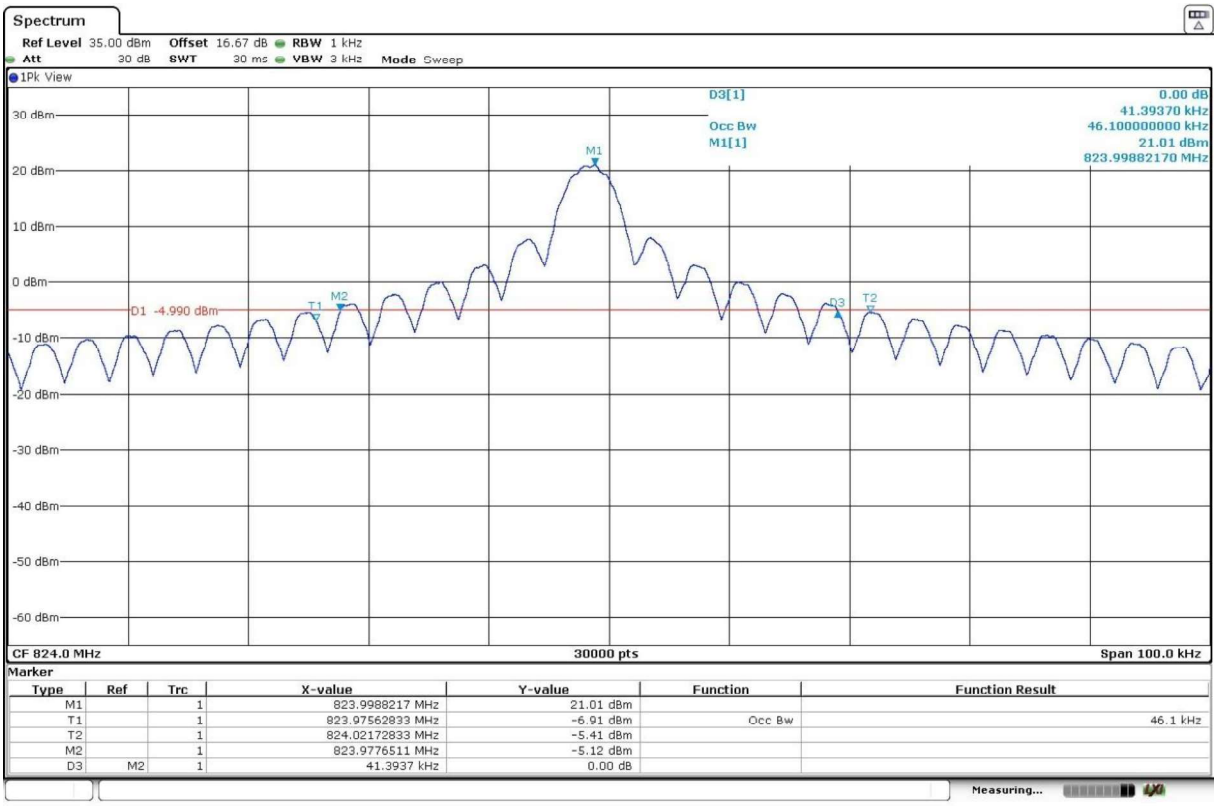
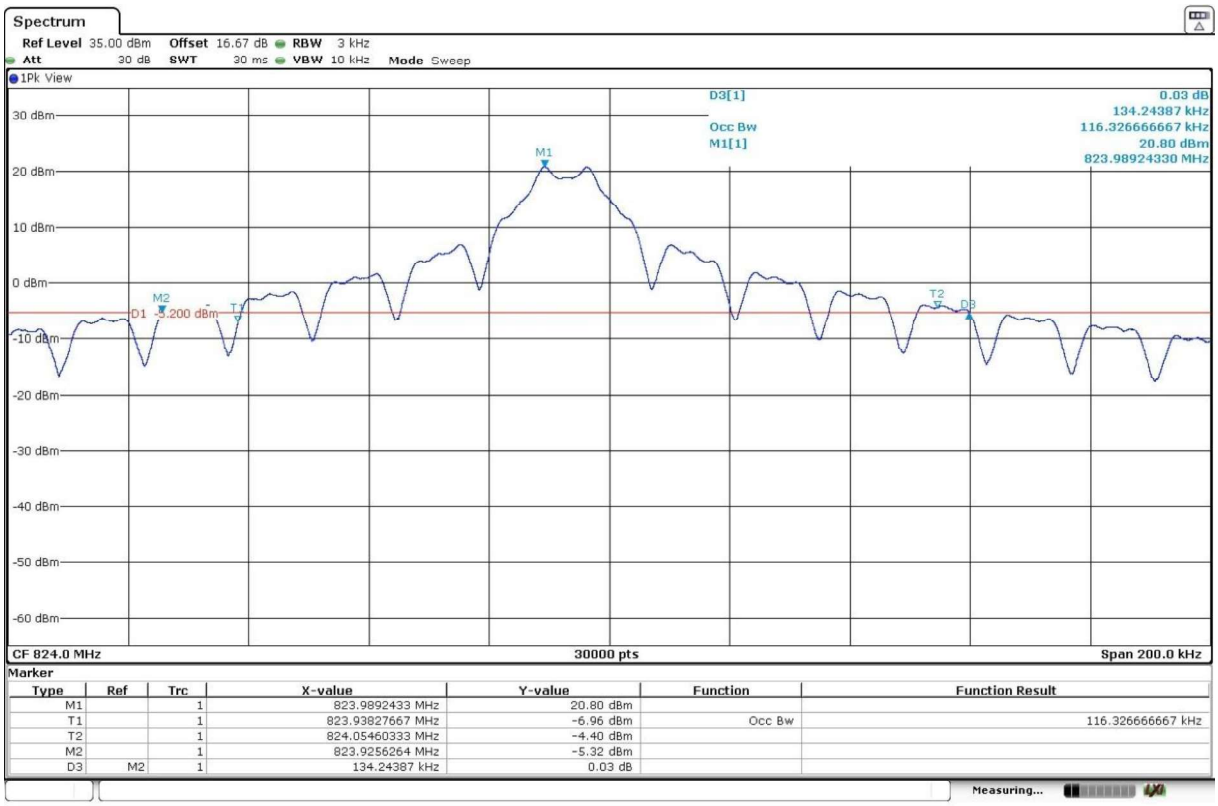
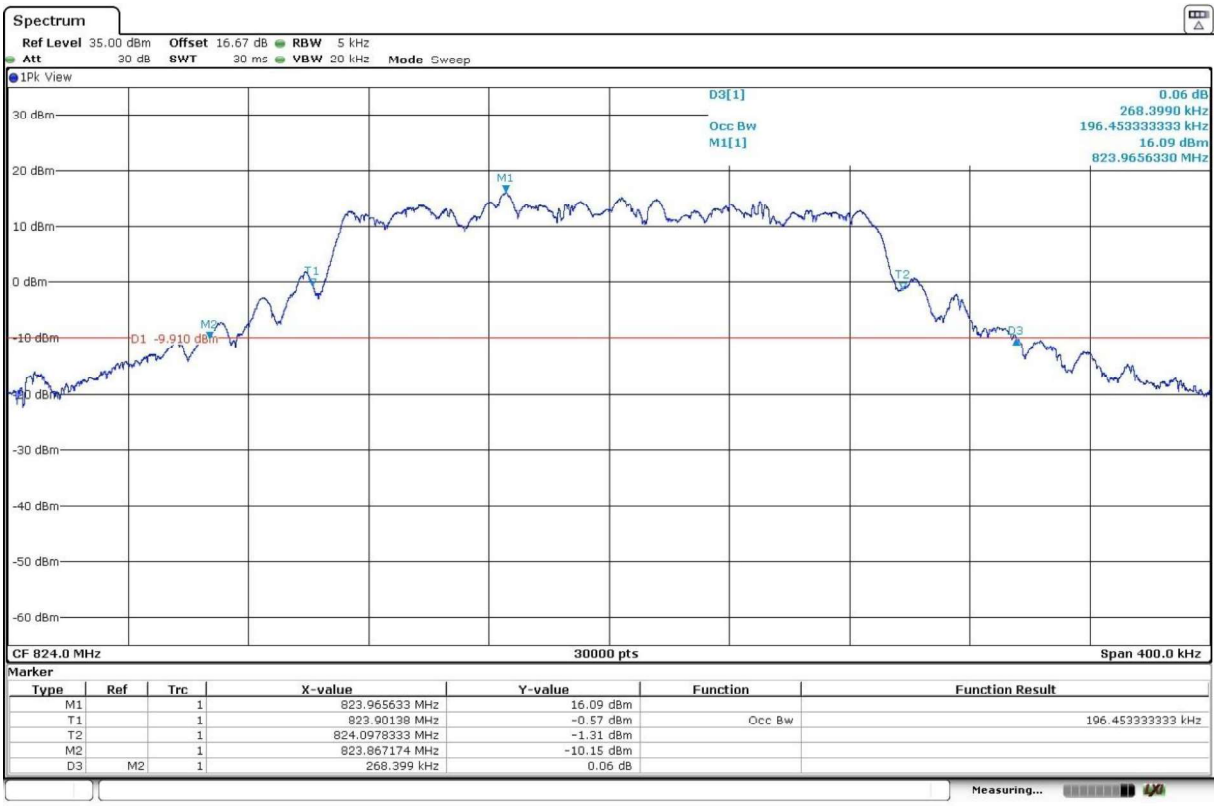
1 tone 3.75 kHz, π/4 - QPSK modulation.



