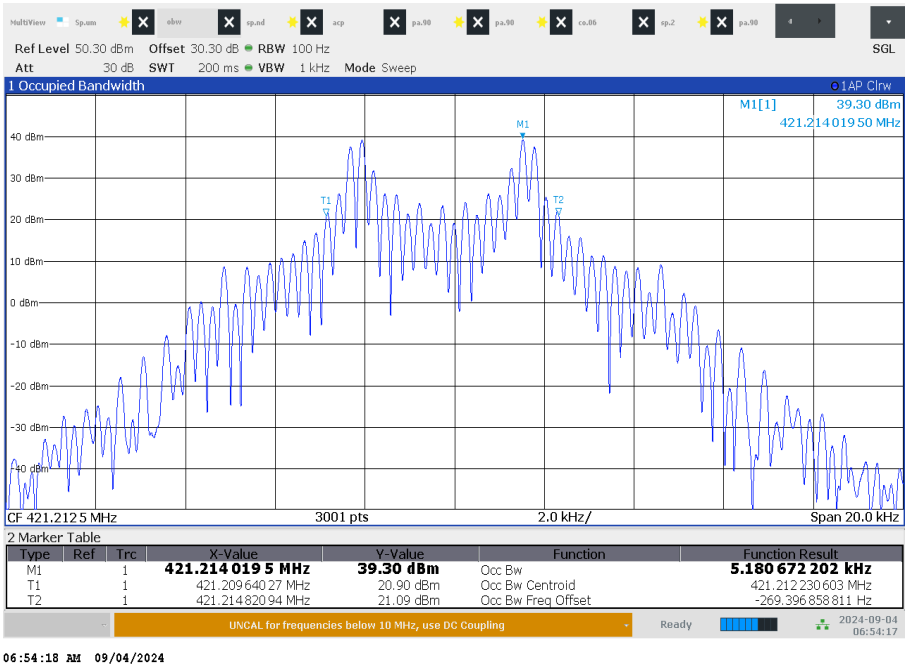


08:46:25 AM 09/04/2024

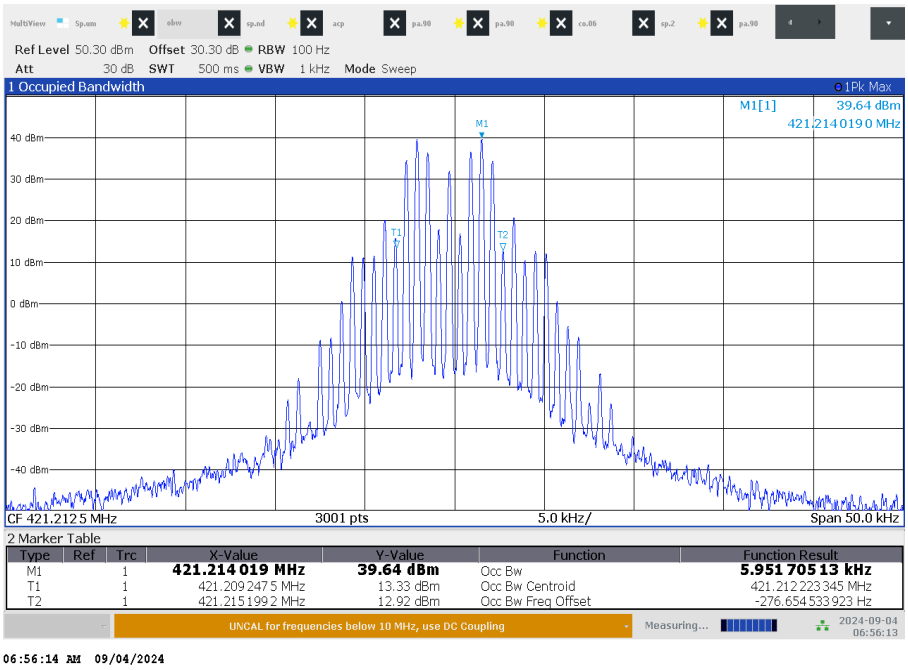
13.3.2 Plots 12.5 kHz bandwidth

Plots 421.2125 MHz

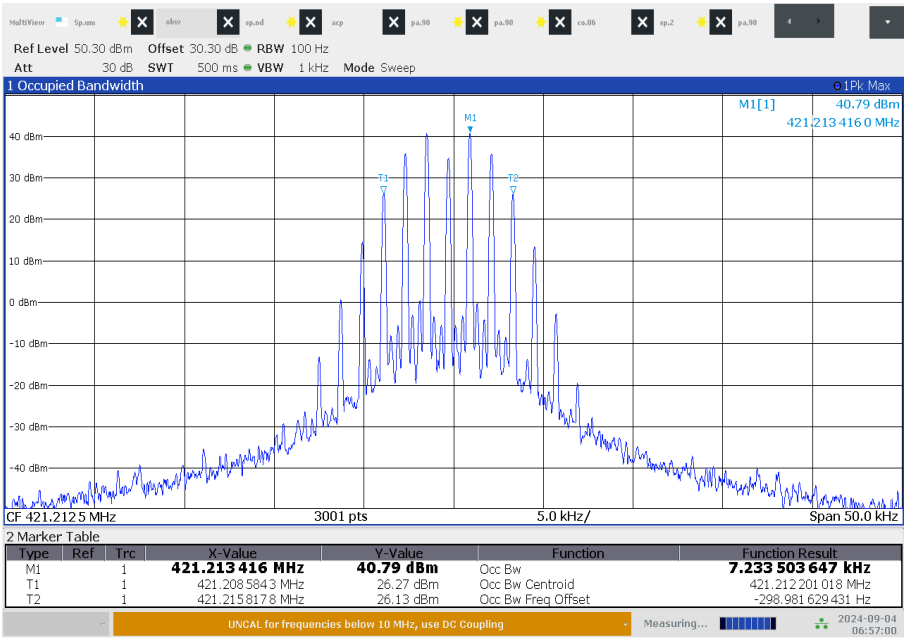
Plot 1: 421.2125 MHz / 512 bits per second



Plot 2: 421.2125 MHz / 1200 bits per second

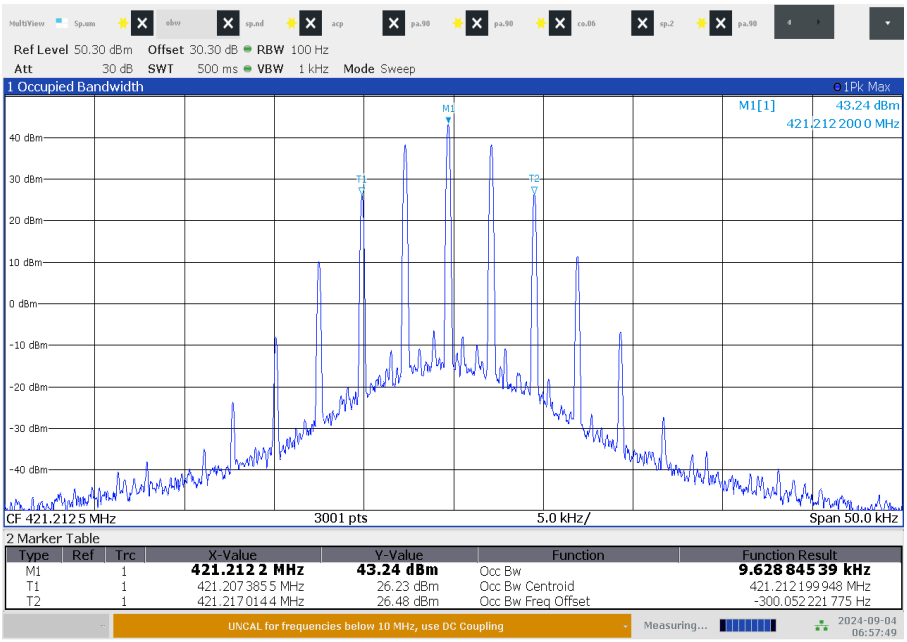


Plot 3: 421.2125 MHz / 2400 bits per second



06:57:01 AM 09/04/2024

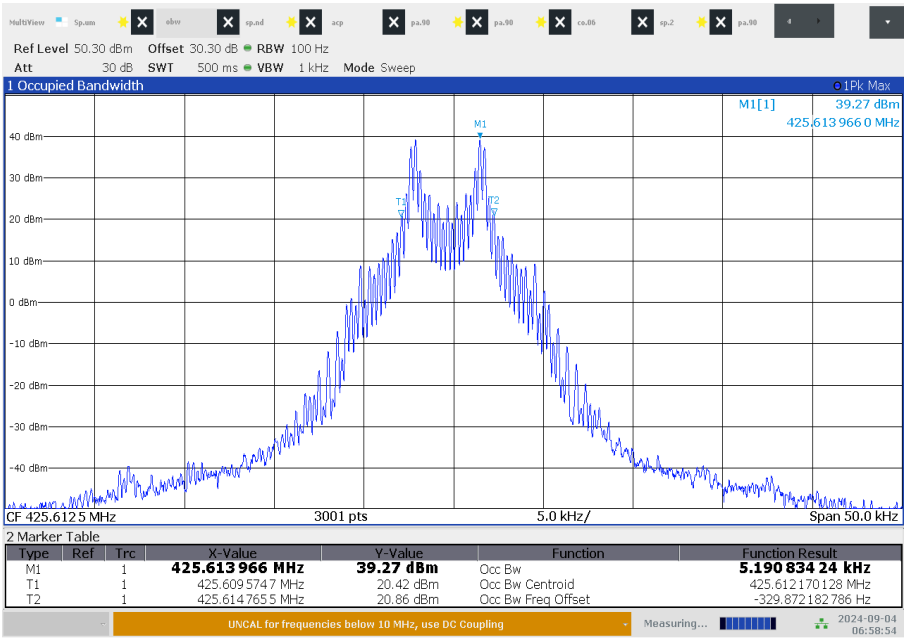
Plot 4: 421.2125 MHz / 4800 bits per second



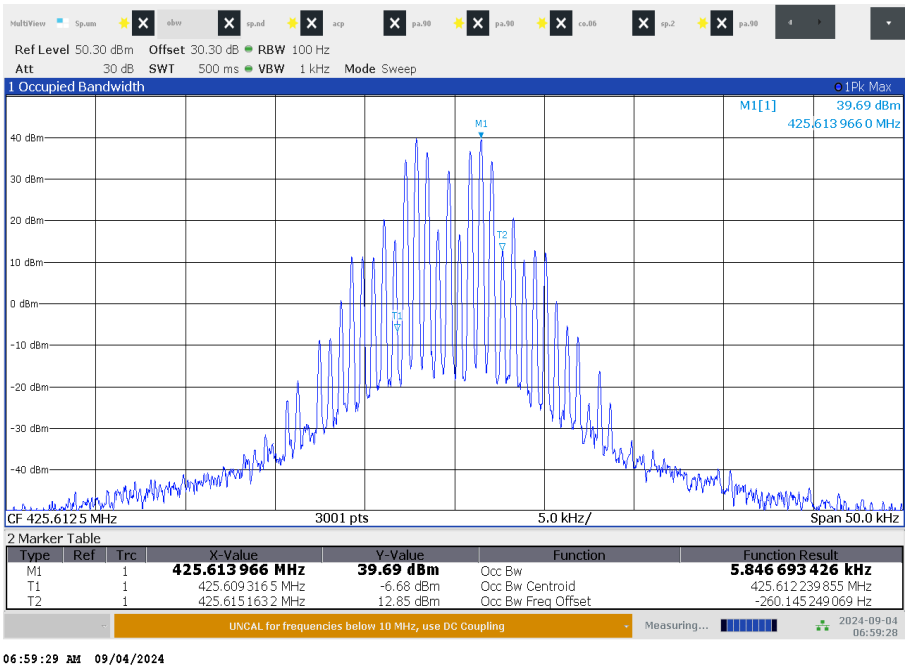
06:57:50 AM 09/04/2024

Plots 425.6125 MHz

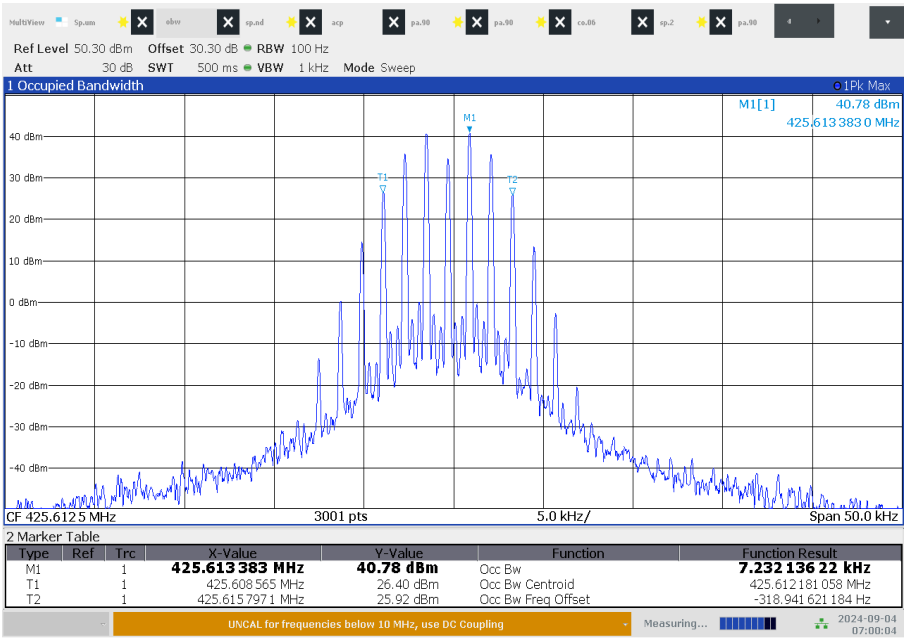
Plot 1: 425.6125 MHz / 512 bits per second



