

## Modulation Characteristics

### Limits

FCC §2.1047.

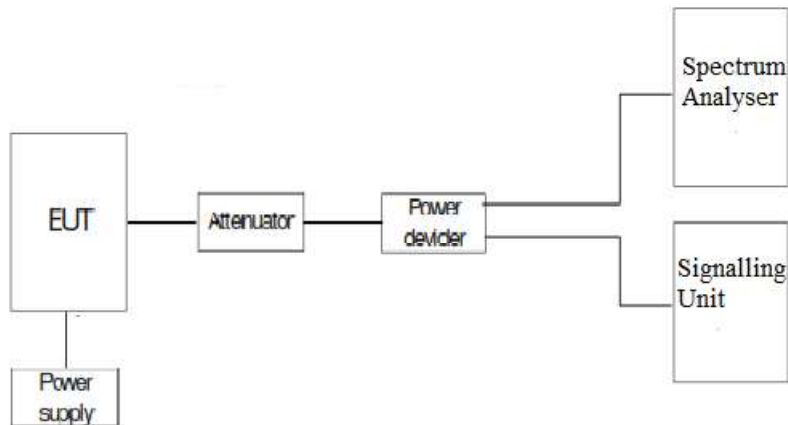
RSS-132. Clause 5.2. Equipment certified under this standard shall use digital modulation.

### Method

For NB-IoT the EUT operates with  $\pi/2$  - BPSK and  $\pi/4$  - QPSK modulation modes in which the information is digitised and coded into a bit stream. The RF transmission is multiplexed using *Orthogonal Frequency Division Multiplexing (OFDM)* with different possible arrangement of subcarriers.

The EUT was set on the middle channel of each band using the Universal Radio Communication tester R&S CMW500 and the modulation scheme is displayed on the spectrum analyser.

### Test setup

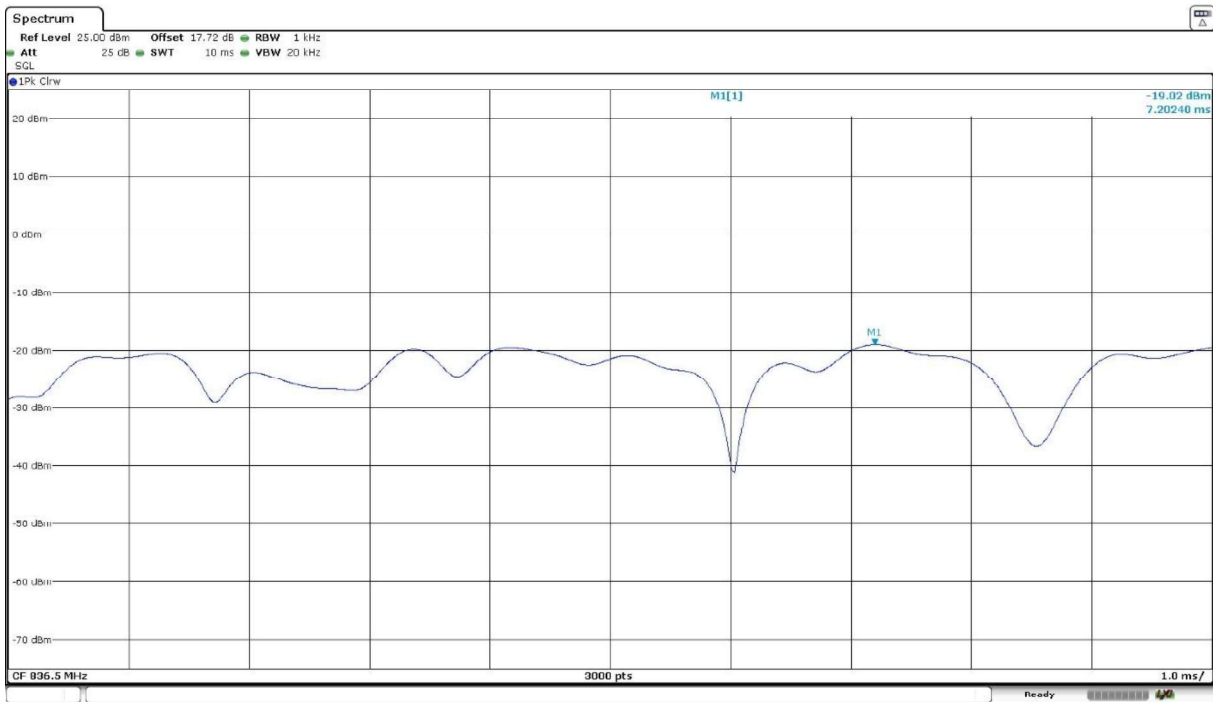


## Results

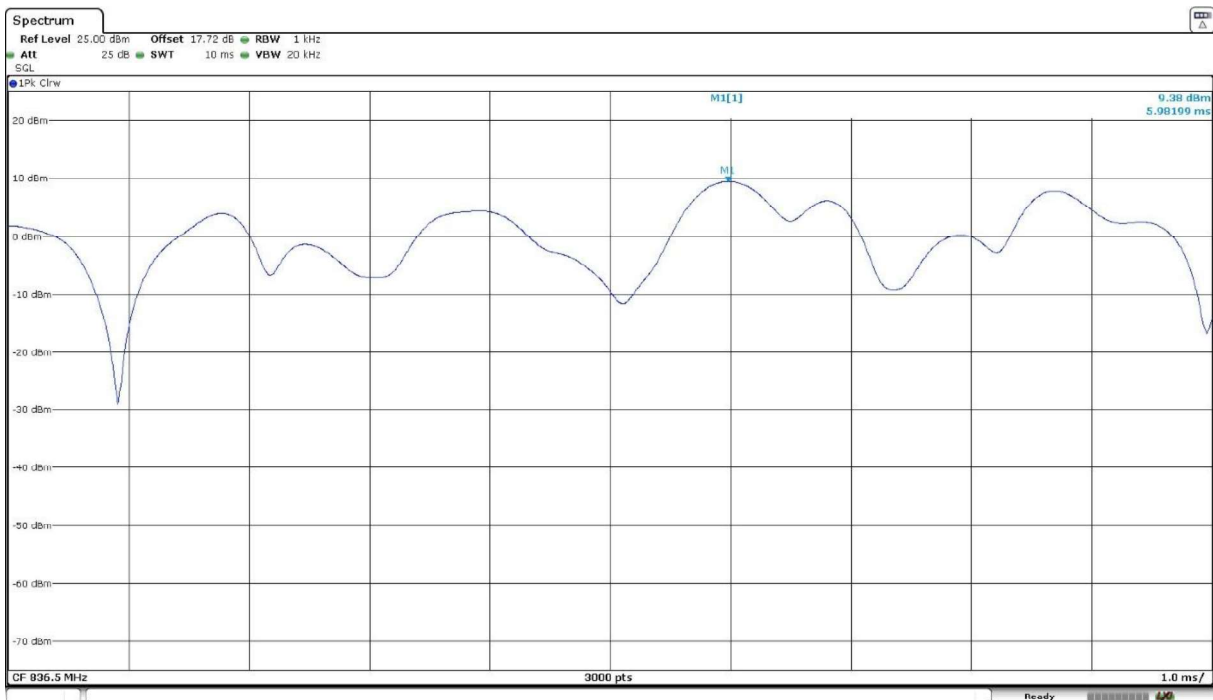
The following plots show the modulation schemes in the EUT.

### NB-IoT Band 5.

Modulation:  $\pi/2$  – BPSK

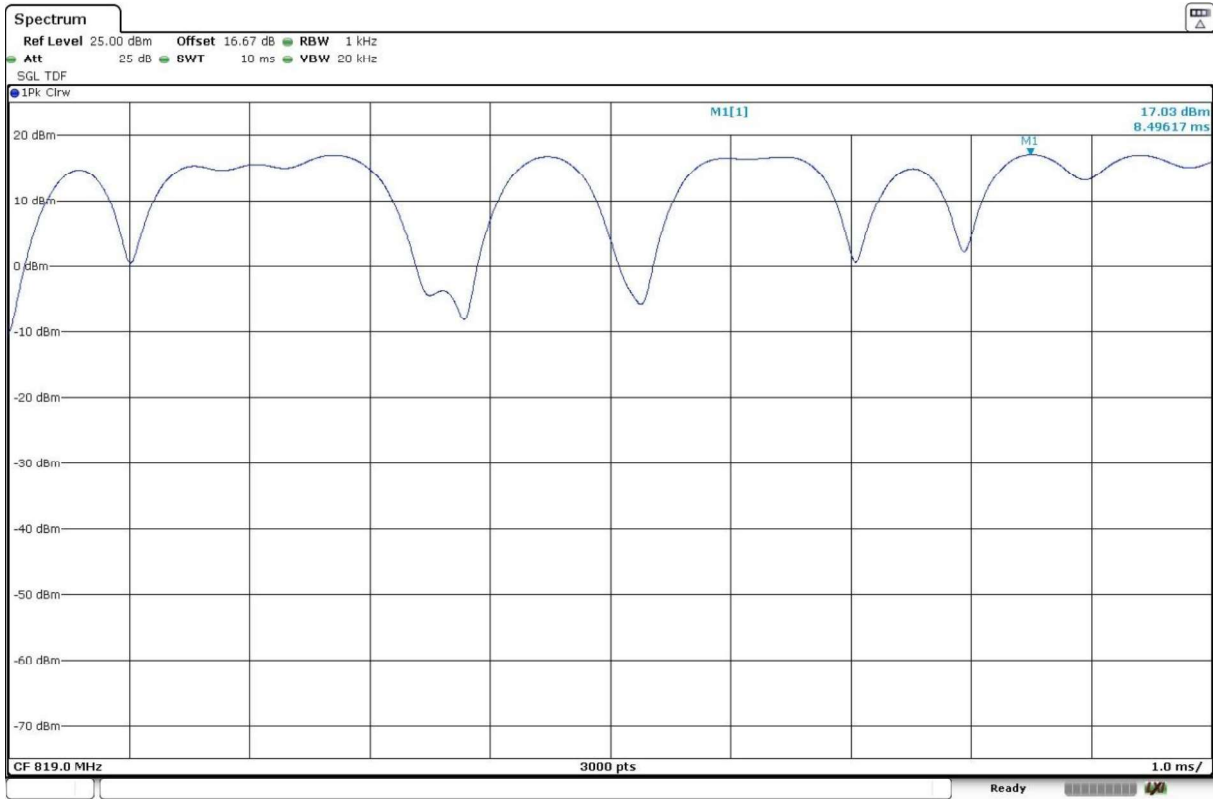


Modulation:  $\pi/4$  - QPSK

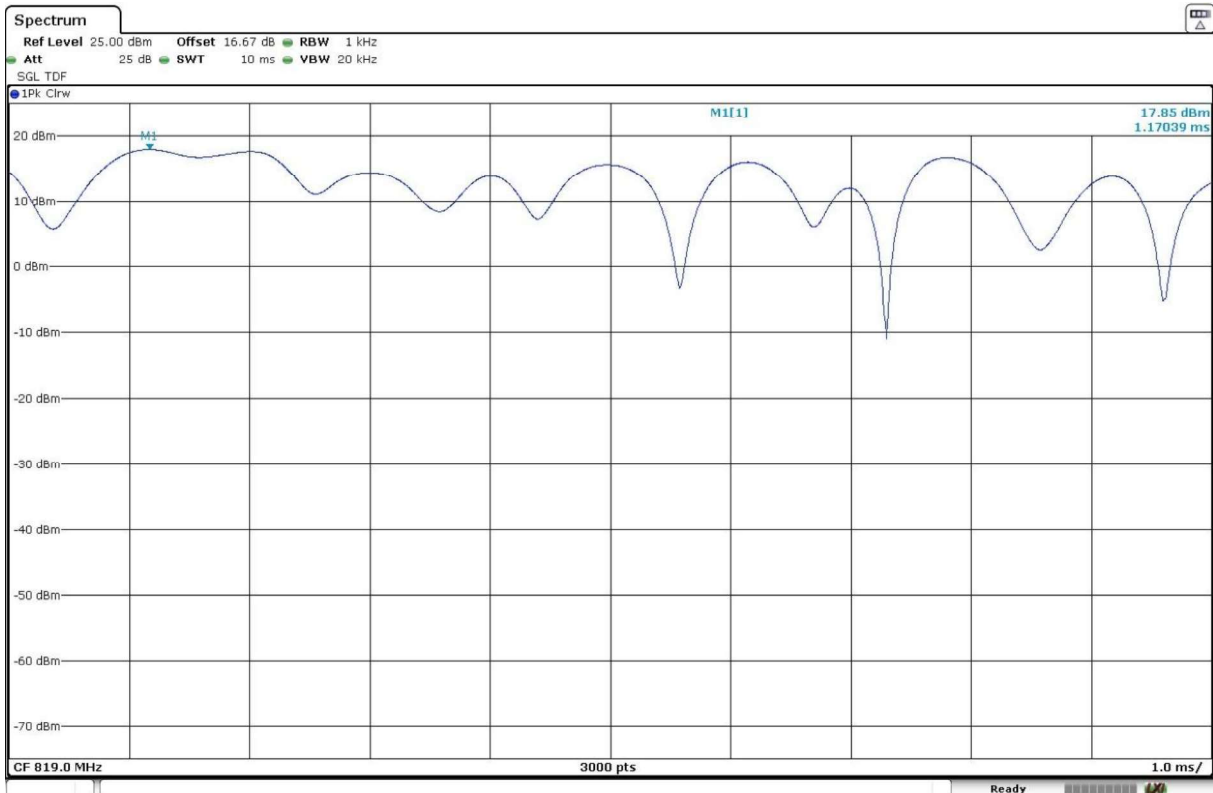


## NBloT Band 26.

Modulation:  $\pi/2$  – BPSK



Modulation:  $\pi/4$  - QPSK



## Occupied Bandwidth

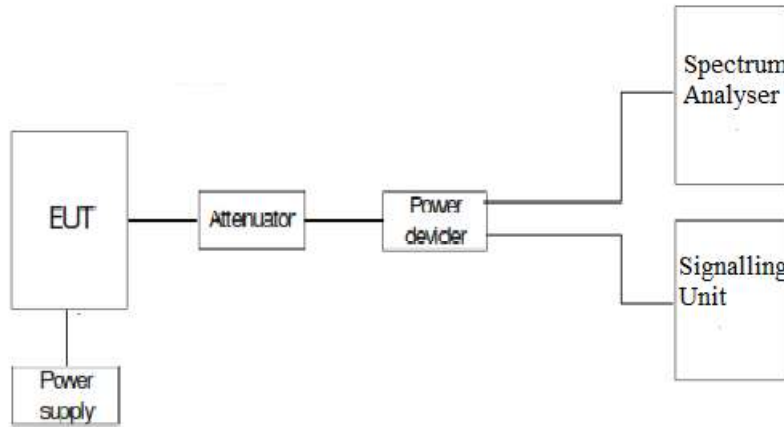
### Limits

FCC §2.1049. Measurements required: Occupied bandwidth.

### Method

The occupied bandwidth measurement was performed at the output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation. The 99% occupied bandwidth was measured directly using the built-in bandwidth measuring option of the spectrum analyser. The -26 dBc bandwidth was measured by setting a level line at 26 dB below the maximum measured carrier level.

### Test setup



### Results

#### NB-IoT Band 5.

1 tone 3.75 kHz,  $\pi/2$  - BPSK modulation.

Channel	99% Occupied Bandwidth (kHz)	-26 dBc Bandwidth (kHz)
Low	44.433333	35.020000
Middle	45.200000	35.035000
High	44.600000	35.025000

1 tone 3.75 kHz,  $\pi/4$  - QPSK modulation.

Channel	99% Occupied Bandwidth (kHz)	-26 dBc Bandwidth (kHz)
Low	44.566667	41.091300
Middle	44.333333	40.934300
High	44.300000	41.092000

1 tone 15 kHz,  $\pi/2$  - BPSK modulation.

Channel	99% Occupied Bandwidth (kHz)	-26 dBc Bandwidth (kHz)
Low	115.466667	133.627200
Middle	115.133333	131.293000
High	115.200000	133.682800

12 tones 15 kHz,  $\pi/4$  - QPSK modulation.

Channel	99% Occupied Bandwidth (kHz)	-26 dBc Bandwidth (kHz)
Low	193.466667	296.354000
Middle	194.400000	295.363000
High	195.733333	317.550000

#### NBLoT Band 26.

1 tone 3.75 kHz,  $\pi/2$  - BPSK modulation.

Channel	99% Occupied Bandwidth (kHz)	-26 dBc Bandwidth (kHz)
Low	44.916667	34.977300
Middle	45.106667	35.072500
High	44.953333	34.963900

1 tone 3.75 kHz,  $\pi/4$  - QPSK modulation.

Channel	99% Occupied Bandwidth (kHz)	-26 dBc Bandwidth (kHz)
Low	45.423333	41.174170
Middle	45.366667	41.211800
High	45.293333	41.146500

1 tone 15 kHz,  $\pi/2$  - BPSK modulation.

Channel	99% Occupied Bandwidth (kHz)	-26 dBc Bandwidth (kHz)
Low	116.006667	134.261900
Middle	116.293333	134.346300
High	116.146667	134.264800

12 tones 15 kHz,  $\pi/4$  - QPSK modulation.

Channel	99% Occupied Bandwidth (kHz)	-26 dBc Bandwidth (kHz)
Low	194.213333	307.261000
Middle	194.306667	294.221000
High	194.266667	307.762000

**NBloT Cross-rule channel (824 MHz).**

1 tone 3.75 kHz,  $\pi/2$  - BPSK modulation.

Channel	99% Occupied Bandwidth (kHz)	-26 dBc Bandwidth (kHz)
824 MHz	45.043333	35.014800

1 tone 3.75 kHz,  $\pi/4$  - QPSK modulation.

Channel	99% Occupied Bandwidth (kHz)	-26 dBc Bandwidth (kHz)
824 MHz	46.100000	41.393700

1 tone 15 kHz,  $\pi/2$  - BPSK modulation.

Channel	99% Occupied Bandwidth (kHz)	-26 dBc Bandwidth (kHz)
824 MHz	116.326667	134.243870

12 tones 15 kHz,  $\pi/4$  - QPSK modulation.

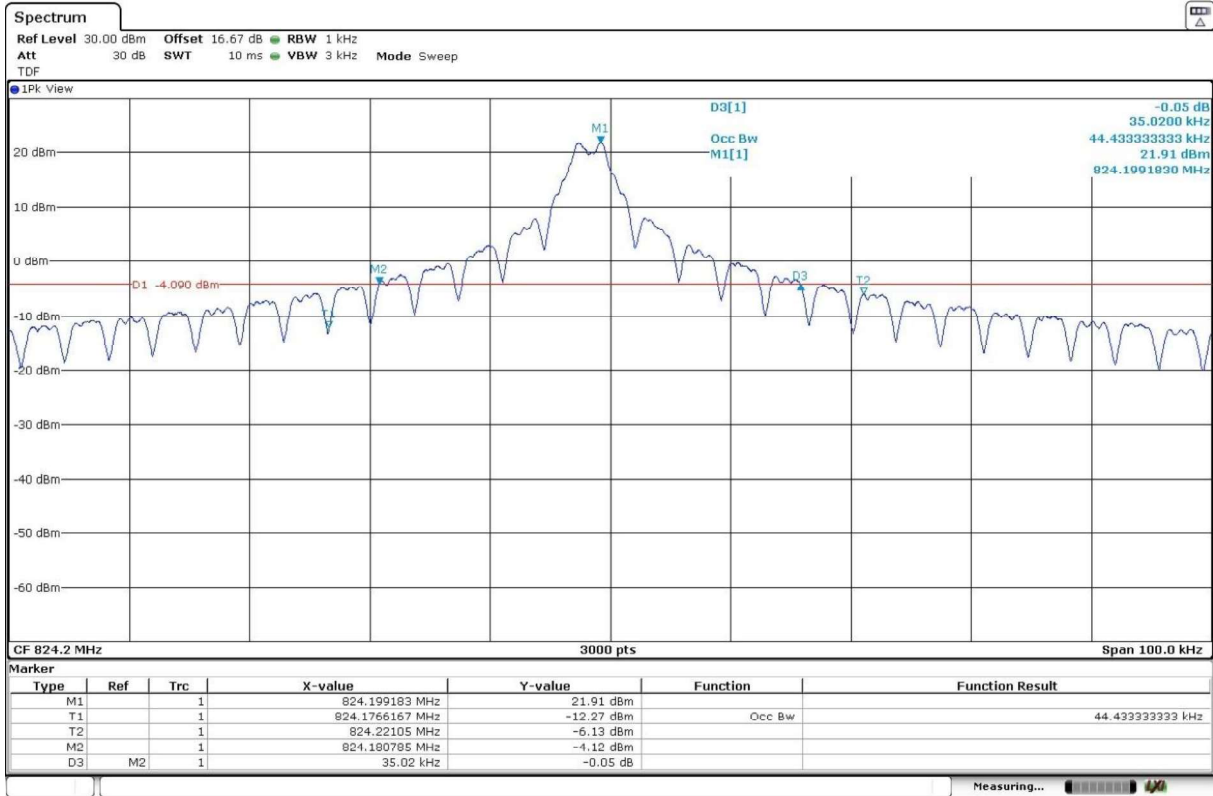
Channel	99% Occupied Bandwidth (kHz)	-26 dBc Bandwidth (kHz)
824 MHz	196.453333	268.399000

**Attachments**

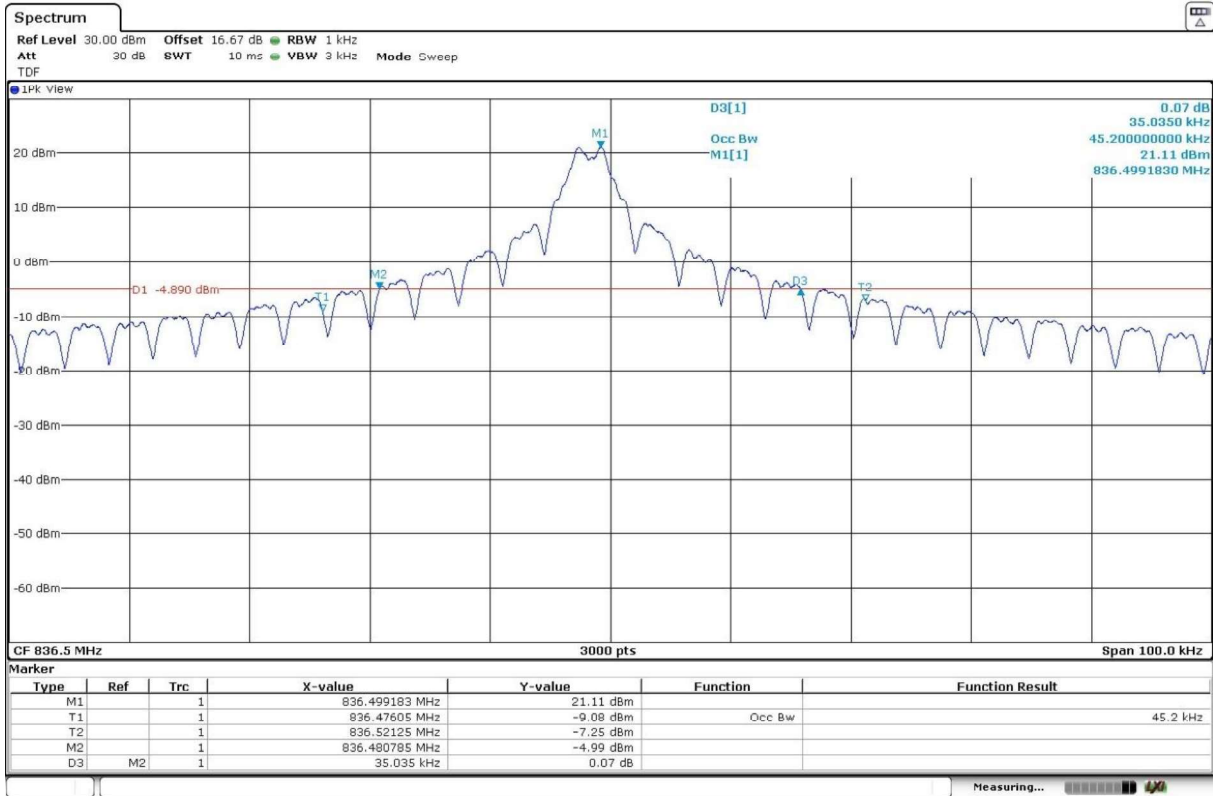
**NBLoT Band 5.**

1 tone 3.75 kHz,  $\pi/2$  - BPSK modulation.

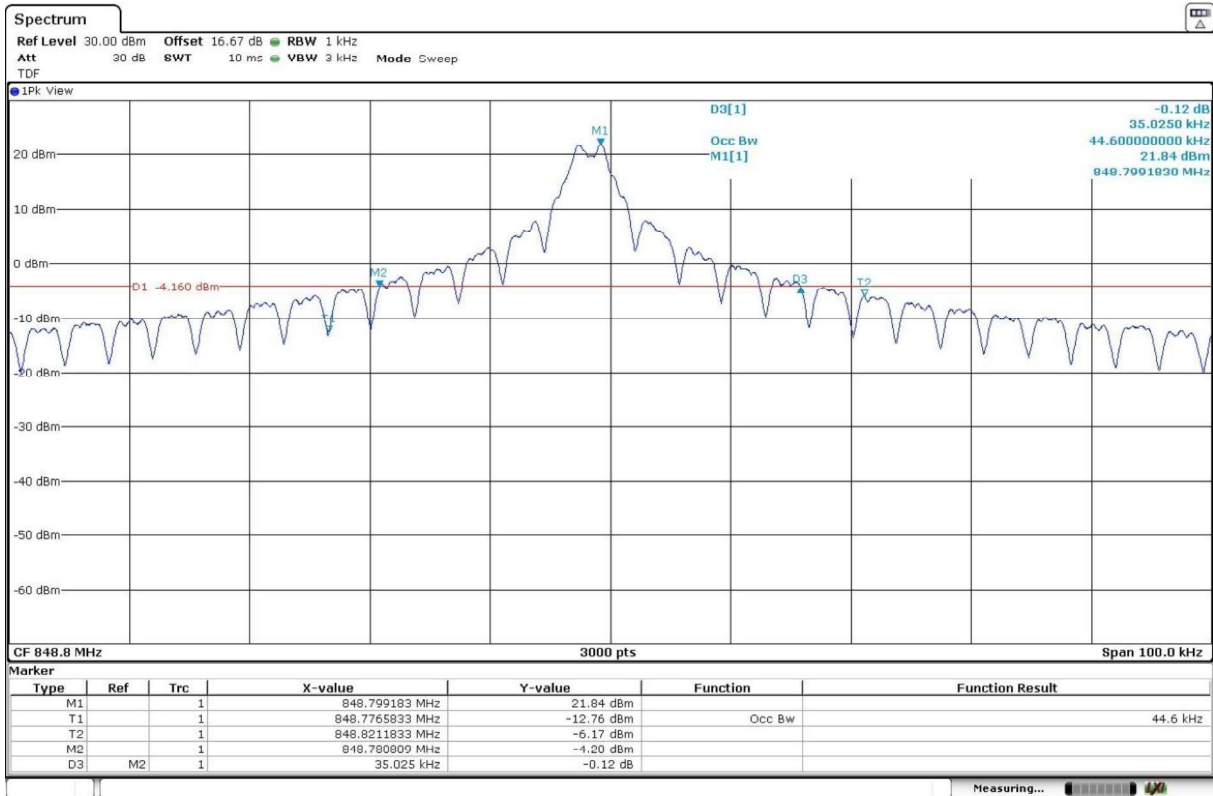
- Low Channel:



- Middle Channel:



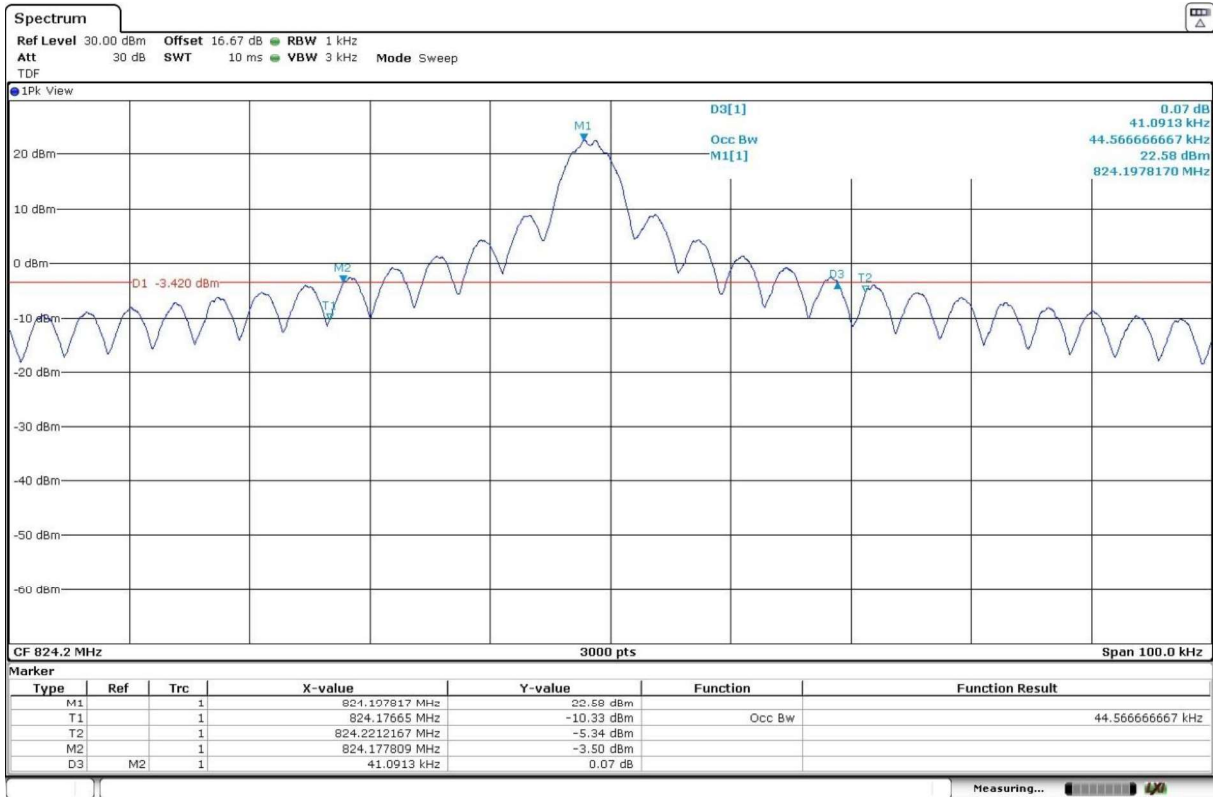
- High Channel:



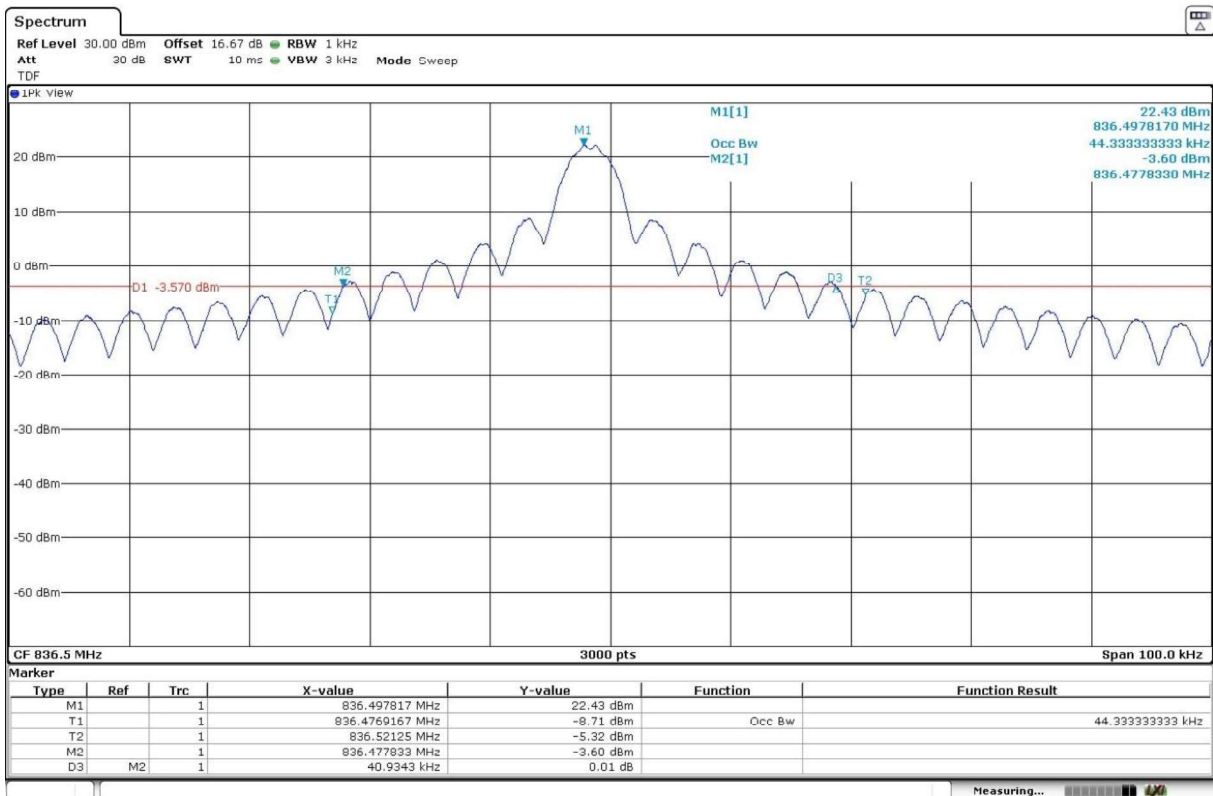


1 tone 3.75 kHz,  $\pi/4$  - QPSK modulation.

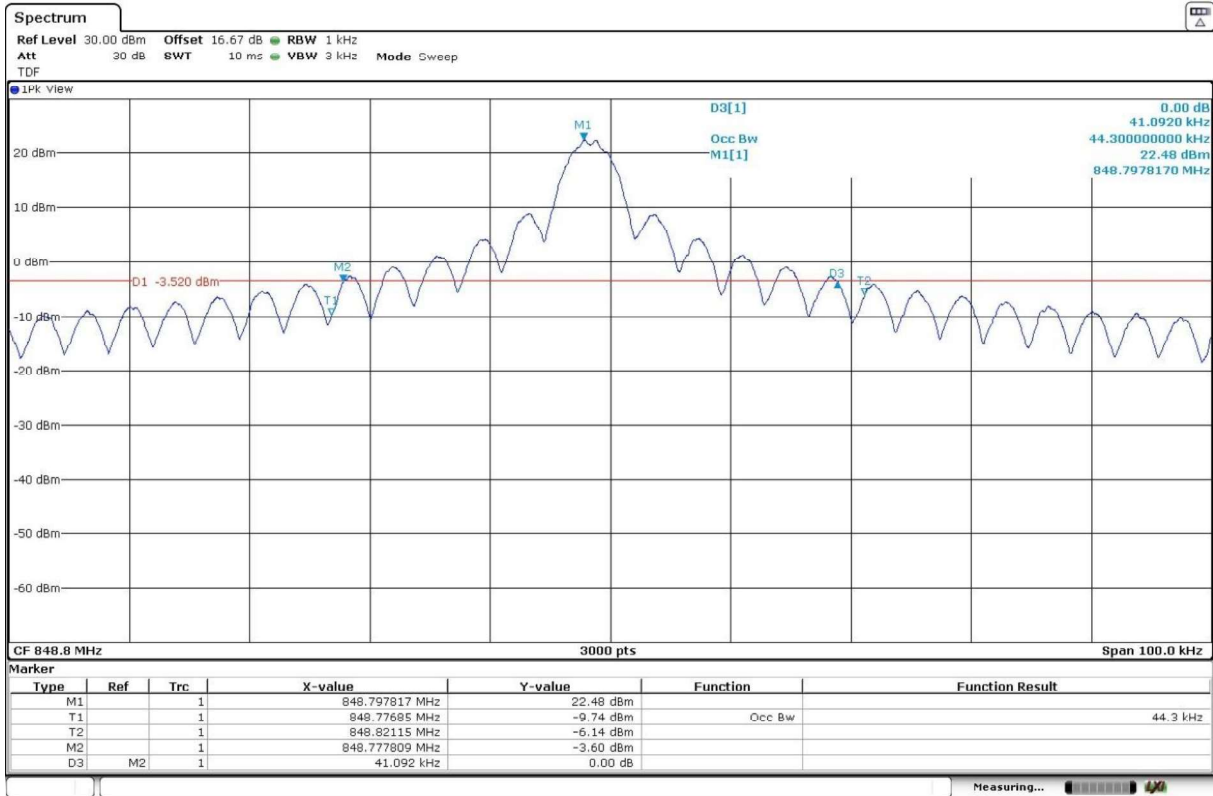
- Low Channel:



- Middle Channel:

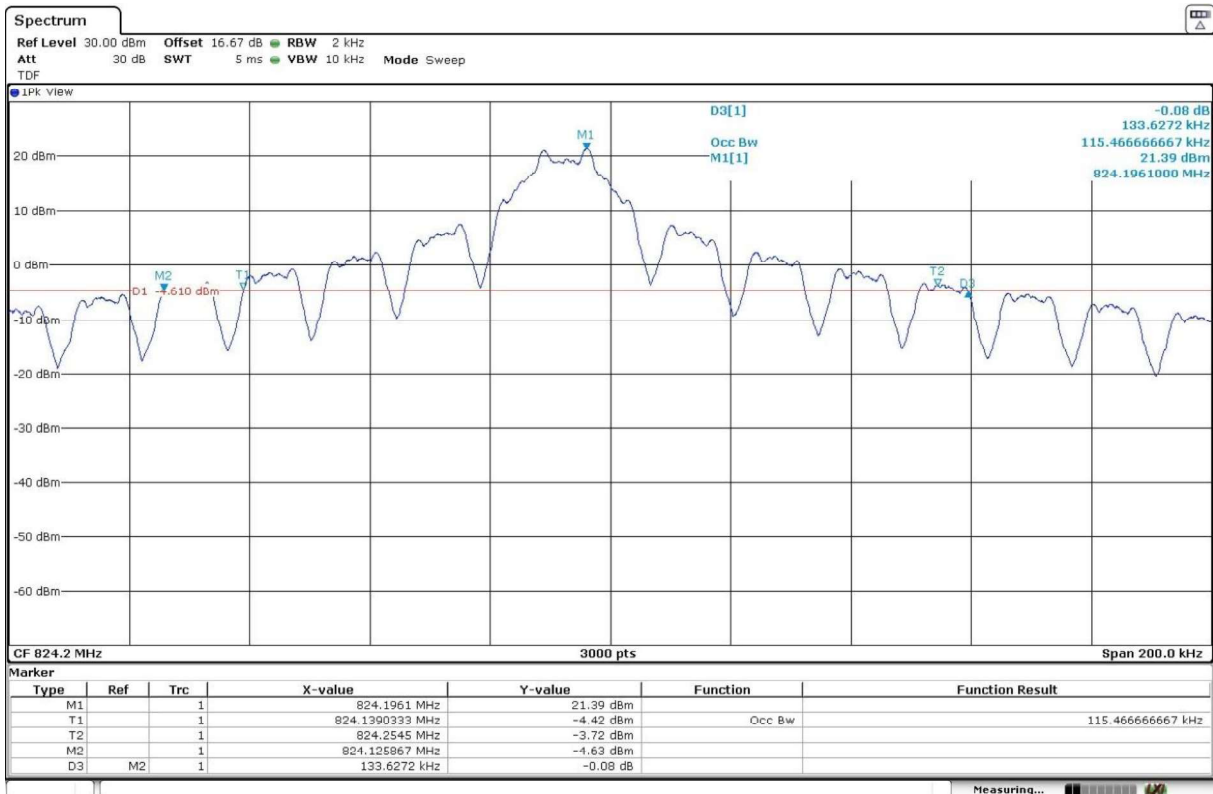


- High Channel:

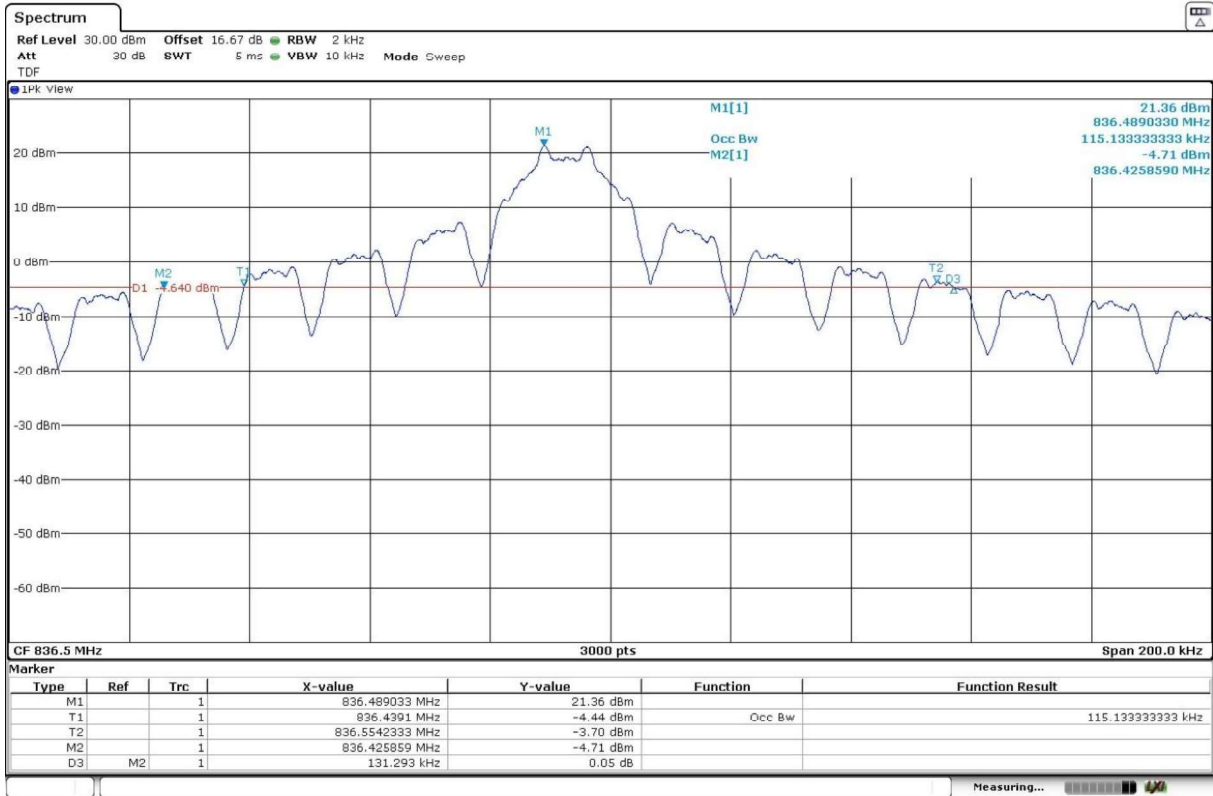


1 tone 15 kHz,  $\pi/2$  - BPSK modulation.

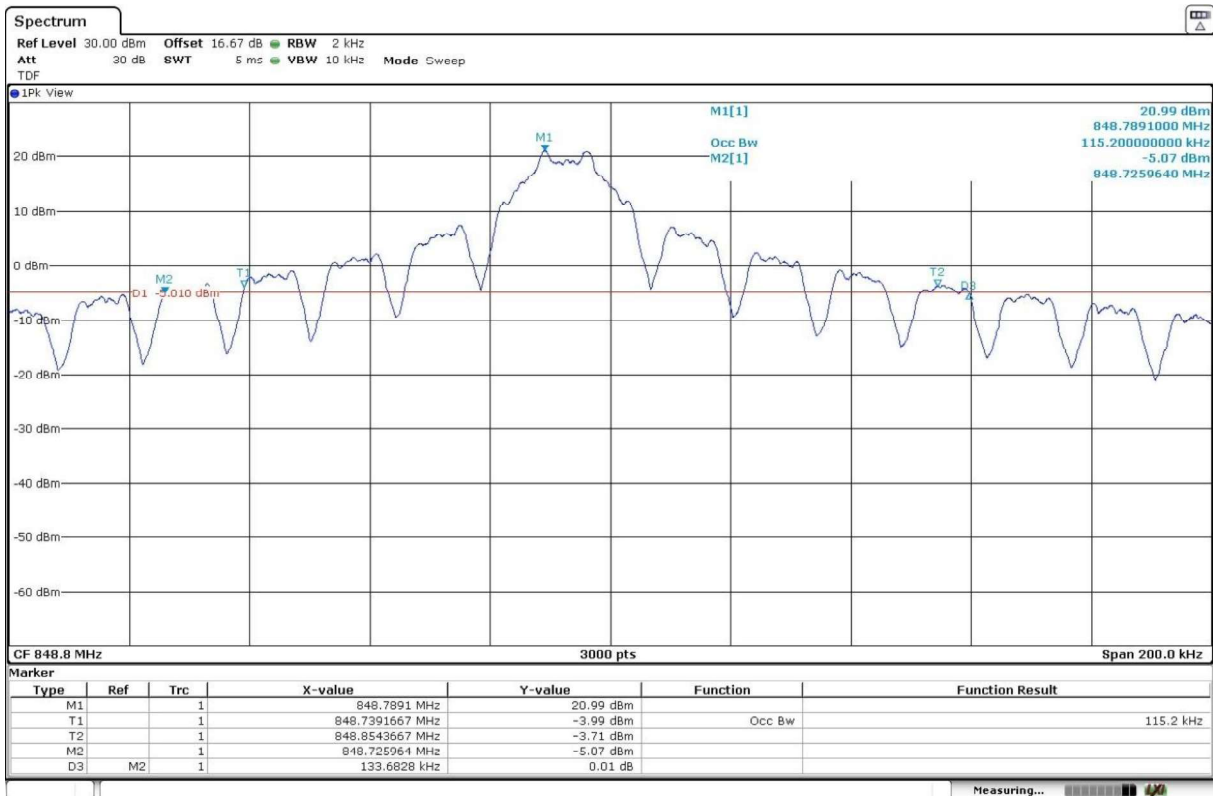
- Low Channel:



- Middle Channel:

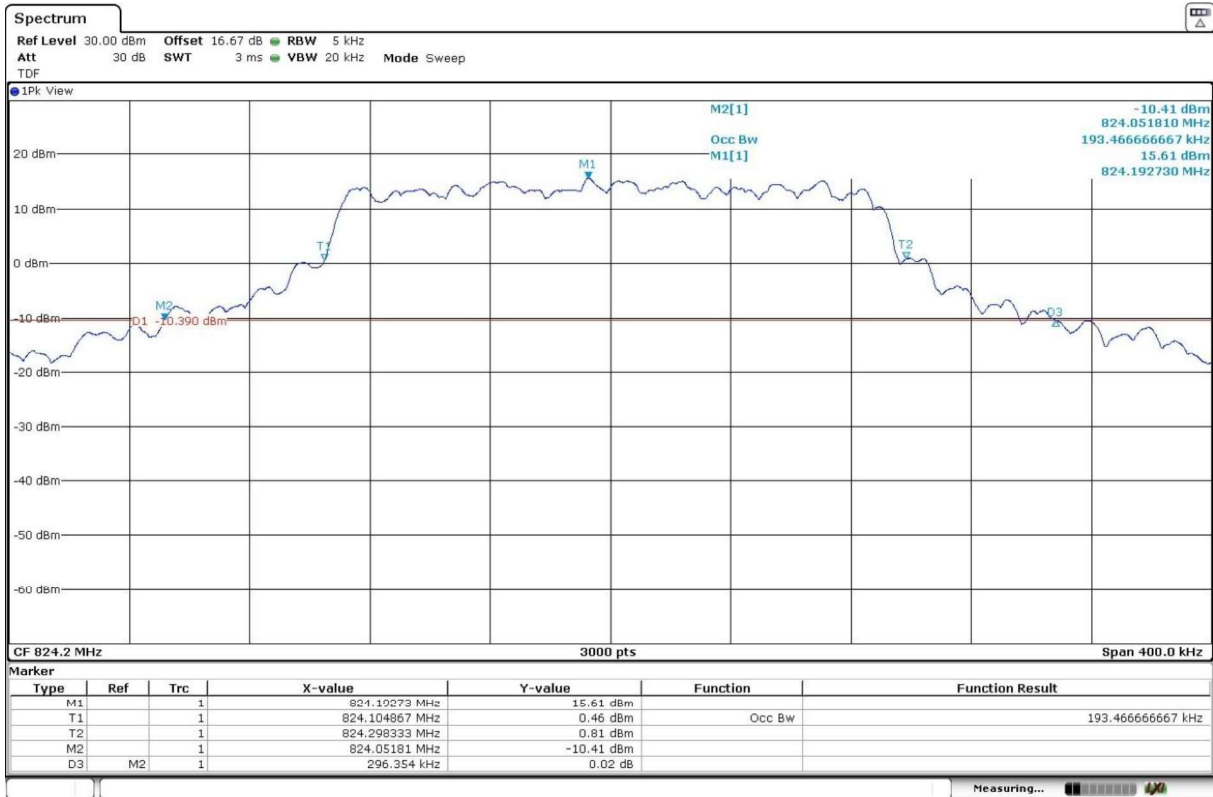


- High Channel:

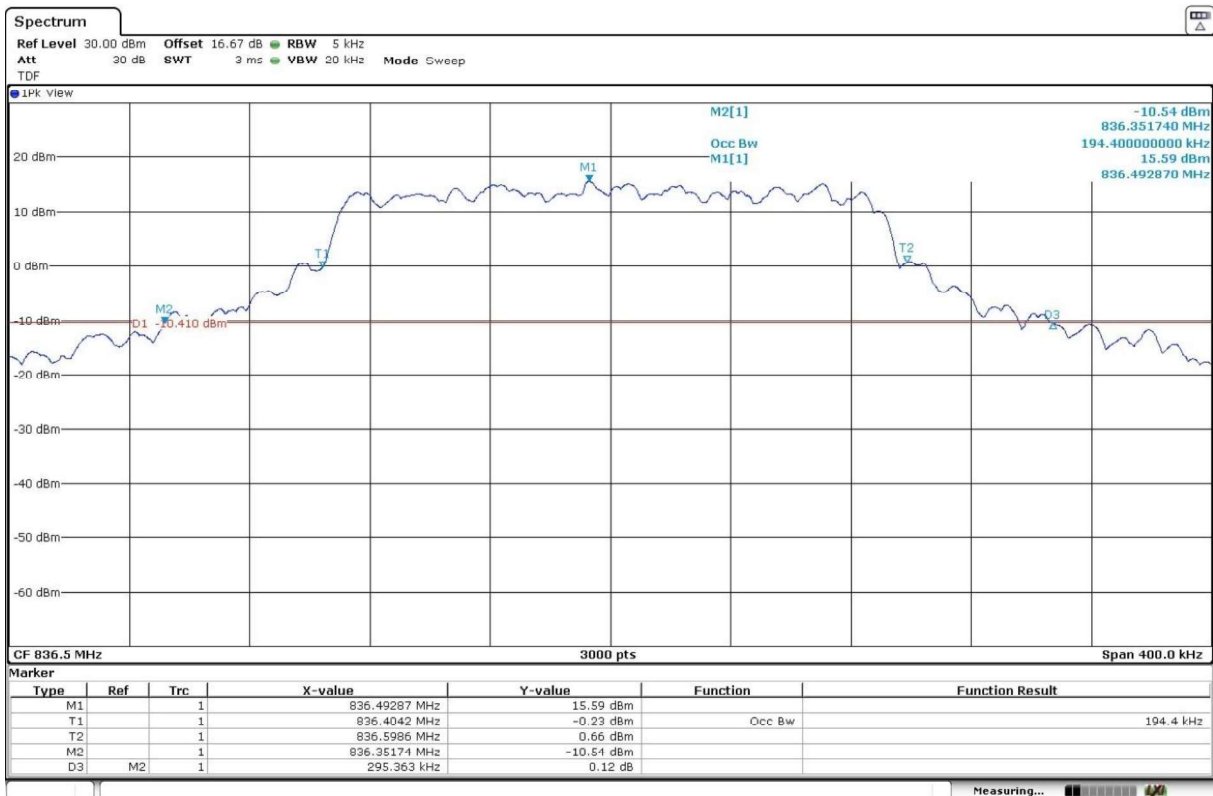


12 tones 15 kHz,  $\pi/4$  - QPSK modulation.

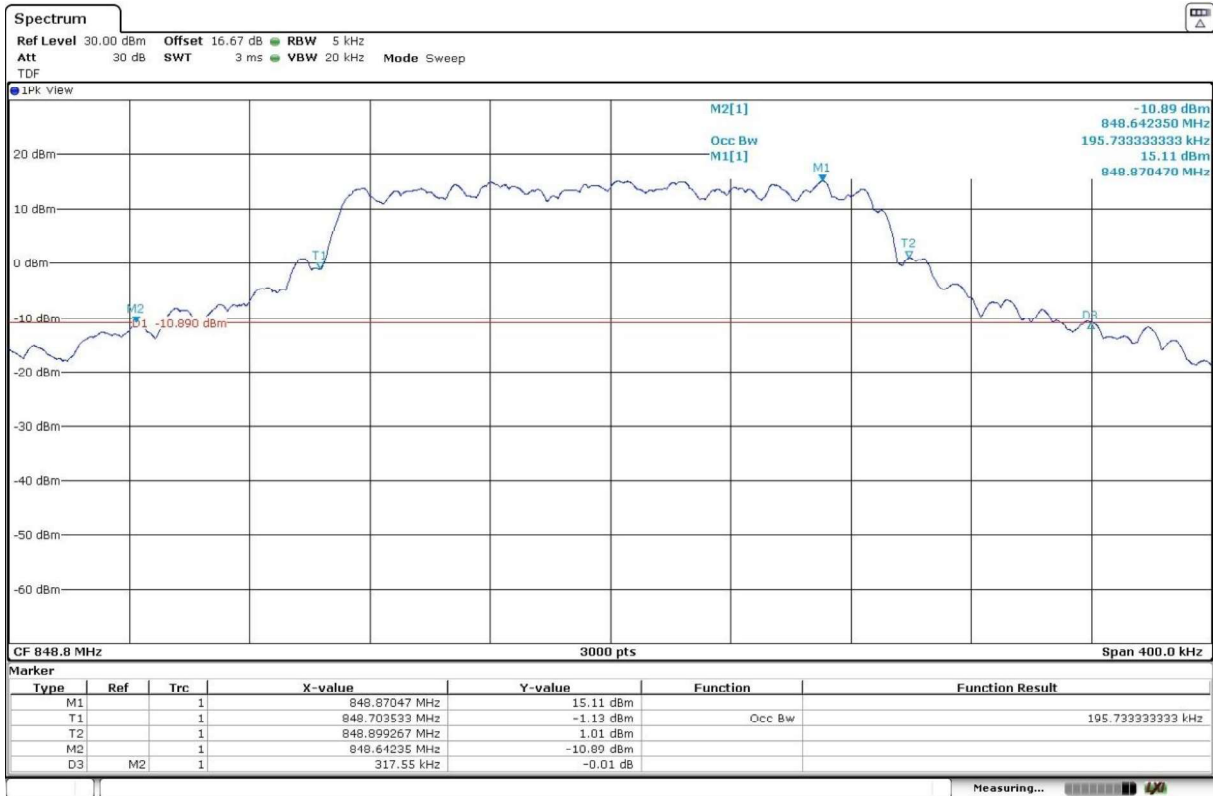
- Low Channel:



- Middle Channel:



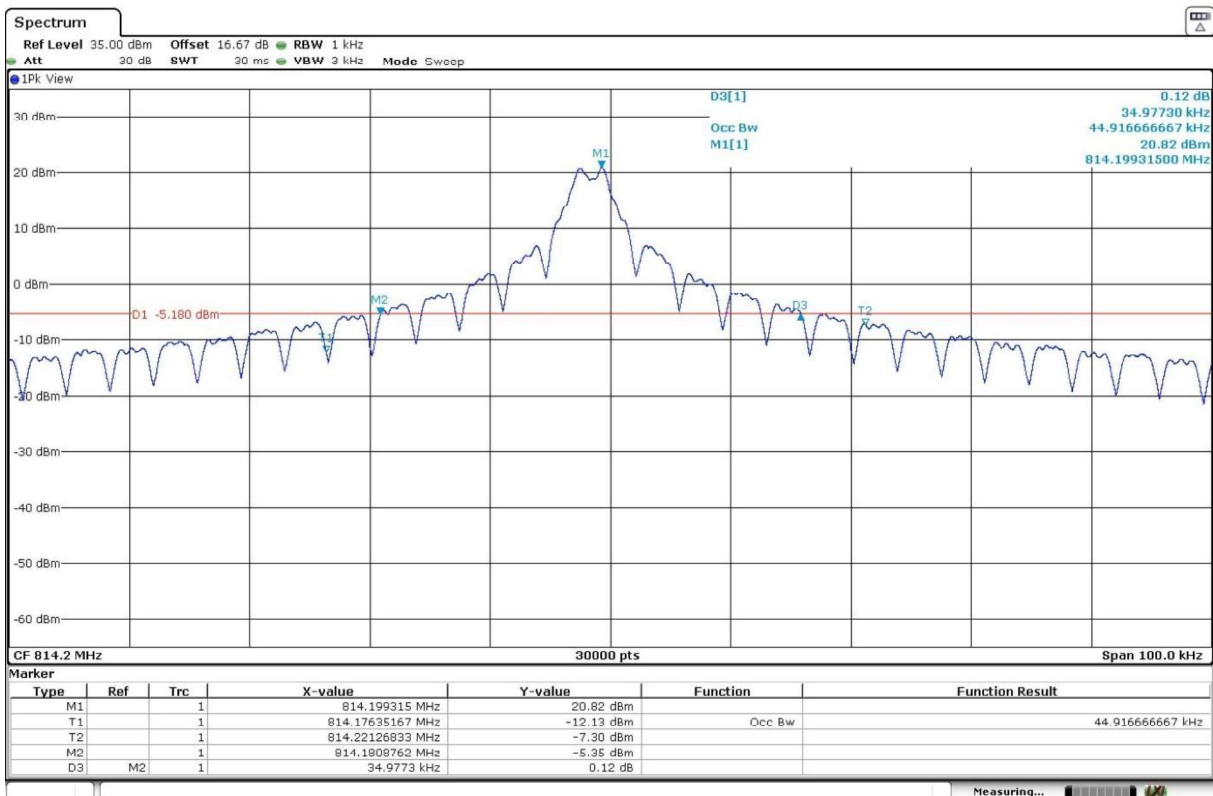
- High Channel:



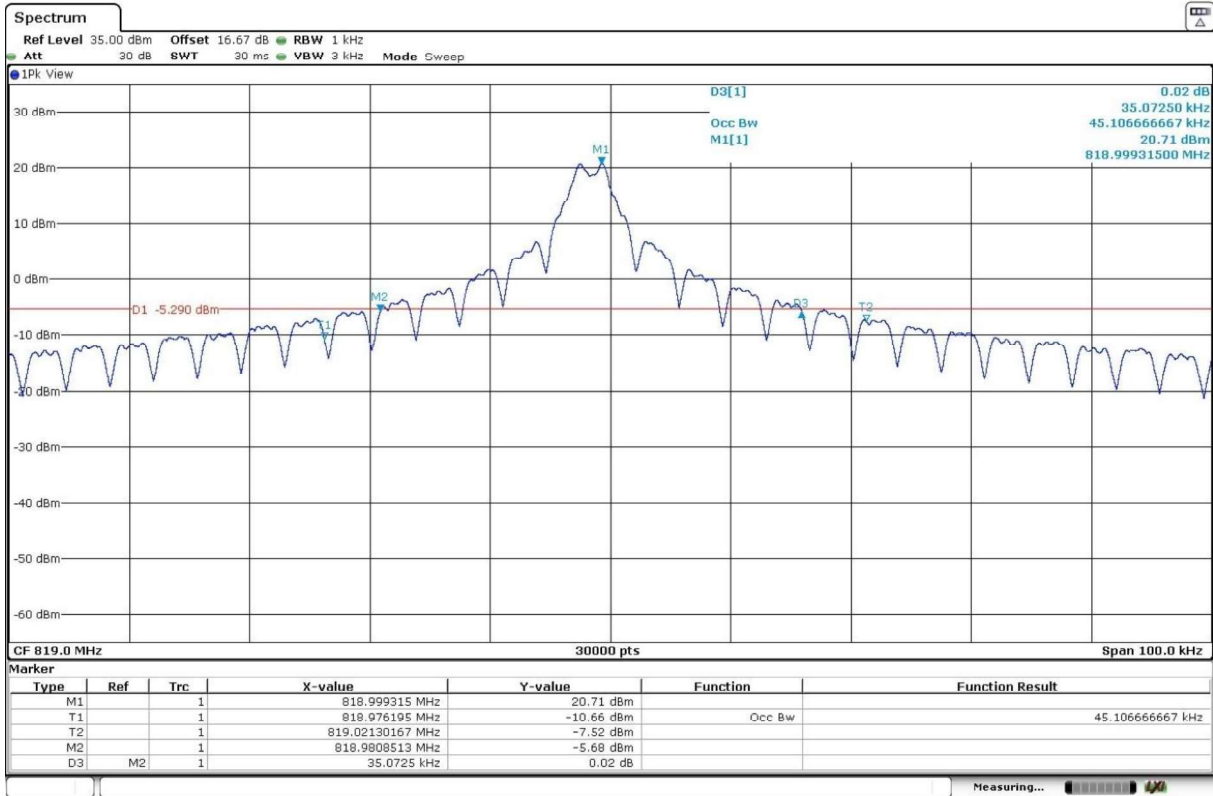
NBLoT Band 26.

1 tone 3.75 kHz,  $\pi/2$  - BPSK modulation.

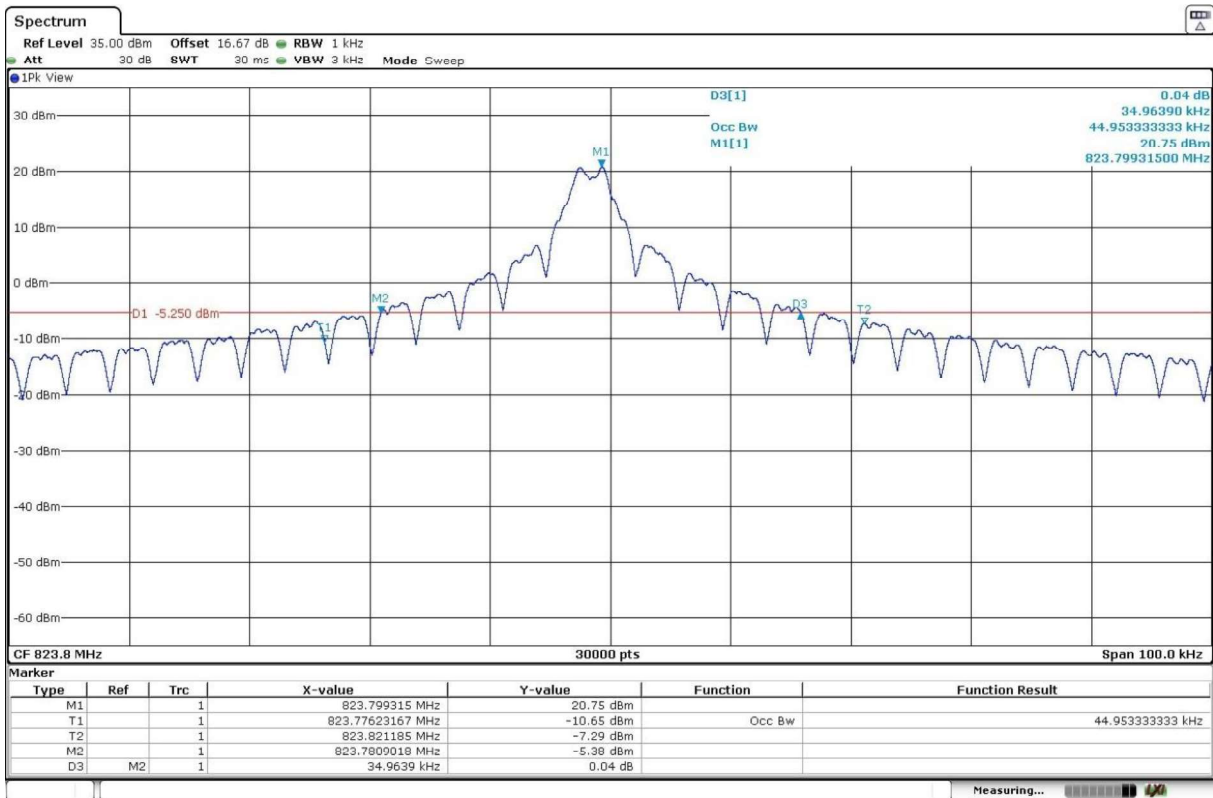
- Low Channel:



- Middle Channel:



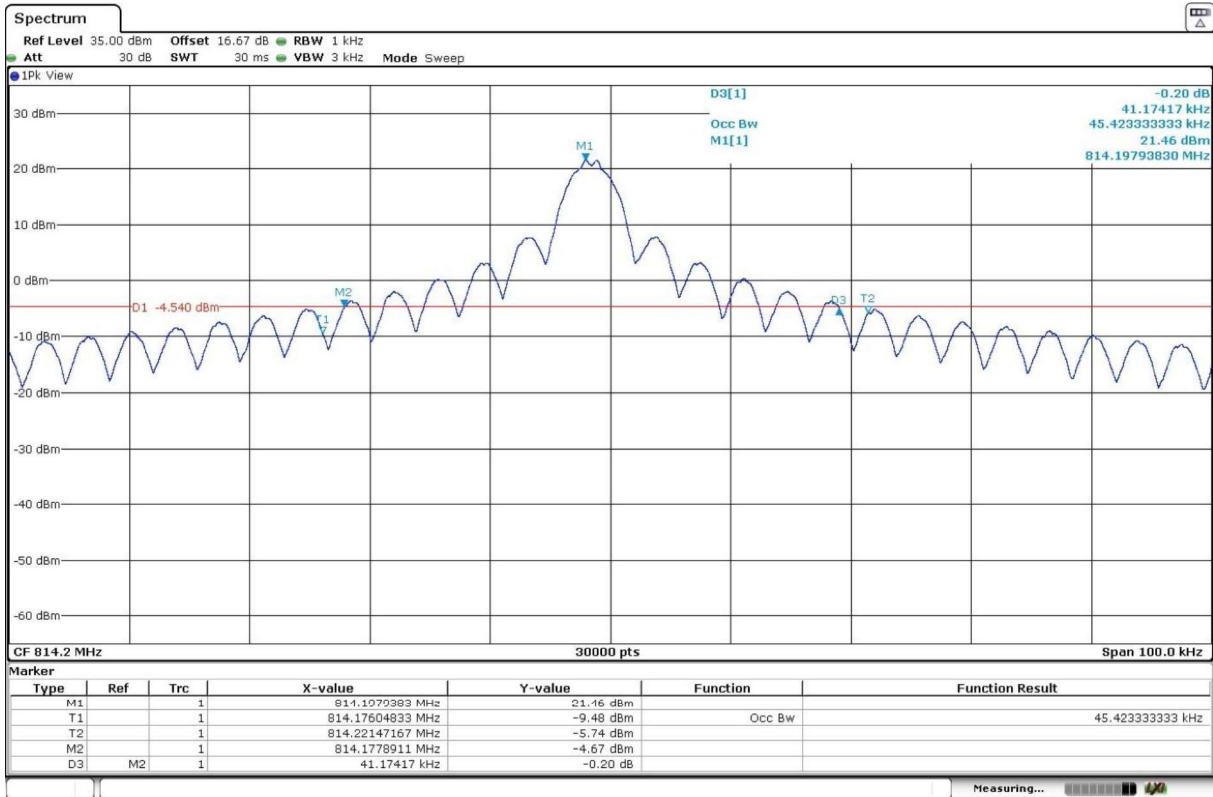
- High Channel:



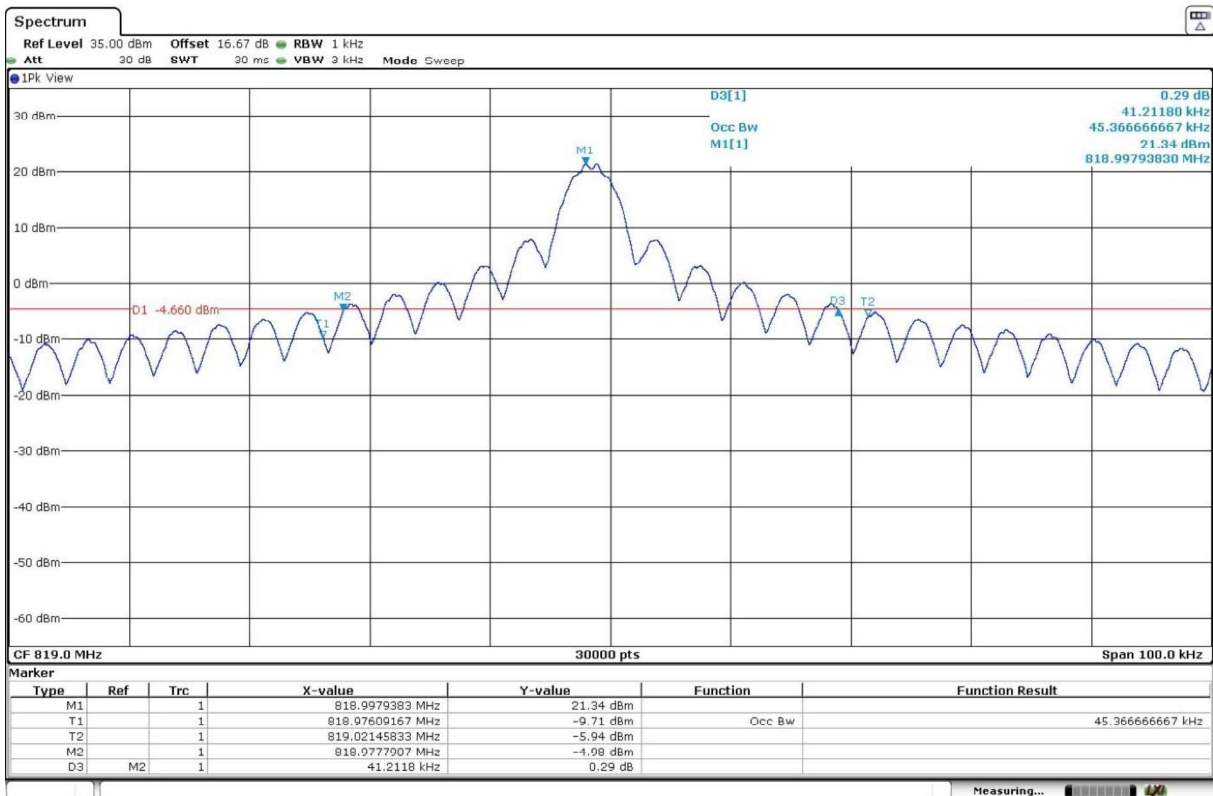


1 tone 3.75 kHz,  $\pi/4$  - QPSK modulation.

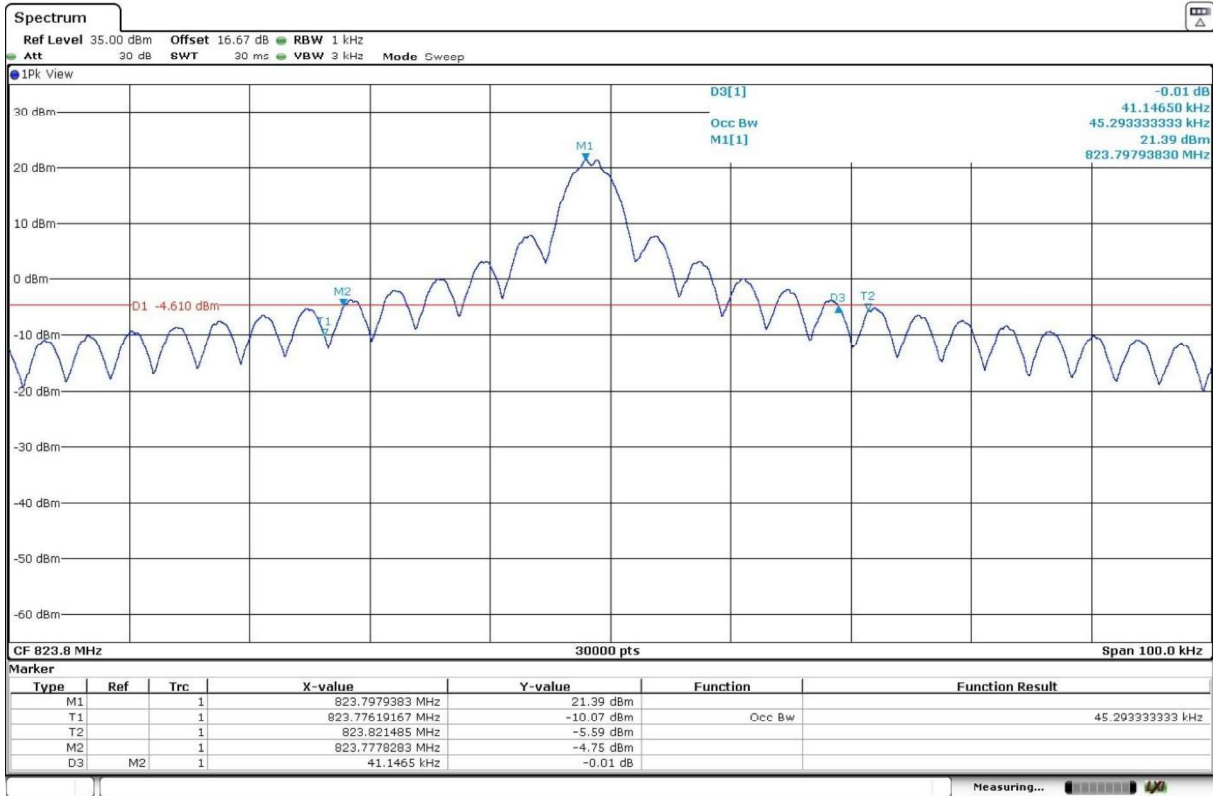
- Low Channel:



- Middle Channel:

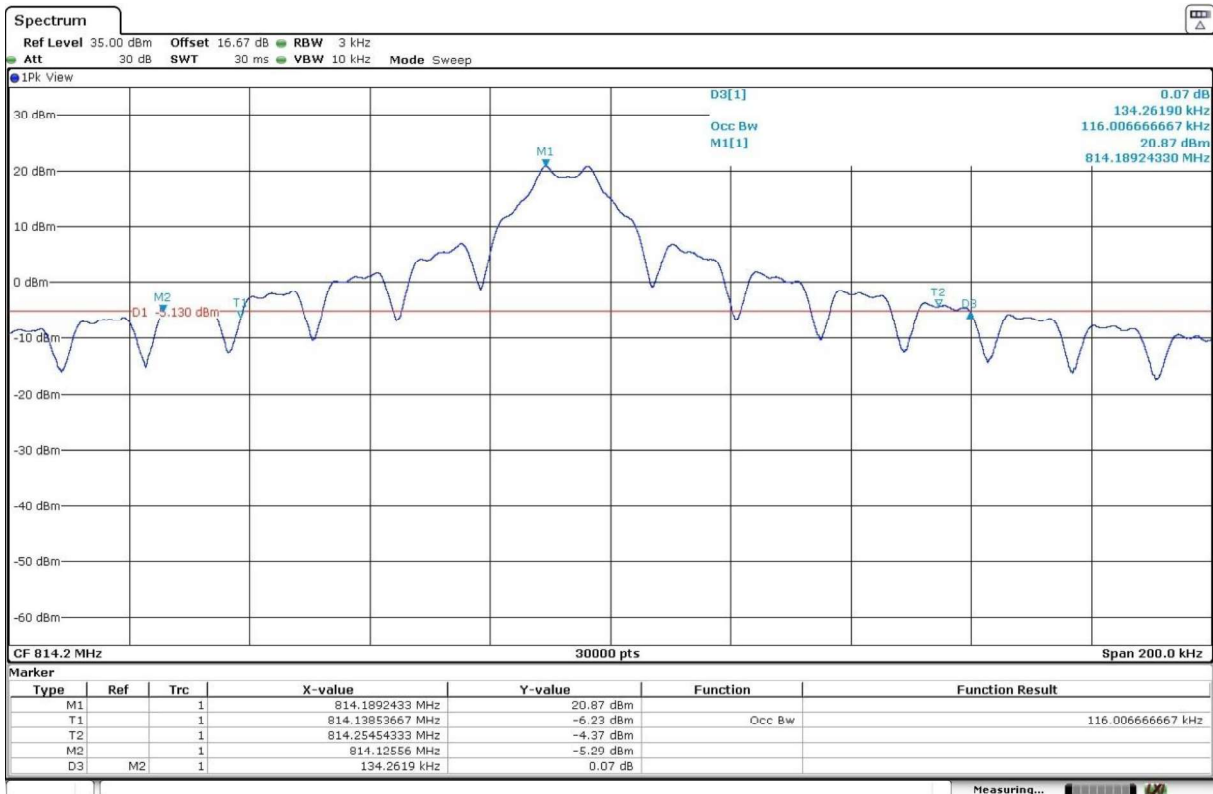


- High Channel:



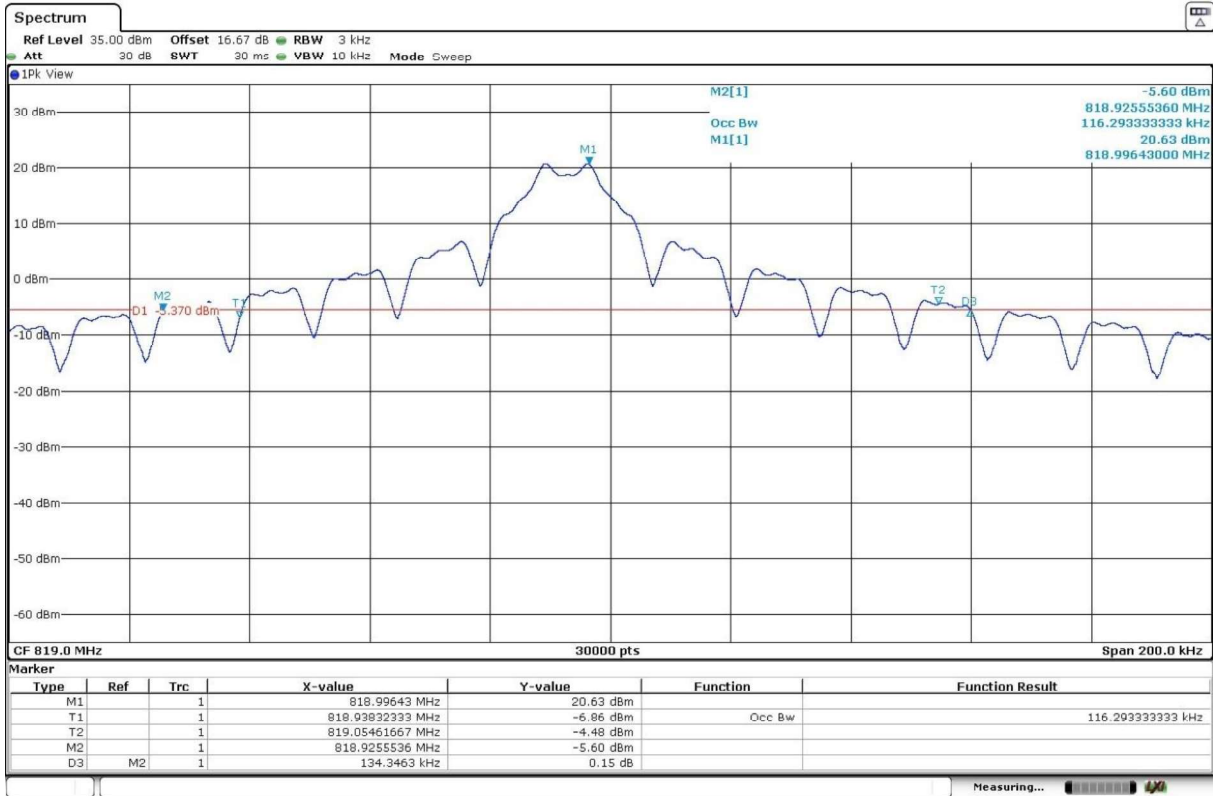
1 tone 15 kHz,  $\pi/2$  - BPSK modulation.

- Low Channel:

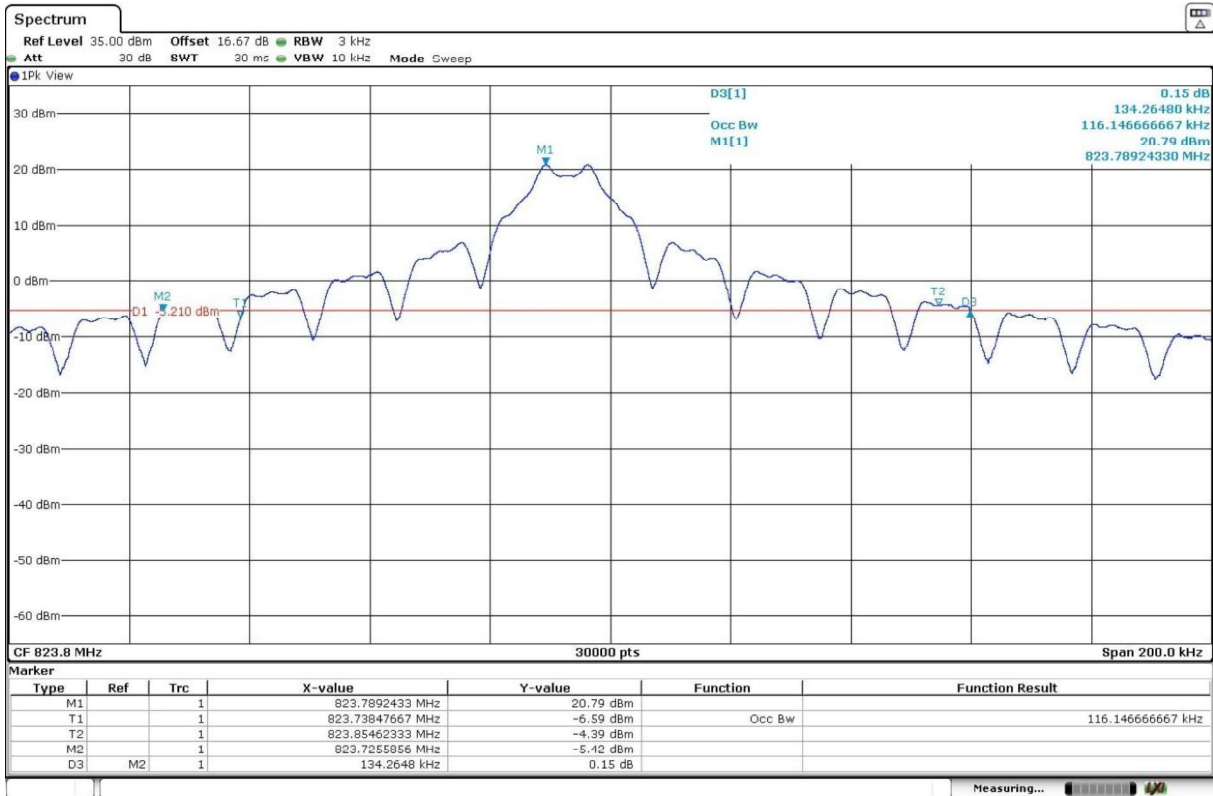




- Middle Channel:

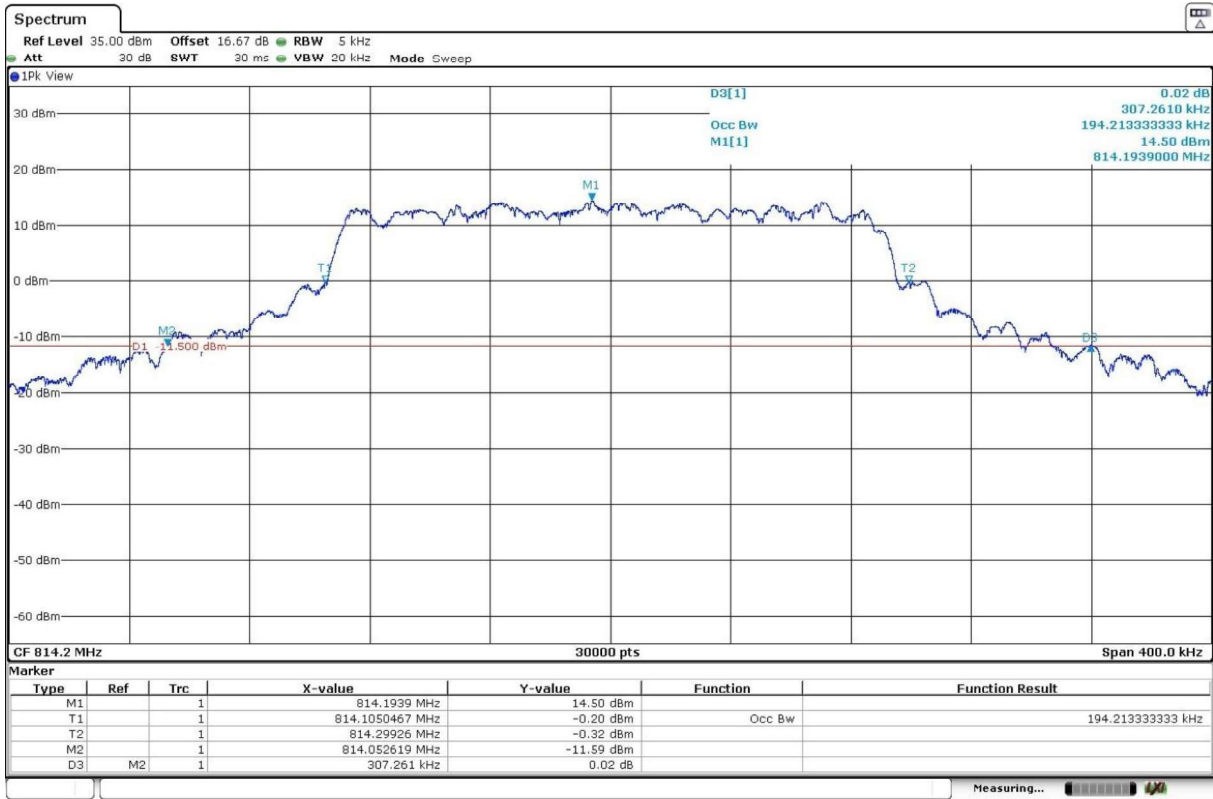


- High Channel:

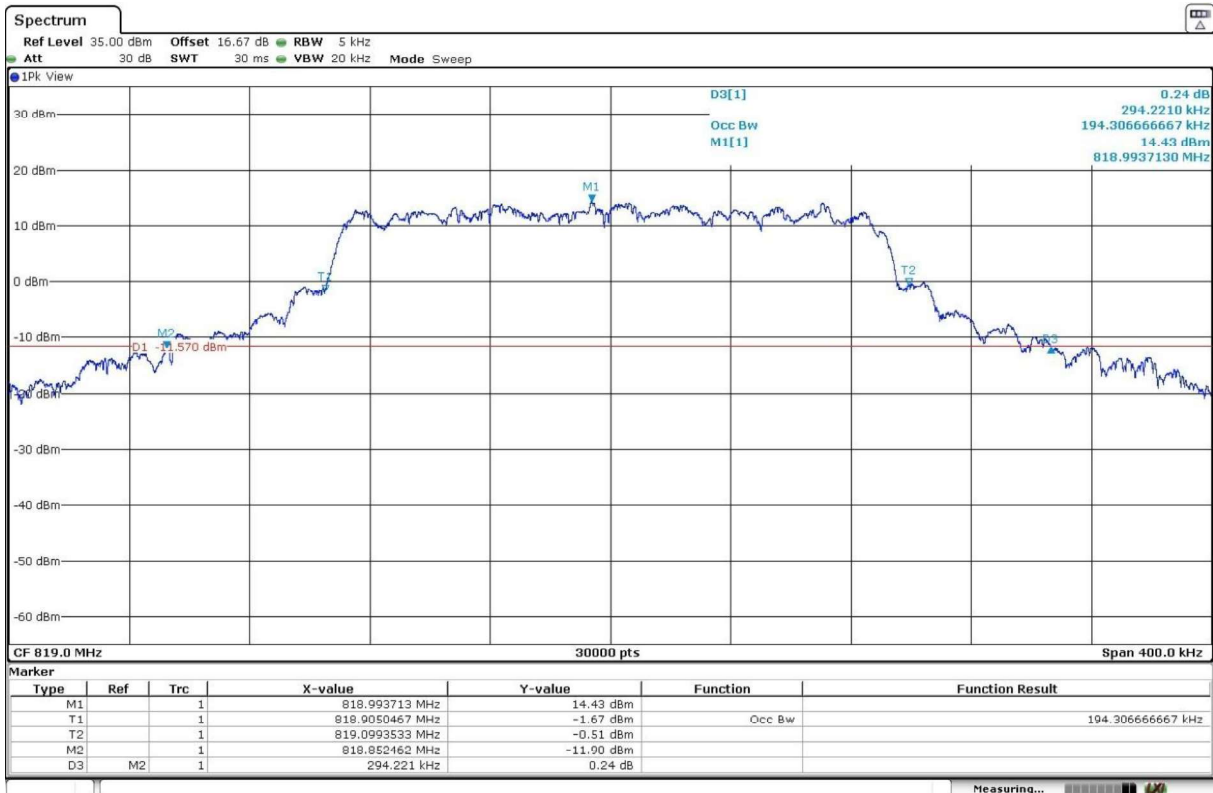


12 tones 15 kHz,  $\pi/4$  - QPSK modulation.

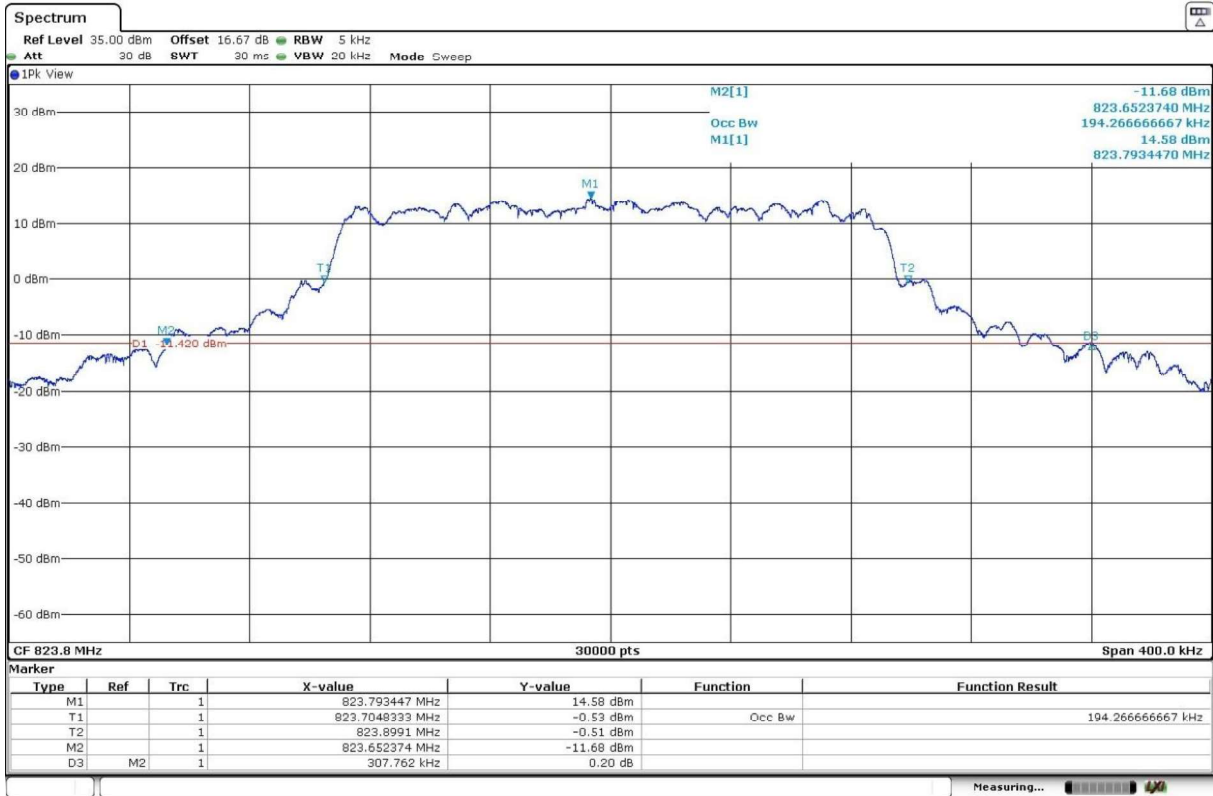
- Low Channel:



- Middle Channel:



- High Channel:



NBLoT Cross-rule channel (824 MHz).

1 tone 3.75 kHz,  $\pi/2$  - BPSK modulation.

