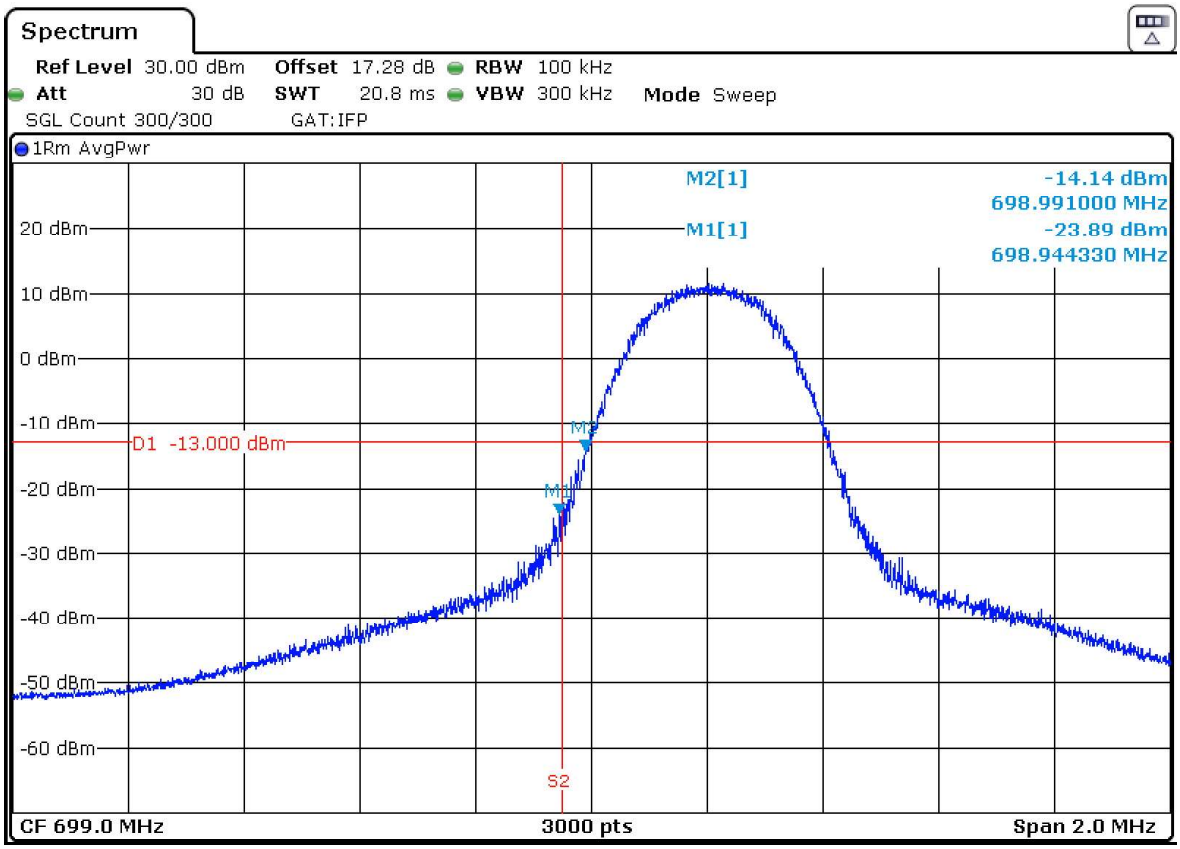
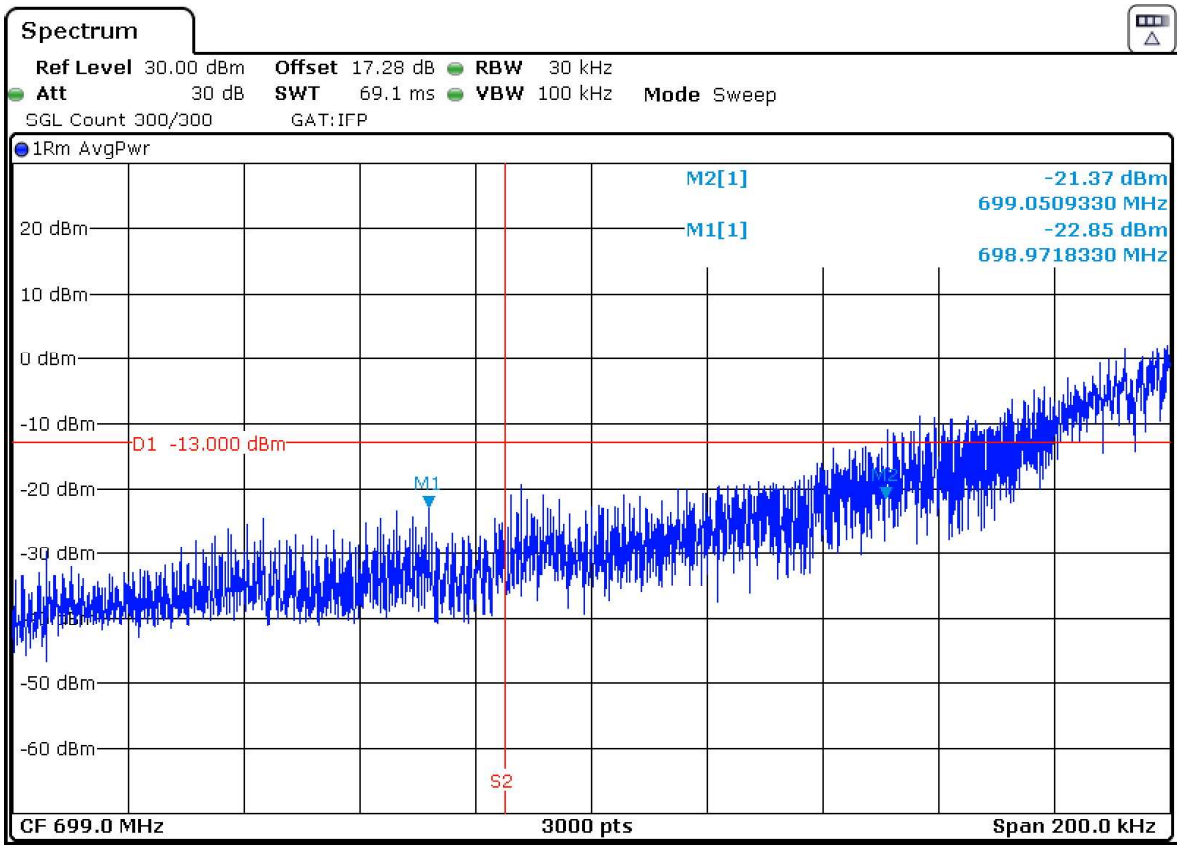
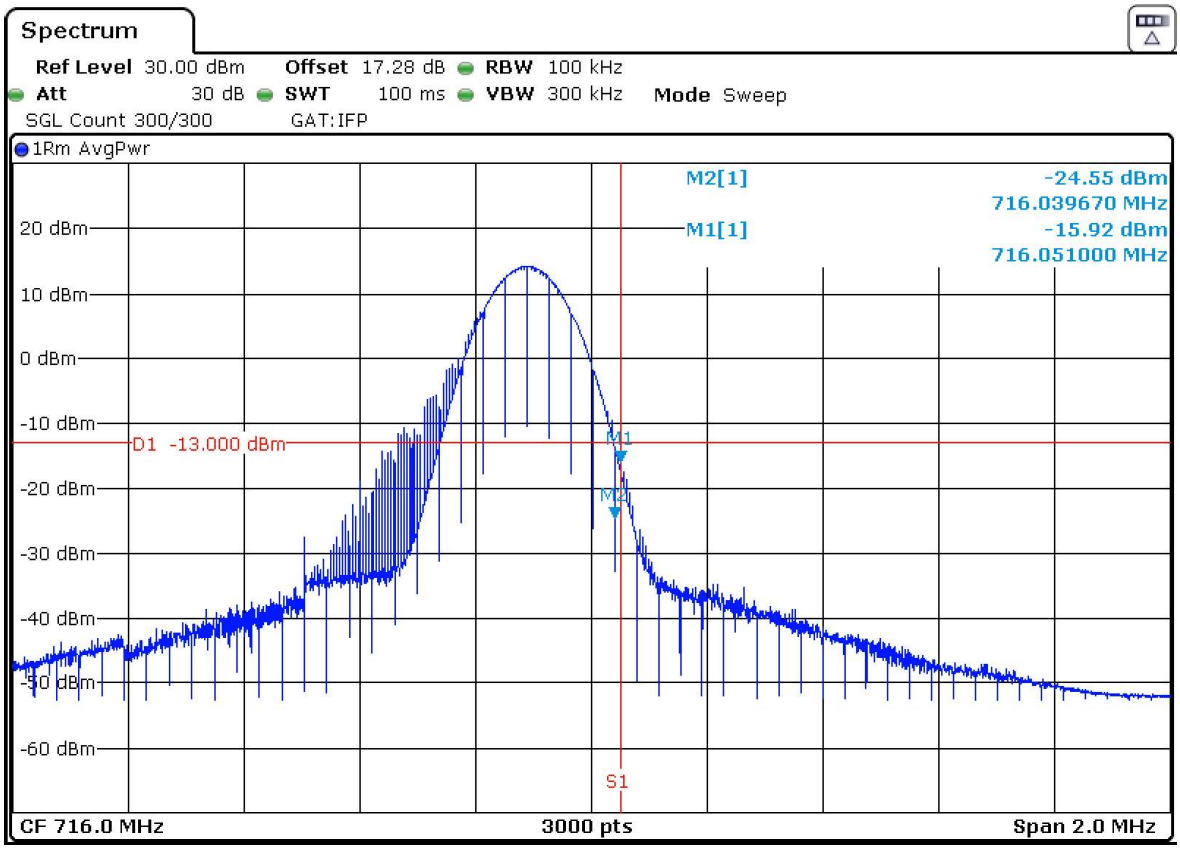
12 Tones 15 kHz, Offset Tone = 0. π/4 - QPSK modulation. Low Block Edge:

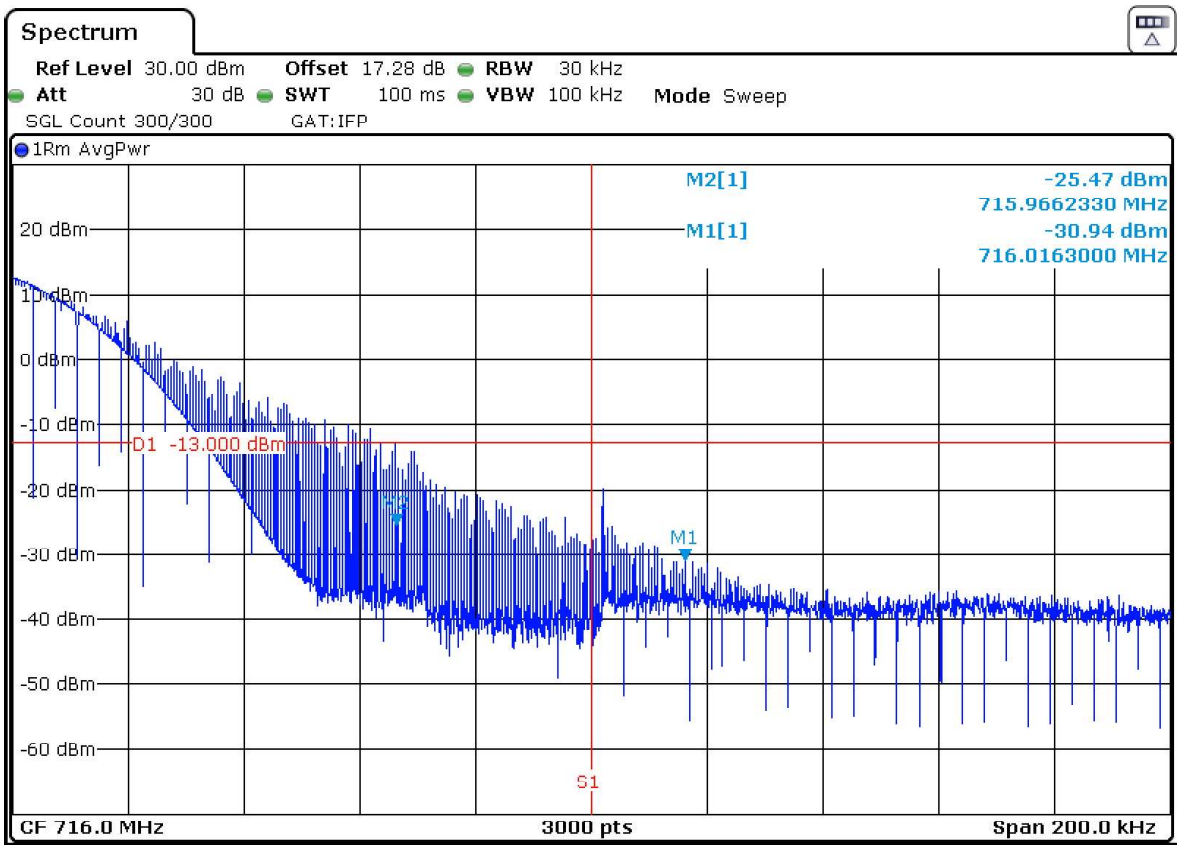




NOTE: Zoom (100kHz) with RBW=30kHz.

