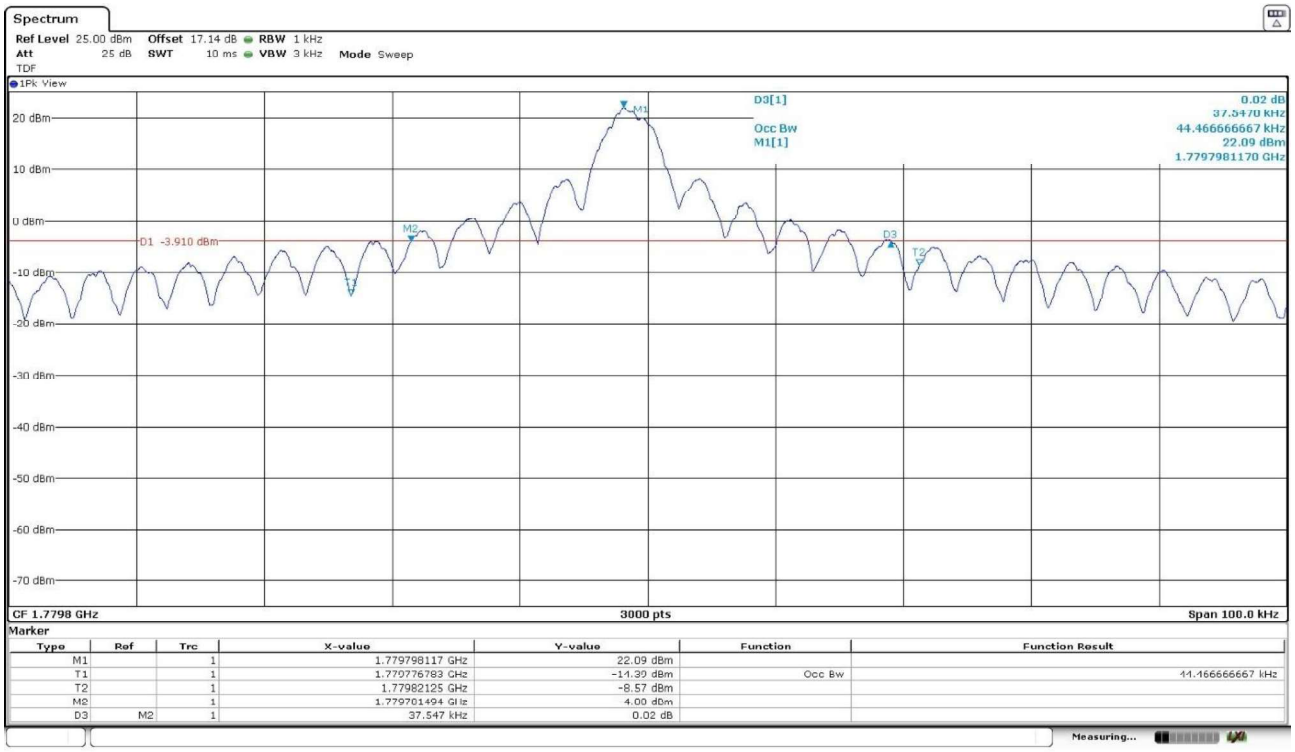
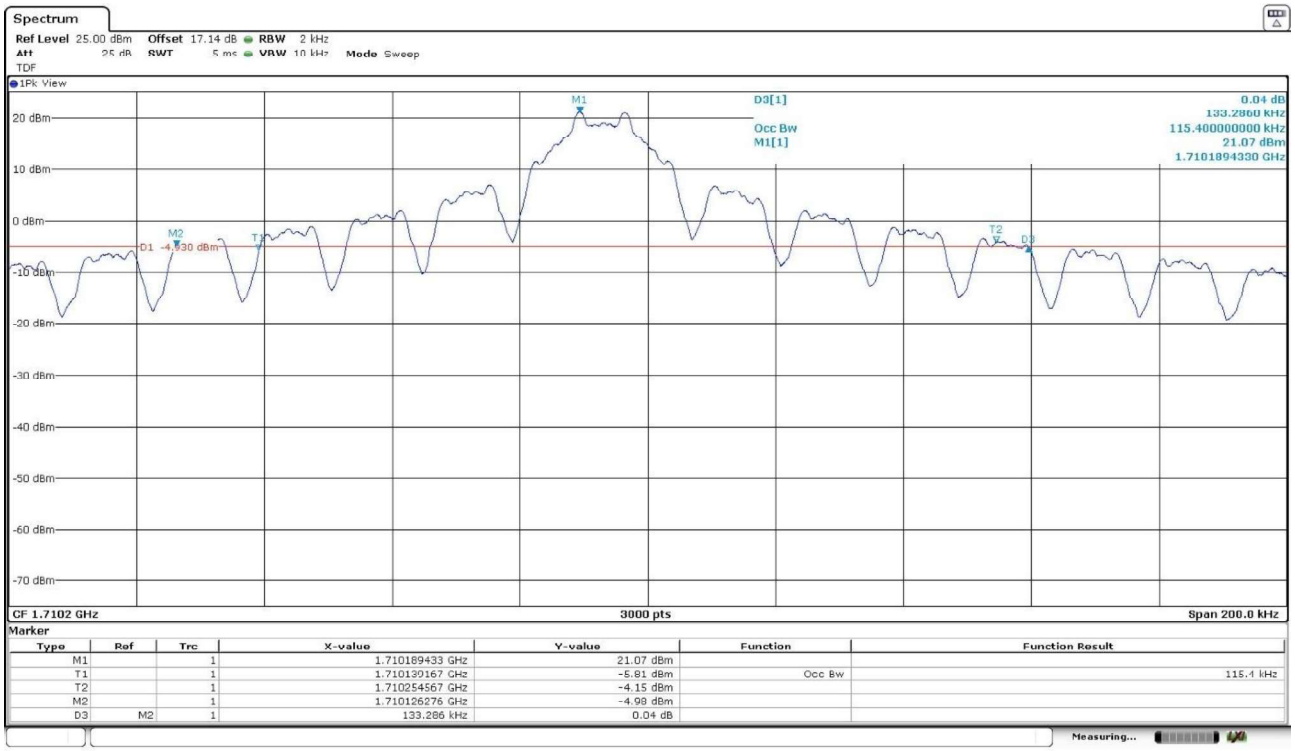
- High Channel:

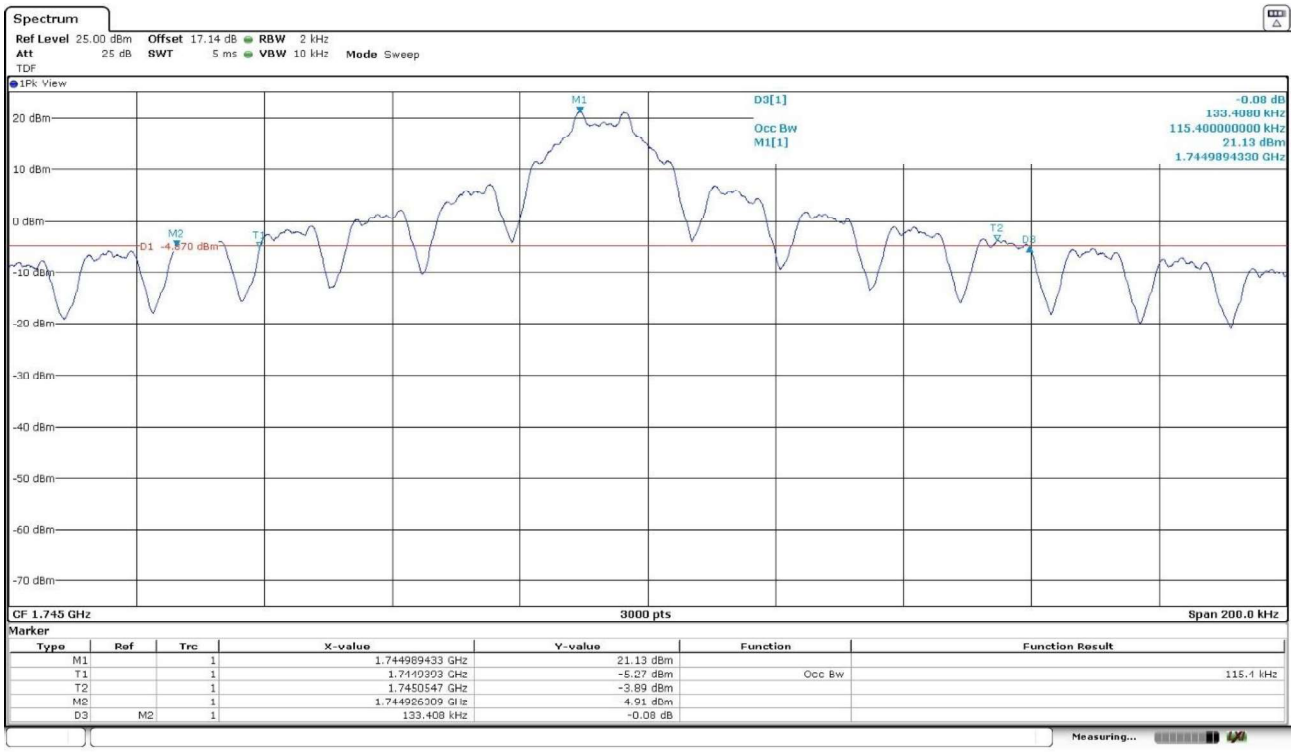


1 tone 15 kHz, π/2 - BPSK modulation.

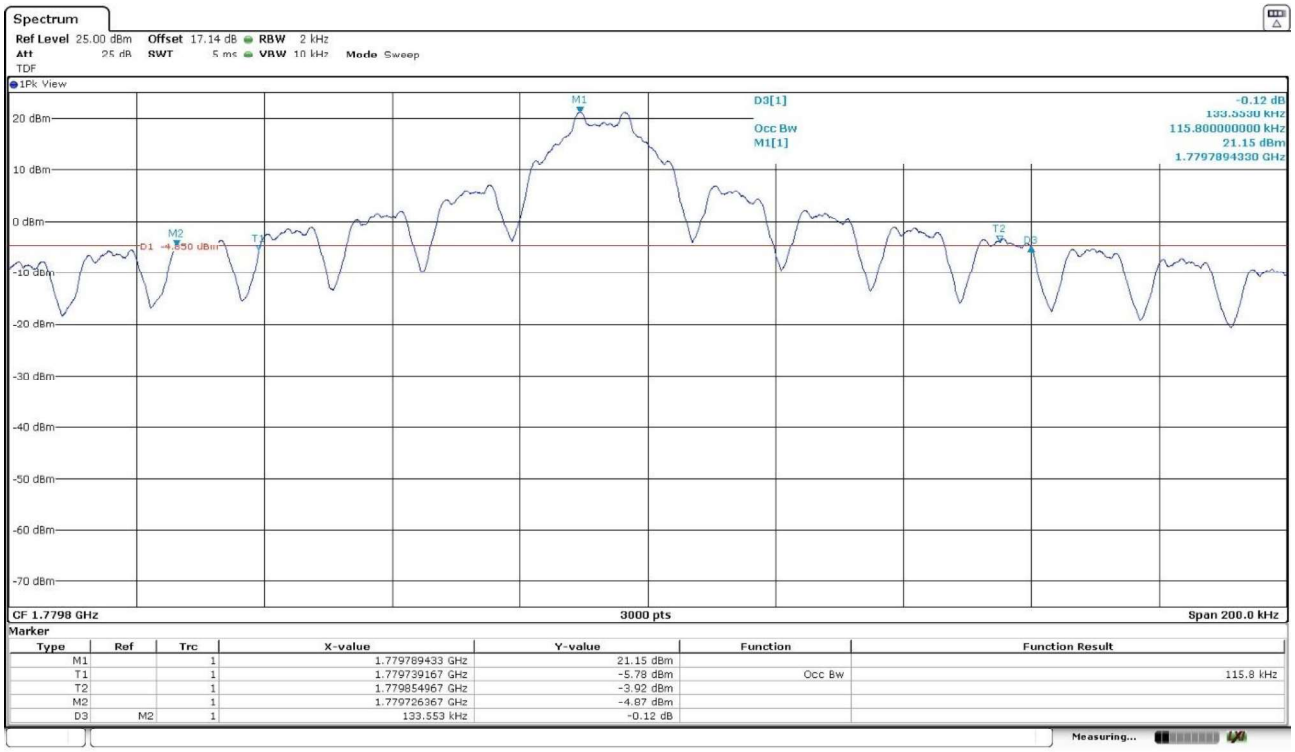
- Low Channel:



- Middle Channel:

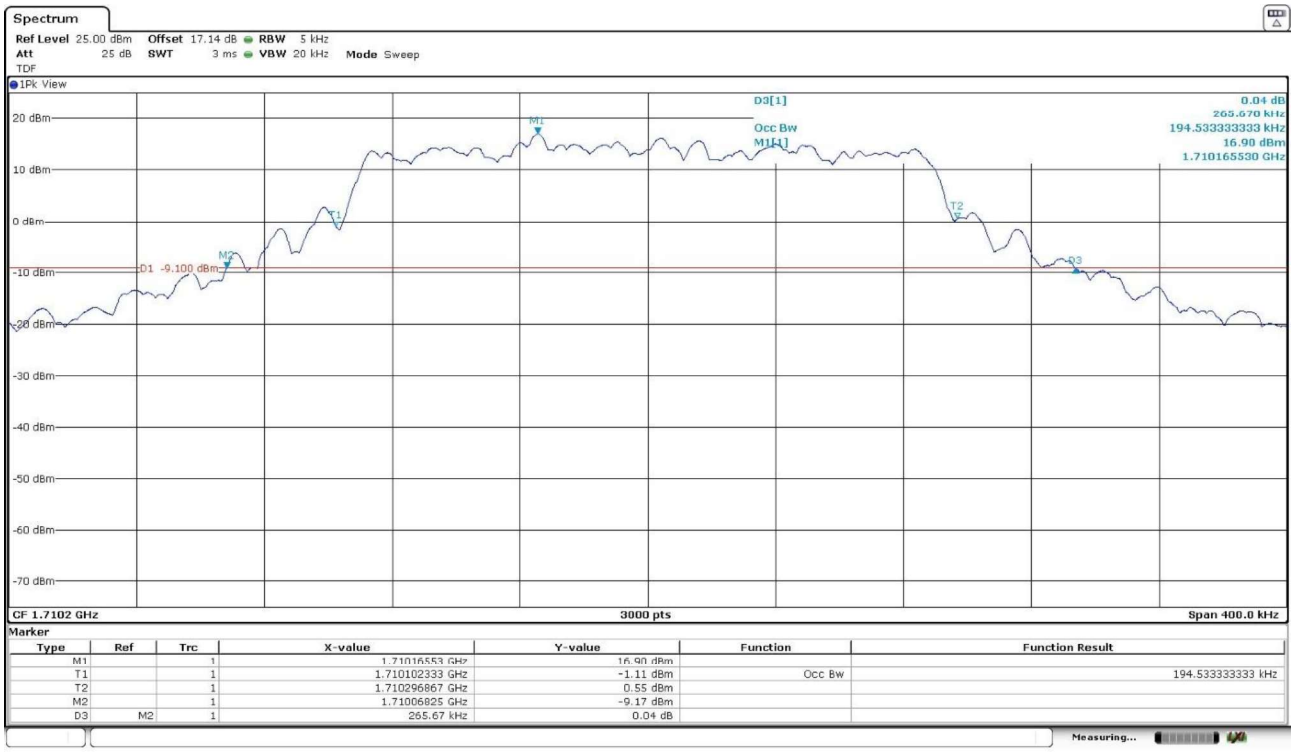


- High Channel:

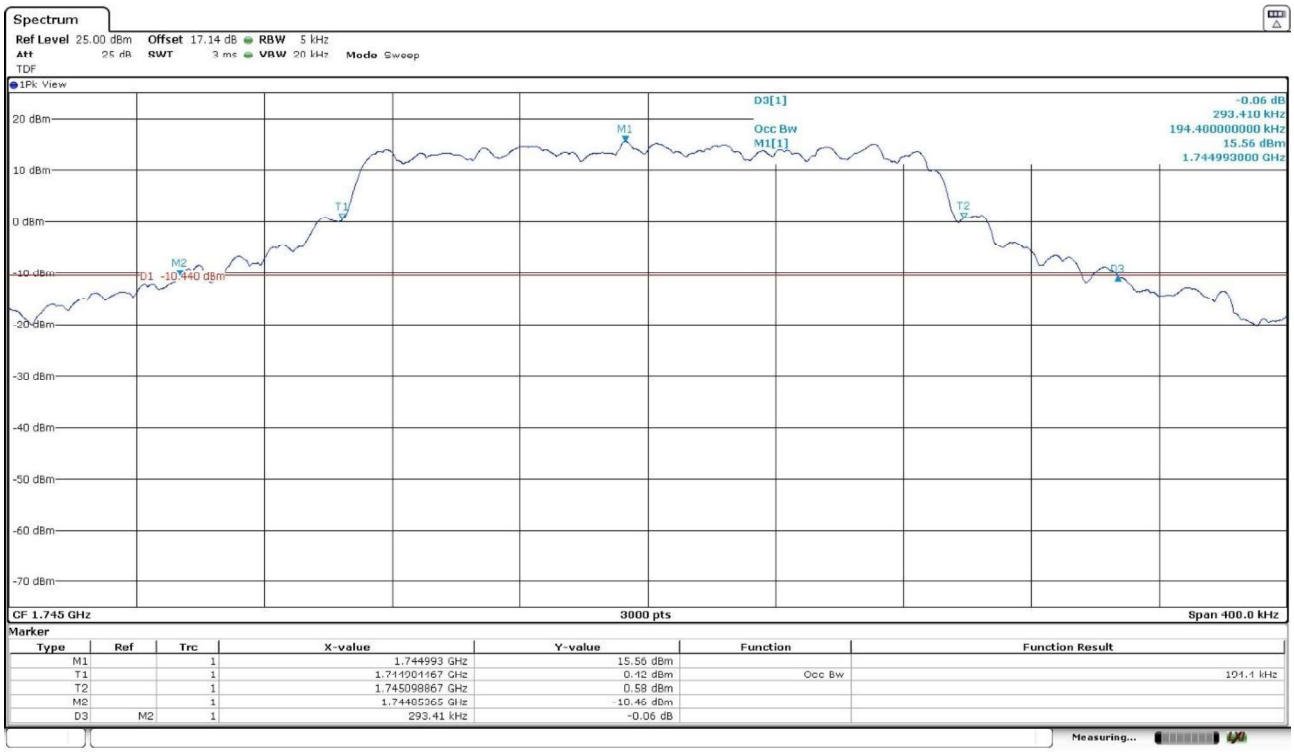


12 tones 15 kHz, π/4 - QPSK modulation.

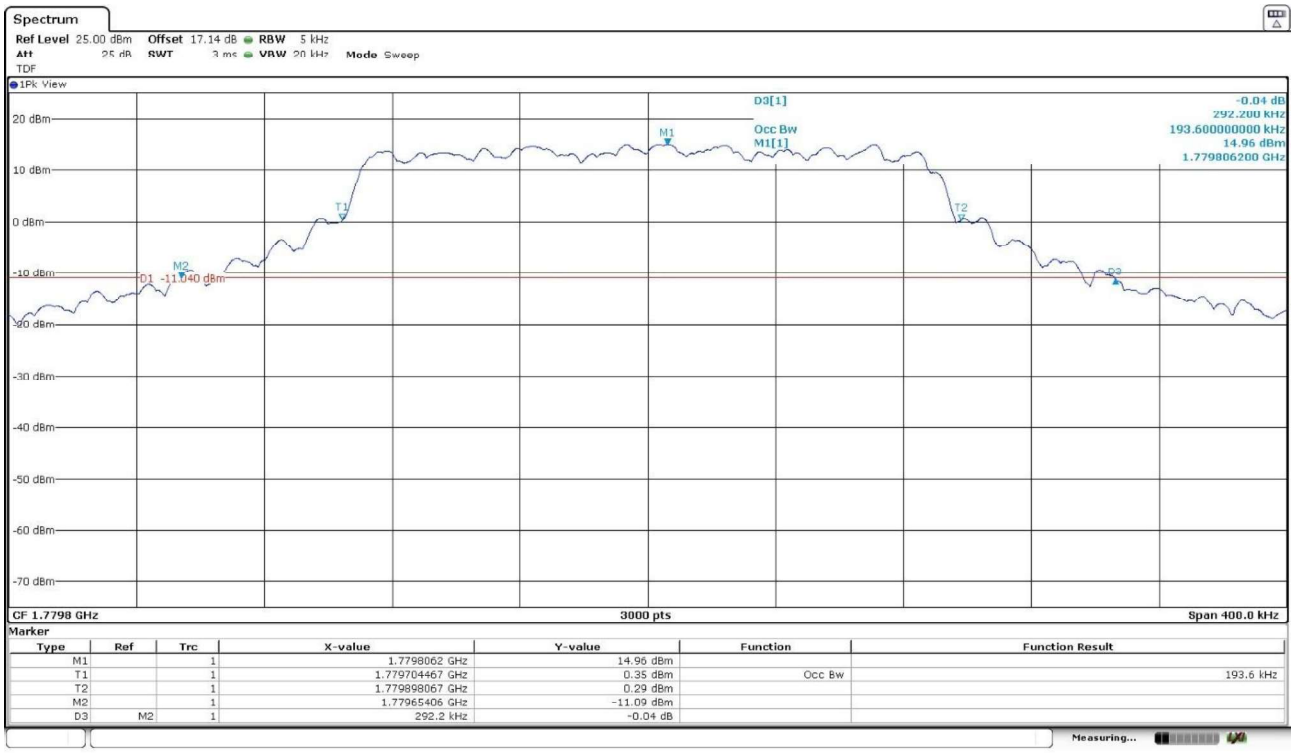
- Low Channel:



- Middle Channel:



- High Channel:



Spurious Emissions at Antenna Terminals

Limits

FCC §27.53 (c):

On any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB. Compliance is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater.

On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations. Compliance is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

FCC §27.53 (g):

For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater.

RSS-130, Clause 4.7.1:

The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 $\log_{10}$ p (watts), dB.

RSS-130, Clause 4.7.2:

The power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power, P (dBW), by at least 65 + 10 $\log_{10}$ p(watts), dB, for mobile and portable equipment.

FCC §27.53 (h), RSS-139, Clause 6.6:

According to specification, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater.

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

At Po transmitting power, the specified minimum attenuation becomes 65+10 log (Po), and the level in dBm relative to Po becomes:

Po (dBm) – [65 + 10 log (Po in mW) - 30] = -35 dBm

Method

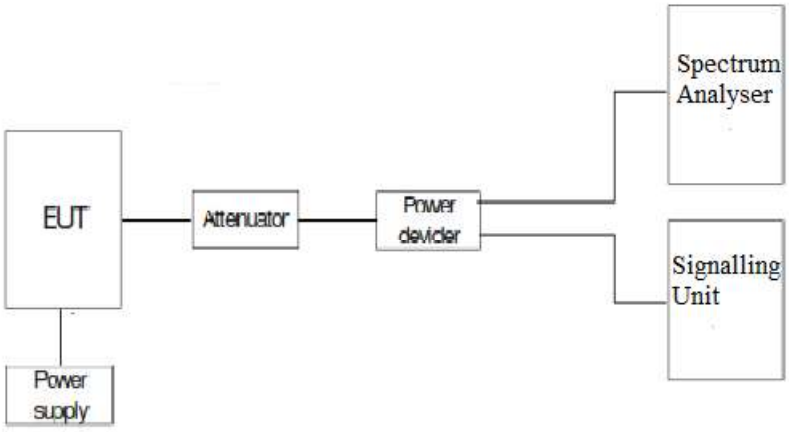
The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50-Ohm attenuator and a power divider.

The spectrum was investigated from 9 kHz to 8 GHz for NBIoT Bands 12 and 13 and from 9 kHz to 20 GHz for NBIoT Band 66.

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 Band 12:

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 Band 13:

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)	Limit (dBm)
6217.739000	-27.69	-13

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

Spurious Frequency (MHz)	Conducted Emission Level (dBm)	Limit (dBm)
6256.139000	-26.36	-13

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

Spurious Frequency (MHz)	Conducted Emission Level (dBm)	Limit (dBm)
6294.539000	-25.99	-13

Verdict

Pass

NBIoT Band 66:

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

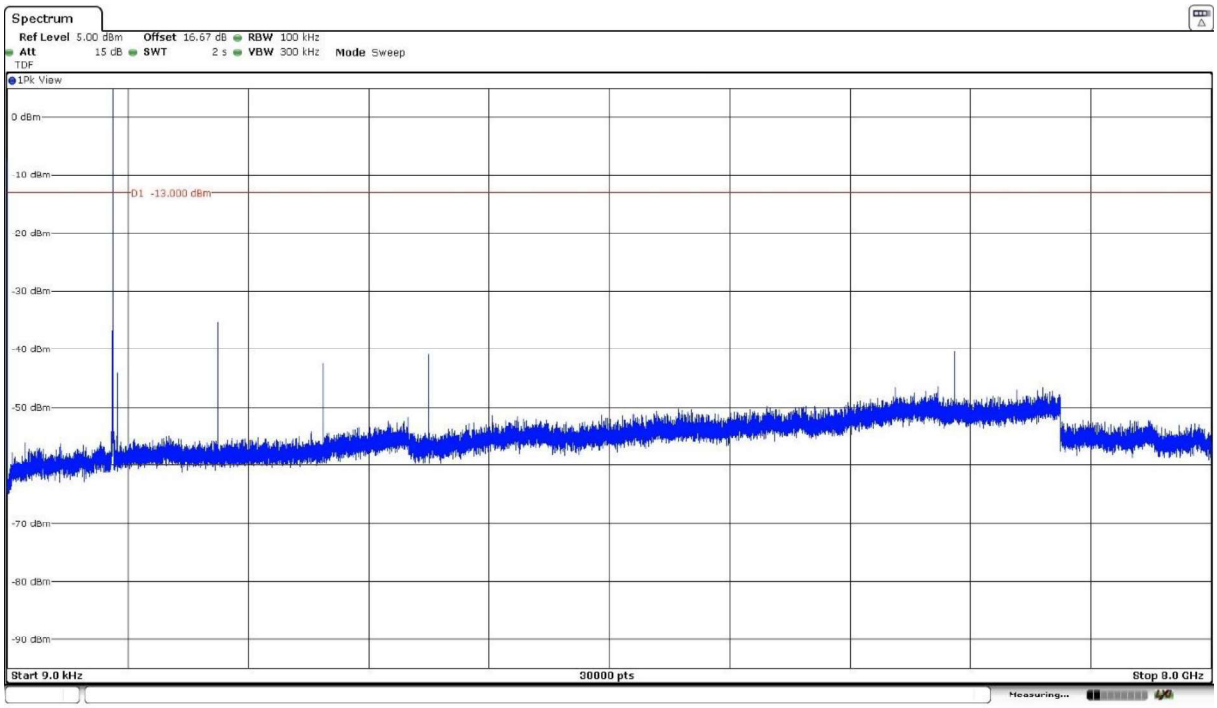
Attachments

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

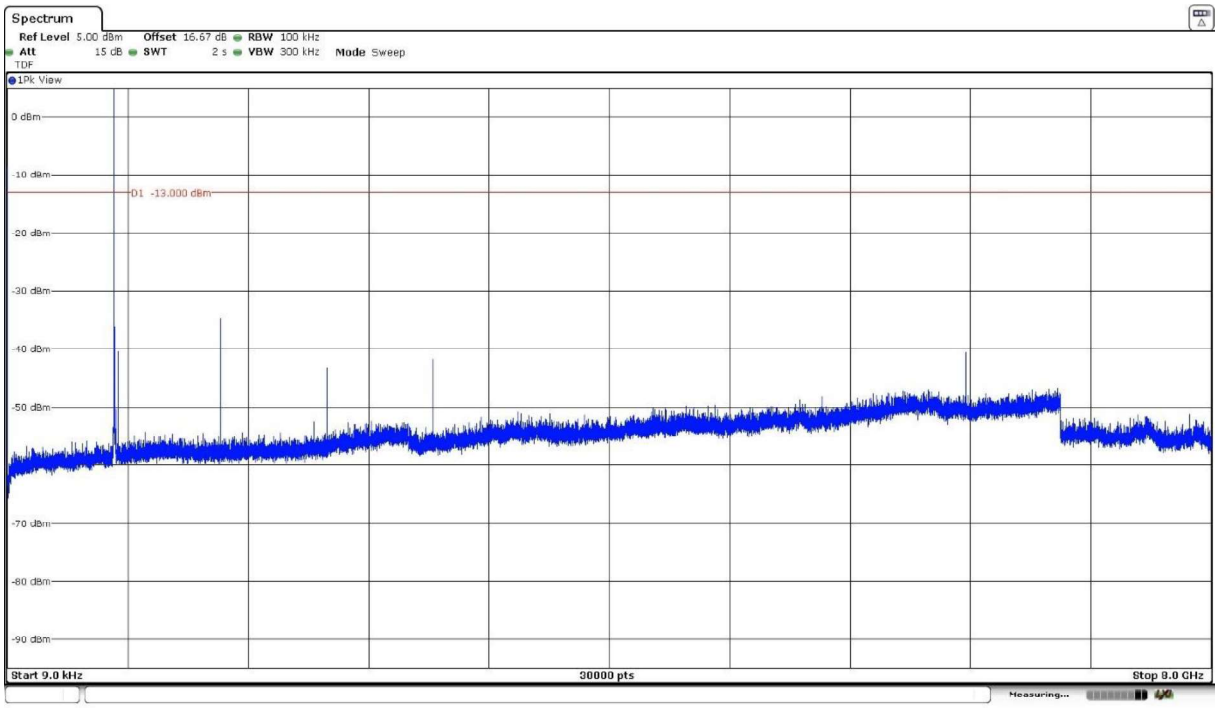
NBIoT Band 12.

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

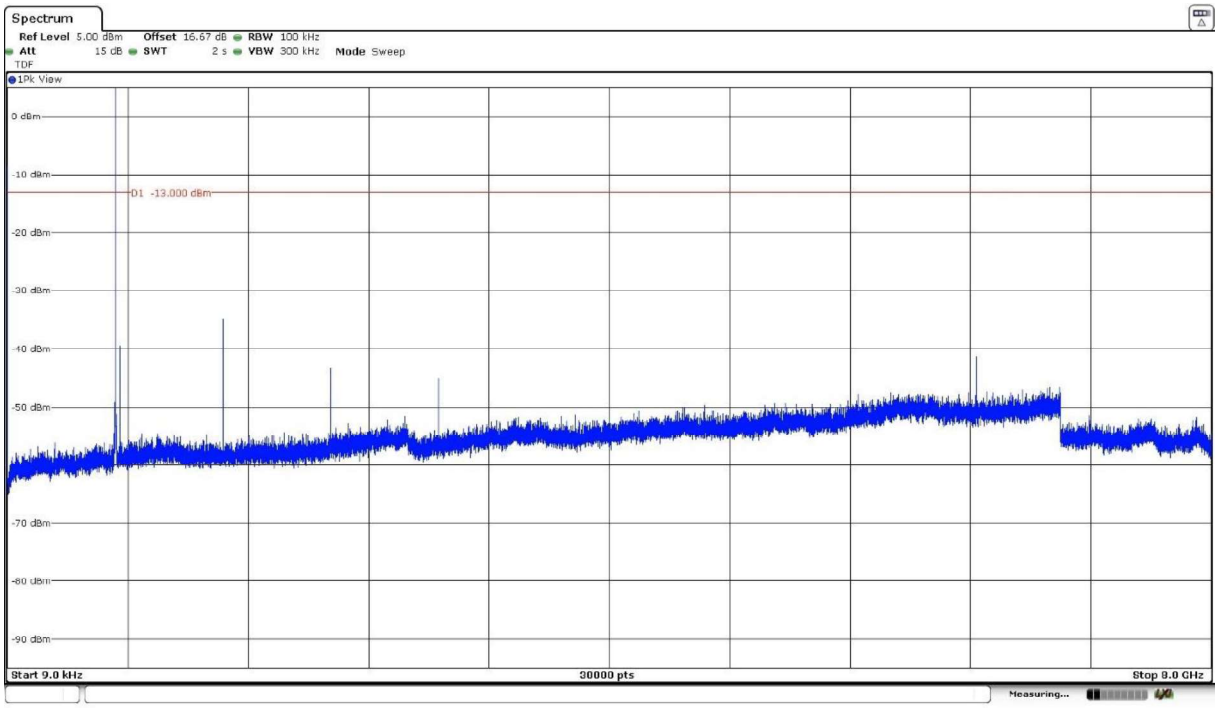
- Low Channel:



- Middle Channel:



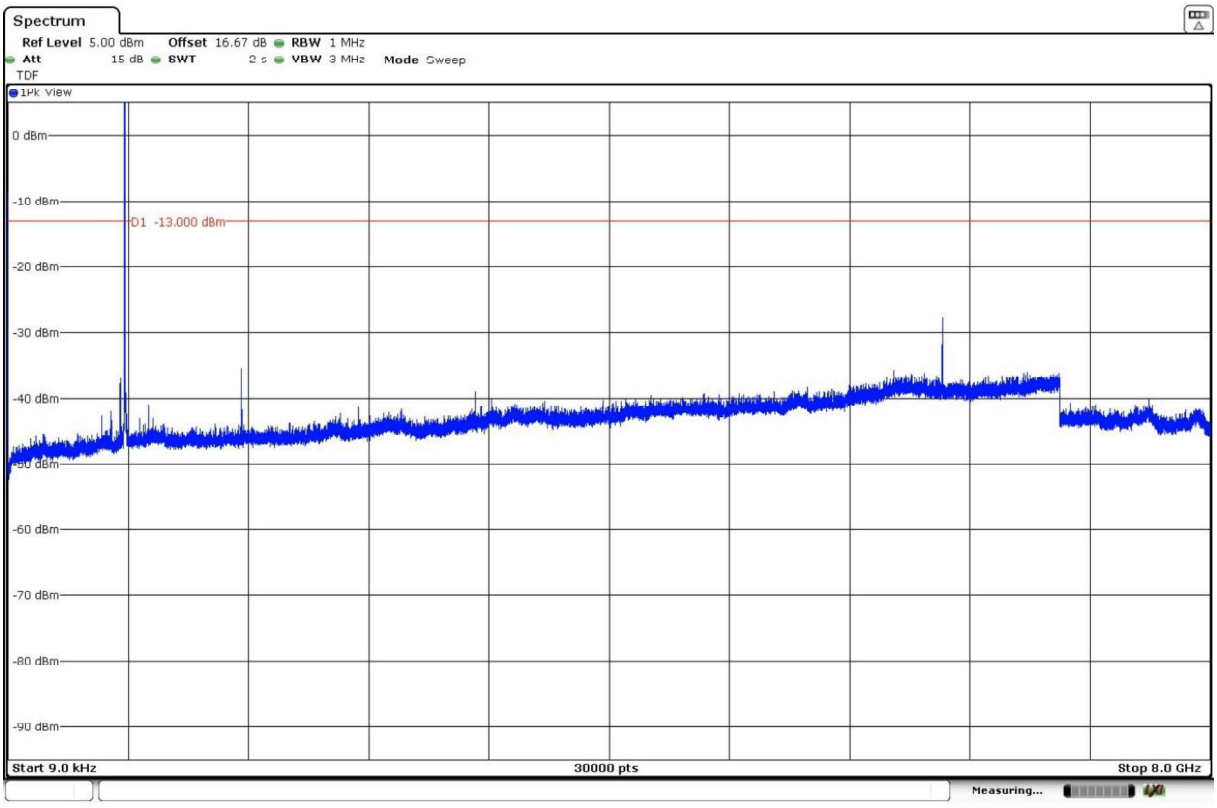
- High Channel:



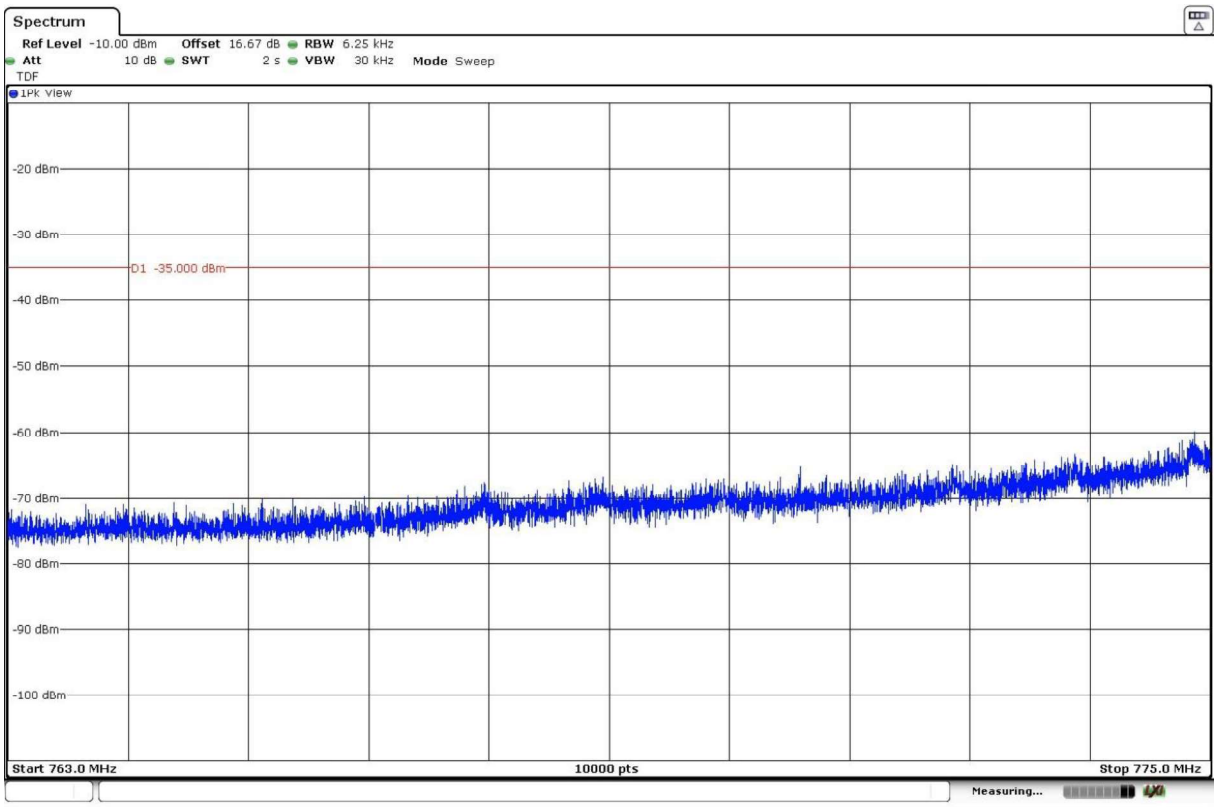
NBIoT Band 13.

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

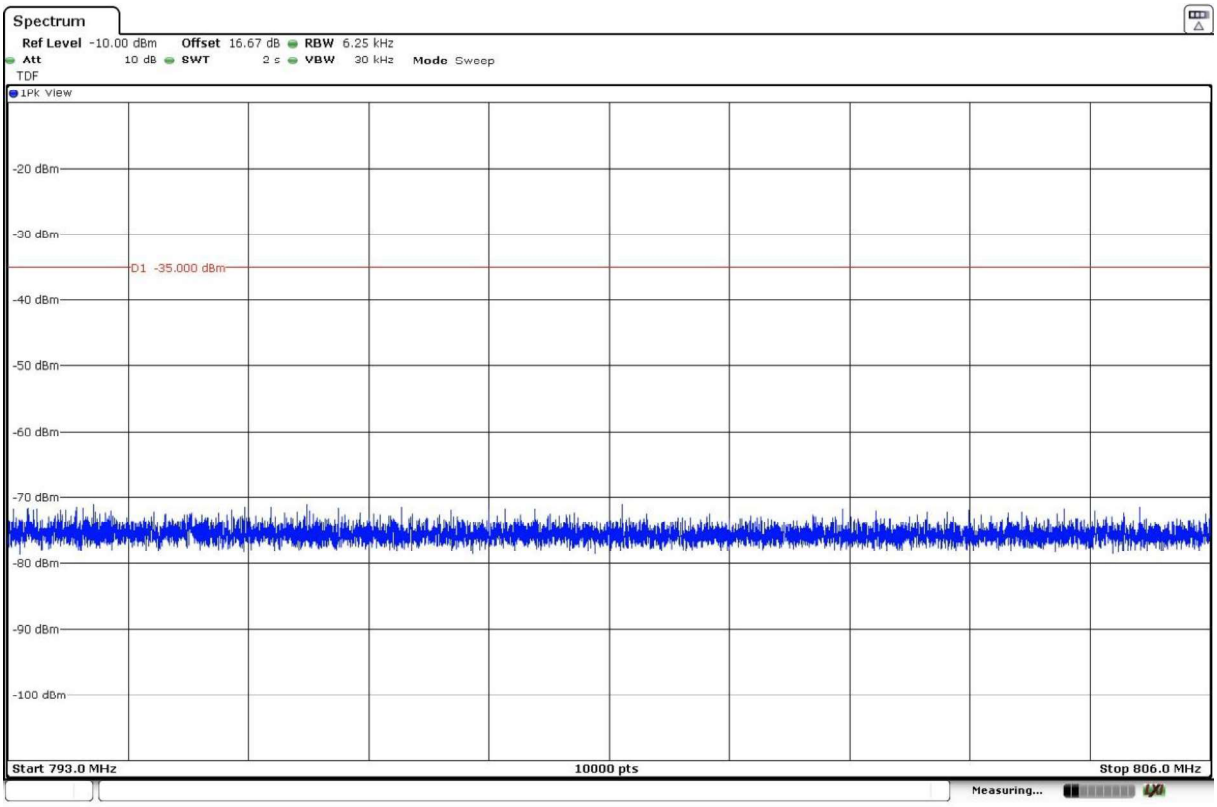
- Low Channel:
  - Frequency range 9 kHz – 8 GHz



- Frequency range 763 MHz – 775 MHz

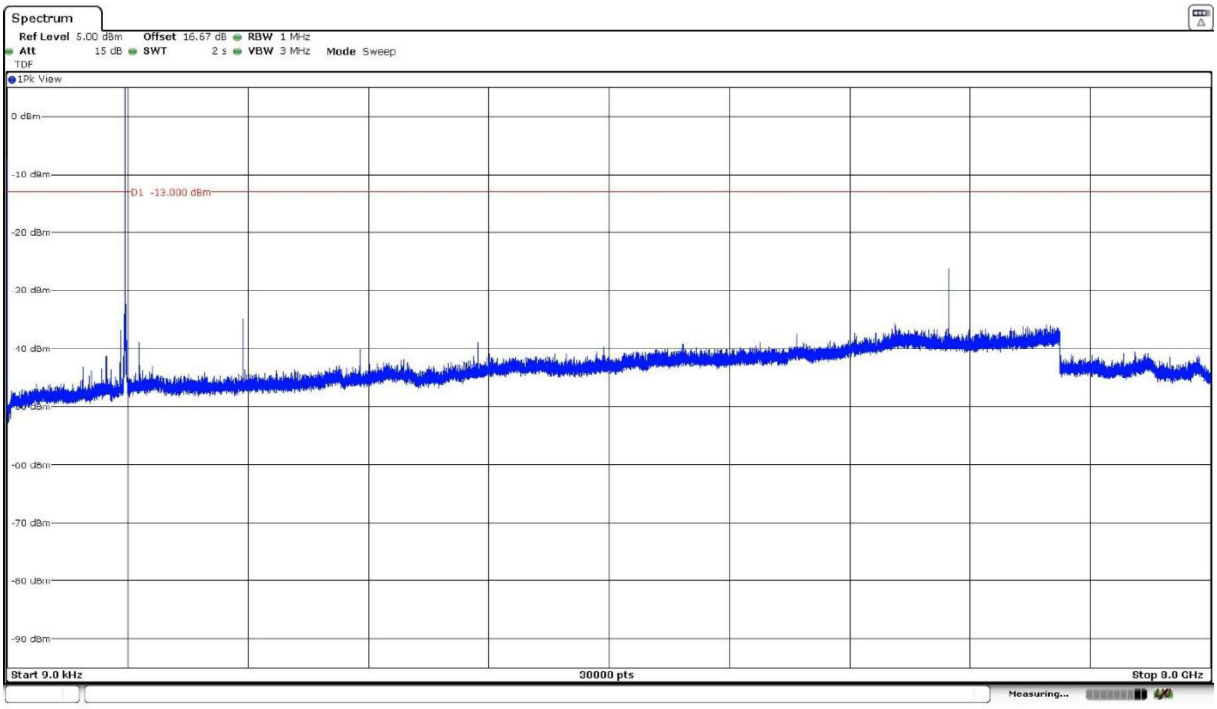


- Frequency range 793 MHz – 806 MHz

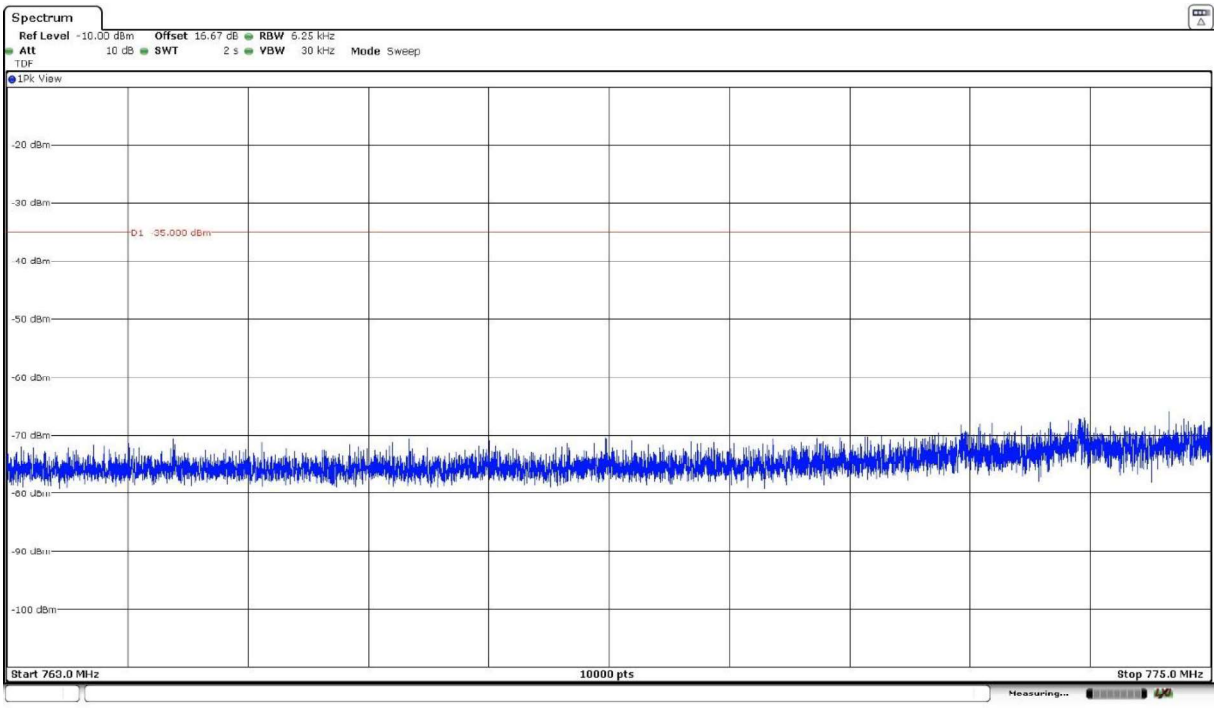


- Middle Channel:

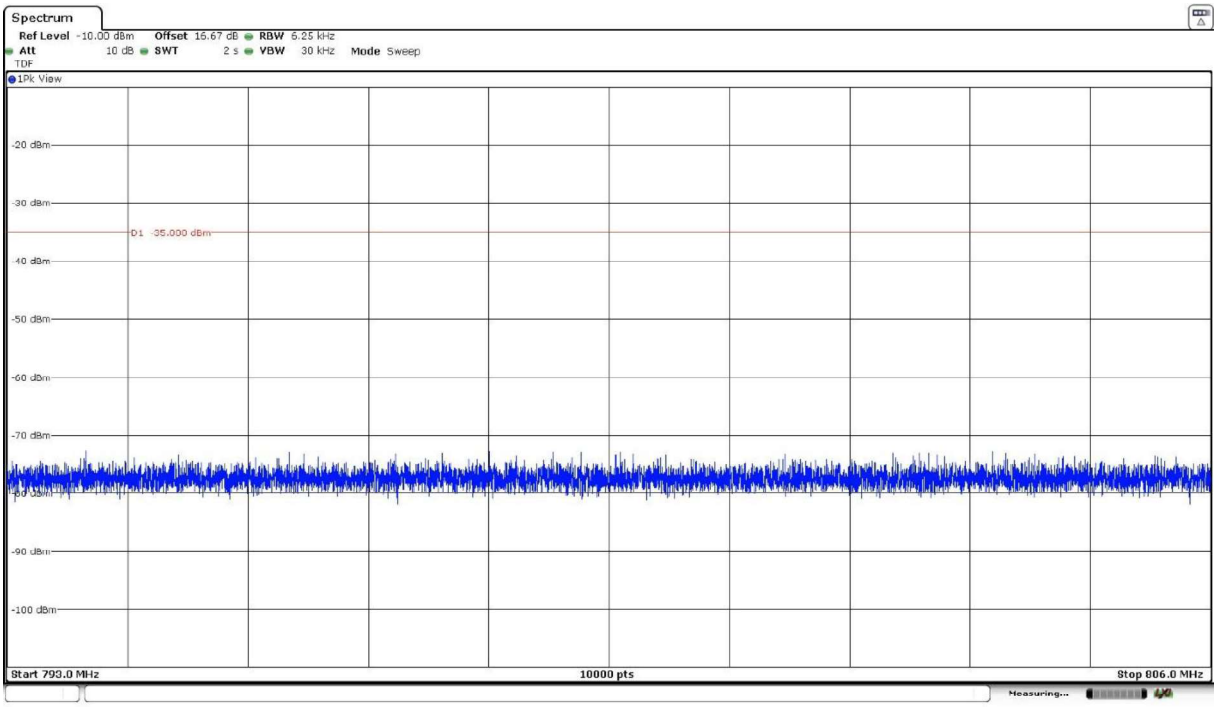
  - Frequency range 9 kHz – 8 GHz



  - Frequency range 763 MHz – 775 MHz

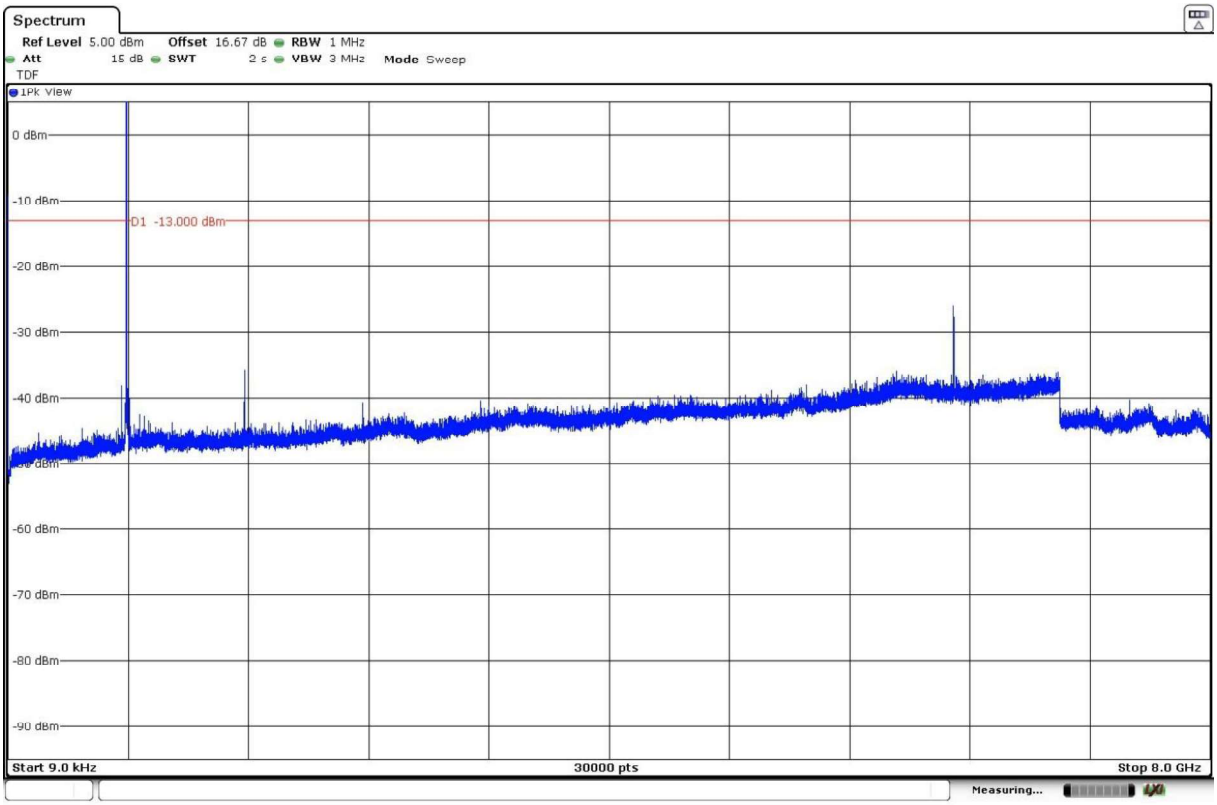


- Frequency range 793 MHz – 806 MHz

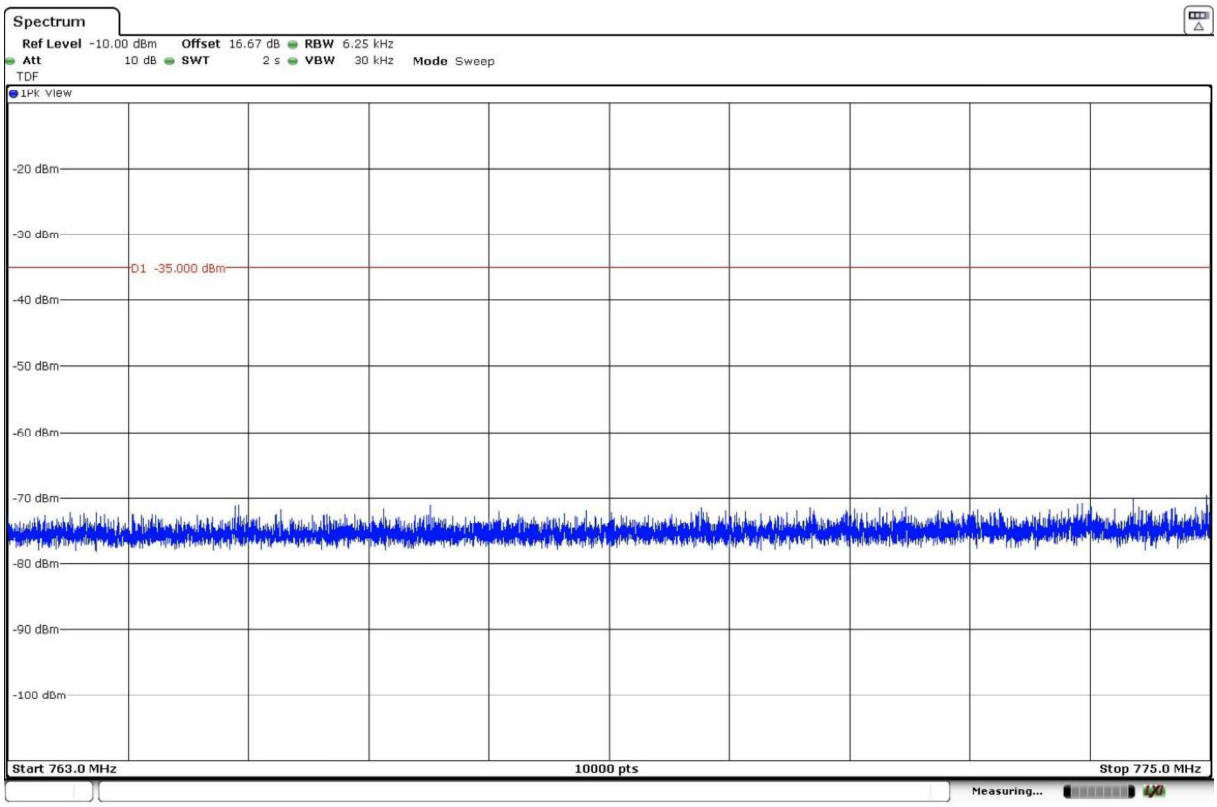


- High Channel:

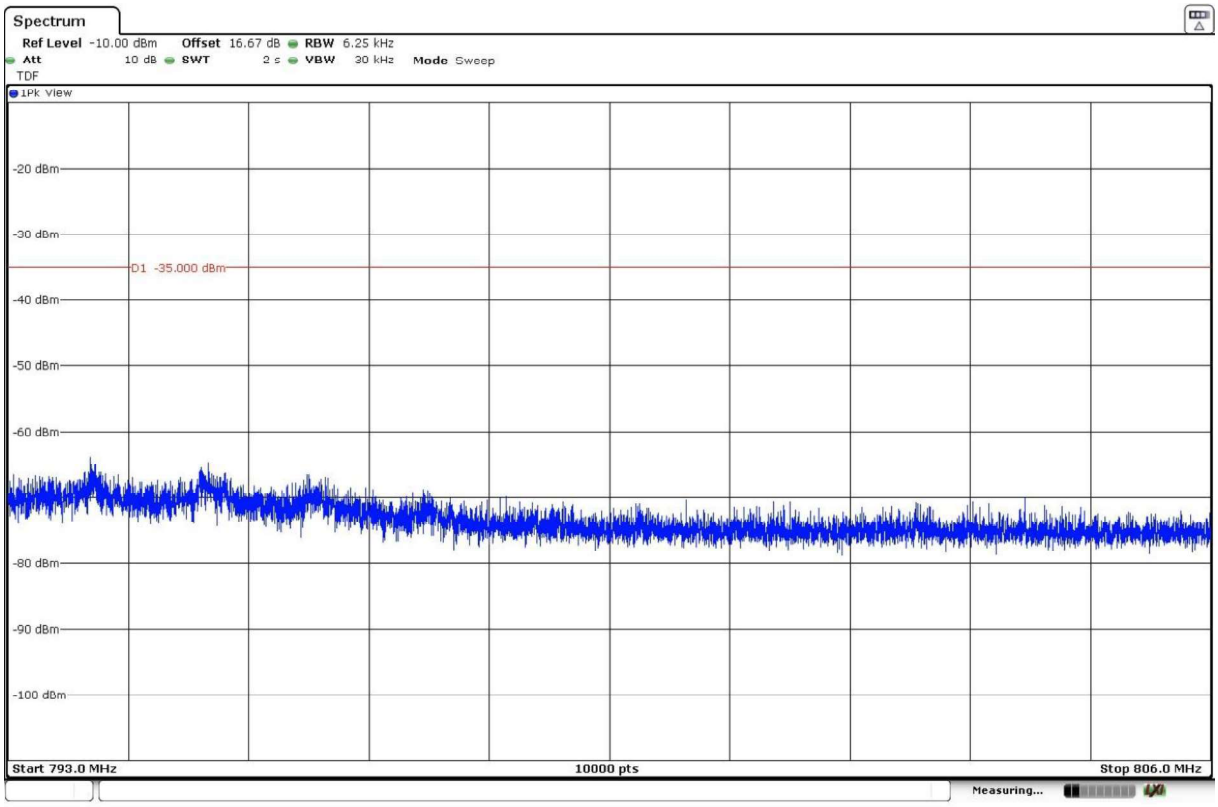
- Frequency range 9 kHz – 8 GHz



- Frequency range 763 MHz – 775 MHz



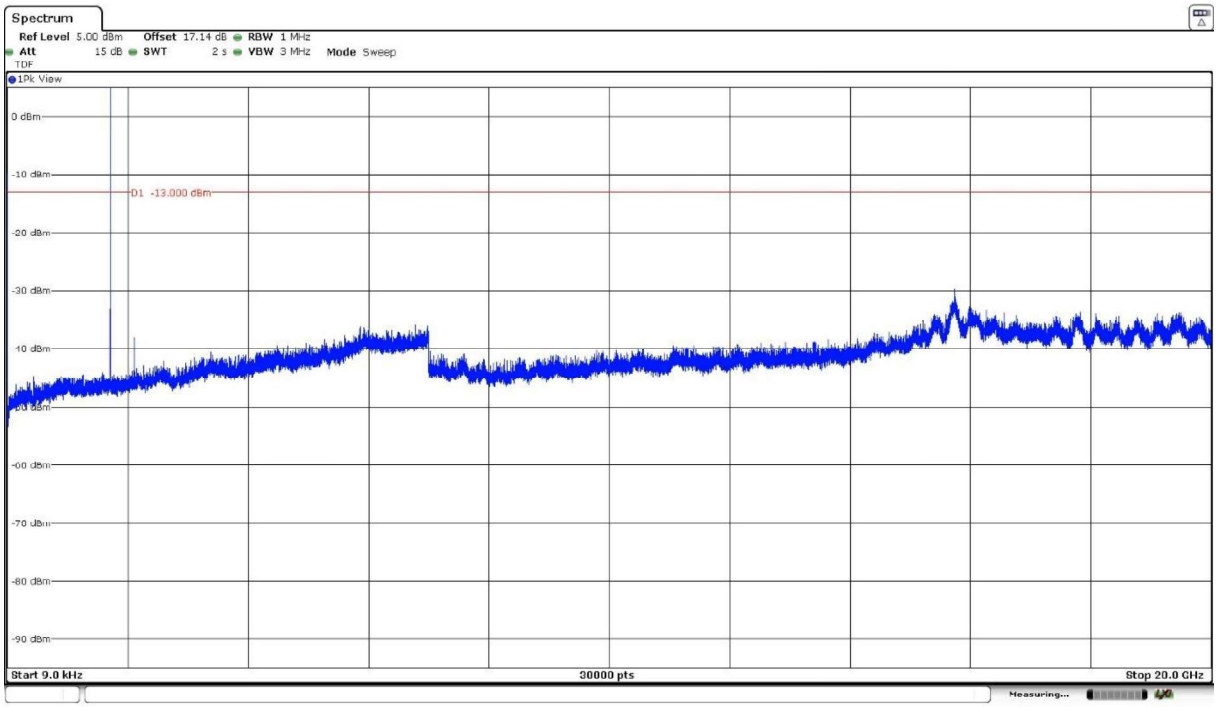
- Frequency range 793 MHz – 806 MHz



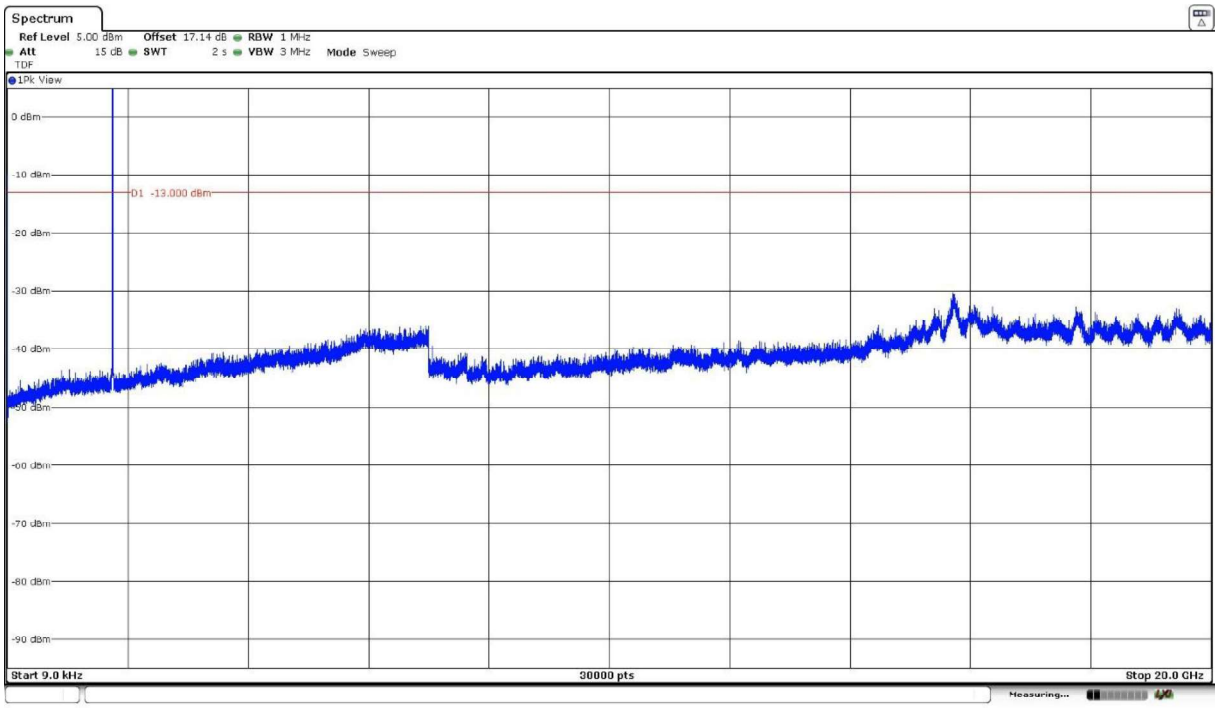
NBIoT Band 66.

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

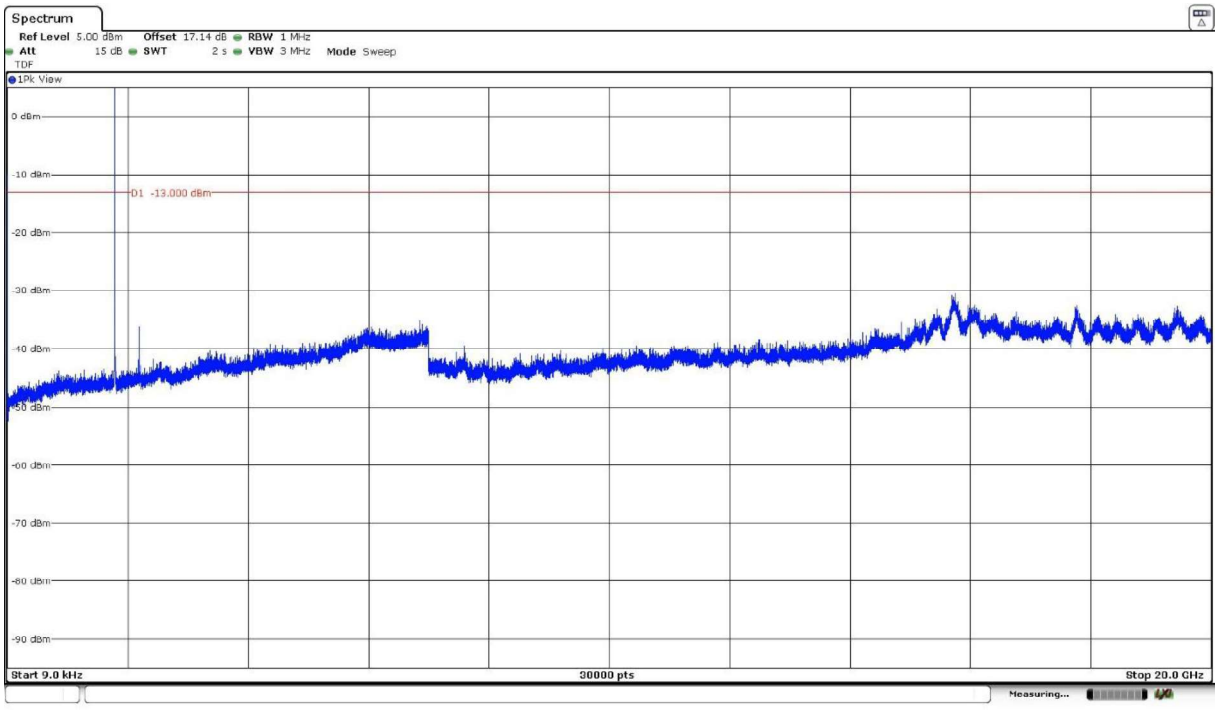
- Low Channel:



- Middle Channel:



- High Channel:



Spurious Emissions at Antenna Terminals at Block Edges

Limits

FCC §27.53 (c):

> On any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB.

FCC §27.53 (g):

> For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB.

RSS-130 Clause 4.7.1:

> The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least $43 + 10 \log_{10} p$ (watts), dB.

FCC §27.53 (h), RSS-139 Clause 6.6:

> According to specification, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10} (P)$ dB.

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 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.

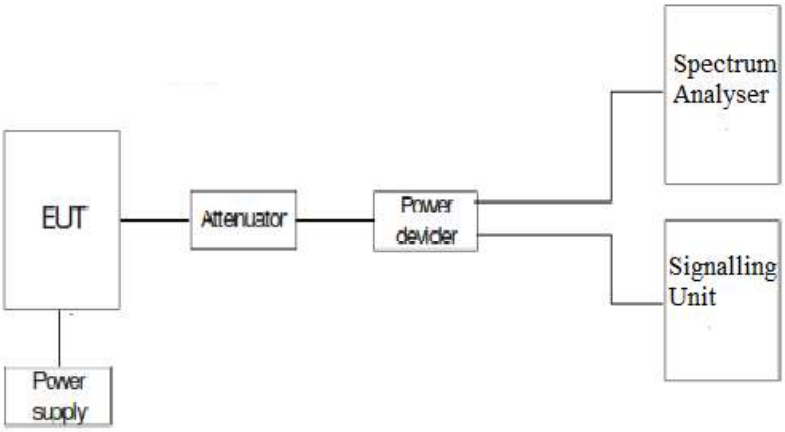
The configuration of modulation which is the worst case for conducted power was used. Lowest and highest channels were tested to show compliance with low and high block edges respectively.

For LTE Bands 4 and 66, as stated in FCC part 27.53 (h) (3) / RSS-139 Clause 6.6, in the 1 MHz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

For LTE Band 12, as stated in FCC part 27.53 (g) / RSS-130 Clause 4.7.1, in the 100 kHz bands immediately outside and adjacent to the licensee's frequency block or band, a resolution bandwidth of 30 kHz may be employed.

For LTE Band 13, as stated in FCC part 27.53 (c) (5) / RSS-130 Clause 4.7.1, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed.

Test setup



Results

NBIoT Band 4:

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

A preliminary measurement determined π/4 - QPSK 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 highest Block Edge at antenna port (dBm)
1 Tone 3.75 kHz, Offset Tone = 47 π/4 - QPSK	-31.39
1 Tone 15 kHz, Offset Tone =11 π/4 - QPSK	-29.49
12 Tones 15kHz, Offset Tone = 0 π/4 - QPSK	-28.36

Verdict

Pass

NBIoT Band 12:

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	-32.23
1 Tone 15 kHz, Offset Tone = 0 π/2 - BPSK	-27.38
12 Tones 15kHz, Offset Tone = 0 π/4 - QPSK	-22.85

NBIoT configuration	Maximum measured level at highest Block Edge at antenna port (dBm)
1 Tone 3.75 kHz, Offset Tone = 47 π/4 - QPSK	-30.94
1 Tone 15 kHz, Offset Tone = 11 π/2 - BPSK	-29.93
12 Tones 15kHz, Offset Tone = 0 π/4 - QPSK	-24.16

Verdict

Pass

NBIoT Band 13:

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	-34.71
1 Tone 15 kHz, Offset Tone = 0 π/2 - BPSK	-30.05
12 Tones 15kHz, Offset Tone = 0 π/4 - QPSK	-23.95

NBIoT configuration	Maximum measured level at highest Block Edge at antenna port (dBm)
1 Tone 3.75 kHz, Offset Tone = 47 π/4 - QPSK	-30.98
1 Tone 15 kHz, Offset Tone = 11 π/2 - BPSK	-28.97
12 Tones 15kHz, Offset Tone = 0 π/4 - QPSK	-22.49

Verdict

Pass

NBIoT Band 66:

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

A preliminary measurement determined π/4 - QPSK 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	-33.37
1 Tone 15 kHz, Offset Tone = 0 π/4 - QPSK	-26.02
12 Tones 15kHz, Offset Tone = 0 π/4 - QPSK	-28.45

NBIoT configuration	Maximum measured level at highest Block Edge at antenna port (dBm)
1 Tone 3.75 kHz, Offset Tone = 47 π/4 - QPSK	-32.10
1 Tone 15 kHz, Offset Tone = 11 π/4 - QPSK	-25.79
12 Tones 15kHz, Offset Tone = 0 π/4 - QPSK	-27.99

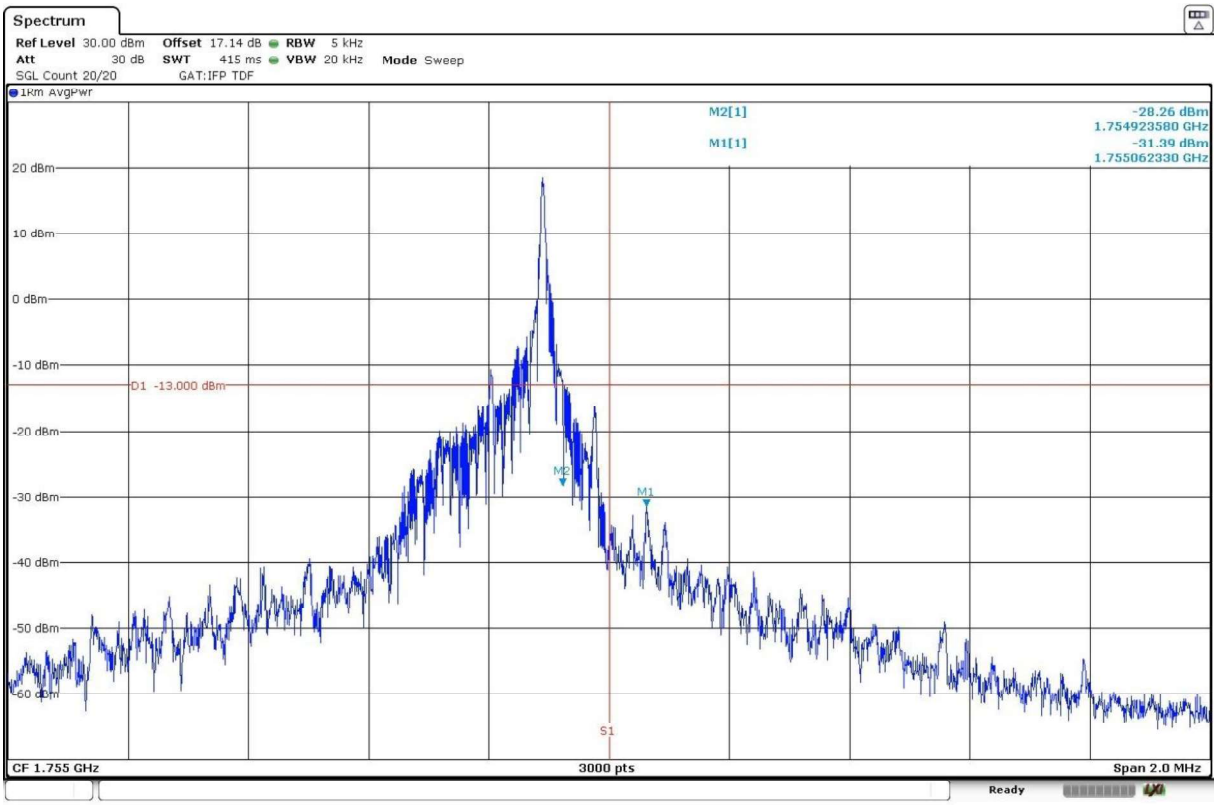
Verdict

Pass

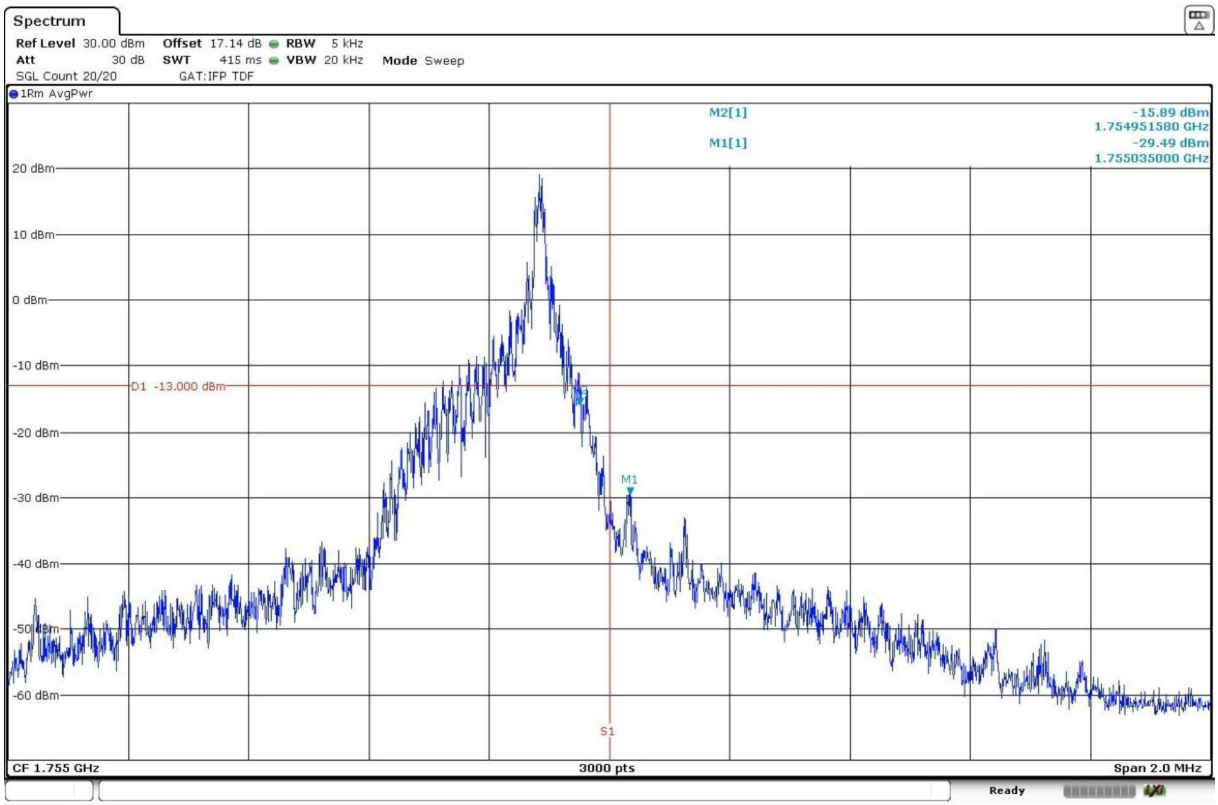
Attachments

NBIoT Band 4.

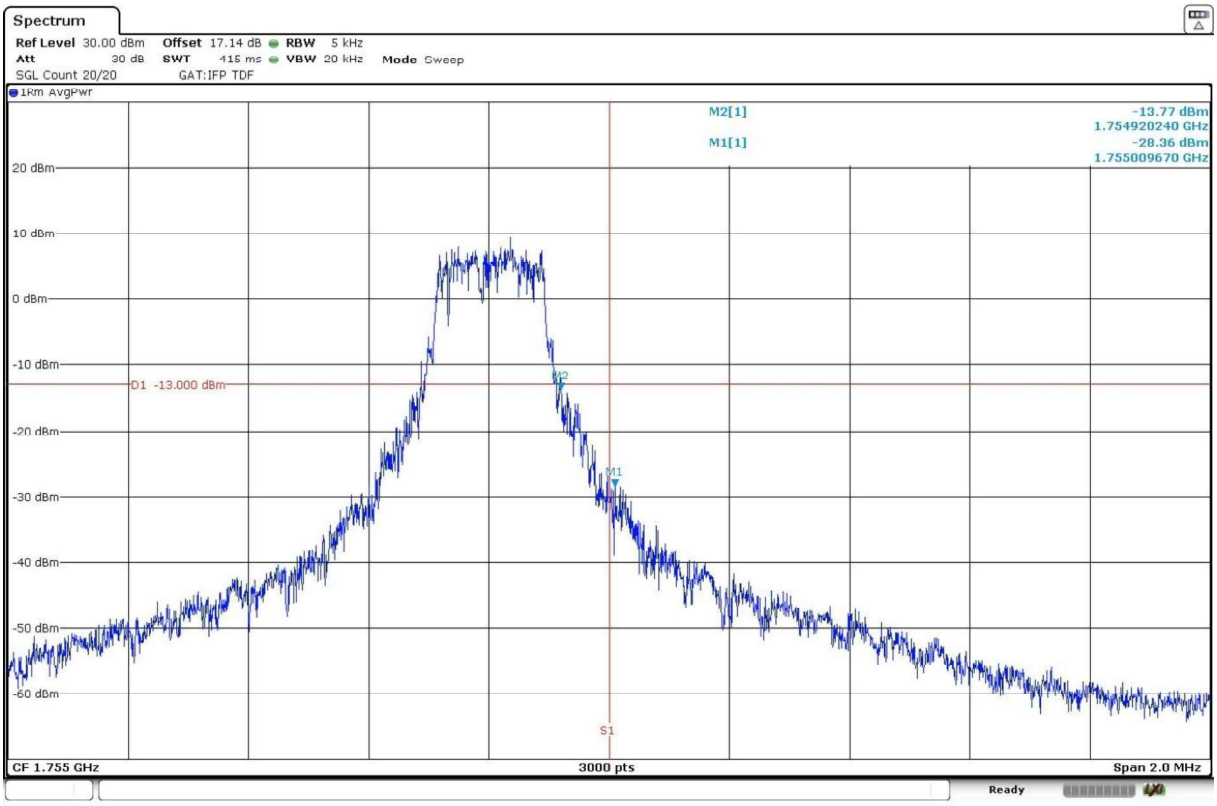
1 Tone 3.75 kHz, Offset Tone = 47. π/4 - QPSK modulation. High Block Edge:



1 Tone 15 kHz, Offset Tone = 11. π/4 - QPSK modulation. High Block Edge:

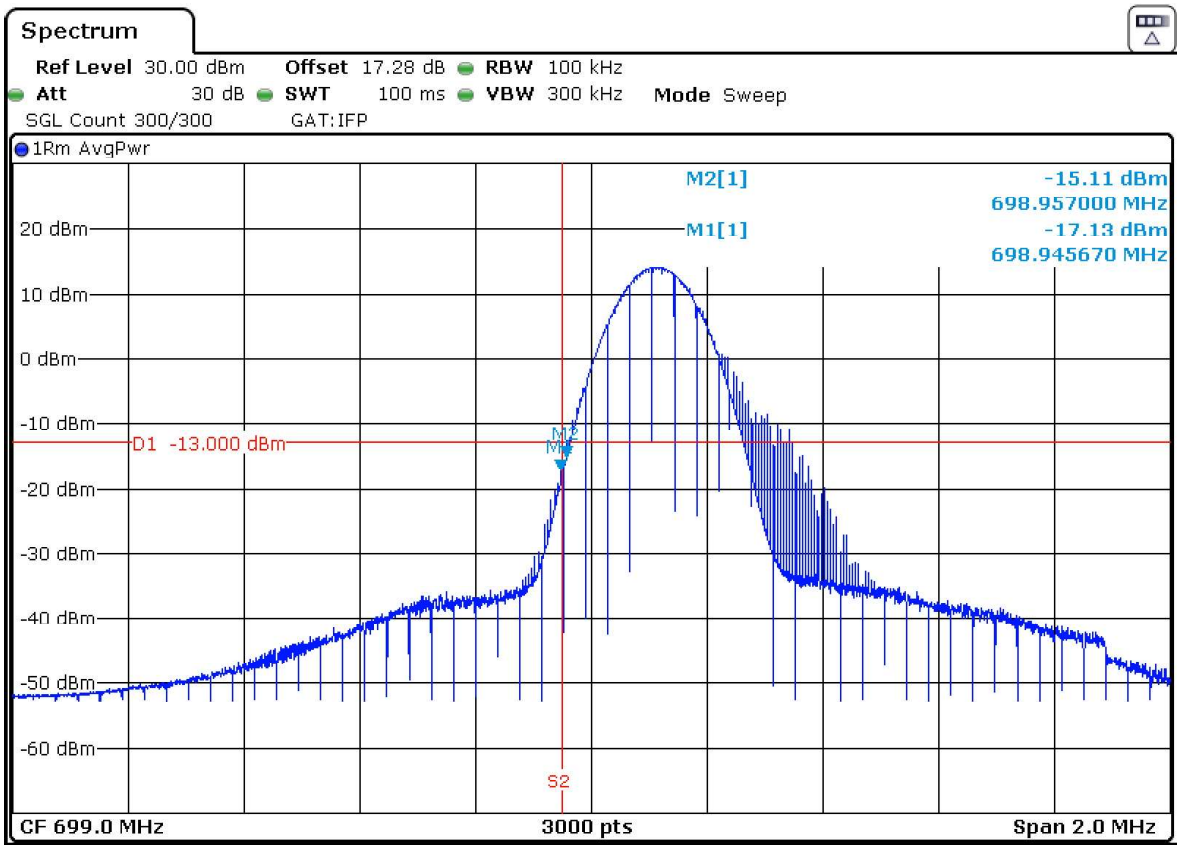


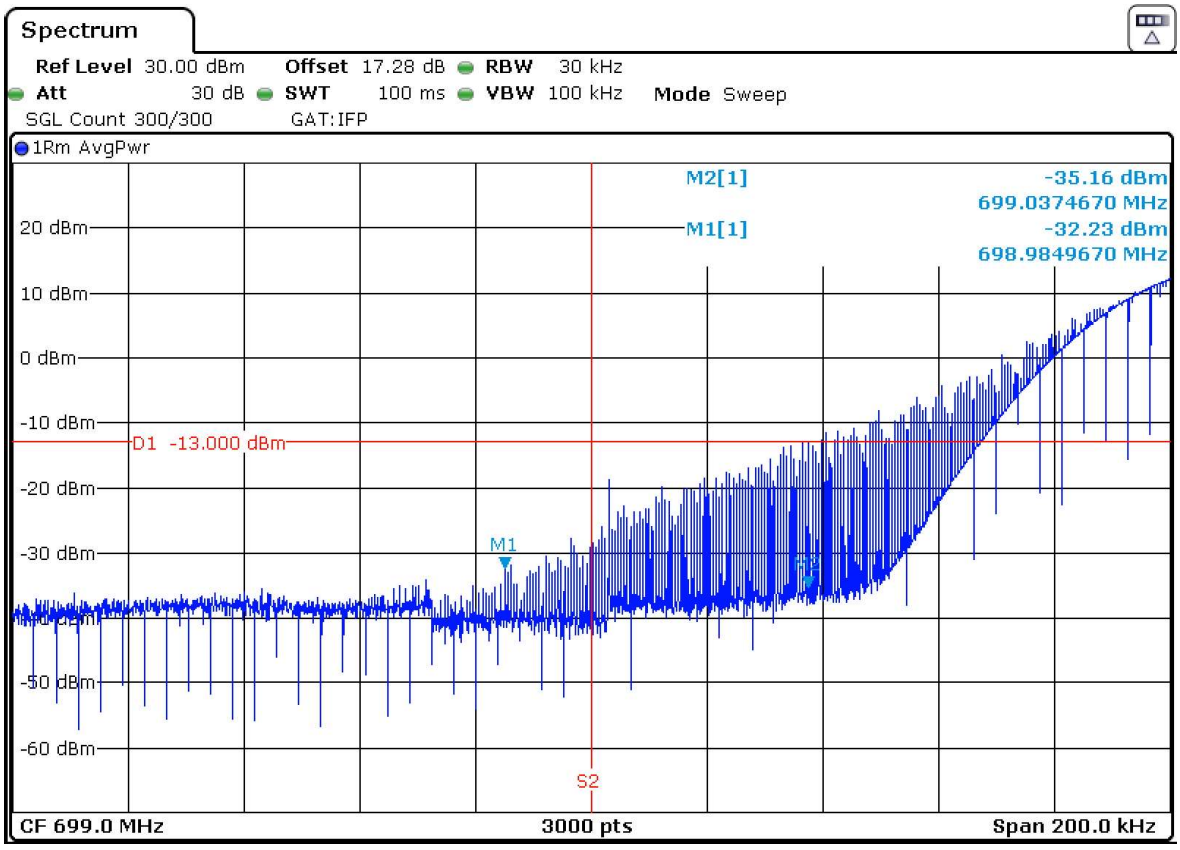
12 Tones 15 kHz, Offset Tone = 0. π/4 - QPSK modulation. High Block Edge:



NBIoT Band 12.

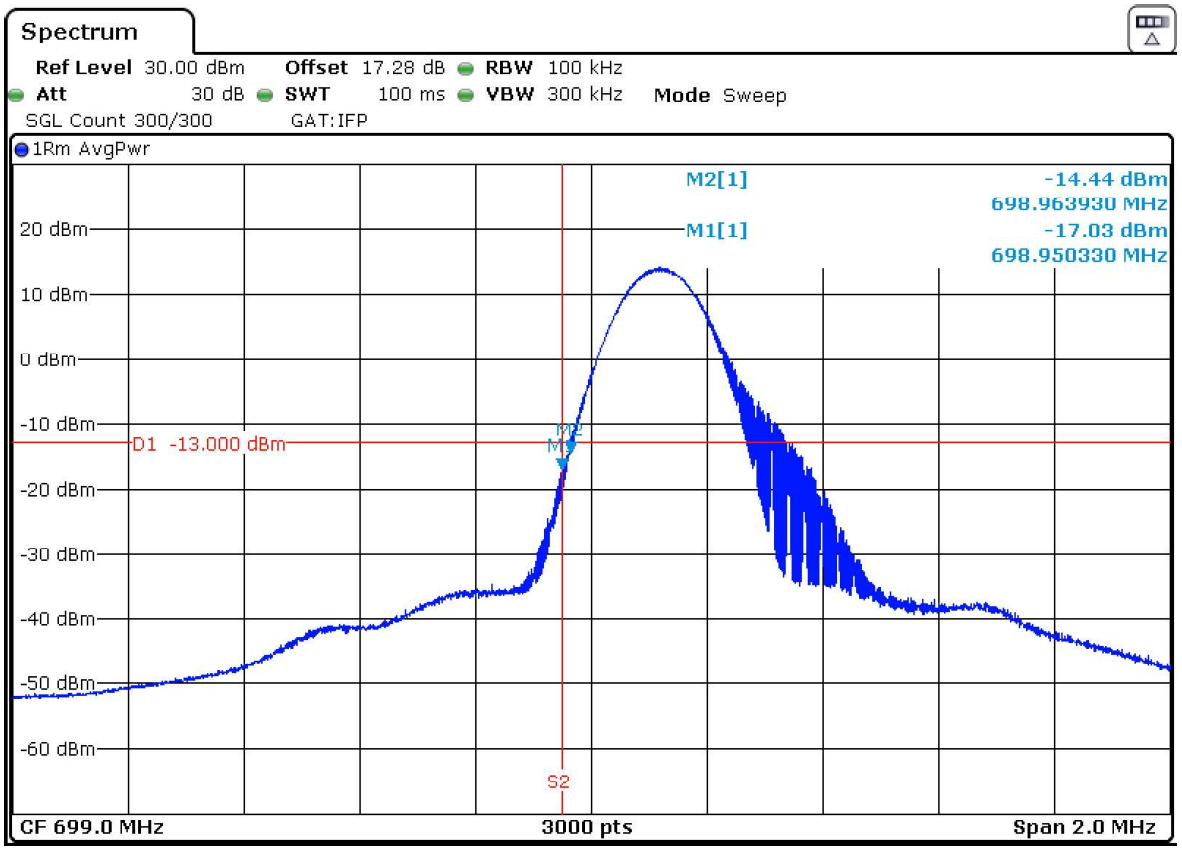
1 Tone 3.75 kHz, Offset Tone = 0. π/4 - QPSK modulation. Low Block Edge:

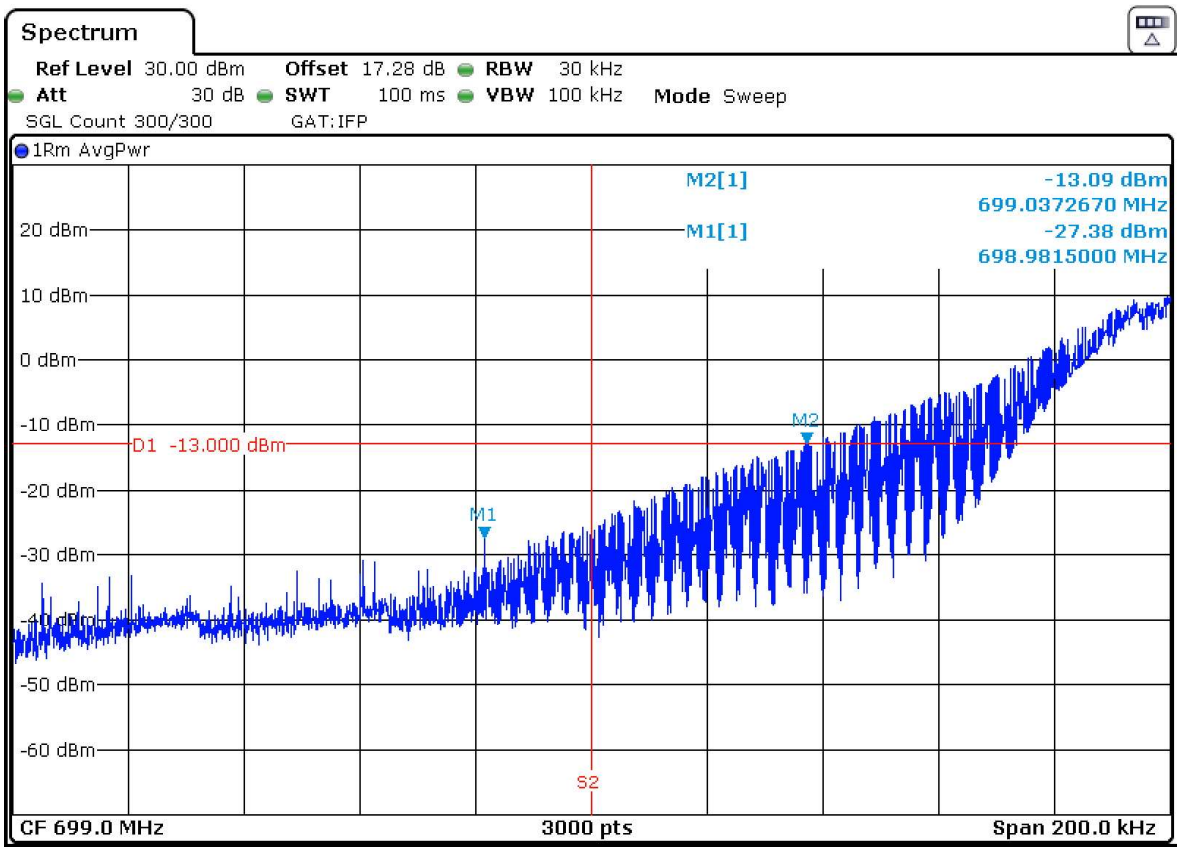




NOTE: Zoom (100kHz) with RBW=30kHz.

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





NOTE: Zoom (100kHz) with RBW=30kHz.