

## Spurious emissions at antenna terminals at Block Edges

### SPECIFICATION

FCC §27.53 (c) & (g) & (h). RSS-130 Clause 4.6. . RSS-139 Clause 6.6.

According to specification. 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.

At  $P_o$  transmitting power. the specified minimum attenuation becomes  $43+10\log (P_o)$ . and the level in dBm relative  $P_o$  becomes:

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

### 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.

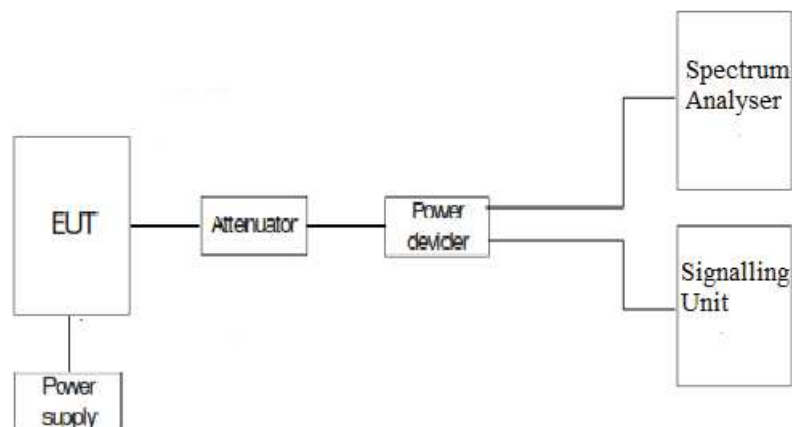
The configuration of modulation which is the worst case for conducted power was used.

For NBLoT Band12 and NBLoT85. as indicated in FCC part 27.53 (g) /RSS-130 Clause 4.6., 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 NBLoT Band 13. as indicated in FCC part 27.53 (c) (5) /RSS-130 Clause 4.6., 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 NBLoT Band 66. as indicated 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/occupied bandwidth of the fundamental emission of the transmitter may be employed.

### TEST SETUP



RESULTS (see plots in next pages)

NBLoT BAND 12.

(Channels in Band 12):	Tone= 3.75 kHz. Offset=0. $\pi/4$ - QPSK	Tone= 15 kHz. Offset=0. $\pi/4$ - QPSK	12 Tones= 15 kHz. Offset=0. $\pi/4$ - QPSK
Maximum measured level at lowest Block Edge at antenna port (dBm)	-31.94	-30.01	-37

(Channels in Band 12):	Tone= 3.75 kHz. Offset=47. $\pi/4$ - QPSK	Tone= 15 kHz. Offset=11. $\pi/4$ - QPSK	12 Tones= 15 kHz. Offset=0. $\pi/4$ - QPSK
Maximum measured level at highest Block Edge at antenna port (dBm)	-27.29	-20	-25.75

NBLoT. BAND 13.

(Channels in Band 13):	Tone= 3.75 kHz. Offset=0. $\pi/4$ - QPSK	Tone= 15 kHz. Offset=0. $\pi/4$ - QPSK	12 Tones= 15 kHz. Offset=0. $\pi/4$ - QPSK
Maximum measured level at lowest Block Edge at antenna port (dBm)	-36.20	-20.47	-25.70

(Channels in Band 13):	Tone= 3.75 kHz. Offset=47. $\pi/4$ - QPSK	Tone= 15 kHz. Offset=11. $\pi/4$ - QPSK	12 Tones= 15 kHz. Offset=0. $\pi/4$ - QPSK
Maximum measured level at highest Block Edge at antenna port (dBm)	-33.82	-19.87	-24.43

NBLoT. BAND 66.

(Channels in Band 66):	Tone= 3.75 kHz. Offset=0. $\pi/4$ - QPSK	Tone= 15 kHz. Offset=0. $\pi/4$ - QPSK	12 Tones= 15 kHz. Offset=0. $\pi/4$ - QPSK
Maximum measured level at lowest Block Edge at antenna port (dBm)	-30.15	-35.34	-28.75

(Channels in Band 66):	Tone= 3.75 kHz. Offset=47. $\pi/4$ - QPSK	Tone= 15 kHz. Offset=11. $\pi/4$ - QPSK	12 Tones= 15 kHz. Offset=0. $\pi/4$ - QPSK
Maximum measured level at highest Block Edge at antenna port (dBm)	-27.48	-32.16	-30

NBLoT. BAND 85.

(Channels in Band 85):	Tone= 3.75 kHz. Offset=0. $\pi/4$ - QPSK	Tone= 15 kHz. Offset=0. $\pi/4$ - QPSK	12 Tones= 15 kHz. Offset=0. $\pi/4$ - QPSK
Maximum measured level at lowest Block Edge at antenna port (dBm)	-21.75	-29.28	-22.22

(Channels in Band 85):	Tone= 3.75 kHz. Offset=47. $\pi/4$ - QPSK	Tone= 15 kHz. Offset=11. $\pi/4$ - QPSK	12 Tones= 15 kHz. Offset=0. $\pi/4$ - QPSK
Maximum measured level at highest Block Edge at antenna port (dBm)	-20.89	-31.72	-30.98

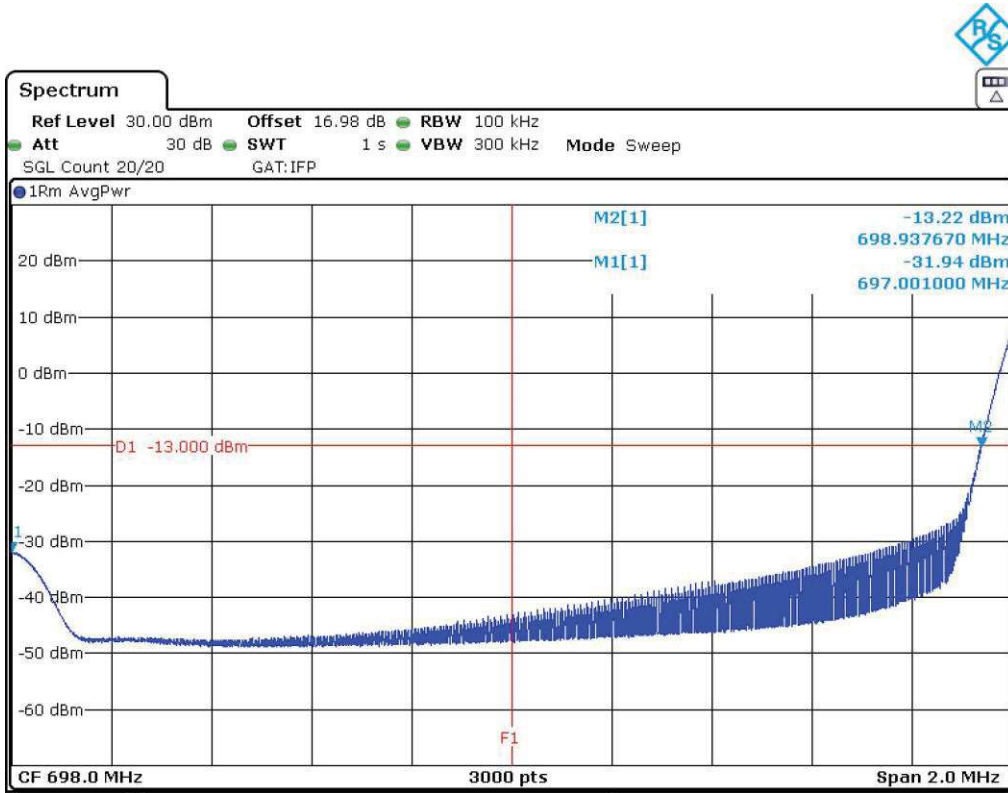
Measurement uncertainty =  $<\pm 1.20$  dB.

Verdict: PASS

NBLoT. BAND 12.

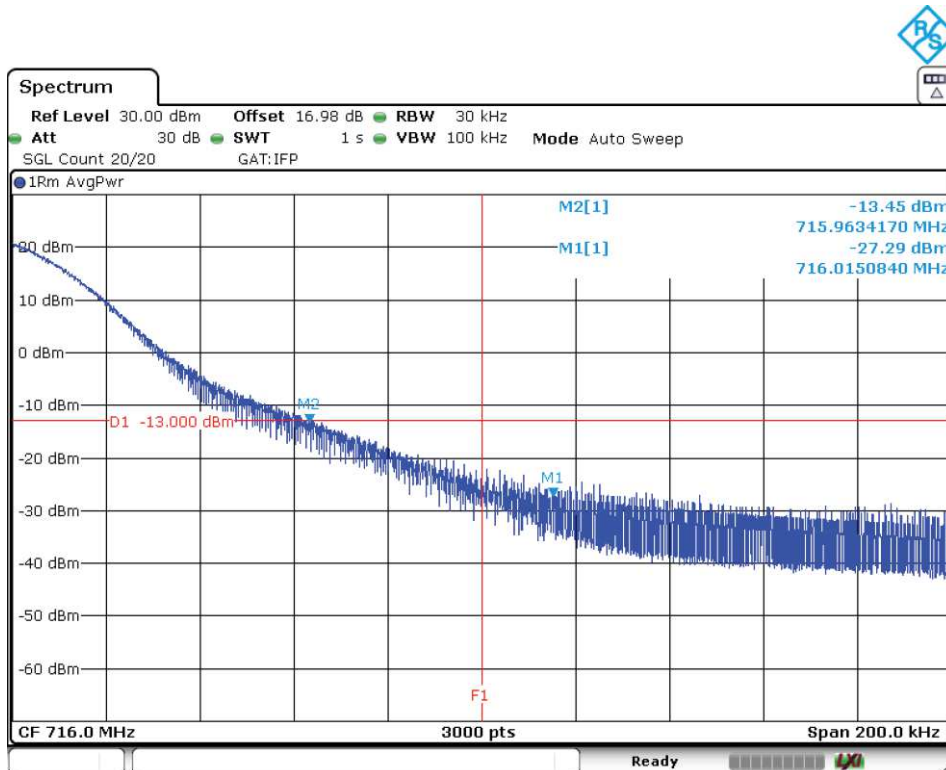
1 tone  $\pi/2$  – BPSK. BW=3.75 kHz Offset = 0

CHANNEL LOWEST



1 tone  $\pi/2$  – BPSK. BW=3.75 kHz Offset = 47

CHANNEL HIGHEST

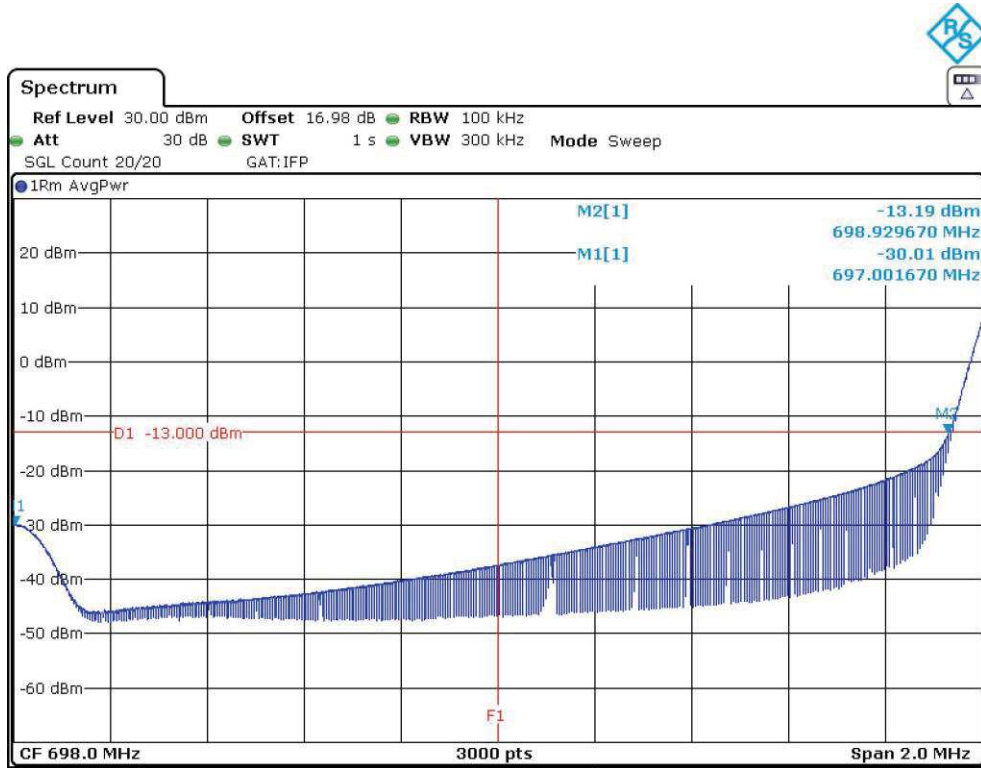


NOTE: Zoom (100KHz) with RBW=30KHz.

NBLoT. BAND 12.

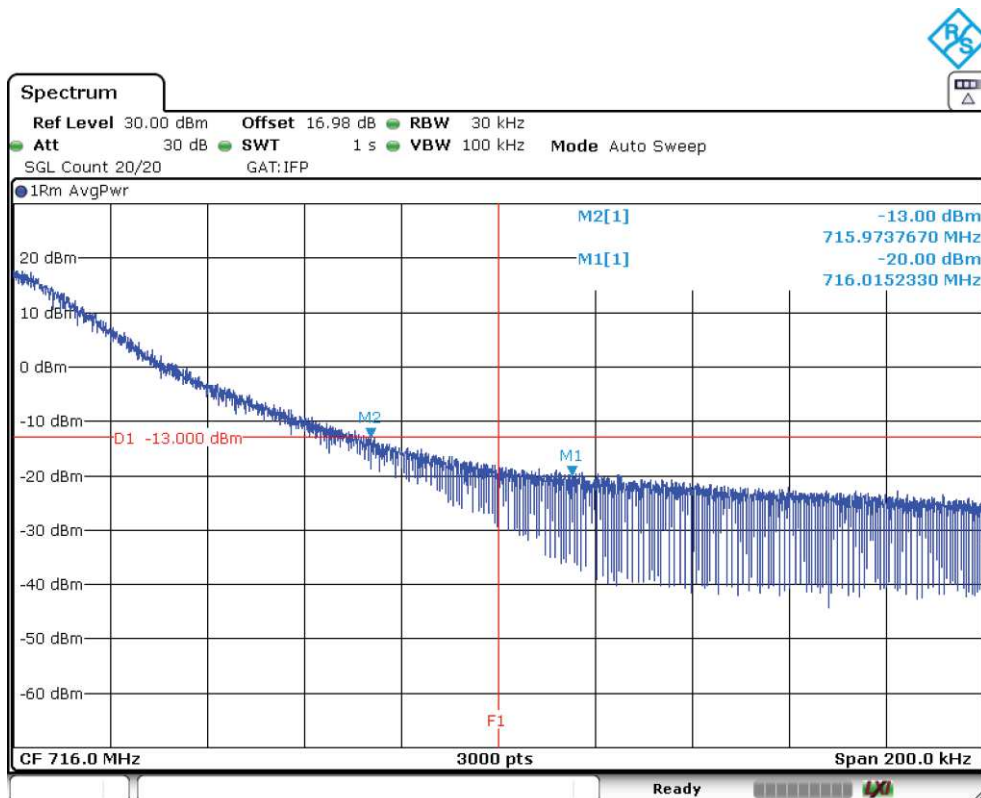
1 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 0

CHANNEL LOWEST



1 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 11

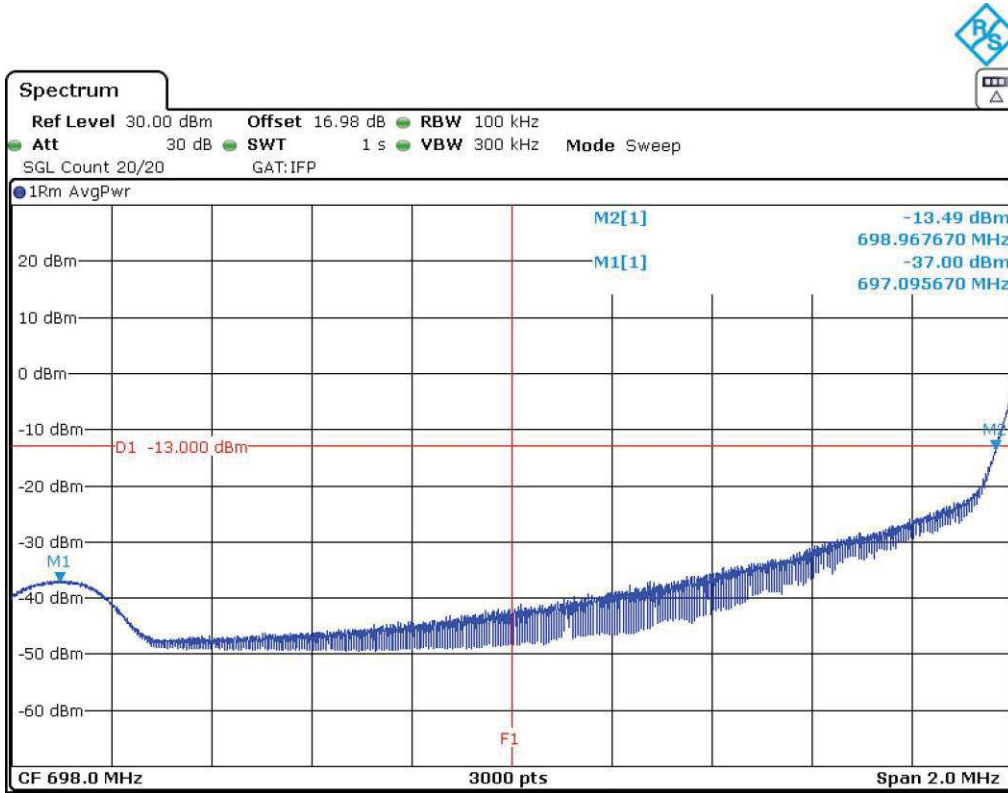
CHANNEL HIGHEST



NBLoT. BAND 12.

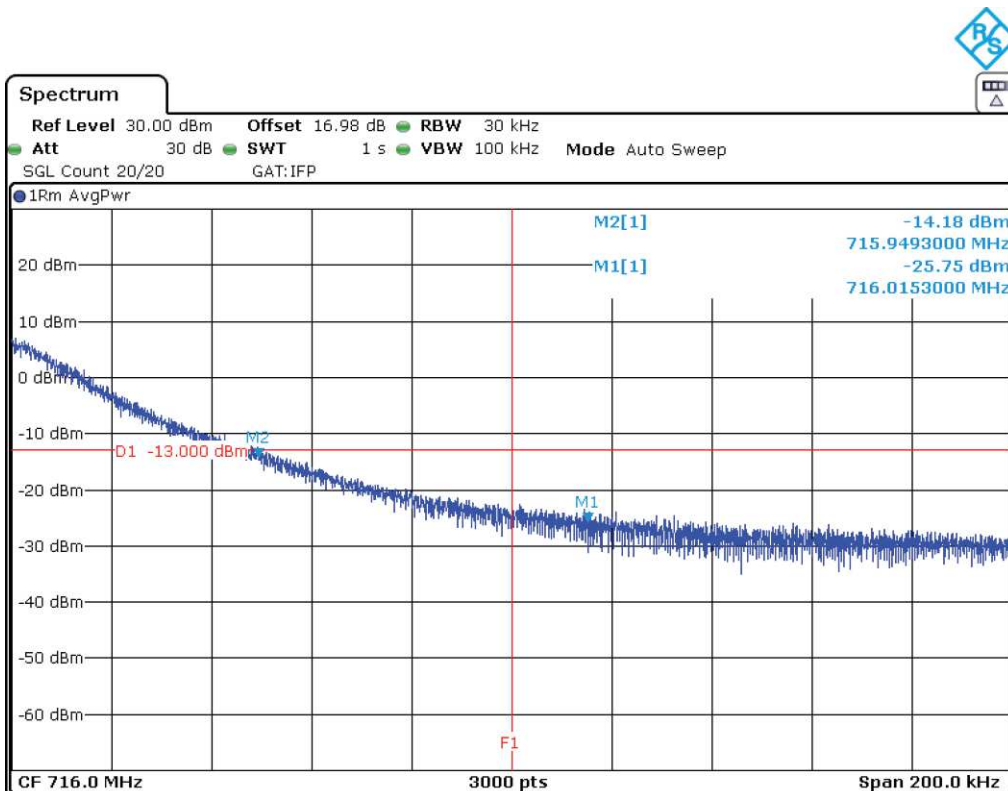
12 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 0

CHANNEL LOWEST



1 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 0

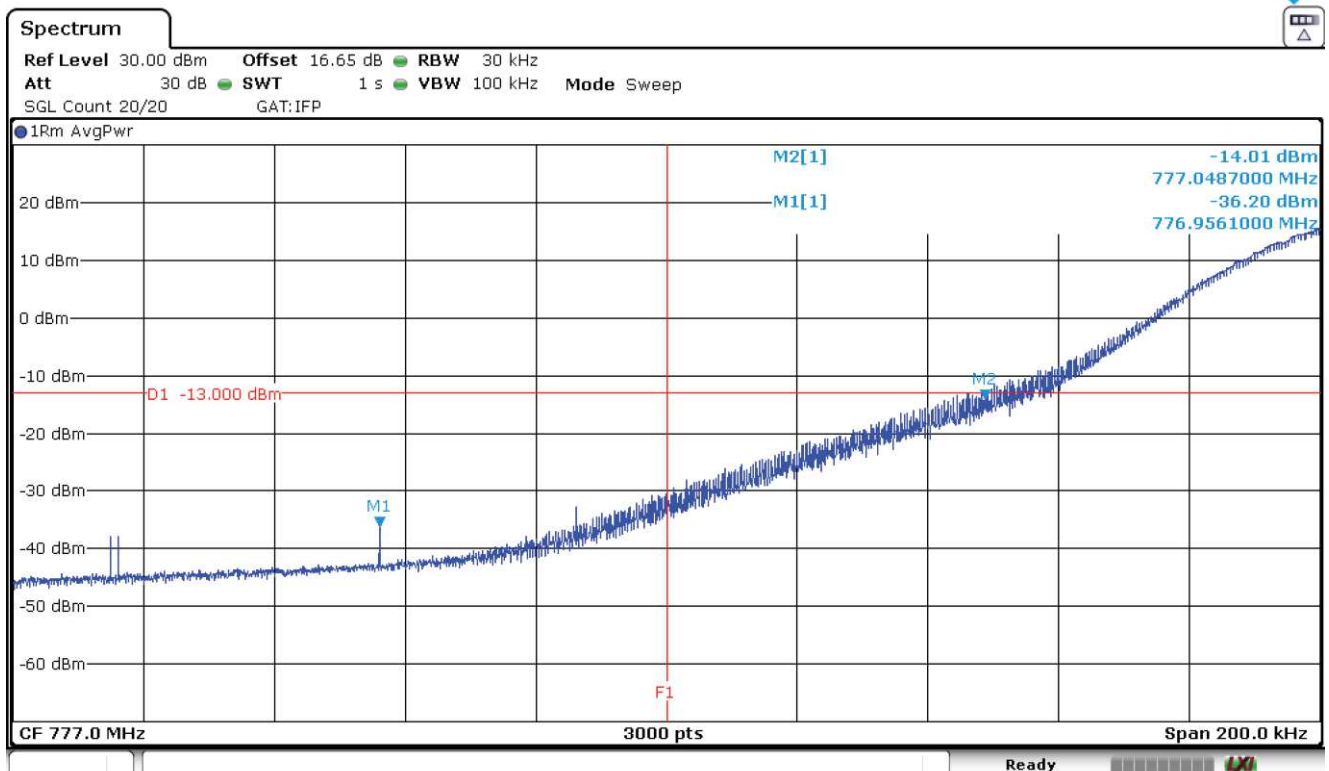
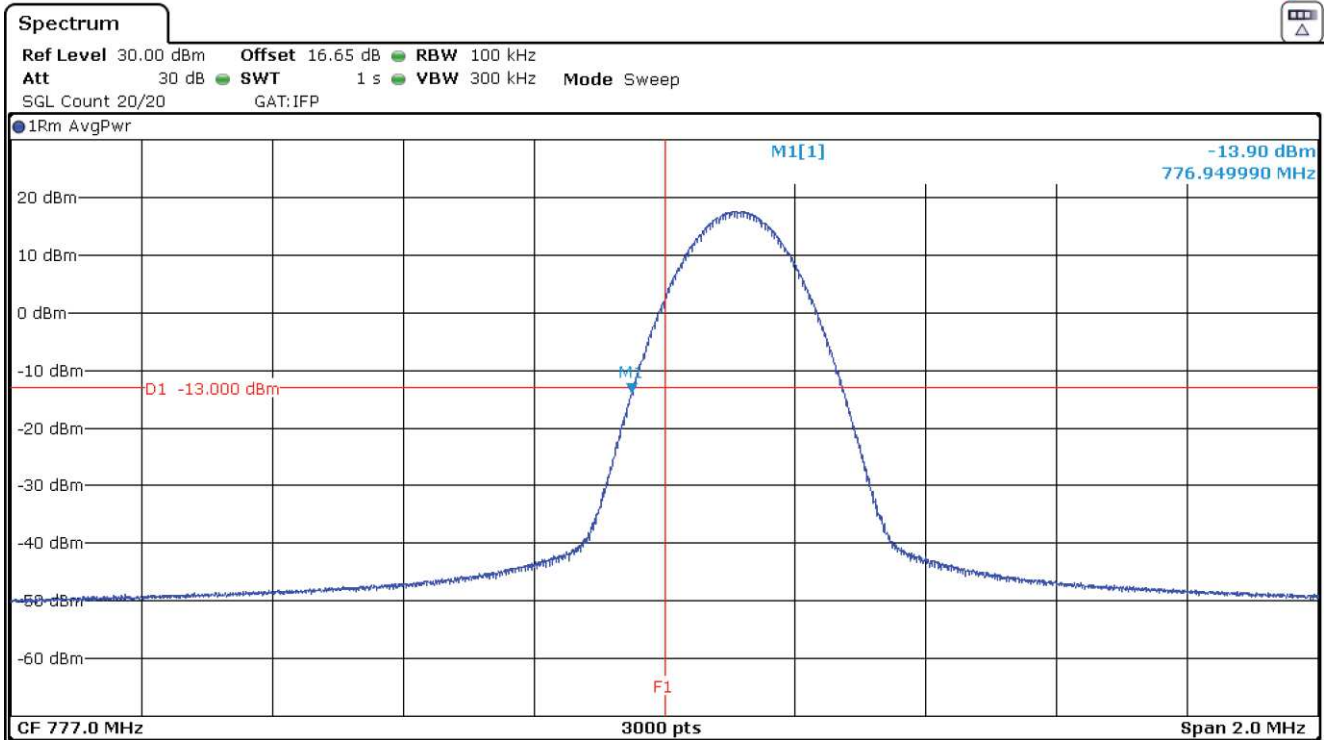
CHANNEL HIGHEST



NBLoT. BAND 13.

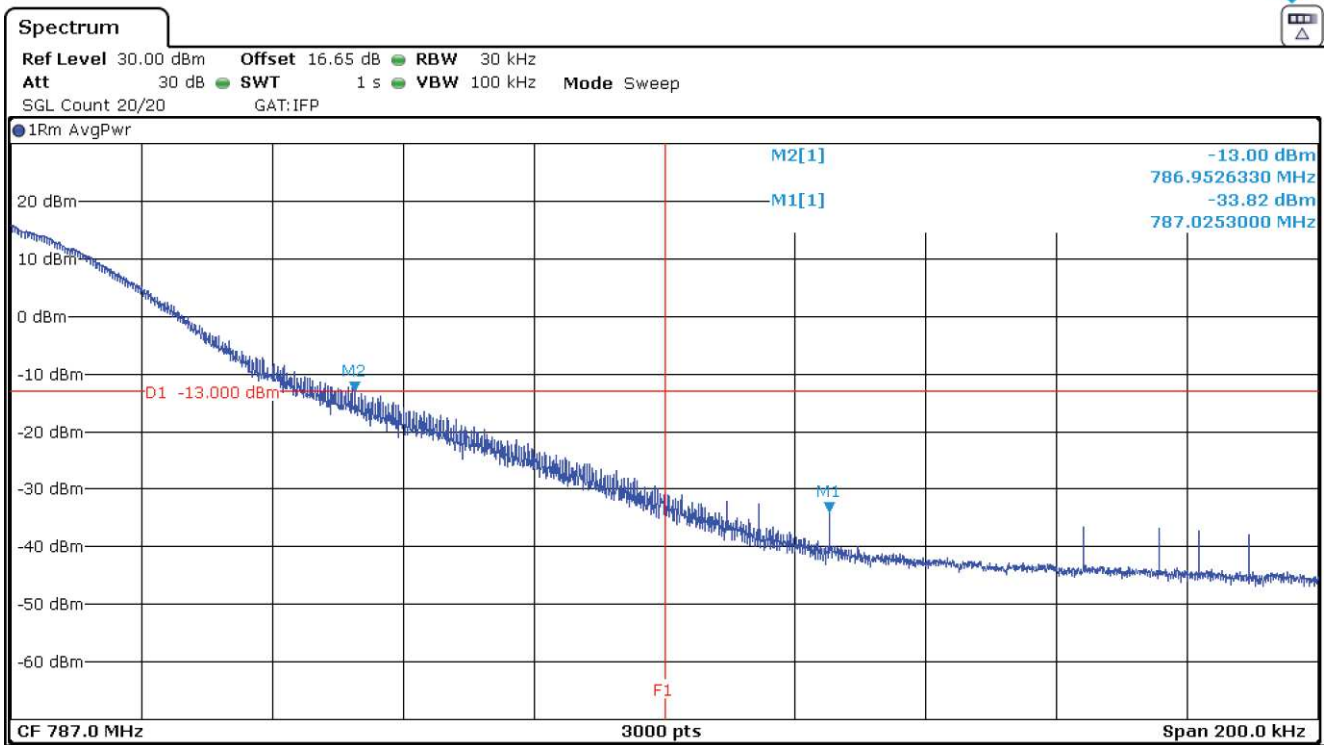
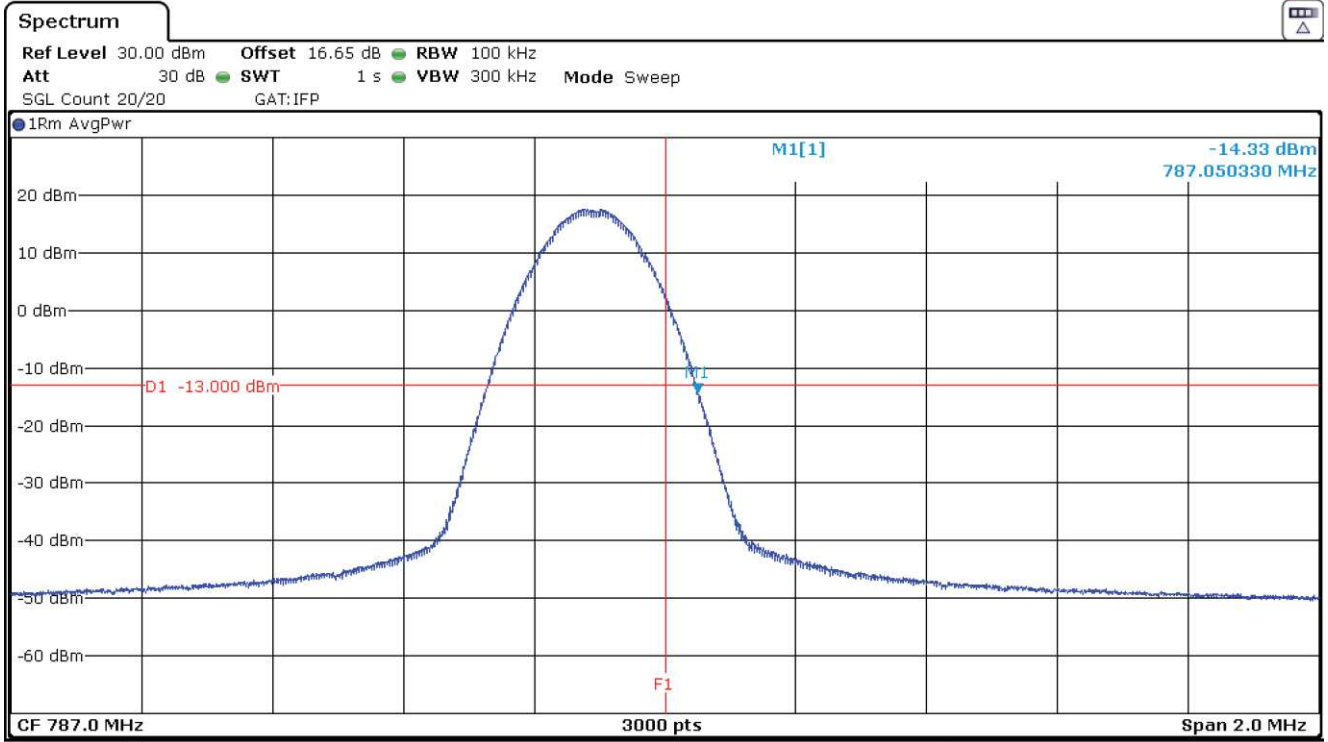
1 tone  $\pi/2$  – BPSK. BW=3.75 kHz Offset = 0

CHANNEL LOWEST



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

1 tone  $\pi/2$  – BPSK. BW=3.75 kHz Offset = 47  
 CHANNEL HIGHEST



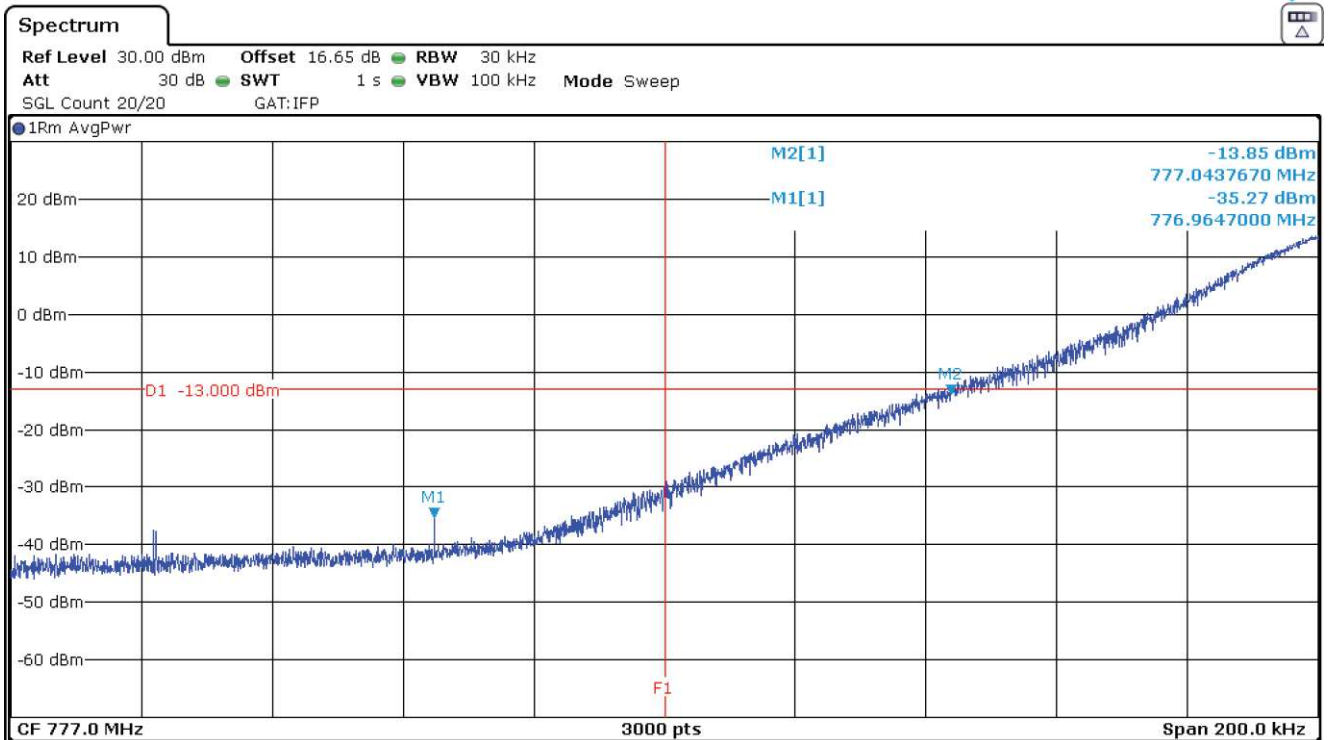
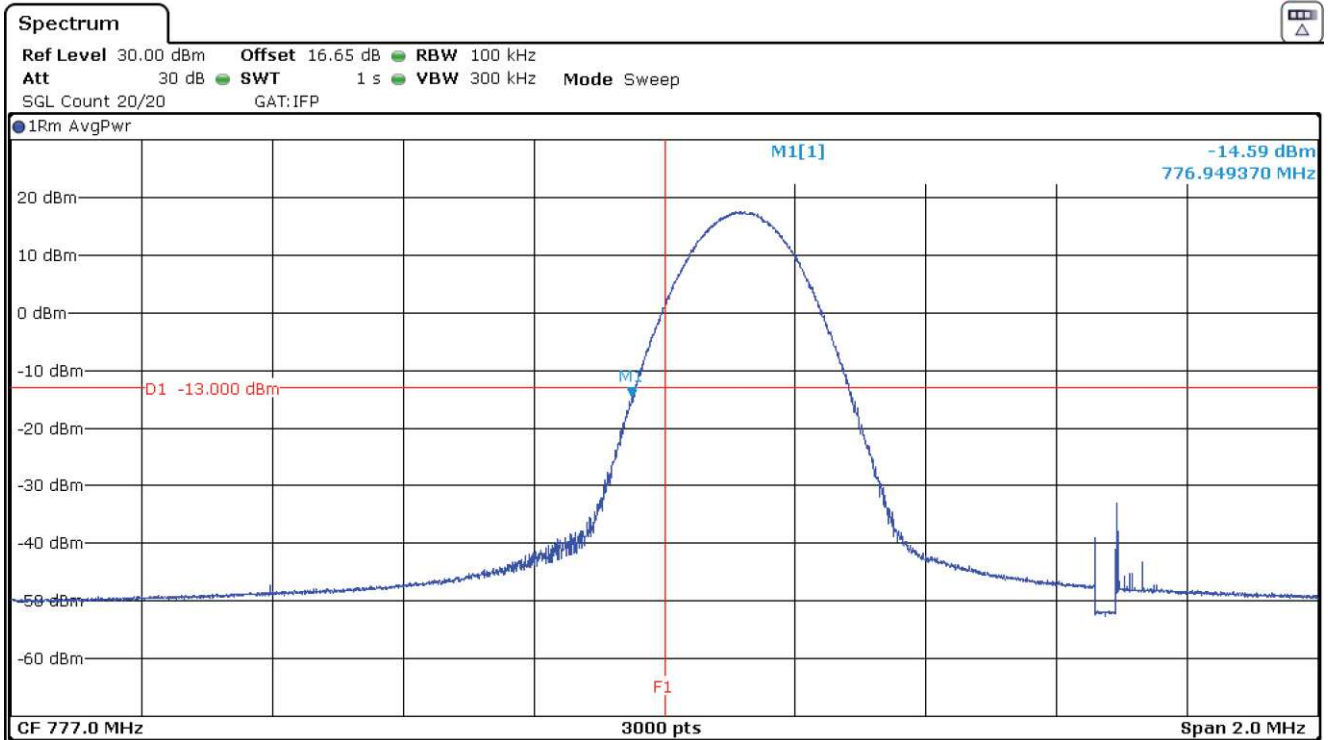
NOTE: Zoom (100KHz) with RBW=30KHz.



NBLoT. BAND 13.

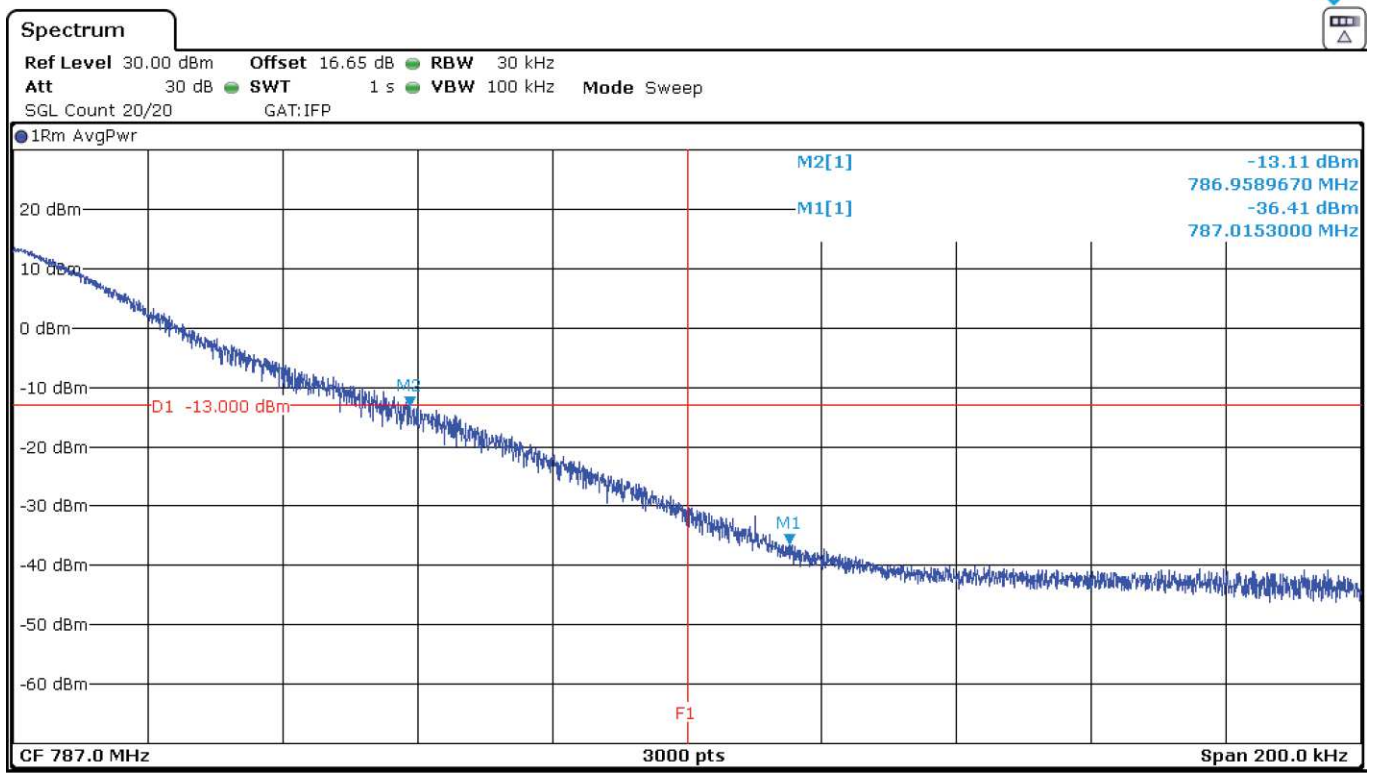
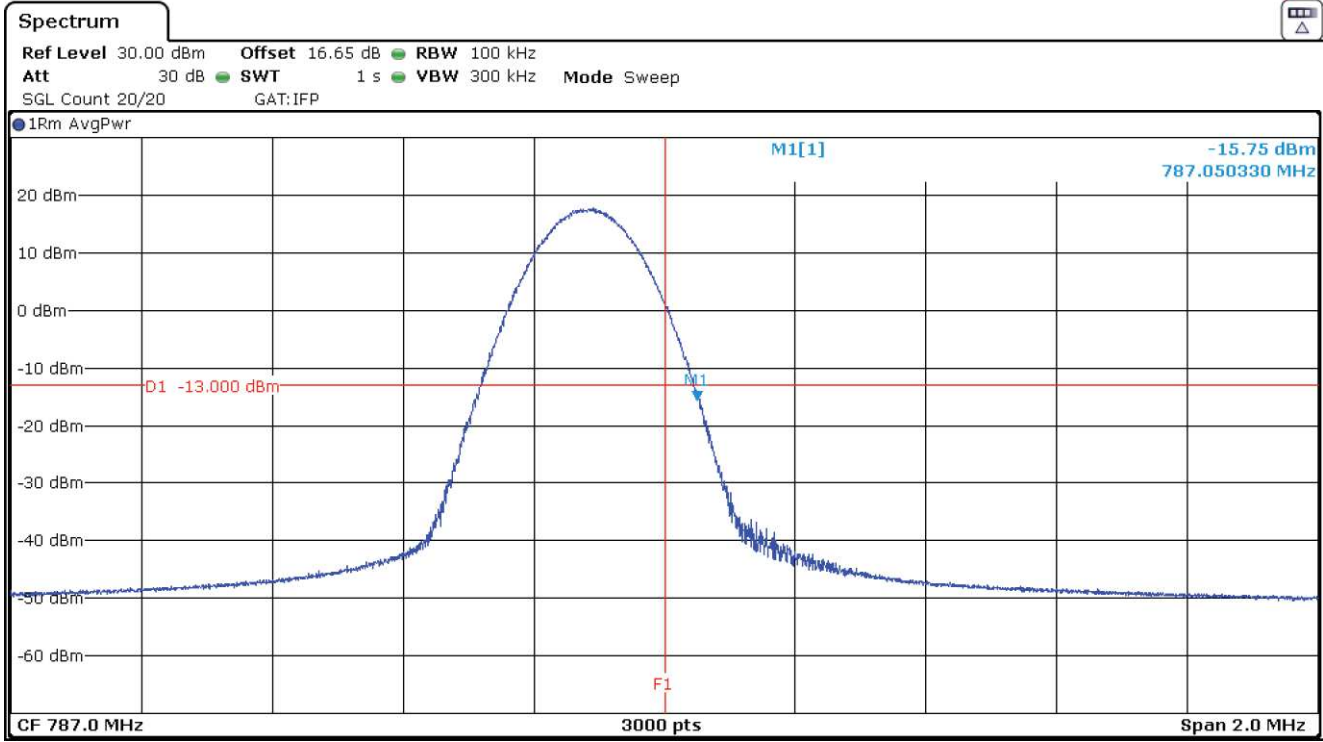
1 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 0