1 tone 15 kHz, π/2 - BPSK modulation.



12 tones 15 kHz, π/4 - QPSK modulation.



Spurious Emissions at Antenna Terminals

Limits

FCC §2.1051 and §22.917. RSS-132 Clause 5.5.

The power of emissions shall be attenuated below the transmitter power (P) by a factor of at least 43 + 10 log (P) dB. P in watts.

In the spectrum below 1 GHz, instrumentation should employ a reference bandwidth of 100 kHz or greater. In the spectrum above 1 GHz, instrumentation should employ a reference bandwidth of 1 MHz.

FCC §90.691.

(a) Out-of-band emission requirement shall apply only to the "outer" channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows:

(1) For any frequency removed from the EA licensee's frequency block by up to and including 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 116 Log10(f/6.1) decibels or 50 + 10 Log10(P) decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 12.5 kHz.

(2) For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 43 + 10Log10(P) decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

(b) When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section.

At Po transmitting power, the specified minimum attenuation becomes 43+10 log (Po), and the level in dBm relative to Po becomes:

$$Po\ (dBm) - [43 + 10 \log (Po\ in\ mW) - 30] = -13\ dBm$$

Method

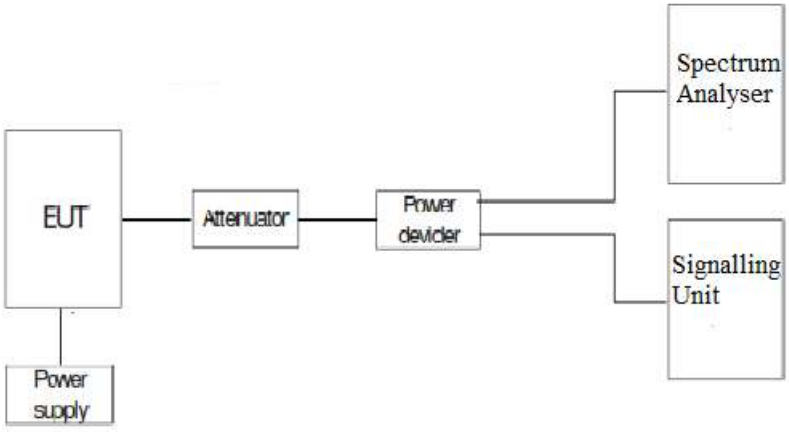
The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50-Ohm attenuator and a power divider.

The spectrum was investigated from 9 kHz to 8.5 GHz.

The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

The configuration of tones and modulation which is the worst case for conducted power was used.

Test setup



Results

NBIoT 814 – 824 MHz Band:

Preliminary measurements determined π/4 - QPSK modulation, 3 tones 15 kHz, Offset Tone = 6, as the worst case. The next results are for this worst-case configuration.

- Low Channel: Spurious signals found at less than 20dB below the limit:

Spurious Frequency (MHz)	Conducted Emission Level (dBm)
6513.749000	-31.16

- Middle Channel: Spurious signals found at less than 20dB below the limit:

Spurious Frequency (MHz)	Conducted Emission Level (dBm)
6552.449000	-32.94

- High Channel: No spurious signals found at less than 20dB below the limit.

Verdict

Pass

NBIoT 824 – 849 MHz Band:

Preliminary measurements determined π/4 - QPSK modulation, 3 tones 15 kHz, Offset Tone = 6, as the worst case. The next results are for this worst-case configuration.

- Low Channel: No spurious signals found at less than 20dB below the limit.
- Middle Channel: No spurious signals found at less than 20dB below the limit.
- High Channel: No spurious signals found at less than 20dB below the limit.

Verdict

Pass

NBIoT Cross-rule channel (824 MHz):

Preliminary measurements determined π/4 - QPSK modulation, 3 tones 15 kHz, Offset Tone = 6, as the worst case. The next results are for this worst-case configuration.

No spurious signals found at less than 20dB below the limit.

Verdict

Pass

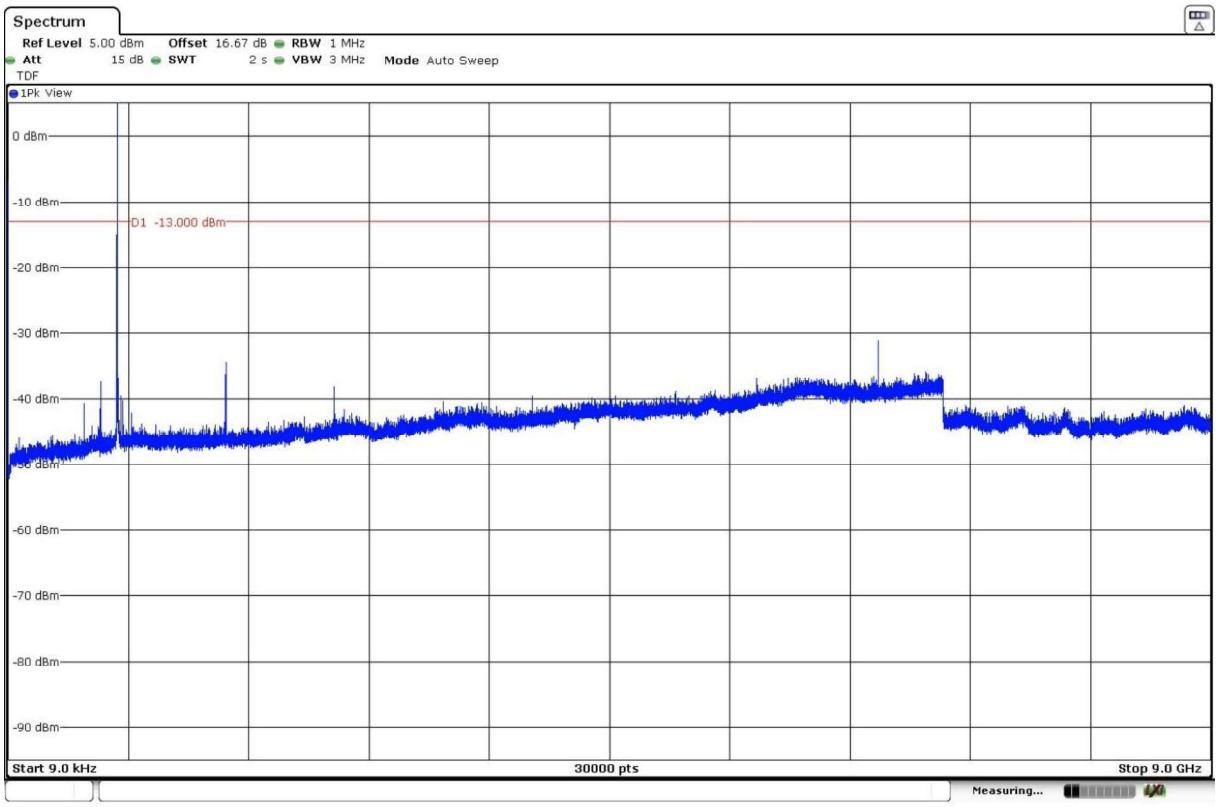
Attachments

The peak above the limit on all plots below is the carrier frequency.

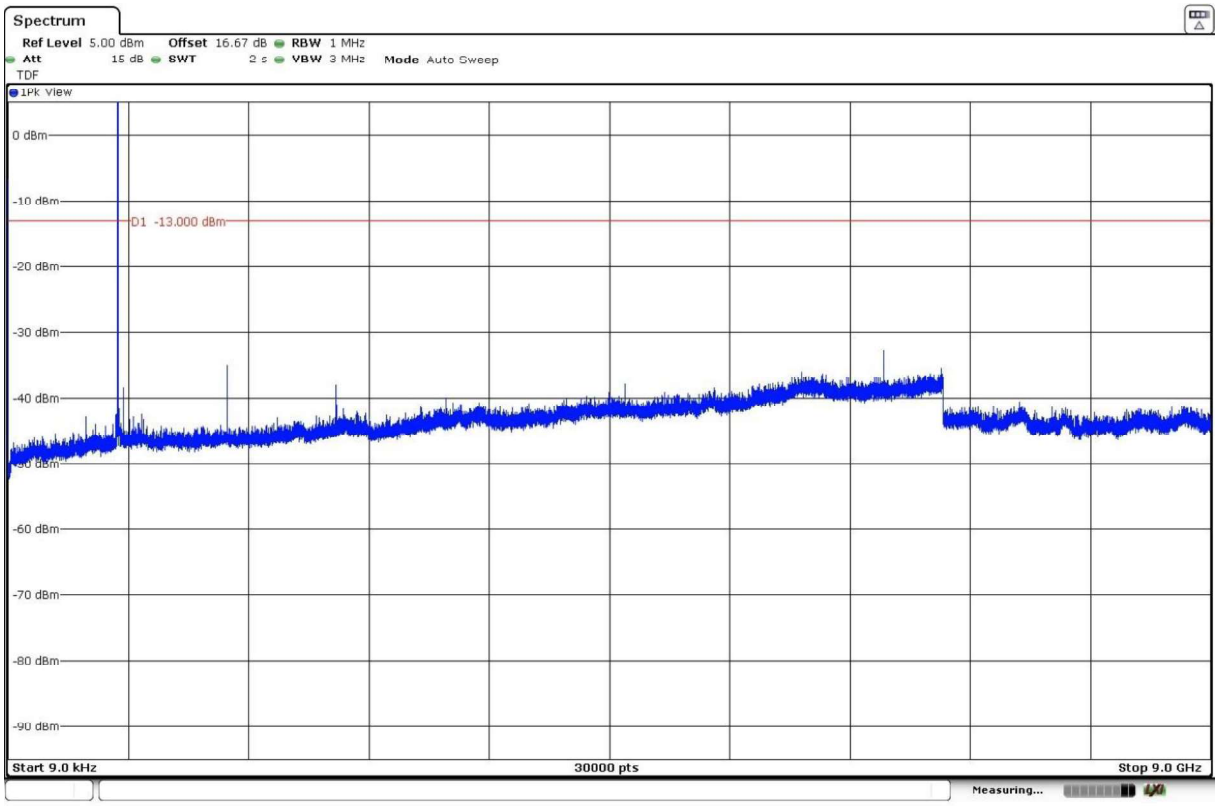
NBIoT 814 – 824 MHz Band.

π/4 - QPSK modulation. 3 tones 15 kHz, Offset Tone = 6.

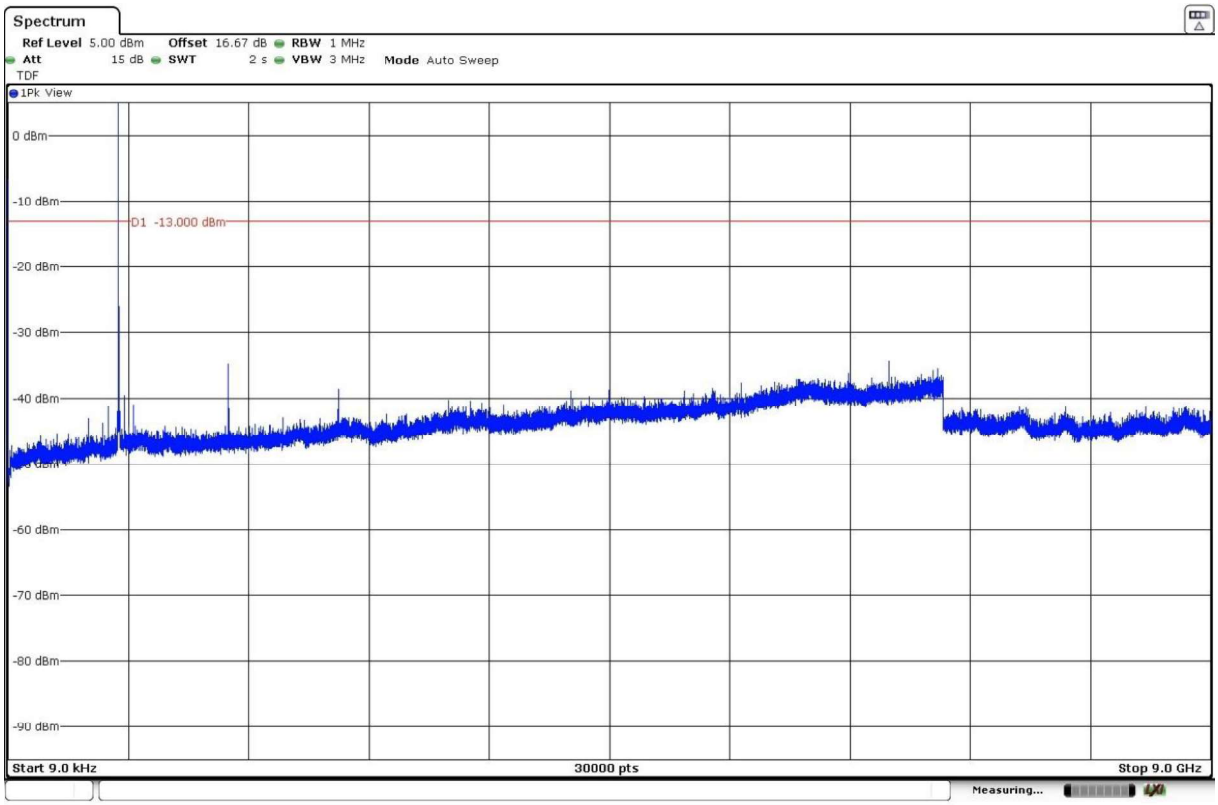
- Low Channel:



- Middle Channel:



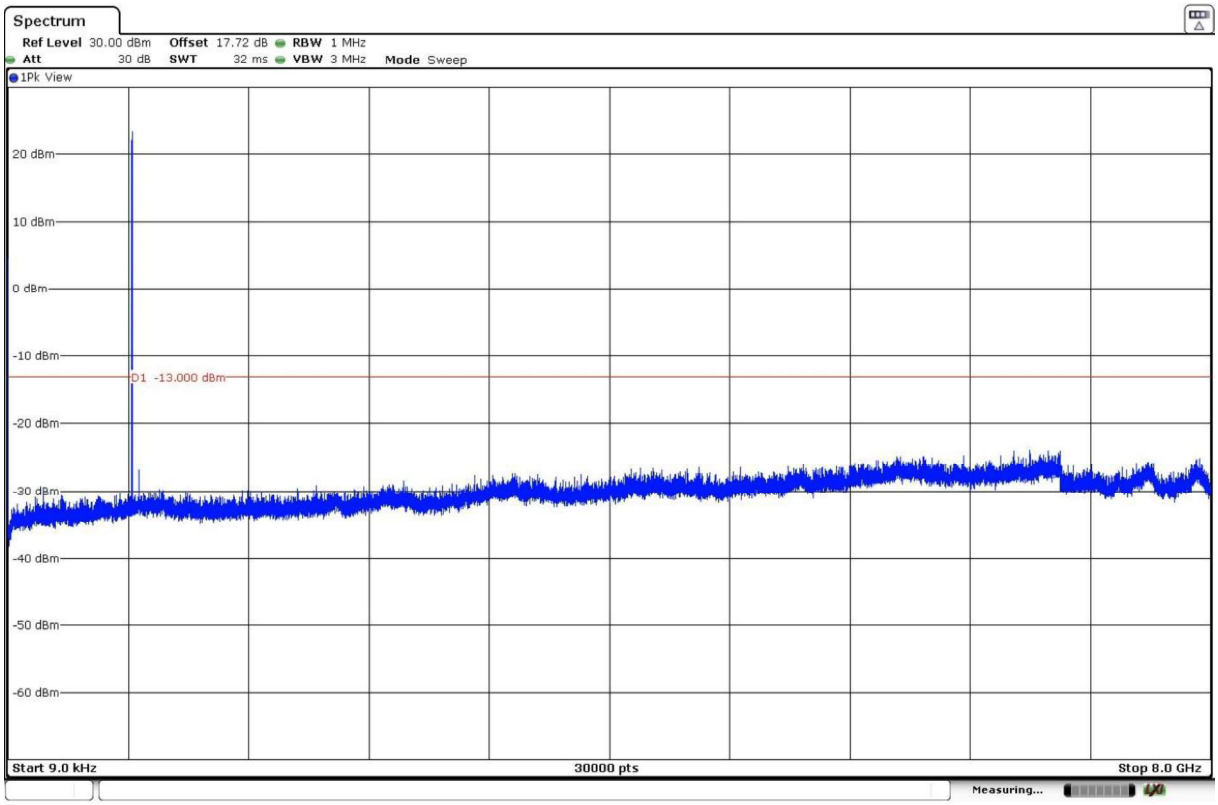
- High Channel:



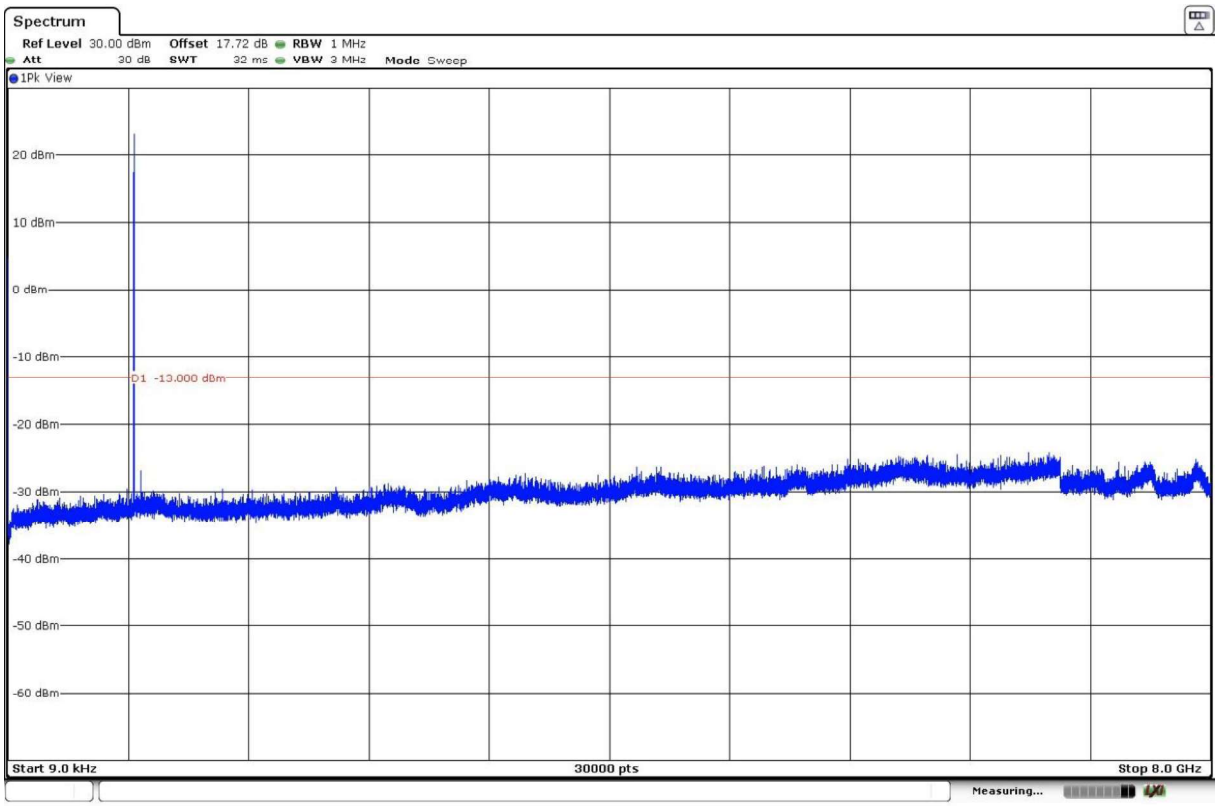
NBIoT 824 – 849 MHz Band.

π/4 - QPSK modulation. 3 tones 15 kHz, Offset Tone = 6.

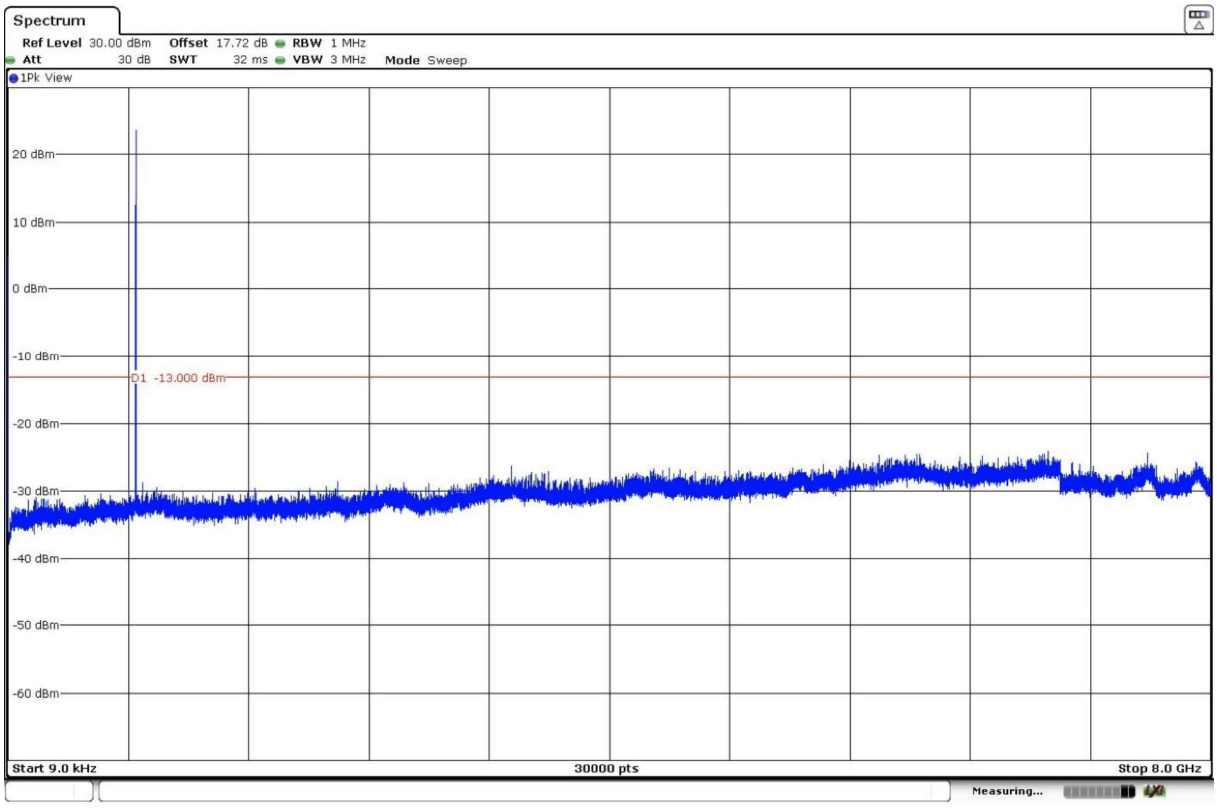
- Low Channel:



- Middle Channel:

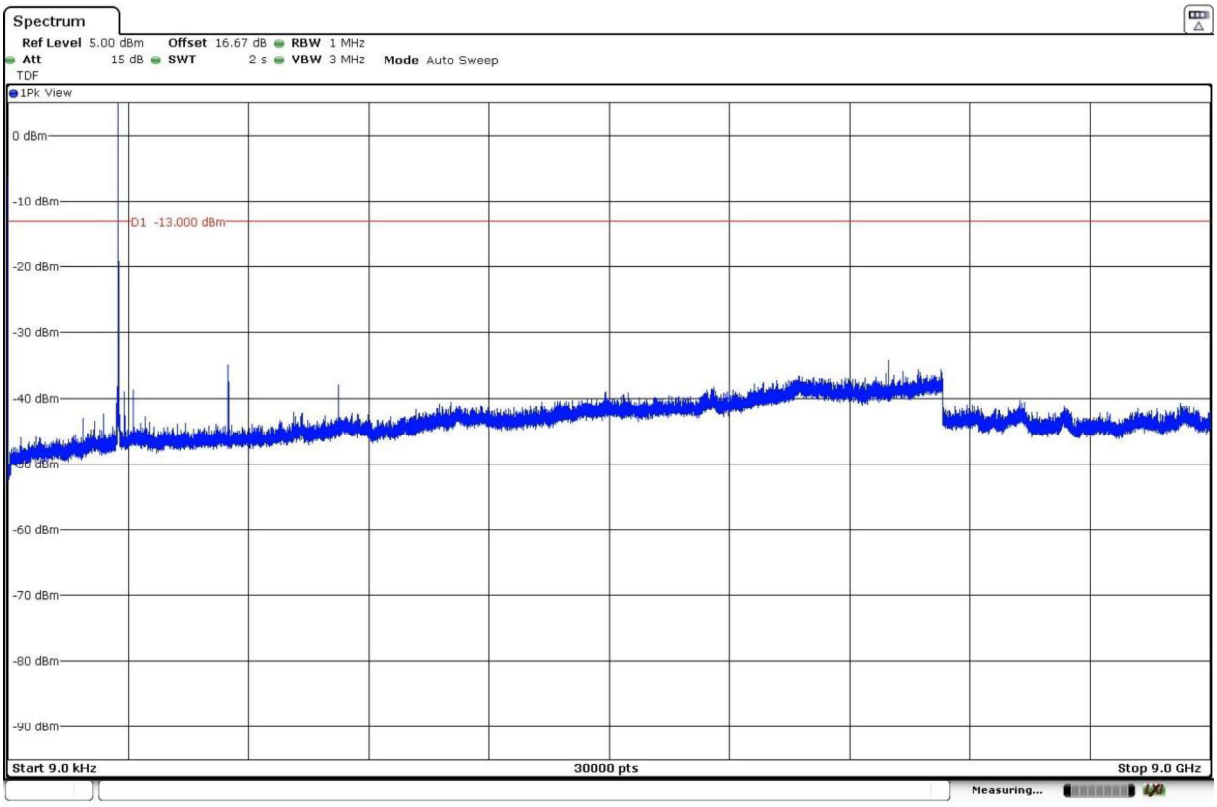


- High Channel:



NBIoT Cross-rule channel (824 MHz).

π/4 - QPSK modulation. 3 tones 15 kHz, Offset Tone = 6.



Spurious Emissions at Antenna Terminals at Block Edges

Limits

FCC §2.1051 and §22.917. RSS-132 Clause 5.5.

> The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

FCC §90.691.

> (a) Out-of-band emission requirement shall apply only to the "outer" channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows:
>
> > (1) For any frequency removed from the EA licensee's frequency block by up to and including 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 116 Log10(f/6.1) decibels or 50 + 10 Log10(P) decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 12.5 kHz.
> >
> > (2) For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least 43 + 10Log10(P) decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

At Po transmitting power, the specified minimum attenuation becomes 43+10 log (Po), and the level in dBm relative to Po becomes:

$$Po\ (dBm) - [43 + 10 \log (Po \text{ in mW}) - 30] = -13\ dBm$$

Method

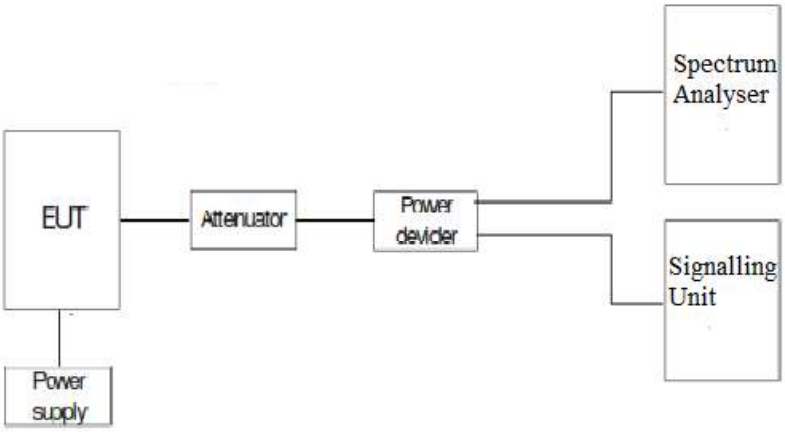
The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50-Ohm attenuator and a power splitter.

The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

The configuration of modulation which is the worst case for conducted power was used. Lowest and highest channels were tested to show compliance with low and high block edges respectively.

As stated in FCC part 22.917 / RSS-132 Clause 5.5, in the 1 MHz bands immediately outside and adjacent to the frequency block or band a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

Test setup



Results

NBIoT Band 5.

A preliminary measurement determined π/4 - QPSK modulation as the worst case for 1 tone of 3.75 kHz.

A preliminary measurement determined π/2 - BPSK modulation as the worst case for 1 tone of 15 kHz.

The next results are for these worst-case modulations.

NBIoT configuration	Maximum measured level at lowest Block Edge at antenna port (dBm)
1 Tone 3.75 kHz, Offset Tone = 0 π/4 - QPSK	-36.41
1 Tone 15 kHz, Offset Tone = 0 π/2 - BPSK	-30.31
12 Tones 15kHz, Offset Tone = 0 π/4 - QPSK	-25.30

NBIoT configuration	Maximum measured level at highest Block Edge at antenna port (dBm)
1 Tone 3.75 kHz, Offset Tone = 47 π/4 - QPSK	-30.19
1 Tone 15 kHz, Offset Tone = 11 π/2 - BPSK	-29.62
12 Tones 15kHz, Offset Tone = 0 π/4 - QPSK	-21.30

Verdict

Pass

NBIoT 814 – 824 MHz Band. EA MASK.

A preliminary measurement determined π/4 - QPSK modulation as the worst case for 1 tone of 3.75 kHz.

A preliminary measurement determined π/2 - BPSK modulation as the worst case for 1 tone of 15 kHz.

The results attached are for these worst-case modulations.

A marker is displayed to show compliance at the frequency removed from the EA licensee's frequency block by 37.5 kHz plus one half of the resolution bandwidth used, i.e. 50 kHz.

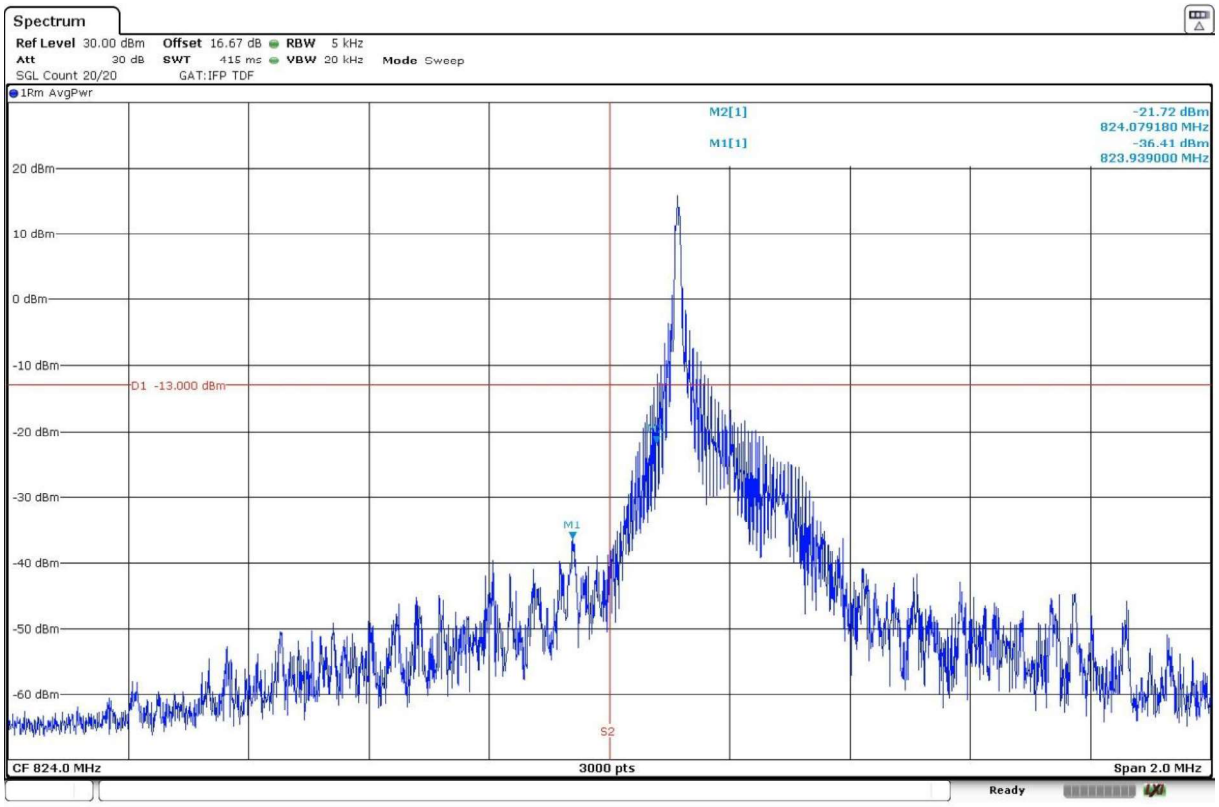
Verdict

Pass

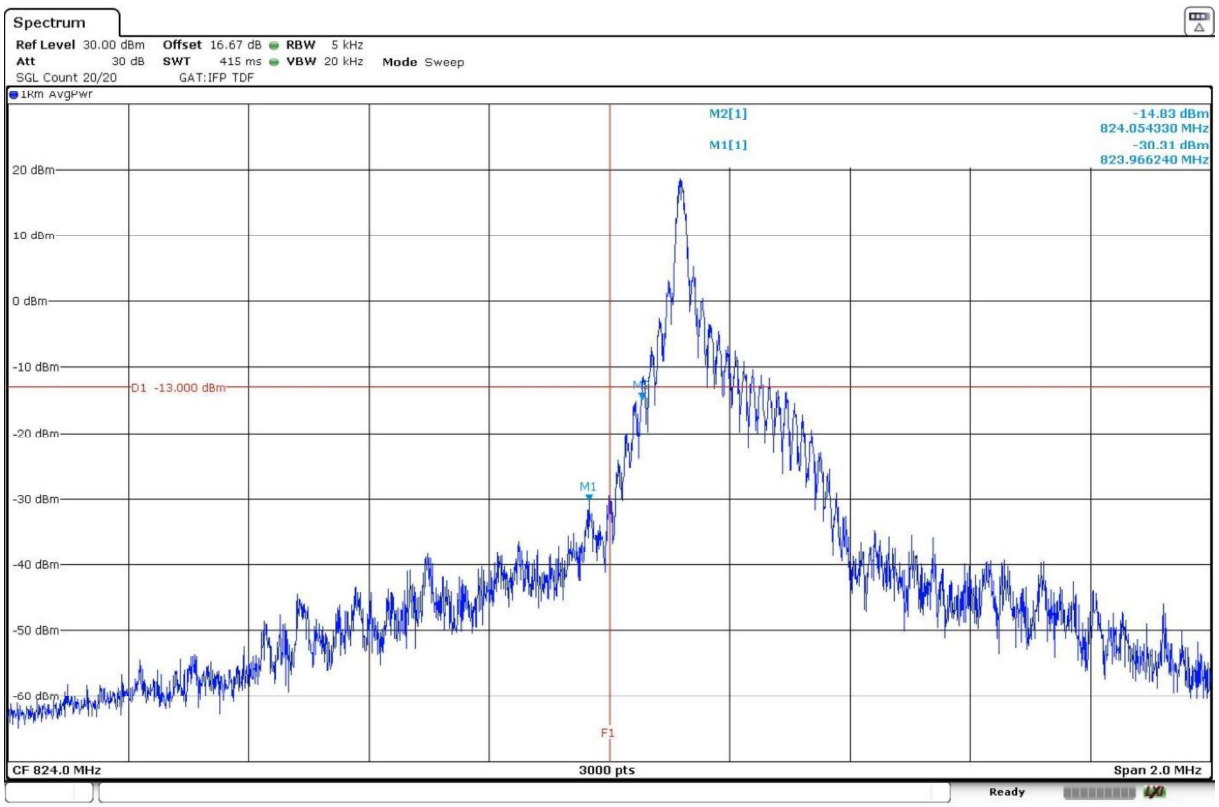
Attachments

NBIoT Band 5.

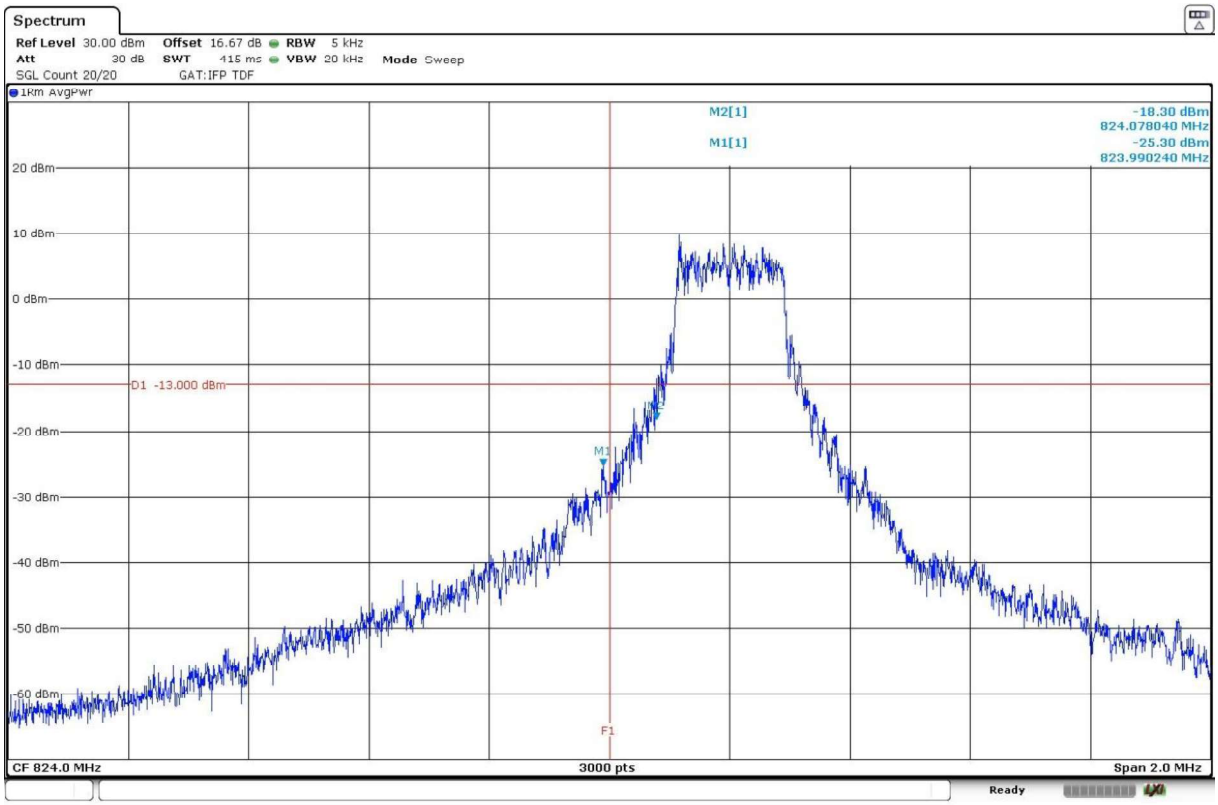
1 Tone 3.75 kHz, Offset Tone = 0. π/4 - QPSK modulation. Low Block Edge:



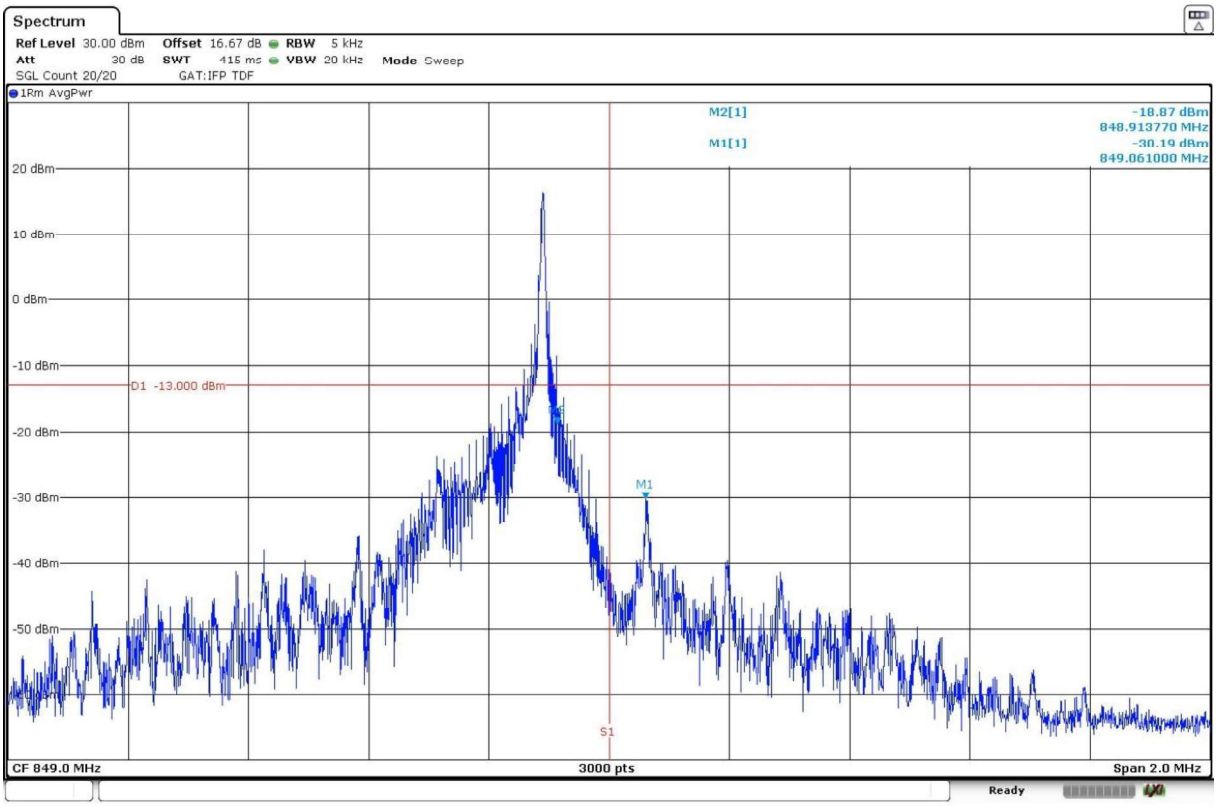
1 Tone 15 kHz, Offset Tone = 0. π/2 – BPSK modulation. Low Block Edge:



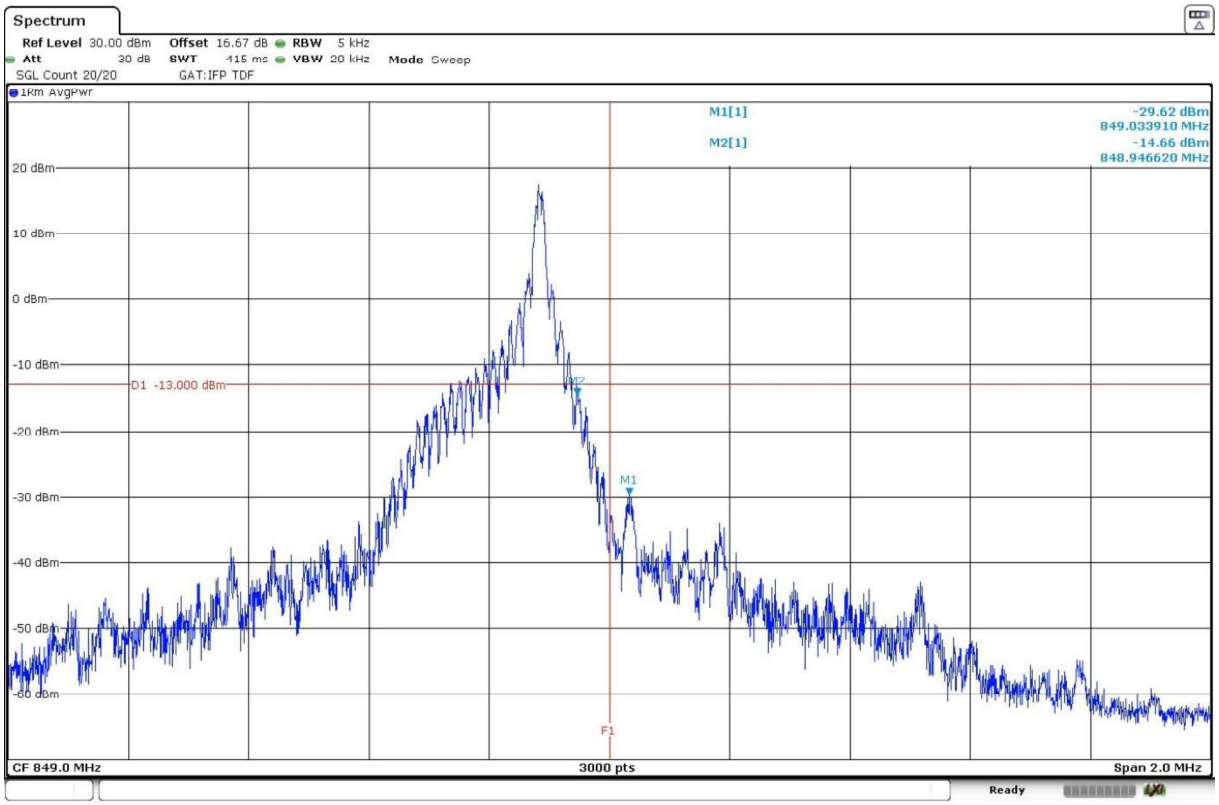
12 Tones 15 kHz, Offset Tone = 0. π/4 - QPSK modulation. Low Block Edge:



1 Tone 3.75 kHz, Offset Tone = 47. π/4 - QPSK modulation. High Block Edge:



1 Tone 15 kHz, Offset Tone = 11. π/2 - BPSK modulation. High Block Edge:



12 Tones 15 kHz, Offset Tone = 0. π/4 - QPSK modulation. High Block Edge: