



## TEST REPORT

BNetzA-CAB-02/21-102

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

### Testing laboratory

**CTC advanced GmbH**

Untertuerkheimer Strasse 6 – 10

66117 Saarbruecken / Germany

Phone: + 49 681 5 98 - 0

Fax: + 49 681 5 98 - 9075

Internet: <https://www.ctcadvanced.com>

e-mail: [mail@ctcadvanced.com](mailto:mail@ctcadvanced.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 starting with the registration number: D-PL-12076-01.

### Applicant

**Berlinger & Co.AG**

Mitteldorfstrasse 2

9608 Ganterschwil / SWITZERLAND

Phone: +41 71 982 88 11

Contact: Bernd Heisterkamp

e-mail: [RnD@berlinger.com](mailto:RnD@berlinger.com)

### 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

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:

Andreas Luckenbill  
Head of Department  
Radio Communications

### Test performed:

Marco Bertolino  
Lab Manager  
Radio Communications

## 1 Table of contents

<b>1</b>	<b>Table of contents .....</b>	<b>2</b>
<b>2</b>	<b>General information .....</b>	<b>4</b>
2.1	Notes and disclaimer .....	4
2.2	Application details .....	4
2.3	Test laboratories sub-contracted .....	4
<b>3</b>	<b>Test standard/s, references and accreditations .....</b>	<b>5</b>
<b>4</b>	<b>Reporting statements of conformity – decision rule .....</b>	<b>6</b>
<b>5</b>	<b>Test environment .....</b>	<b>7</b>
<b>6</b>	<b>Test item.....</b>	<b>7</b>
6.1	General description .....	7
6.2	Additional information .....	7
<b>7</b>	<b>Description of the test setup.....</b>	<b>8</b>
7.1	Shielded semi anechoic chamber .....	9
7.2	Shielded fully anechoic chamber.....	10
7.3	Radiated measurements > 18 GHz.....	11
7.4	Conducted measurements normal and extreme conditions.....	12
<b>8</b>	<b>Sequence of testing .....</b>	<b>13</b>
8.1	Sequence of testing radiated spurious 9 kHz to 30 MHz .....	13
8.2	Sequence of testing radiated spurious 30 MHz to 1 GHz .....	14
8.3	Sequence of testing radiated spurious 1 GHz to 18 GHz .....	15
8.4	Sequence of testing radiated spurious above 18 GHz .....	16
<b>9</b>	<b>Measurement uncertainty .....</b>	<b>17</b>
<b>10</b>	<b>Additional information and comments .....</b>	<b>17</b>
<b>11</b>	<b>Summary of measurement results.....</b>	<b>18</b>
11.1	Part 22/RSS-132: LTE band 5 .....	18
<b>12</b>	<b>RF measurements .....</b>	<b>19</b>
12.1	Description of test setup .....	19
12.2	Results LTE band 5.....	19
12.2.1	RF output power .....	19
12.2.2	Frequency stability .....	21
12.2.3	Spurious emissions radiated.....	23
12.2.4	Spurious emissions conducted.....	30
12.2.5	Block edge compliance.....	47
12.2.6	Occupied bandwidth.....	58
<b>13</b>	<b>Summary of measurement results.....</b>	<b>87</b>
13.1	Part 24/RSS-133: LTE band 2 .....	87
<b>14</b>	<b>RF measurements .....</b>	<b>88</b>
14.1	Description of test setup .....	88
14.2	Results LTE band 2.....	88

14.2.1	RF output power .....	88
14.2.2	Frequency stability .....	91
14.2.3	Spurious emissions radiated .....	93
14.2.4	Spurious emissions conducted .....	100
14.2.5	Block edge compliance .....	117
14.2.6	Occupied bandwidth .....	128
<b>15</b>	<b>Summary of measurement results .....</b>	<b>157</b>
<b>15.1</b>	<b>Part 27/RSS-139: LTE band 4 .....</b>	<b>157</b>
<b>15.2</b>	<b>Part 27/RSS-130: LTE band 12 .....</b>	<b>158</b>
<b>15.3</b>	<b>Part 27/RSS-130: LTE band 13 .....</b>	<b>158</b>
<b>16</b>	<b>RF measurements .....</b>	<b>159</b>
<b>16.1</b>	<b>Description of test setup .....</b>	<b>159</b>
<b>16.2</b>	<b>Results LTE band 4 .....</b>	<b>159</b>
16.2.1	RF output power .....	159
16.2.2	Frequency stability .....	162
16.2.3	Spurious emissions radiated .....	164
16.2.4	Spurious emissions conducted .....	171
16.2.5	Block edge compliance .....	188
16.2.6	Occupied bandwidth .....	199
<b>16.3</b>	<b>Results LTE band 12 .....</b>	<b>228</b>
16.3.1	RF output power .....	228
16.3.2	Frequency stability .....	231
16.3.3	Spurious emissions radiated .....	233
16.3.4	Spurious emissions conducted .....	239
16.3.5	Block edge compliance .....	255
16.3.6	Occupied bandwidth .....	265
<b>16.4</b>	<b>Results LTE band 13 .....</b>	<b>294</b>
16.4.1	RF output power .....	294
16.4.2	Frequency stability .....	296
16.4.3	Spurious emissions radiated .....	298
16.4.4	Spurious emissions conducted .....	304
16.4.5	Block edge compliance .....	320
16.4.6	Occupied bandwidth .....	330
<b>17</b>	<b>Observations .....</b>	<b>359</b>
<b>18</b>	<b>Glossary .....</b>	<b>360</b>
<b>19</b>	<b>Document history .....</b>	<b>361</b>
<b>20</b>	<b>Accreditation Certificate – D-PL-12076-01-04 .....</b>	<b>361</b>
<b>21</b>	<b>Accreditation Certificate – D-PL-12076-01-05 .....</b>	<b>362</b>

## 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.

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 CTC advanced GmbH.

The testing service provided by CTC advanced GmbH has been rendered under the current "General Terms and Conditions for CTC advanced GmbH".

CTC 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 CTC 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 CTC advanced GmbH test report include or imply any product or service warranties from CTC advanced GmbH, including, without limitation, any implied warranties of merchantability, fitness for purpose, or non-infringement, all of which are expressly disclaimed by CTC advanced GmbH.

All rights and remedies regarding vendor's products and services for which CTC advanced GmbH has prepared this test report shall be provided by the party offering such products or services and not by CTC 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:	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 <a href="https://www.dakks.de/as/ast/d/D-PL-12076-01-04e.pdf">https://www.dakks.de/as/ast/d/D-PL-12076-01-04e.pdf</a>
D-PL-12076-01-05	Telecommunication FCC requirements <a href="https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf">https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf</a>



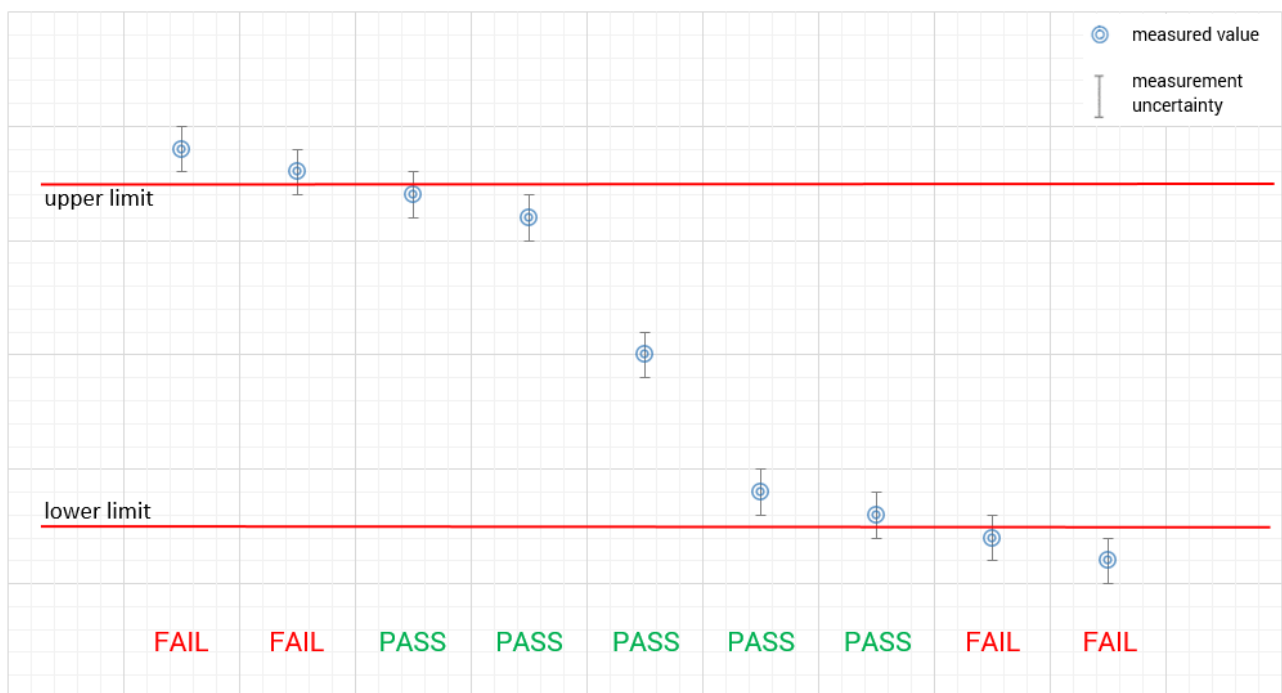
ISED Testing Laboratory Recognized Listing Number: DE0001  
FCC designation number: DE0002

#### 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."

measured value, measurement uncertainty, verdict



## 5 Test environment

Temperature	:	T <sub>nom</sub>	+20 °C during room temperature tests
		T <sub>max</sub>	+75 °C during high temperature tests
		T <sub>min</sub>	-30 °C during low temperature tests
Relative humidity content	:		42 %
Barometric pressure	:		1018 hpa
Power supply	:	V <sub>nom</sub>	5 V DC by external mains adapter
			3.6 V DC by battery
		V <sub>max</sub>	4.0
		V <sub>min</sub>	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
		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	:	modulated carrier	
Use of frequency spectrum	:		
Type of modulation	:	BPSK and QPSK	
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	

### 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.

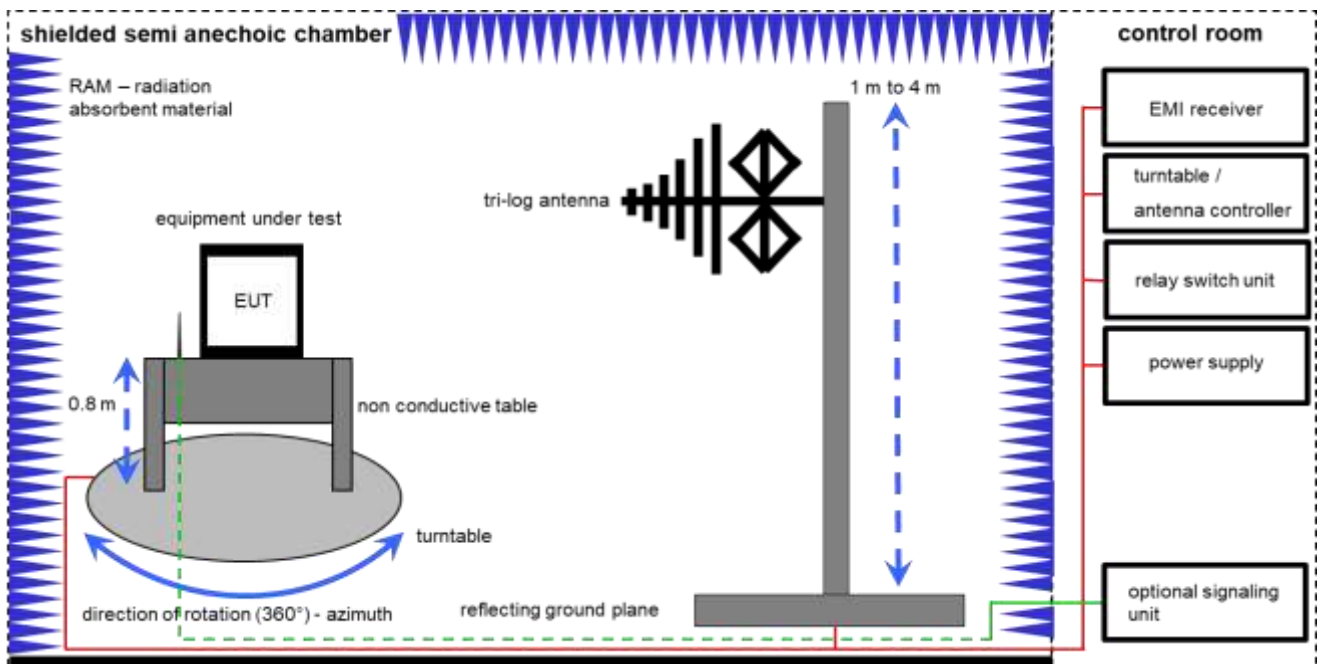
### **Agenda:** Kind of Calibration

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
vlk!	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)

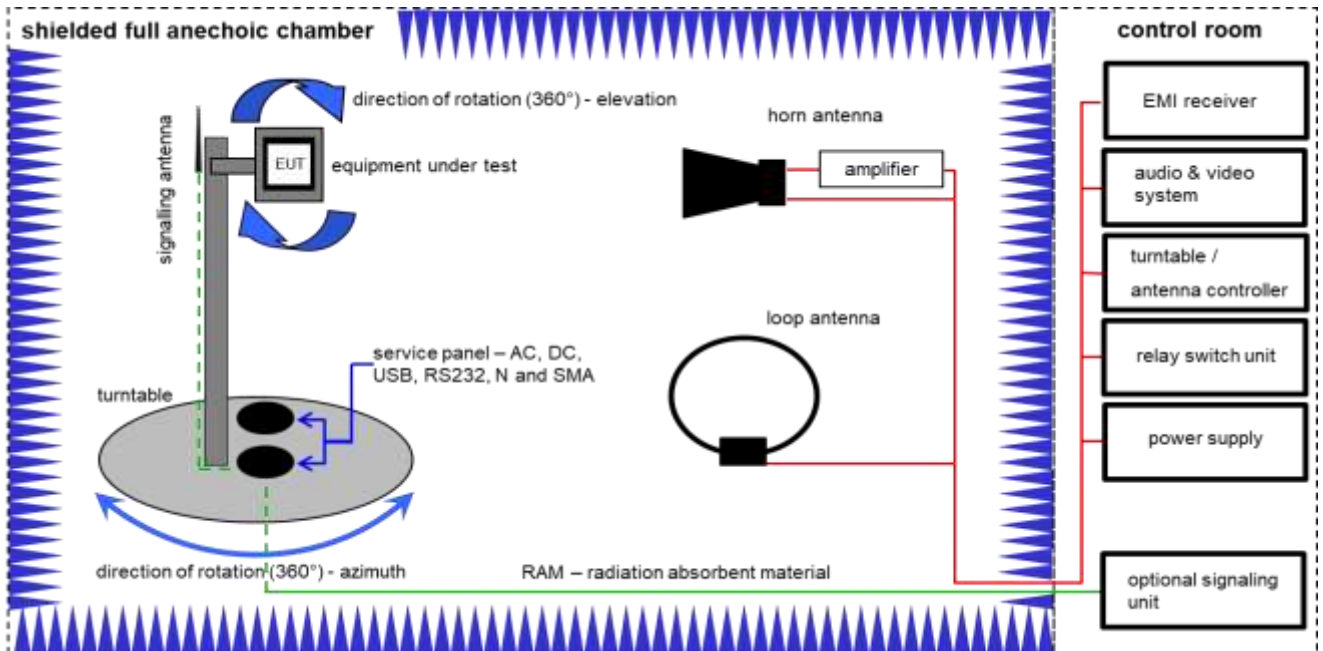
Example calculation:

FS [dB $\mu$ V/m] = 12.35 [dB $\mu$ V/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dB $\mu$ V/m] (35.69  $\mu$ V/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	vKI!	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	vKI!	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)

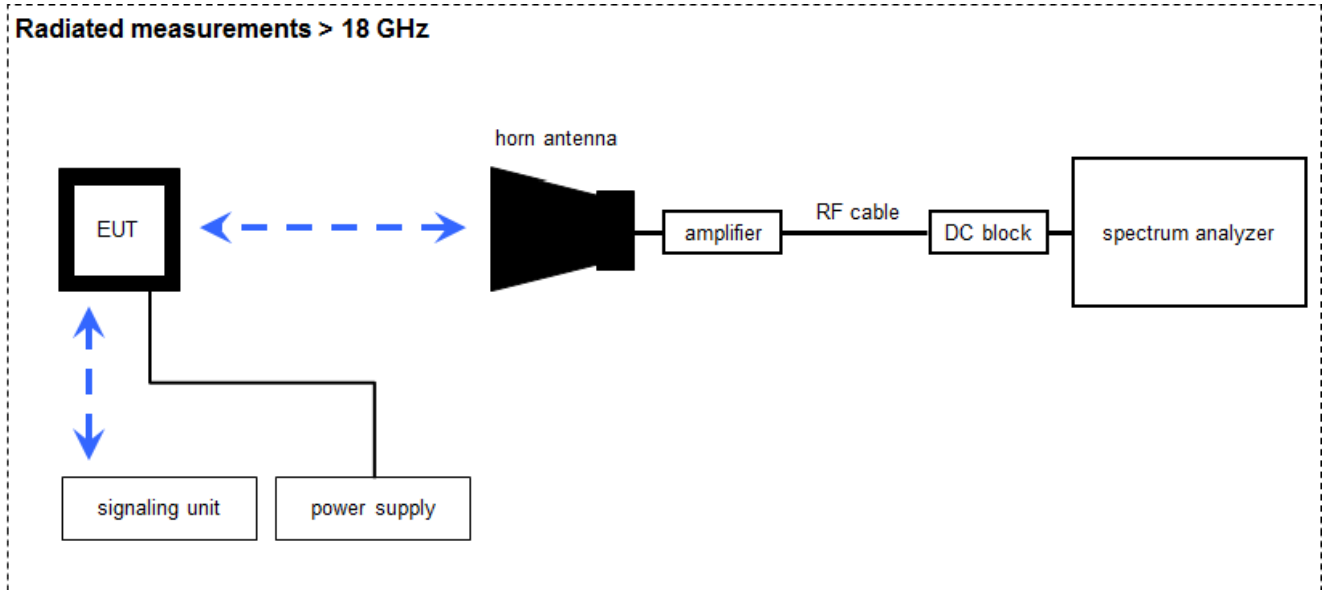
Example calculation:

$$OP \text{ [dBm]} = -39.0 \text{ [dBm]} + 57.0 \text{ [dB]} - 12.0 \text{ [dBi]} + (-36.0) \text{ [dB]} = -30 \text{ [dBm]} (1 \mu\text{W})$$

### 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)

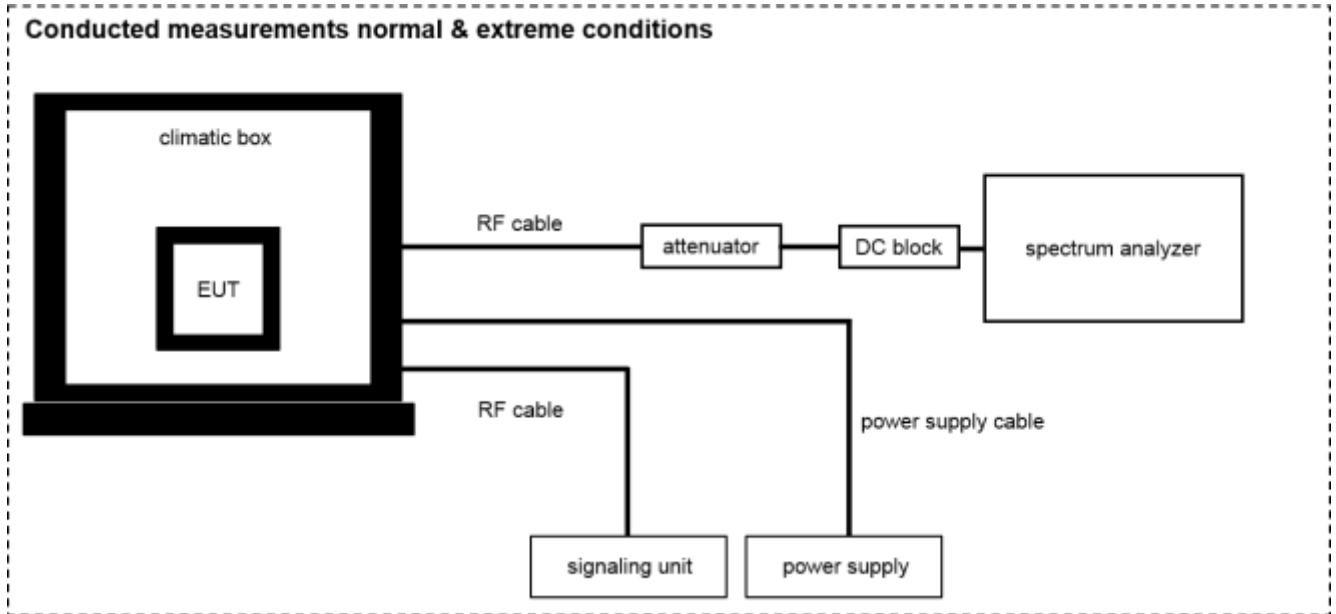
Example calculation:

$$OP \text{ [dBm]} = -59.0 \text{ [dBm]} + 44.0 \text{ [dB]} - 20.0 \text{ [dBi]} + 5.0 \text{ [dB]} = -30 \text{ [dBm]} \text{ (1 } \mu\text{W)}$$

**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	vIKI!	-/-	-/-
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	-/-	2V2403033A45 23	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  $\pm 45^\circ$  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 <sup>-6</sup>	
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

<input checked="" type="checkbox"/>	No deviations from the technical specifications were ascertained
<input type="checkbox"/>	There were deviations from the technical specifications ascertained
<input type="checkbox"/>	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	FCC: CFR Part 2 & Part 22 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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
Frequency Stability	Extreme	Extreme	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
Spurious Emissions Radiated	Nominal	Nominal	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
Spurious Emissions Conducted	Nominal	Nominal	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
Block Edge Compliance	Nominal	Nominal	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-
Occupied Bandwidth	Nominal	Nominal	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-/-

**Notes:**

<b>C</b>	Compliant	<b>NC</b>	Not compliant	<b>NA</b>	Not applicable	<b>NP</b>	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 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. (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. The peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB [...].
Power: <b>38.45 dBm ERP</b> PAPR: <b>13 dB</b>	

**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	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 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 $\pm 2.5$ ppm for mobile stations and $\pm 1.5$ ppm for base stations.
<b><math>\pm 2.5</math> ppm</b>	

**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 ISED: RSS-Gen, 6.13

**Limits:**

FCC	ISED
§ 22.917(a) & (b)	RSS-132, 5.5
<p>(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 <math>43 + 10 \log(P)</math> dB.</p> <p>(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.</p> <p>(b)(2) In the spectrum above 1 GHz, instrumentation should employ a reference bandwidth of 1 MHz.</p>	<p>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 <math>43 + 10 \log_{10}(P)</math> (watts).</p> <p>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 <math>43 + 10 \log_{10}(P)</math> (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.</p>
<b>-13 dBm</b>	



**Results:**

**BPSK:**

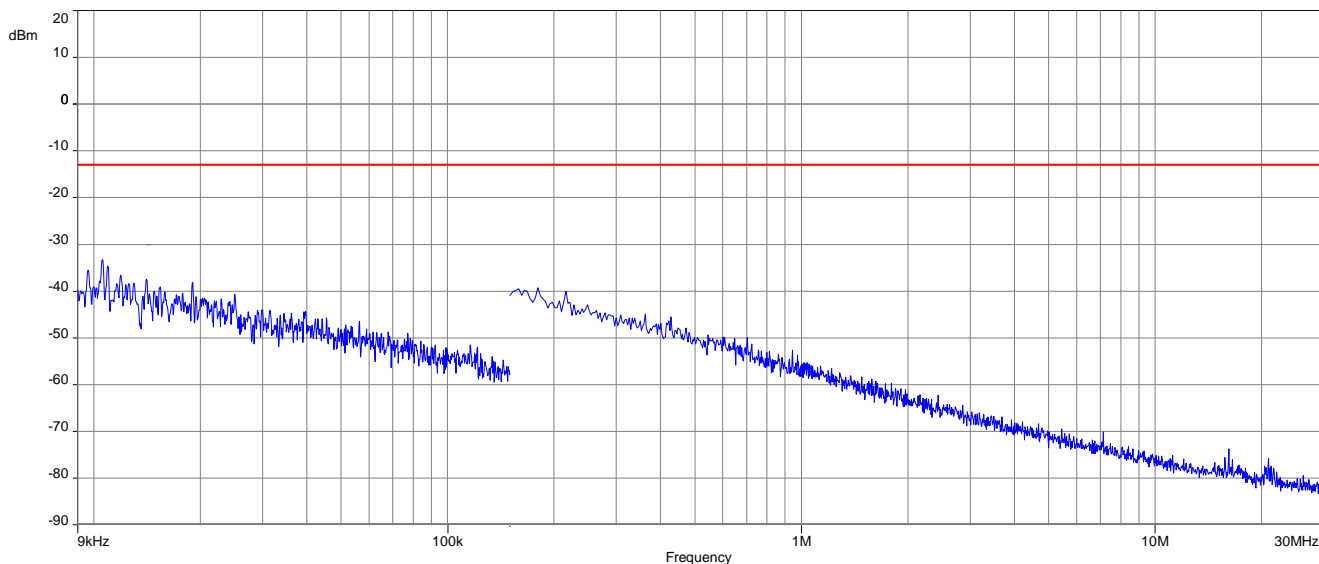
SPURIOUS EMISSION LEVEL					
LOWEST CHANNEL		MIDDLE CHANNEL		HIGHEST CHANNEL	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
-/-		All detected emissions are more than 20 dB below the limit.		-/-	
-/-	-/-	-/-	-/-	-/-	-/-
-/-	-/-	-/-	-/-	-/-	-/-