CHANNEL LOWEST



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

1 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 11  
 CHANNEL HIGHEST

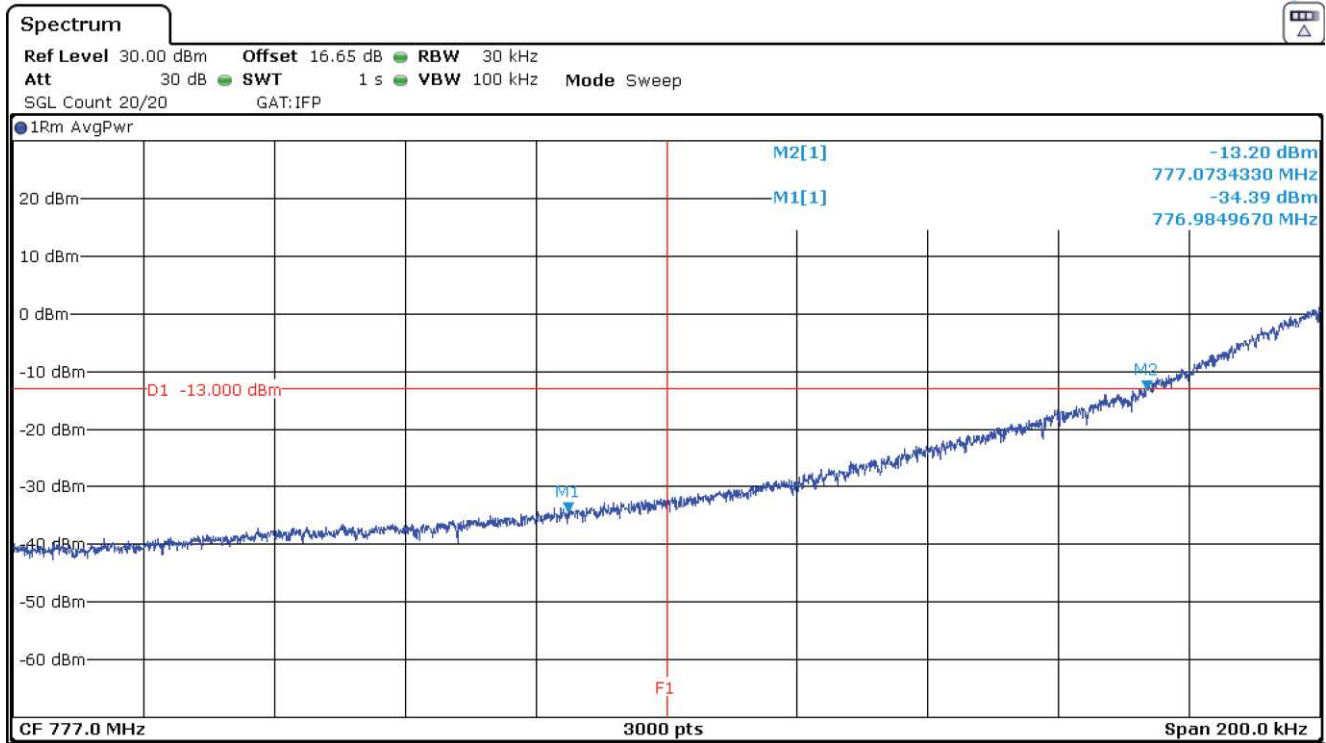
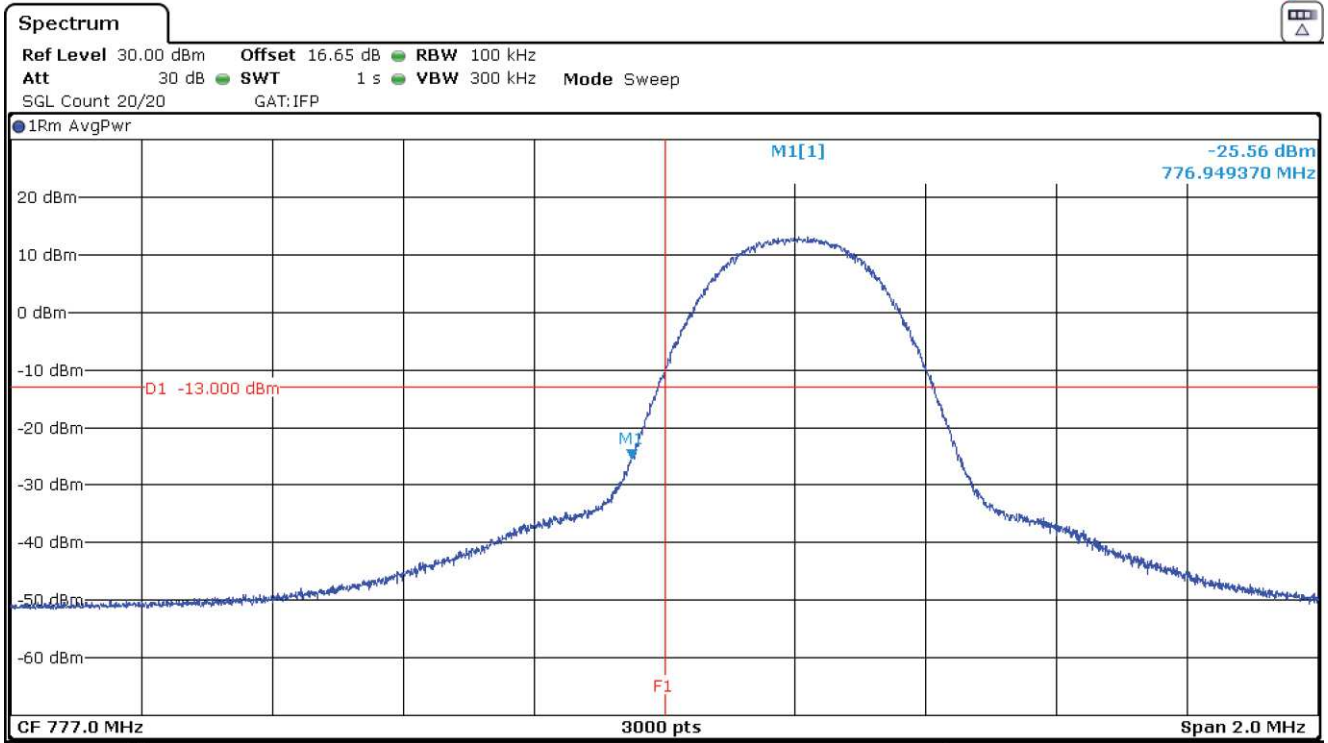


NOTE: Zoom (100KHz) with RBW=30KHz.

NB-IoT. BAND 13.

12 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 0

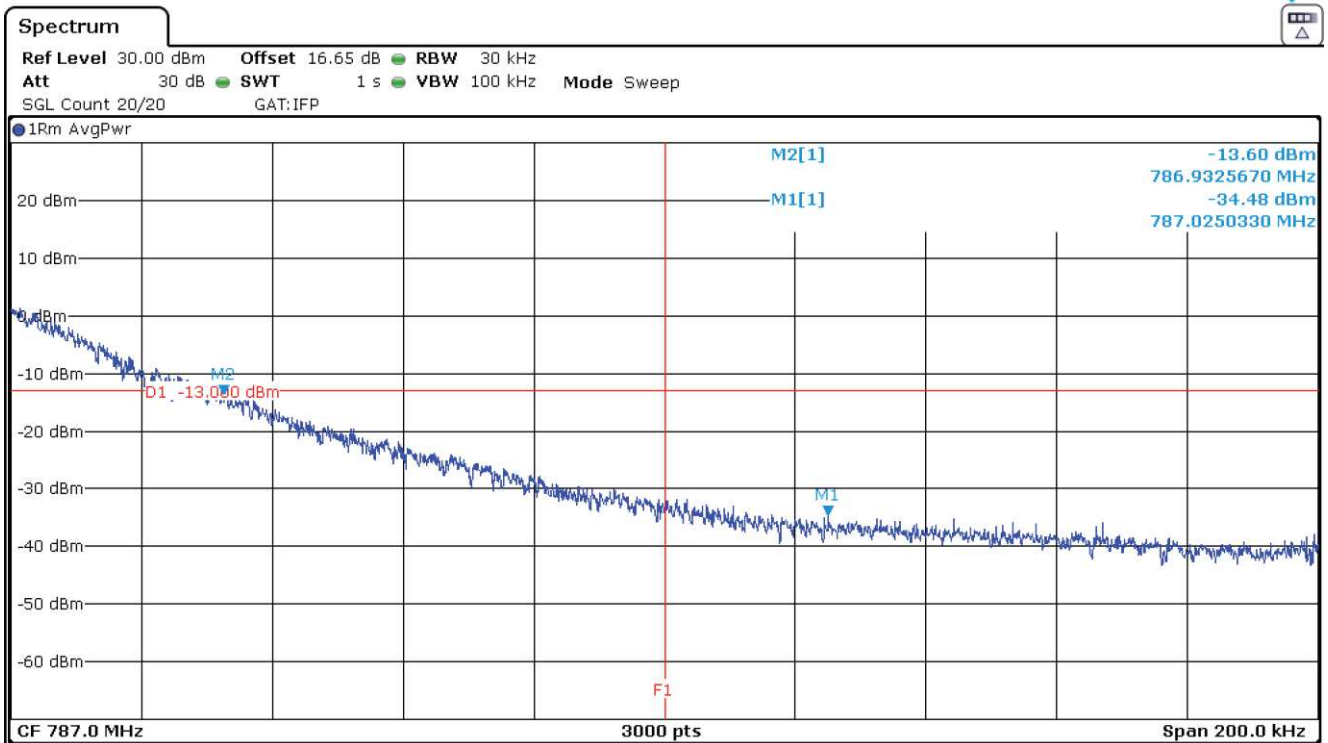
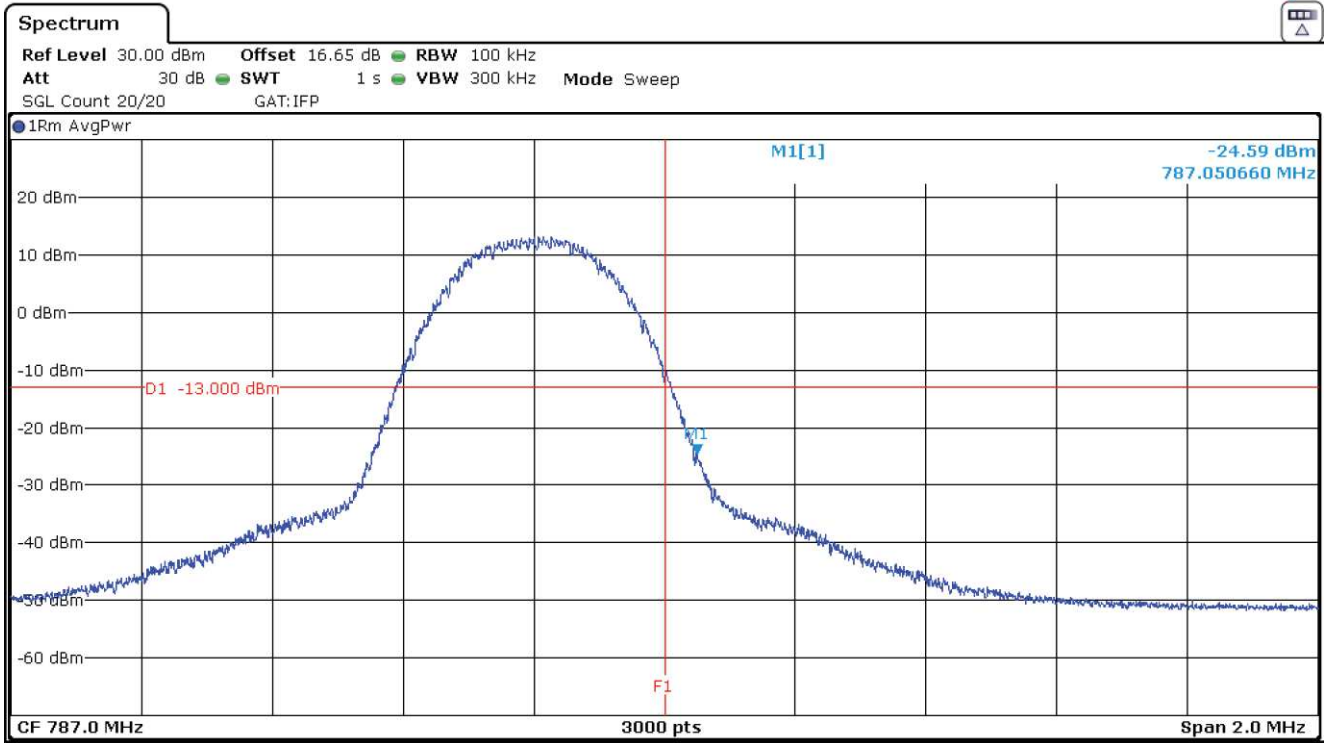
CHANNEL LOWEST



NB IoT. BAND 13.

12 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 0

CHANNEL HIGHEST

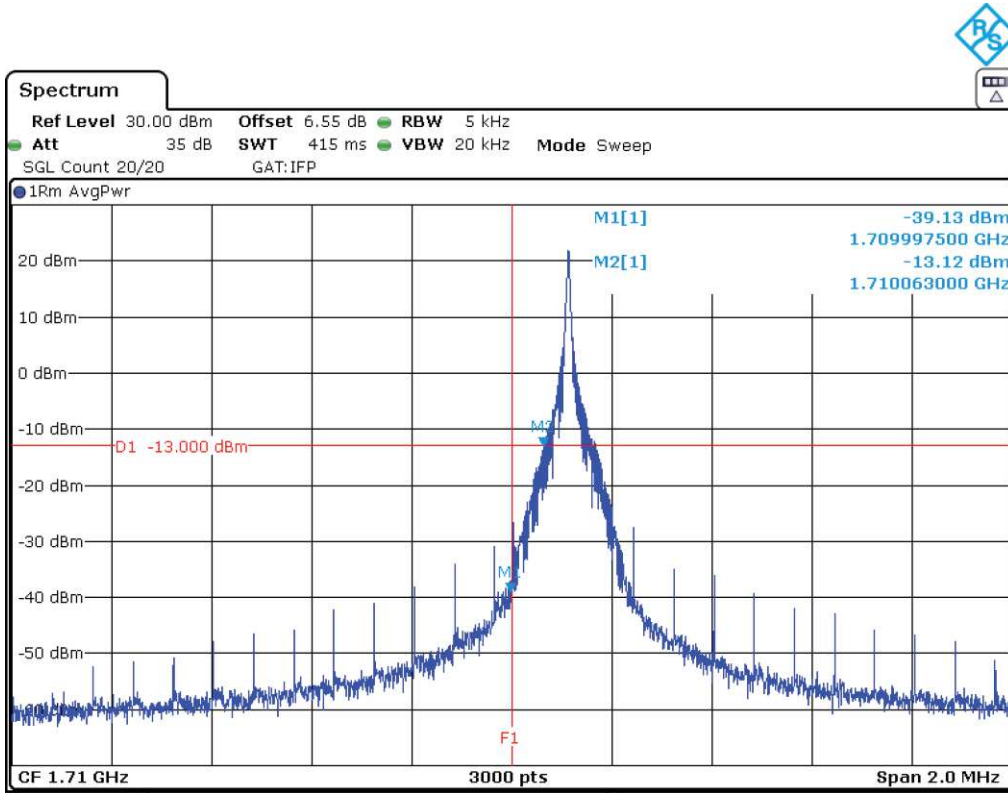


NOTE: Zoom (100KHz) with RBW=30KHz.

NB-IoT. BAND 66.

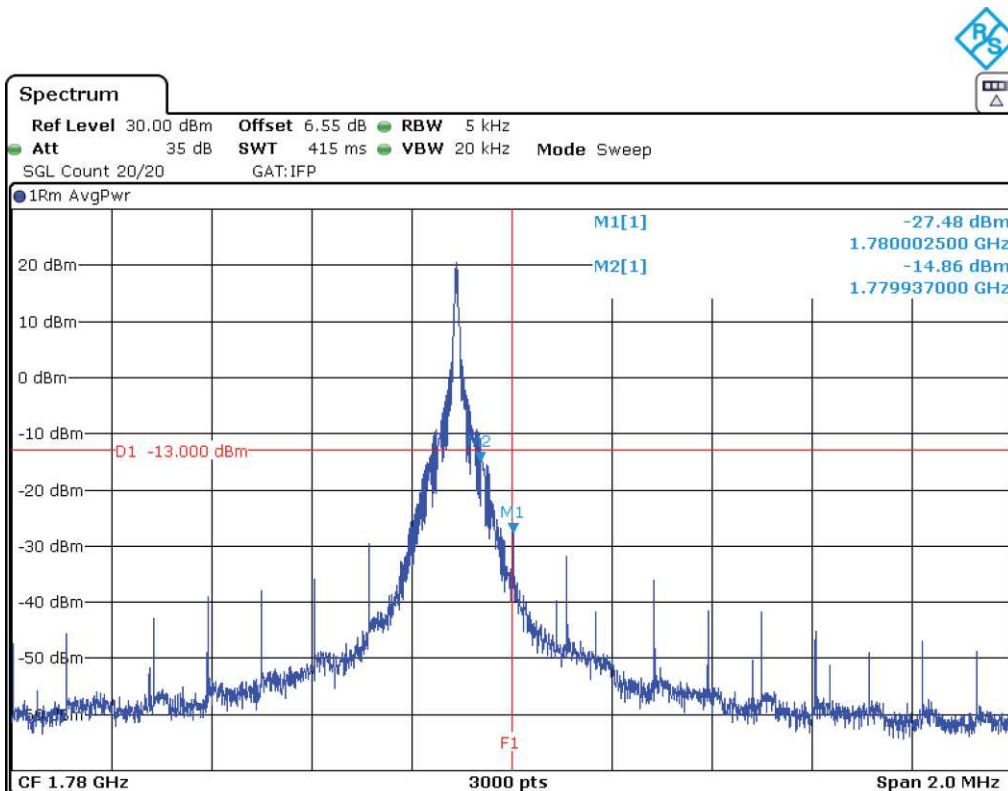
1 tone  $\pi/2$  – BPSK. BW=3.75 kHz Offset = 0

CHANNEL LOWEST



1 tone  $\pi/2$  – BPSK. BW=3.75 kHz Offset = 47

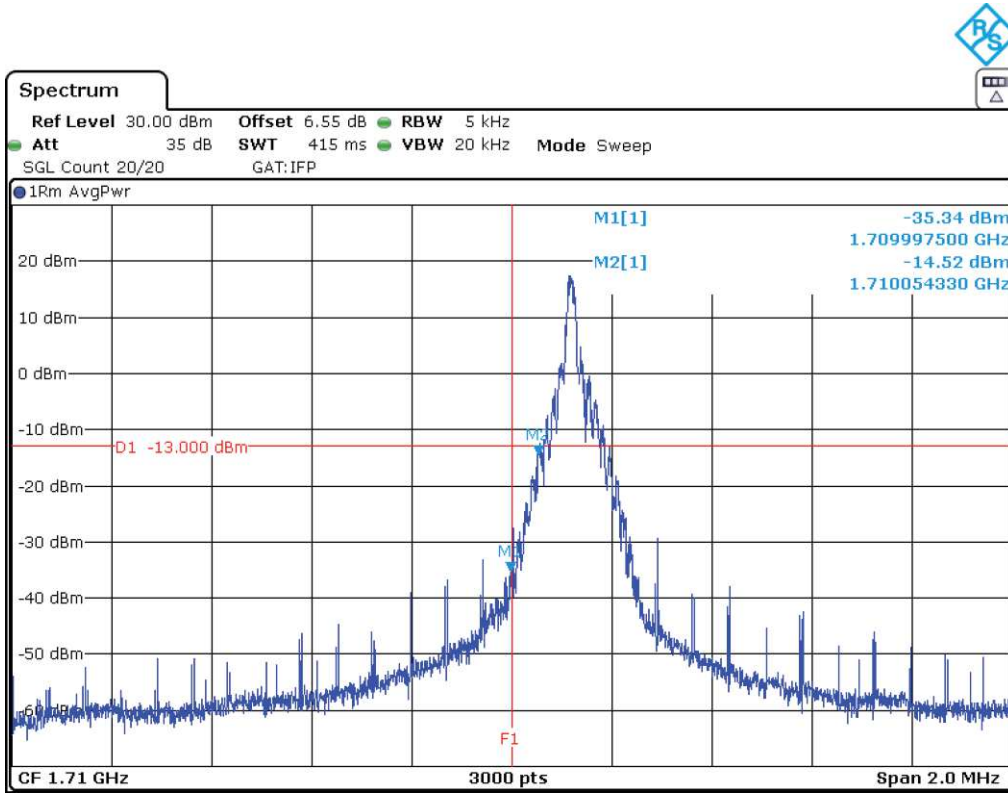
CHANNEL HIGHEST



NB-IoT. BAND 66.

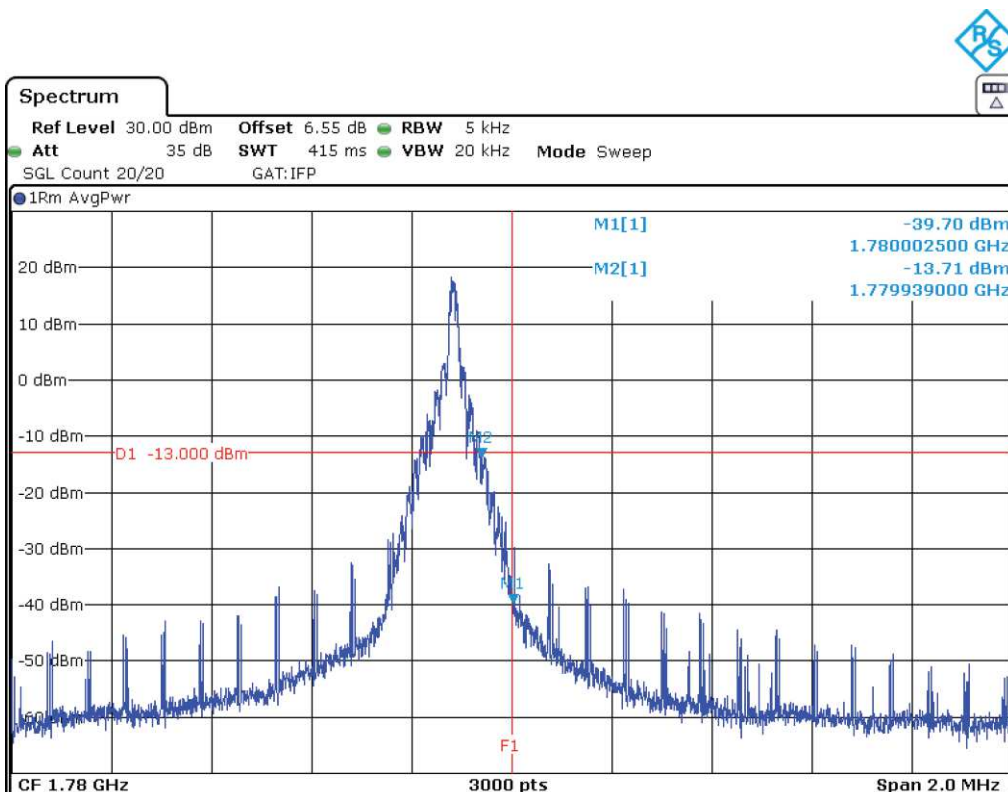
1 tone  $\pi/2$  – BPSK. BW=15 kHz Offset = 0

CHANNEL LOWEST



1 tone  $\pi/2$  – BPSK. BW=15 kHz Offset = 11

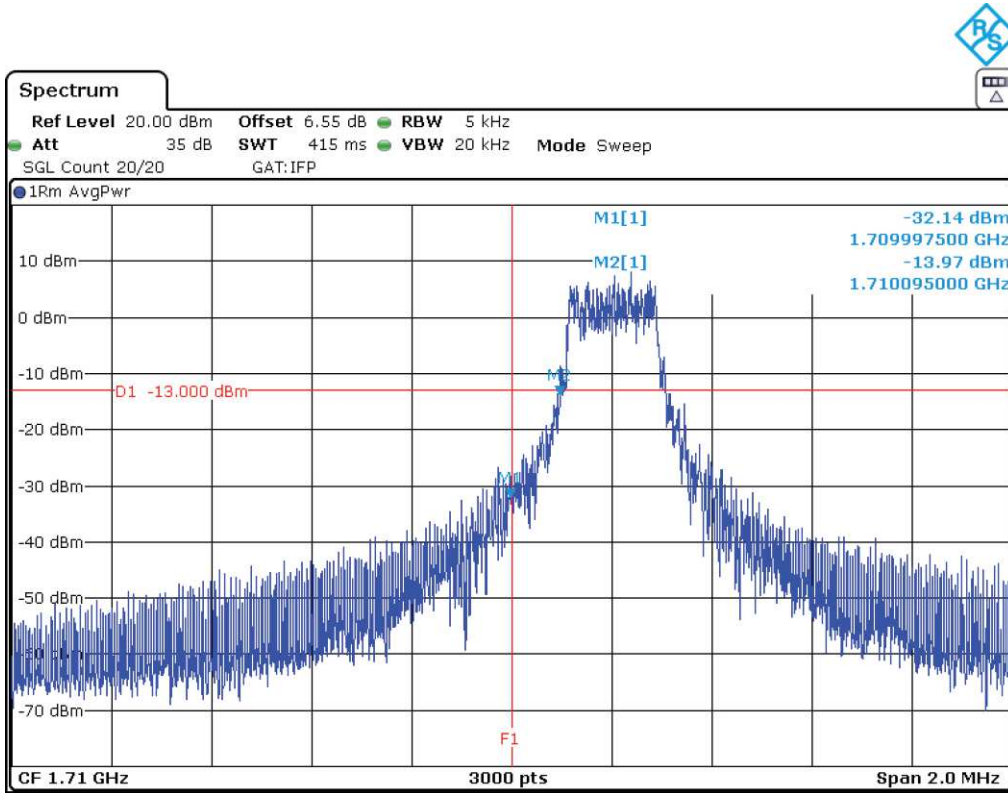
CHANNEL HIGHEST



NB-IoT. BAND 66.

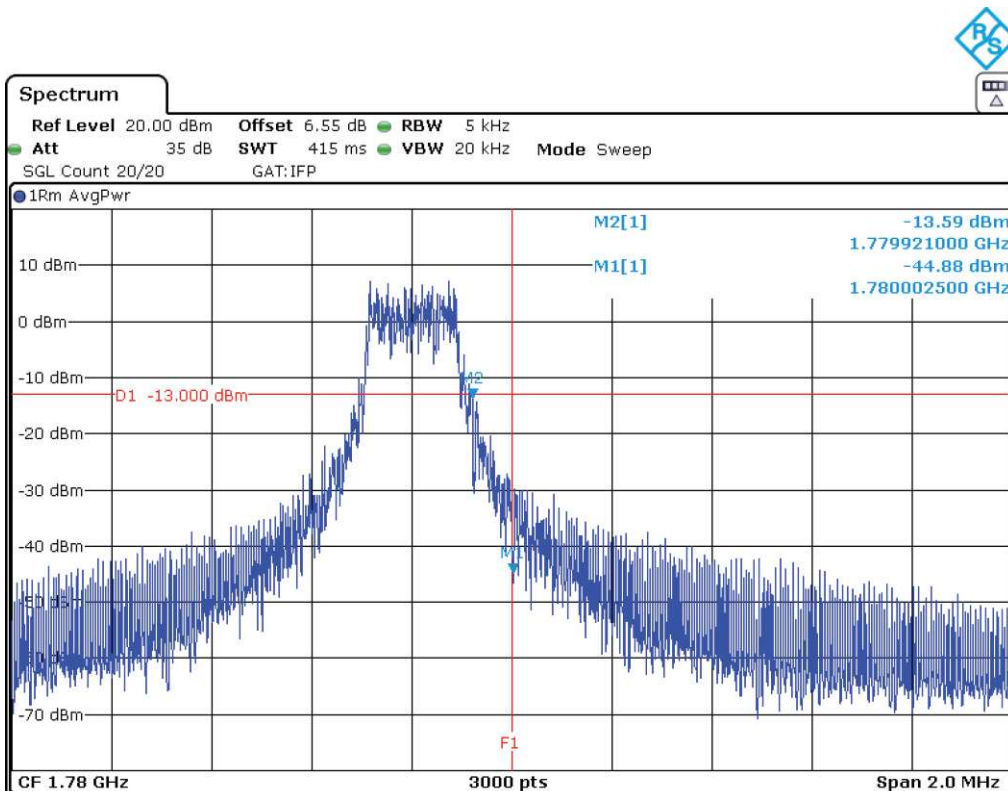
15 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 0

CHANNEL LOWEST



15 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 0

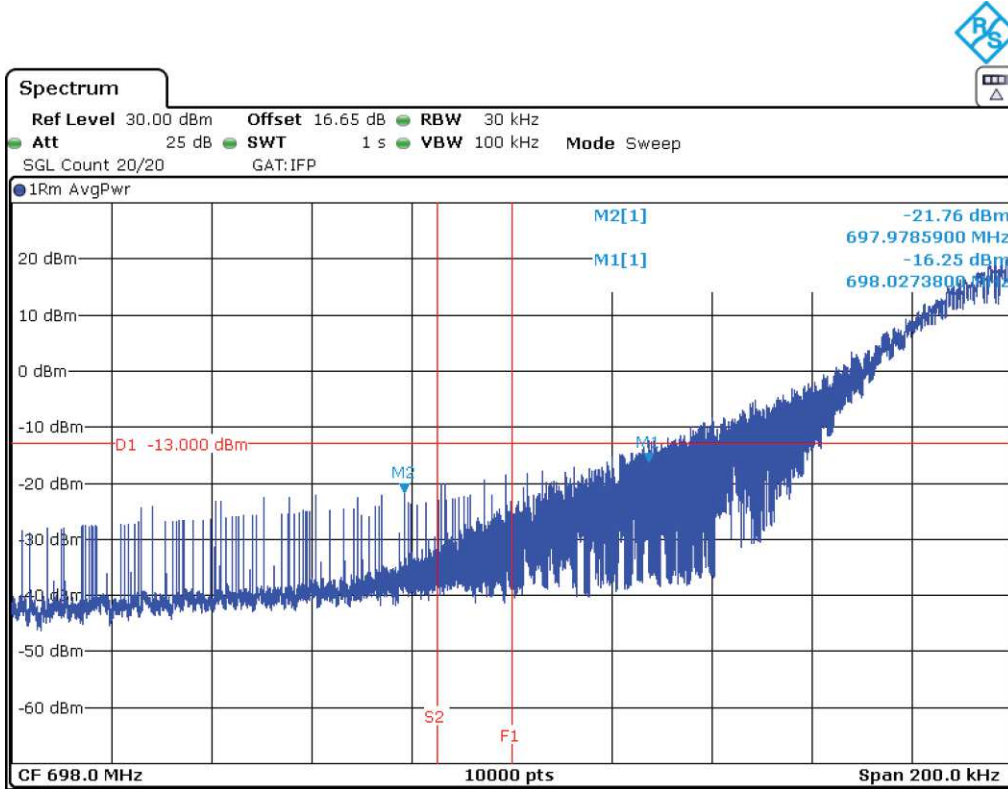
CHANNEL HIGHEST



NB-IoT. BAND 85.

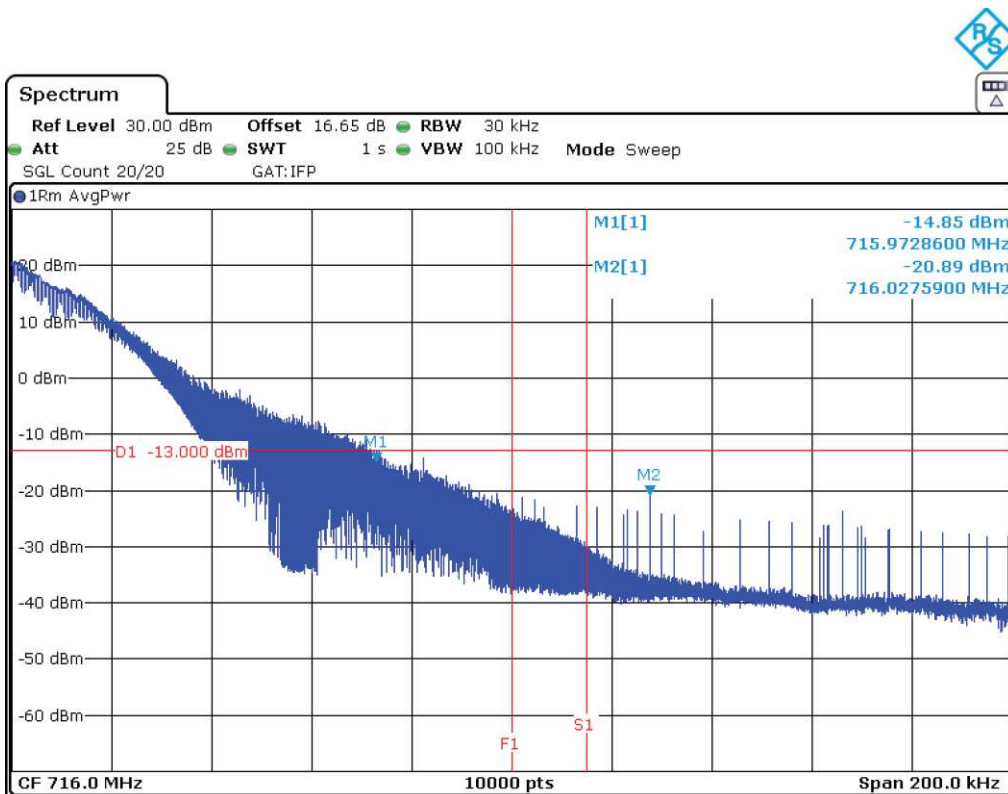
1 tone  $\pi/4$  – QPSK. BW=3.75 kHz Offset = 0

CHANNEL LOWEST



1 tone  $\pi/4$  – QPSK. BW=3.75 kHz Offset = 47

CHANNEL HIGHEST

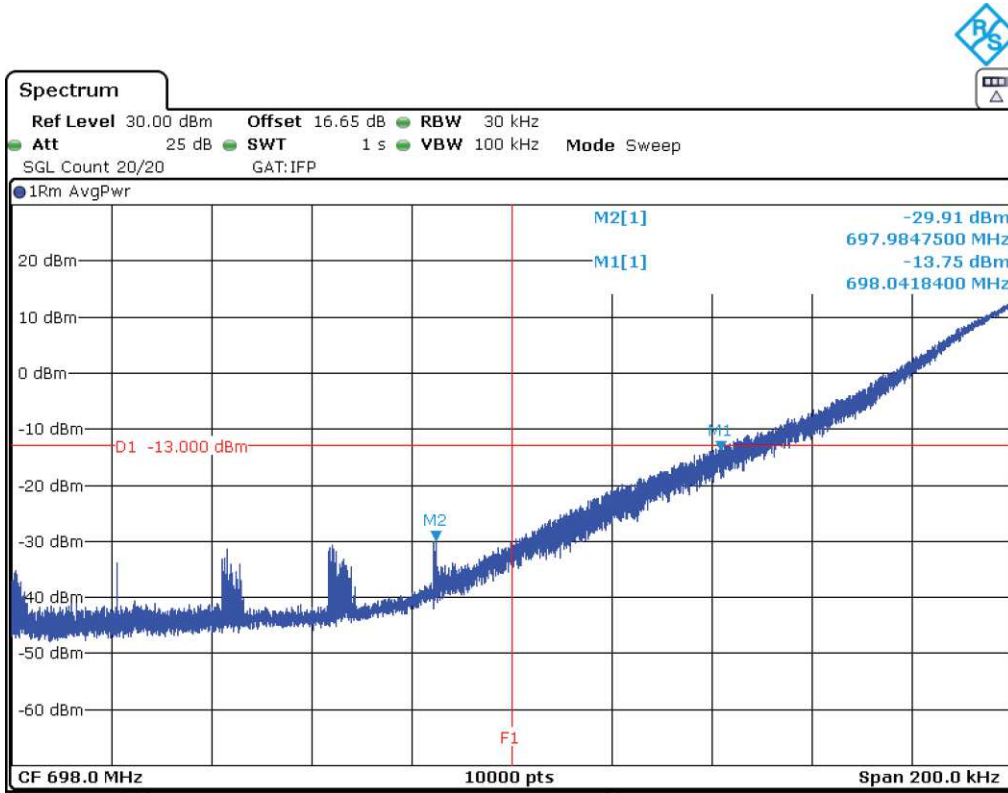




NB-IoT. BAND 85.

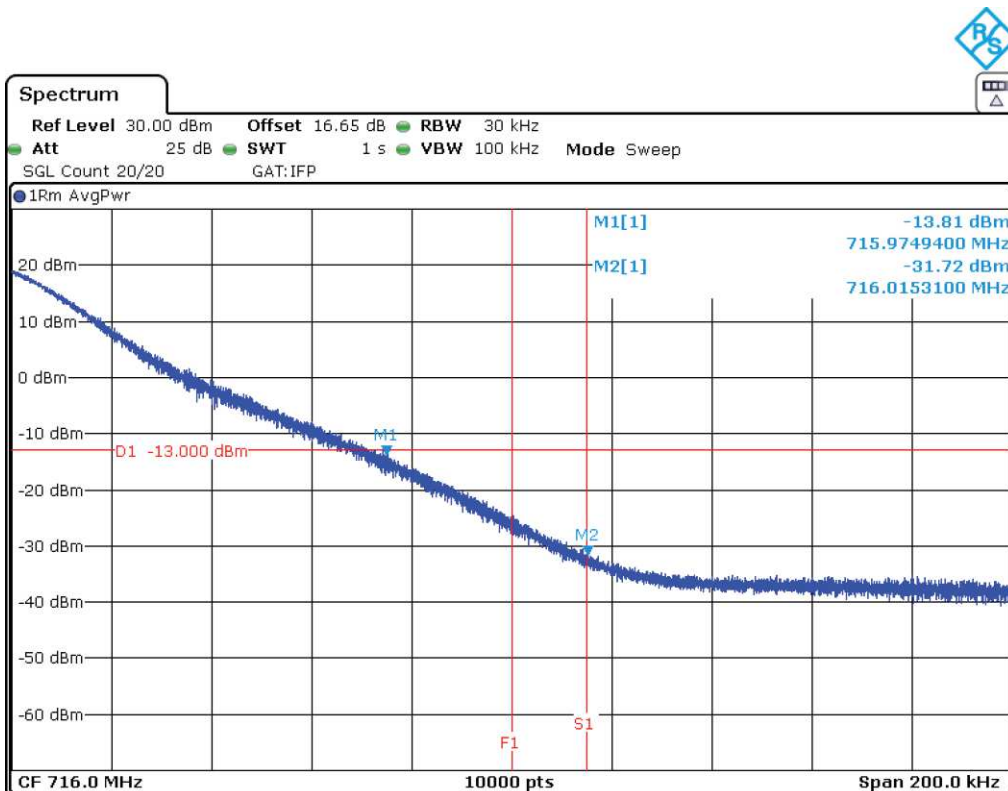
1 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 0

CHANNEL LOWEST



1 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 11

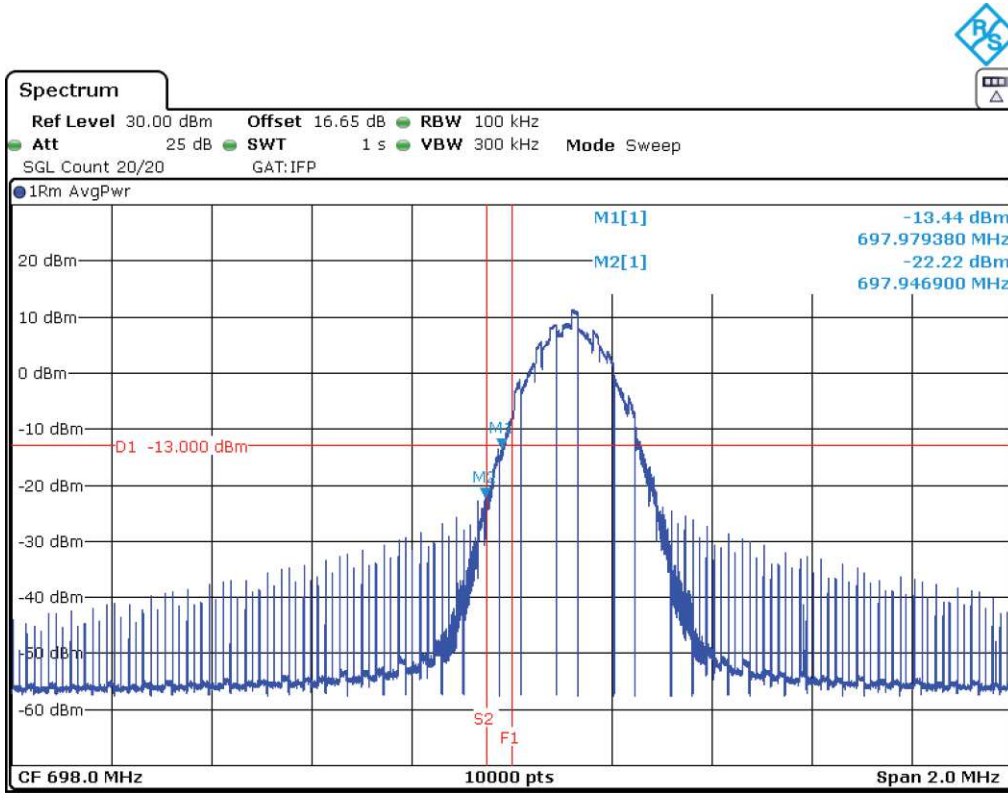
CHANNEL HIGHEST



NB-IoT. BAND 85.

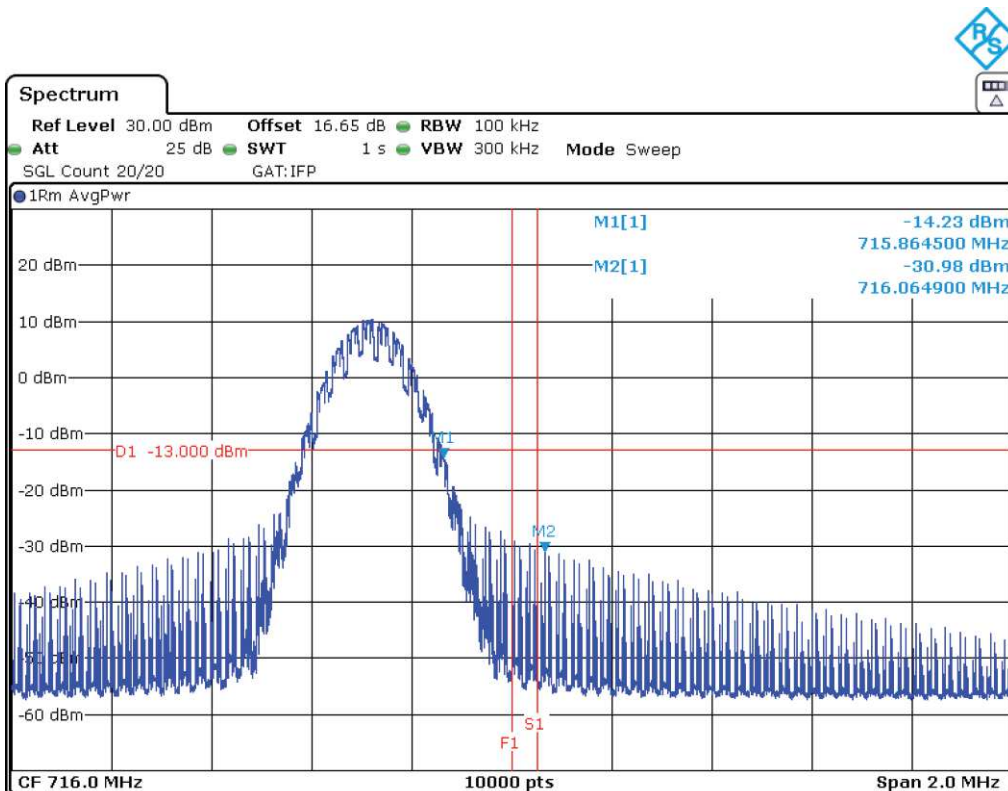
12 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 0

CHANNEL LOWEST



12 tone  $\pi/4$  – QPSK. BW=15 kHz Offset = 0

CHANNEL HIGHEST



## Radiated emissions

### SPECIFICATION

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. However. in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block. a resolution bandwidth of at least 30 kHz may be employed

FCC §27.53 (c) & (f).

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.

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.

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 ( $-40$  dBm)/MHz equivalent isotropically radiated power (EIRP) for wideband signals. and  $-80$  dBW ( $-50$  dBm) EIRP for discrete emissions of less than 700 Hz bandwidth.

RSS-130 Clause 4.6.

The power of any unwanted emissions in any 100 kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power. P (dBW). by at least  $43 + 10 \log_{10} p$  (watts). dB.

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 ( $-40$  dBm) /MHz for wideband signal and  $-80$  dBW ( $-50$  dBm) for discrete emission with bandwidth less than 700 Hz.

FCC §27.53 (h). RSS-139 Clause 6.6.

According to specification. 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.

At  $P_o$  transmitting power. the specified minimum attenuation becomes  $43+10 \log (P_o)$ . and the level in dBm relative  $P_o$  becomes:

$P_o$  (dBm) –  $[43 + 10 \log (P_o \text{ in mwatts}) - 30] = -13$  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 below 1 GHz and at 1 m distance for measurements above 1 GHz.

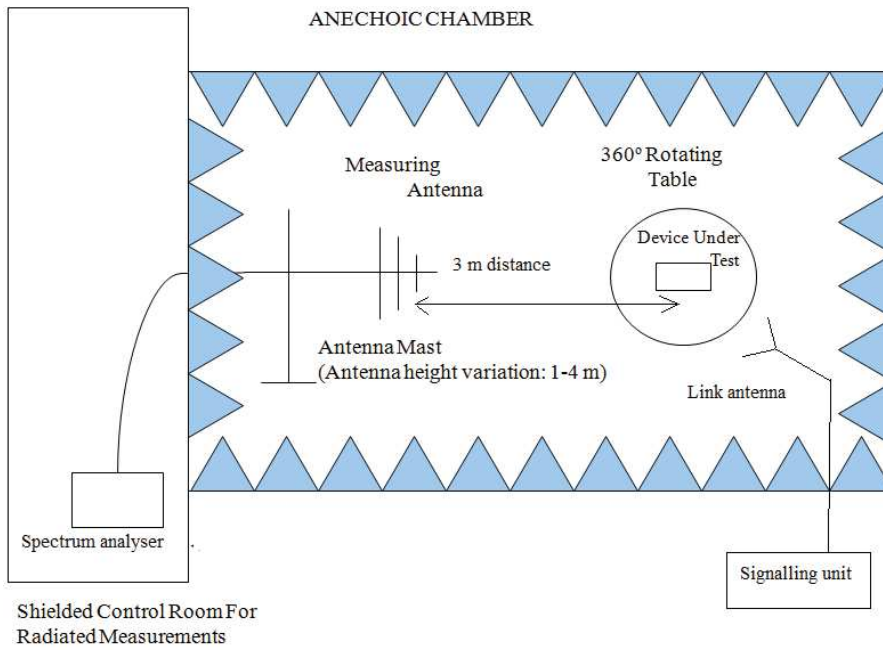
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum field strength (dB $\mu$ V/m) is measured and recorded.

The maximum field strength (dB $\mu$ V/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:

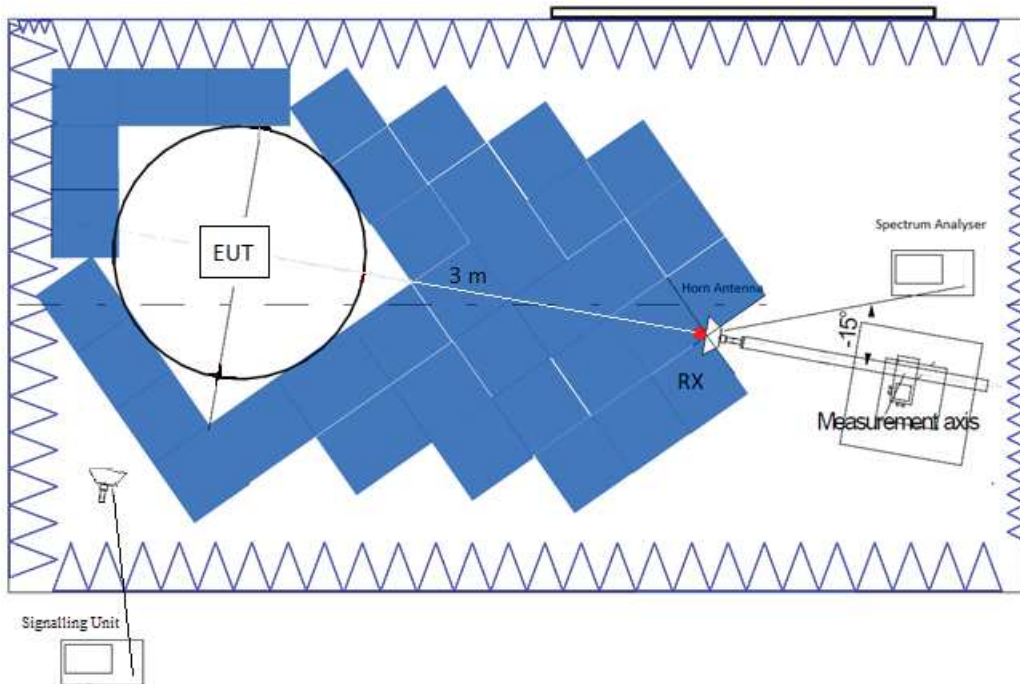
$EIRP$  (dBm) =  $E$  (dB $\mu$ V/m) +  $20\log(D) - 104.8$ ; where D is the measurement distance (in the far field region) in m.  $D = 3$  m

**TEST SETUP**

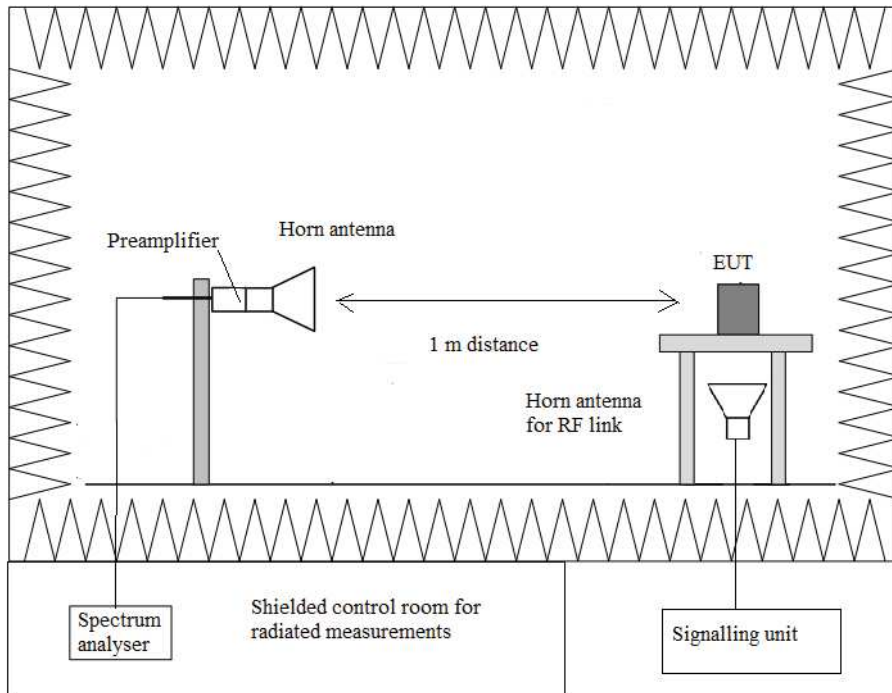
Radiated measurements below 1 GHz.



Radiated measurements above 1 GHz.



Radiated measurements above 18 GHz.



## RESULTS

### NB IoT. BAND 12.

Preliminary measurements determined that 1 tone of 15kHz ( $\pi/4$  – QPSK) as the worst case. The results in the next tables shows the results for this configuration.

#### 1. CHANNEL: LOWEST

##### **Frequency range 30 MHz-1000 MHz.**

No radiated spurious signals were detected.

##### **Frequency range 1 GHz-8 GHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

#### 2. CHANNEL: MIDDLE

##### **Frequency range 30 MHz-1000 MHz.**

No radiated spurious signals were detected.

##### **Frequency range 1 GHz-8 GHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

#### 3. CHANNEL: HIGHEST

##### **Frequency range 30 MHz-1000 MHz.**

No radiated spurious signals were detected.

##### **Frequency range 1 GHz-8 GHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Measurement uncertainty (dB)	< $\pm$ 4.65 for $f < 1$ GHz < $\pm$ 4.98 for $f \geq 1$ GHz up to 8 GHz
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Verdict: PASS

NBLoT. BAND 13.

Preliminary measurements determined that 1 tone of 15kHz ( $\pi/4$  – QPSK) as the worst case. The results in the next tables shows the results for this configuration.

1. CHANNEL: LOWEST

**Frequency range 30 MHz-1000 MHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

**Frequency range 1 GHz-8 GHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

**Frequency range 1559 MHz-1610 MHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE

**Frequency range 30 MHz-1000 MHz.**

No radiated spurious signals were detected.

**Frequency range 1 GHz-8 GHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

**Frequency range 1559 MHz-1610 MHz.**

Spurious frequency (MHz)	Detector	E.I.R.P. (dBm)	Polarization
1.563834	RMS	-48.74	H

3. CHANNEL: HIGHEST

**Frequency range 30 MHz-1000 MHz.**

No radiated spurious signals were detected.

**Frequency range 1 GHz-8 GHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

**Frequency range 1559 MHz-1610 MHz.**

Spurious frequency (MHz)	Detector	E.I.R.P. (dBm)	Polarization
1.573561	RMS	-48.08	H

Measurement uncertainty (dB)	< $\pm$ 4.65 for $f < 1$ GHz < $\pm$ 4.98 for $f \geq 1$ GHz up to 8 GHz
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Verdict: PASS

NBLoT. BAND 66.

Preliminary measurements determined that 1 tone of 3.75kHz as the worst case. The results in the next tables shows the results for this configuration.

1. CHANNEL: LOWEST

**Frequency range 30 MHz-1000 MHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

**Frequency range 1 GHz-18 GHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE

**Frequency range 30 MHz-1000 MHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

**Frequency range 1 GHz-18 GHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST

**Frequency range 30 MHz-1000 MHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

**Frequency range 1 GHz-18 GHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Measurement uncertainty (dB)	<±4.65 for f < 1GHz <±3.98 for f ≥ 1 GHz up to 3 GHz <±4.98 for f ≥ 3 GHz up to 18 GHz
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Verdict: PASS



NBLoT. BAND 85.

Preliminary measurements determined that 1 tone of 15kHz ( $\pi/4$  – QPSK) as the worst case. The results in the next tables shows the results for this configuration.

1. CHANNEL: LOWEST

**Frequency range 30 MHz-1000 MHz.**

No radiated spurious signals were detected.

**Frequency range 1 GHz-8 GHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE

**Frequency range 30 MHz-1000 MHz.**

No radiated spurious signals were detected.

**Frequency range 1 GHz-8 GHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST

**Frequency range 30 MHz-1000 MHz.**

No radiated spurious signals were detected.

**Frequency range 1 GHz-8 GHz.**

No radiated spurious signals were detected at less than 20 dB respect to the limit.

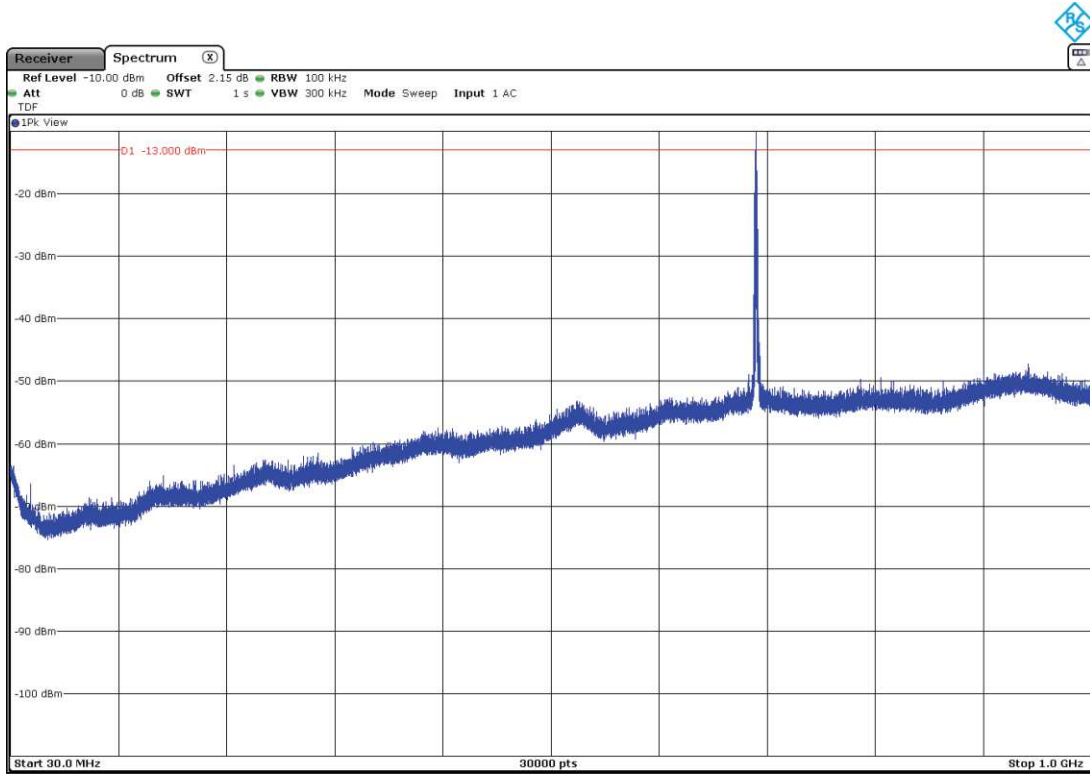
Measurement uncertainty (dB)	< $\pm$ 4.65 for $f < 1\text{GHz}$ < $\pm$ 4.98 for $f \geq 1\text{GHz}$ up to 8 GHz
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Verdict: PASS

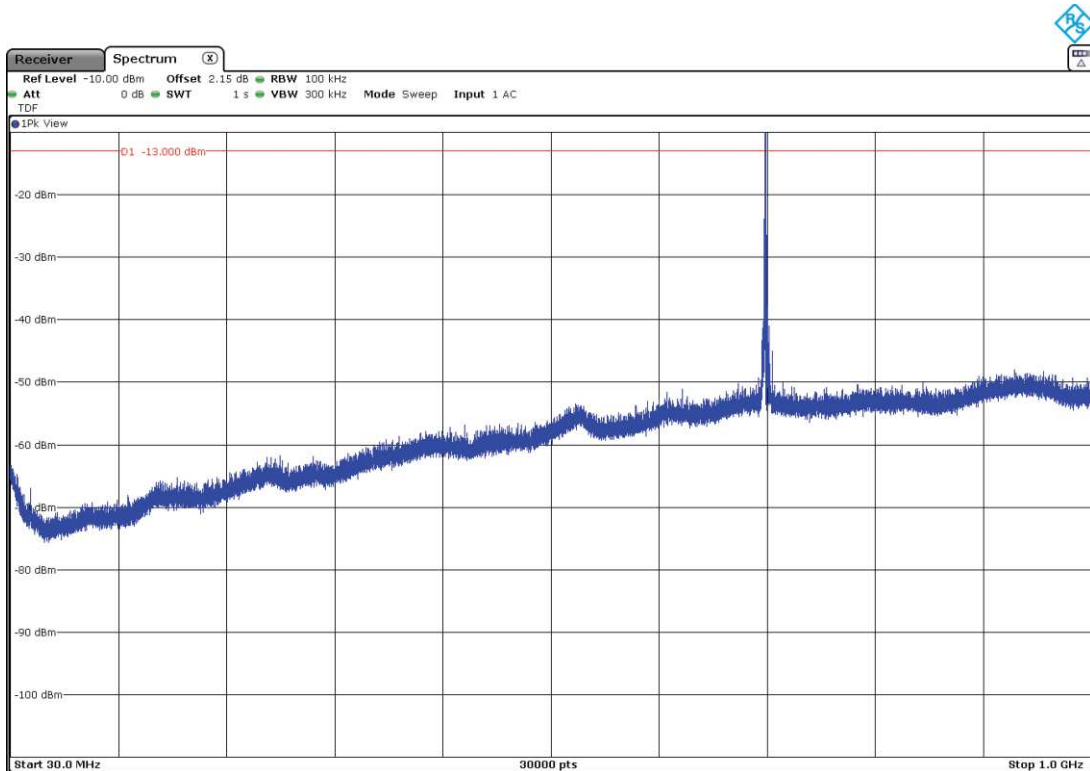
## NB IoT Band 12

Frequency range 30 MHz to 1 GHz

CHANNEL: LOWEST

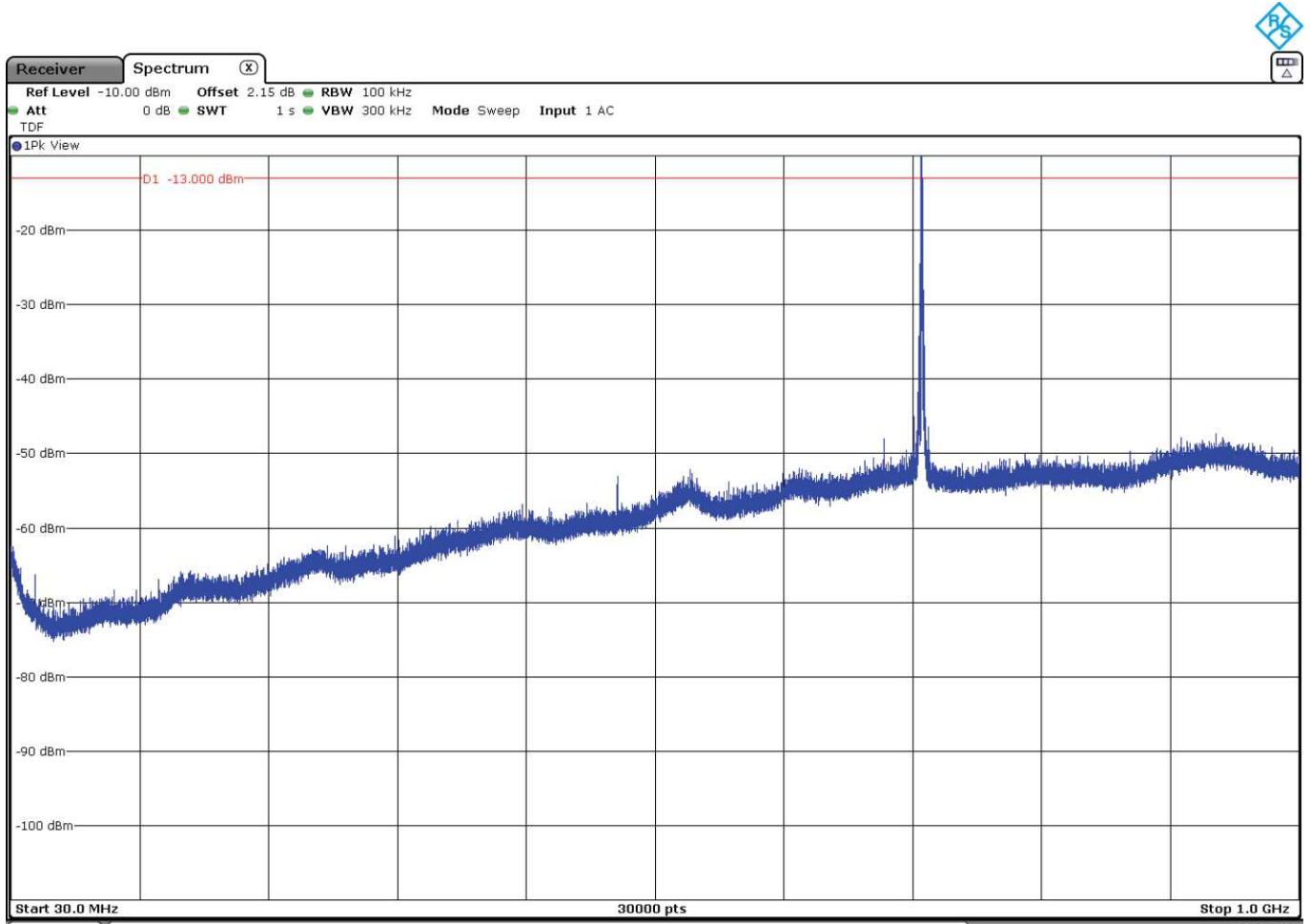


Note: The peak above the limit is the carrier frequency.



Note: The peak above the limit is the carrier frequency.

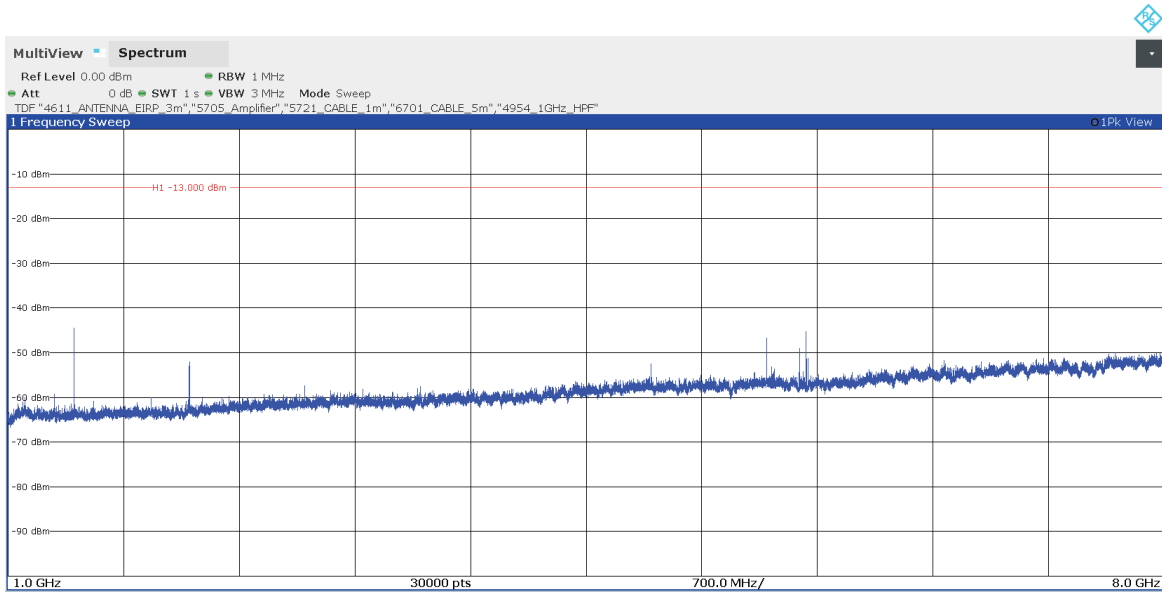
CHANNEL: HIGHEST



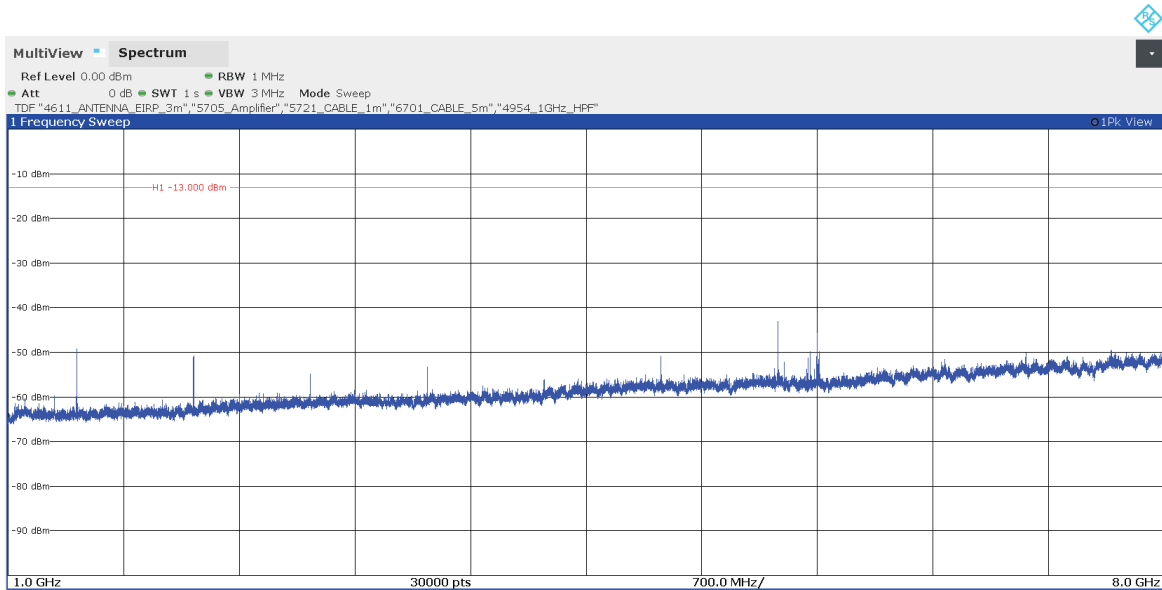
Note: The peak above the limit is the carrier frequency.

Frequency range 1 GHz to 8 GHz

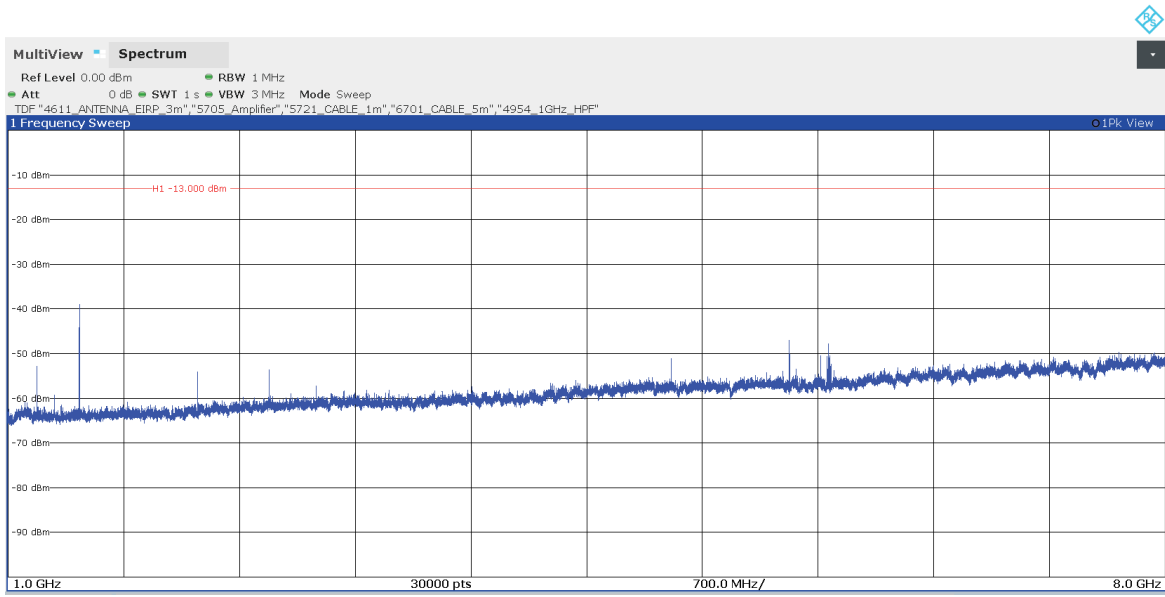
CHANNEL: LOWEST



CHANNEL: MIDDLE



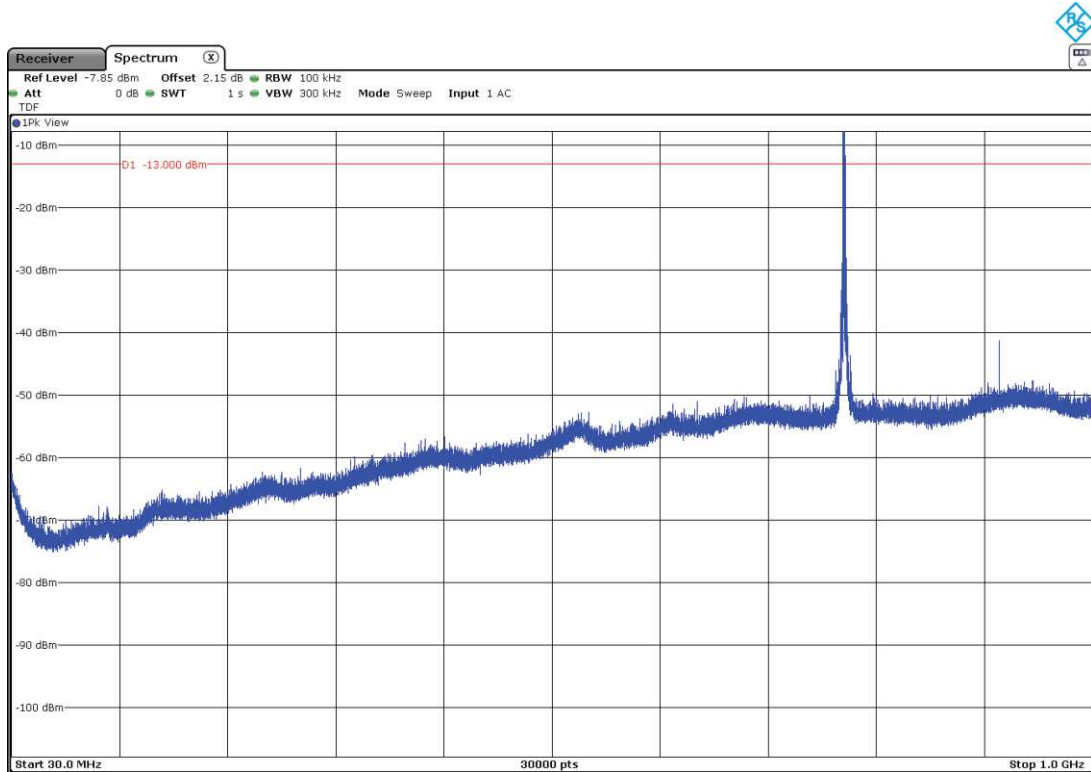
CHANNEL: HIGHEST



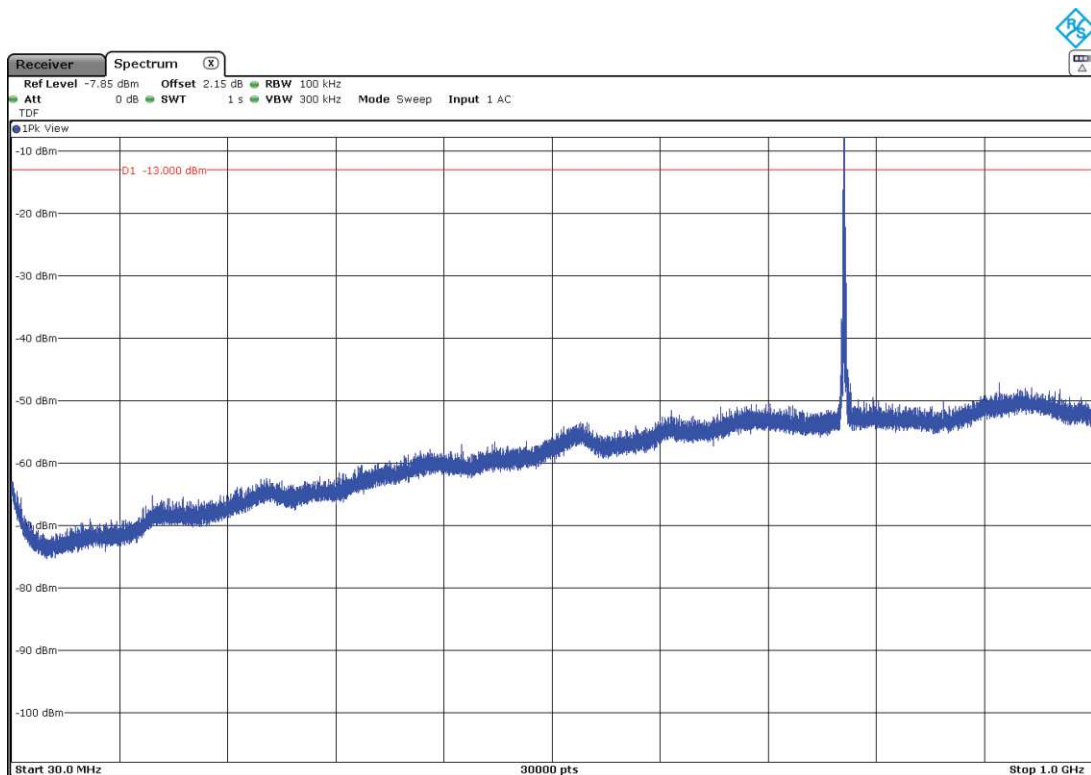
## NB-IoT Band 13

Frequency range 30 MHz to 1 GHz

CHANNEL: LOWEST

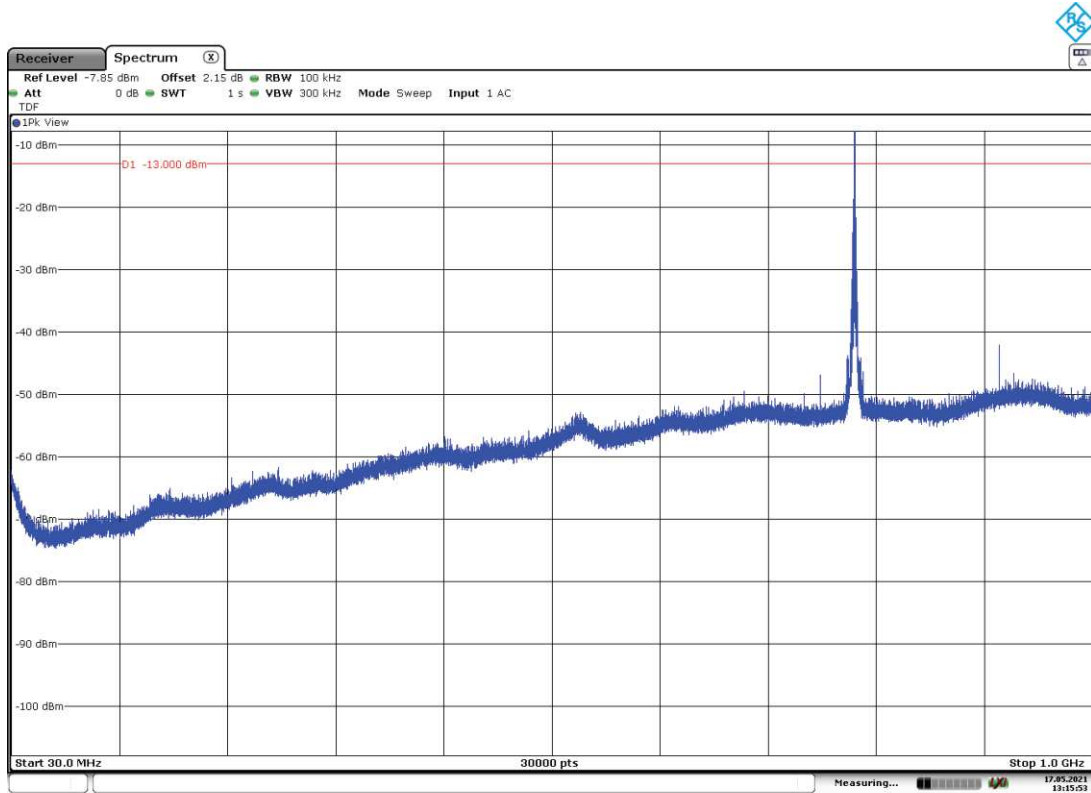


Note: The peak above the limit is the carrier frequency. The peak at 746MHz corresponds to the downlink signal.  
CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency. The peak at 751MHz corresponds to the downlink signal.

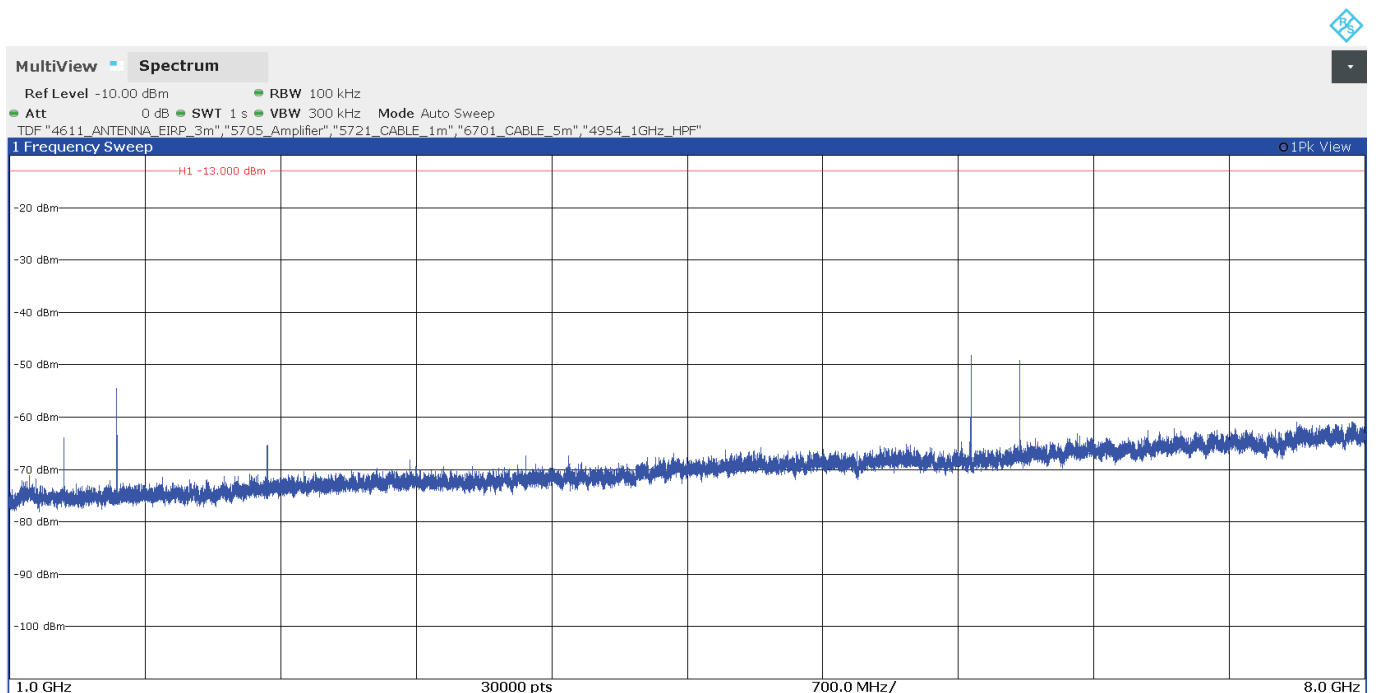
### CHANNEL: HIGHEST



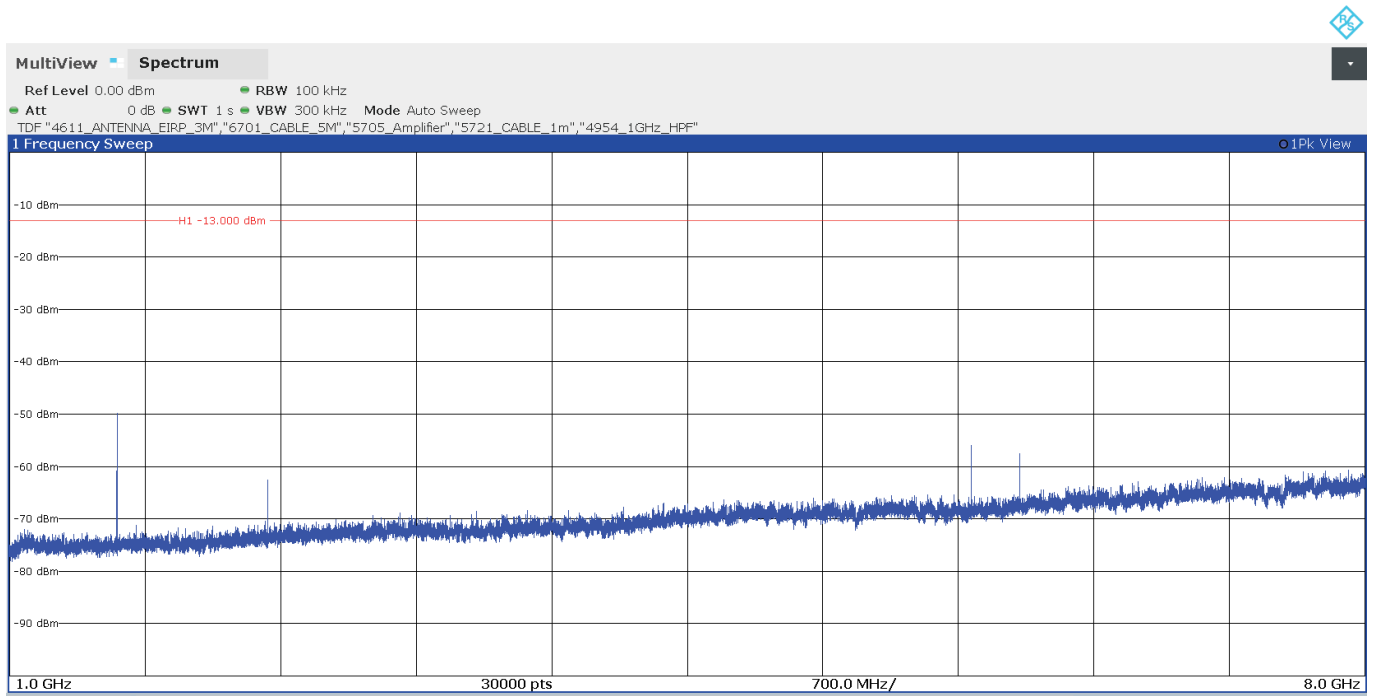
Note: The peak above the limit is the carrier frequency. The peak at 756MHz corresponds to the downlink signal.

### Frequency range 1 GHz to 8 GHz

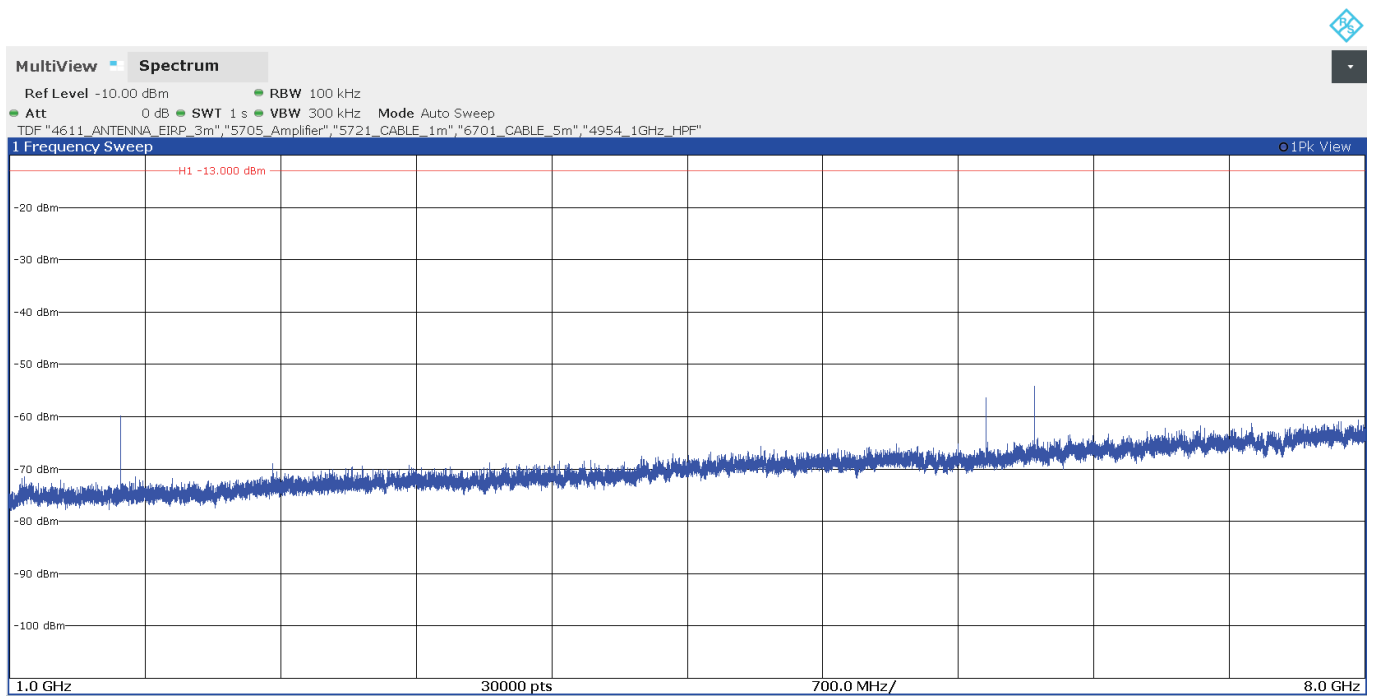
### CHANNEL: LOWEST



### CHANNEL: MIDDLE



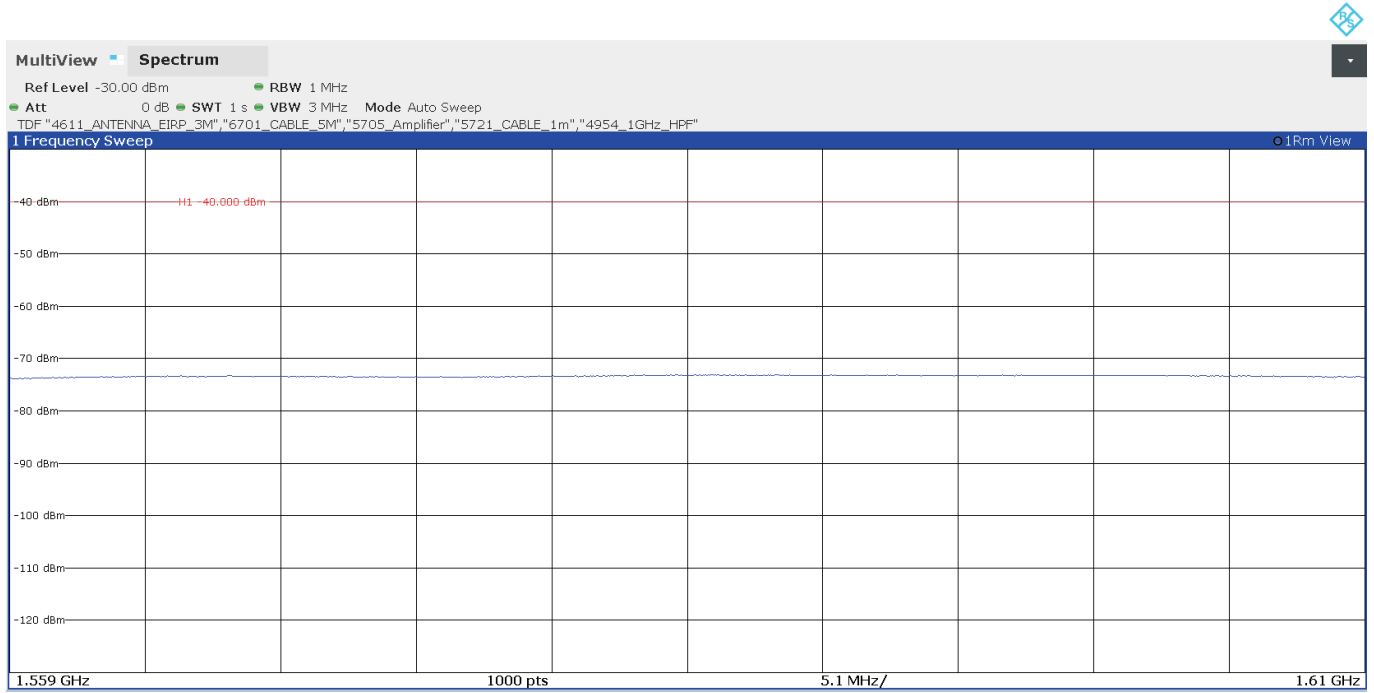
### CHANNEL: HIGHEST



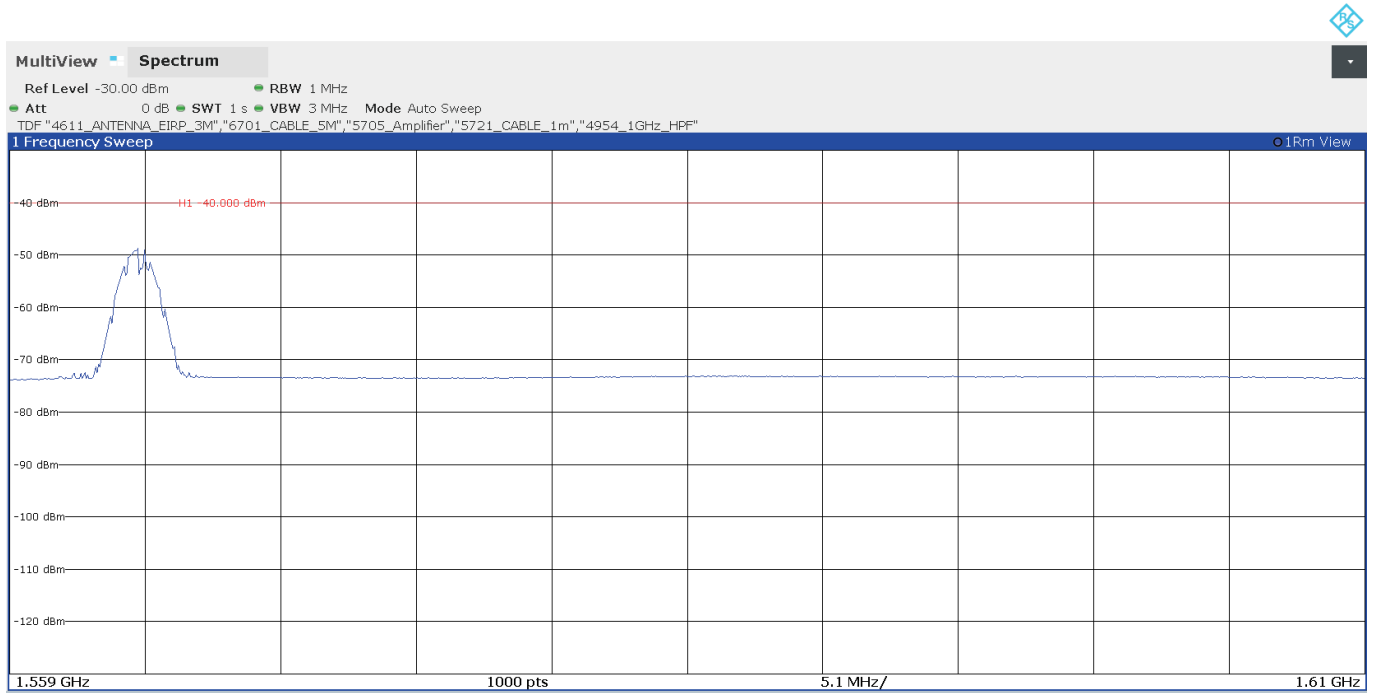


Frequency range 1559 MHz to 1610 MHz.

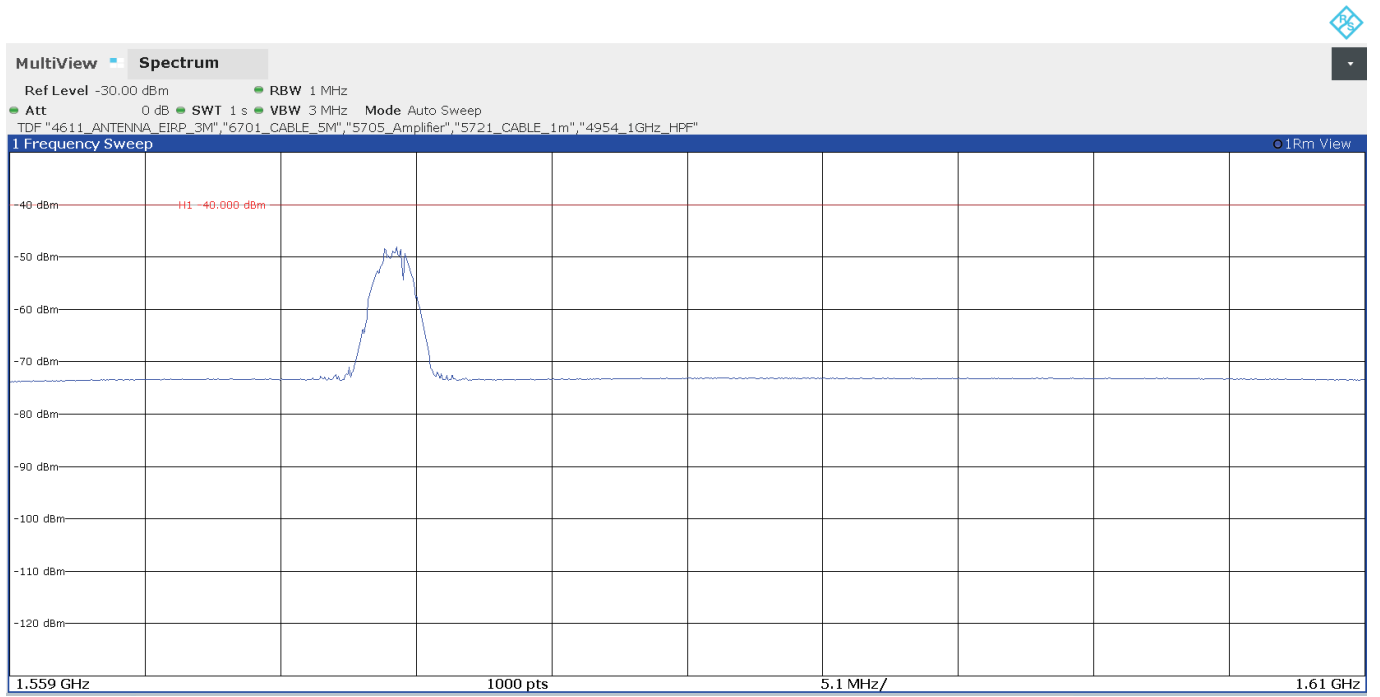
CHANNEL: LOWEST



CHANNEL: MIDDLE



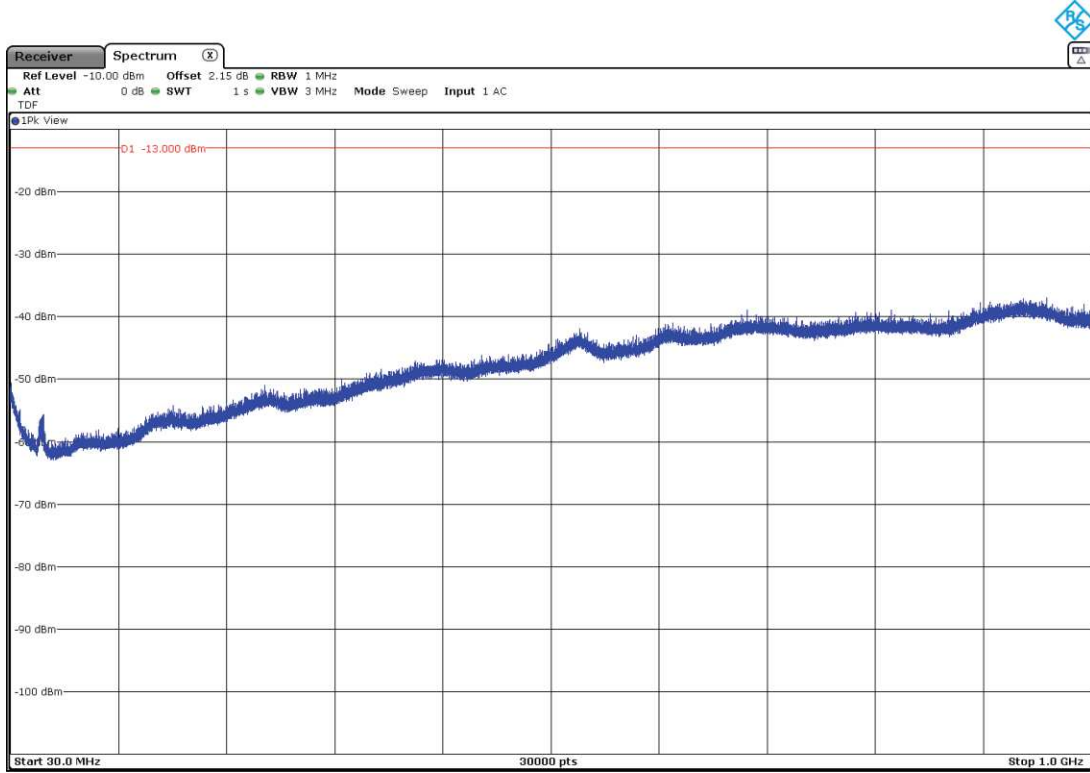
CHANNEL: HIGHEST



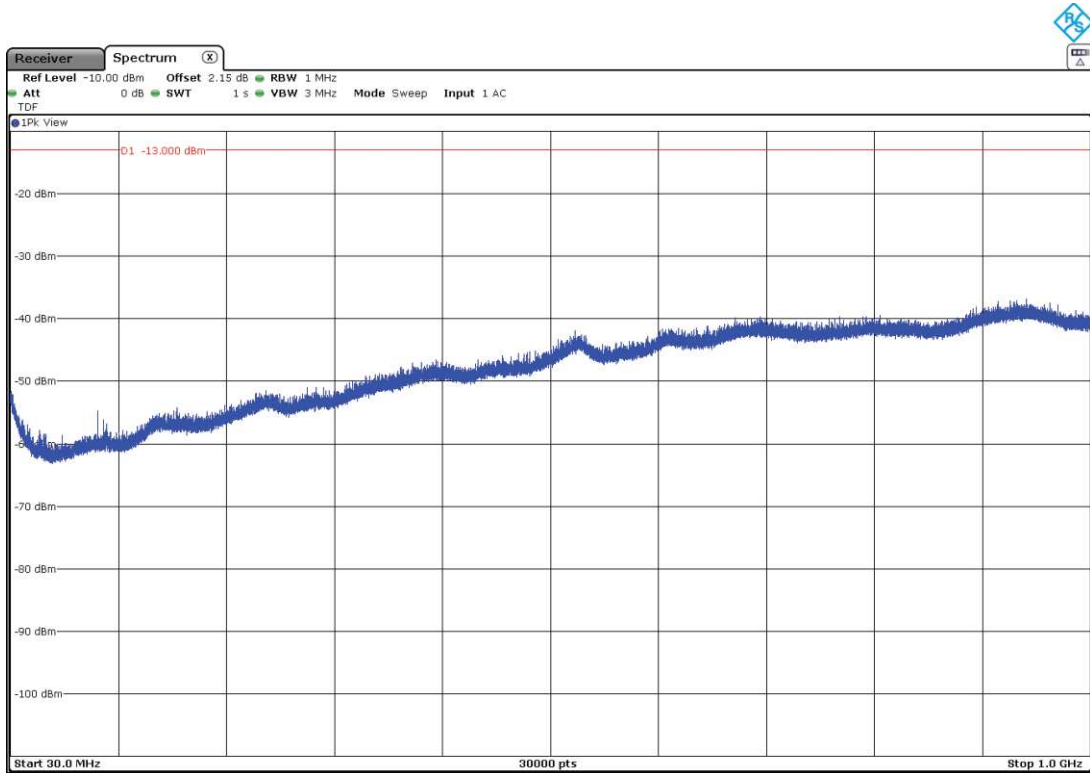
## NB-IoT Band 66

Frequency range 30 MHz to 1 GHz

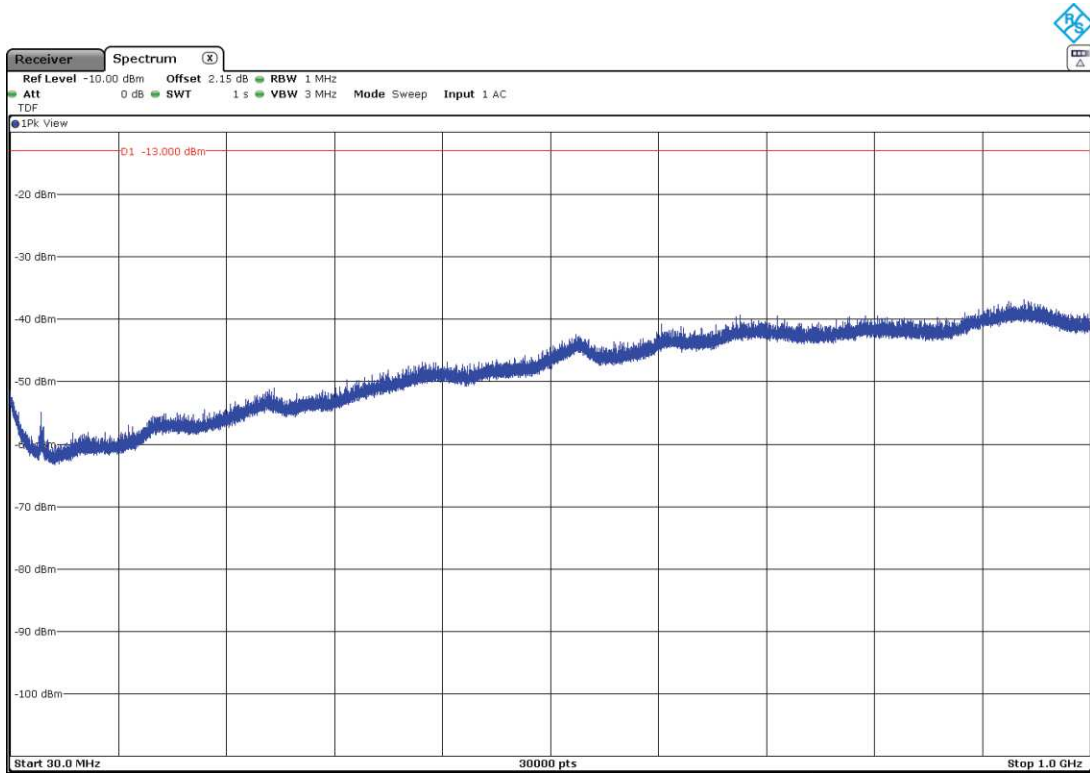
CHANNEL: LOWEST



CHANNEL: MIDDLE

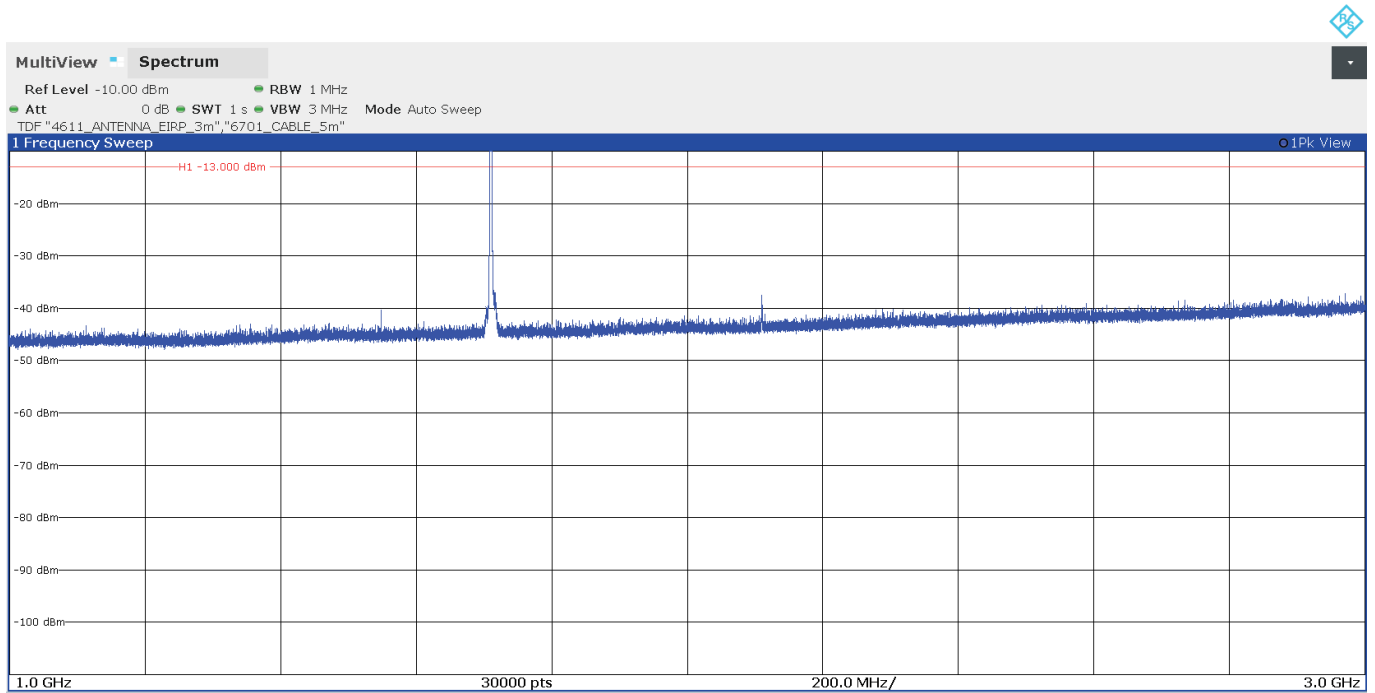


CHANNEL: HIGHEST



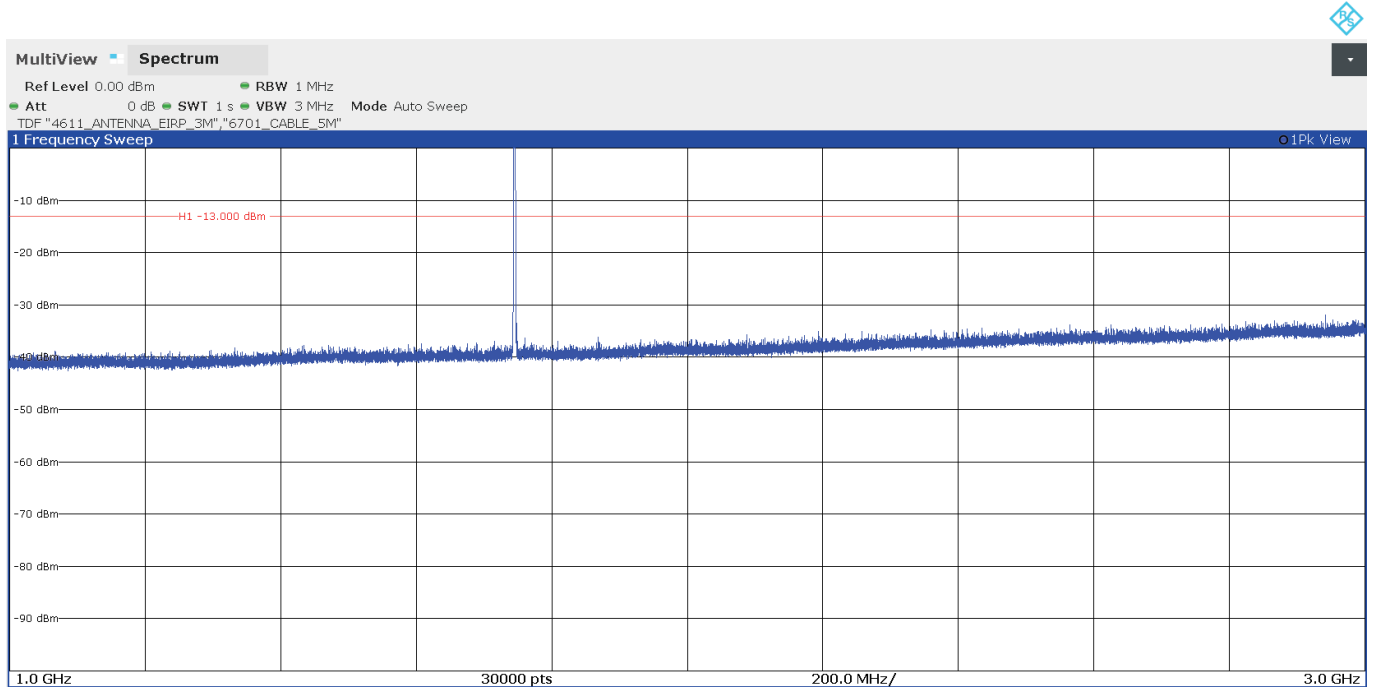
Frequency range 1 GHz to 3 GHz

CHANNEL: LOWEST



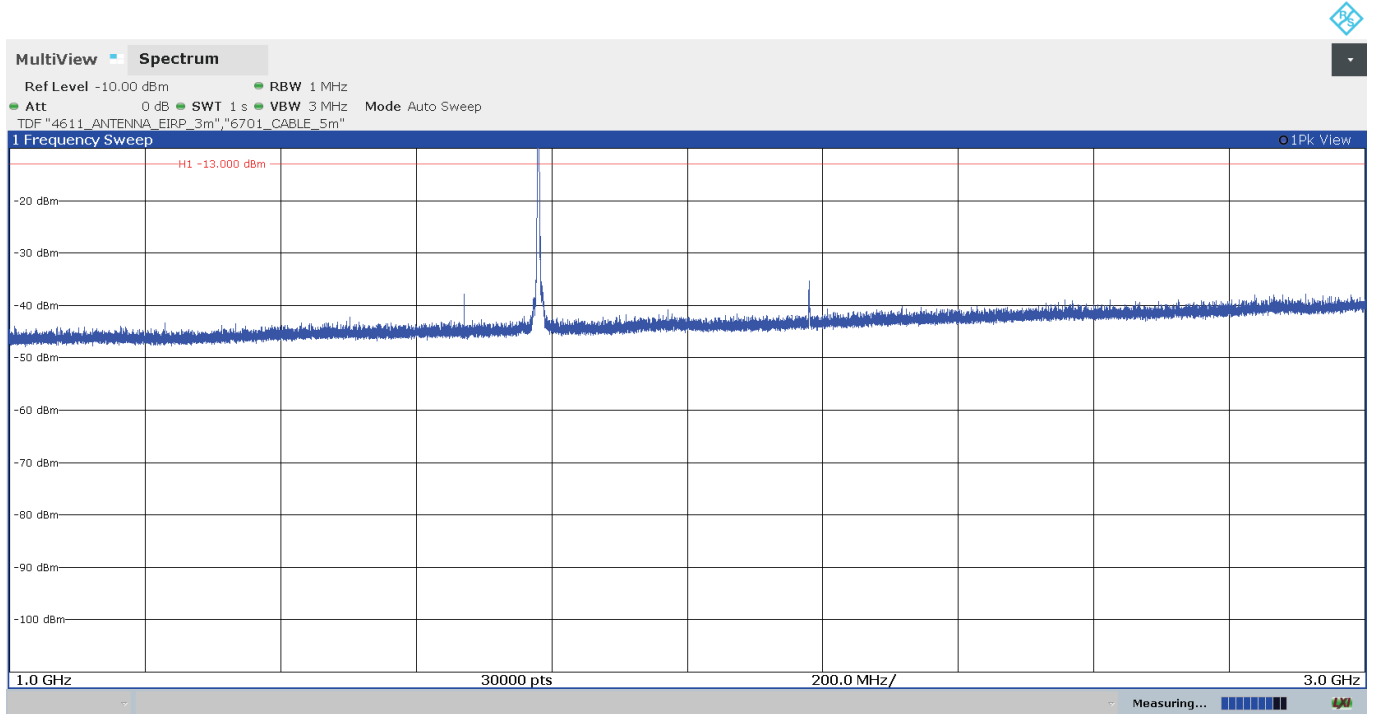
Note: The peak above the limit is the carrier frequency. The peak at 1805MHz corresponds to the downlink signal.

### CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency.

### CHANNEL: HIGHEST

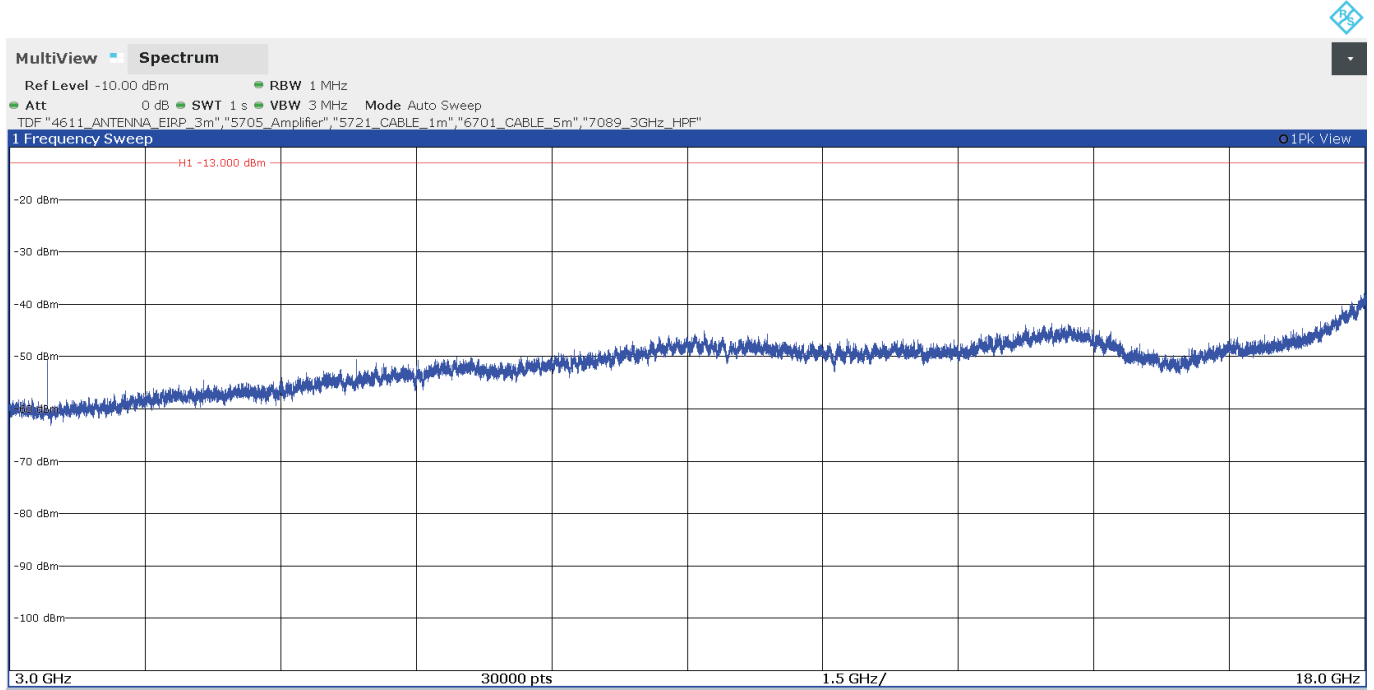


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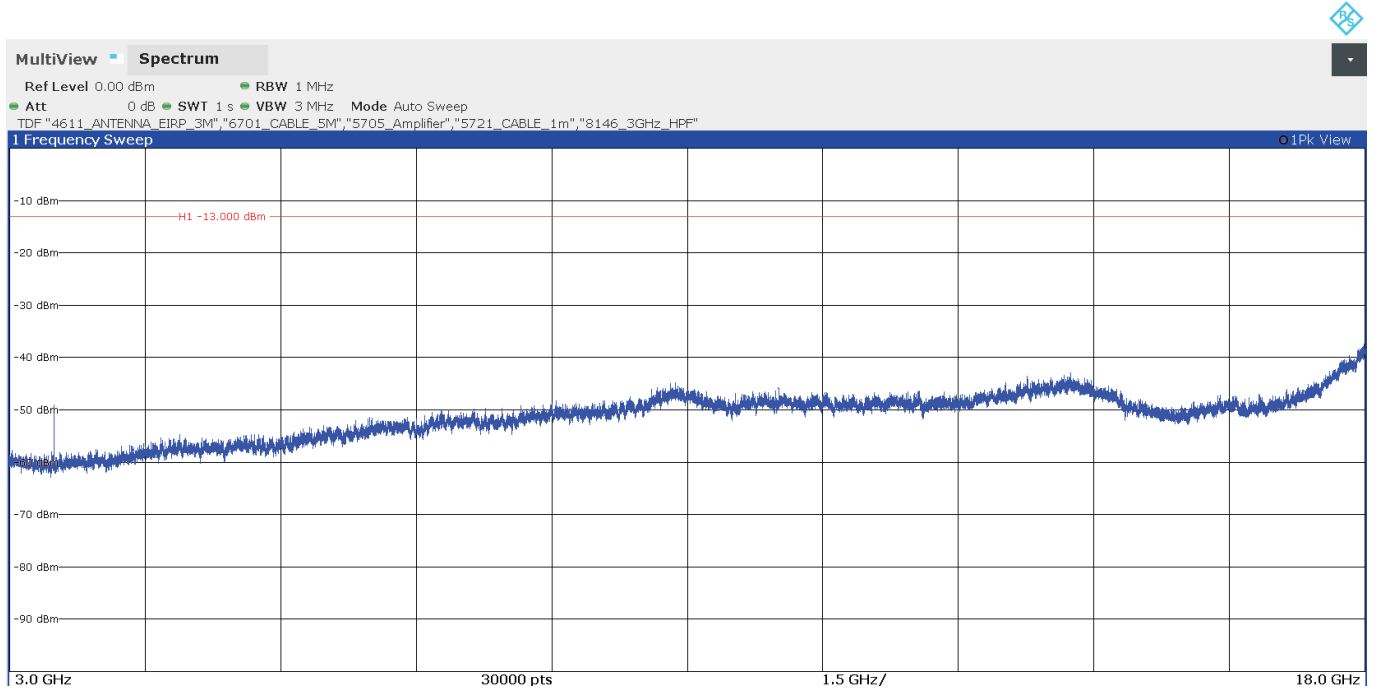
Note: The peak above the limit is the carrier frequency. The peak at 1875MHz corresponds to the downlink signal.

Frequency range 3 GHz to 18 GHz

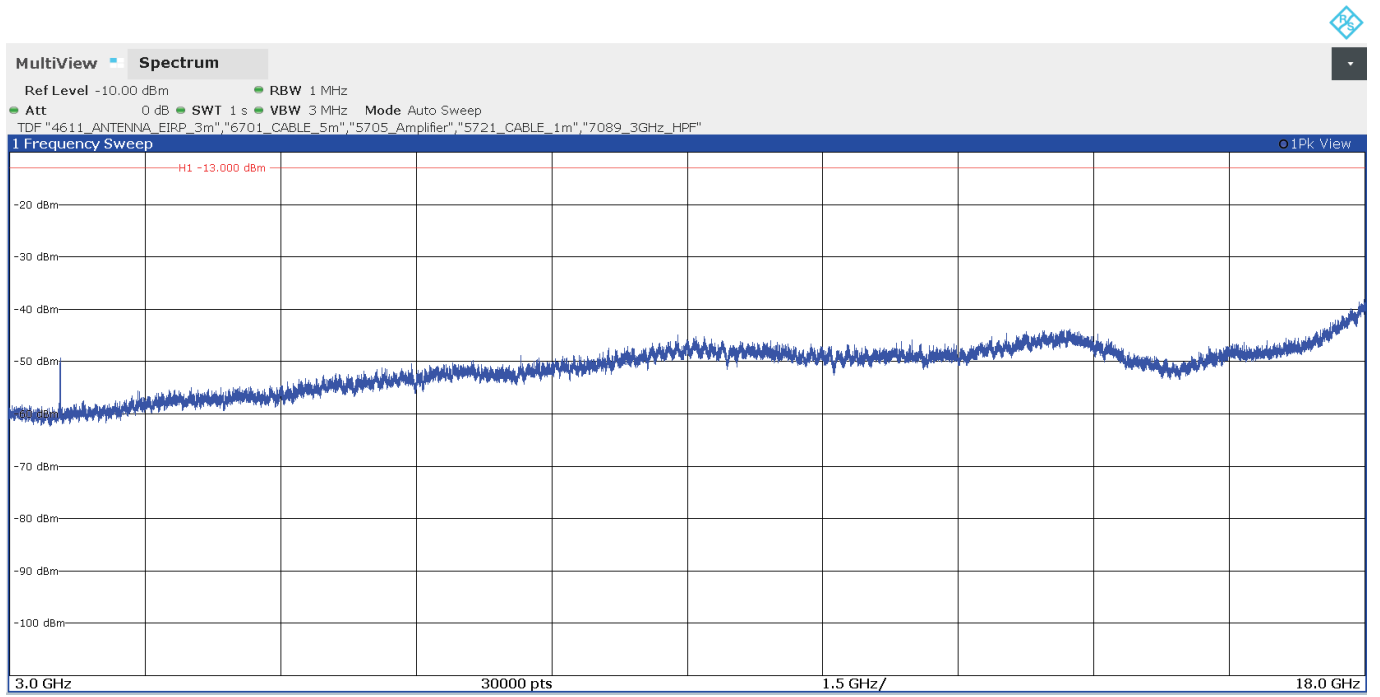
CHANNEL: LOWEST



CHANNEL: MIDDLE



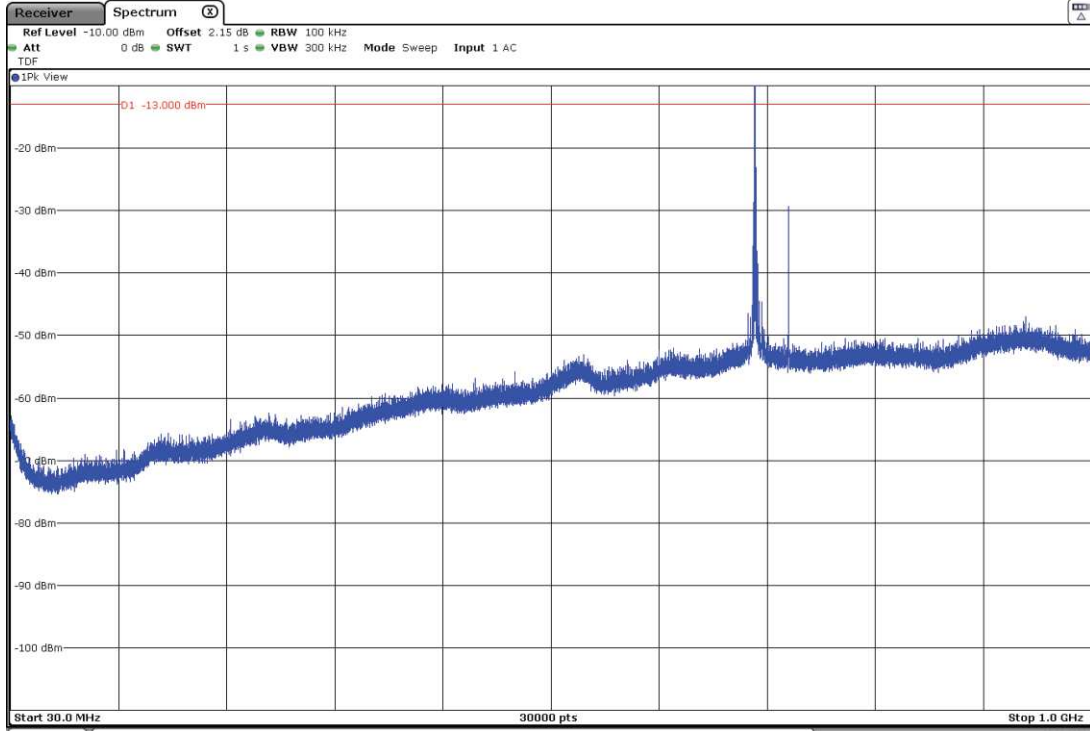
### CHANNEL: HIGHEST



## NB IoT Band 85

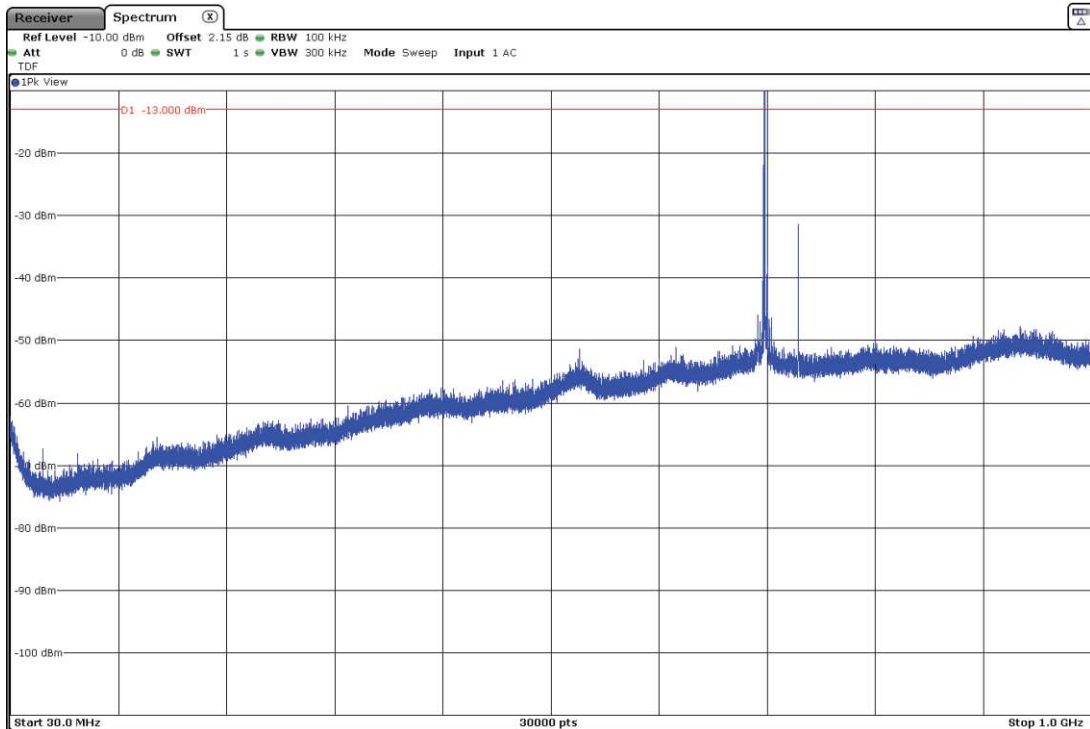
Frequency range 30 MHz to 1 GHz

CHANNEL: LOWEST



Note: The peak above the limit is the carrier frequency. The peak at 728MHz corresponds to the downlink signal

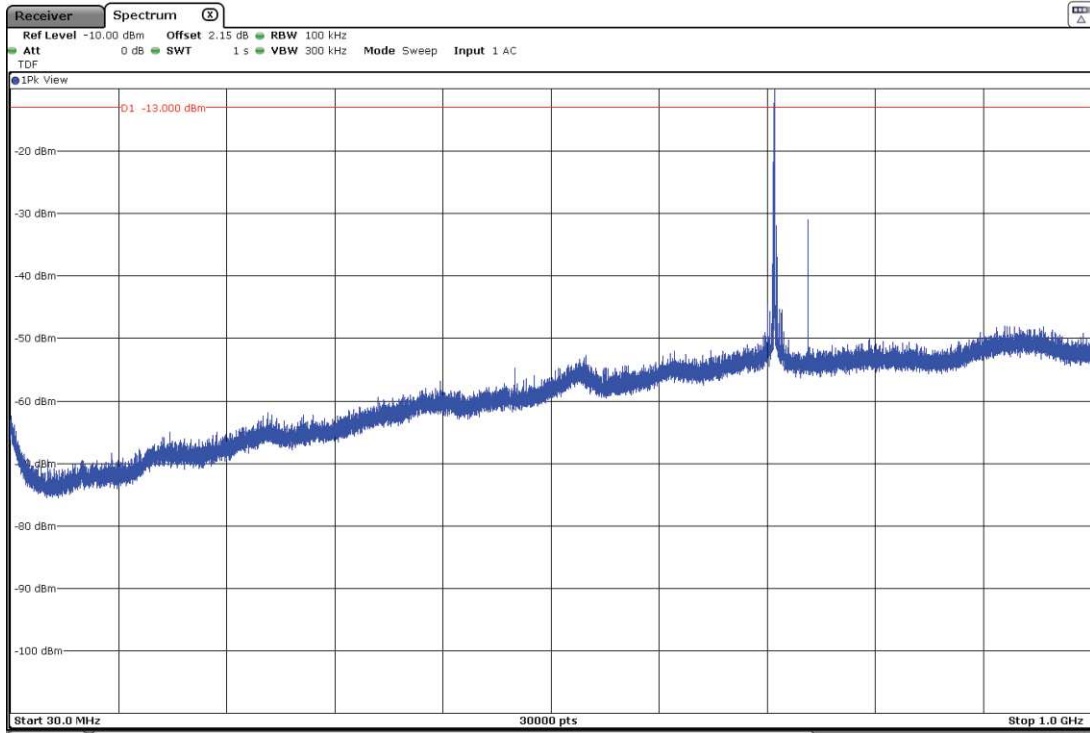
CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency. The peak at 737MHz corresponds to the downlink signal.



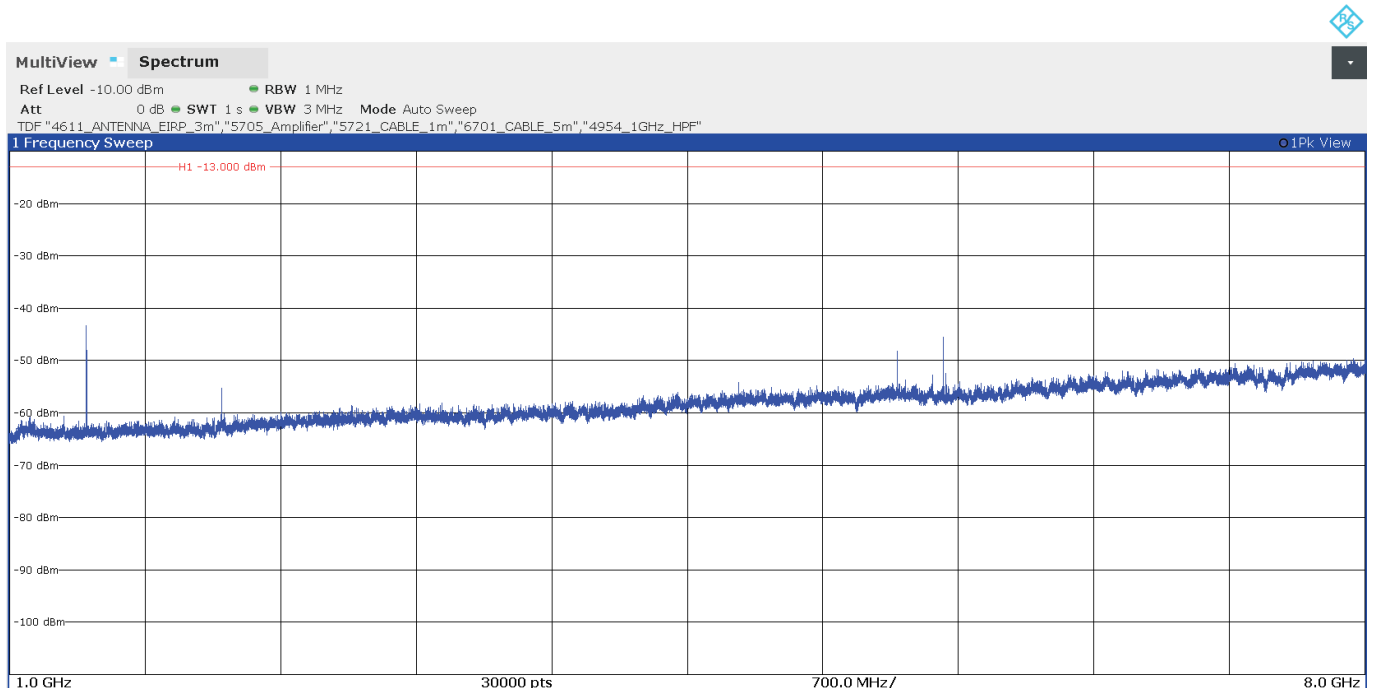
CHANNEL: HIGHEST



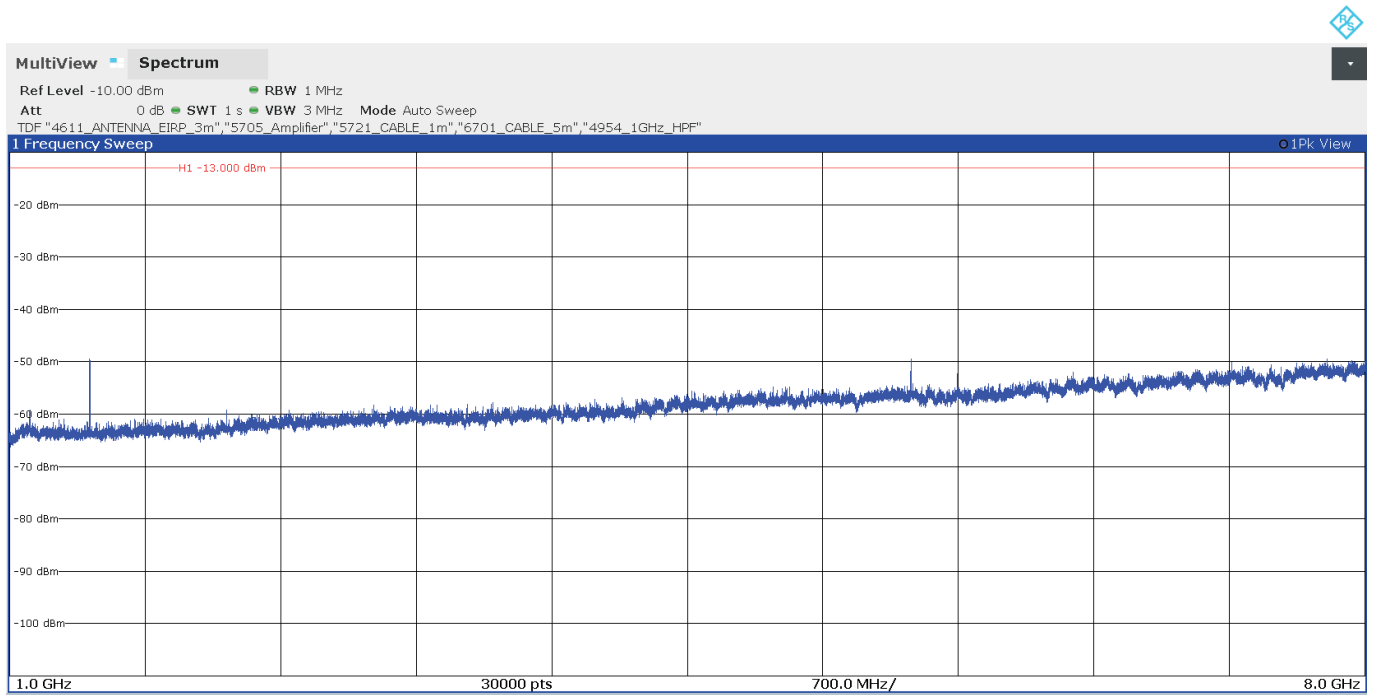
Note: The peak above the limit is the carrier frequency. The peak at 746MHz corresponds to the downlink signal.

Frequency range 1 GHz to 8 GHz

CHANNEL: LOWEST



### CHANNEL: MIDDLE



### CHANNEL: HIGHEST