Plot 2: 425.6125 MHz / 1200 bits per second

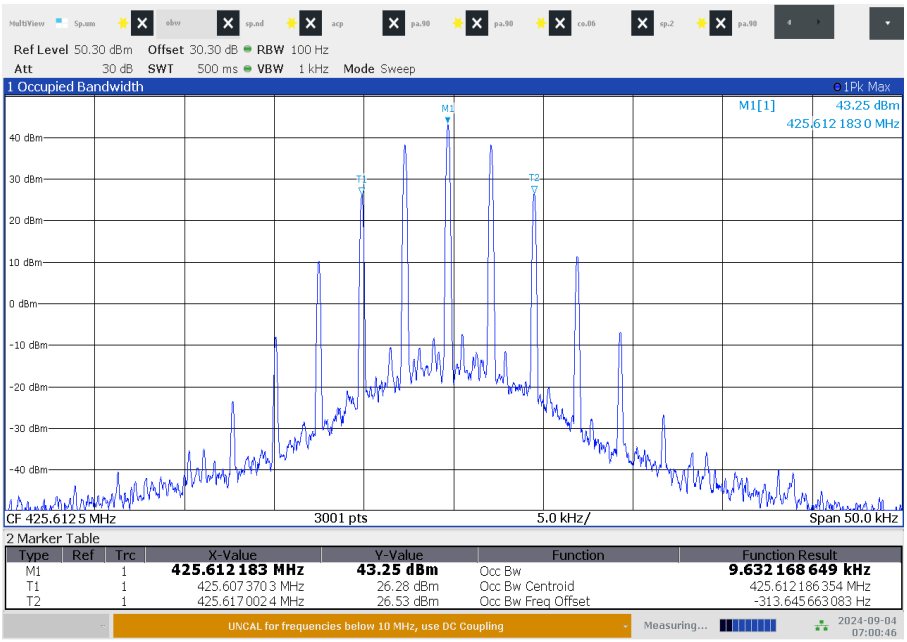


Plot 3: 425.6125 MHz / 2400 bits per second



07:00:05 AM 09/04/2024

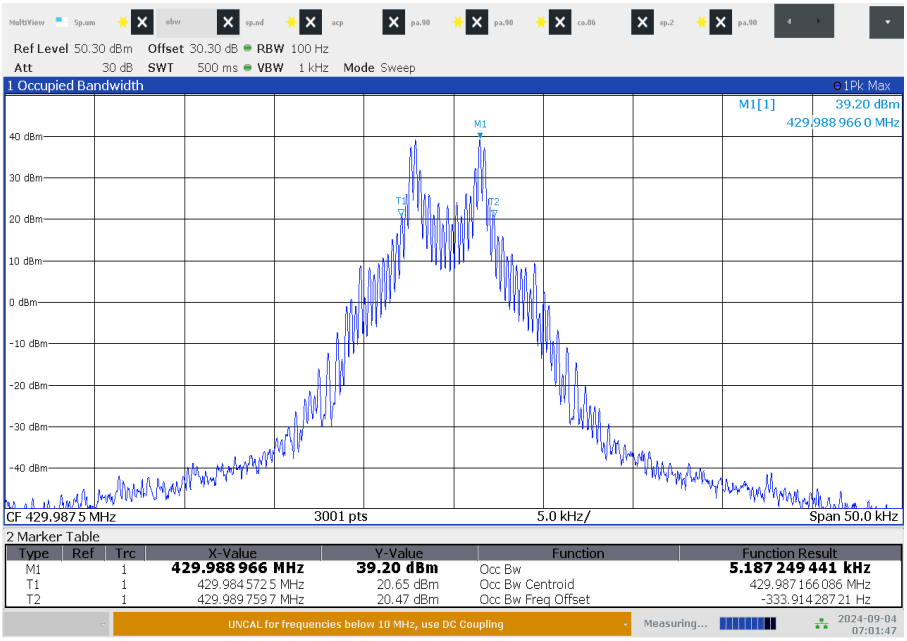
Plot 4: 425.6125 MHz / 4800 bits per second



07:00:47 AM 09/04/2024

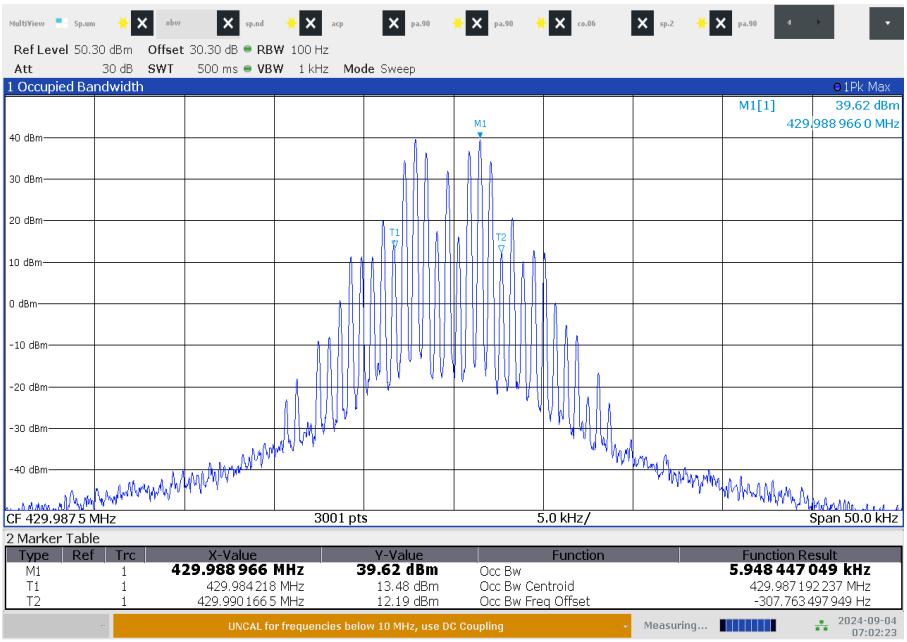
Plots 429.9875 MHz

Plot 1: 429.9875 MHz / 512 bits per second



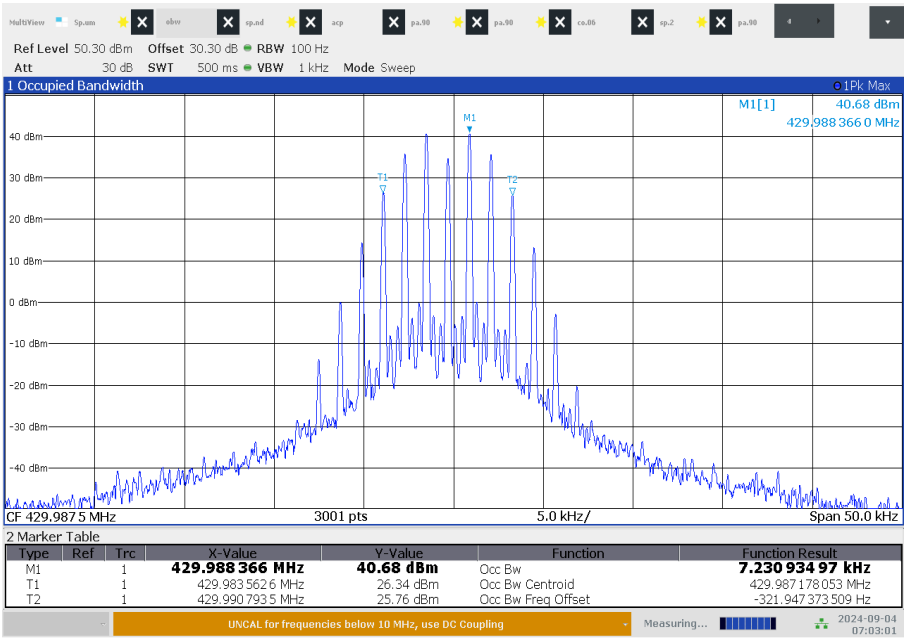
07:01:48 AM 09/04/2024

Plot 2: 429.9875 MHz / 1200 bits per second



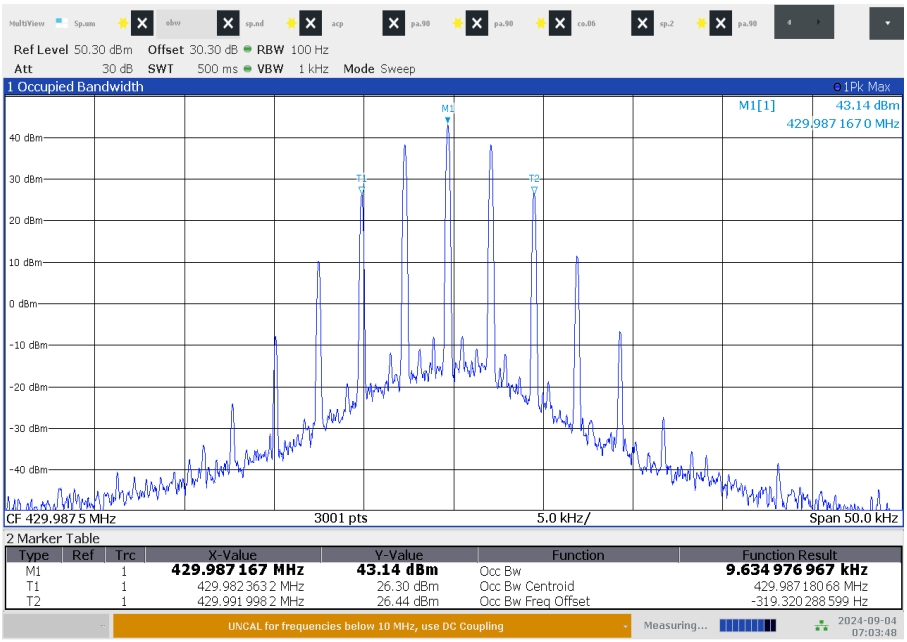
07:02:24 AM 09/04/2024

Plot 3: 429.9875 MHz / 2400 bits per second



07:03:02 AM 09/04/2024

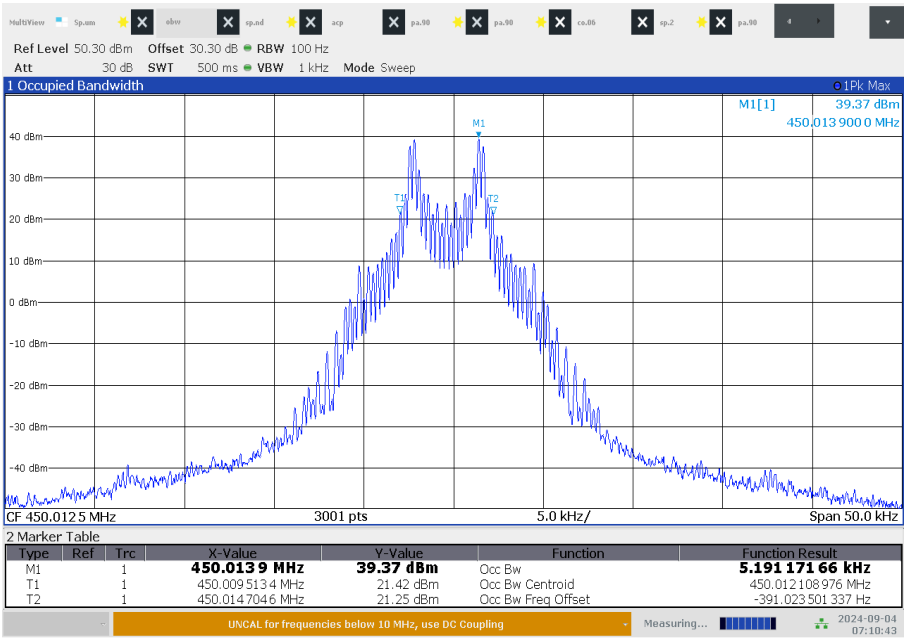
Plot 4: 429.9875 MHz / 4800 bits per second