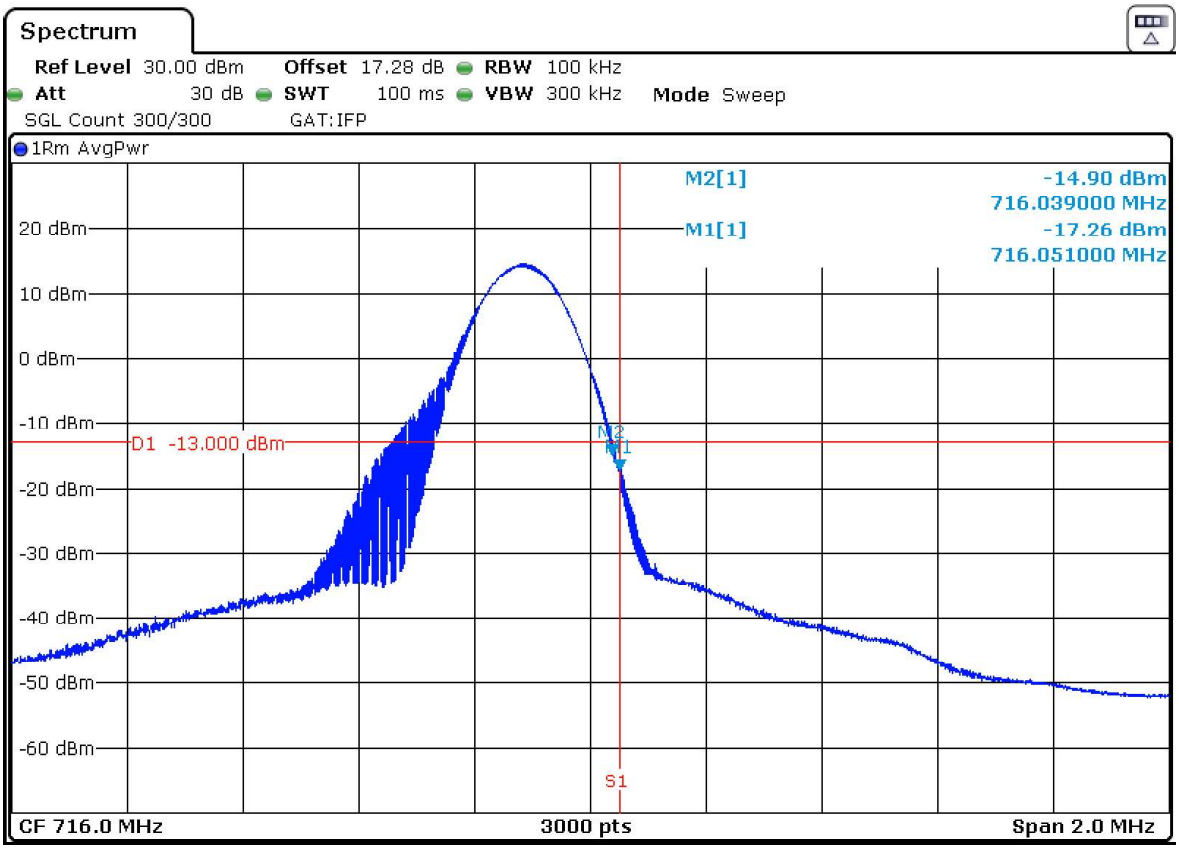
1 Tone 3.75 kHz, Offset Tone = 47. π/4 - QPSK modulation. High Block Edge:

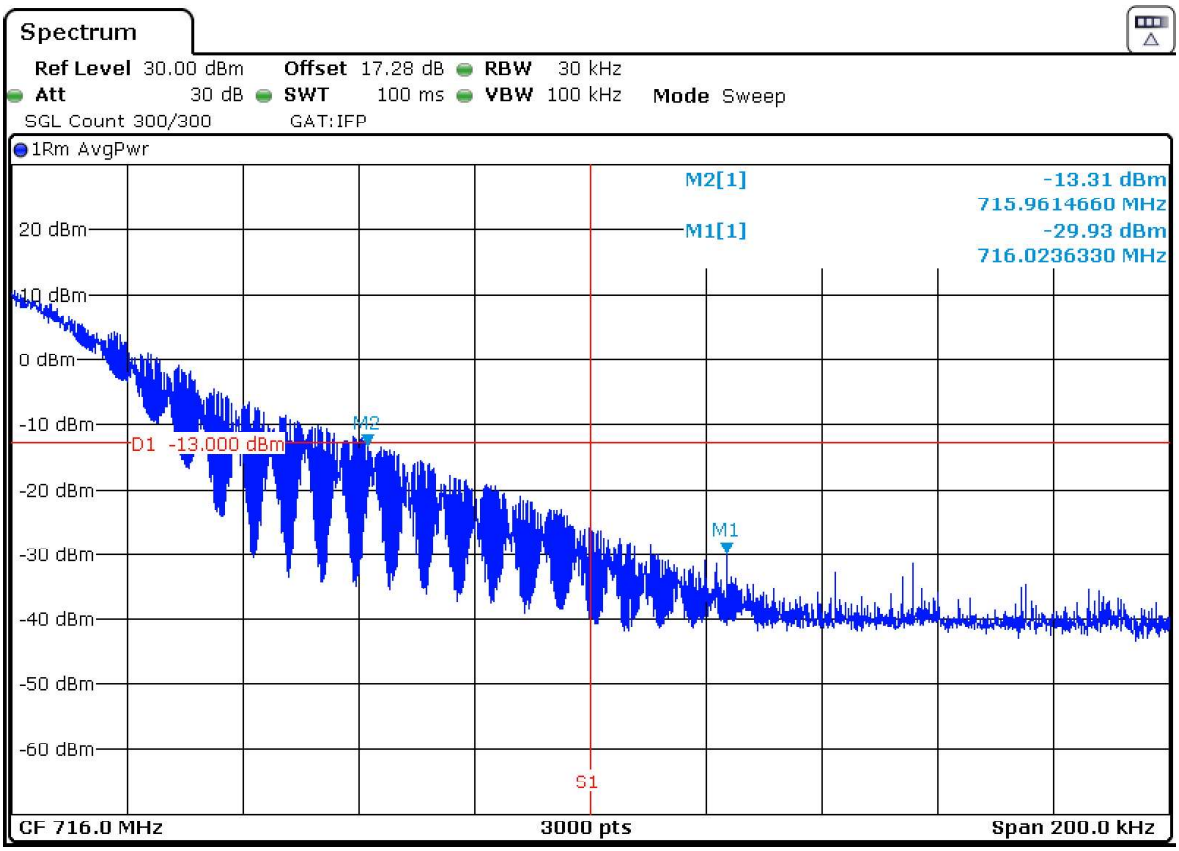




NOTE: Zoom (100kHz) with RBW=30kHz.

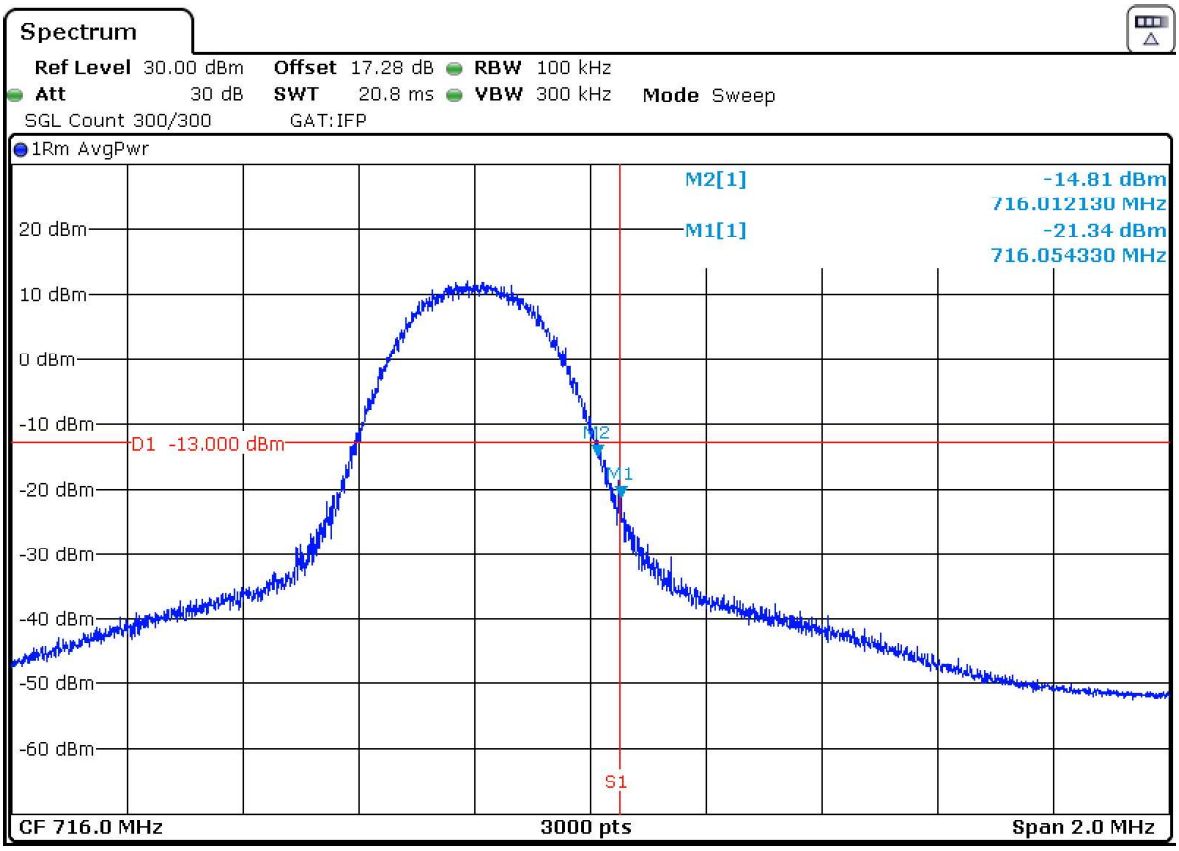
1 Tone 15 kHz, Offset Tone = 11. π/2 - BPSK modulation. High Block Edge:

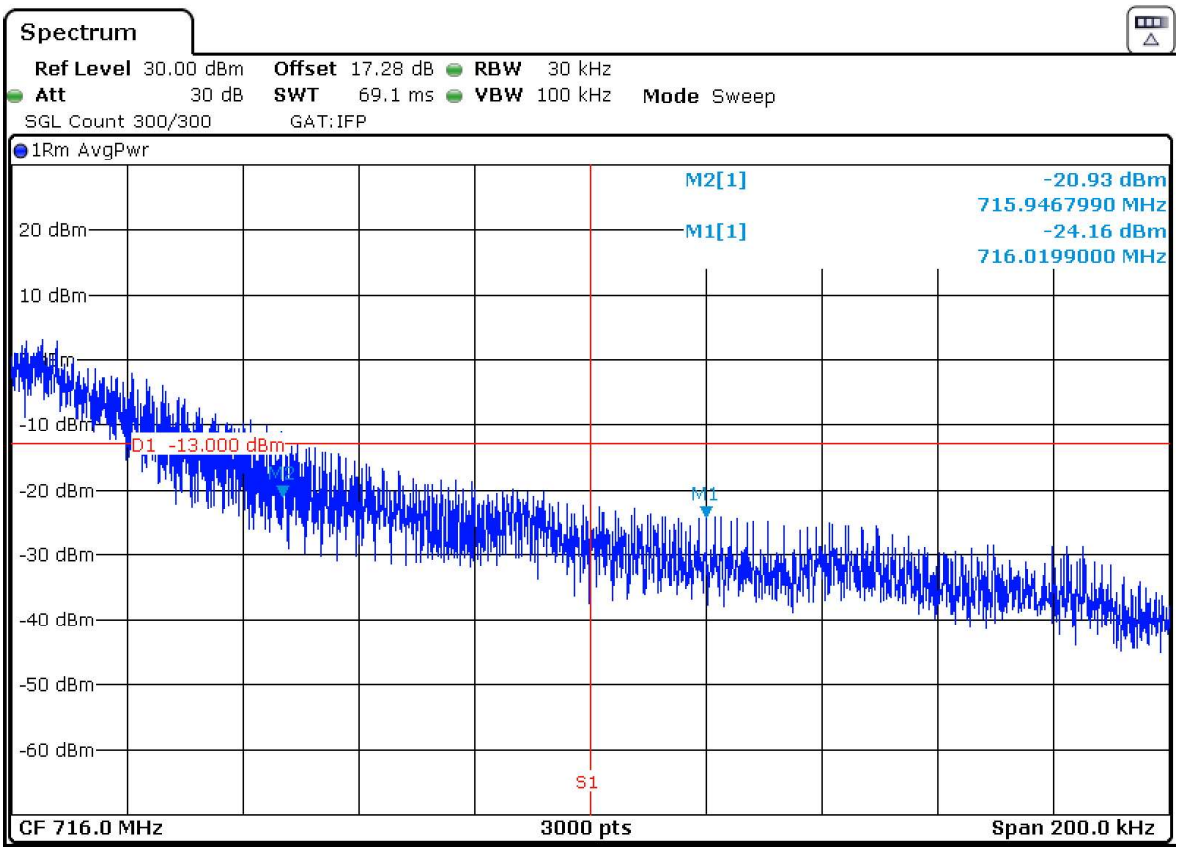




NOTE: Zoom (100kHz) with RBW=30kHz.

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

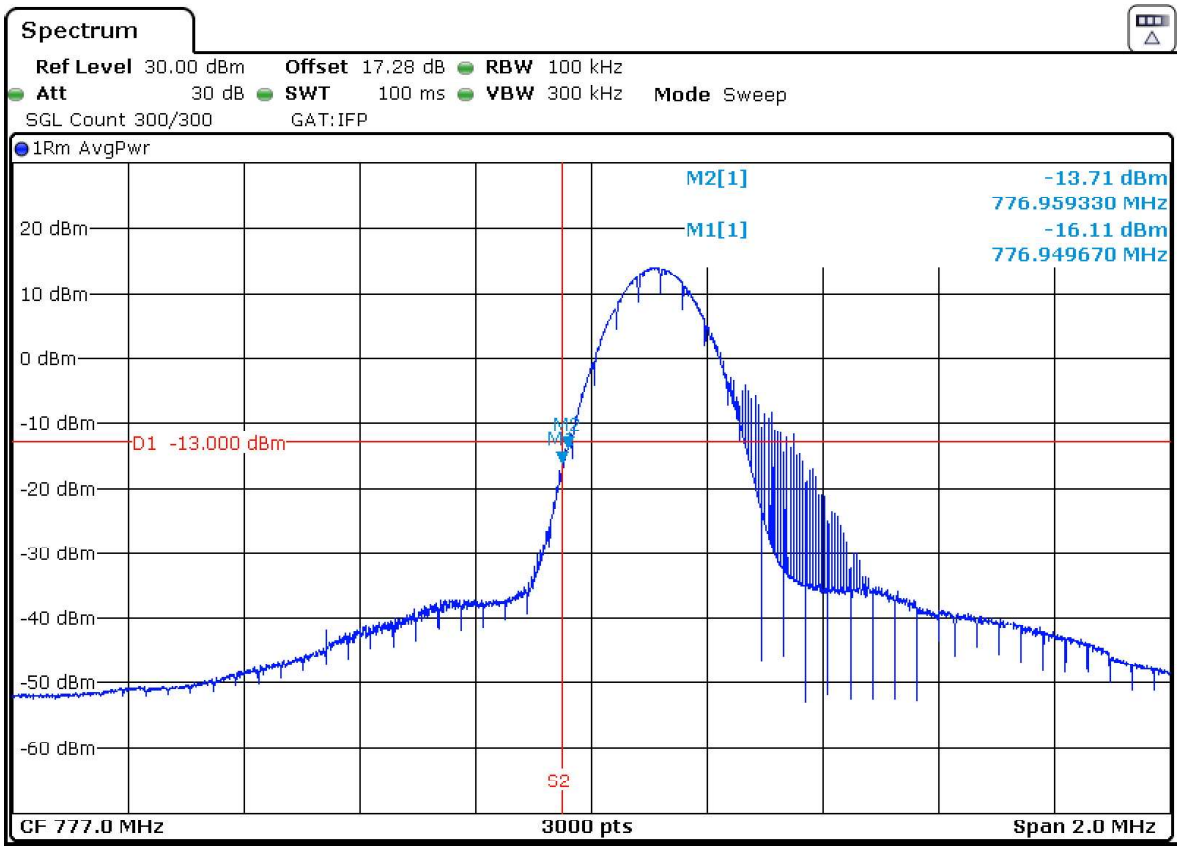


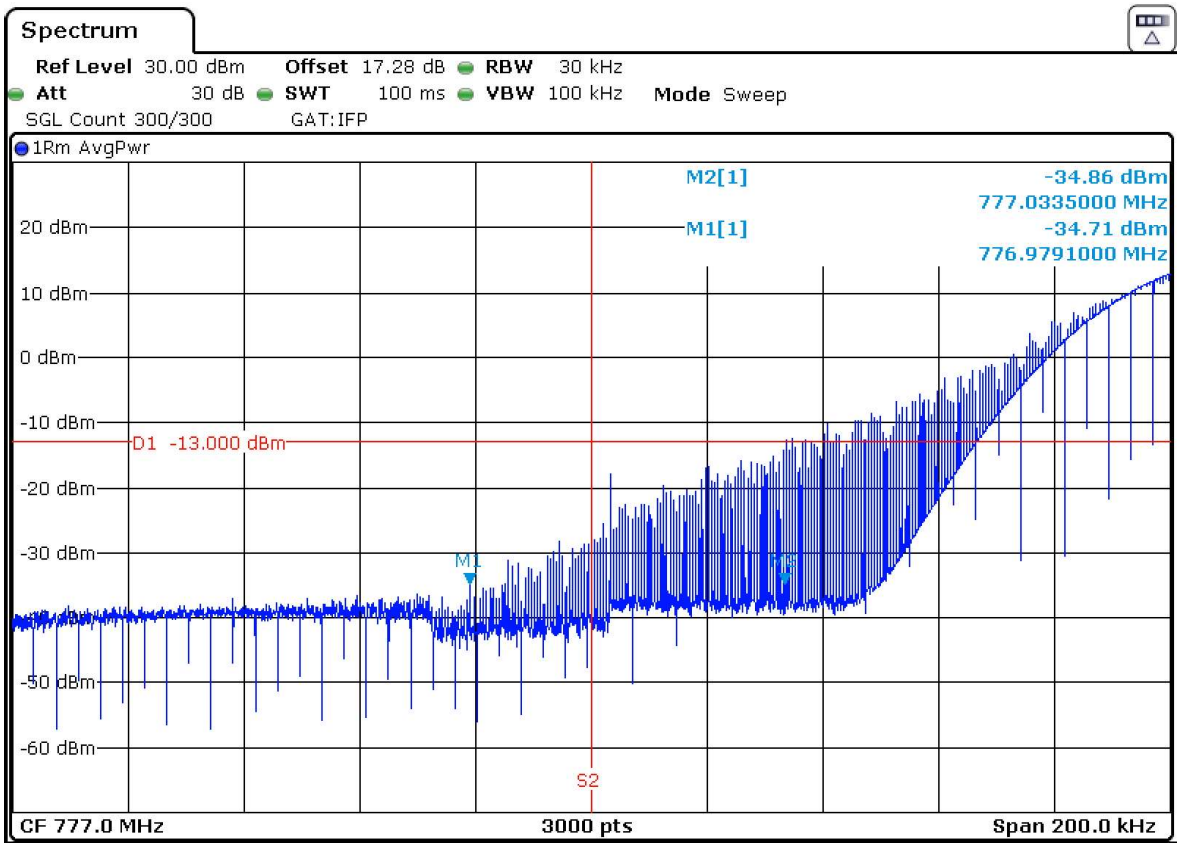


NOTE: Zoom (100kHz) with RBW=30kHz.

NBIoT Band 13.

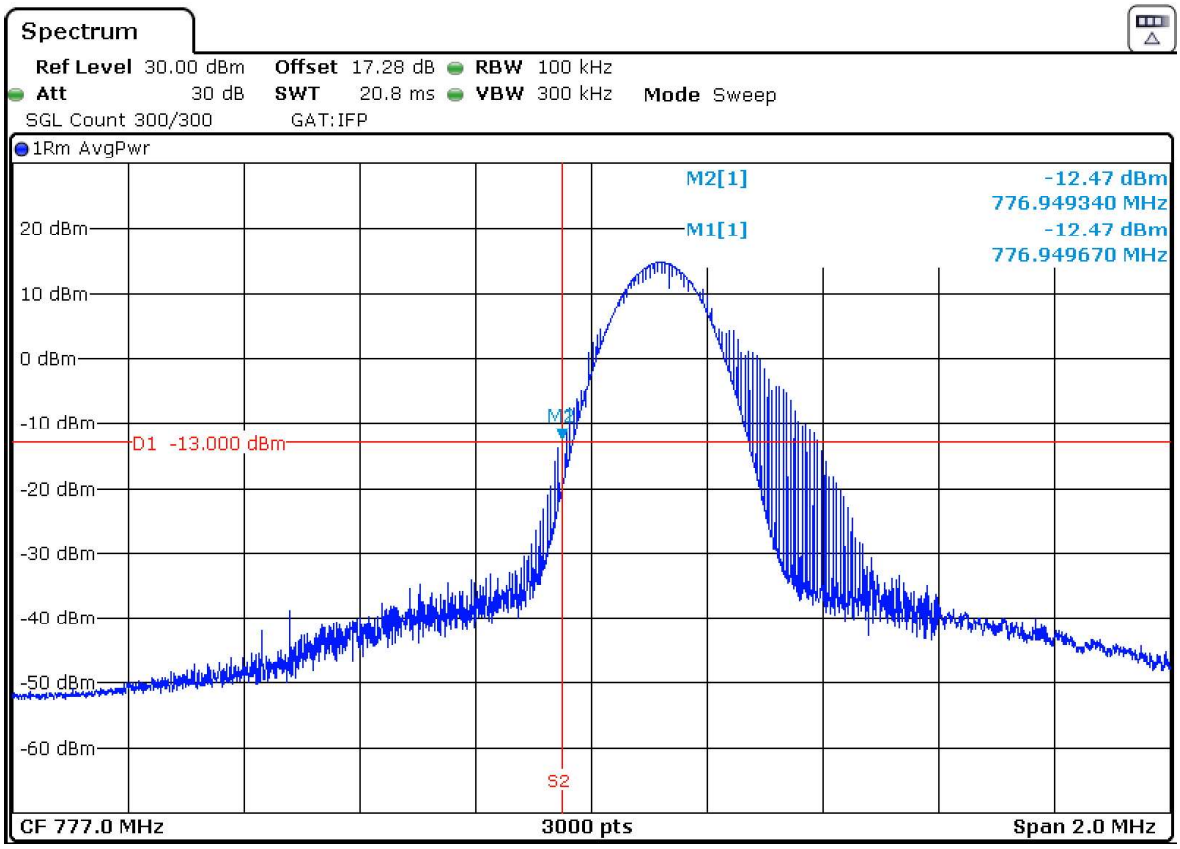
1 Tone 3.75 kHz, Offset Tone = 0. π/4 - QPSK modulation. Low Block Edge:

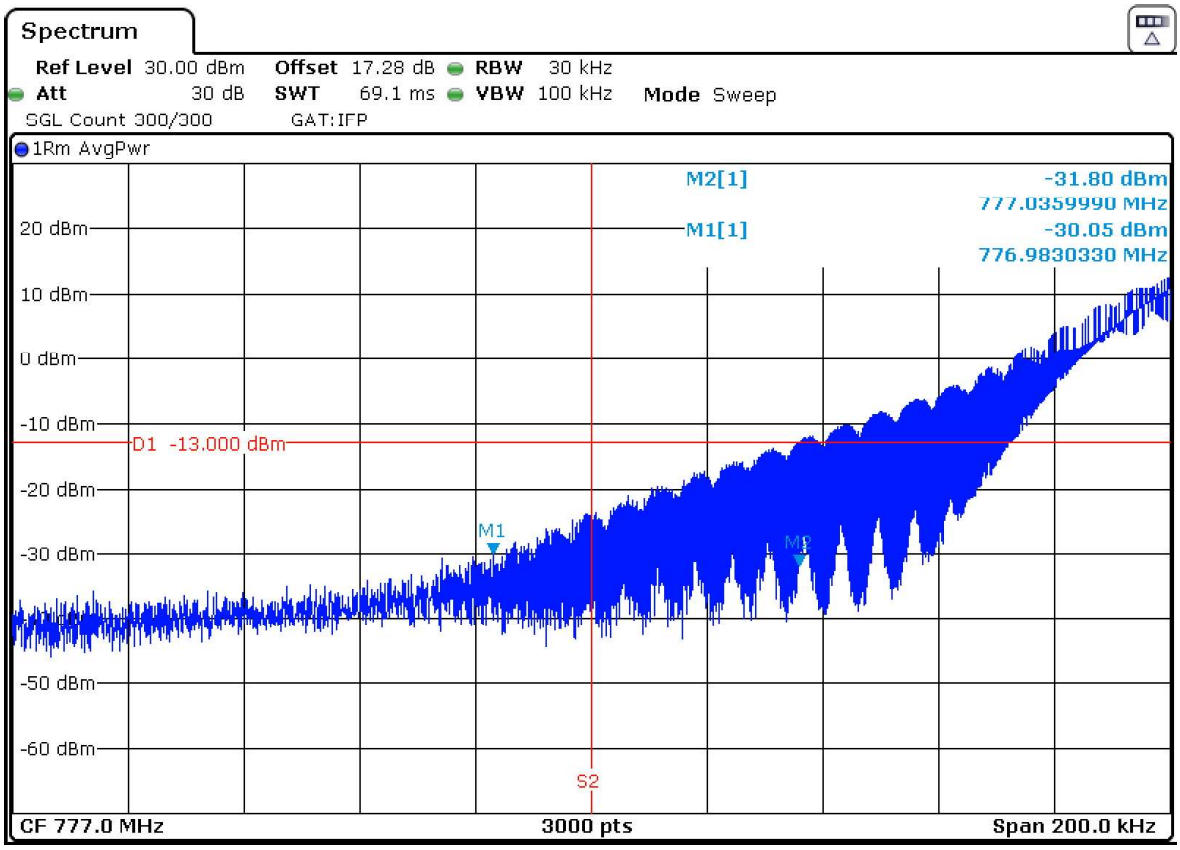




NOTE: Zoom (100kHz) with RBW=30kHz.

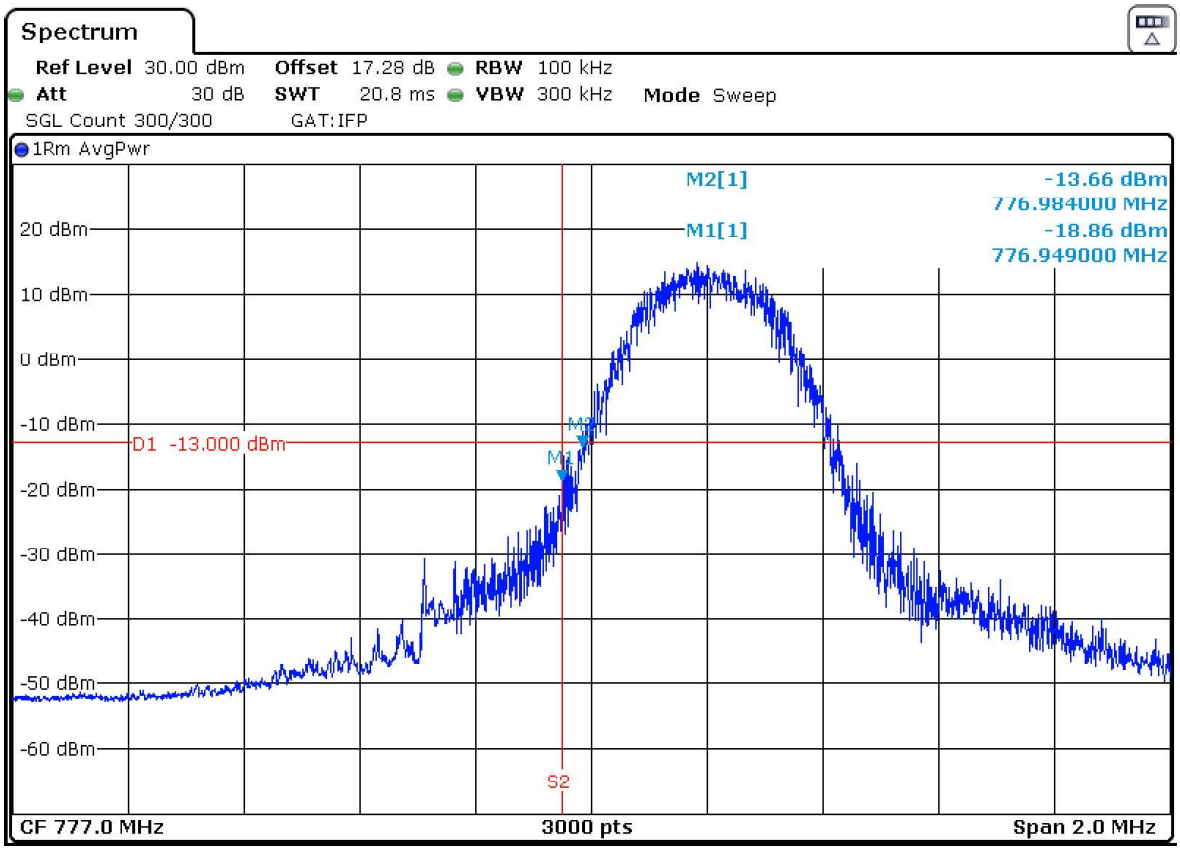
1 Tone 15 kHz, Offset Tone = 0. π/2 - BPSK modulation. Low Block Edge:

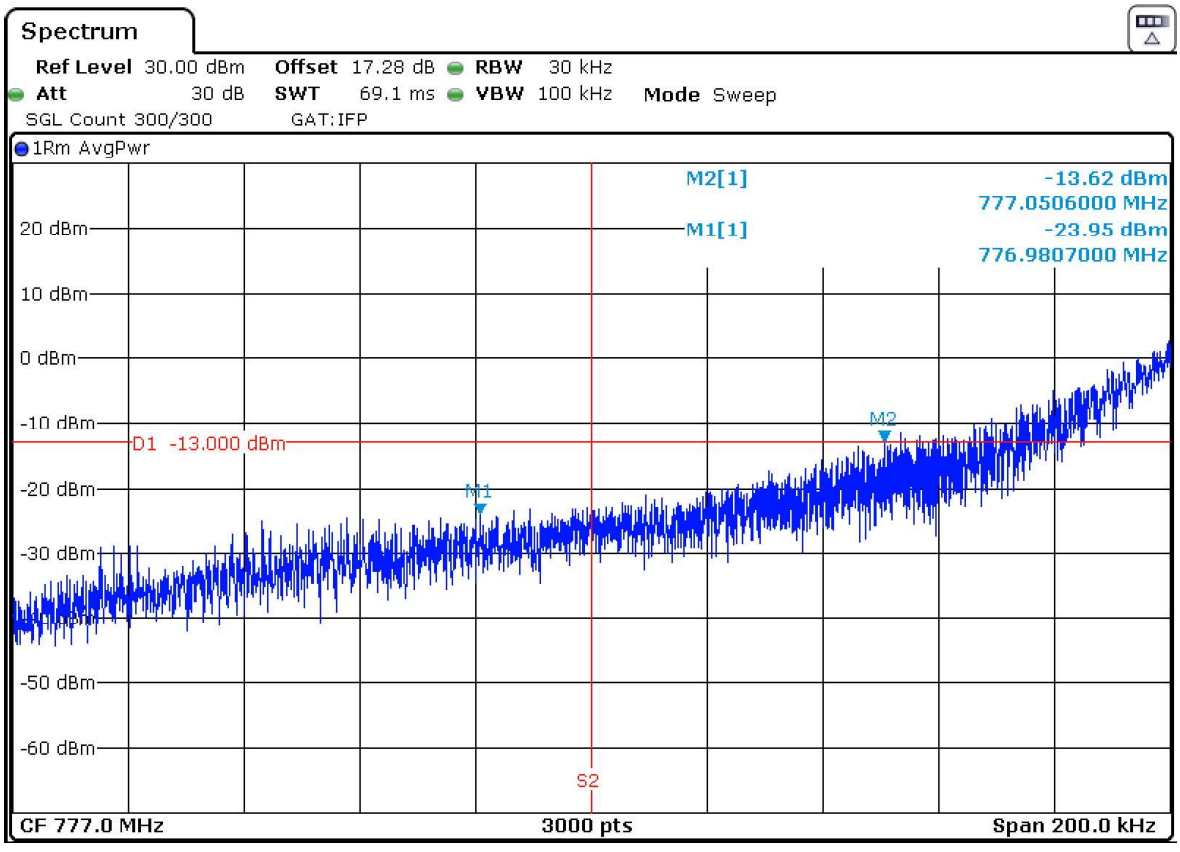




NOTE: Zoom (100kHz) with RBW=30kHz.

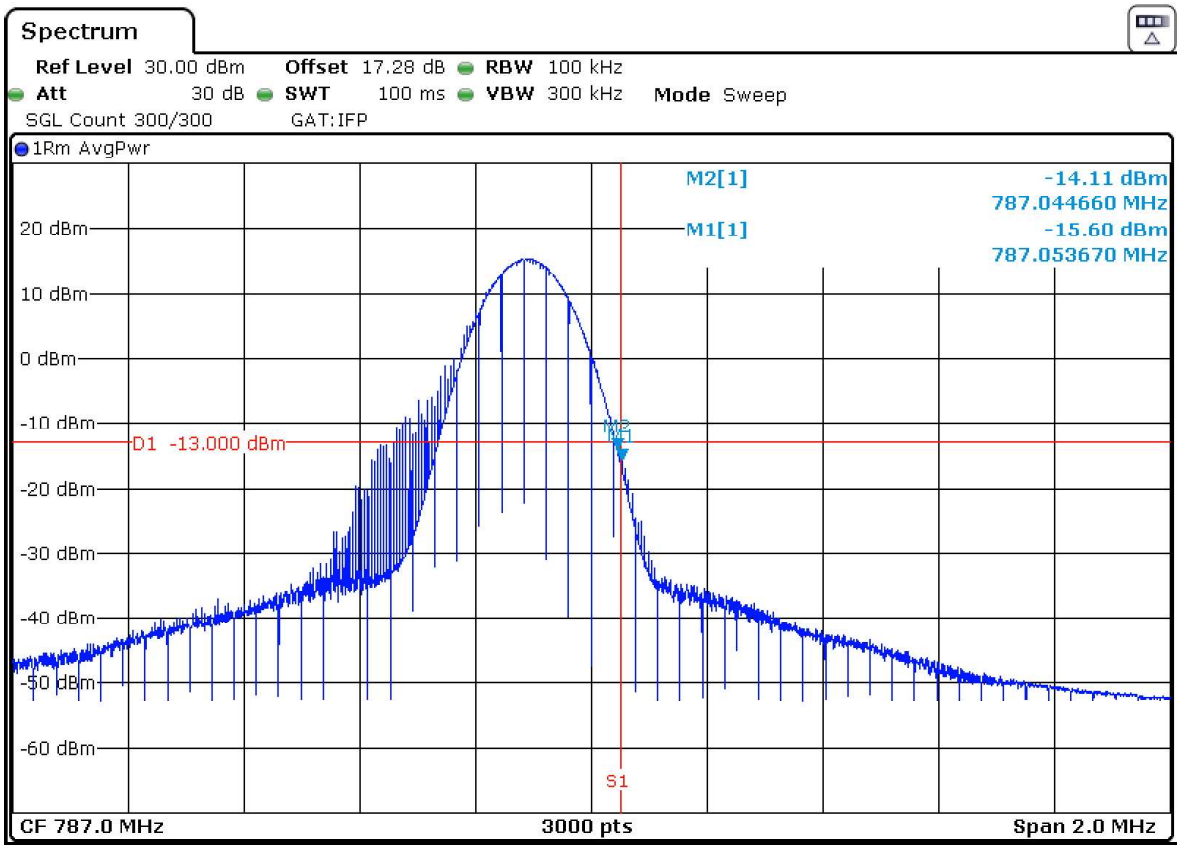
12 Tones 15 kHz, Offset Tone = 0. π/4 - QPSK modulation. Low Block Edge:

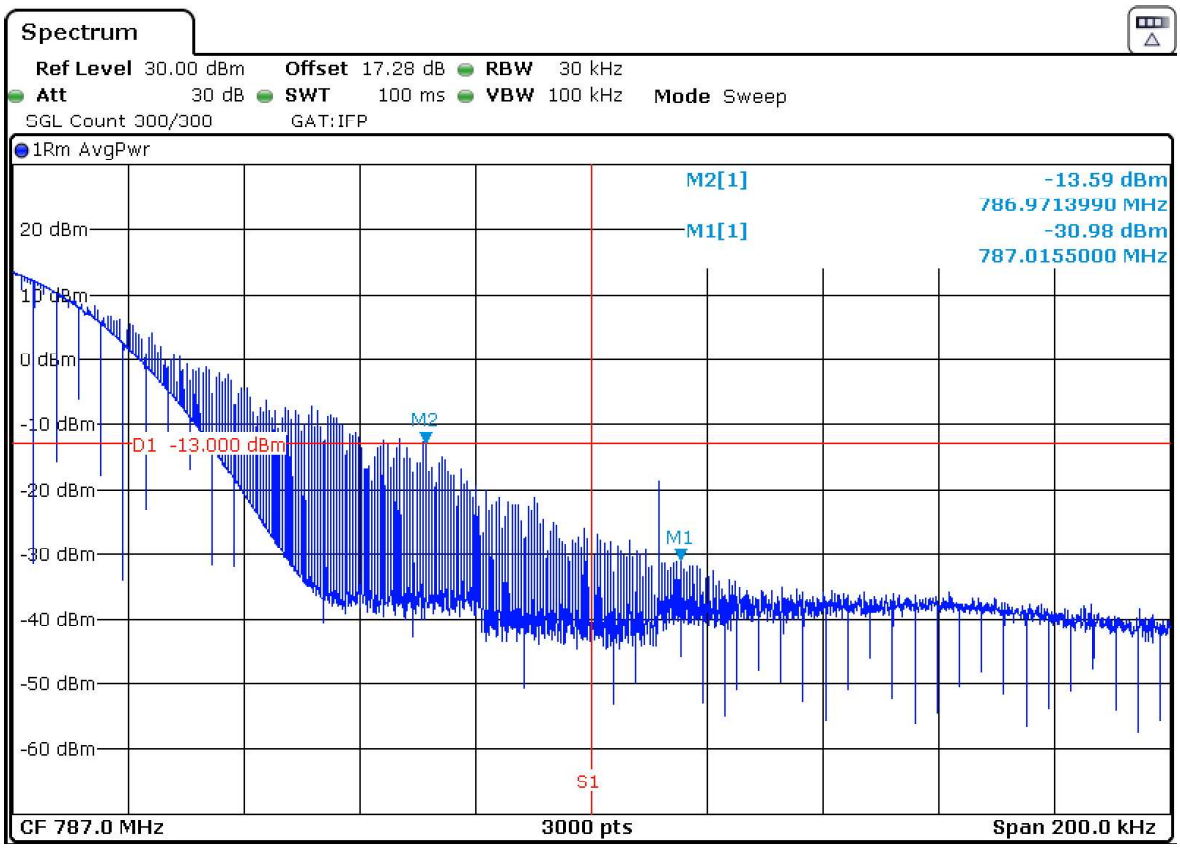




NOTE: Zoom (100kHz) with RBW=30kHz.

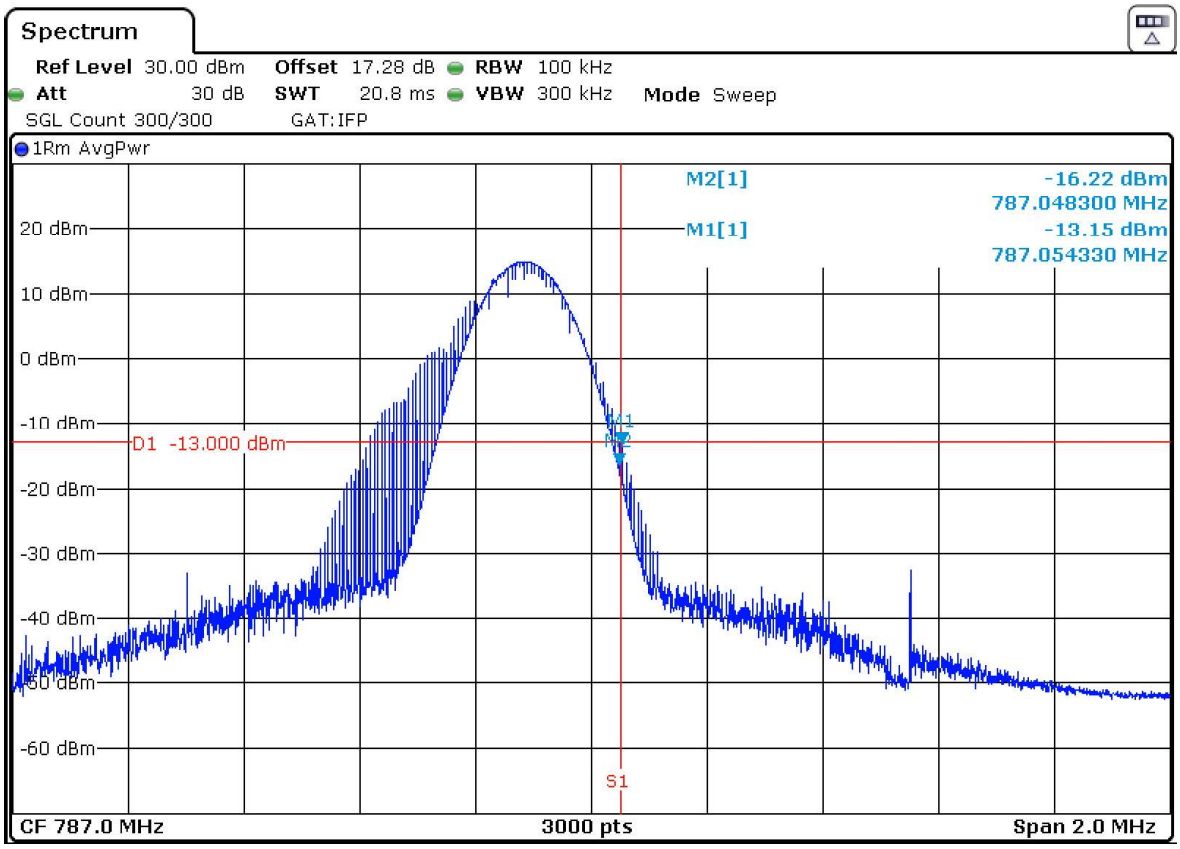
1 Tone 3.75 kHz, Offset Tone = 47. π/4 - QPSK modulation. High Block Edge:

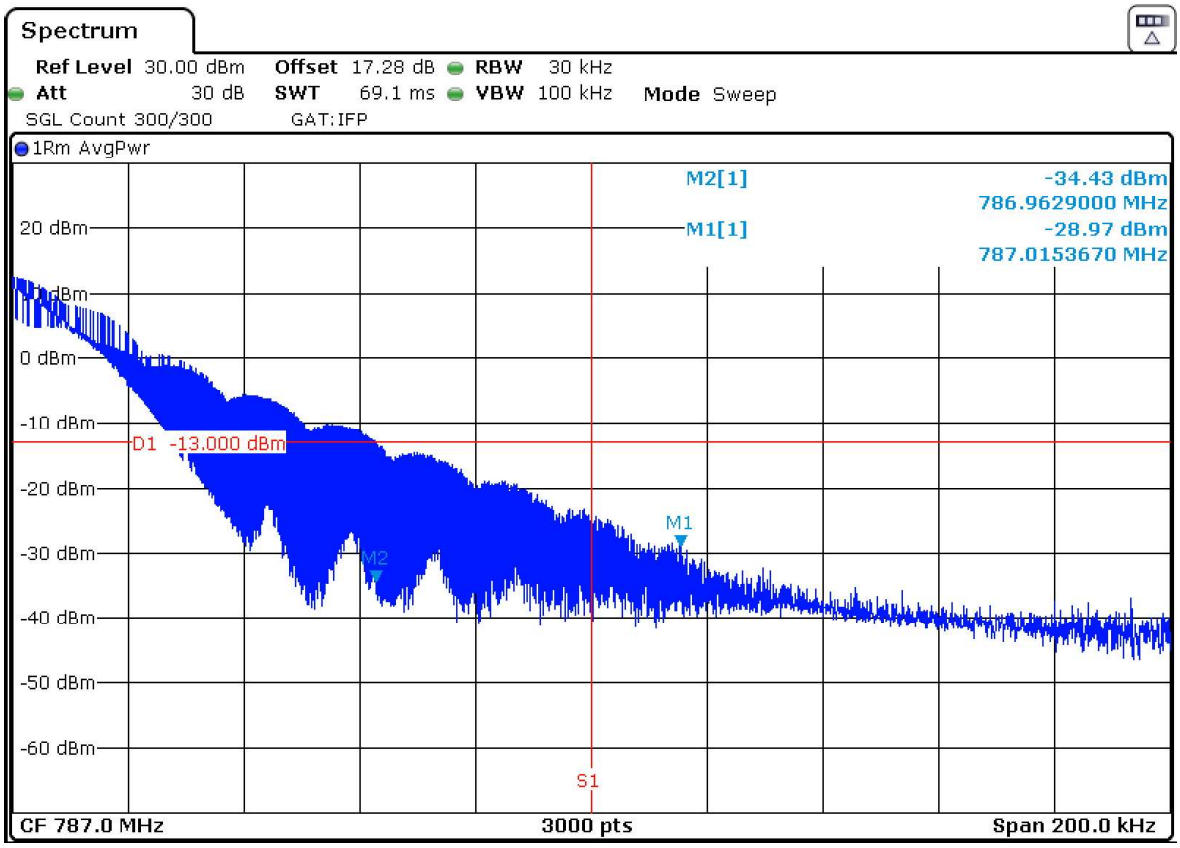




NOTE: Zoom (100kHz) with RBW=30kHz.

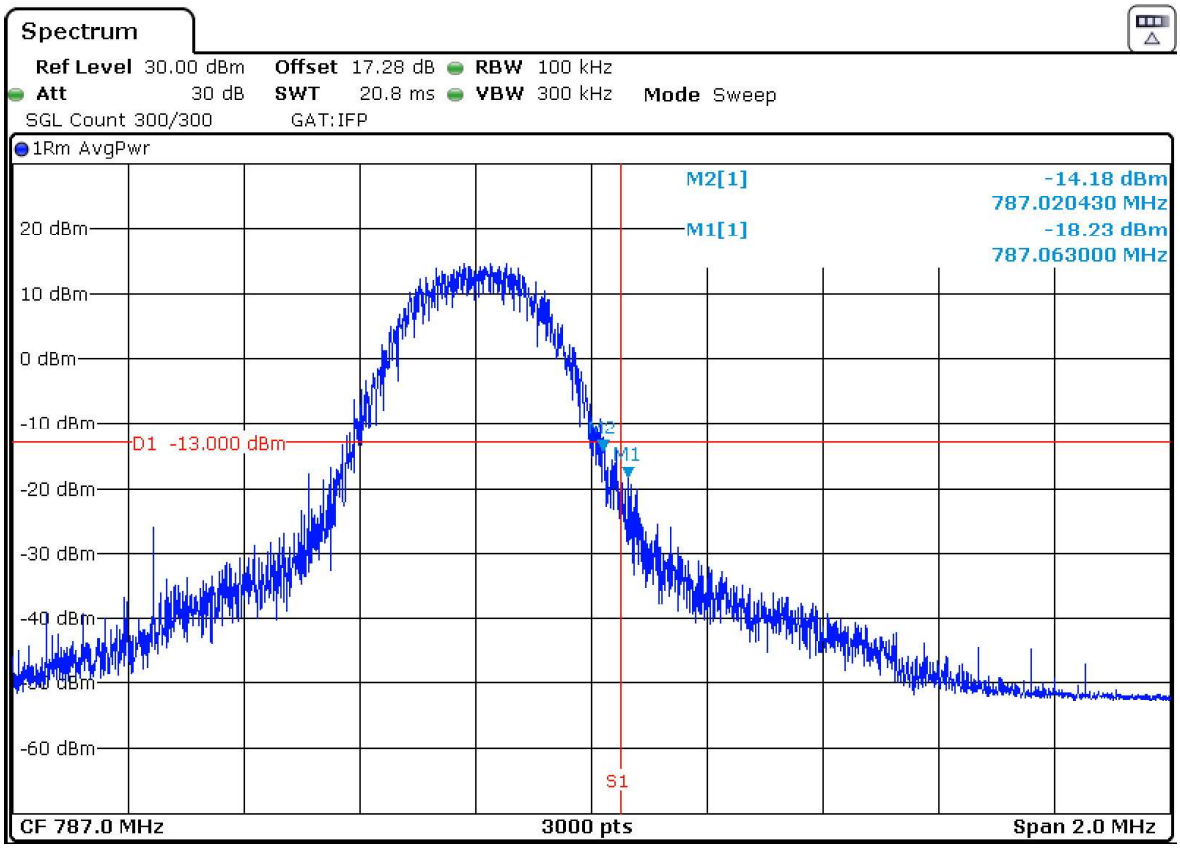
1 Tone 15 kHz, Offset Tone = 11. π/2 - BPSK modulation. High Block Edge:

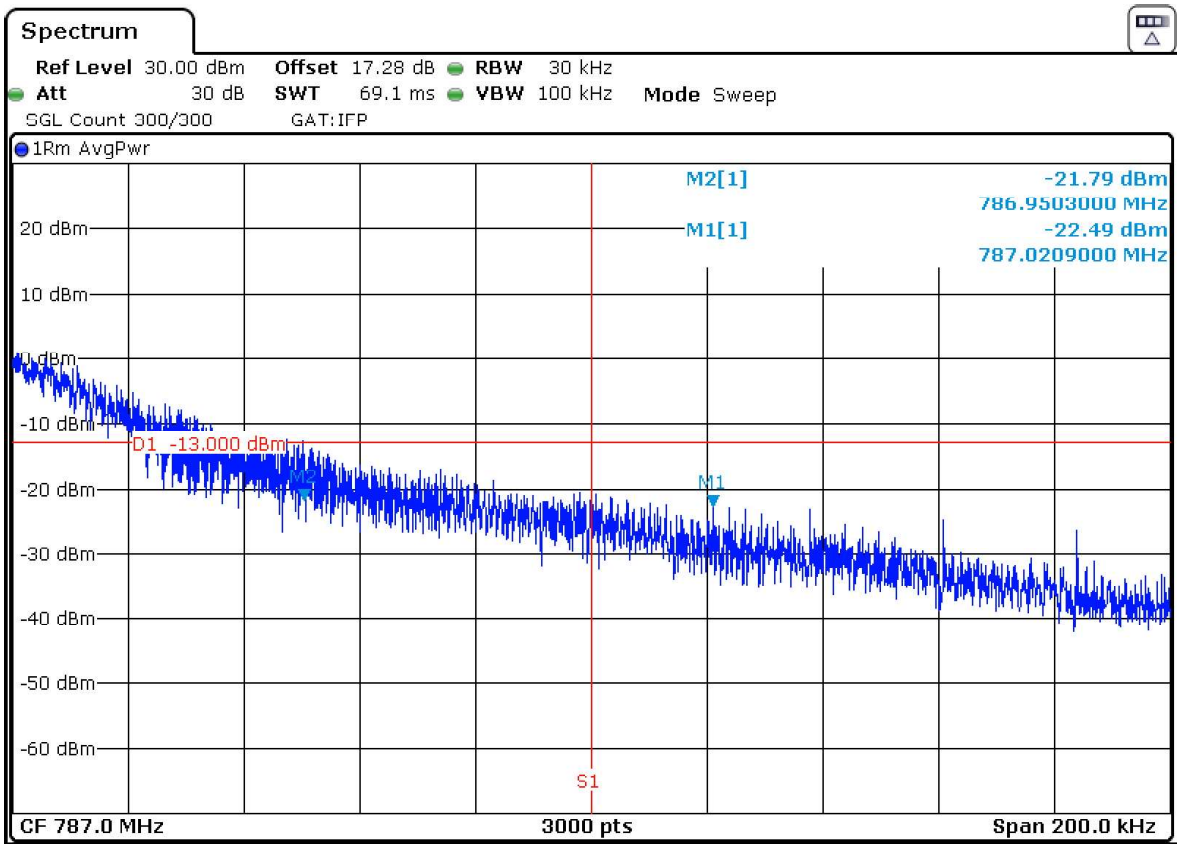




NOTE: Zoom (100kHz) with RBW=30kHz.

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

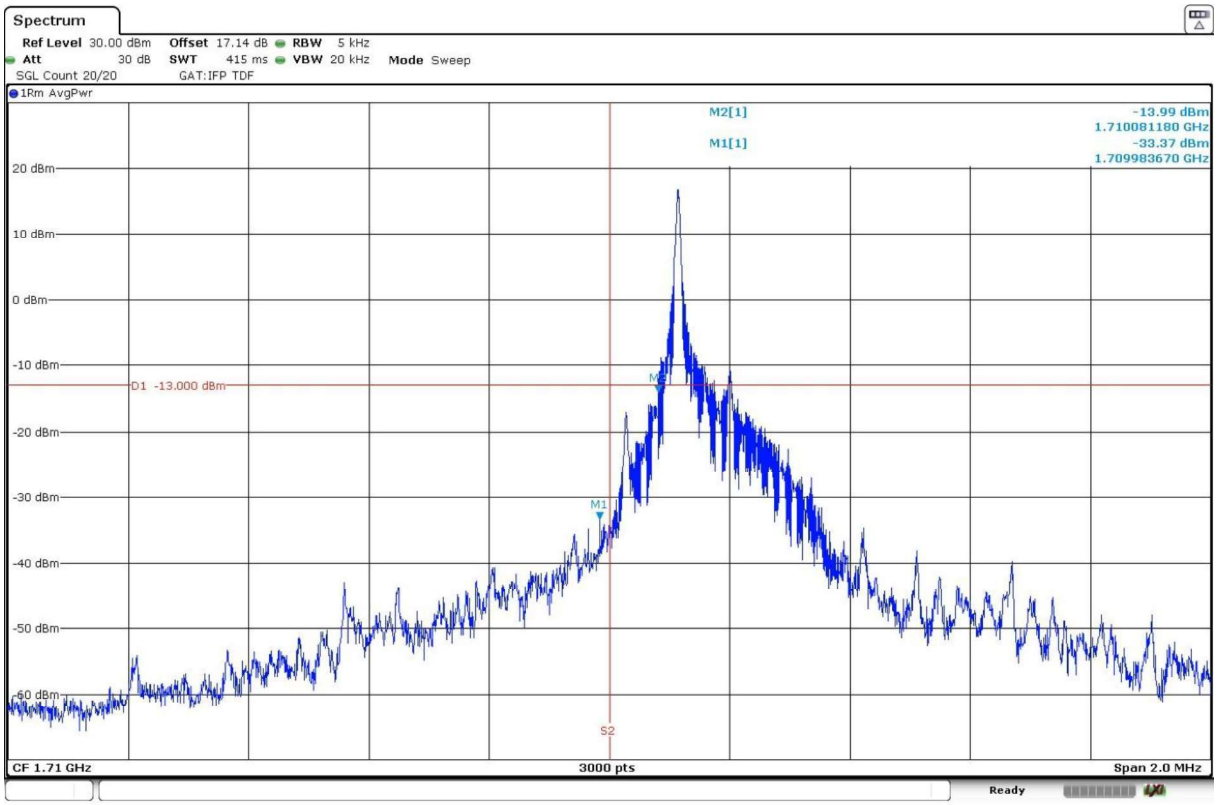




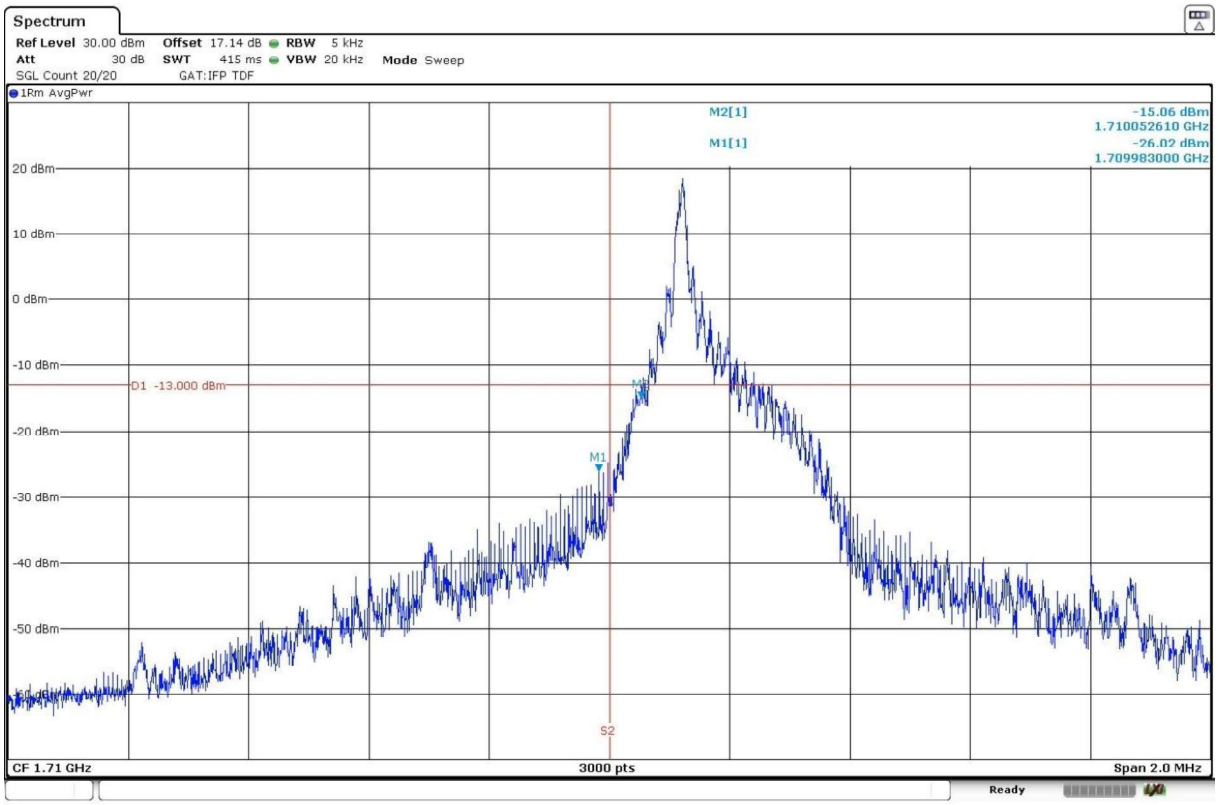
NOTE: Zoom (100kHz) with RBW=30kHz.