**QPSK:**

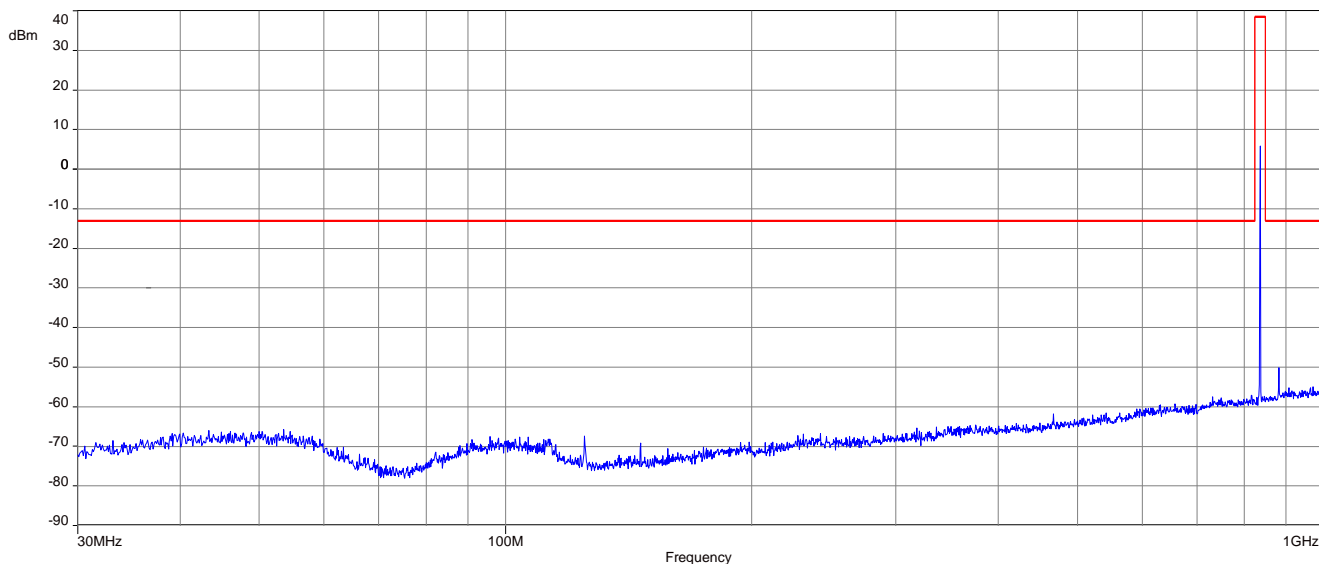
SPURIOUS EMISSION LEVEL					
LOWEST CHANNEL		MIDDLE CHANNEL		HIGHEST CHANNEL	
Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]	Spurious emissions	Level [dBm]
-/-		All detected emissions are more than 20 dB below the limit.		-/-	
-/-	-/-	-/-	-/-	-/-	-/-
-/-	-/-	-/-	-/-	-/-	-/-

**BPSK**

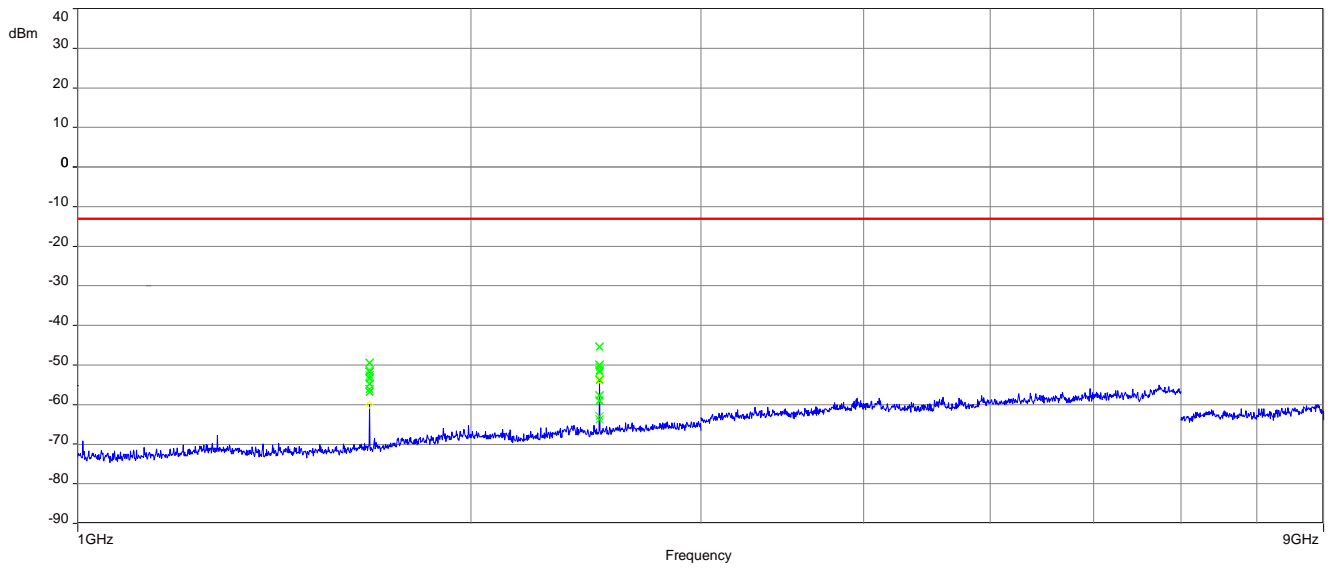
**Plot 1: Mid channel (9 kHz - 30 MHz)**



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

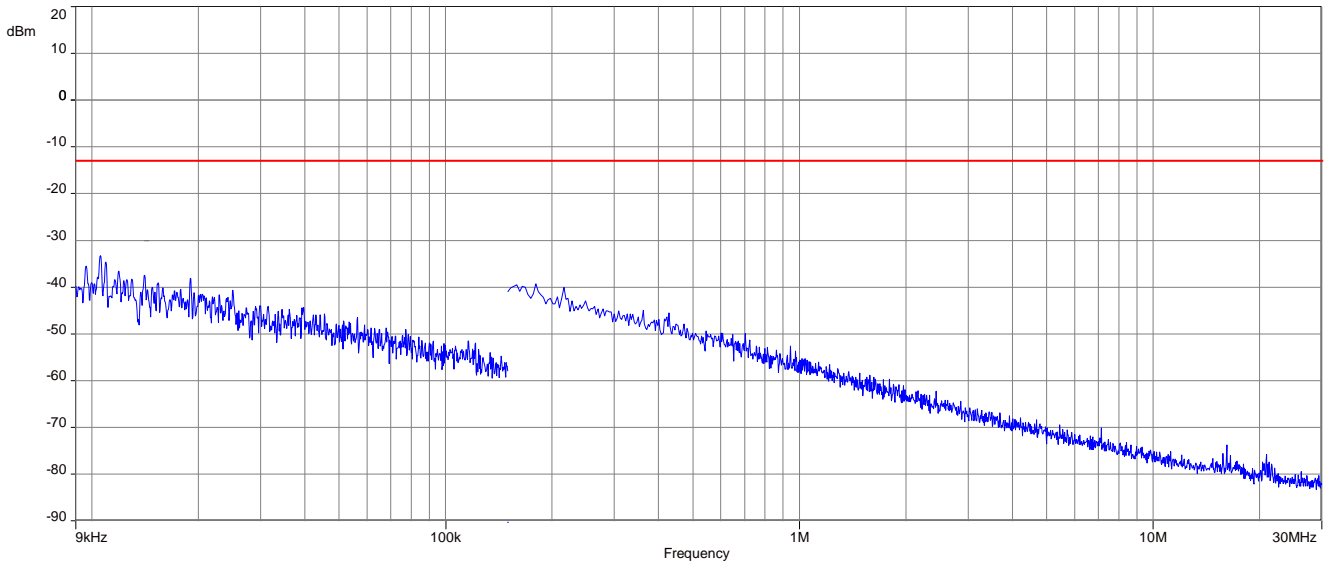


**Plot 3:** Mid channel (1 GHz – 9 GHz)

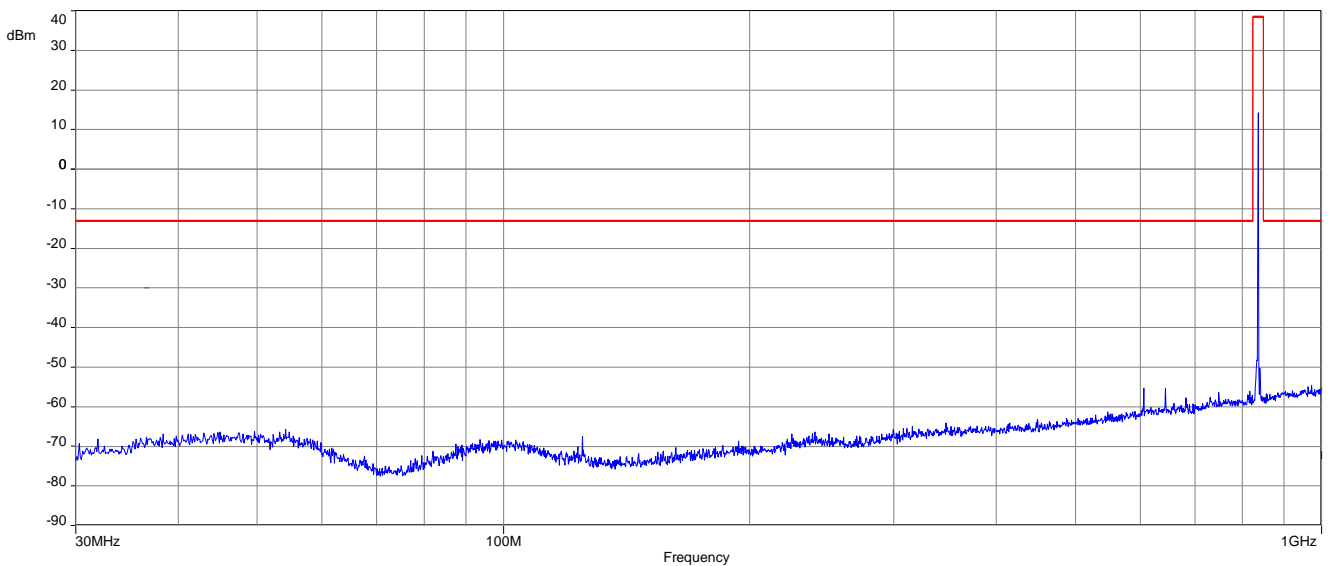


**QPSK**

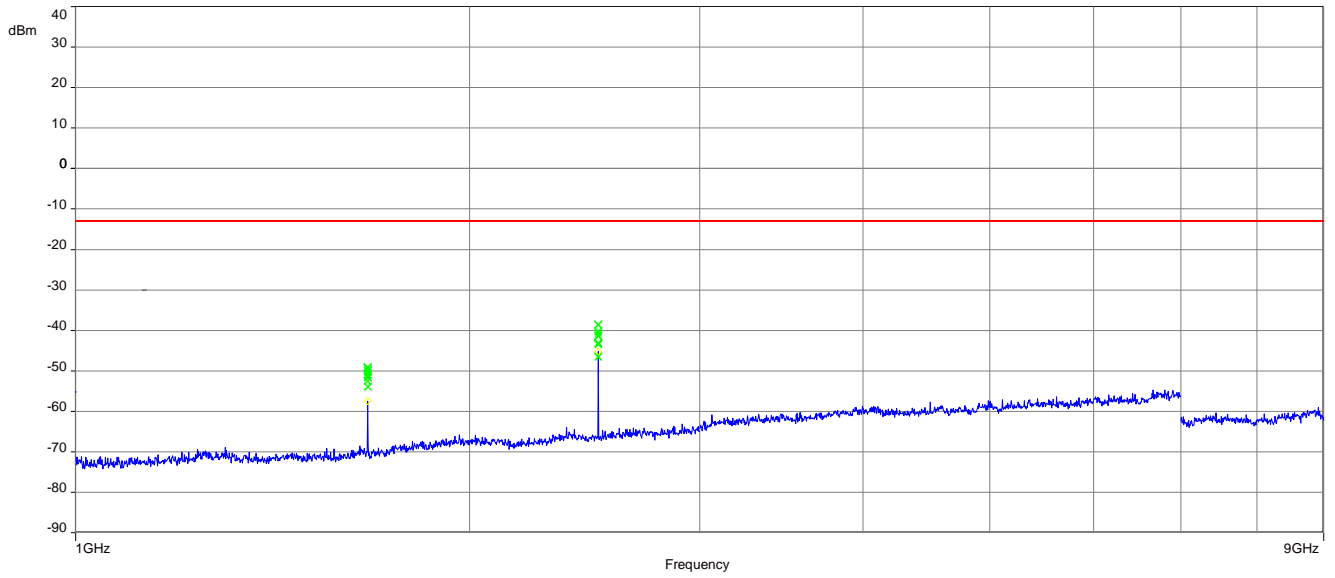
**Plot 1: Mid channel (9 kHz - 30 MHz)**



**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 ISED: RSS-Gen, 6.13

**Limits:**

FCC	ISED
§ 22.917(a) & (b)	RSS-132, 5.5
<p>(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 <b>43 + 10 log(P) dB</b>.</p> <p>(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.</p> <p>(b)(2) In the spectrum above 1 GHz, instrumentation should employ a reference bandwidth of 1 MHz.</p>	<p>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 <b>43 + 10 log<sub>10</sub>(P) (watts)</b>.</p> <p>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 <b>43 + 10 log<sub>10</sub>(P) (watts)</b>. If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.</p>
<b>-13 dBm</b>	

**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	-/-

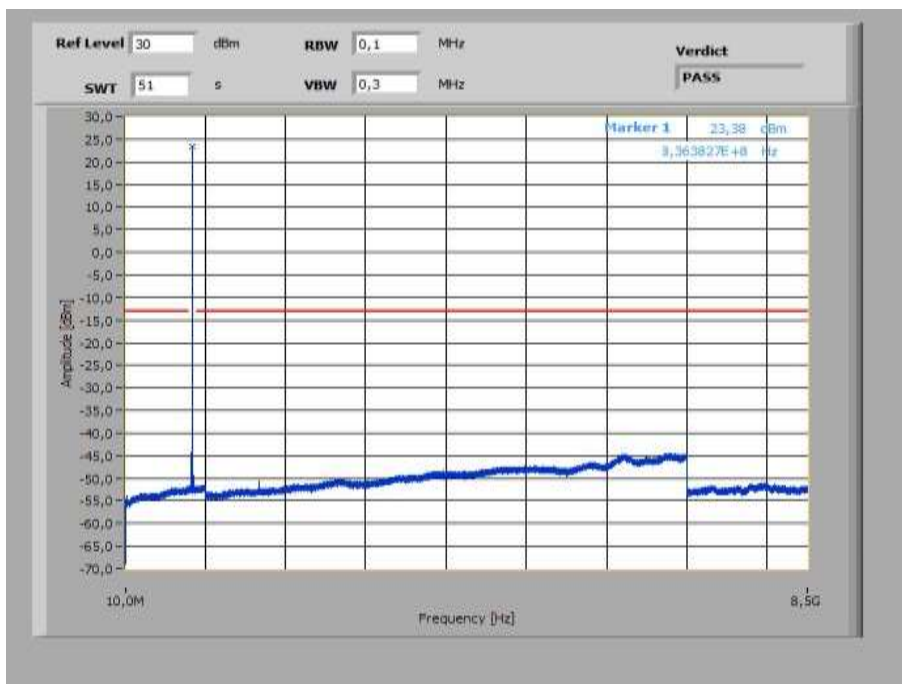


**Plots: BPSK**

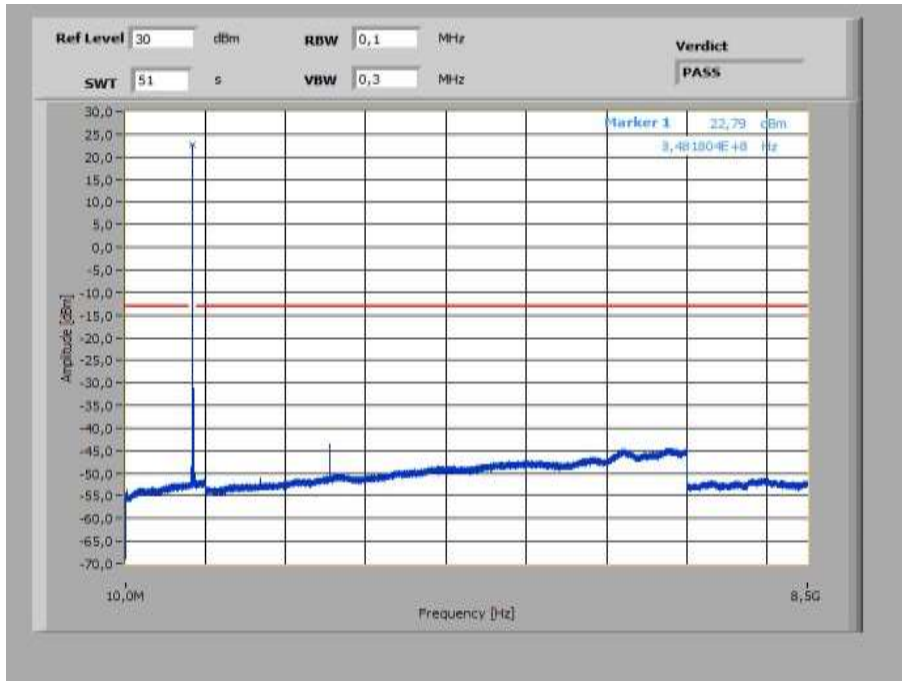
**Plot 1: Lowest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@0 tones**



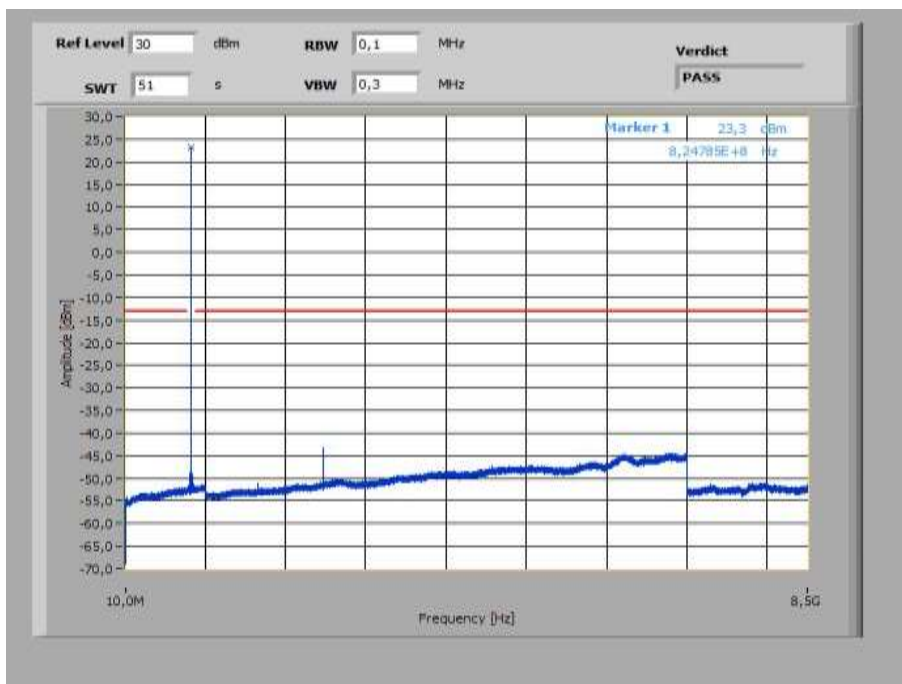
**Plot 2: Middle Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@0 tones**



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



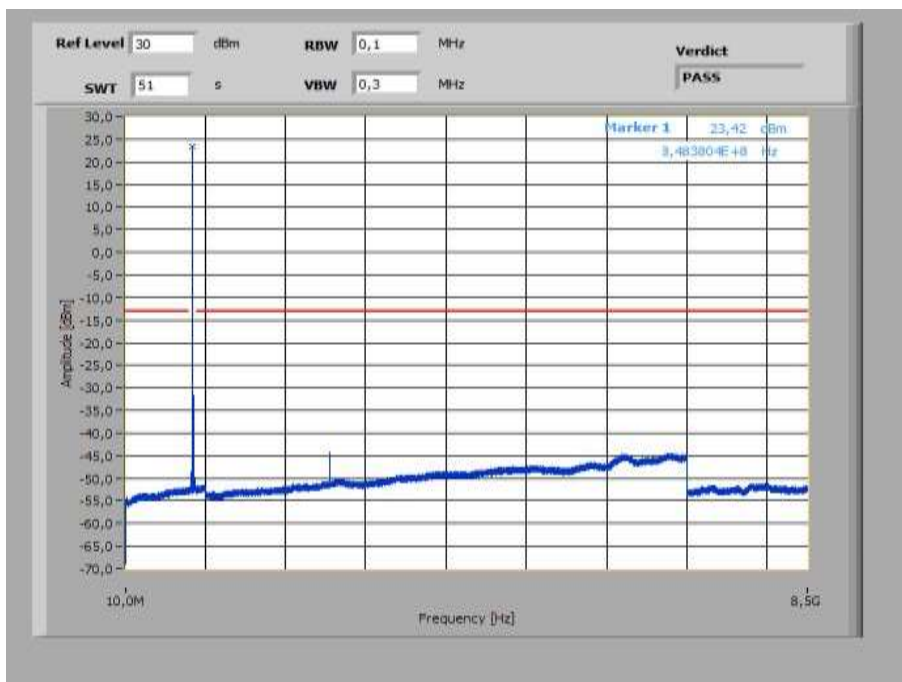
**Plot 4:** Lowest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@47 tones



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



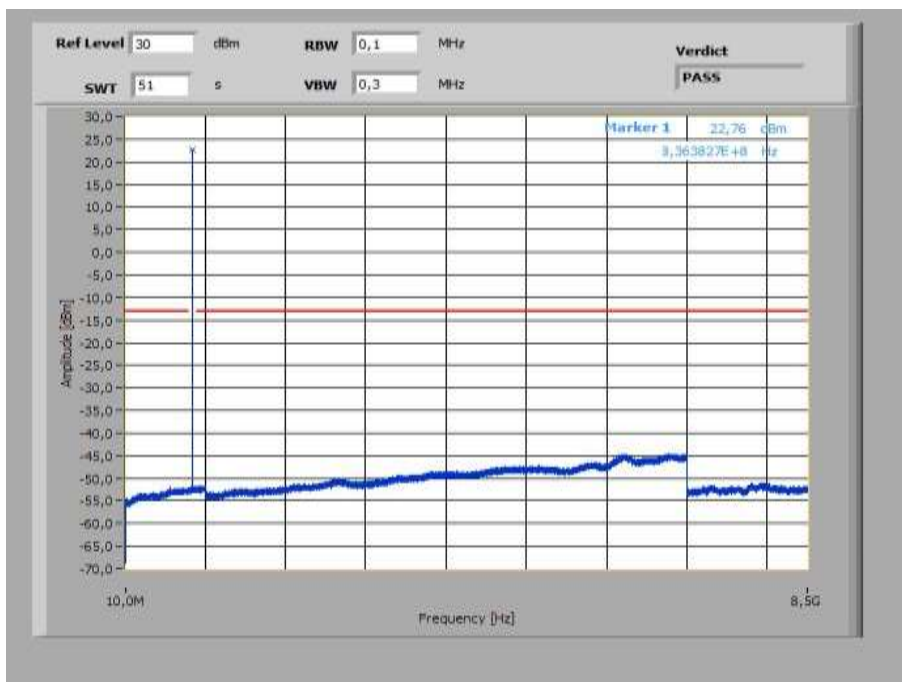
**Plot 6:** Highest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@47 tones



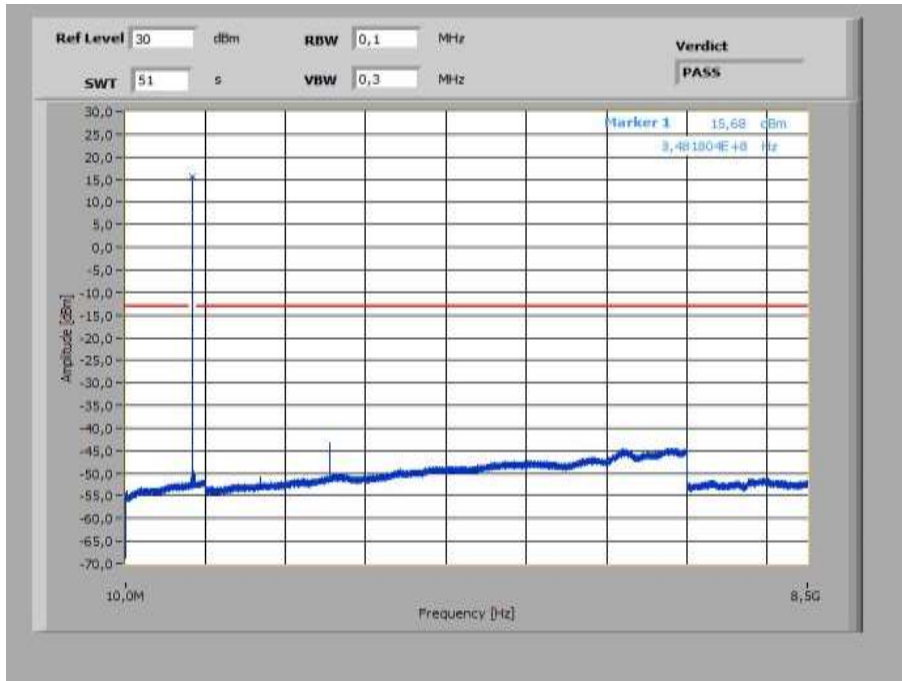
**Plot 7:** Lowest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@0 tones



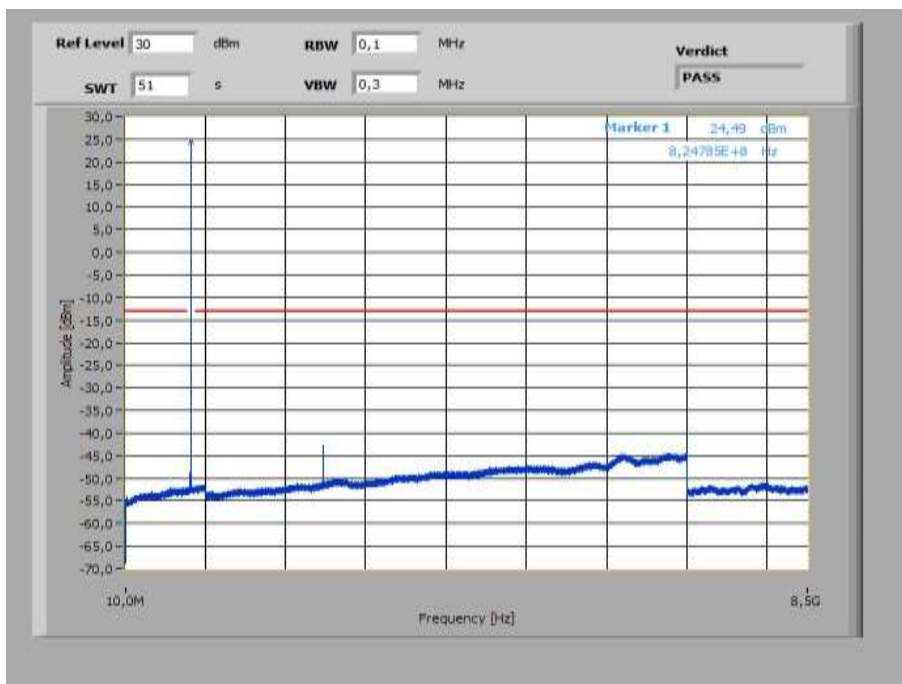
**Plot 8:** Middle Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@0 tones



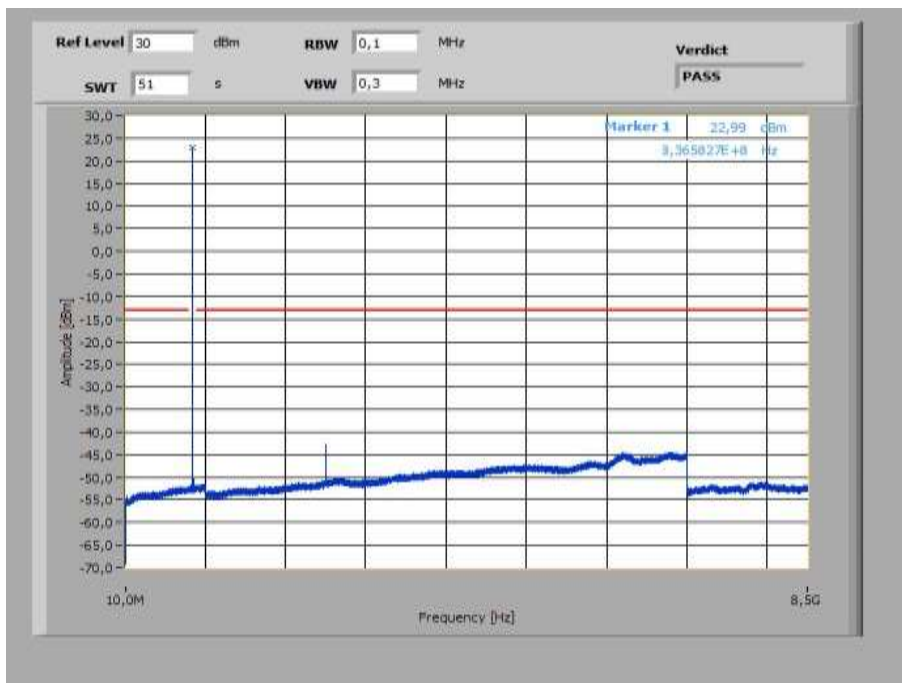
**Plot 9:** Highest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@0 tones



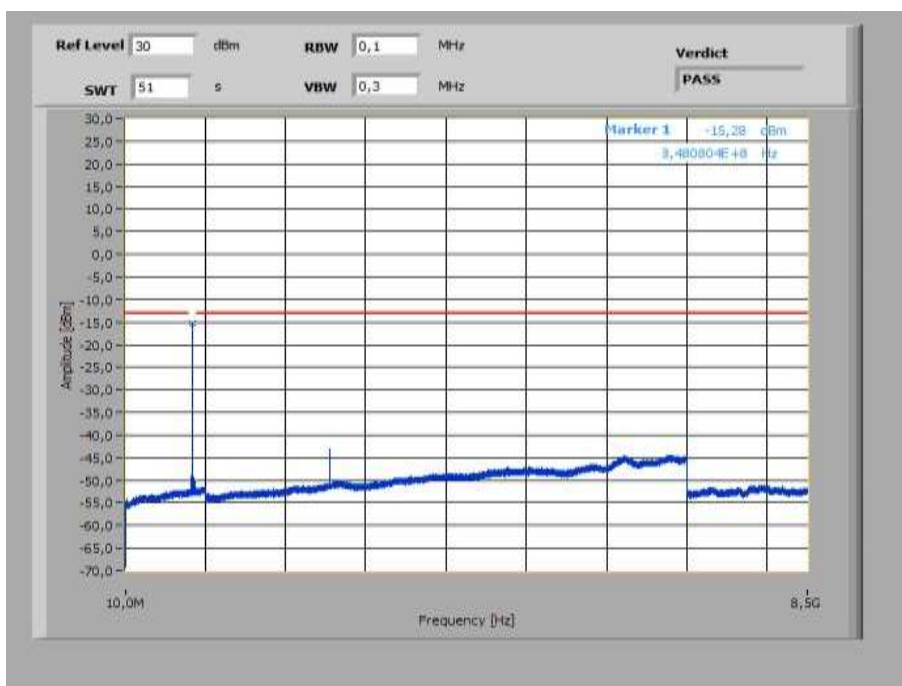
**Plot 10:** Lowest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@11 tones



**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

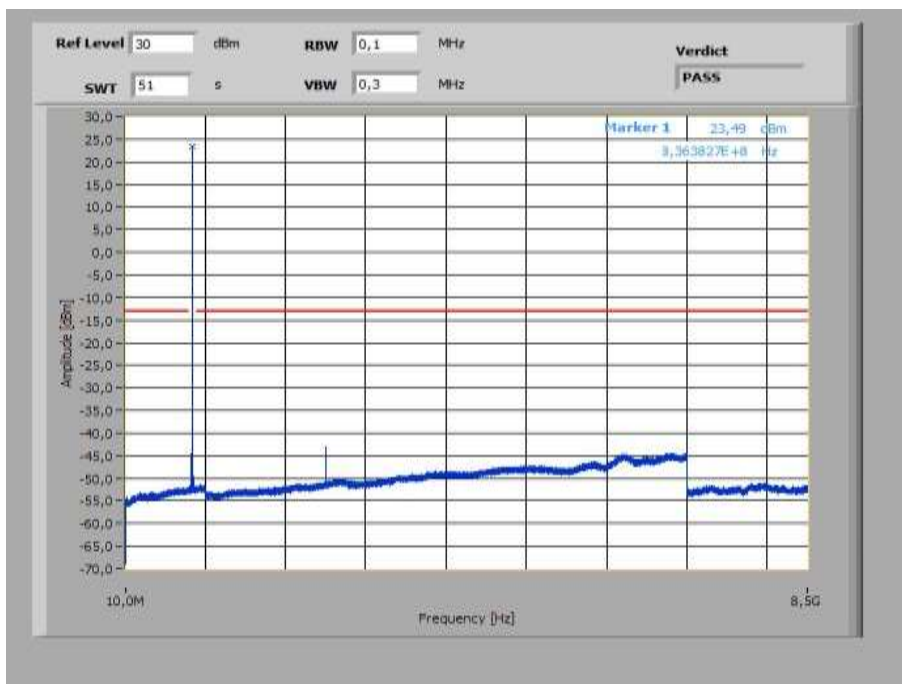


**Plots: QPSK**

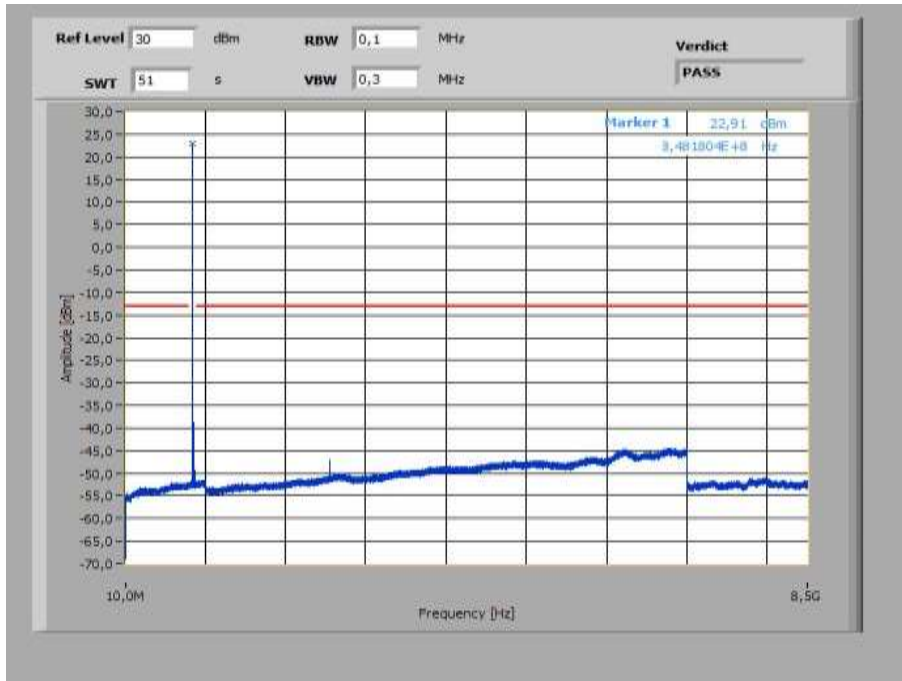
**Plot 1: Lowest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@0 tones**



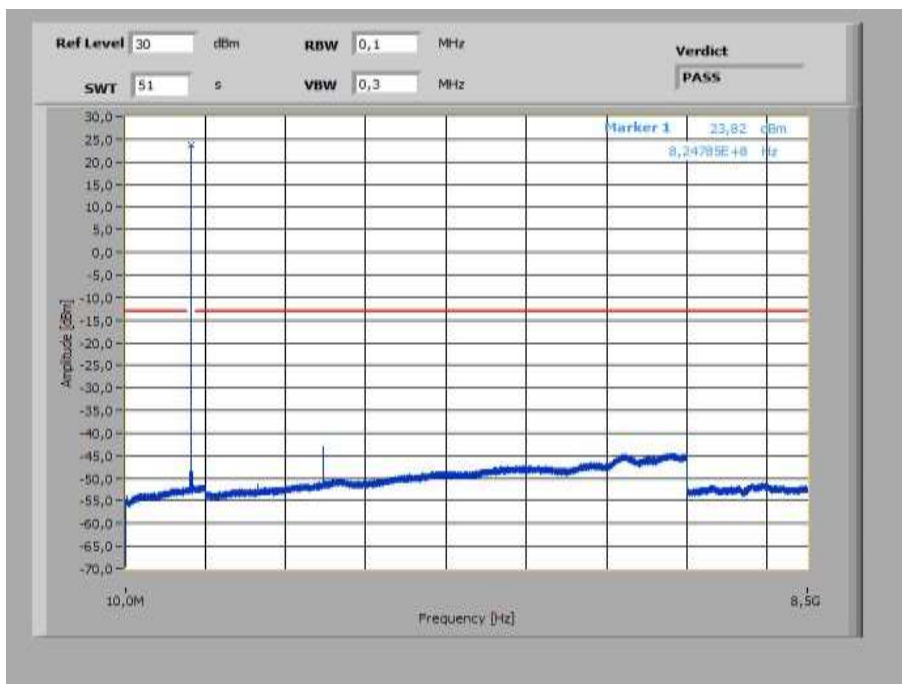
**Plot 2: Middle Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@0 tones**



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

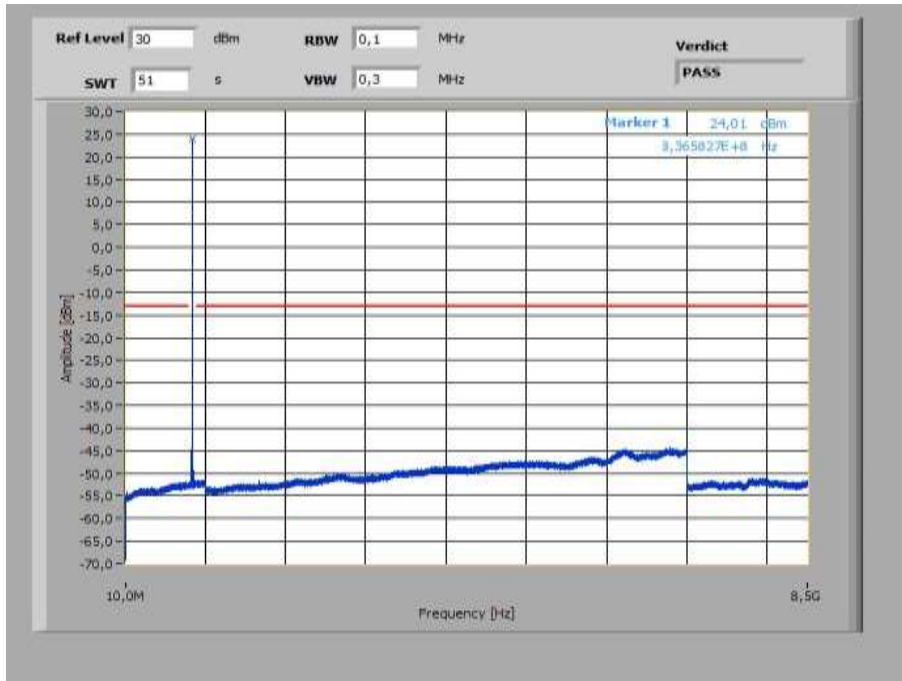


**Plot 4:** Lowest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@47 tones

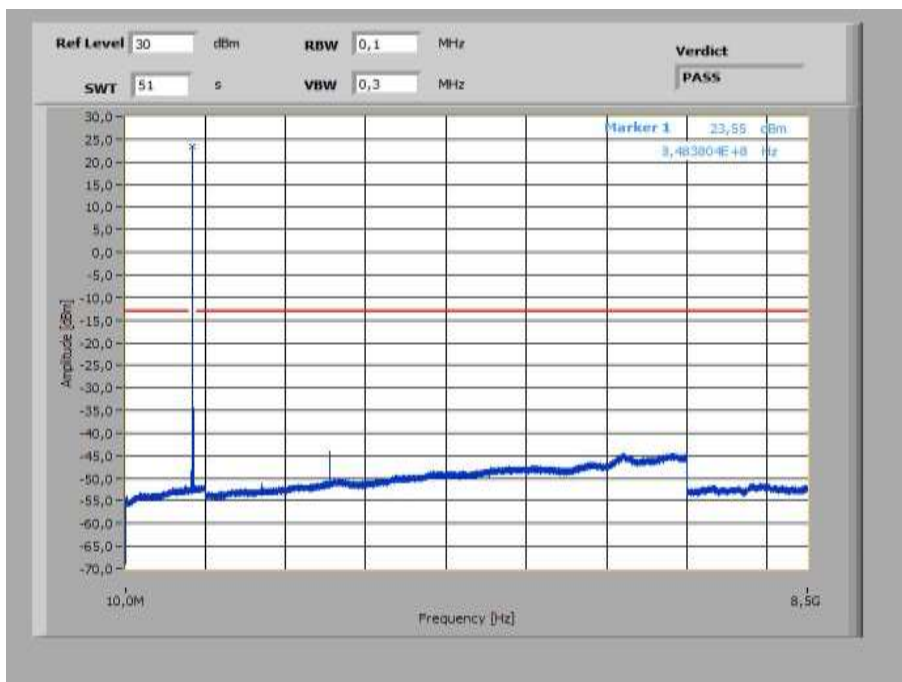




**Plot 5:** Middle Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@47 tones



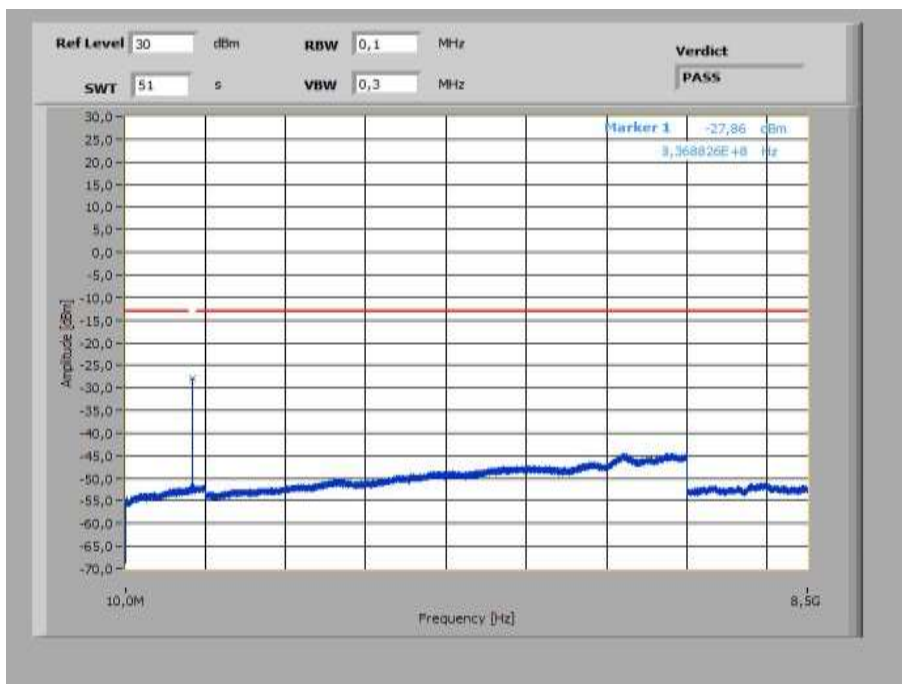
**Plot 6:** Highest Channel (10 MHz – 8.5 GHz), spacing 3.75 kHz, 1@47 tones



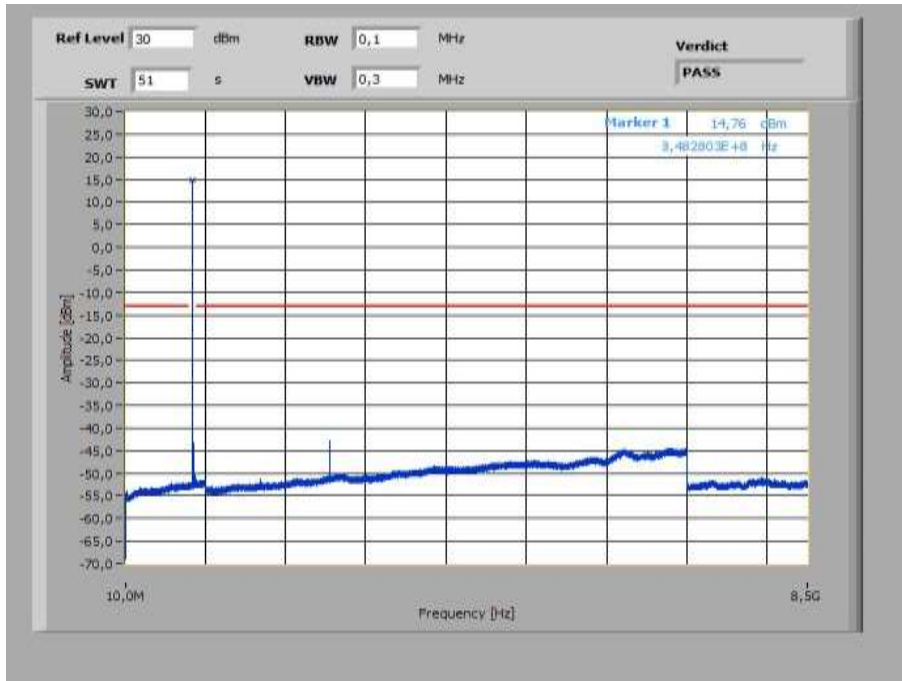
**Plot 7:** Lowest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@0 tones



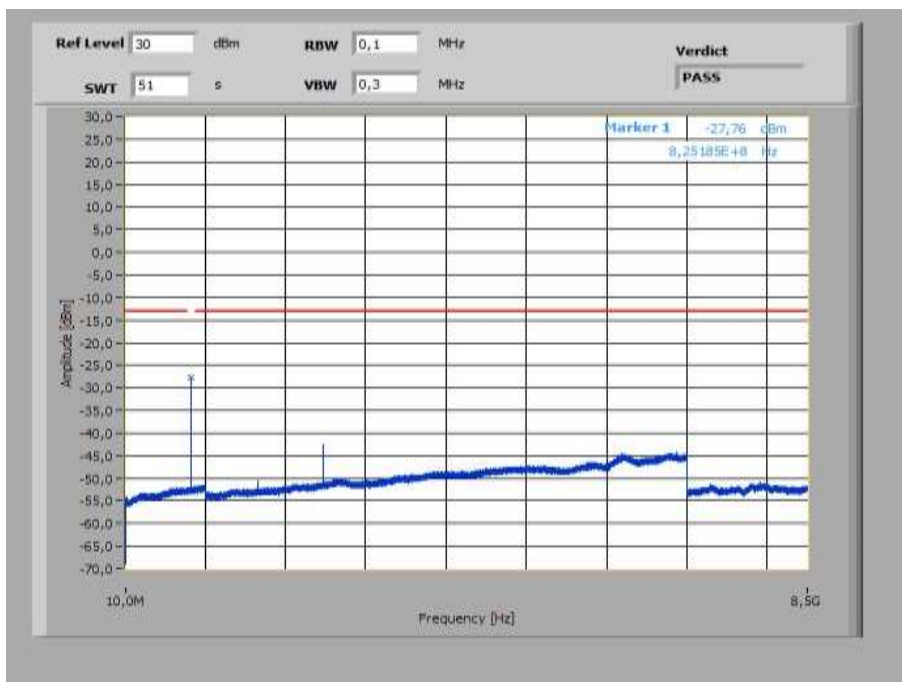
**Plot 8:** Middle Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@0 tones



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



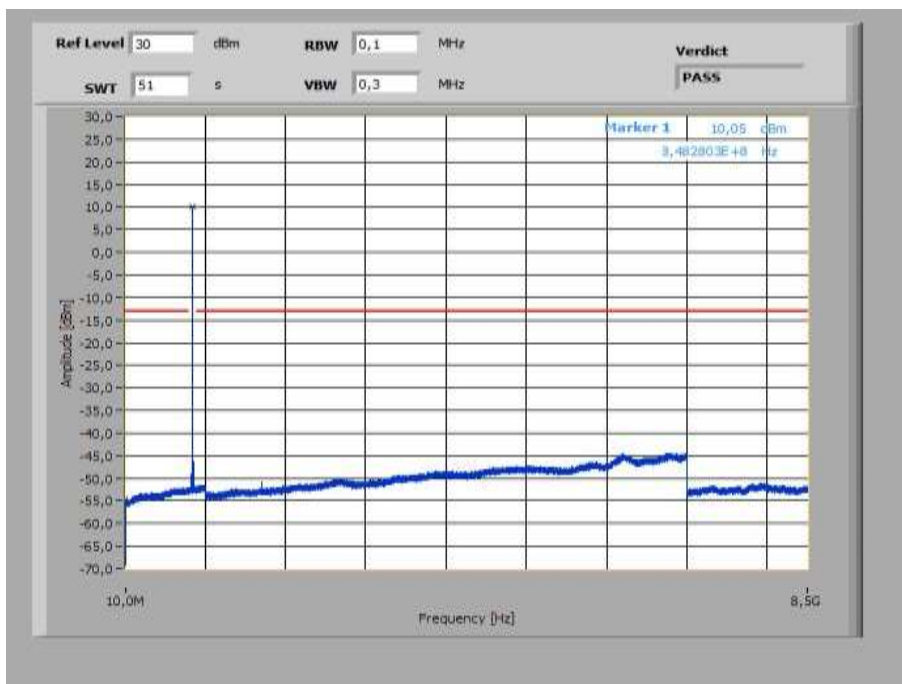
**Plot 10:** Lowest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@11 tones



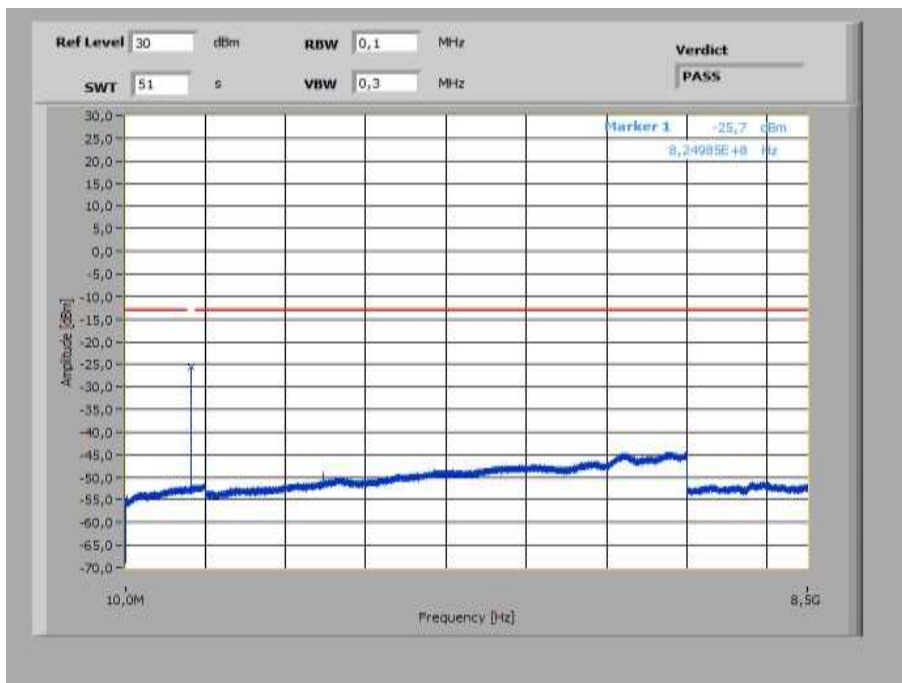
**Plot 11:** Middle Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@11 tones



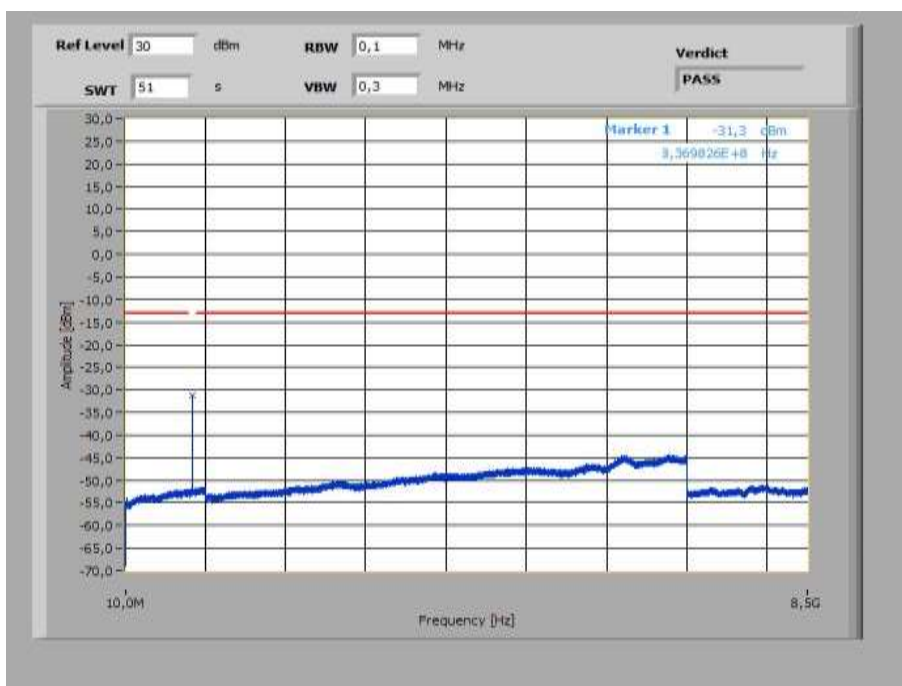
**Plot 12:** Highest Channel (10 MHz – 8.5 GHz), spacing 15 kHz, 1@11 tones



**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 ISED: RSS-Gen, 6.13

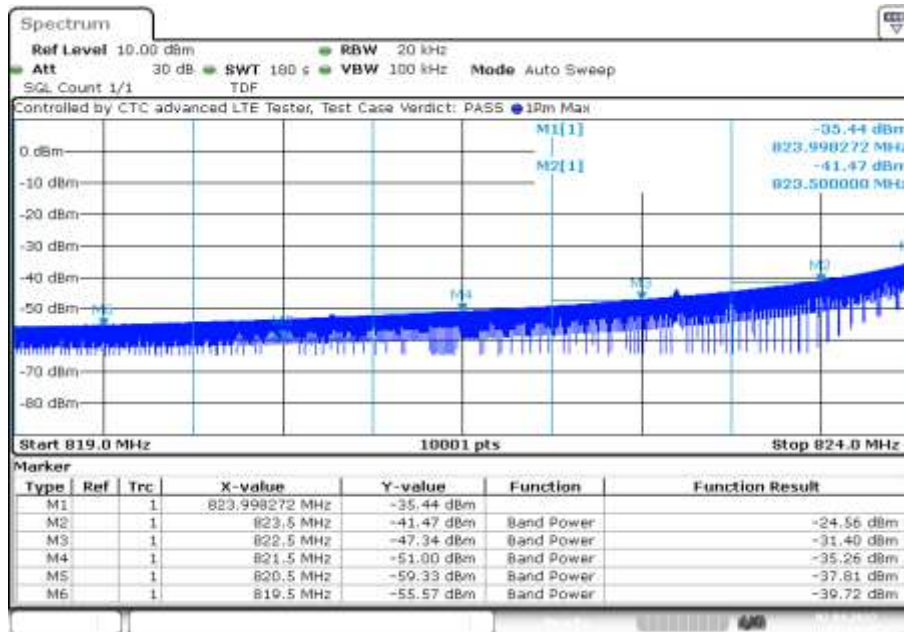
**Limits:**

FCC	ISED
§ 22.917(a) & (b)	RSS-132, 5.5
<p>(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 <b>43 + 10 log(P) dB</b>.</p> <p>(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.</p> <p>(b)(2) In the spectrum above 1 GHz, instrumentation should employ a reference bandwidth of 1 MHz.</p>	<p>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 <b>43 + 10 log10(P) (watts)</b>.</p> <p>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 <b>43 + 10 log10(P) (watts)</b>. If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.</p>
<p><b>-13 dBm</b></p> <p>Correction factor according to KDB 890810 if RBW &lt; 1 % emission bandwidth:  <input checked="" type="checkbox"/> N/A here  <input type="checkbox"/> <math>10 \log (RBW1/RBW2) = X \text{ dB}</math>; whereas: <math>RBW1 = Y, RBW2 = Z</math></p>	



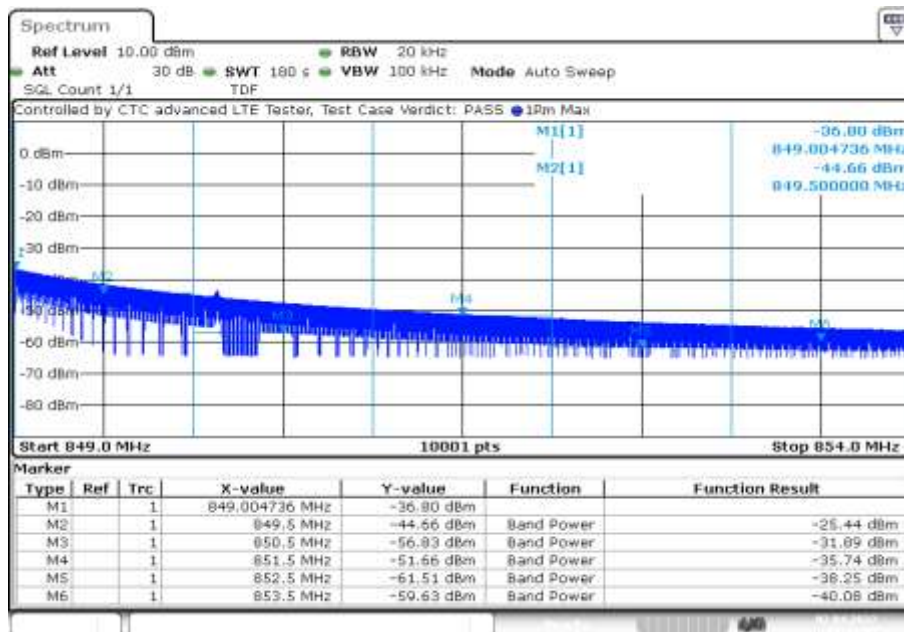
**Results: BPSK**

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



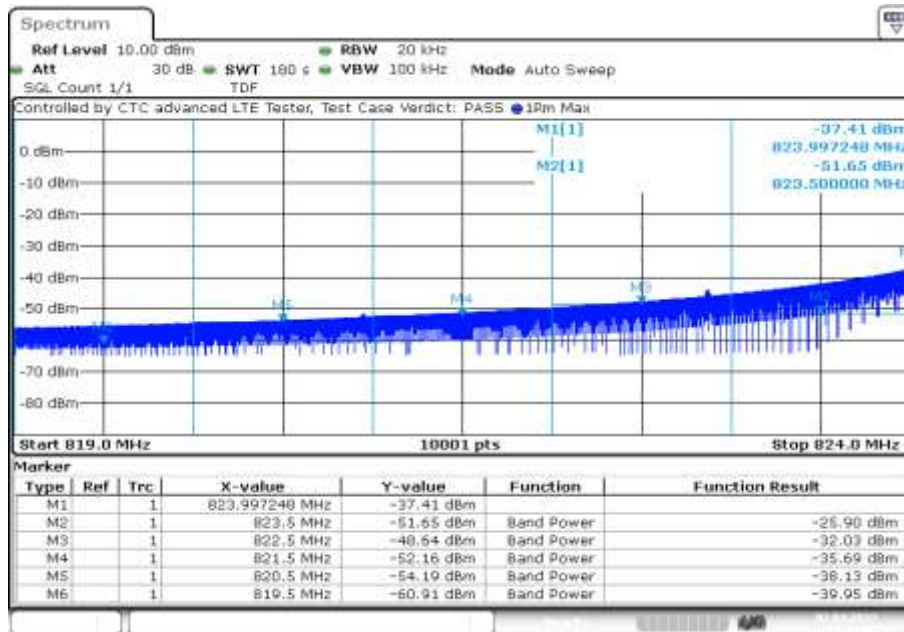
Date: 2.APR.2022 09:12:15

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



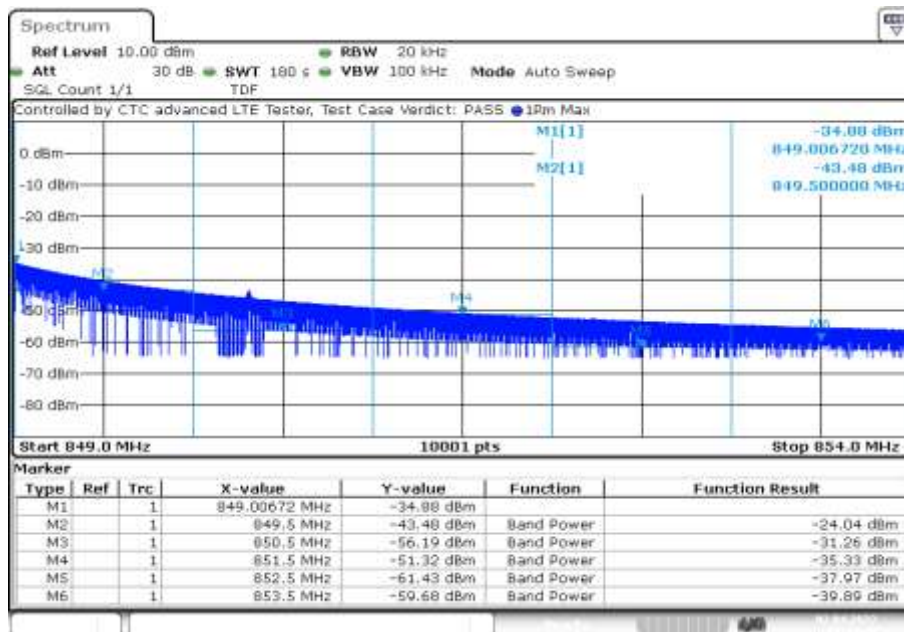
Date: 2.APR.2022 12:30:57

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



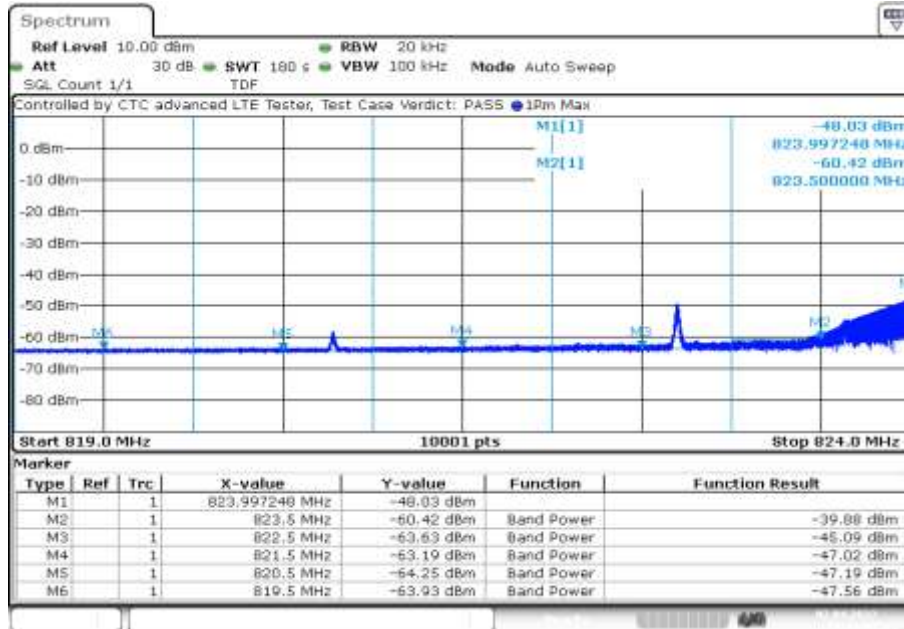
Date: 2.APR.2022 09:24:51

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



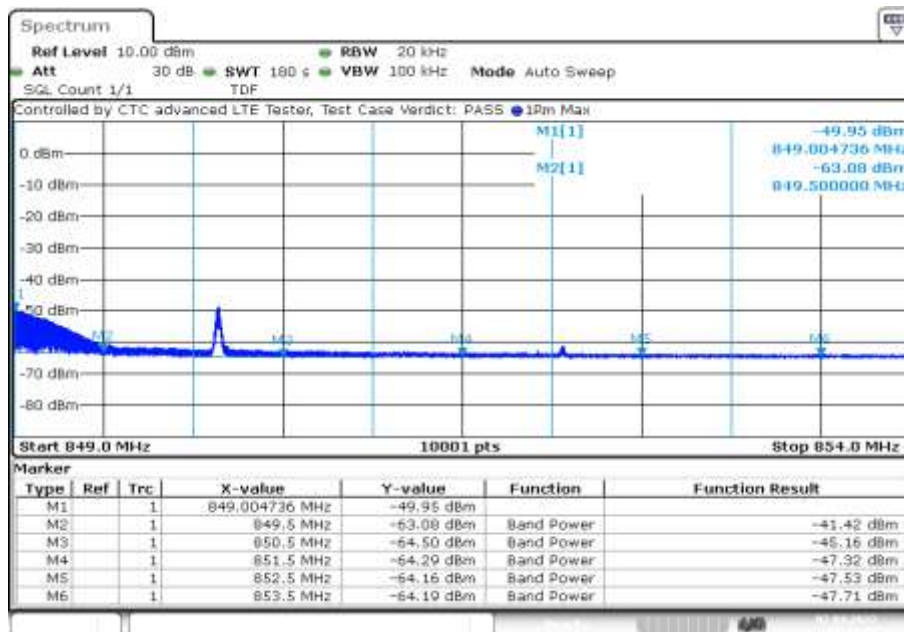
Date: 2.APR.2022 12:43:27

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



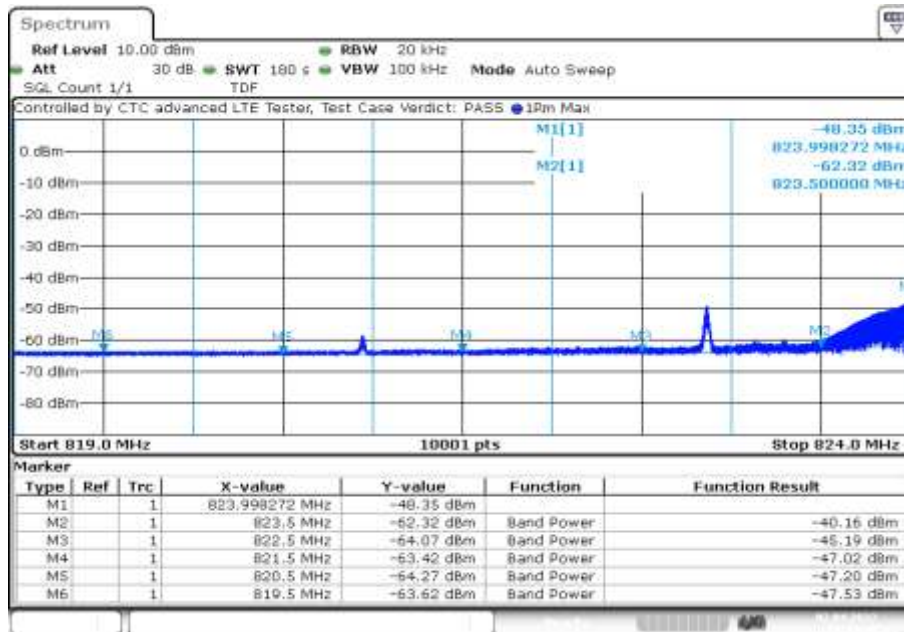
Date: 2.APR.2022 10:03:00

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



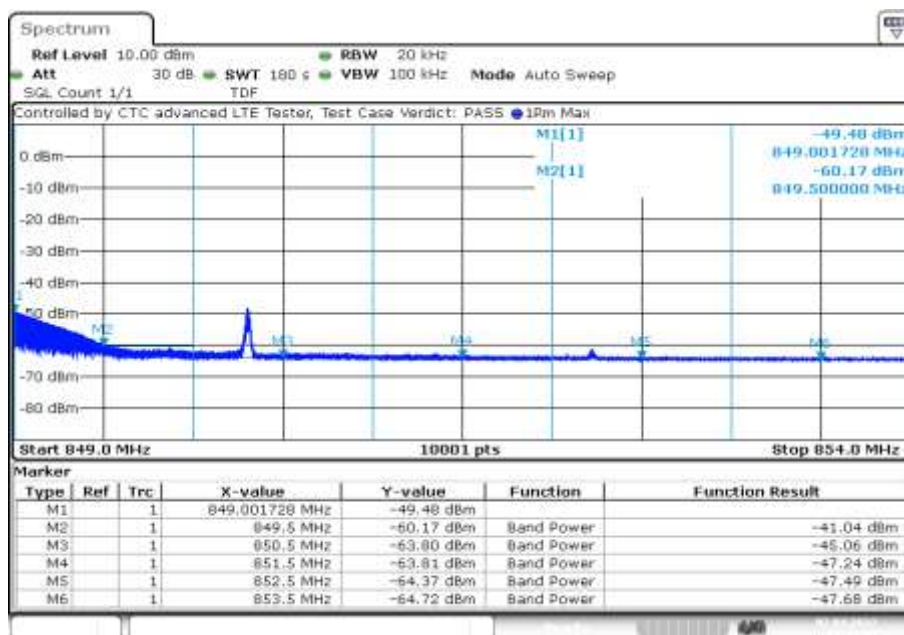
Date: 2.APR.2022 13:21:26

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



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

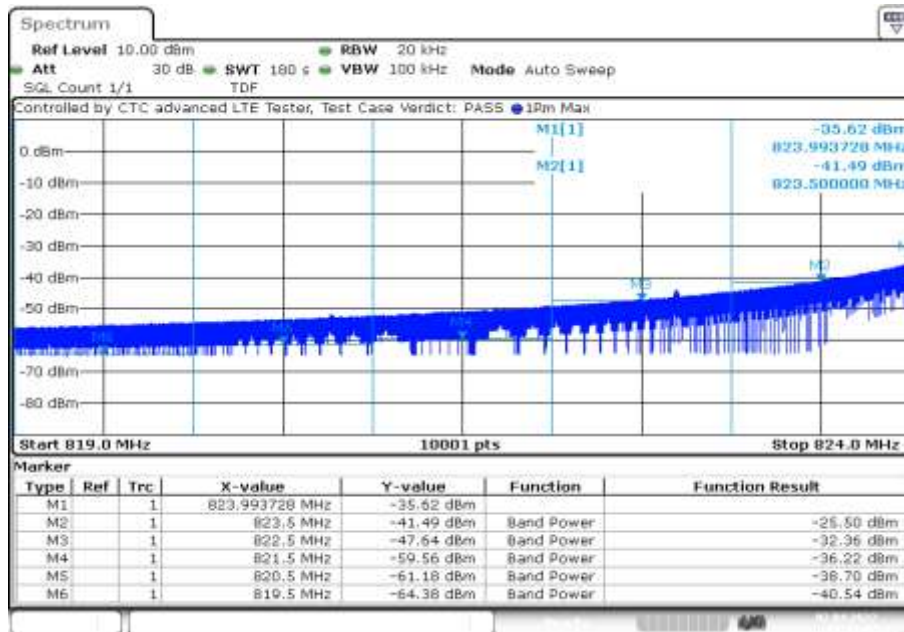
**Plot 8: Highest channel, spacing 15 kHz, 1@11 tones**