07:03:49 AM 09/04/2024

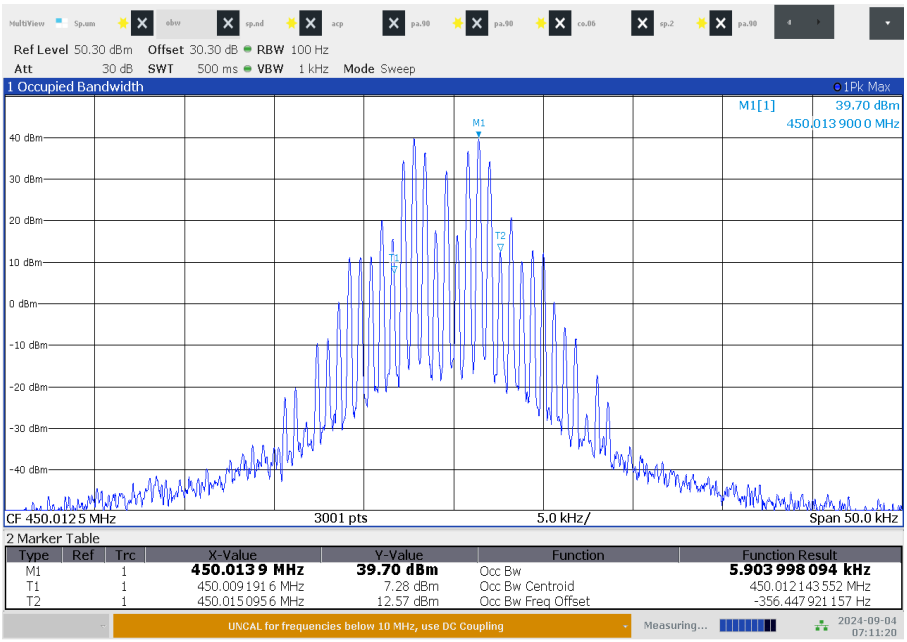
Plots 450.0125 MHz

Plot 1: 450.0125 MHz / 512 bits per second



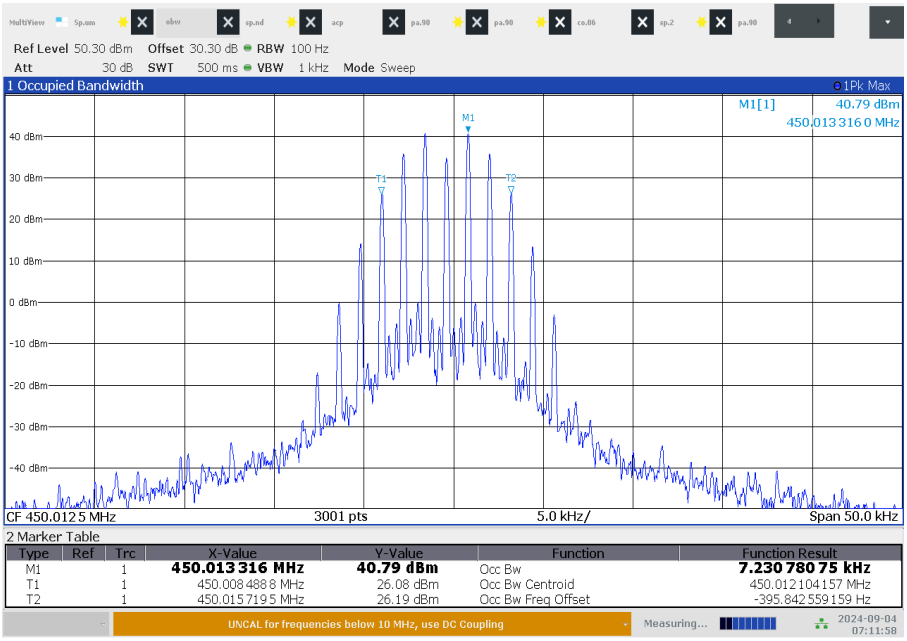
07:10:44 AM 09/04/2024

Plot 2: 450.0125 MHz / 1200 bits per second



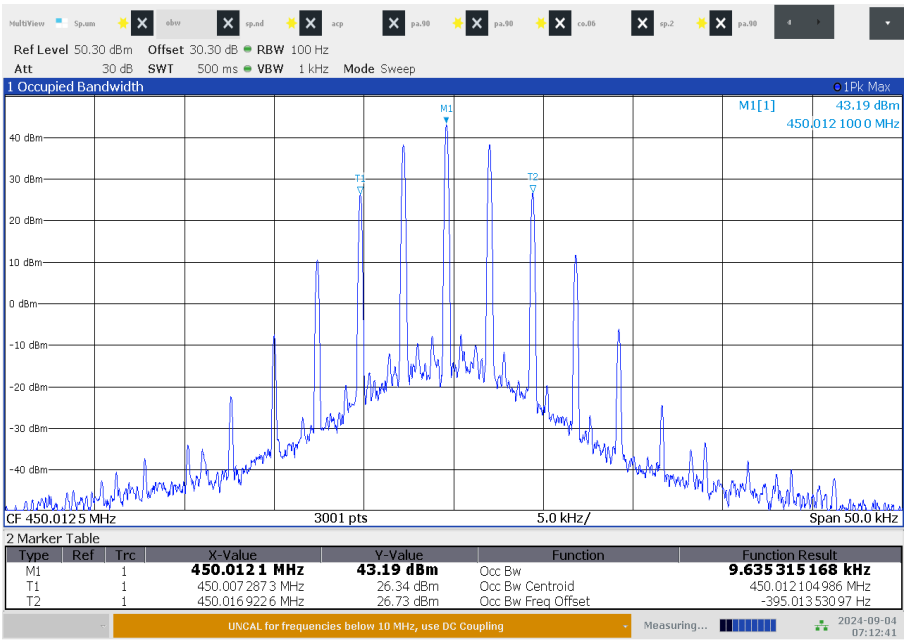
07:11:21 AM 09/04/2024

Plot 3: 450.0125 MHz / 2400 bits per second



07:11:59 AM 09/04/2024

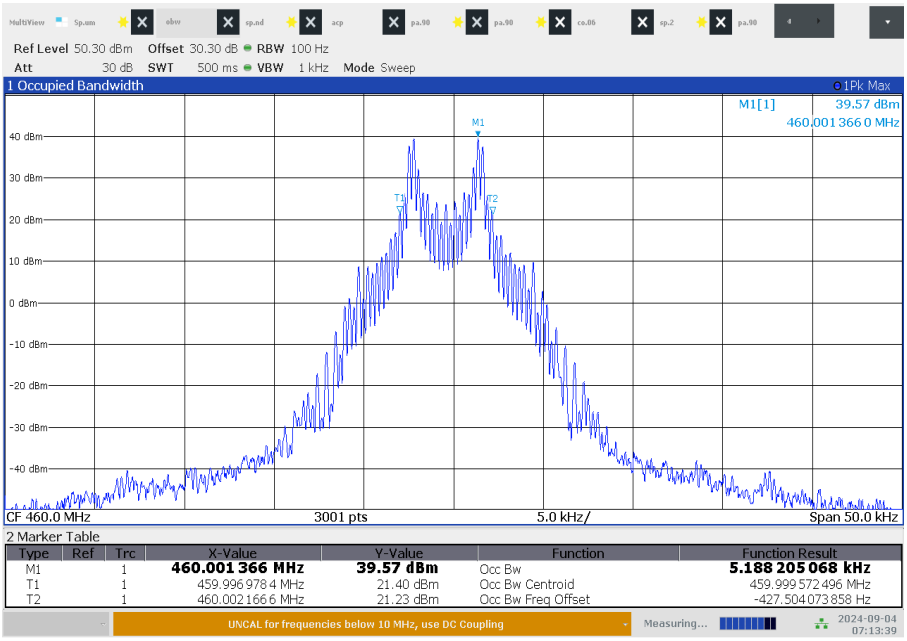
Plot 4: 450.0125 MHz / 4800 bits per second



07:12:42 AM 09/04/2024

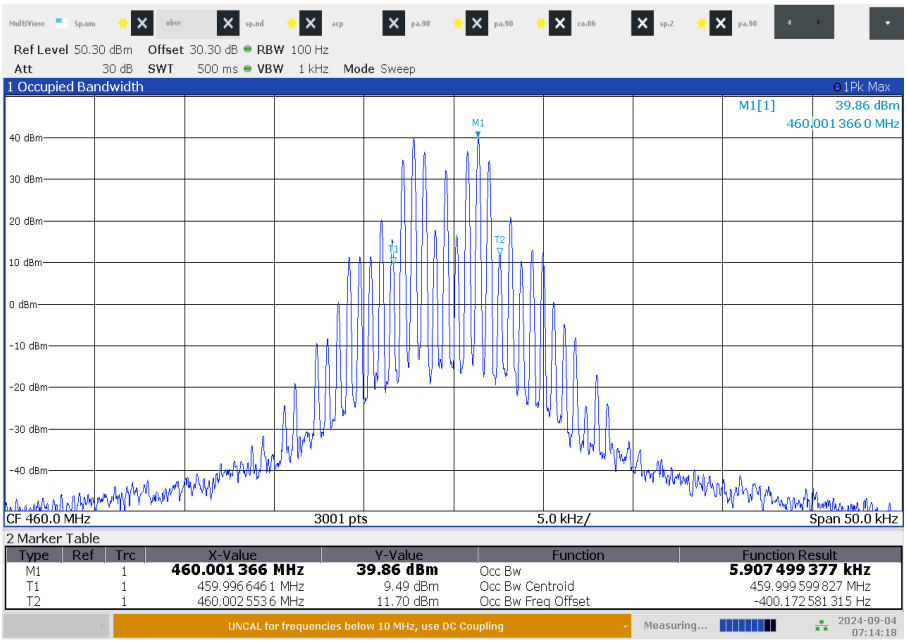
Plots 460.0 MHz

Plot 1: 460.0 MHz / 512 bits per second



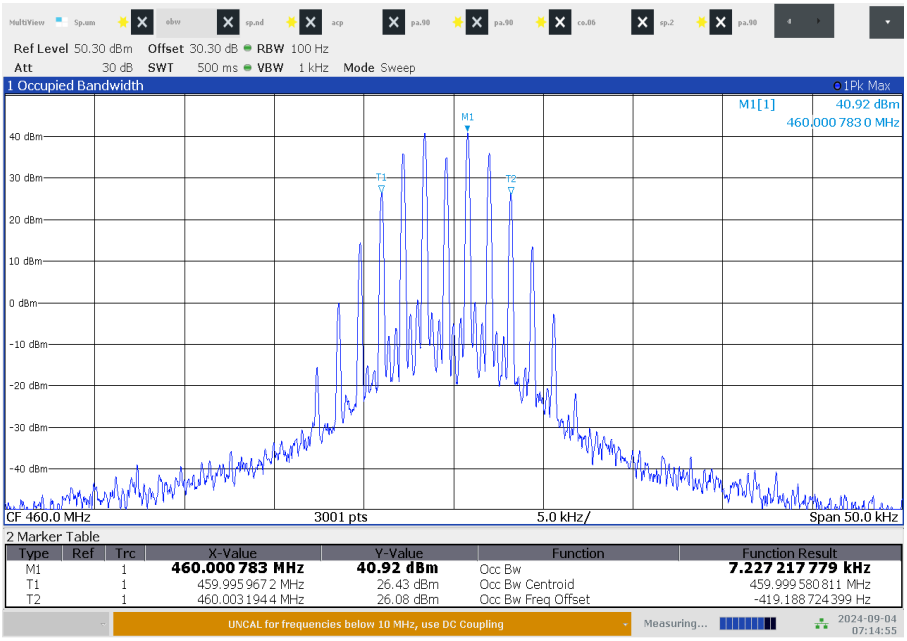
07:13:39 AM 09/04/2024

Plot 2: 460.0 MHz / 1200 bits per second



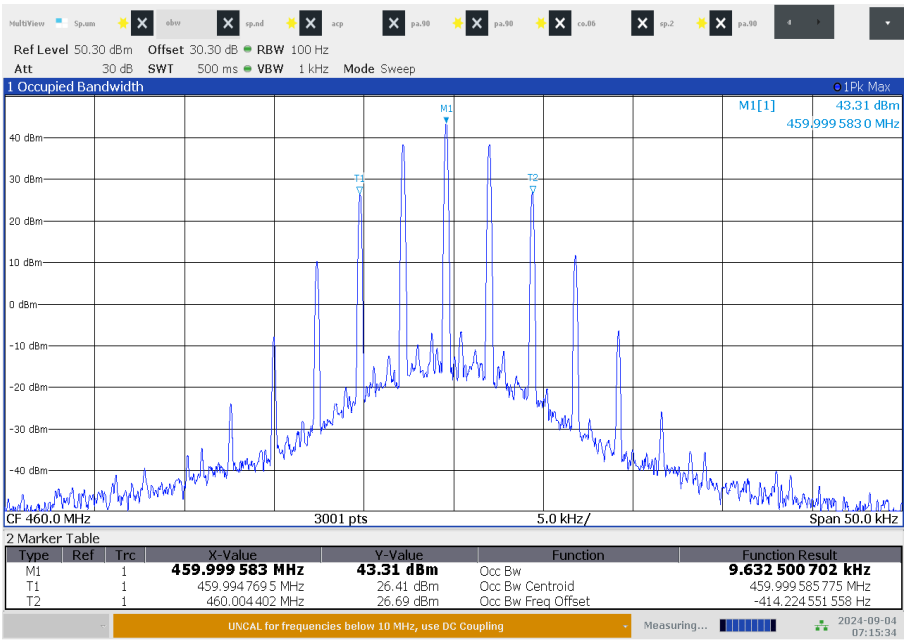
07:14:19 AM 09/04/2024

Plot 3: 460.0 MHz / 2400 bits per second



07:14:56 AM 09/04/2024

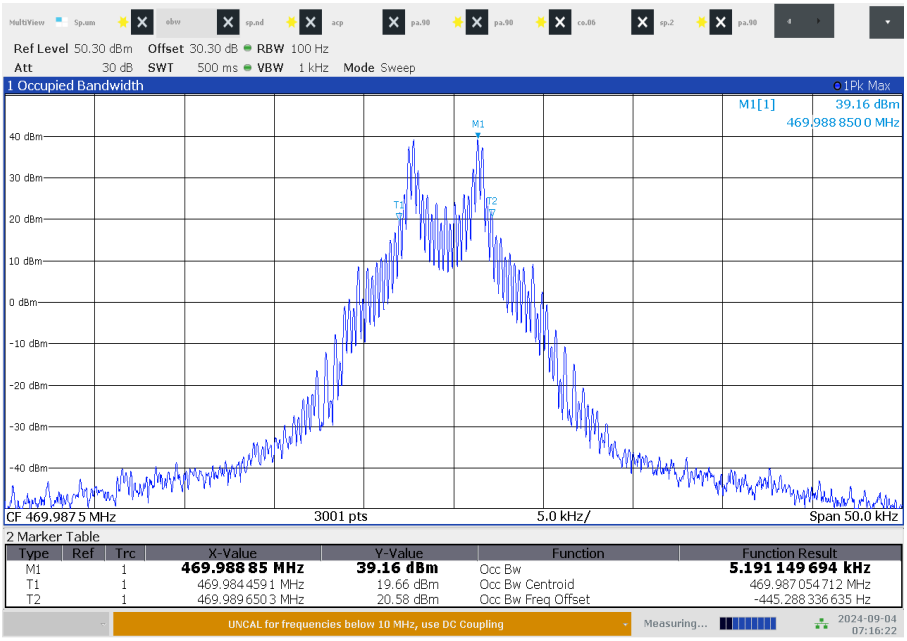
Plot 4: 460.0 MHz / 4800 bits per second