NBIoT Band 66.

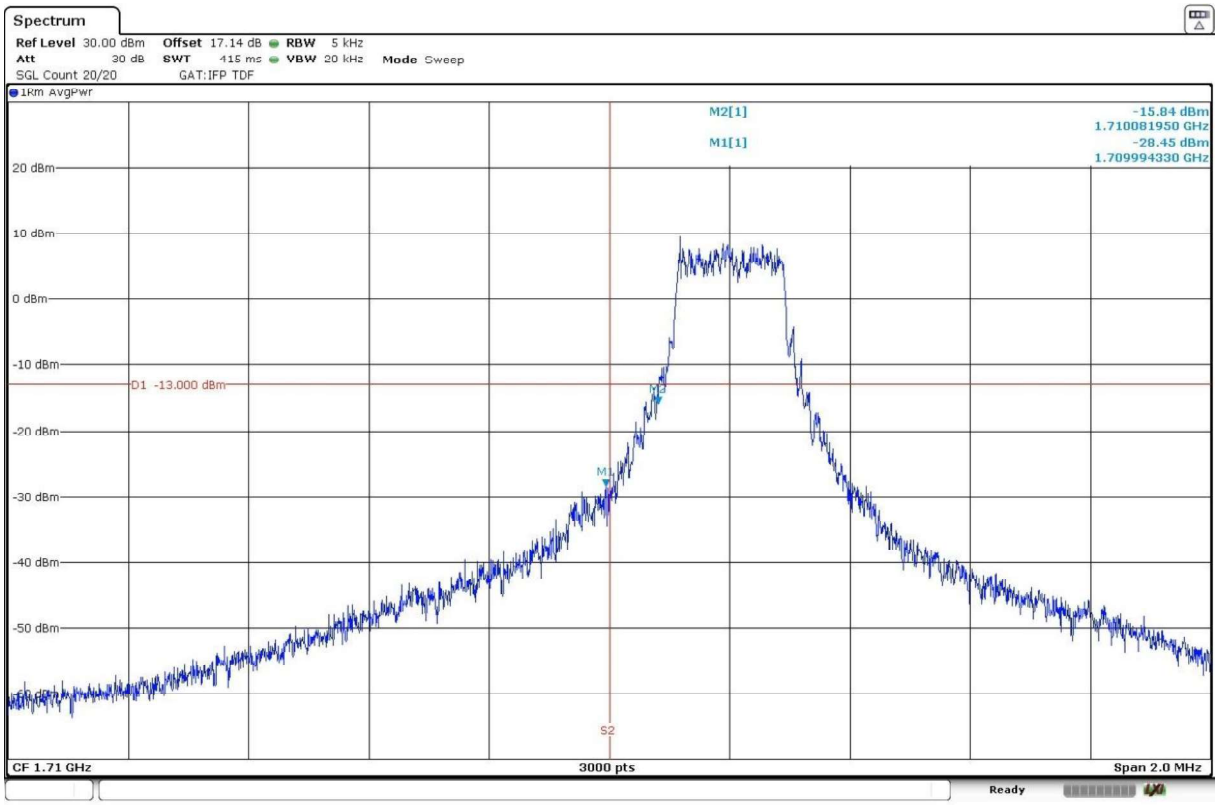
1 Tone 3.75 kHz, Offset Tone = 0. π/4 - QPSK modulation. Low Block Edge:



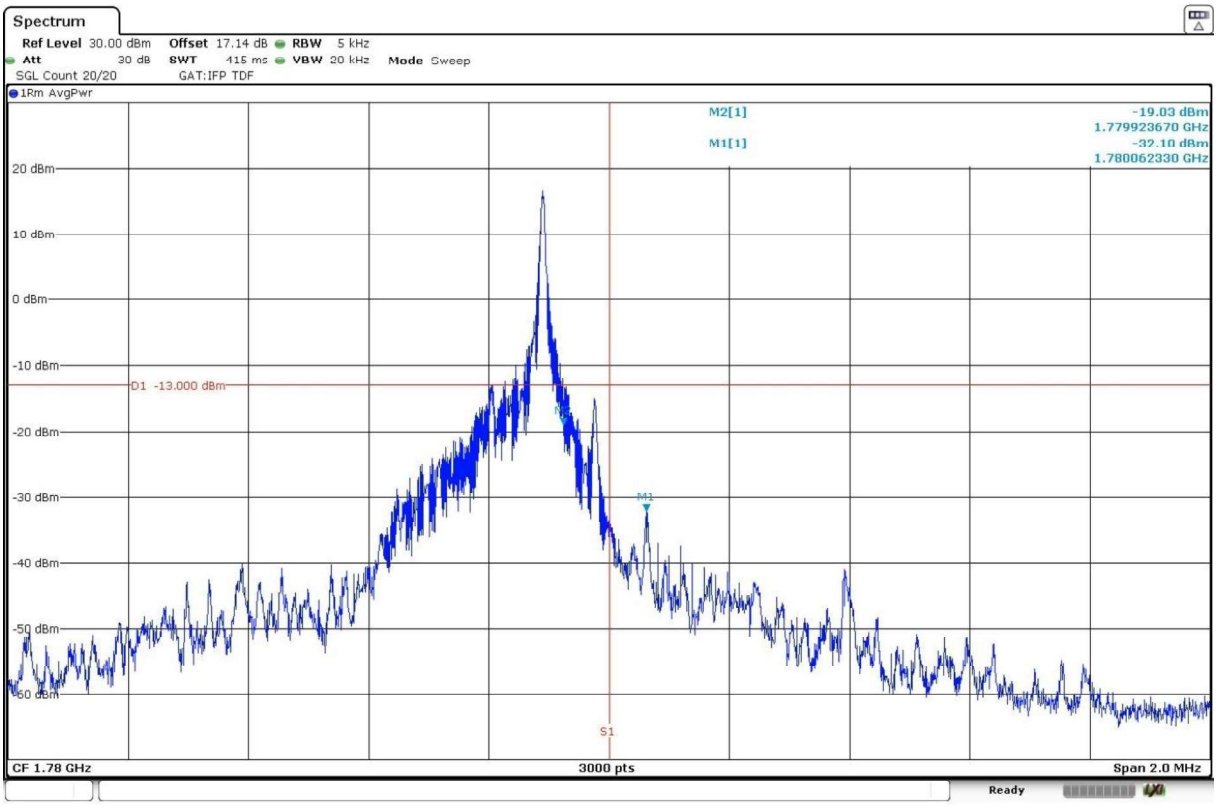
1 Tone 15 kHz, Offset Tone = 0. π/4 - QPSK modulation. Low Block Edge:



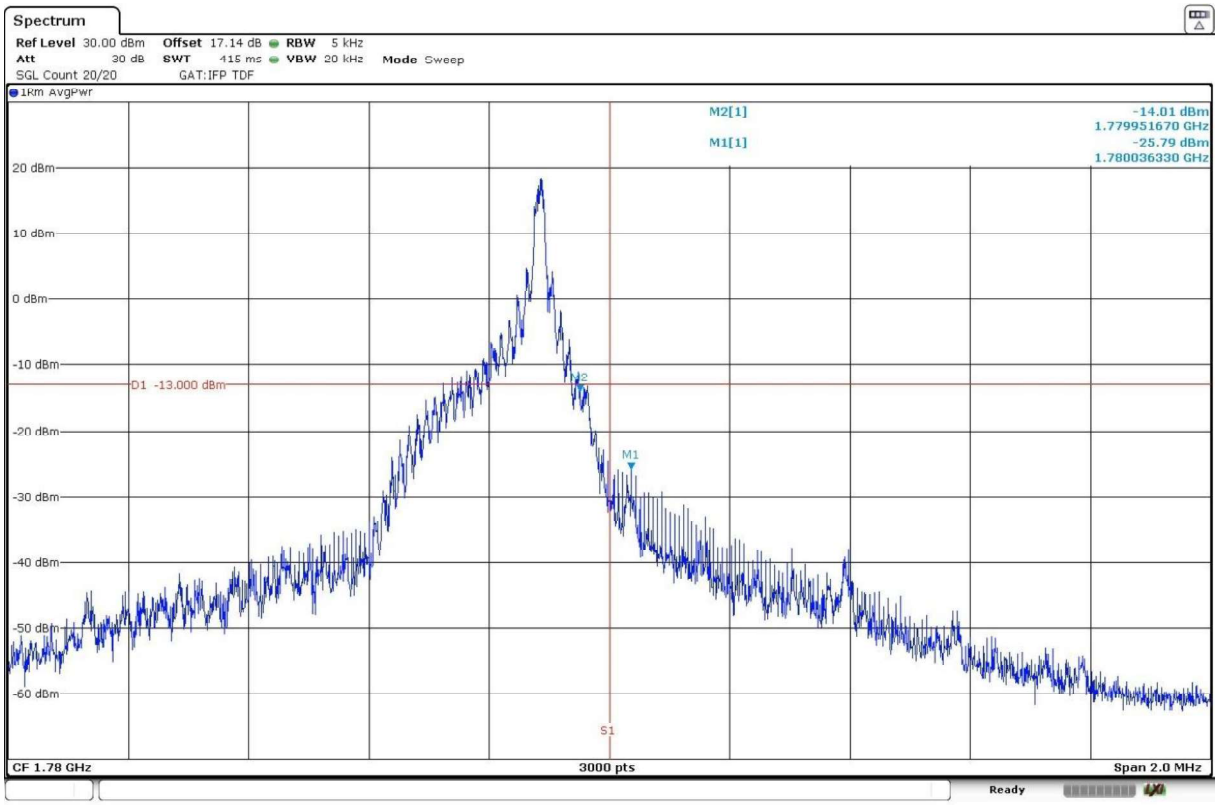
12 Tones 15 kHz, Offset Tone = 0. π/4 - QPSK modulation. Low Block Edge:



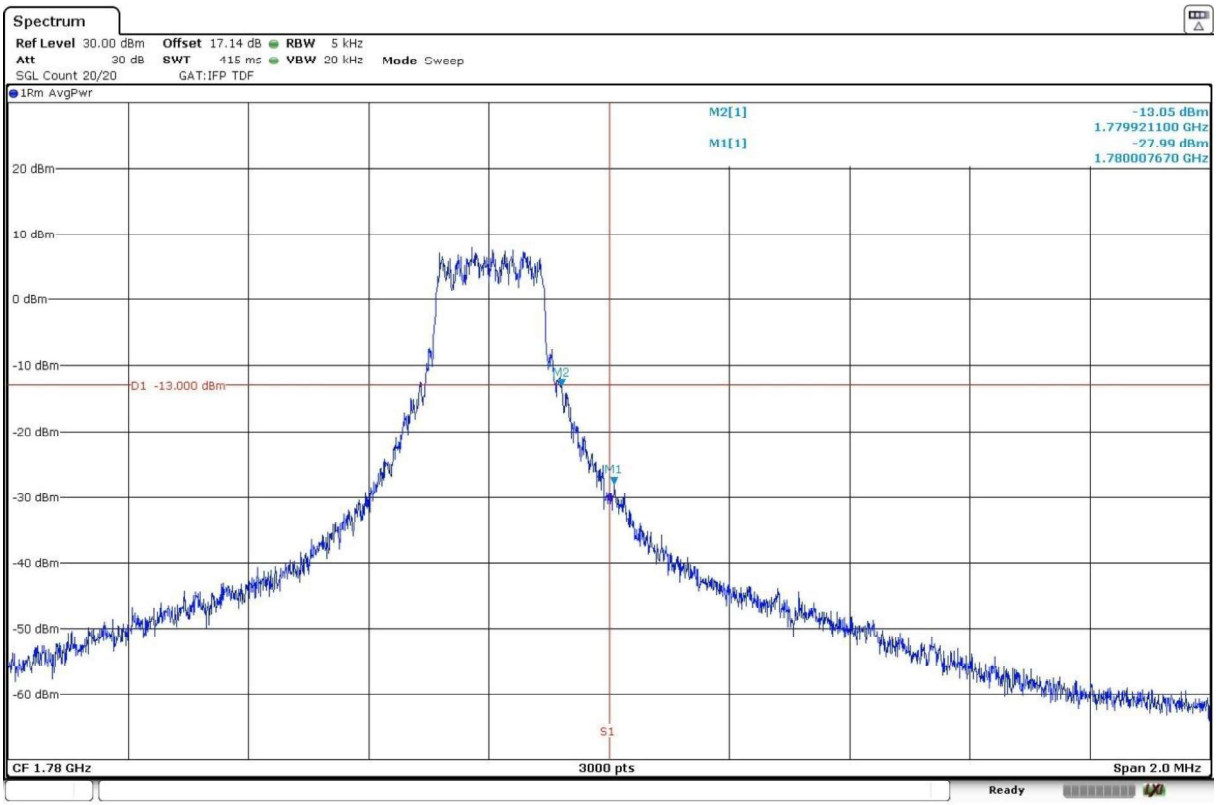
1 Tone 3.75 kHz, Offset Tone = 47. π/4 - QPSK modulation. High Block Edge:



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



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



Radiated Emissions

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 (f):

For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

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.

The e.i.r.p. in the band 1559-1610 MHz shall not exceed -70 dBW/MHz for wideband signal and -80 dBW for discrete emission with bandwidth less than 700 Hz.