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

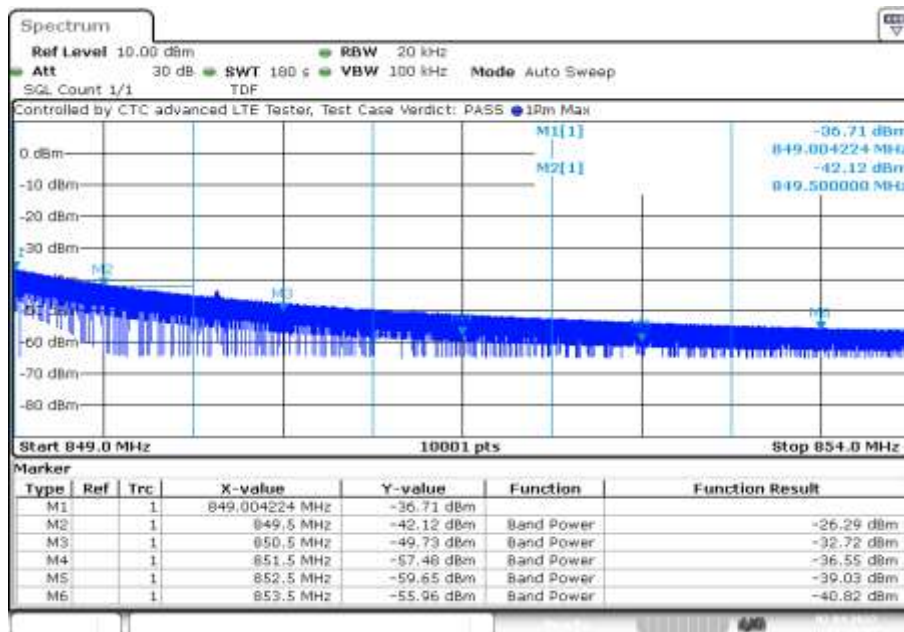
**Results: QPSK**

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



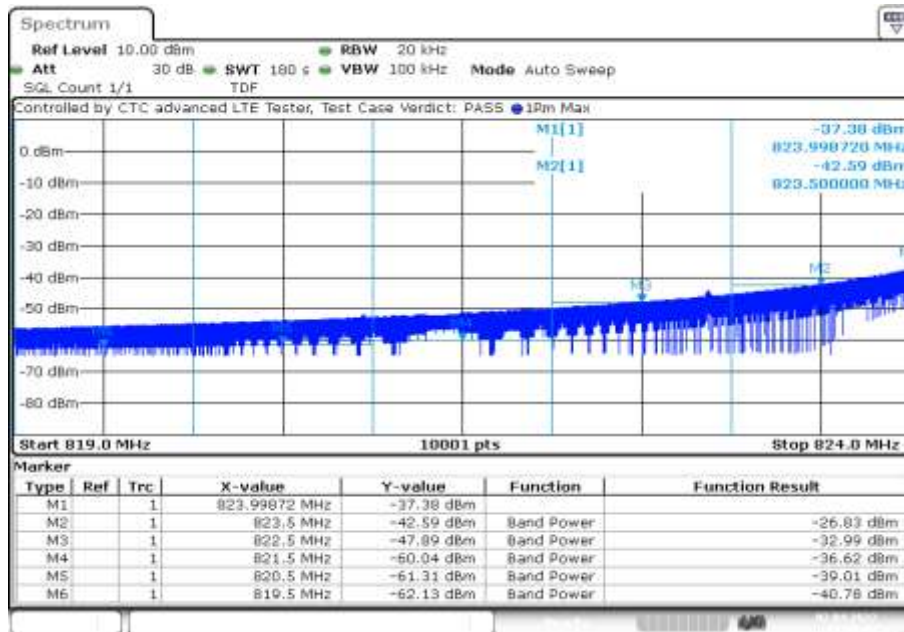
Date: 2.APR.2022 09:37:28

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



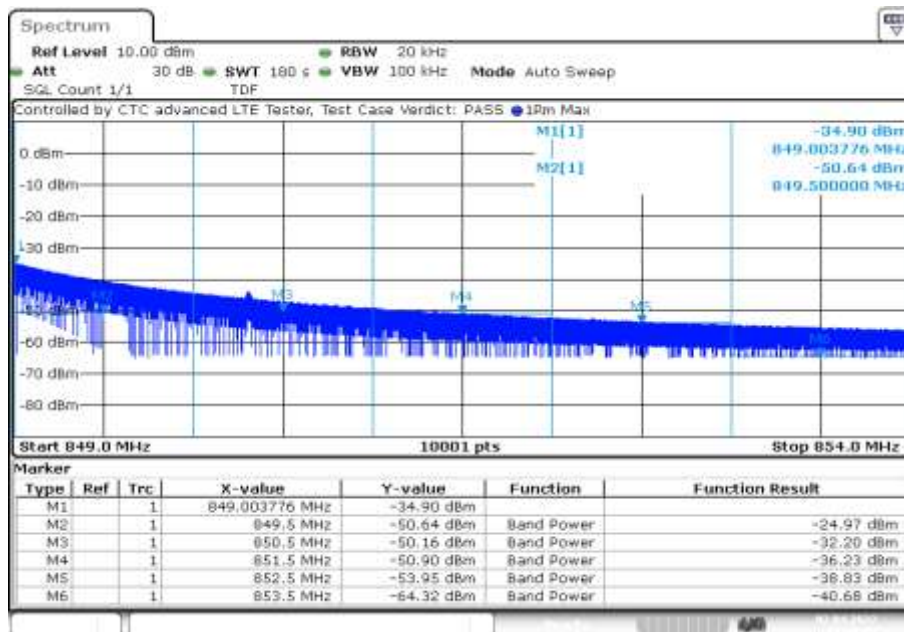
Date: 2.APR.2022 12:55:56

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



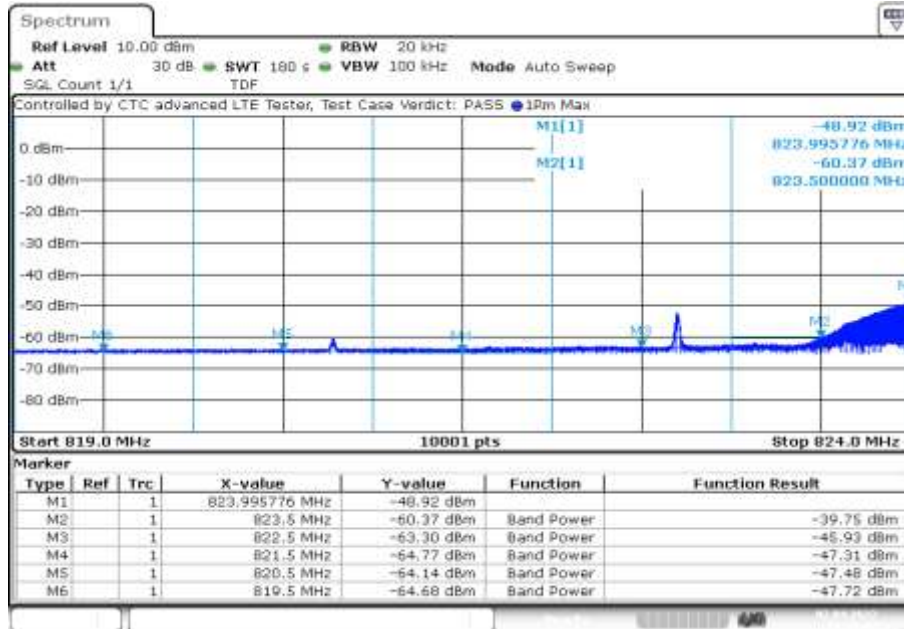
Date: 2.APR.2022 09:50:04

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



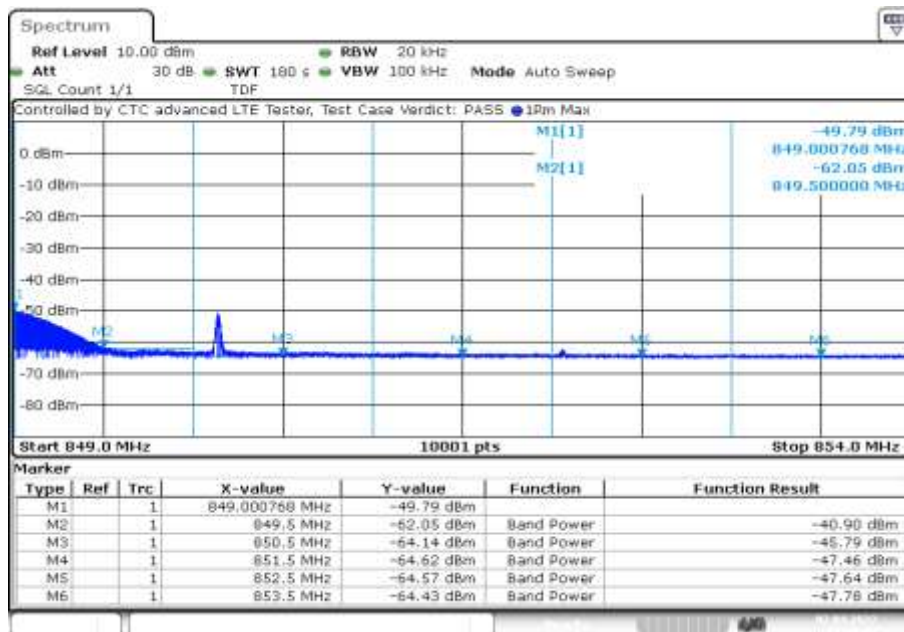
Date: 2.APR.2022 13:08:26

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



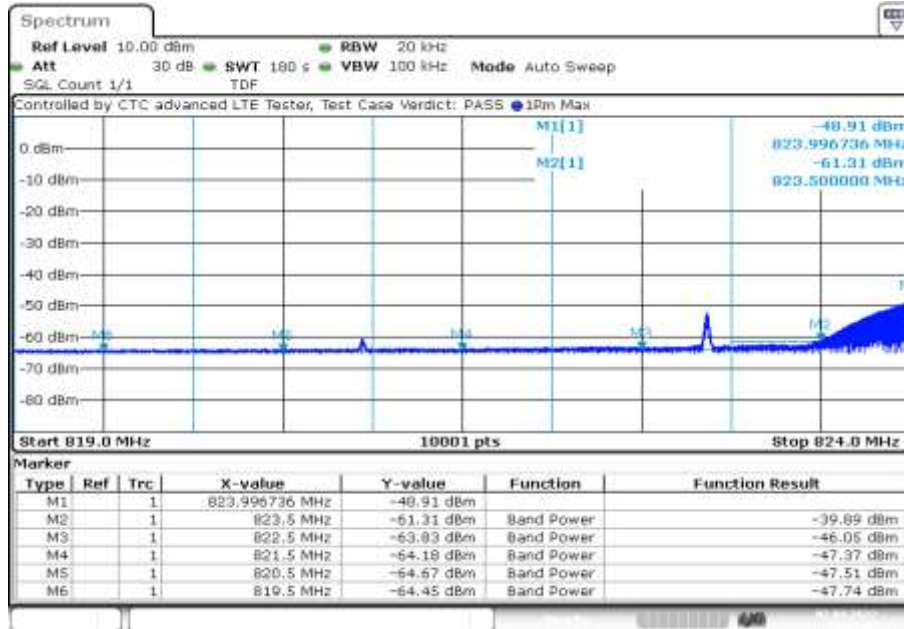
Date: 2.APR.2022 10:28:12

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



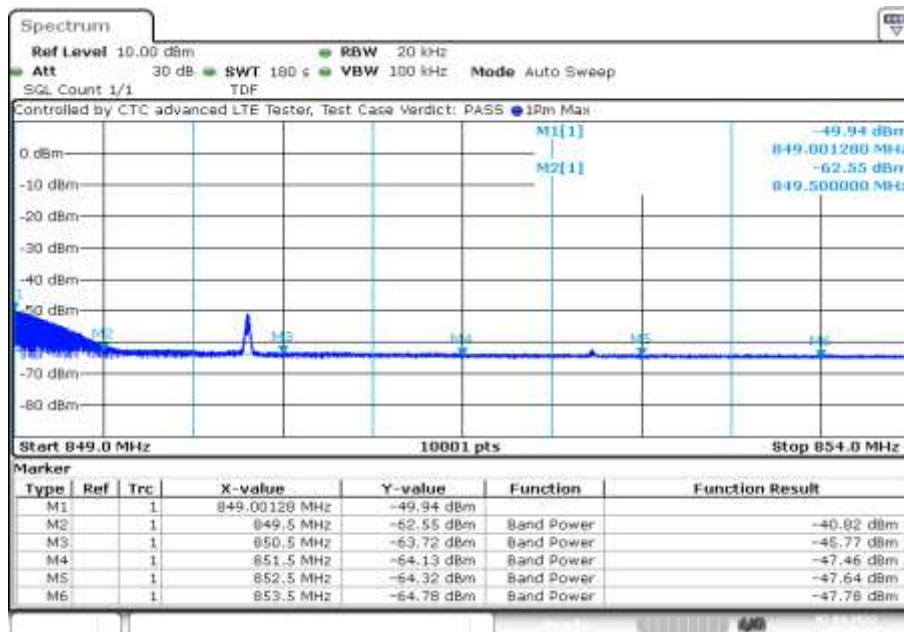
Date: 2.APR.2022 13:46:25

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



Date: 2.APR.2022 10:40:48

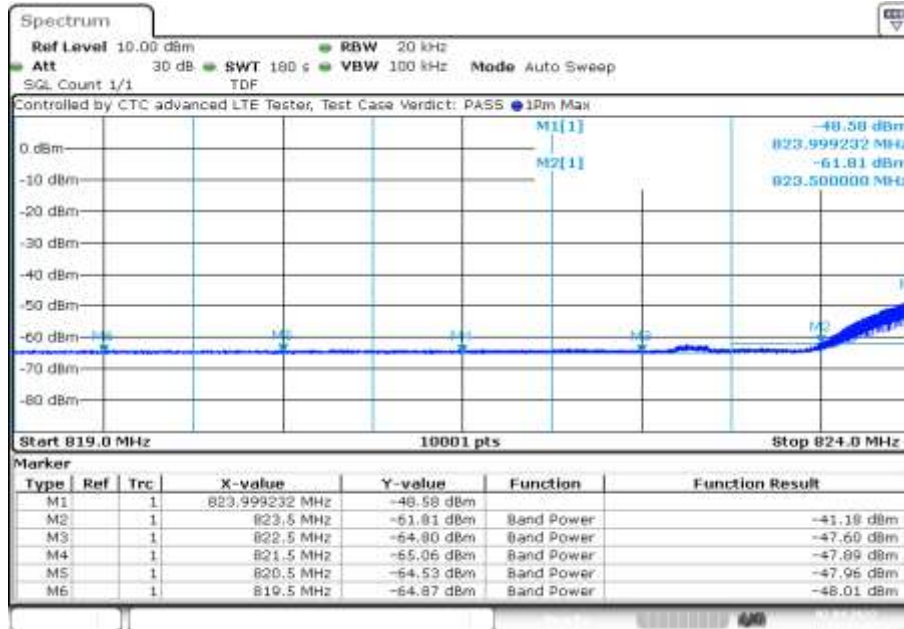
**Plot 8:** Highest channel, spacing 15 kHz, 1@11 tones



Date: 2.APR.2022 13:58:54

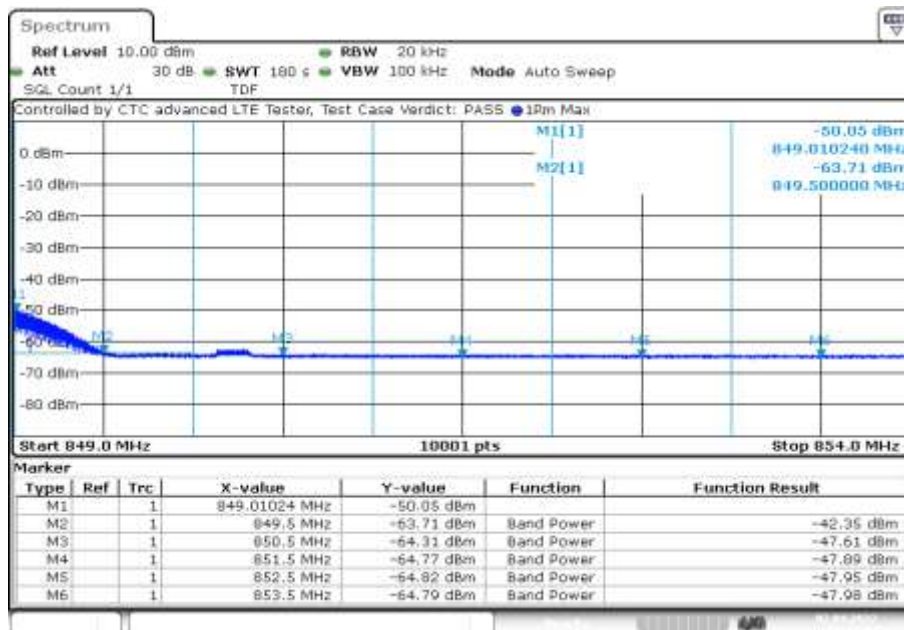


**Plot 7:** Lowest channel, spacing 15 kHz, 12@0 tones



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

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



Date: 2.APR.2022 14:11:24

## 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 ISED: RSS-Gen, 6.7

### Limits:

FCC	ISED
§ 2.1049	RSS-Gen, 6.7
Reporting only	

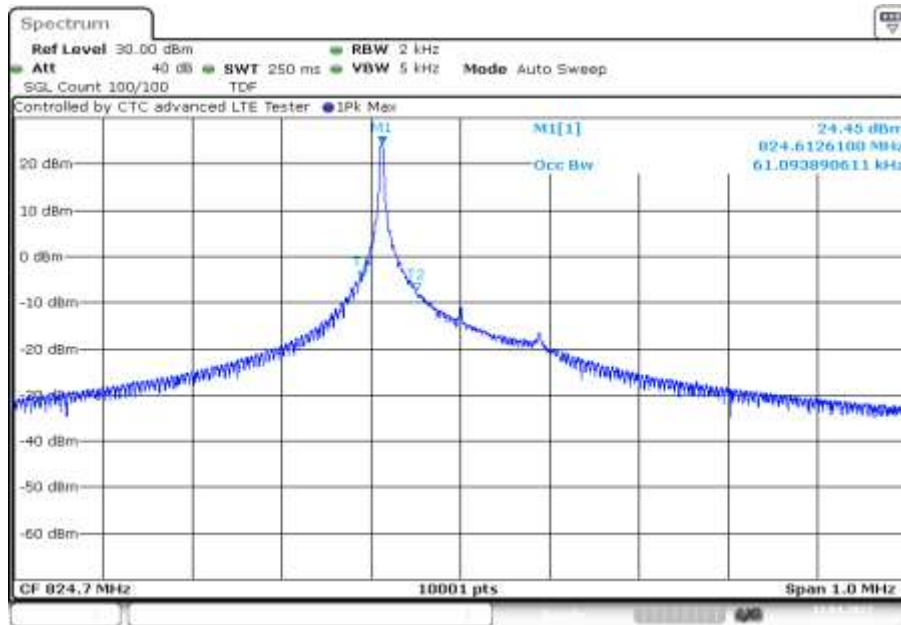
**Results:**

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

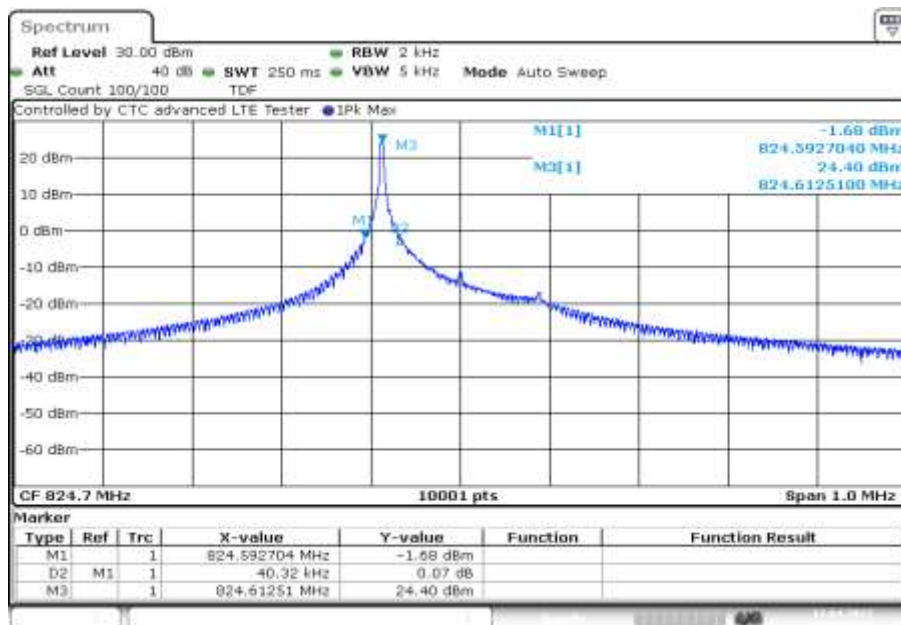
**Plots: BPSK**

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



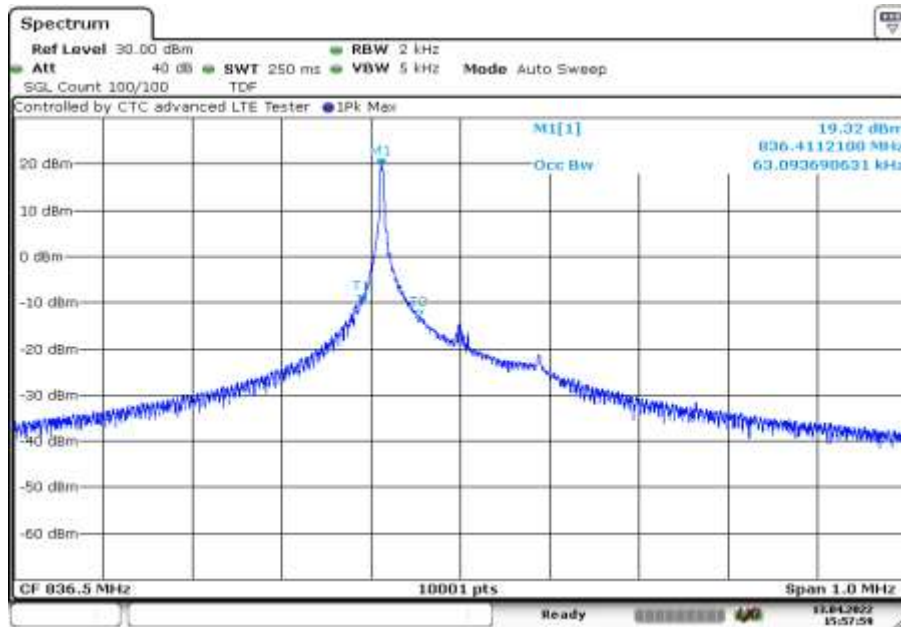
Date: 13.APR.2022 08:49:53

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



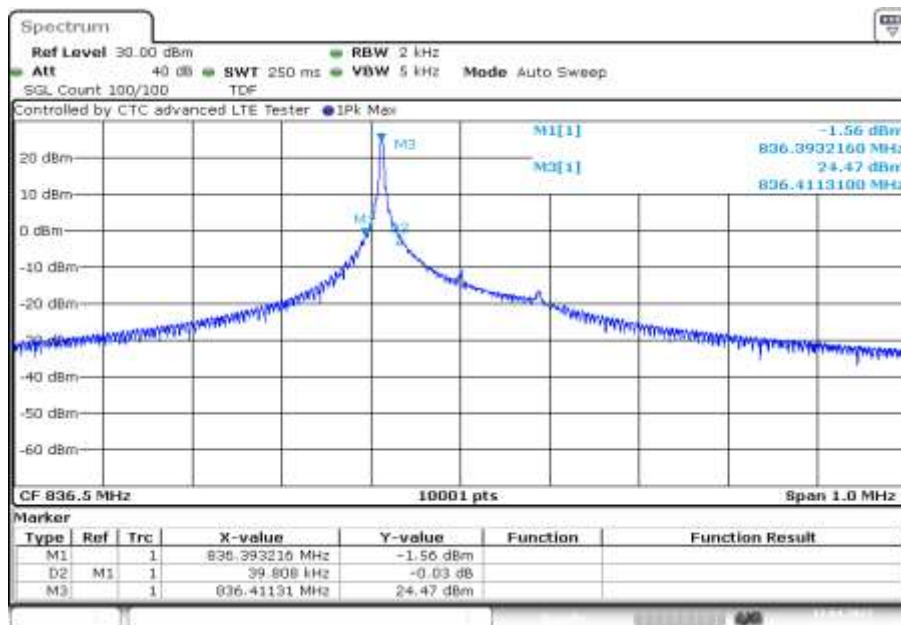
Date: 13.APR.2022 08:50:22

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



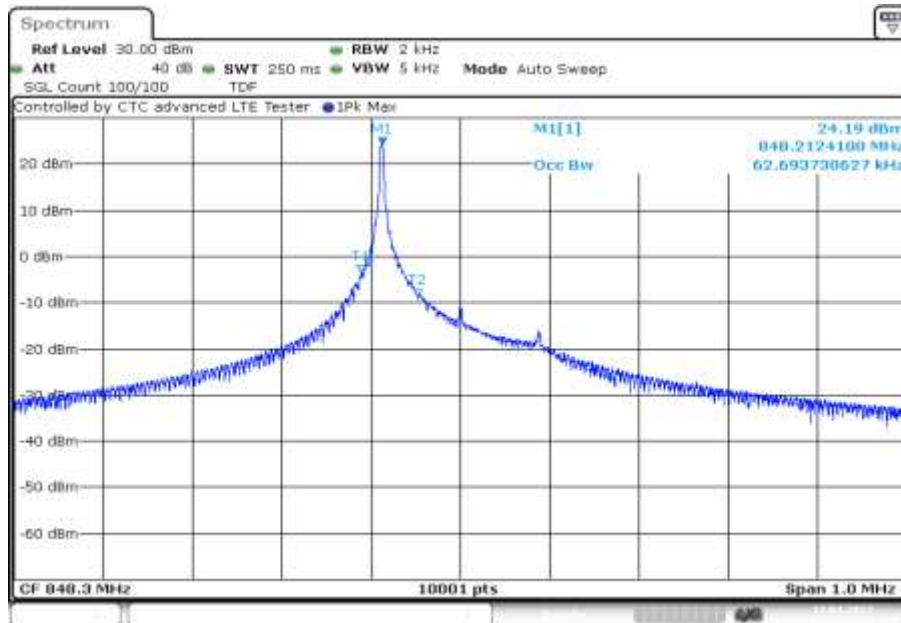
Date: 13.APR.2022 15:57:59

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



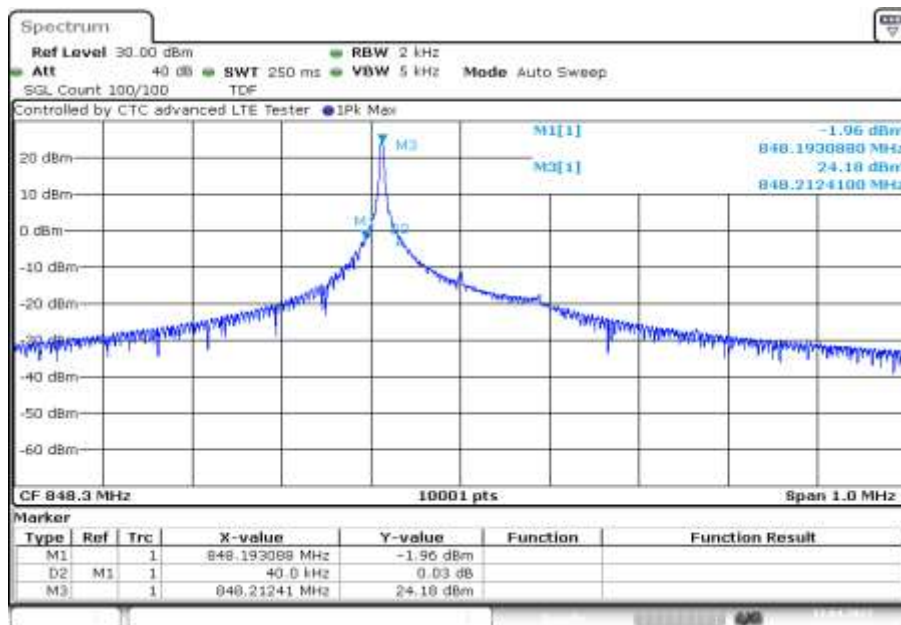
Date: 13.APR.2022 09:00:44

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



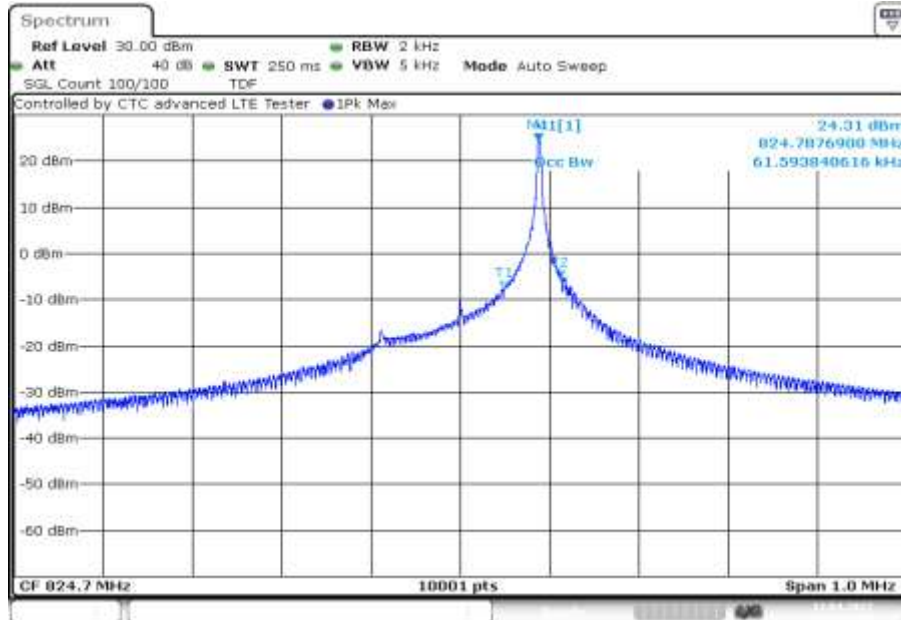
Date: 13.APR.2022 09:10:41

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



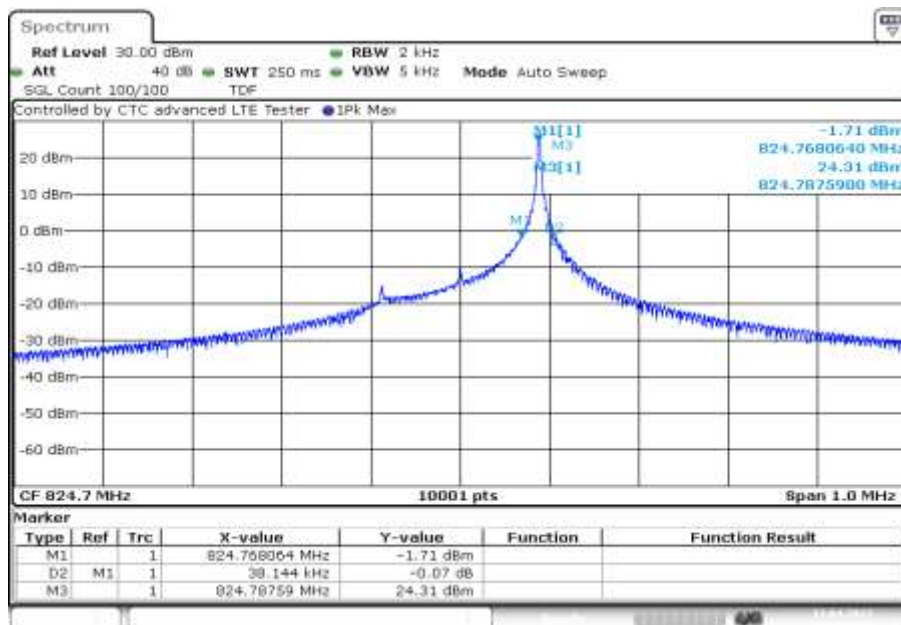
Date: 13.APR.2022 09:11:09

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



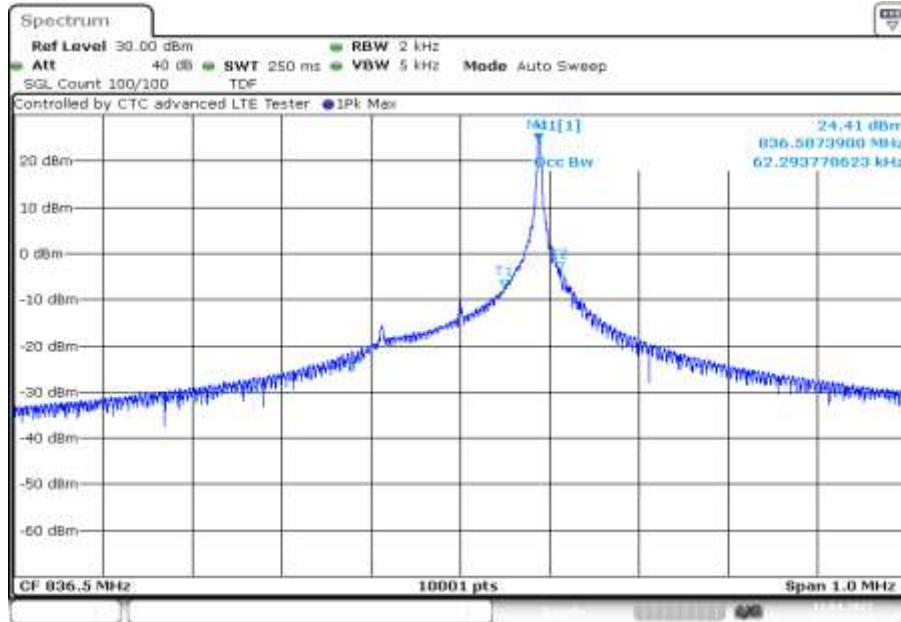
Date: 13.APR.2022 08:51:00

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



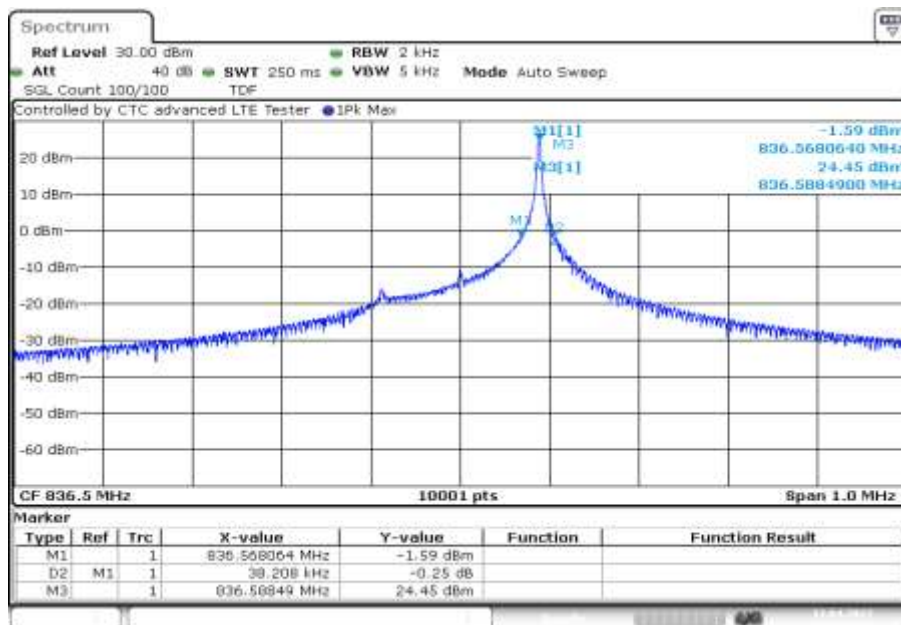
Date: 13.APR.2022 08:51:29

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



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

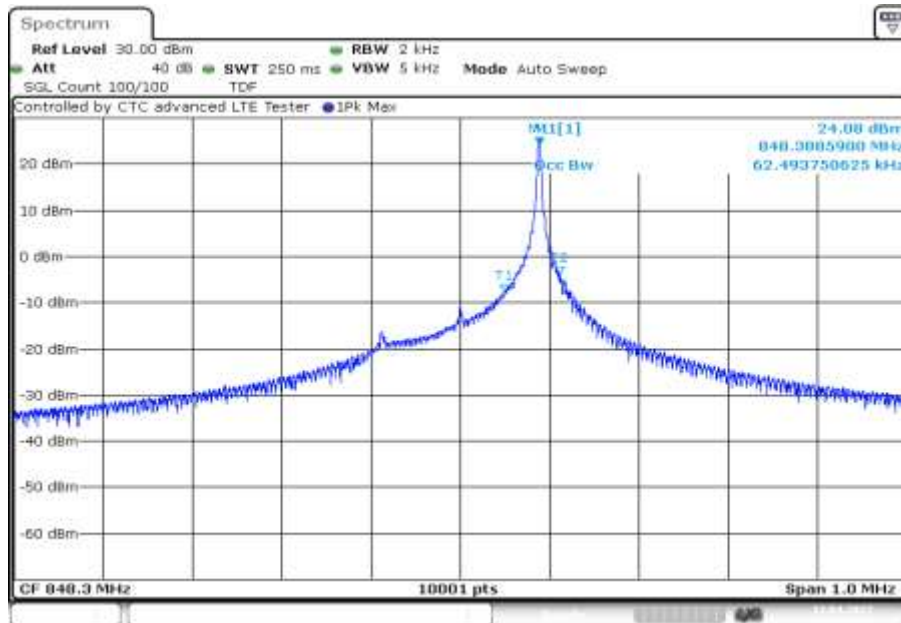
**Plot 10:** mid channel (-26 dBc BW), spacing 3.75 kHz, 1@47 tones



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

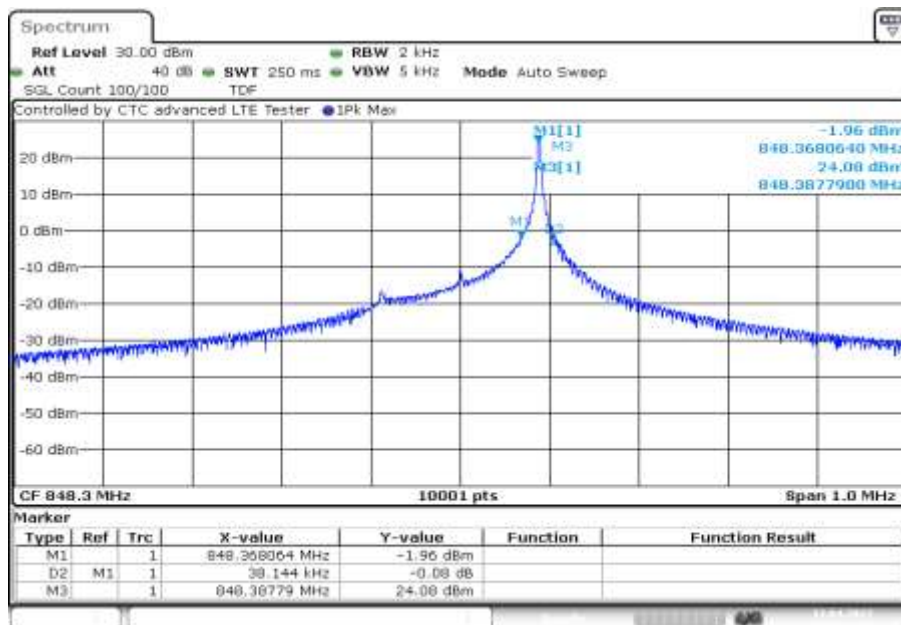


**Plot 11:** high channel (99% - OBW), spacing 3.75 kHz, 1@47 tones



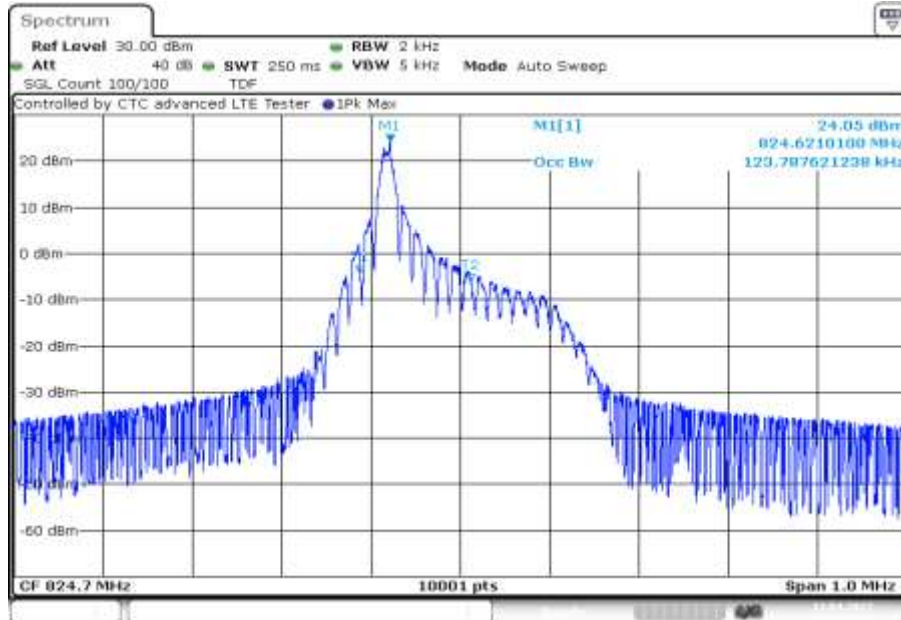
Date: 13.APR.2022 09:11:47

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



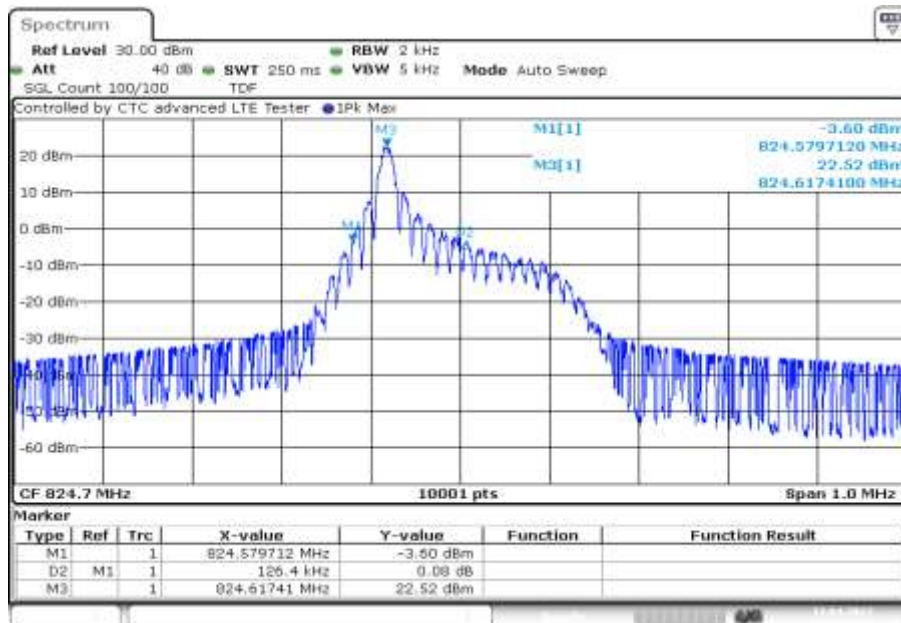
Date: 13.APR.2022 09:12:16

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



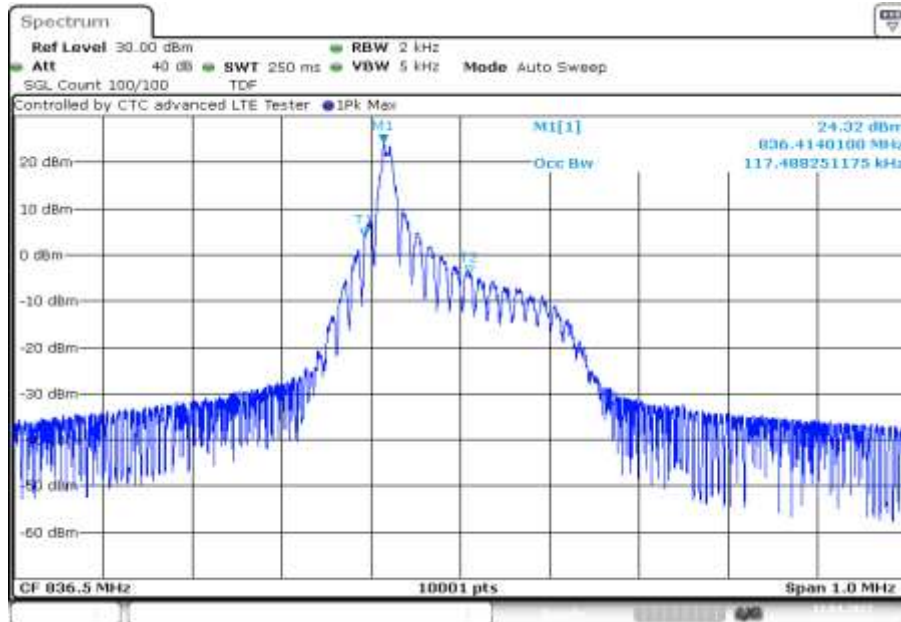
Date: 13.APR.2022 08:54:29

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



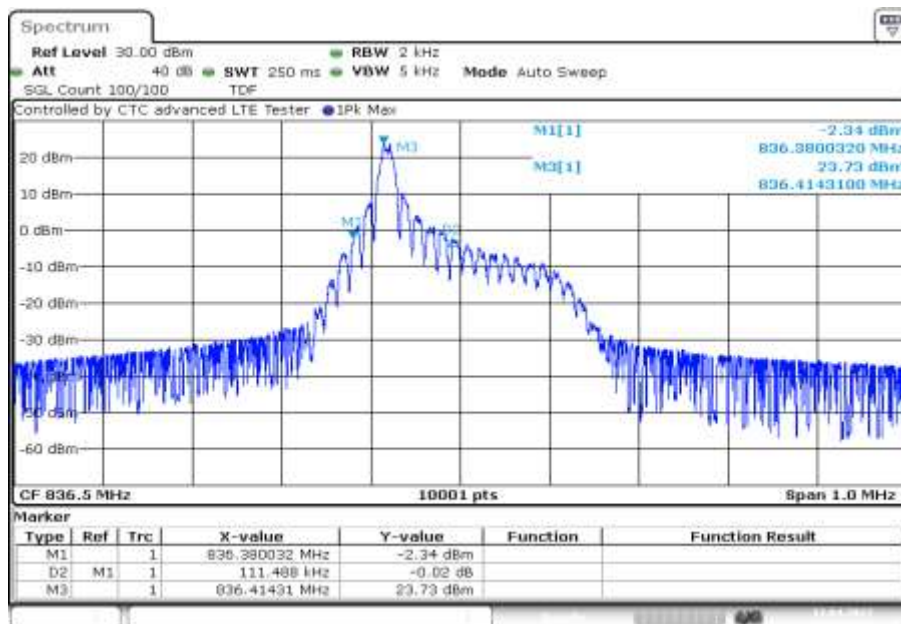
Date: 13.APR.2022 08:54:57

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



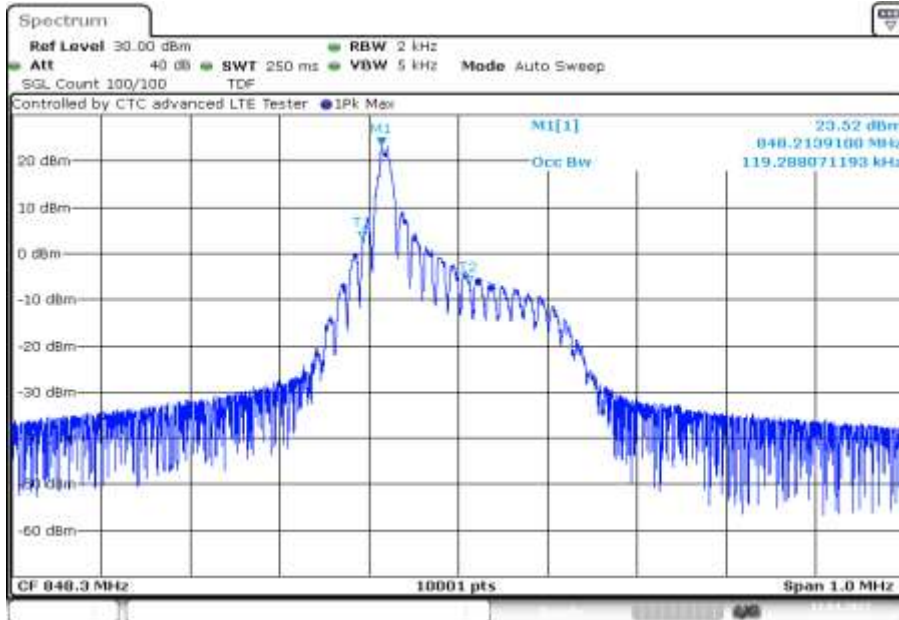
Date: 13.APR.2022 09:04:47

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



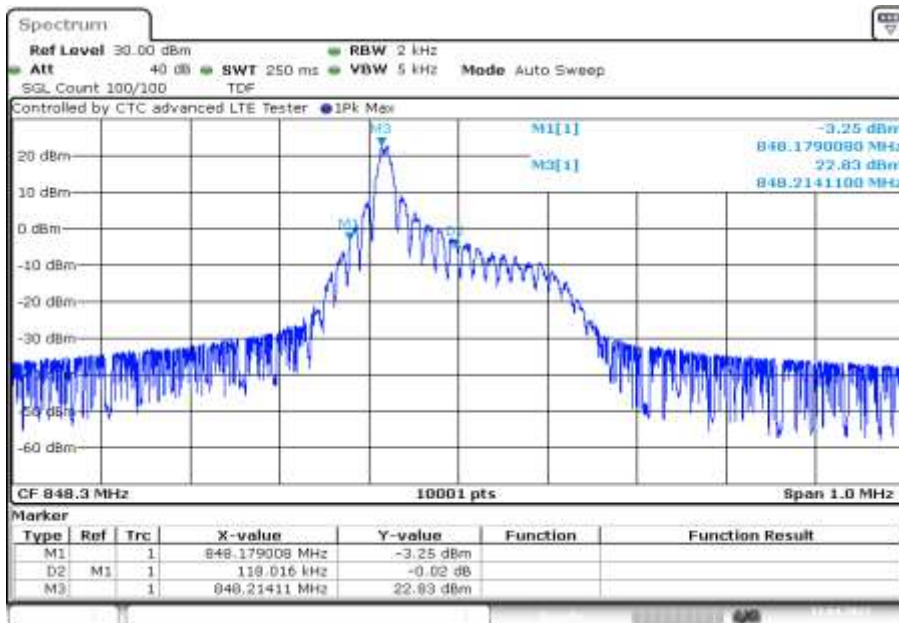
Date: 13.APR.2022 09:05:15

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



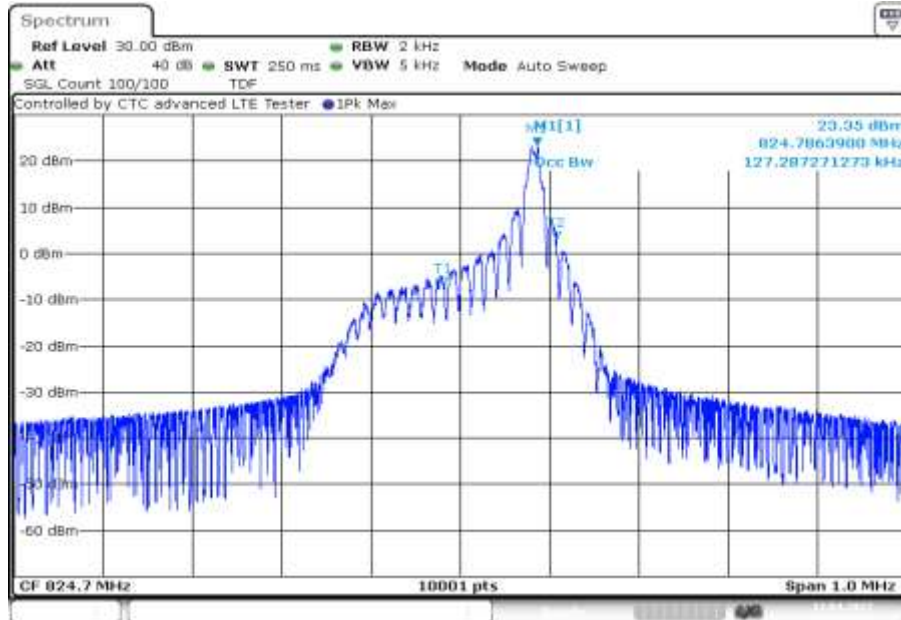
Date: 13.APR.2022 09:15:13

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



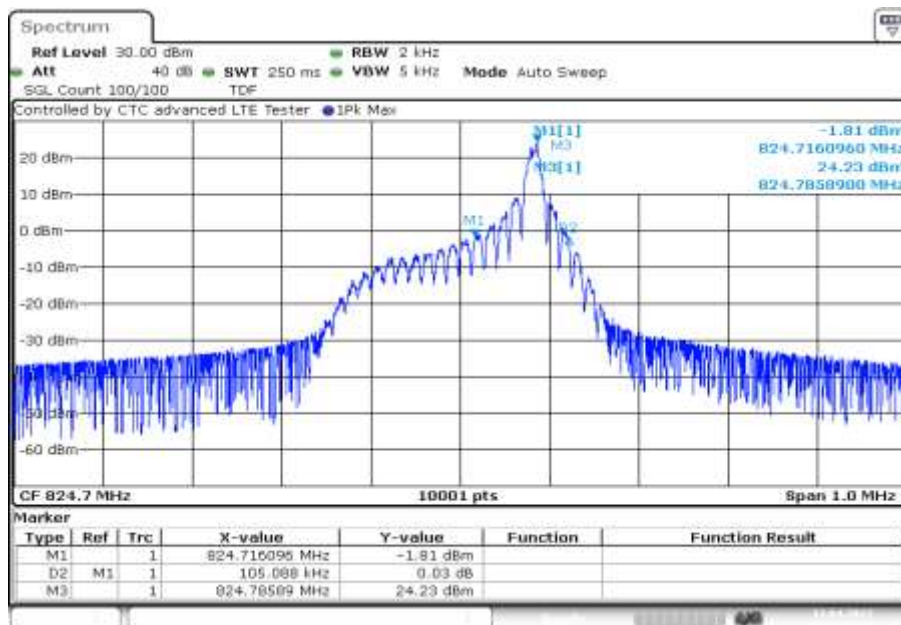
Date: 13.APR.2022 09:15:41

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



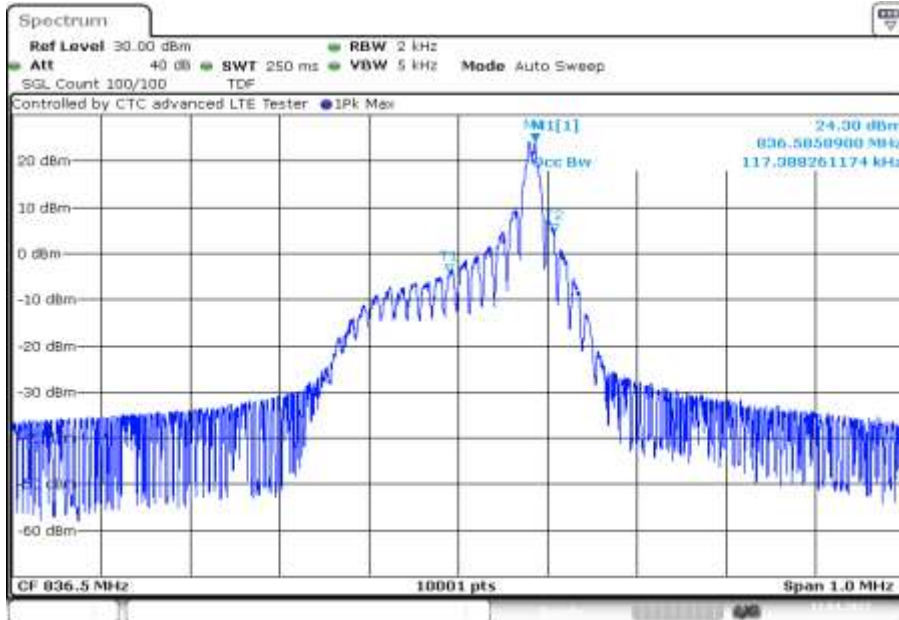
Date: 13.APR.2022 08:55:35

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



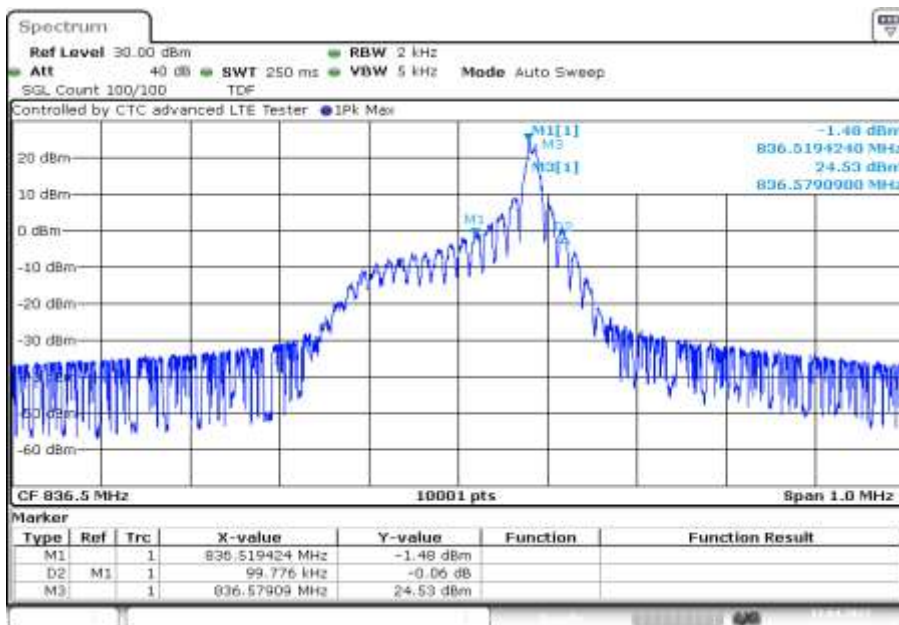
Date: 13.APR.2022 08:56:04

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



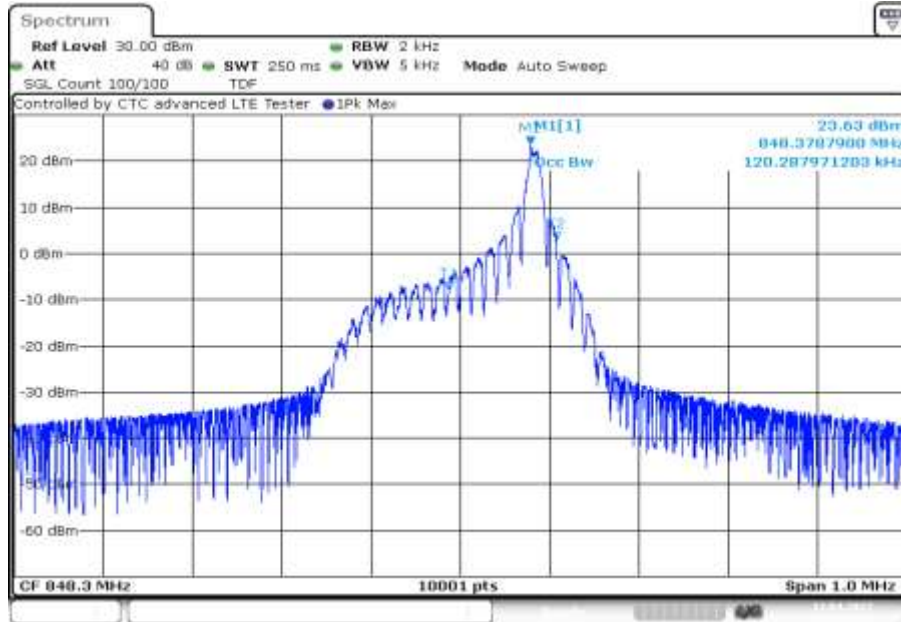
Date: 13.APR.2022 09:05:53

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



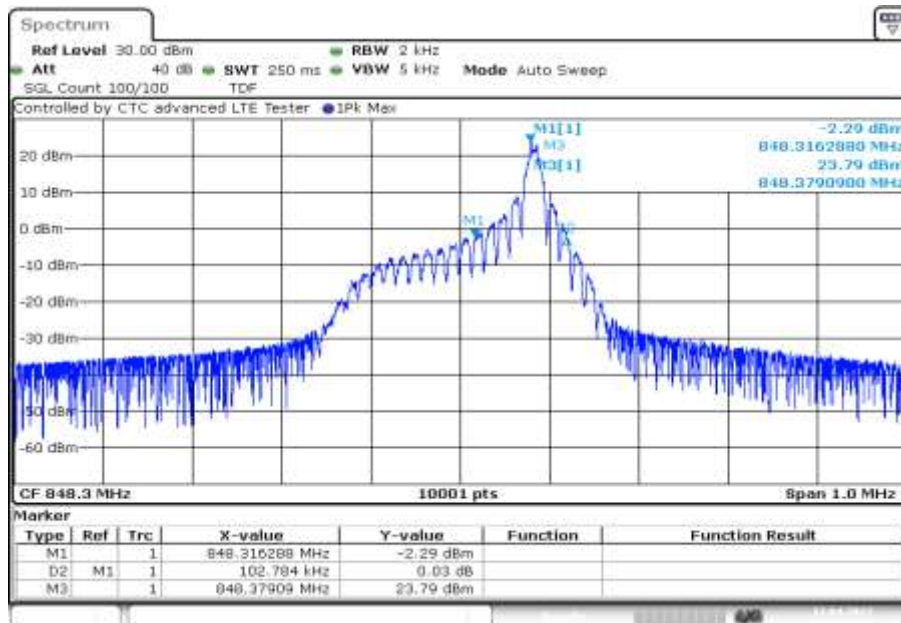
Date: 13.APR.2022 09:06:22

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



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

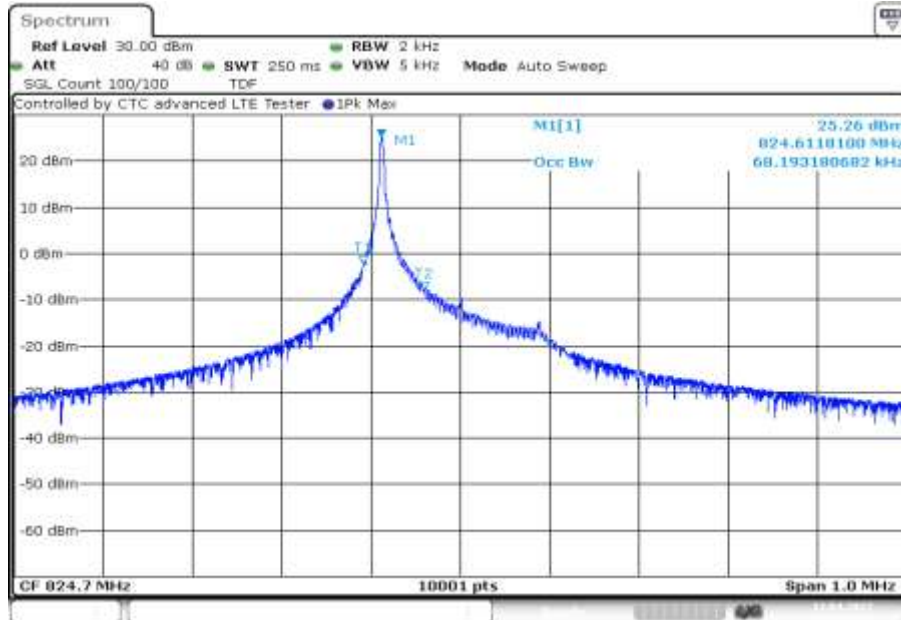
**Plot 24:** high channel (-26 dBc BW), spacing 15 kHz, 1@11 tones



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

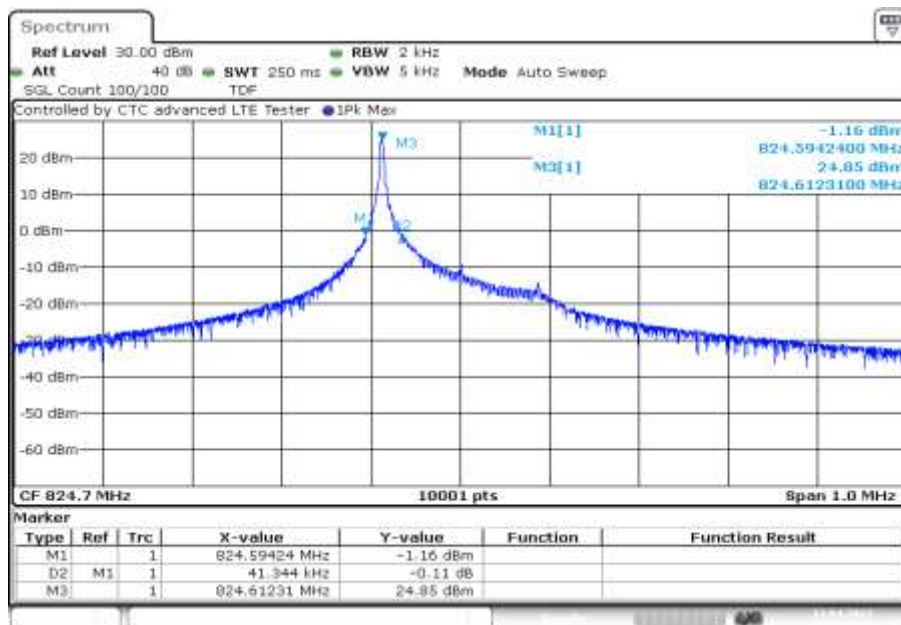
**Plots: QPSK**

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



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

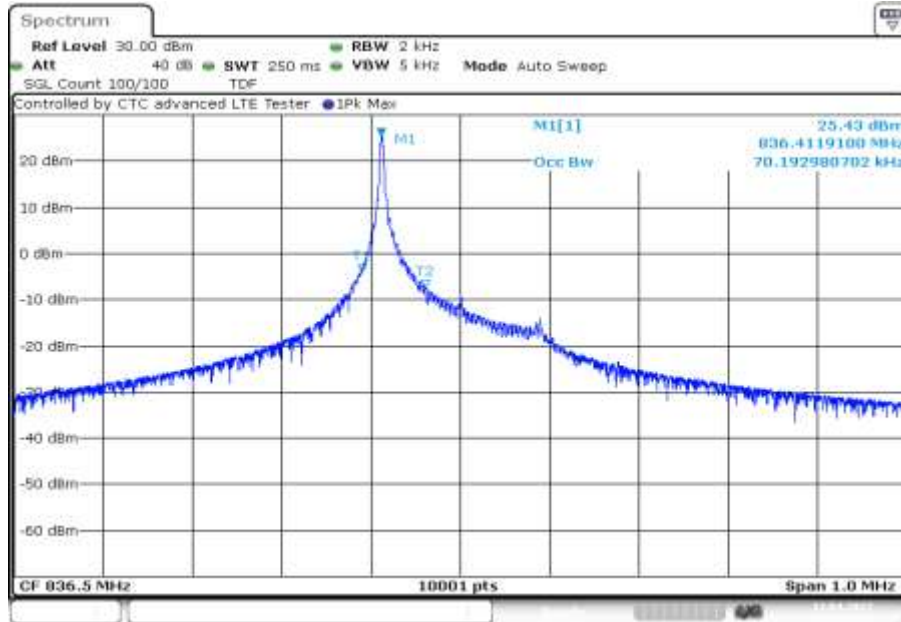
**Plot 2:** low channel (-26 dBc BW), spacing 3.75 kHz, 1@0 tones



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

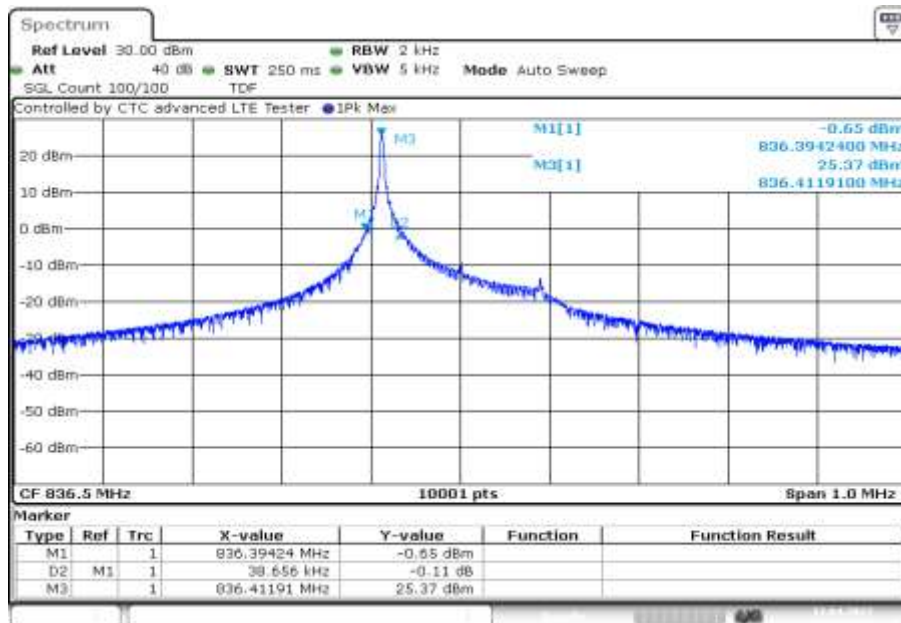


**Plot 3:** mid channel (99% - OBW), spacing 3.75 kHz, 1@0 tones



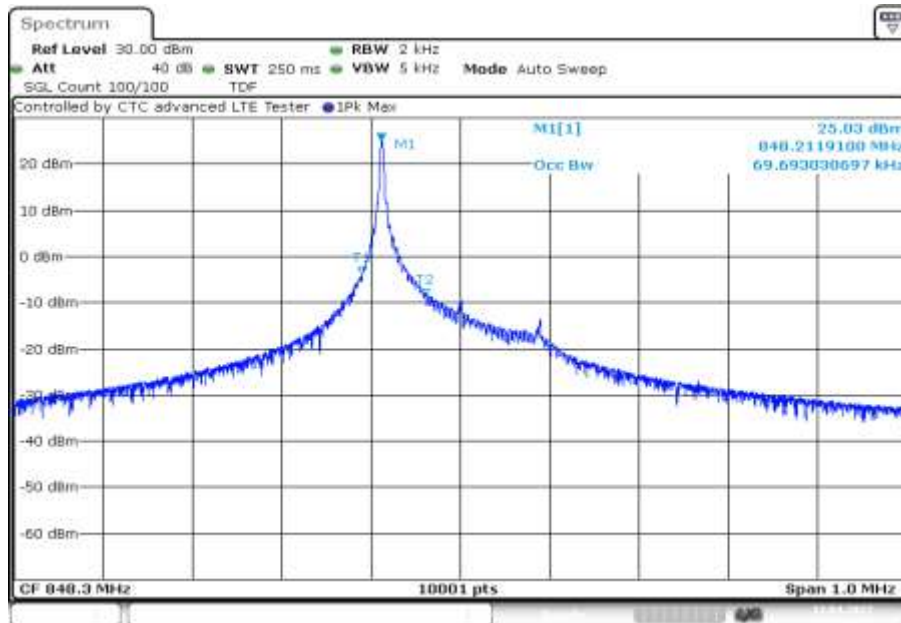
Date: 13.APR.2022 09:02:29

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



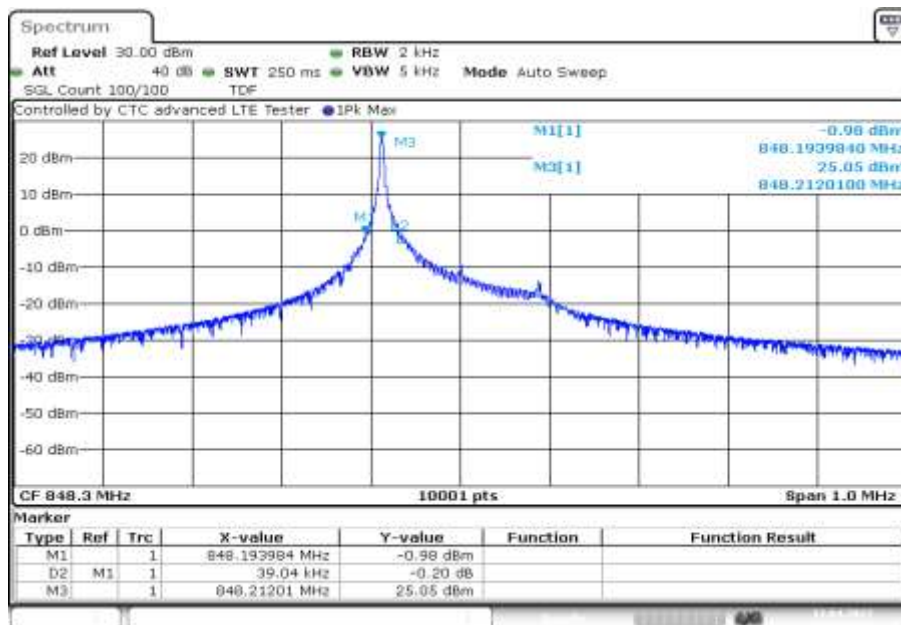
Date: 13.APR.2022 09:02:57

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



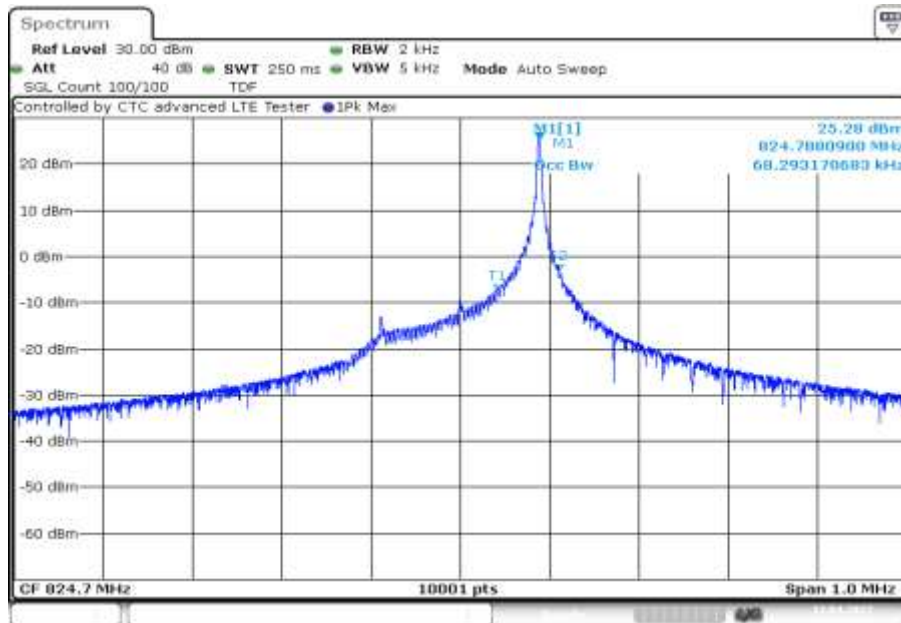
Date: 13.APR.2022 09:12:54

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



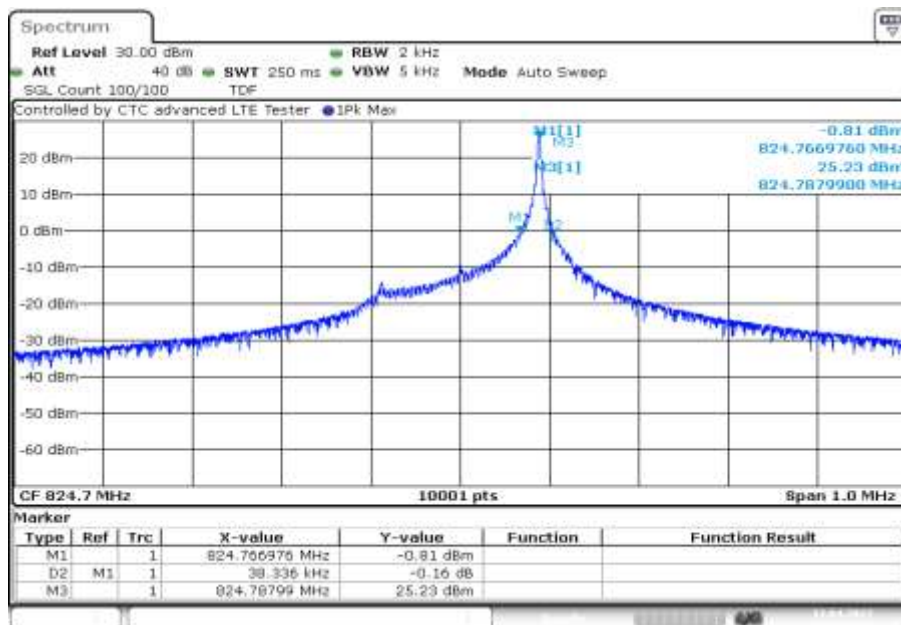
Date: 13.APR.2022 09:13:22

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



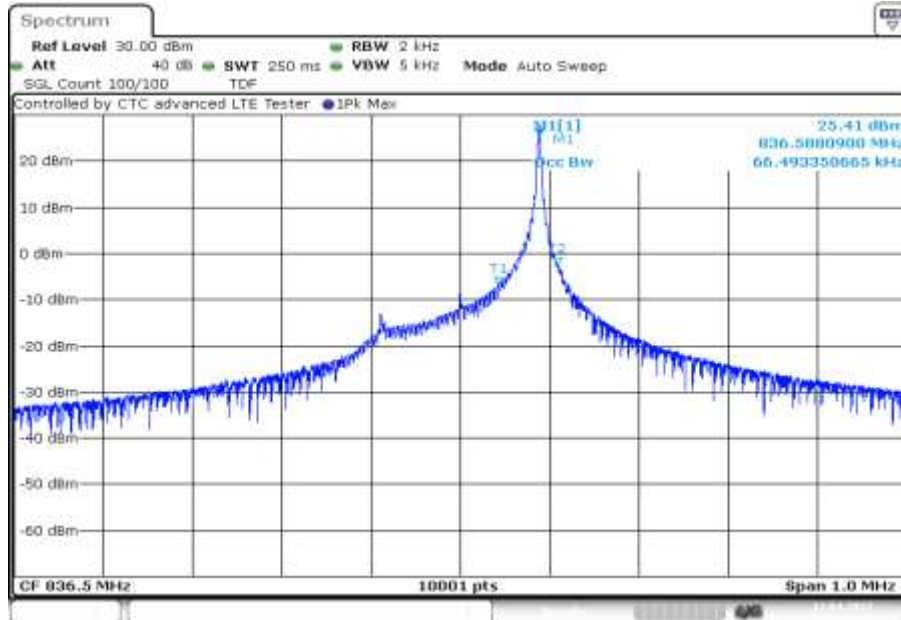
Date: 13.APR.2022 08:53:14

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



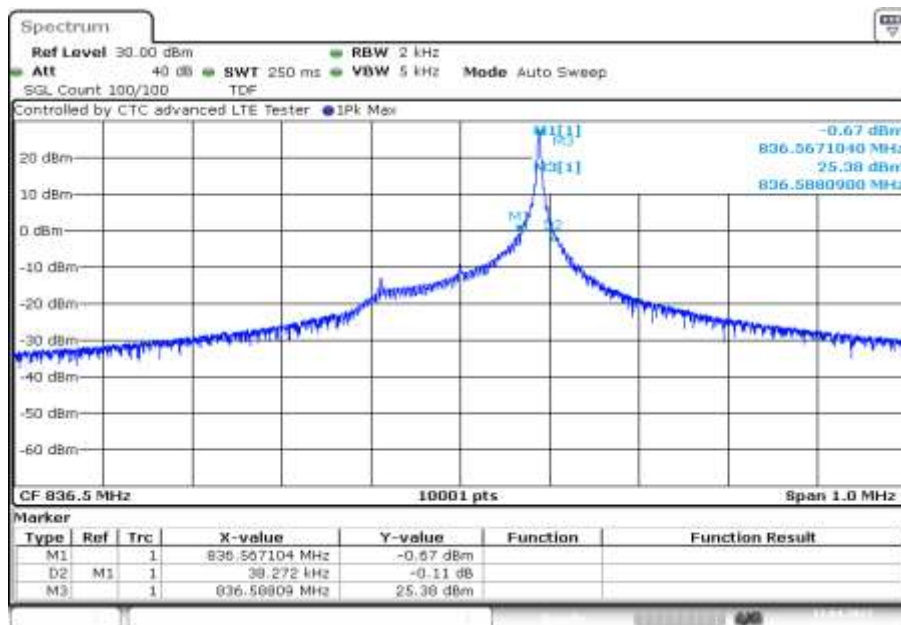
Date: 13.APR.2022 08:53:42

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



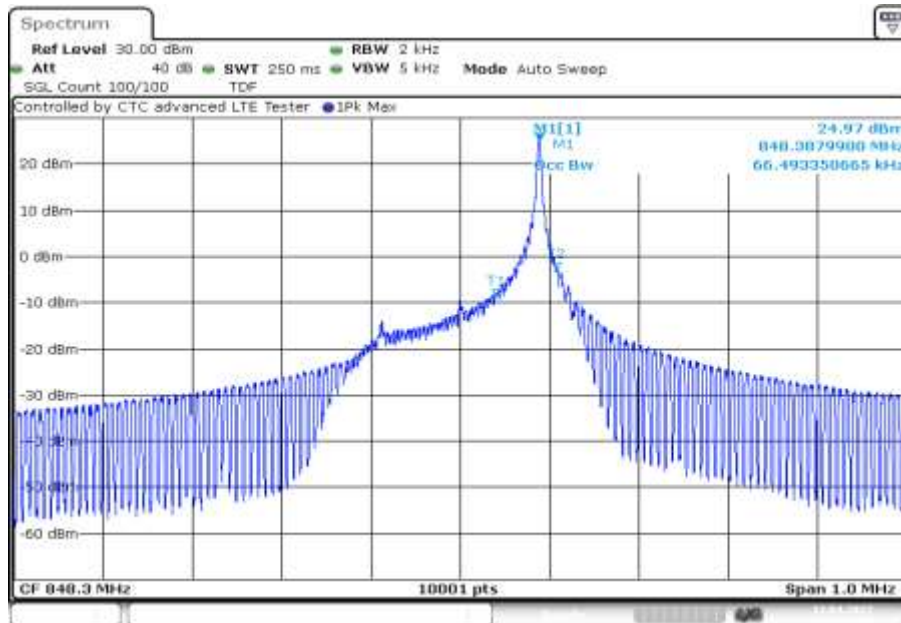
Date: 13.APR.2022 09:03:35

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



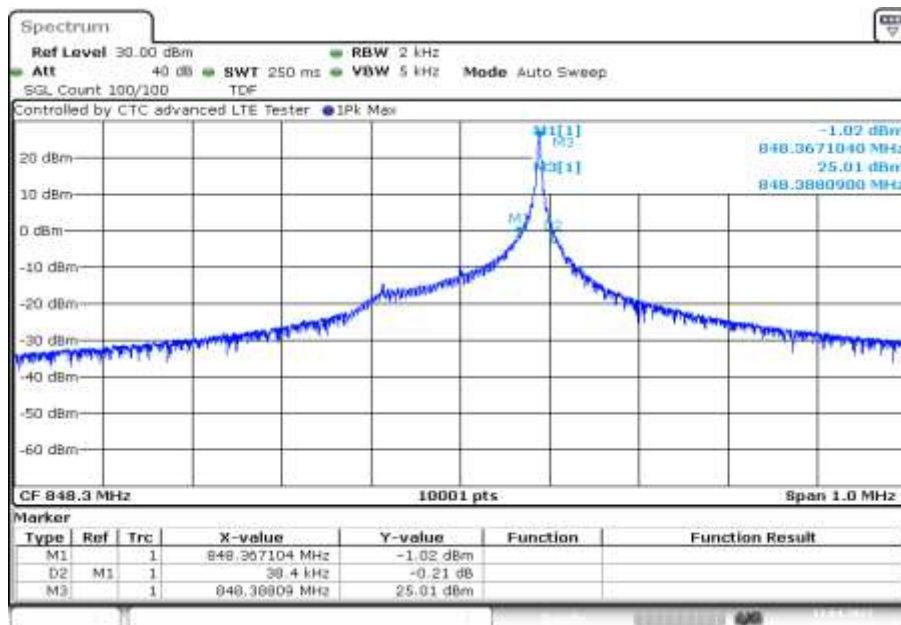
Date: 13.APR.2022 09:04:03

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



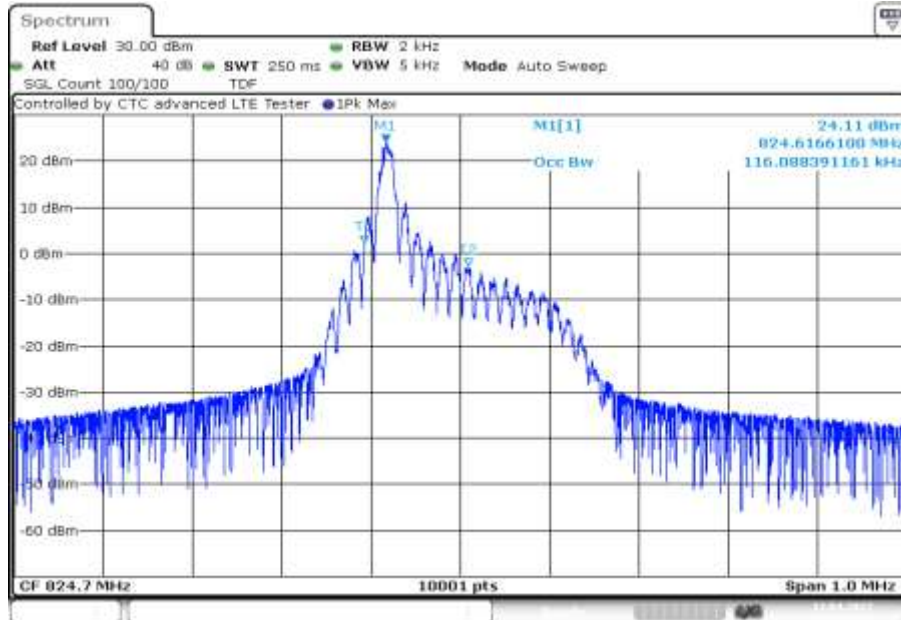
Date: 13.APR.2022 09:14:00

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



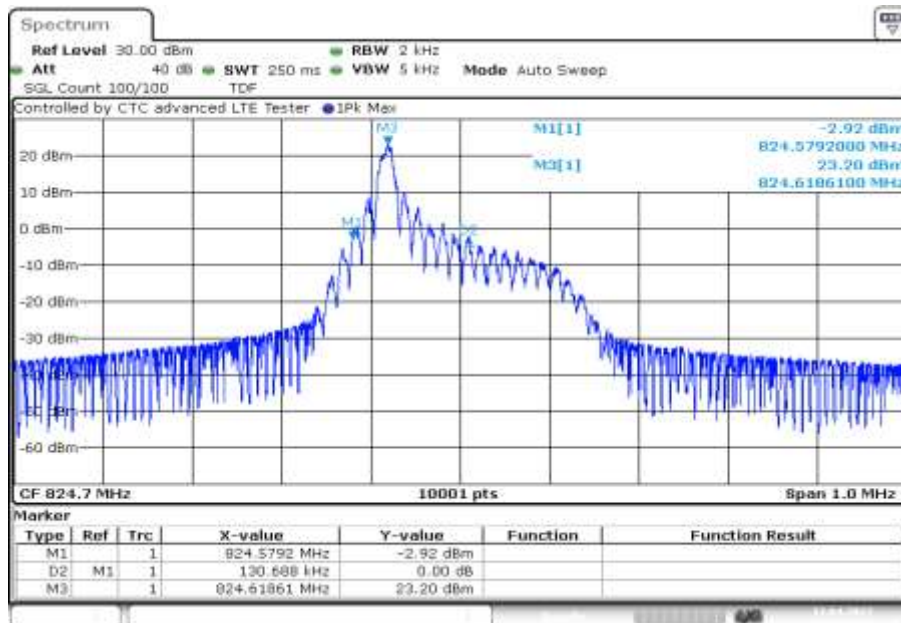
Date: 13.APR.2022 09:14:29

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



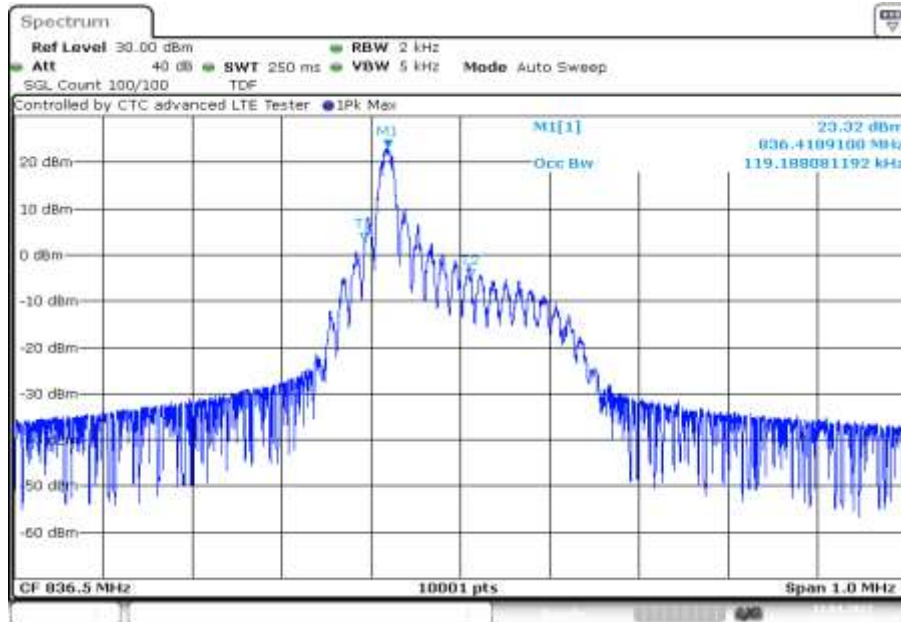
Date: 13.APR.2022 08:56:42

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



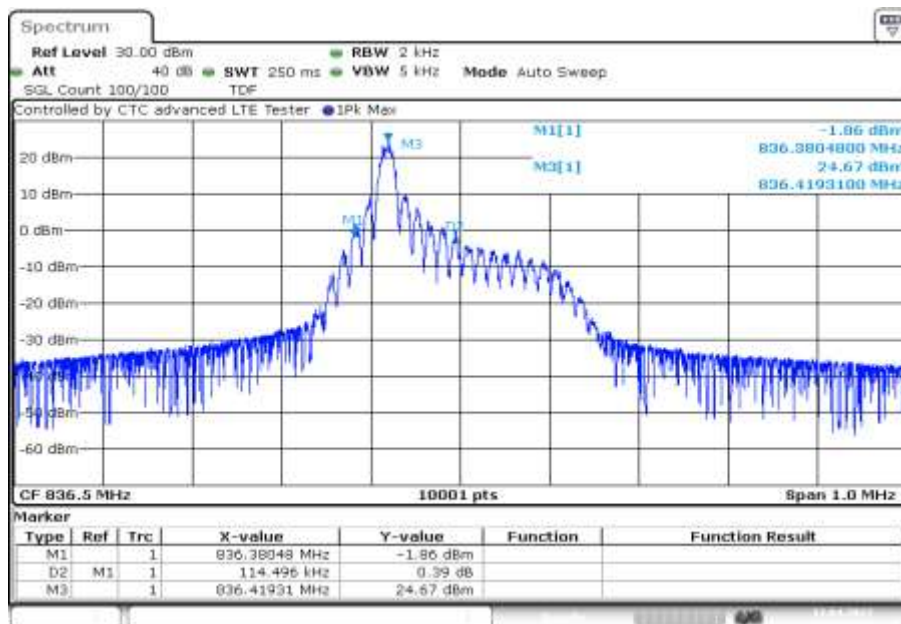
Date: 13.APR.2022 08:57:11

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



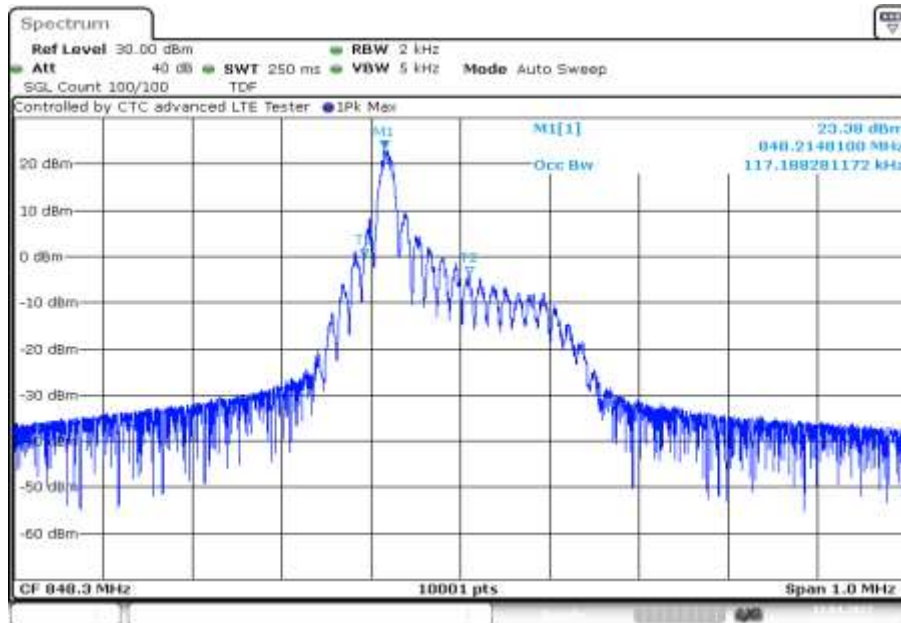
Date: 13.APR.2022 09:07:00

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



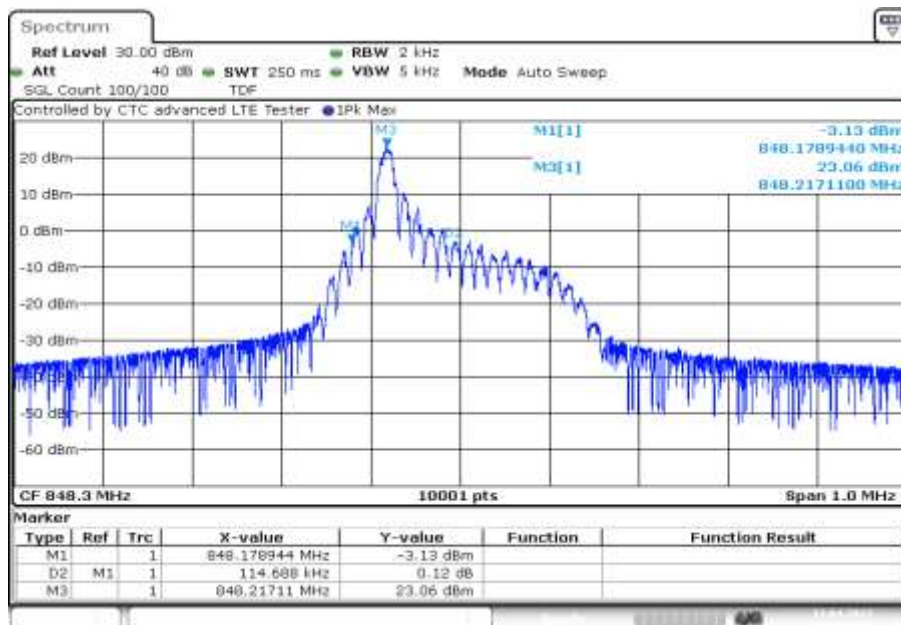
Date: 13.APR.2022 09:07:28

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



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

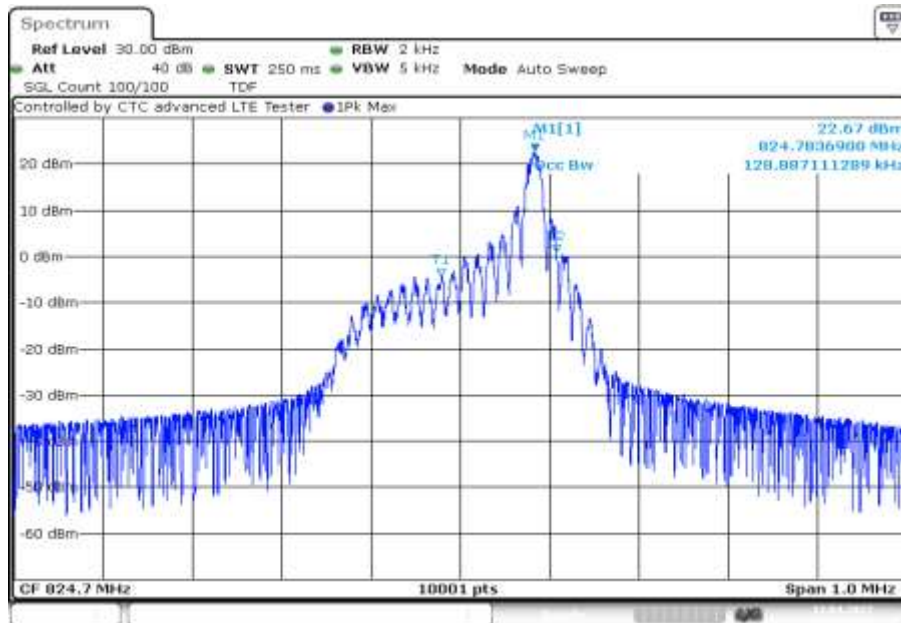
**Plot 18:** high channel (-26 dBc BW), spacing 15 kHz, 1@0 tones



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

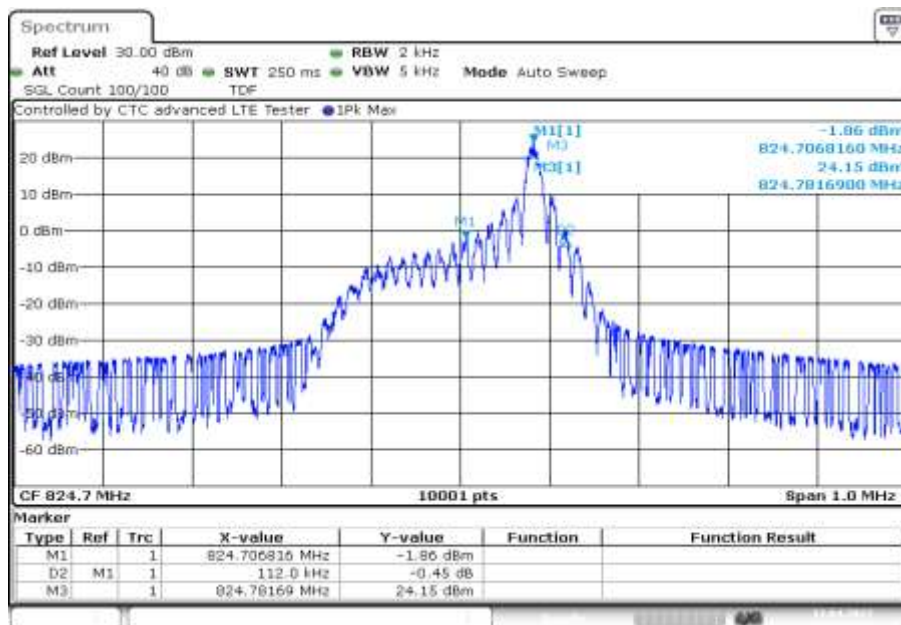


**Plot 19:** low channel (99% - OBW), spacing 15 kHz, 1@11 tones



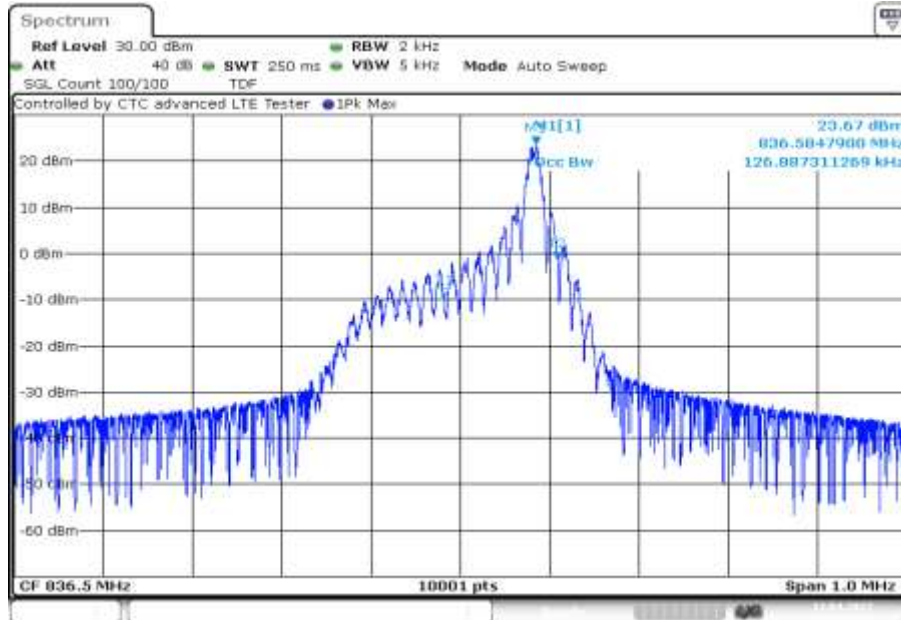
Date: 13.APR.2022 08:57:49

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



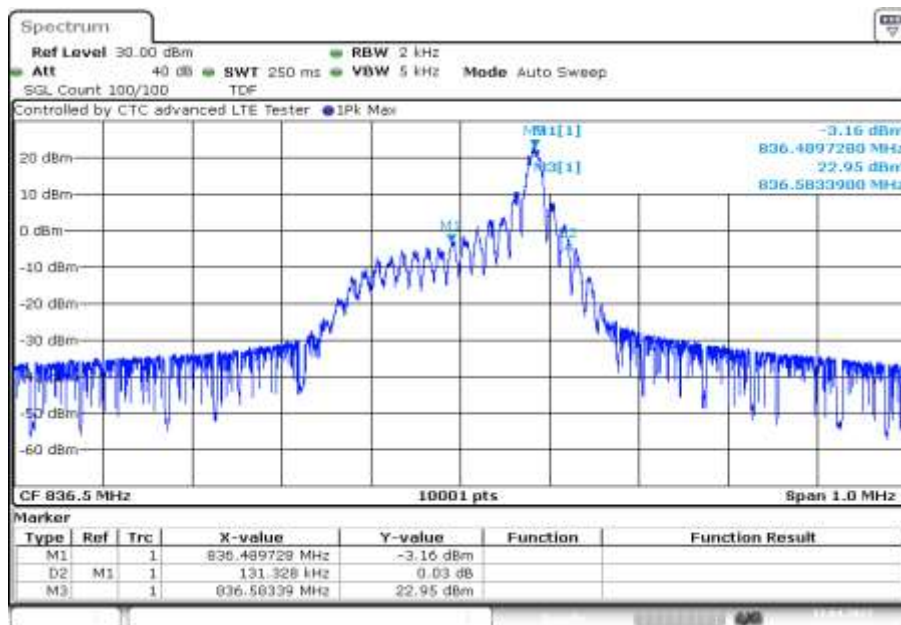
Date: 13.APR.2022 08:58:17

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



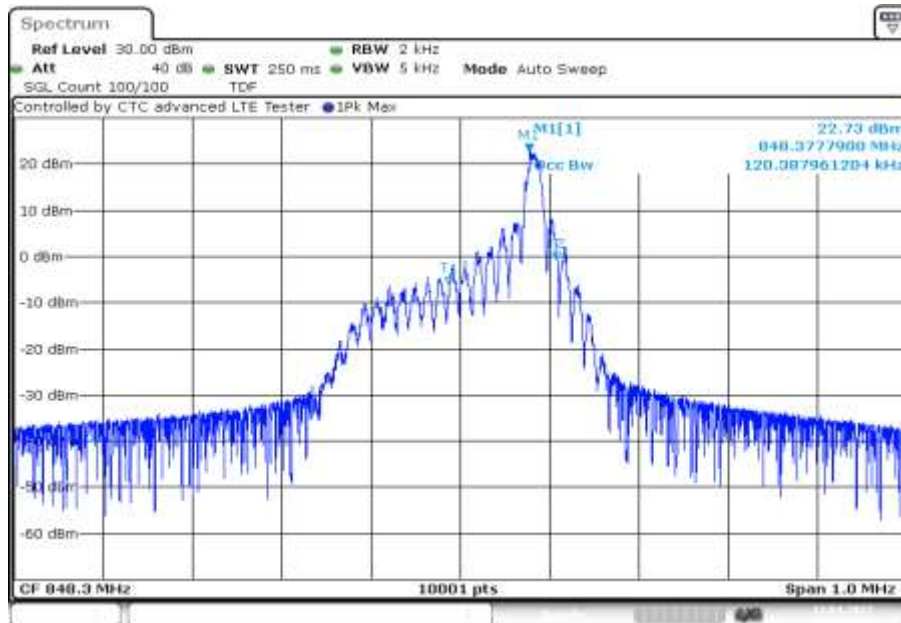
Date: 13.APR.2022 09:08:07

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



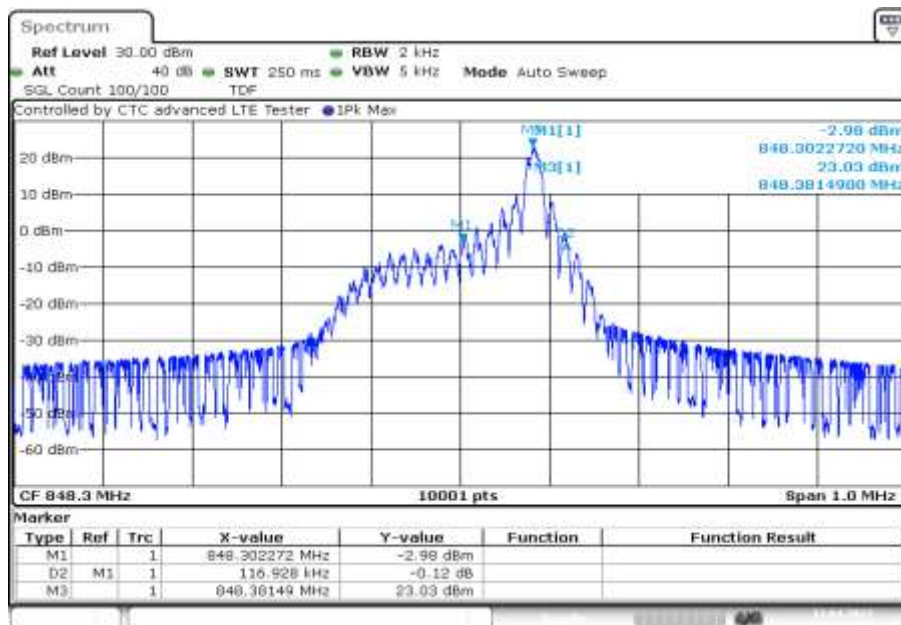
Date: 13.APR.2022 09:08:35

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



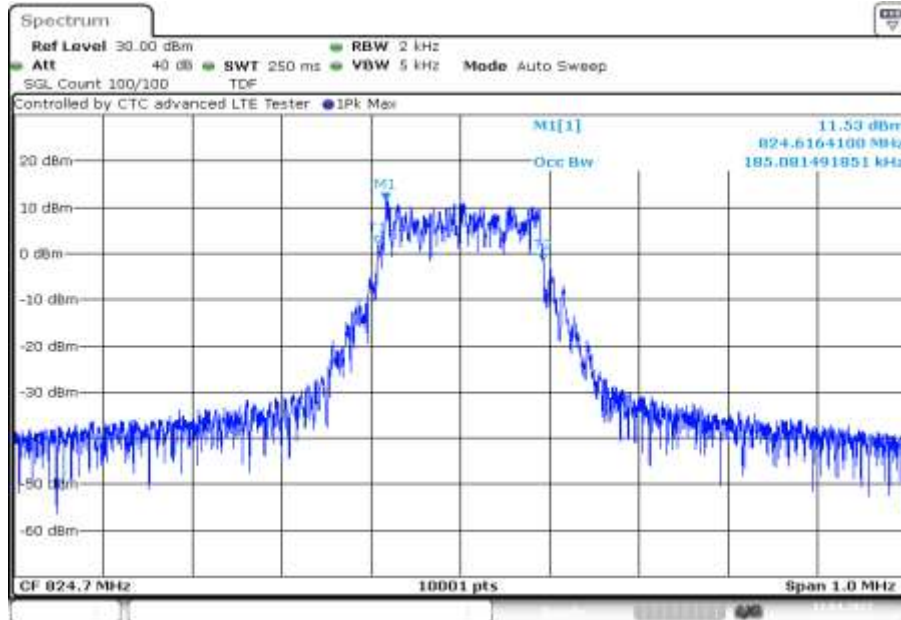
Date: 13.APR.2022 09:18:32

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



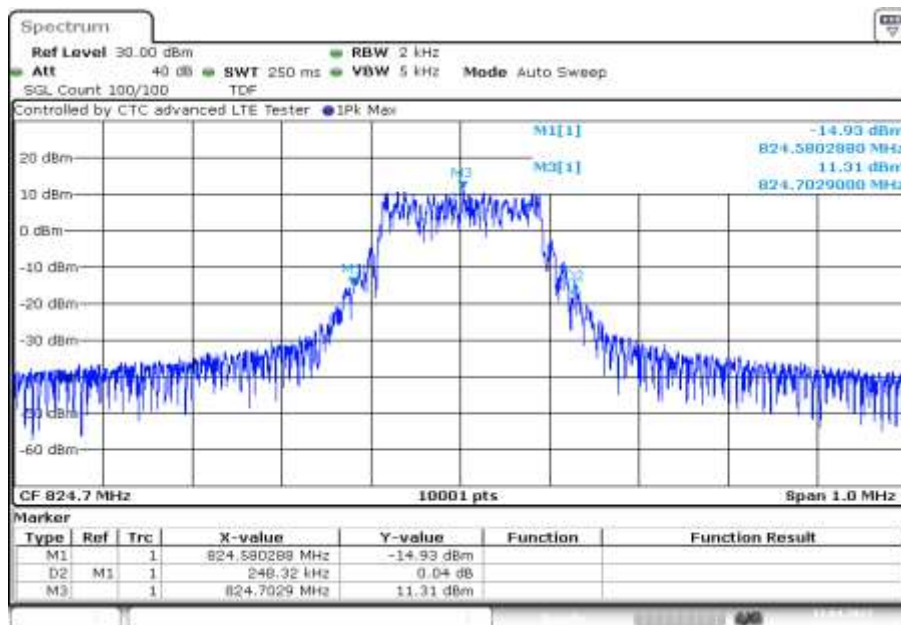
Date: 13.APR.2022 09:19:00

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



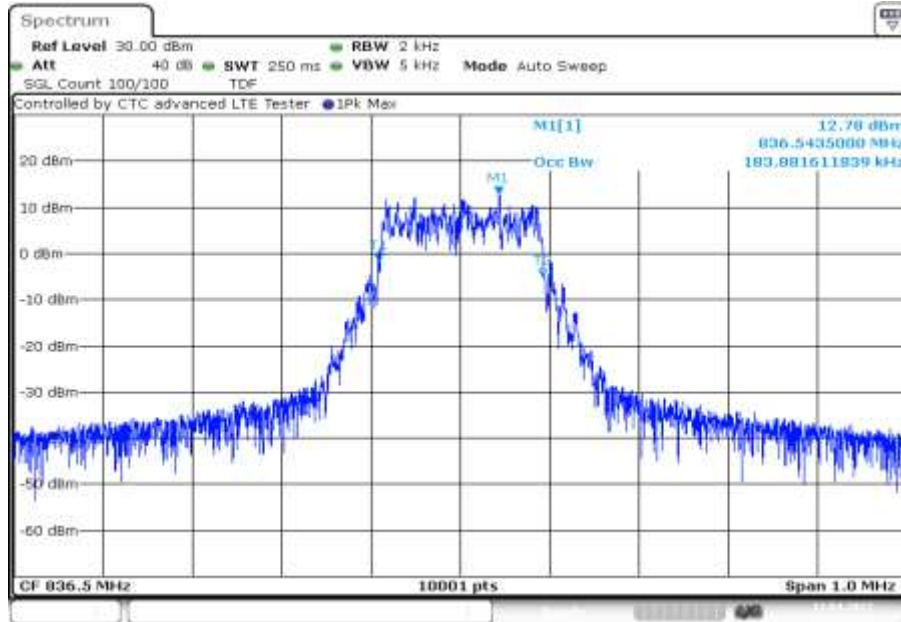
Date: 13.APR.2022 08:58:55

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



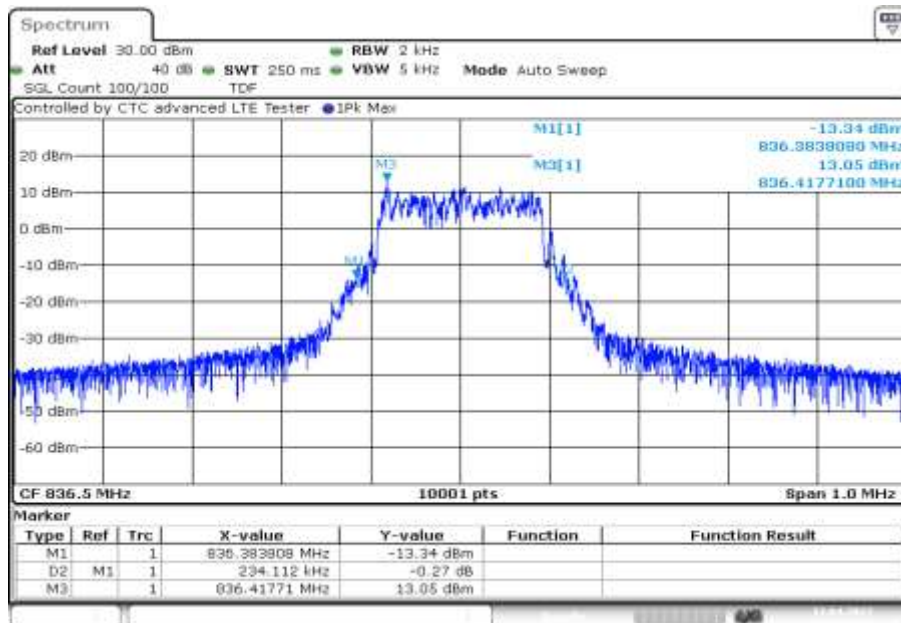
Date: 13.APR.2022 08:59:24

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



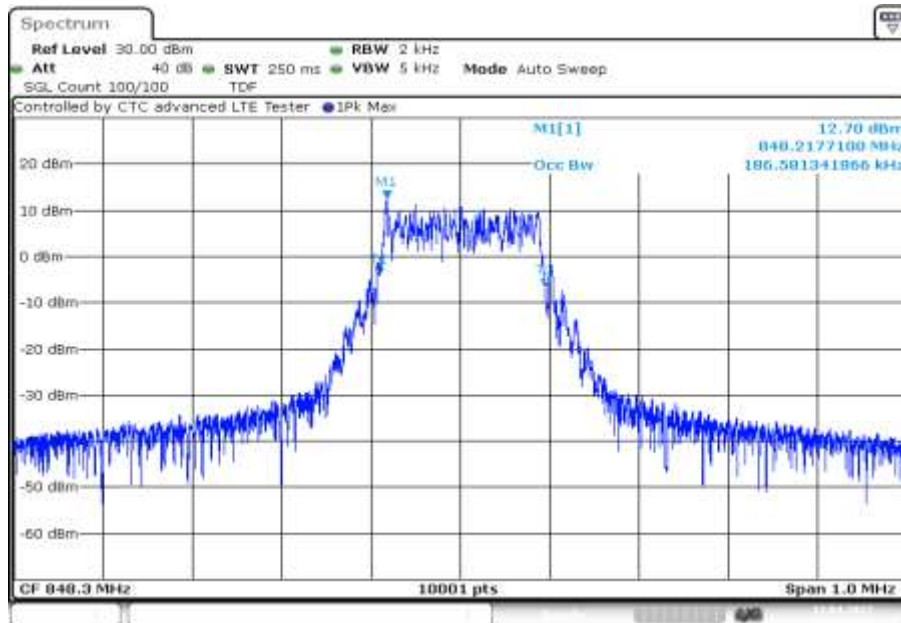
Date: 13.APR.2022 09:09:14

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



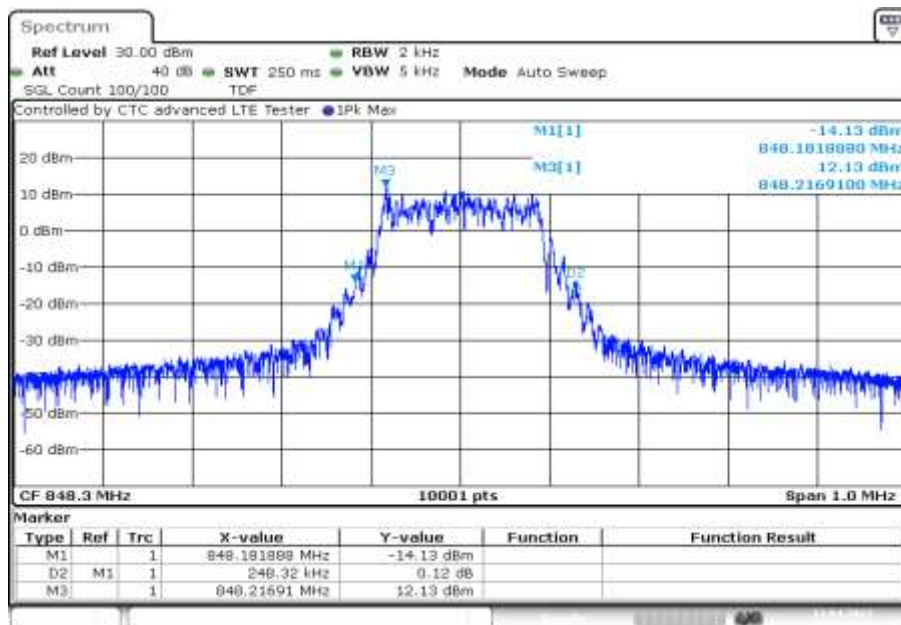
Date: 13.APR.2022 09:09:42

**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