07:15:35 AM 09/04/2024

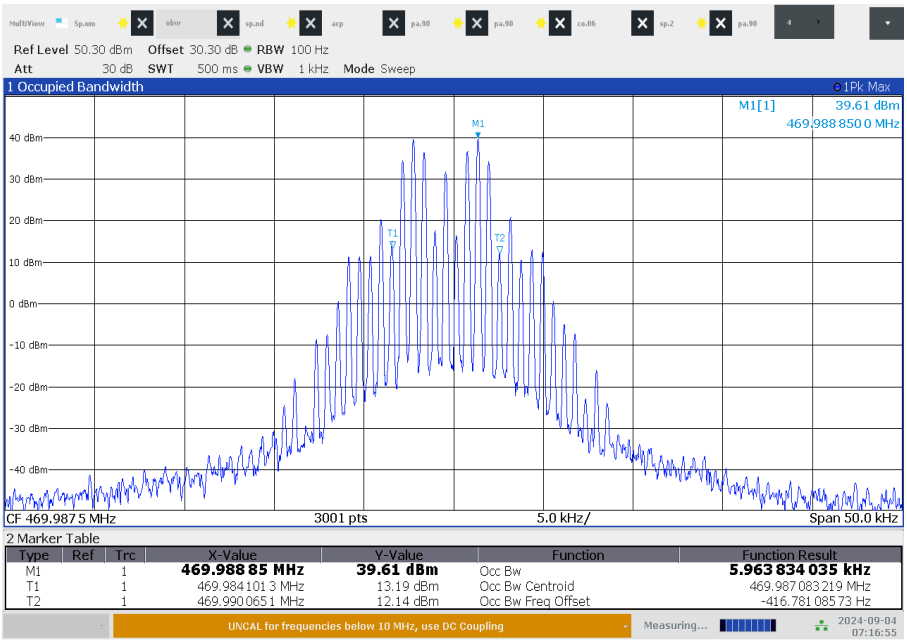
Plots 469.9875 MHz

Plot 1: 469.9875 MHz / 512 bits per second



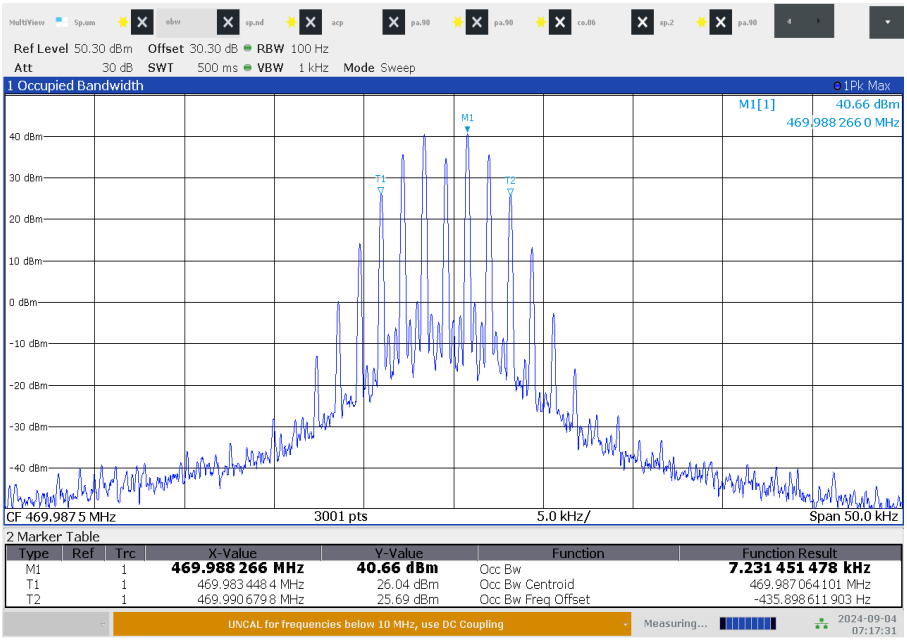
07:16:23 AM 09/04/2024

Plot 2: 469.9875 MHz / 1200 bits per second



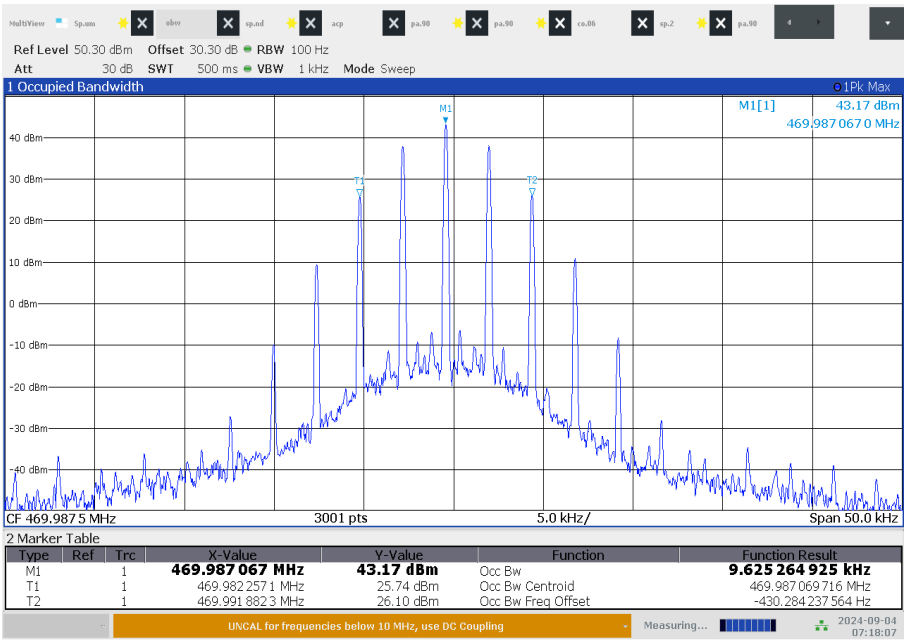
07:16:56 AM 09/04/2024

Plot 3: 469.9875 MHz / 2400 bits per second



07:17:32 AM 09/04/2024

Plot 4: 469.9875 MHz / 4800 bits per second

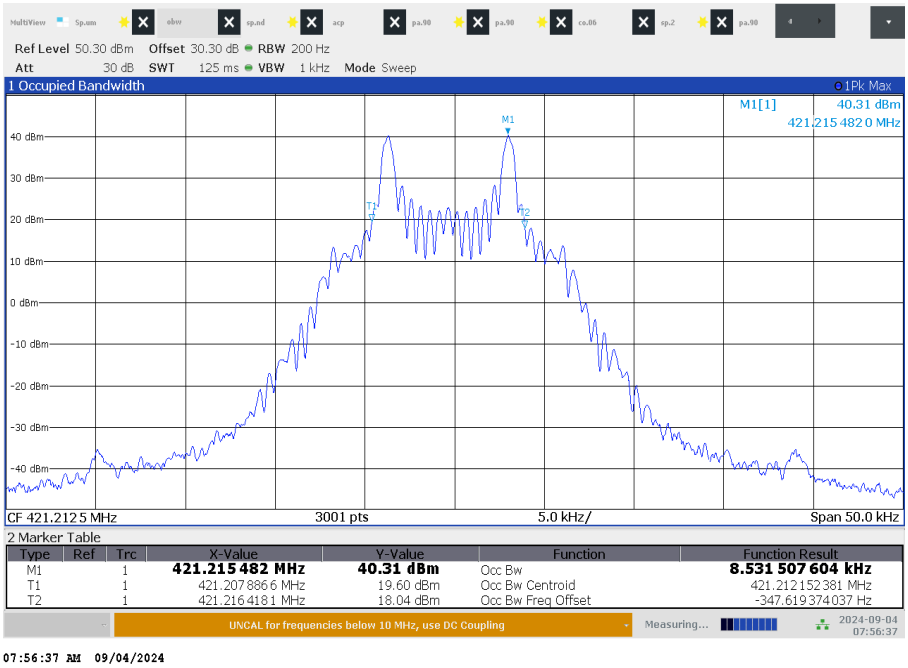


07:18:07 AM 09/04/2024

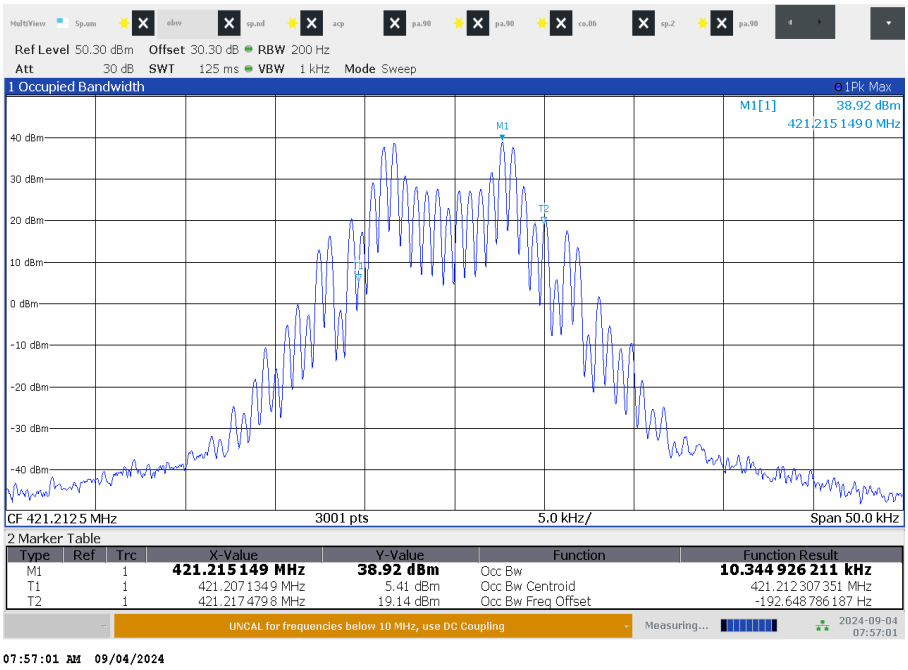
13.3.3 Plots 20 kHz bandwidth

Plots 421.2125 MHz

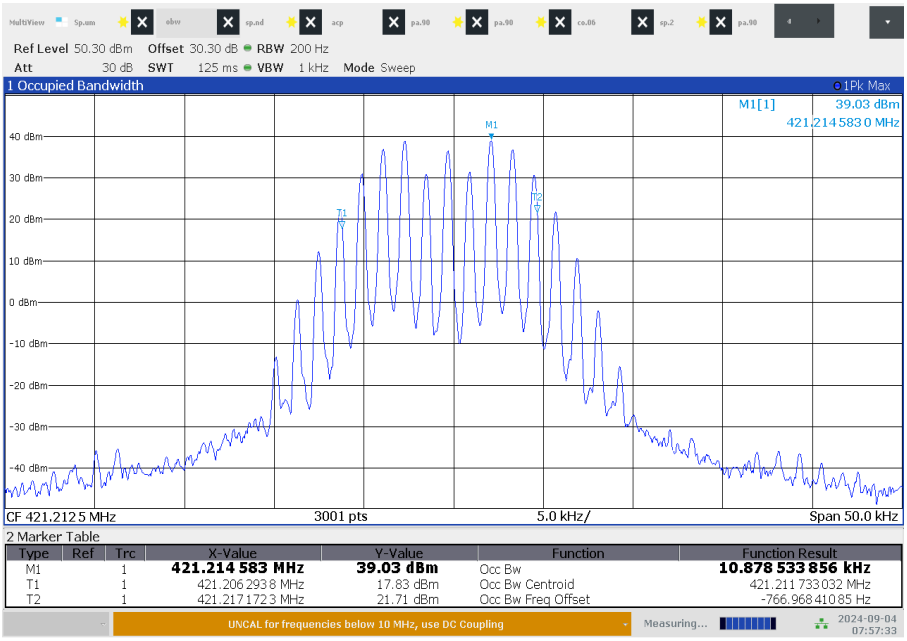
Plot 1: 421.2125 MHz / 512 bits per second



Plot 2: 421.2125 MHz / 1200 bits per second

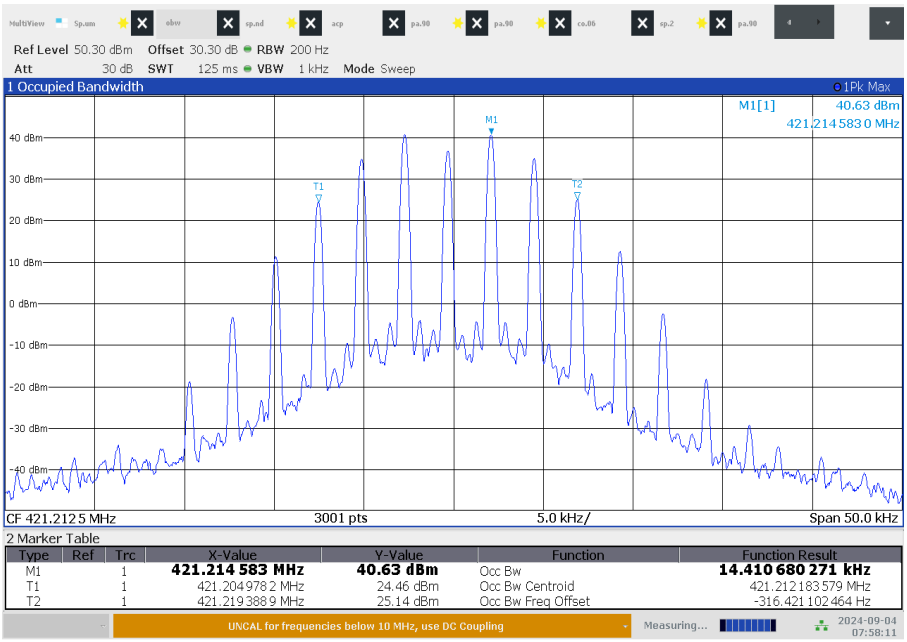


Plot 3: 421.2125 MHz / 2400 bits per second



07:57:33 AM 09/04/2024

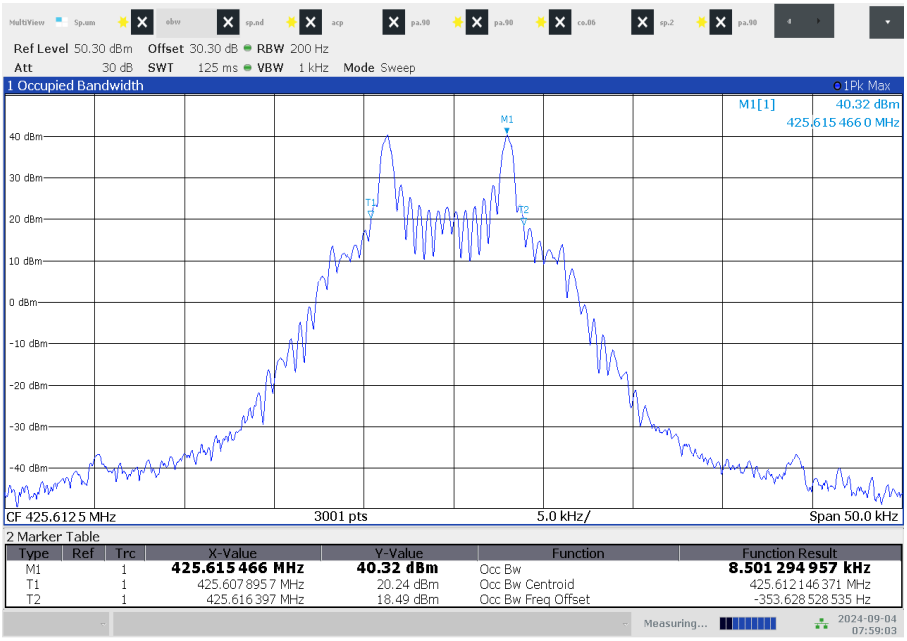
Plot 4: 421.2125 MHz / 4800 bits per second



07:58:11 AM 09/04/2024

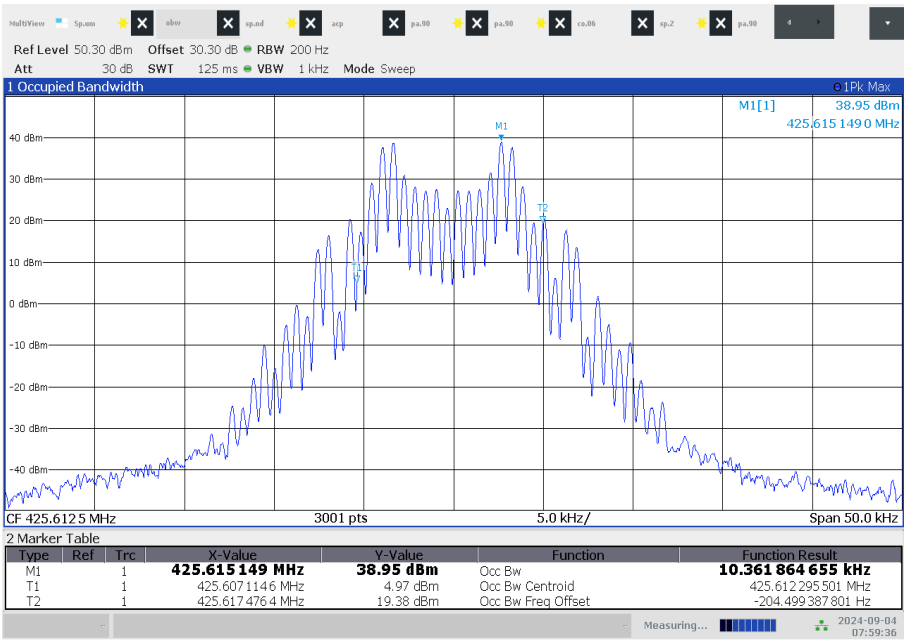
Plots 425.6125 MHz

Plot 1: 425.6125 MHz / 512 bits per second



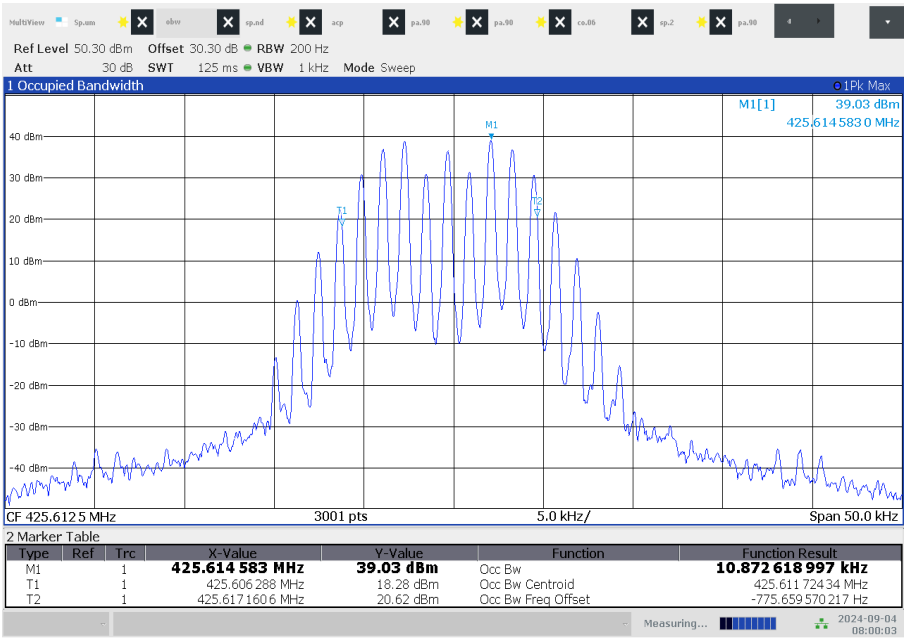
07:59:03 AM 09/04/2024

Plot 2: 425.6125 MHz / 1200 bits per second



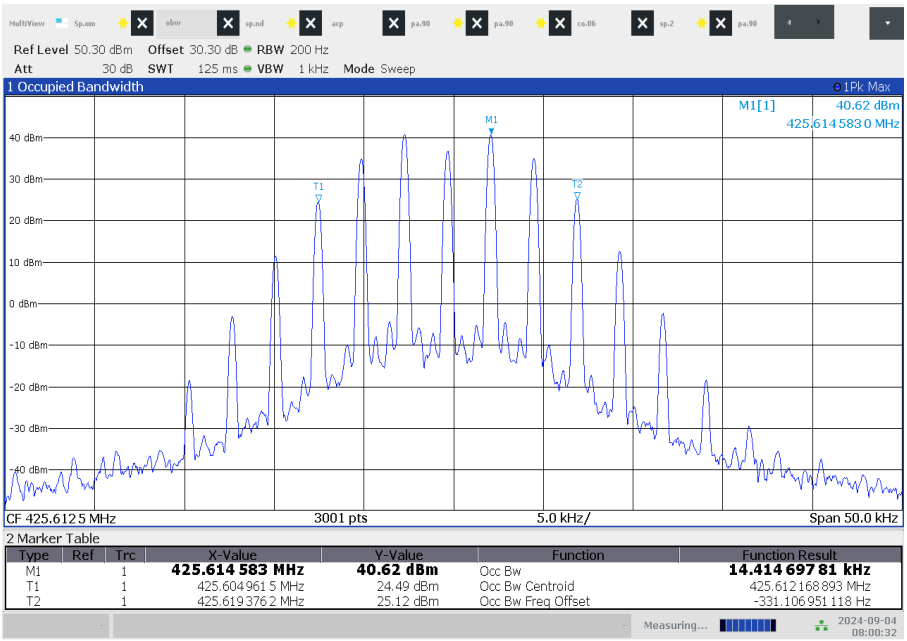
07:59:37 AM 09/04/2024

Plot 3: 425.6125 MHz / 2400 bits per second



08:00:03 AM 09/04/2024

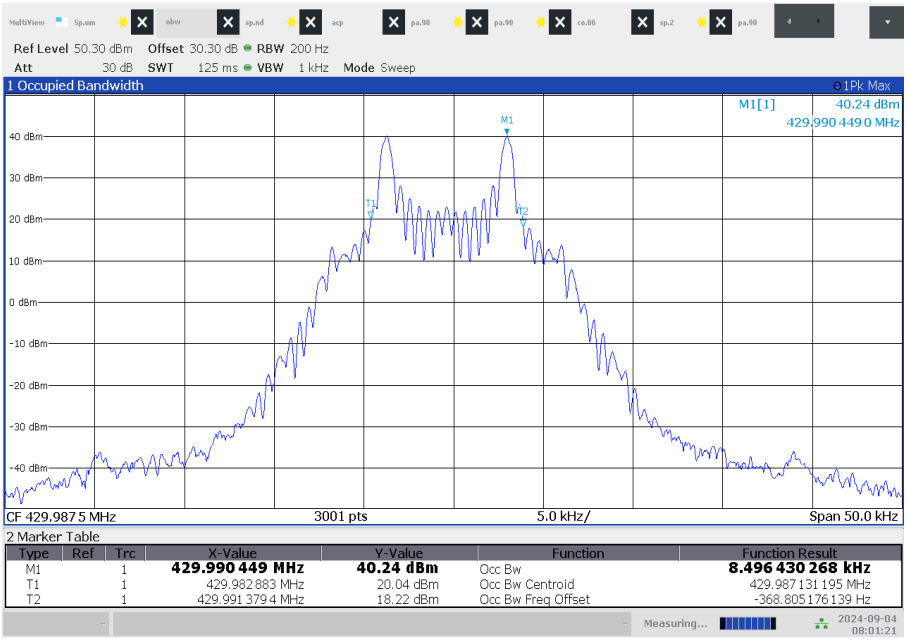
Plot 4: 425.6125 MHz / 4800 bits per second



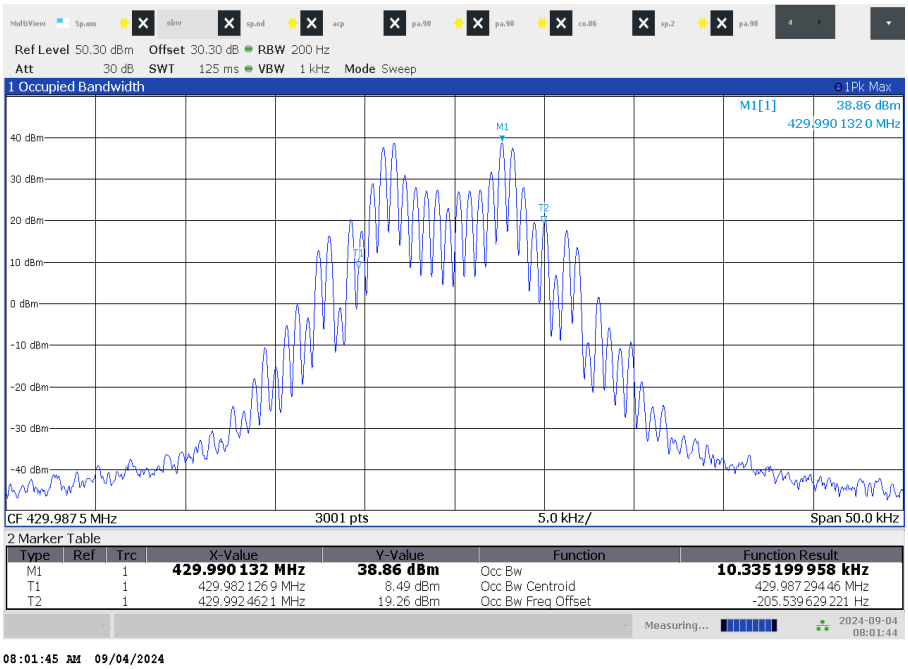
08:00:33 AM 09/04/2024

Plots 429.9875 MHz

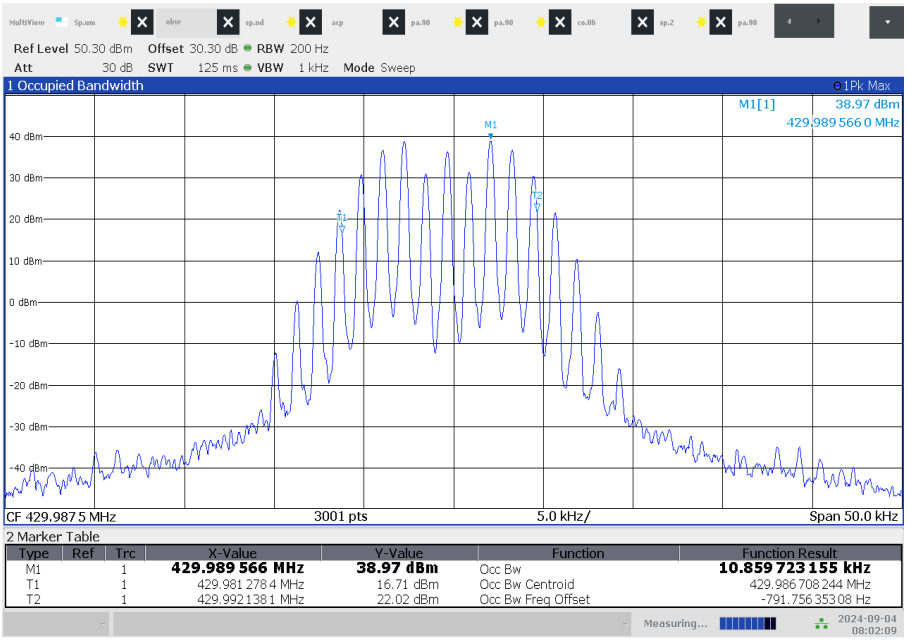
Plot 1: 429.9875 MHz / 512 bits per second



Plot 2: 429.9875 MHz / 1200 bits per second

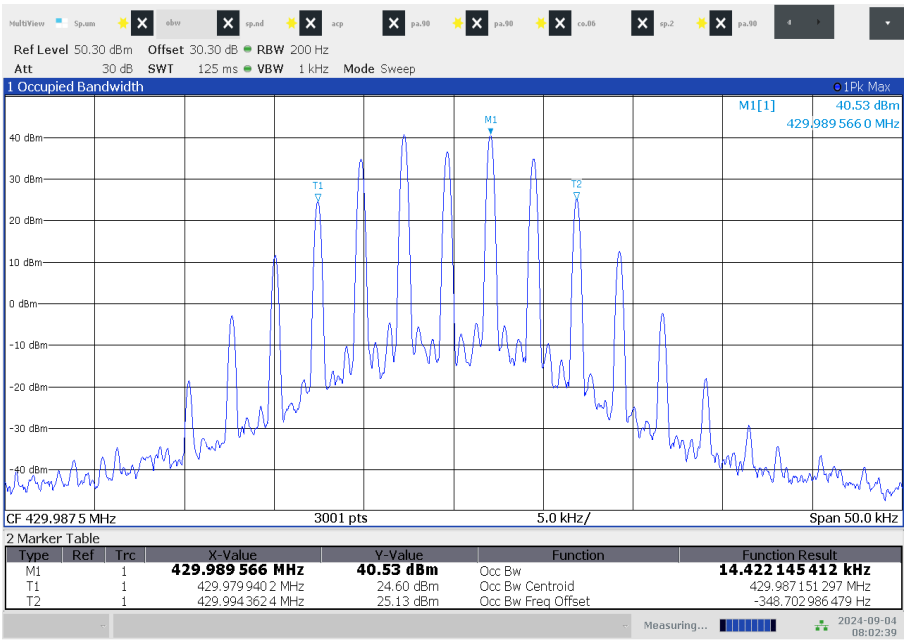


Plot 3: 429.9875 MHz / 2400 bits per second



08:02:10 AM 09/04/2024

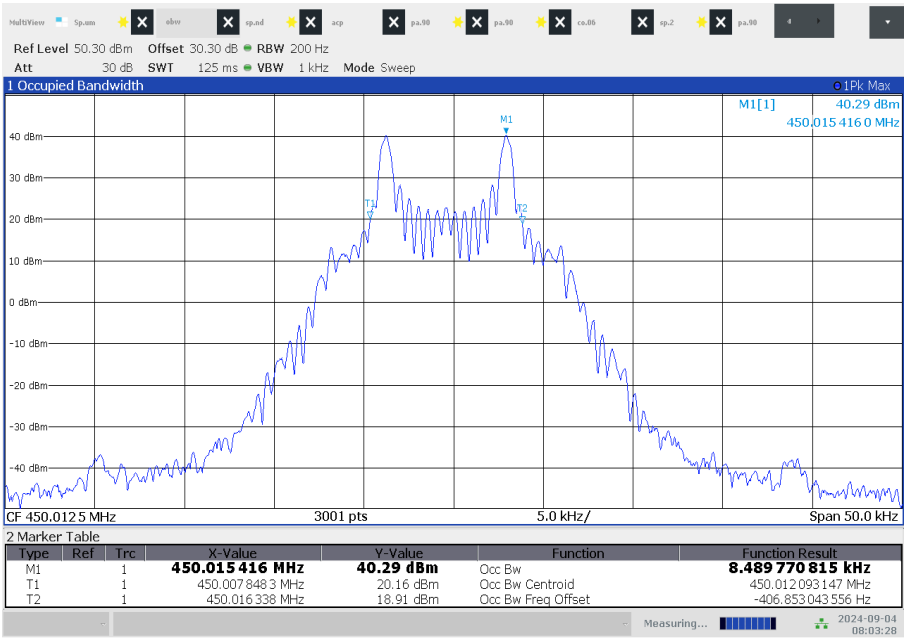
Plot 4: 429.9875 MHz / 4800 bits per second



08:02:40 AM 09/04/2024

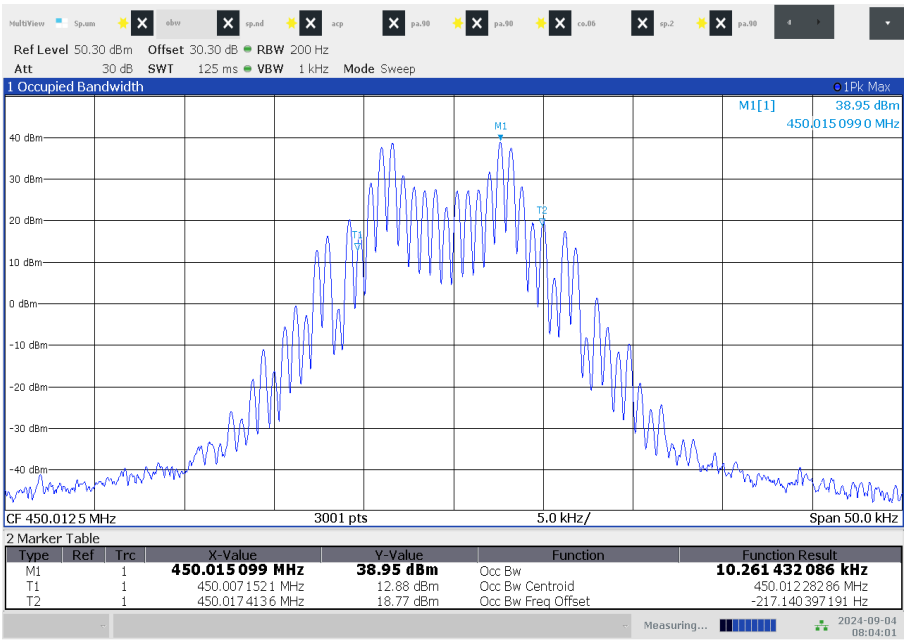
Plots 450.0125 MHz

Plot 1: 450.0125 MHz / 512 bits per second



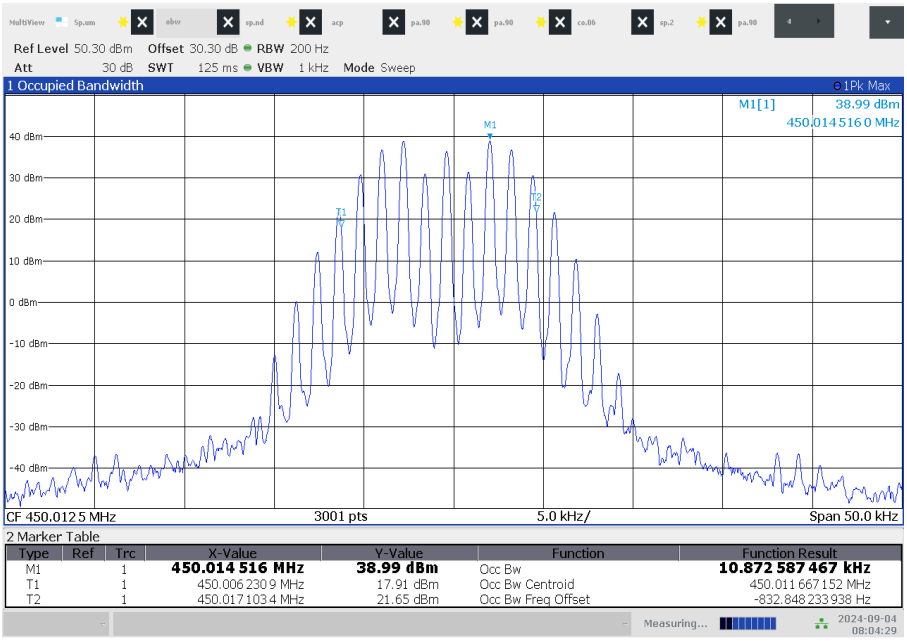
08:03:28 AM 09/04/2024

Plot 2: 450.0125 MHz / 1200 bits per second



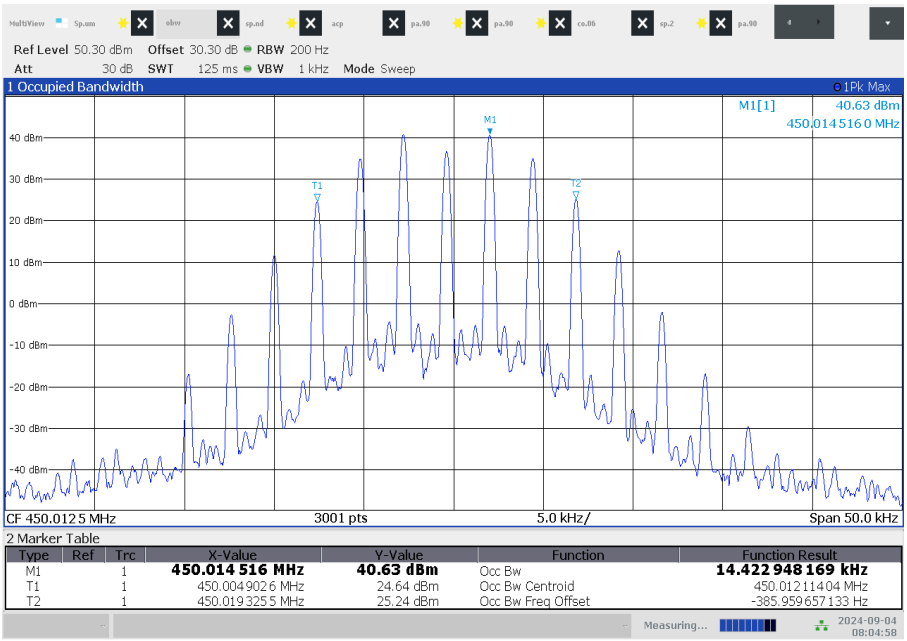
08:04:01 AM 09/04/2024

Plot 3: 450.0125 MHz / 2400 bits per second



08:04:30 AM 09/04/2024

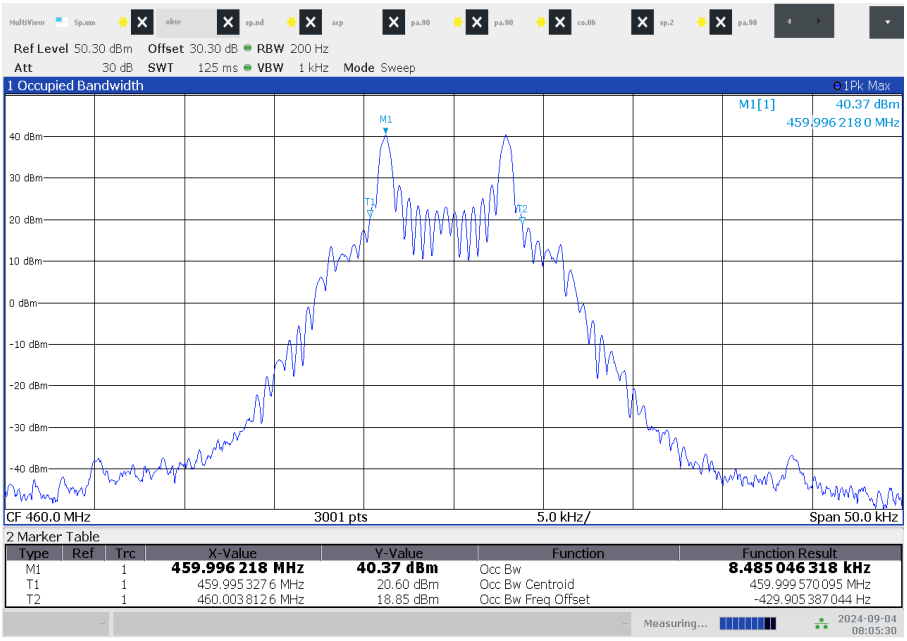
Plot 4: 450.0125 MHz / 4800 bits per second



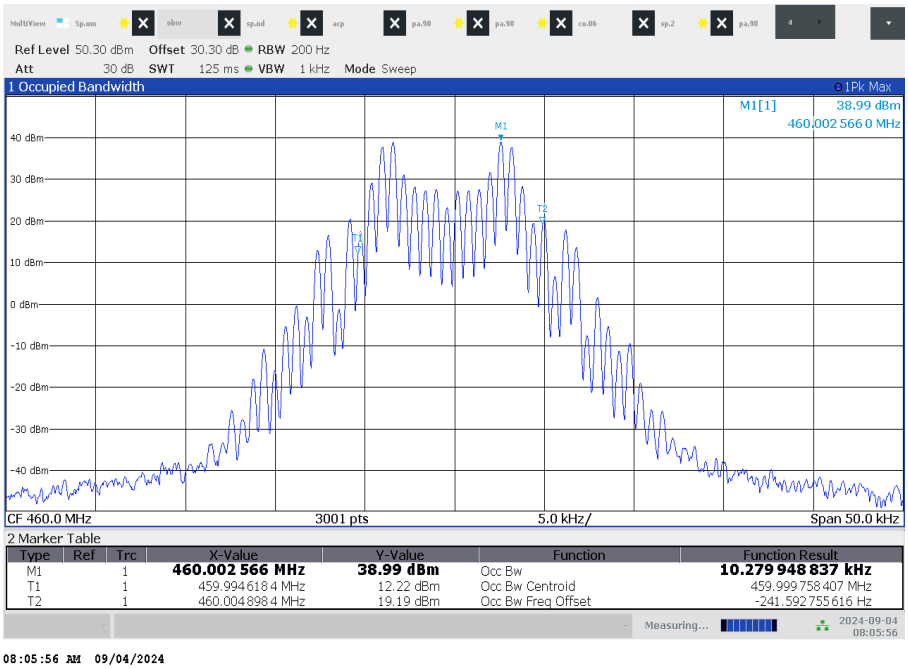
08:04:58 AM 09/04/2024

Plots 460.0 MHz

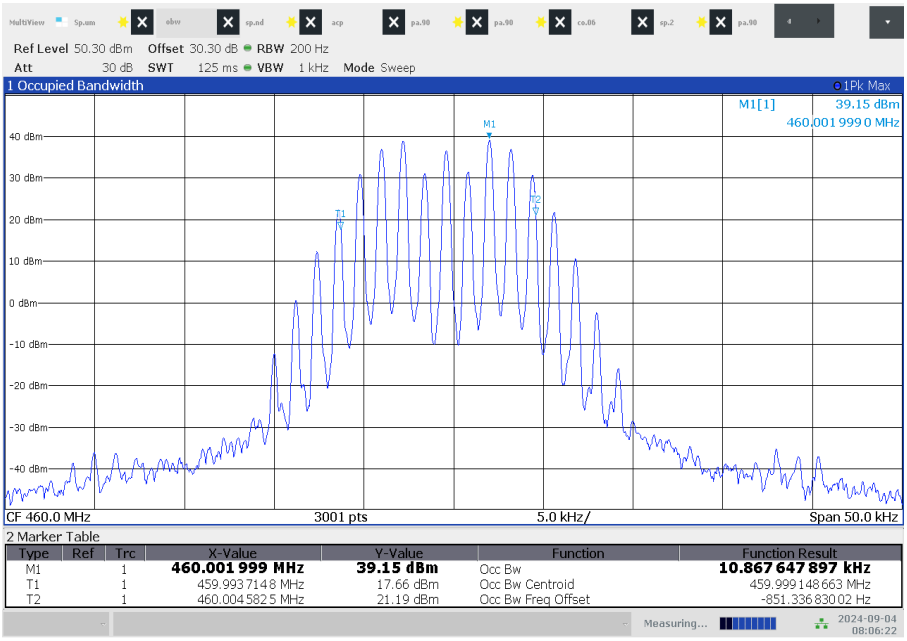
Plot 1: 460.0 MHz / 512 bits per second



Plot 2: 460.0 MHz / 1200 bits per second

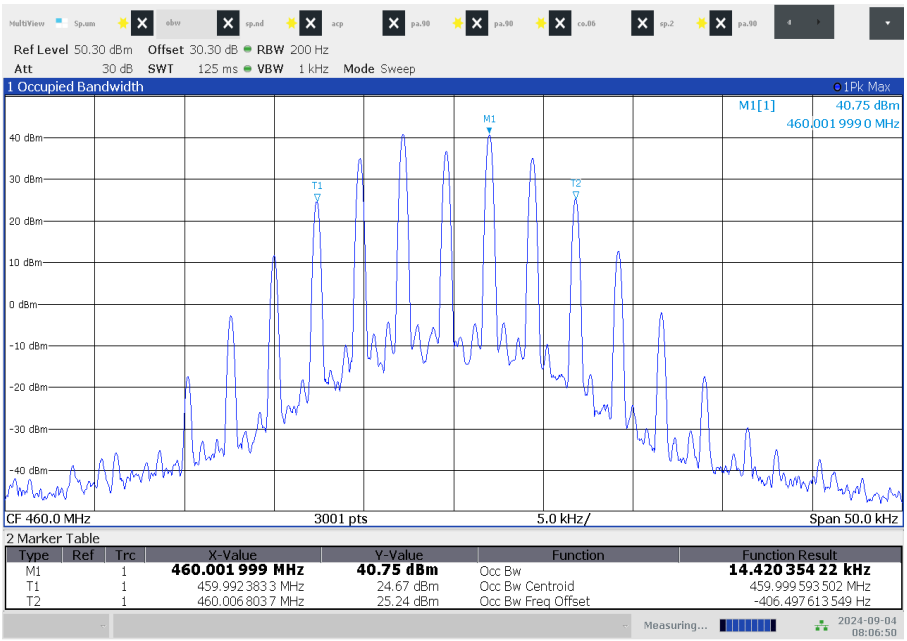


Plot 3: 460.0 MHz / 2400 bits per second



08:06:22 AM 09/04/2024

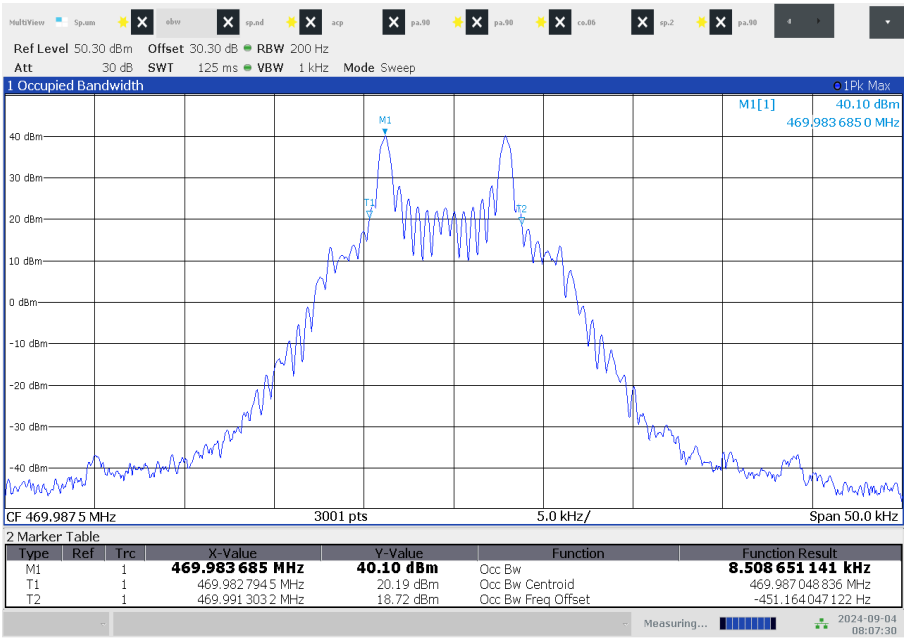
Plot 4: 460.0 MHz / 4800 bits per second



08:06:51 AM 09/04/2024

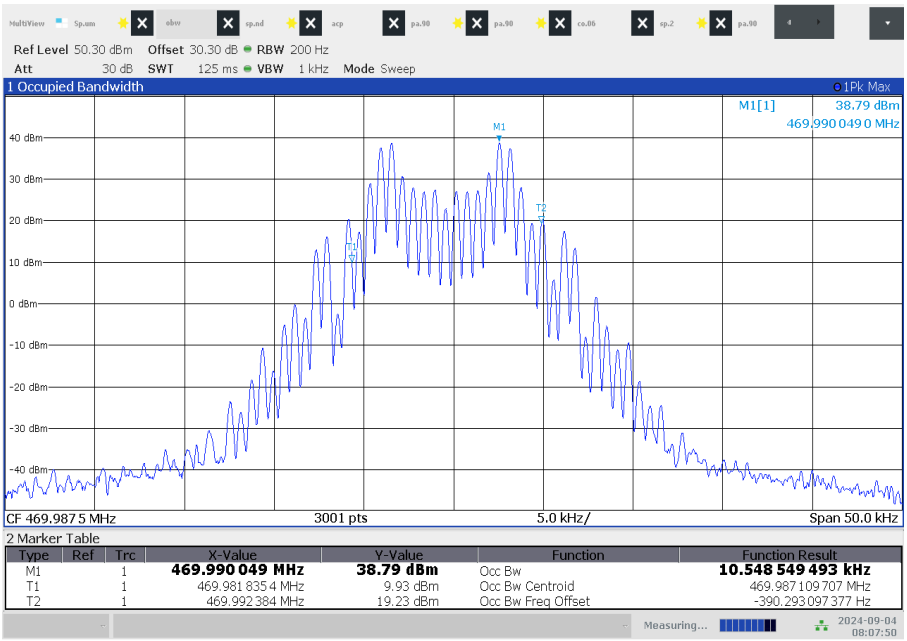
Plots 469.9875 MHz

Plot 1: 469.9875 MHz / 512 bits per second



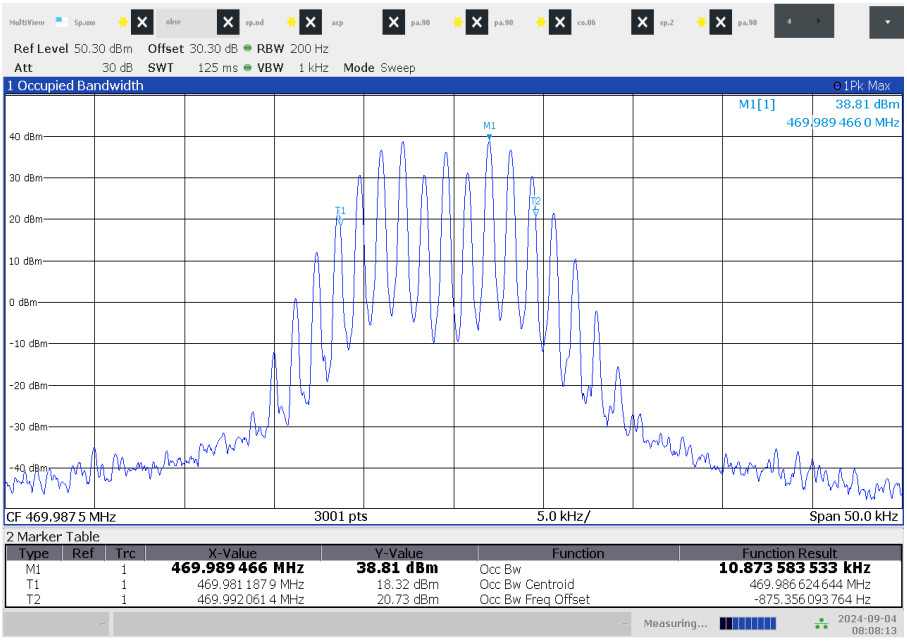
08:07:31 AM 09/04/2024

Plot 2: 469.9875 MHz / 1200 bits per second



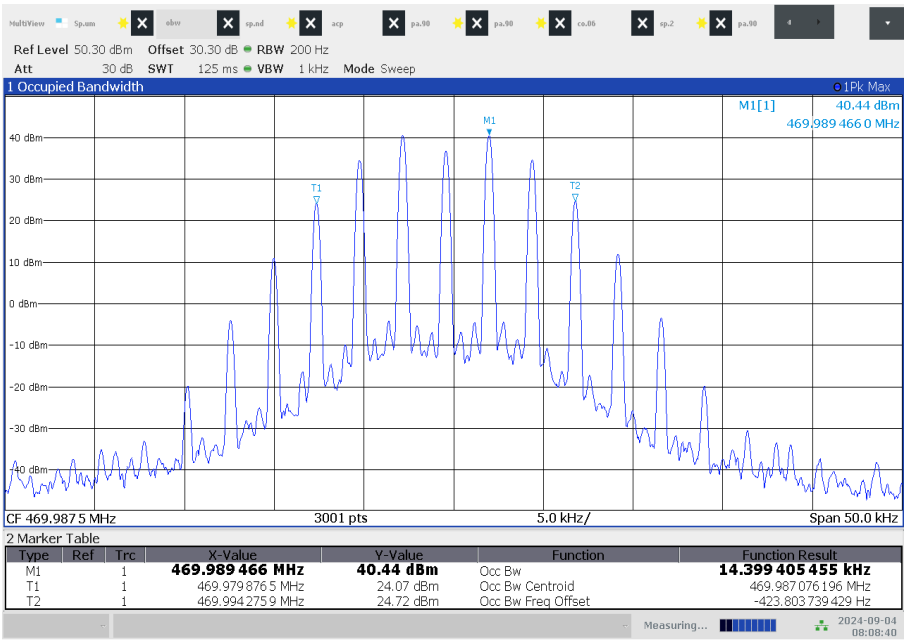
08:07:51 AM 09/04/2024

Plot 3: 469.9875 MHz / 2400 bits per second



08:08:14 AM 09/04/2024

Plot 4: 469.9875 MHz / 4800 bits per second

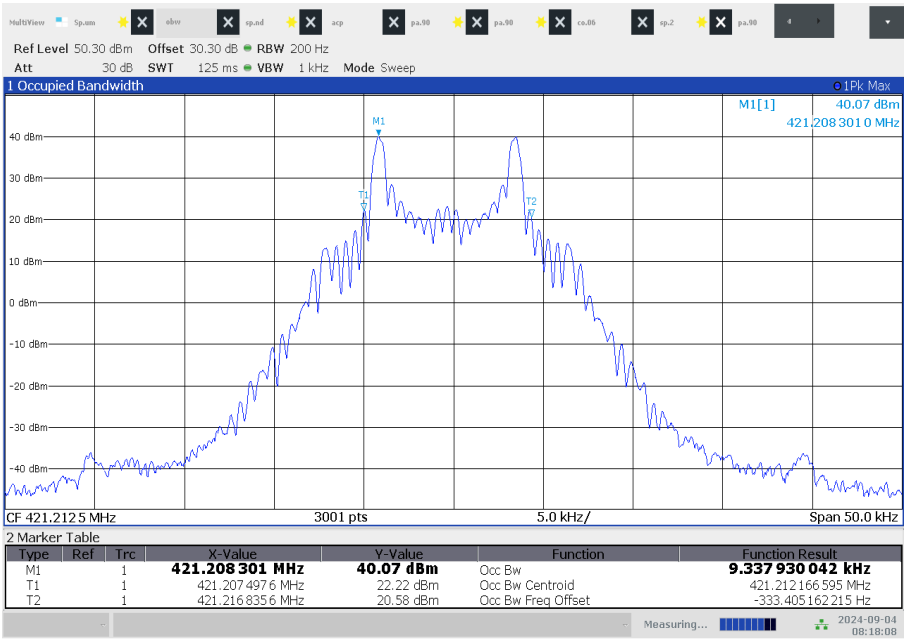


08:08:40 AM 09/04/2024

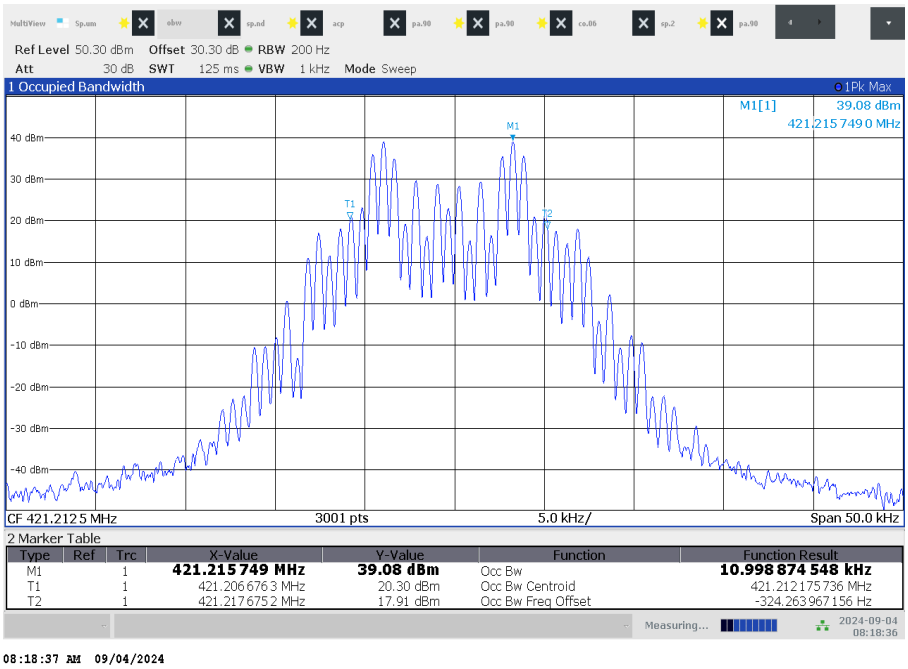
13.3.4 Plots 25 kHz bandwidth

Plots 421.2125 MHz

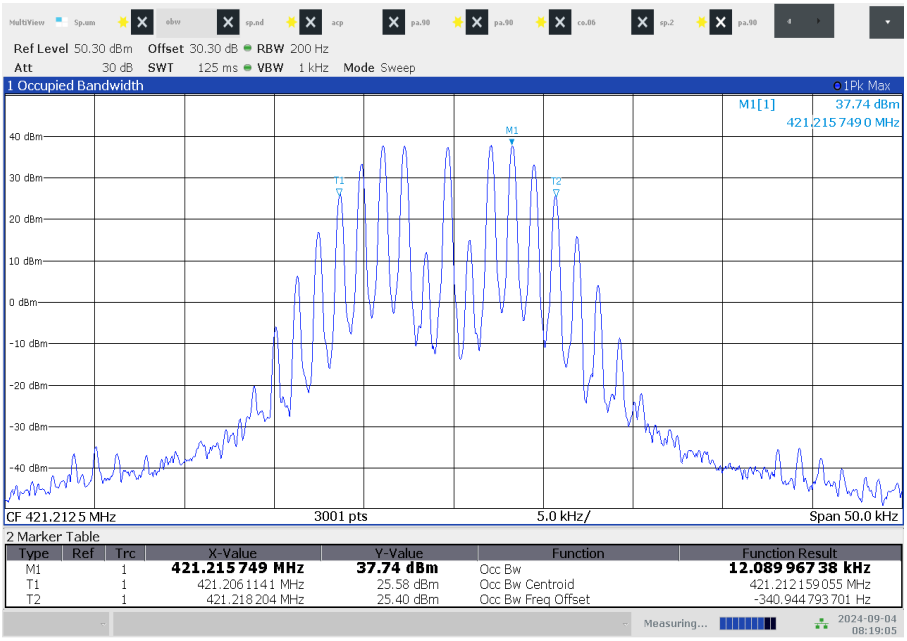
Plot 1: 421.2125 MHz / 512 bits per second



Plot 2: 421.2125 MHz / 1200 bits per second

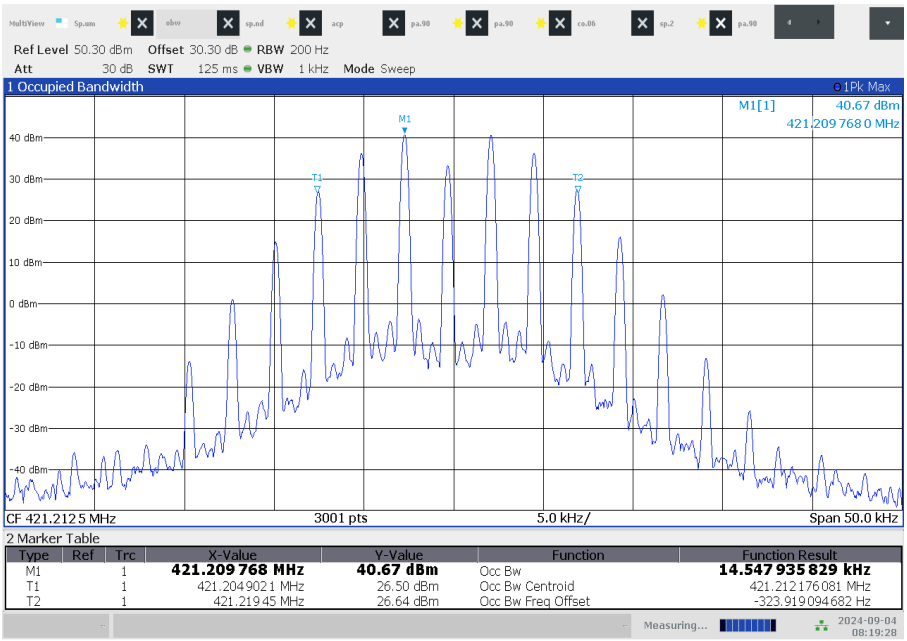


Plot 3: 421.2125 MHz / 2400 bits per second



08:19:06 AM 09/04/2024

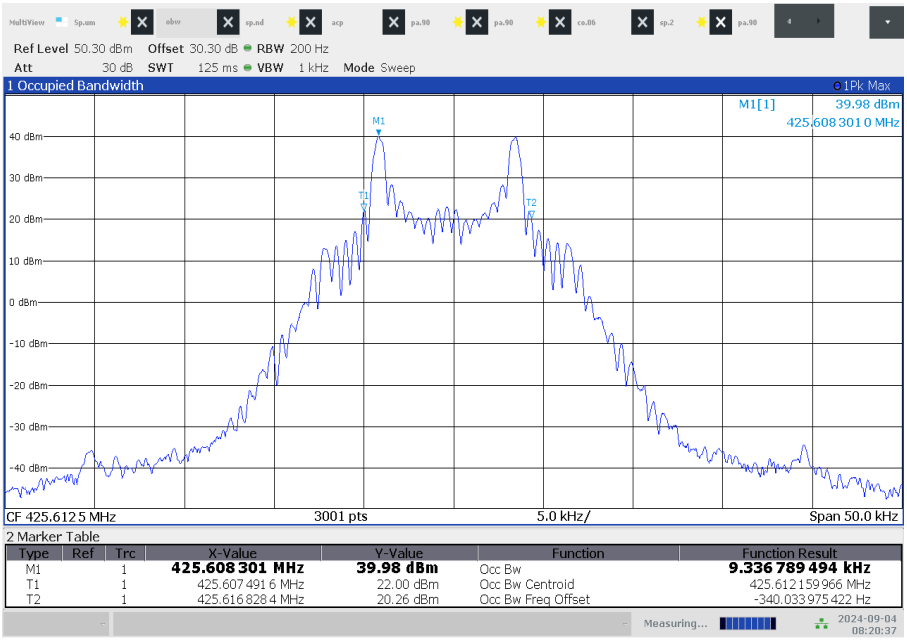
Plot 4: 421.2125 MHz / 4800 bits per second



08:19:28 AM 09/04/2024

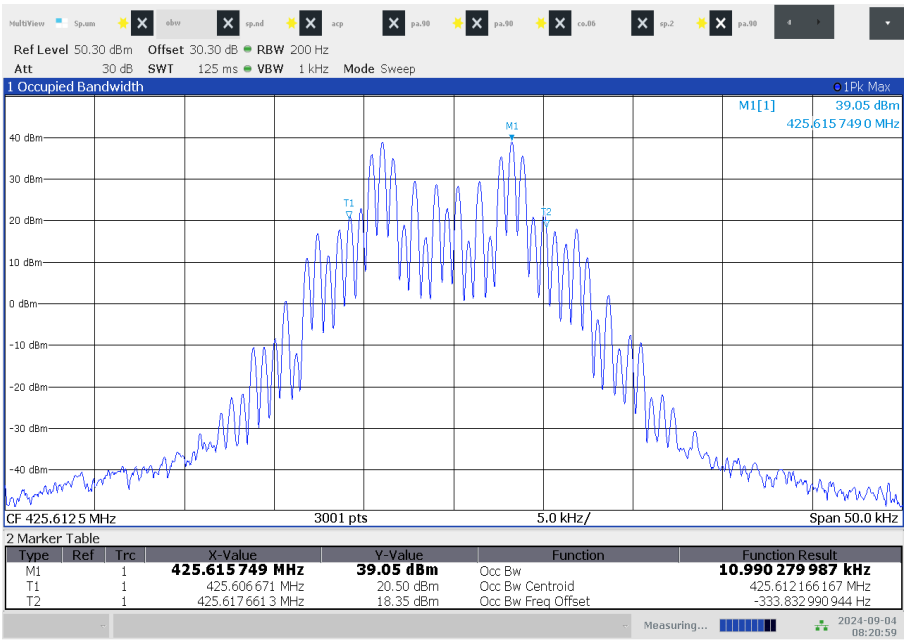
Plots 425.6125 MHz

Plot 1: 425.6125 MHz / 512 bits per second



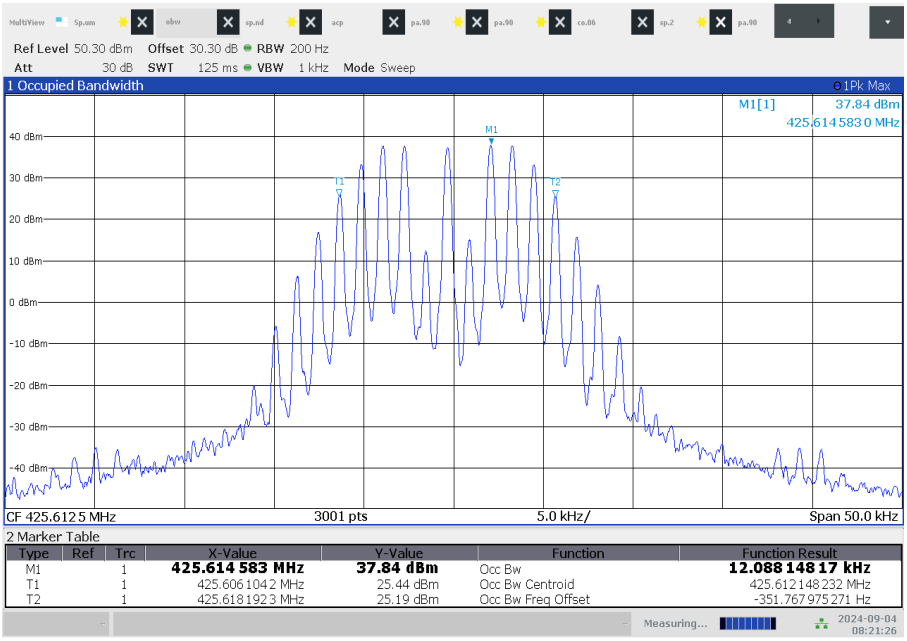
08:20:37 AM 09/04/2024

Plot 2: 425.6125 MHz / 1200 bits per second



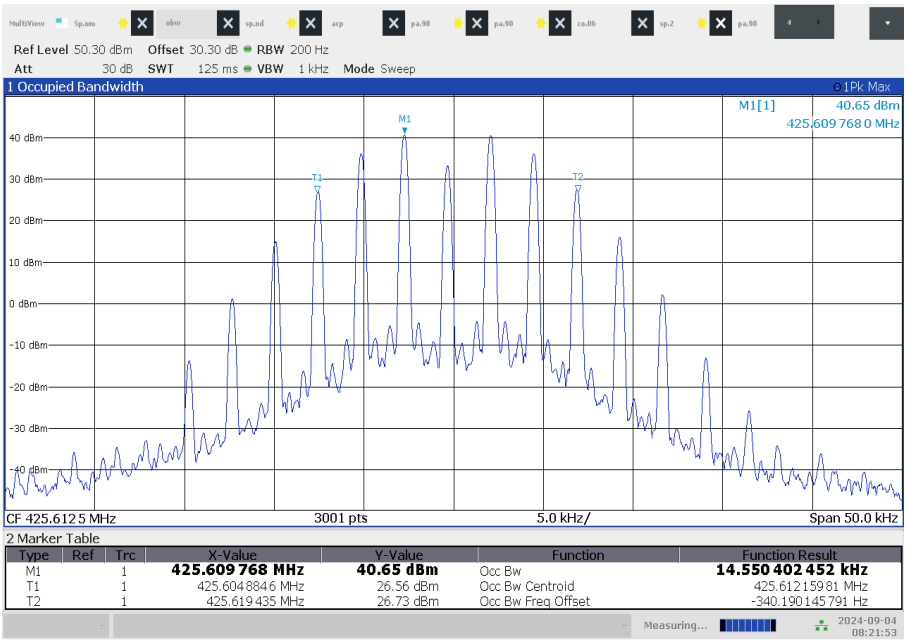
08:20:59 AM 09/04/2024

Plot 3: 425.6125 MHz / 2400 bits per second



08:21:27 AM 09/04/2024

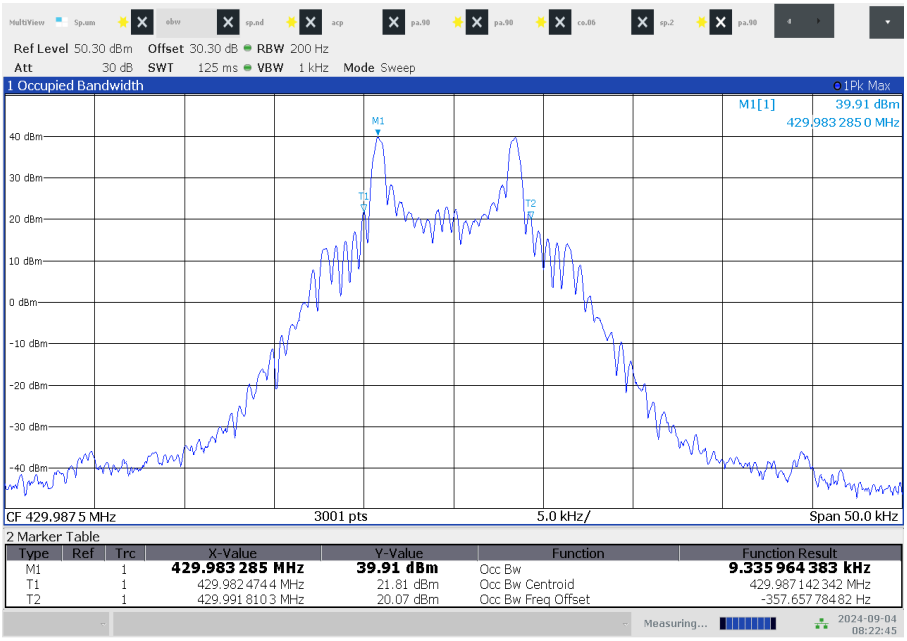
Plot 4: 425.6125 MHz / 4800 bits per second



08:21:53 AM 09/04/2024

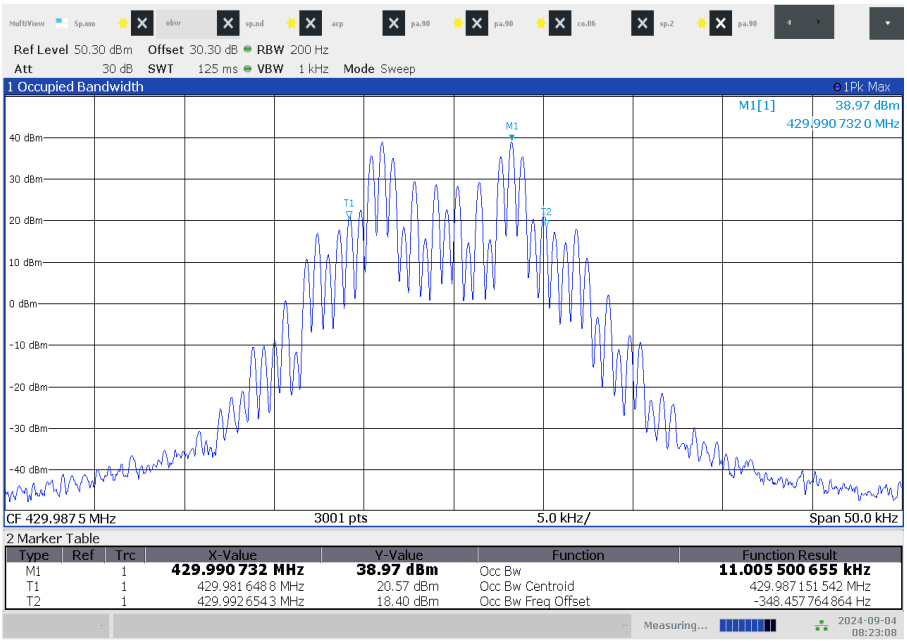
Plots 429.9875 MHz

Plot 1: 429.9875 MHz / 512 bits per second



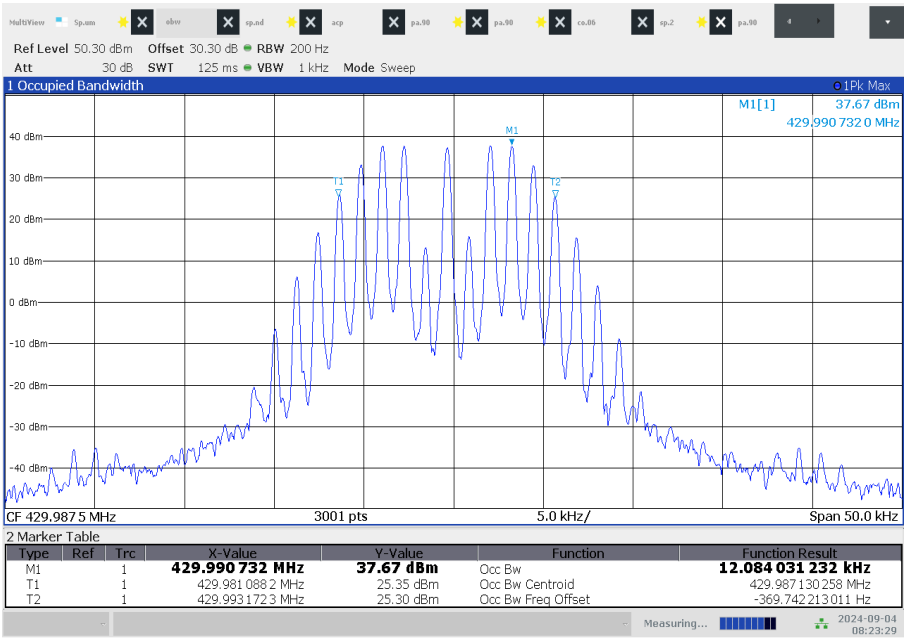
08:22:45 AM 09/04/2024

Plot 2: 429.9875 MHz / 1200 bits per second



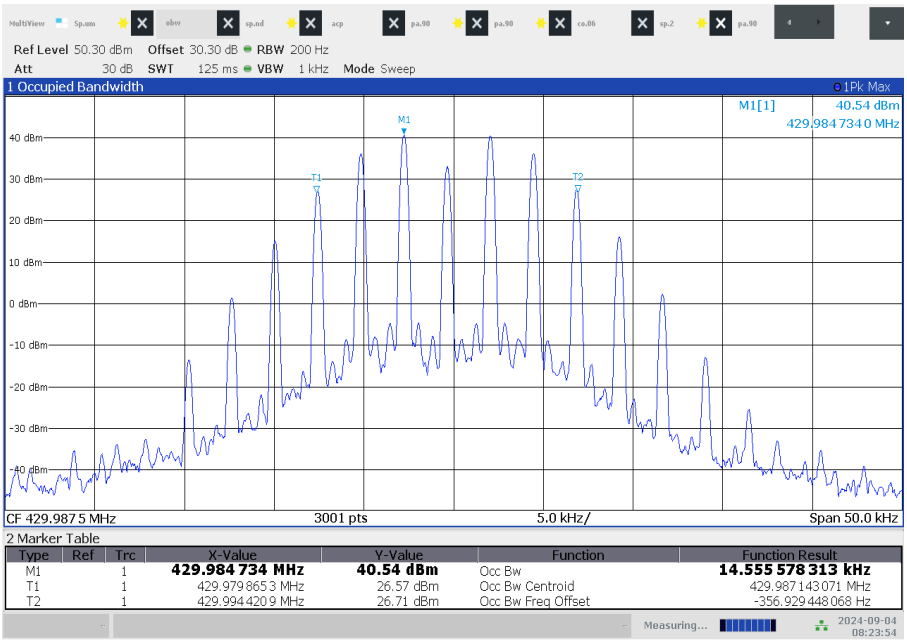
08:23:08 AM 09/04/2024

Plot 3: 429.9875 MHz / 2400 bits per second



08:23:29 AM 09/04/2024

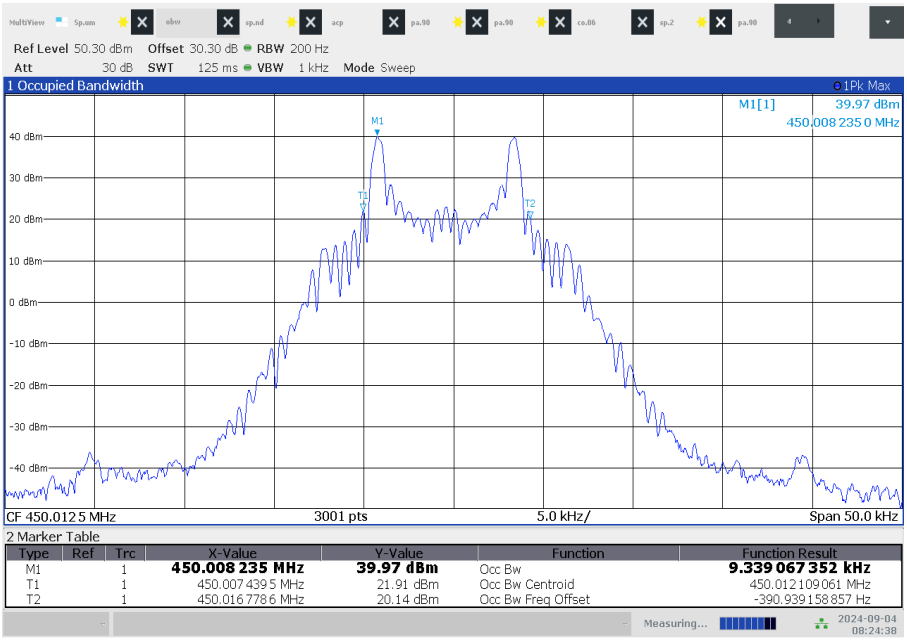
Plot 4: 429.9875 MHz / 4800 bits per second



08:23:55 AM 09/04/2024

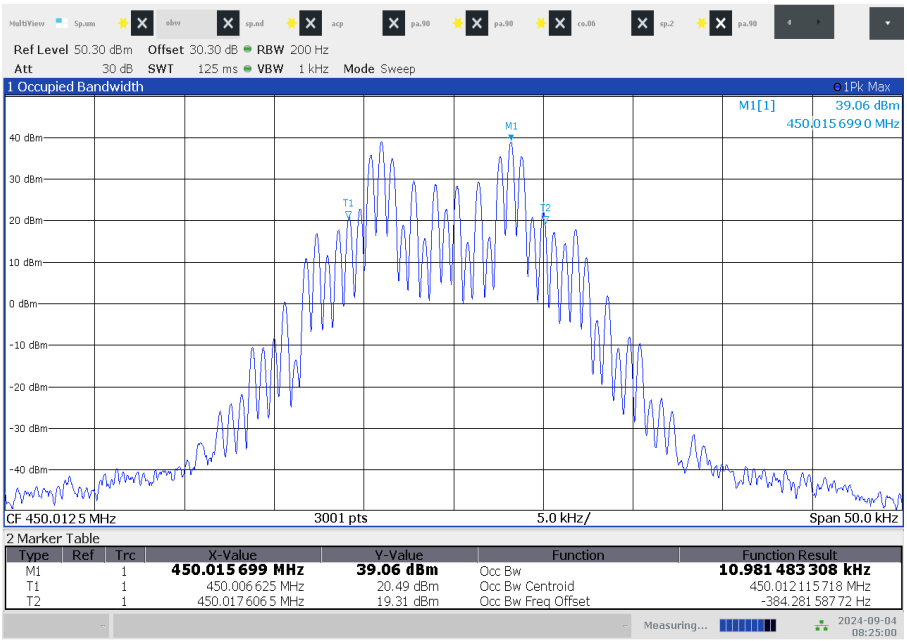
Plots 450.0125 MHz

Plot 1: 450.0125 MHz / 512 bits per second



08:24:38 AM 09/04/2024

Plot 2: 450.0125 MHz / 1200 bits per second



08:25:00 AM 09/04/2024