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. 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 measurement was performed with the EUT inside an anechoic chamber. The spectrum was scanned from 30 MHz to at least the 10th harmonic of the highest frequency generated within the equipment.

The EUT was placed on a non-conductive stand at a 3-meter distance from the measuring antenna for measurements from 30 MHz up to 18 GHz.

Detected emissions were maximized at each frequency by rotating the EUT and adjusting the height and polarization of the measuring antenna. The maximum meter reading was recorded.

The maximum field strength (dBµV/m) of each detected emission at less than 20 dB respect to the limit is converted to an equivalent EIRP level (dBm) according to ANSI C63.26 with the formula:

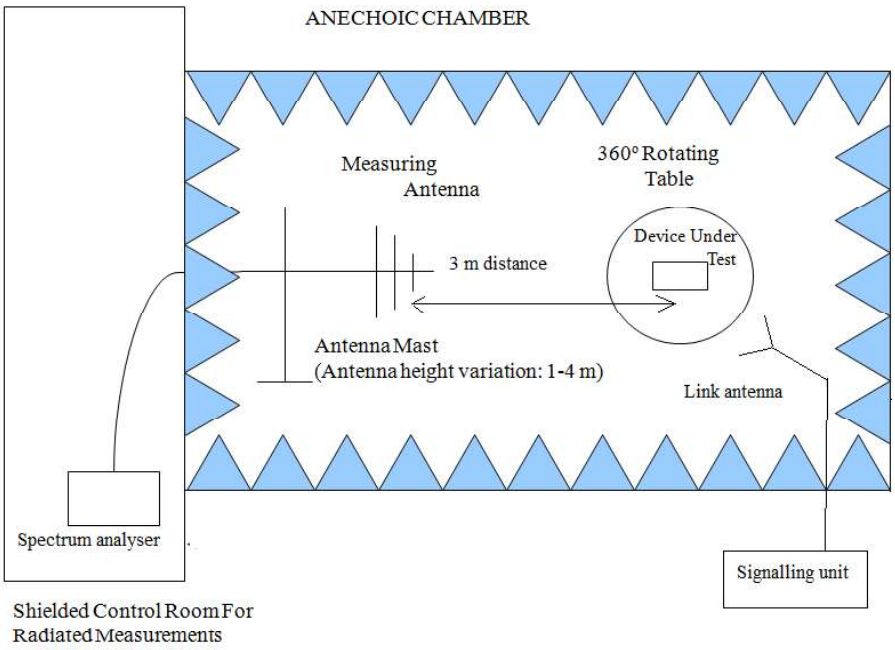
$$EIRP\ (dBm) = E(dB\mu V/m) + 20 \log (D) - 104.8$$

Where D is the measurement distance (in the far field region) in m. D = 3m.

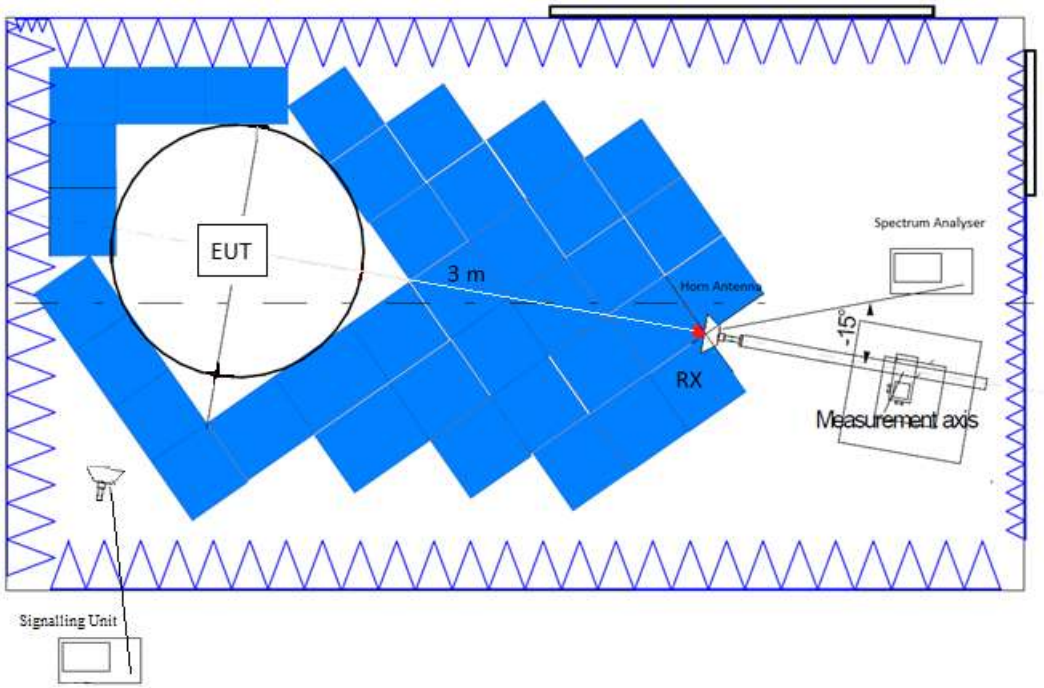
The configuration of tones and modulation which is the worst case for conducted power was used.

Test setup

Radiated measurements below 1 GHz.



Radiated measurements between 1 GHz and 18 GHz.



Results

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.

NBIoT Band 12:

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

- **Low Channel:**

  Frequency range 30 MHz – 1 GHz

  No spurious frequencies at less than 20 dB below the limit.

  Frequency range 1 GHz – 8 GHz

  No spurious frequencies at less than 20 dB below the limit.

- **Middle Channel:**

  Frequency range 30 MHz – 1 GHz

  No spurious frequencies at less than 20 dB below the limit.

  Frequency range 1 GHz – 8 GHz

  No spurious frequencies at less than 20 dB below the limit.

- **High Channel:**

  Frequency range 30 MHz – 1 GHz

  No spurious frequencies at less than 20 dB below the limit.

  Frequency range 1 GHz – 8 GHz

  No spurious frequencies at less than 20 dB below the limit.

Verdict

Pass

NBIoT Band 13:

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

- **Low Channel:**

Frequency range 30 MHz – 1 GHz

No spurious frequencies at less than 20 dB below the limit.

Frequency range 1 GHz – 8.5 GHz

Spurious Frequency (MHz)	Emission Level E.I.R.P (dBm)	Polarization	Detecto	Limit (dBm)
6217.880000	-32.66	V	Peak	-13

Frequency range 1559 MHz – 1610 MHz

Spurious Frequency (MHz)	Emission Level E.I.R.P (dBm)	Polarization	Detecto	Limit (dBm)
1567.050400	-47.09	H	Peak	-40
1602.112900	-46.61	H	Peak	
1603.240000	-46.68	H	Peak	
1604.203900	-46.35	H	Peak	

Only wideband signals were detected, no discrete signals.

- **Middle Channel:**

Frequency range 30 MHz – 1 GHz

No spurious frequencies at less than 20 dB below the limit.

Frequency range 1 GHz – 8.5 GHz

No spurious frequencies at less than 20 dB below the limit.

Frequency range 1559 MHz – 1610 MHz

Spurious Frequency (MHz)	Emission Level E.I.R.P (dBm)	Polarization	Detecto	Limit (dBm)
1563.903700	-46.26	H	Peak	-40
1572.226900	-47.44	H	Peak	
1603.928500	-47.15	H	Peak	
1607.365900	-46.17	H	Peak	

Only wideband signals were detected, no discrete signals.

- **High Channel:**

Frequency range 30 MHz – 1 GHz

No spurious frequencies at less than 20 dB below the limit.

Frequency range 1 GHz – 8.5 GHz

No spurious frequencies at less than 20 dB below the limit.

Frequency range 1559 MHz – 1610 MHz

Spurious Frequency (MHz)	Emission Level E.I.R.P (dBm)	Polarization	Detecto	Limit (dBm)
1573.685500	-46.66	H	Peak	-40
1594.167100	-47.85	H	Peak	
1605.162700	-47.06	H	Peak	
1606.259200	-45.08	H	Peak	

Only wideband signals were detected, no discrete signals.

Verdict

Pass

NBIoT Band 66:

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

- **Low Channel:**

  Frequency range 30 MHz – 1 GHz

  No spurious frequencies at less than 20 dB below the limit.

  Frequency range 1 GHz – 18 GHz

  No spurious frequencies at less than 20 dB below the limit.

- **Middle Channel:**

  Frequency range 30 MHz – 1 GHz

  No spurious frequencies at less than 20 dB below the limit.

  Frequency range 1 GHz – 18 GHz

  No spurious frequencies at less than 20 dB below the limit.

- **High Channel:**

  Frequency range 30 MHz – 1 GHz

  No spurious frequencies at less than 20 dB below the limit.

  Frequency range 1 GHz – 18 GHz

  No spurious frequencies at less than 20 dB below the limit.

Verdict

Pass

Attachments

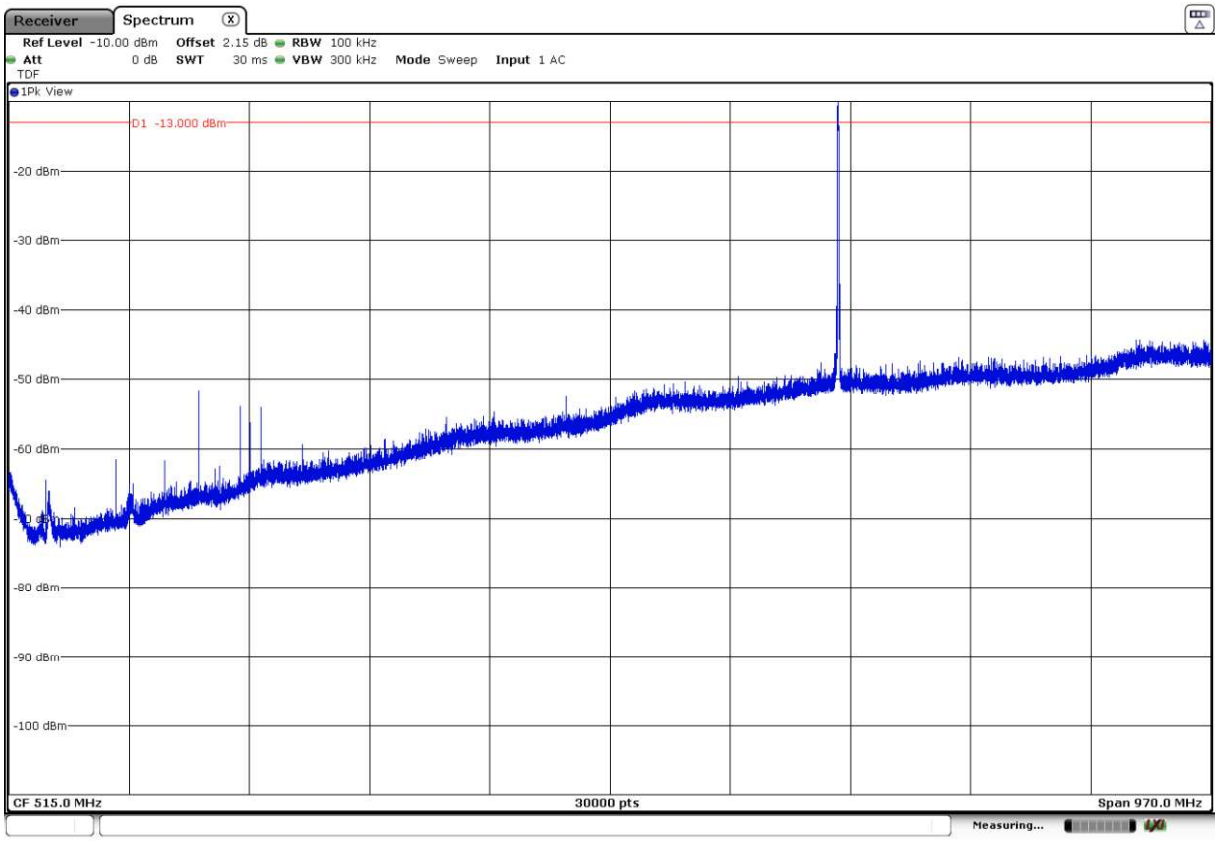
The peak above the limit on the plots below is the carrier frequency.

NBIoT Band 12.

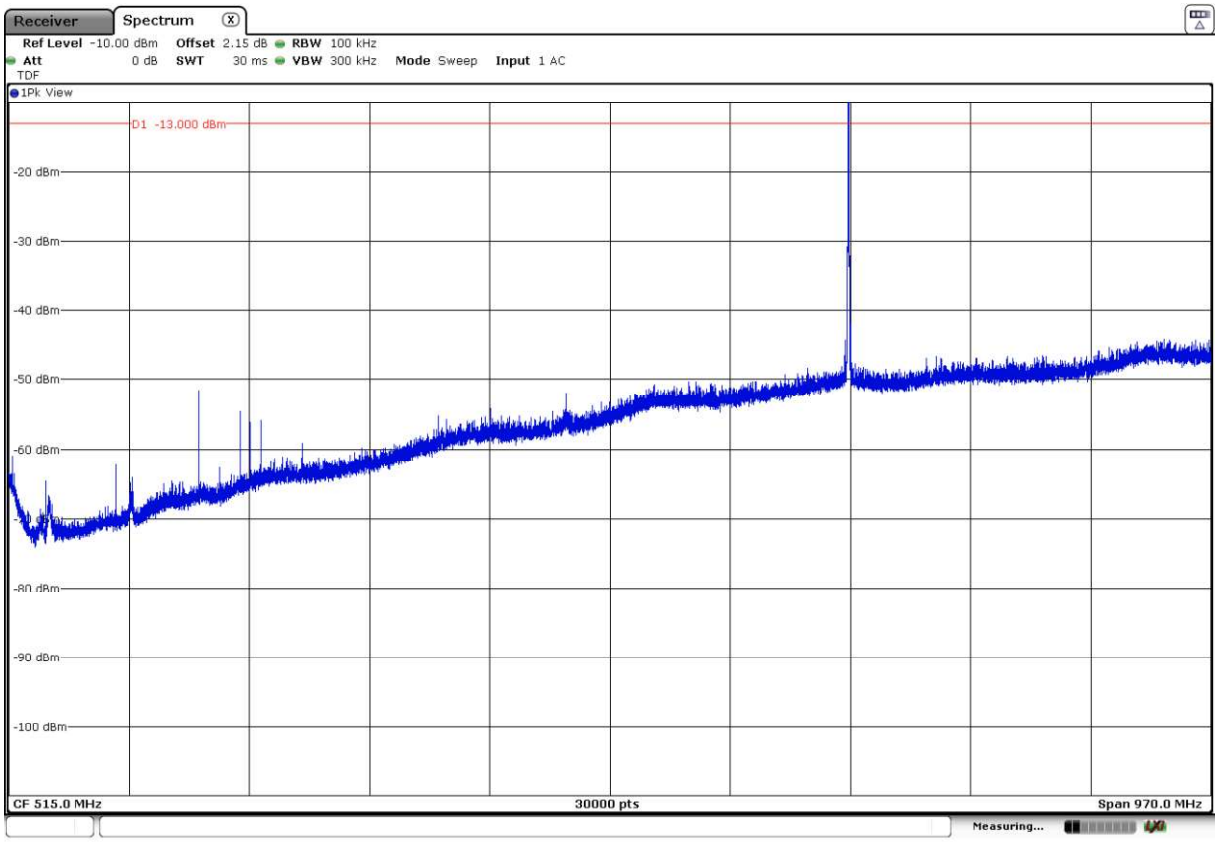
π/4 - QPSK modulation. 3 tones 15 kHz, Offset Tone = 6.

FREQUENCY RANGE 30 MHz – 1 GHz

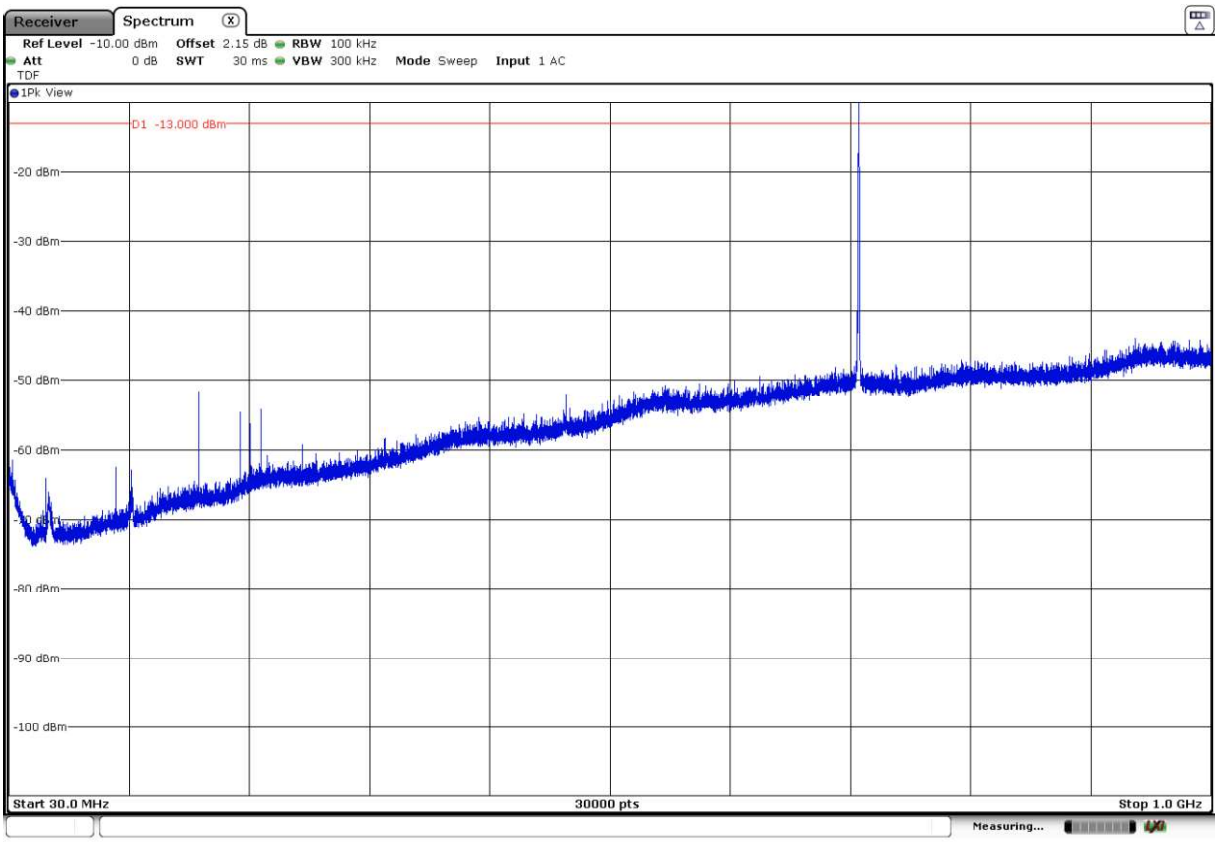
- Low Channel:



- Middle Channel:

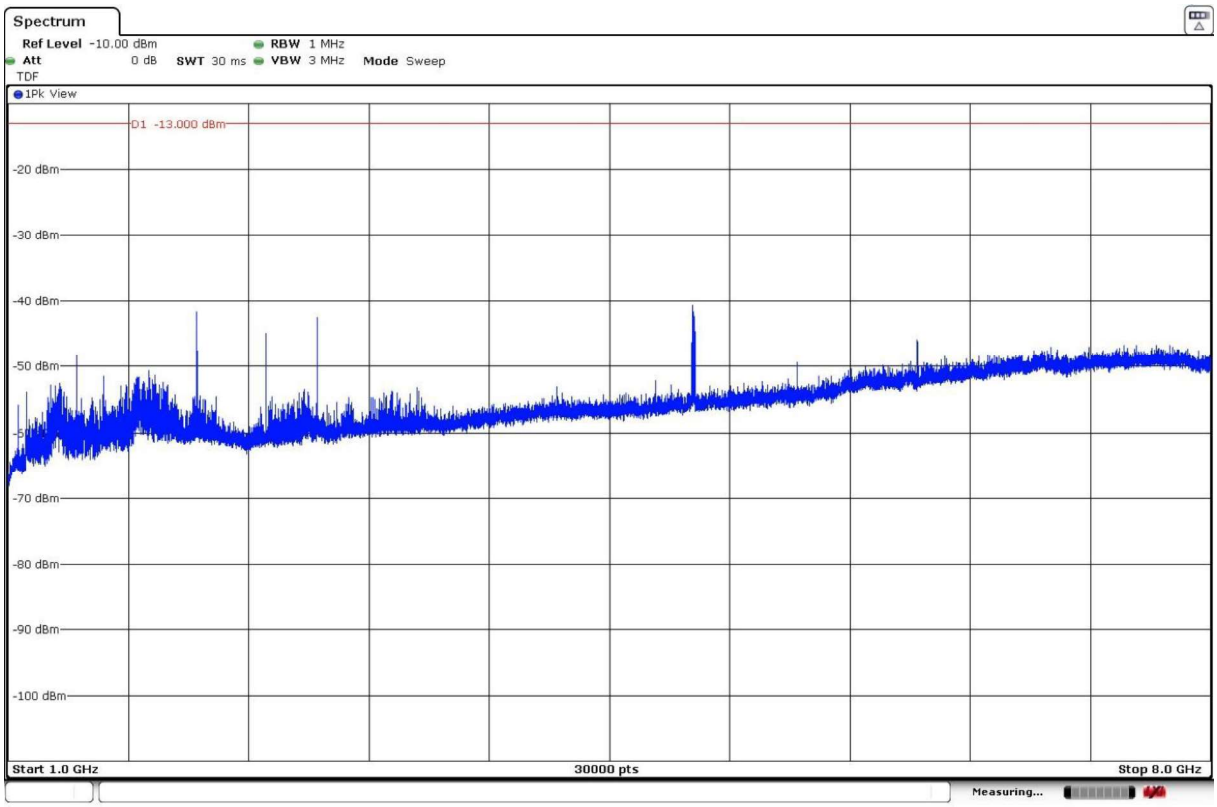


- High Channel:

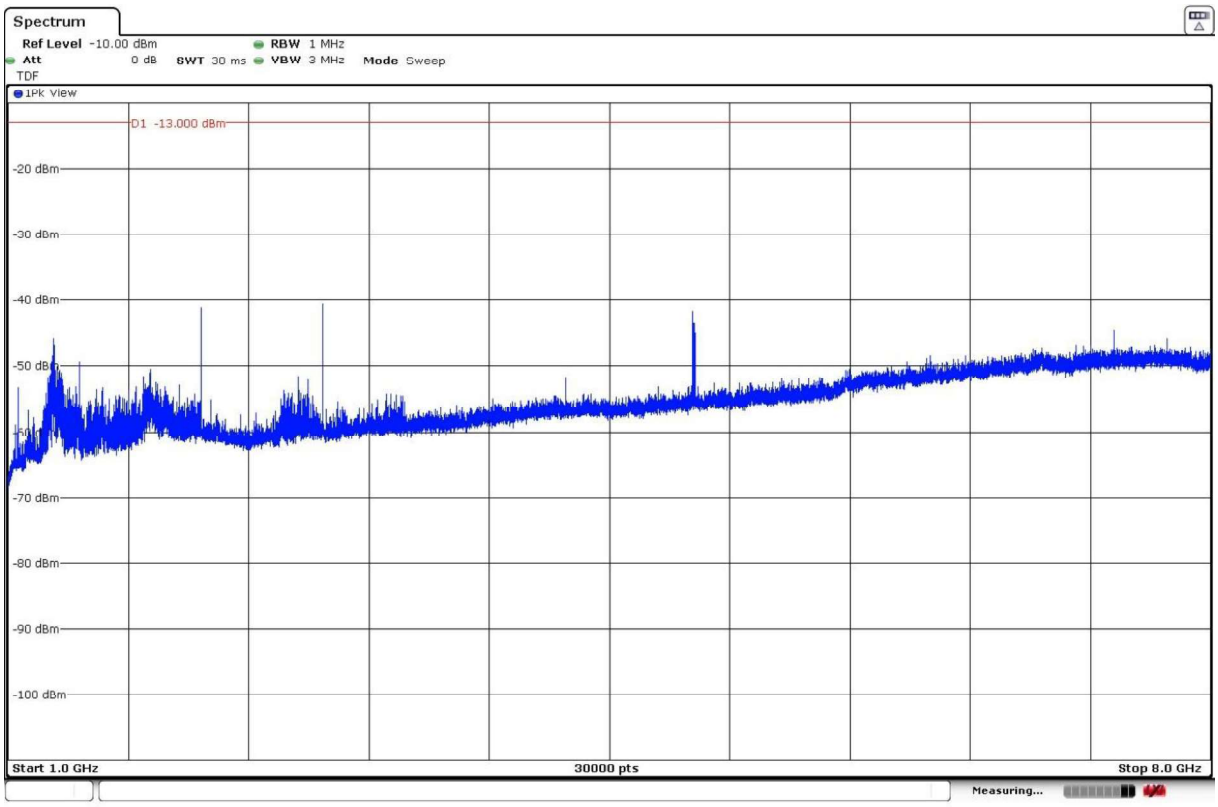


FREQUENCY RANGE 1 GHz – 8 GHz

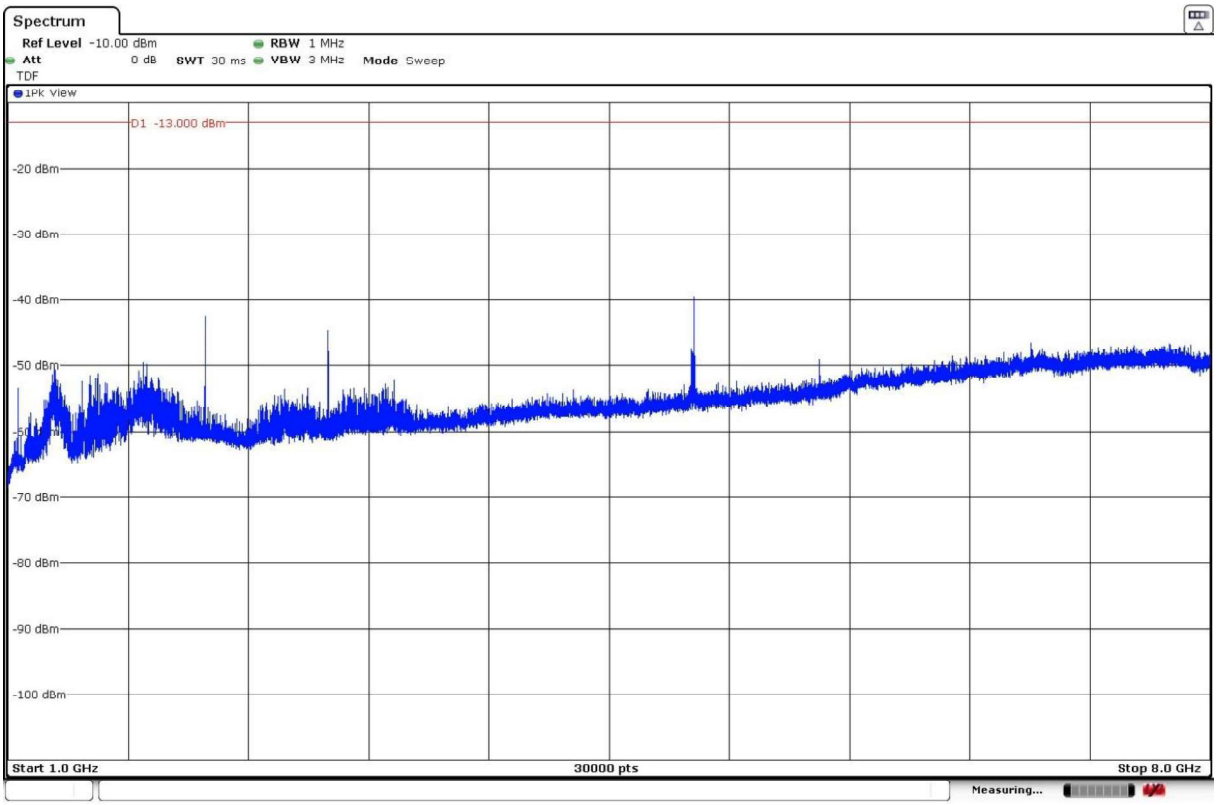
- Low Channel:



- Middle Channel:



- High Channel:



NBIoT Band 13.

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

FREQUENCY RANGE 30 MHz – 1 GHz

- Low Channel: