

## Occupied Bandwidth

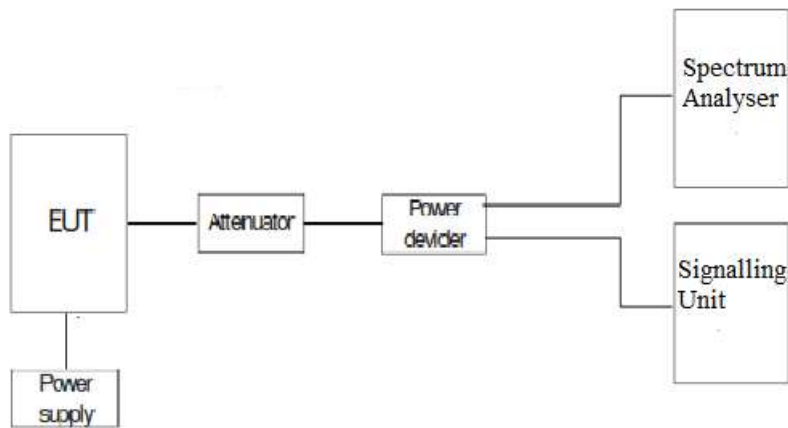
### Limits

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 and the -26 dBc bandwidth were measured directly using the built-in bandwidth measuring option of spectrum analyser.

### Test Setup



**Results**

**LTE Bands:** The worst case of Occupied Bandwidth corresponds to all Resource Blocks (RB) with Offset 0, regardless the nominal bandwidth selected.

**LTE Cat NB1 Band 26. Sub-band 814-824 MHz:**

LTE Cat NB1 Band 26. Sub-band 814-824 MHz. Pi/2-BPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=0.

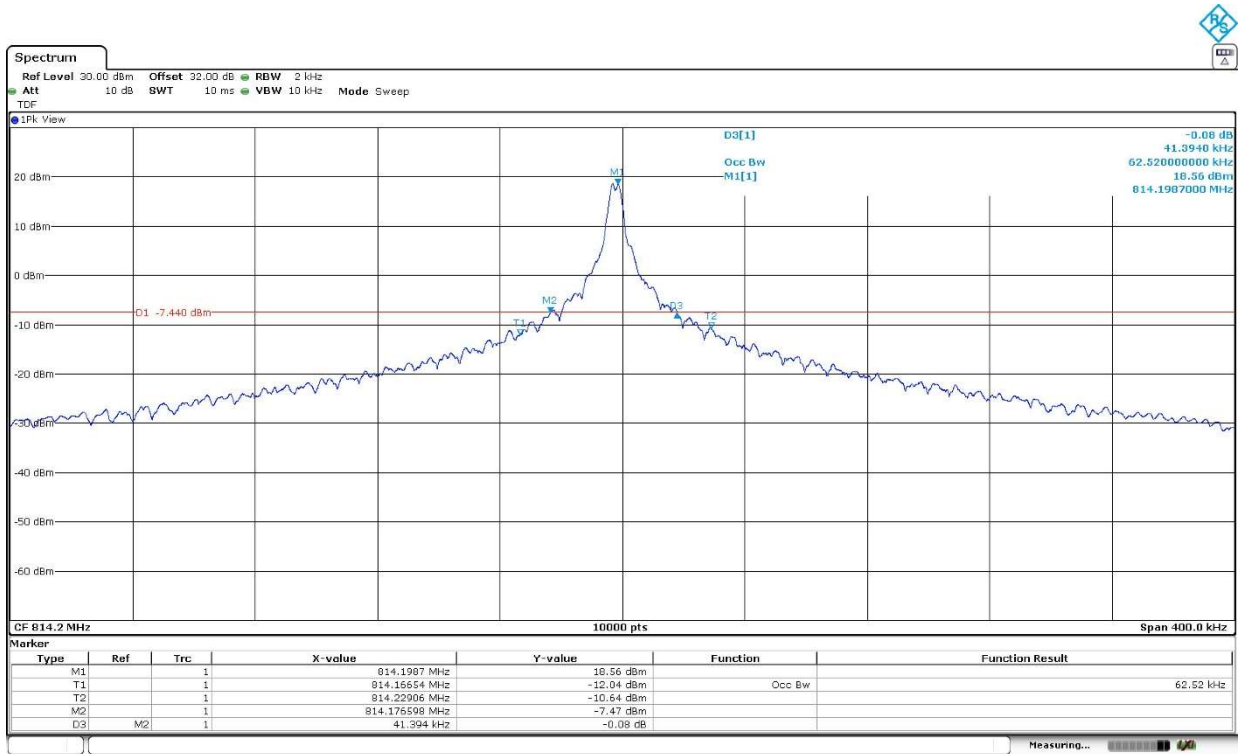
|                               | Low Channel | Middle Channel | High Channel |
|-------------------------------|-------------|----------------|--------------|
| 99% Occupied Bandwidth (kHz)  | 62.52000    | 62.28000       | 62.56000     |
| -26 dBc Bandwidth (kHz)       | 41.39400    | 41.62100       | 41.30500     |
| Measurement uncertainty (kHz) | <±4.67      |                |              |

LTE Cat NB1 Band 26. Sub-band 814-824 MHz. Pi/4-QPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=3.

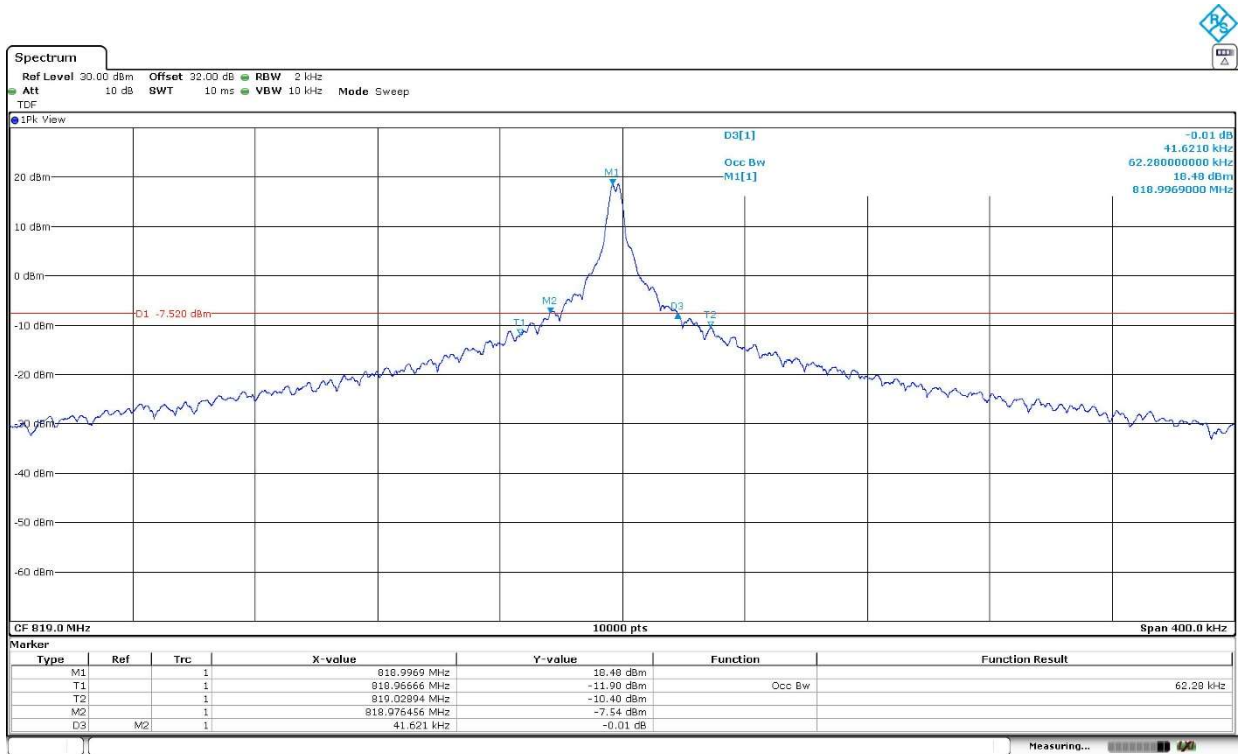
|                               | Low Channel | Middle Channel | High Channel |
|-------------------------------|-------------|----------------|--------------|
| 99% Occupied Bandwidth (kHz)  | 67.04000    | 65.94000       | 66.32000     |
| -26 dBc Bandwidth (kHz)       | 41.94100    | 41.95800       | 41.95900     |
| Measurement uncertainty (kHz) | <±4.67      |                |              |

LTE Cat NB1 Band 26. Sub-band 814-824 MHz. Pi/2-BPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23.  
 MSC/TBS=0.

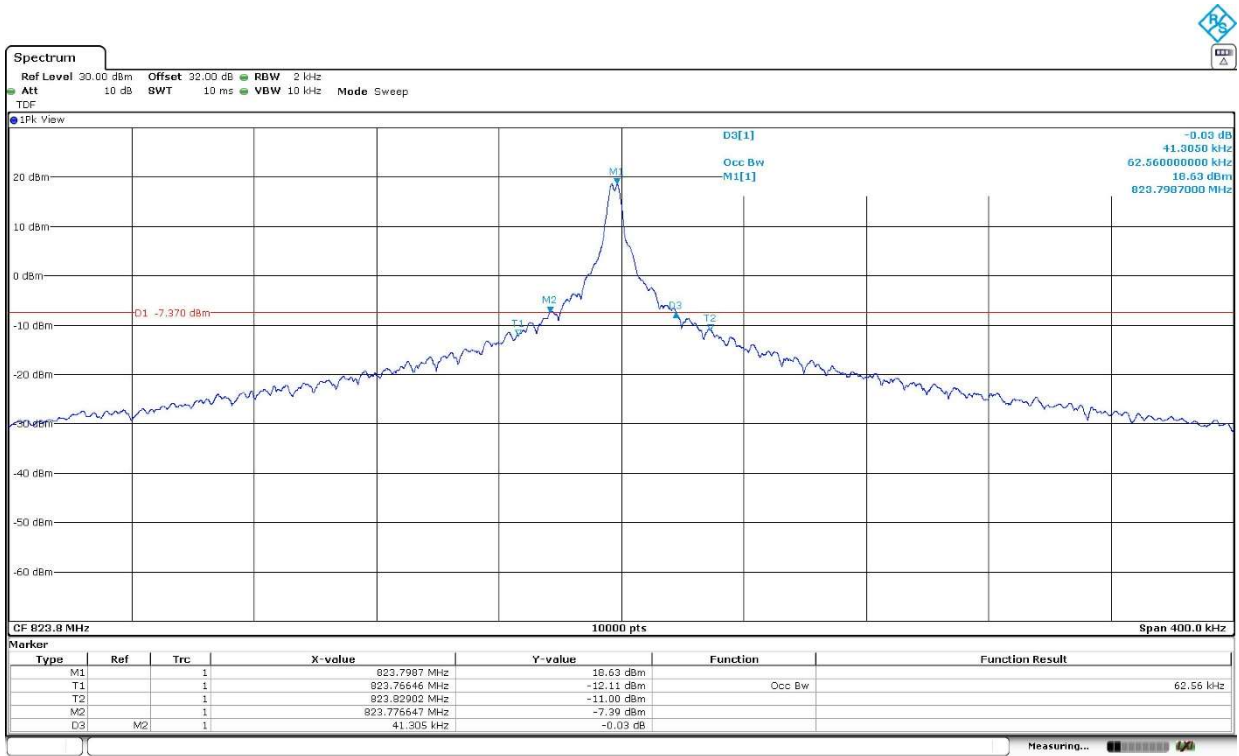
Low Channel:



Middle Channel:

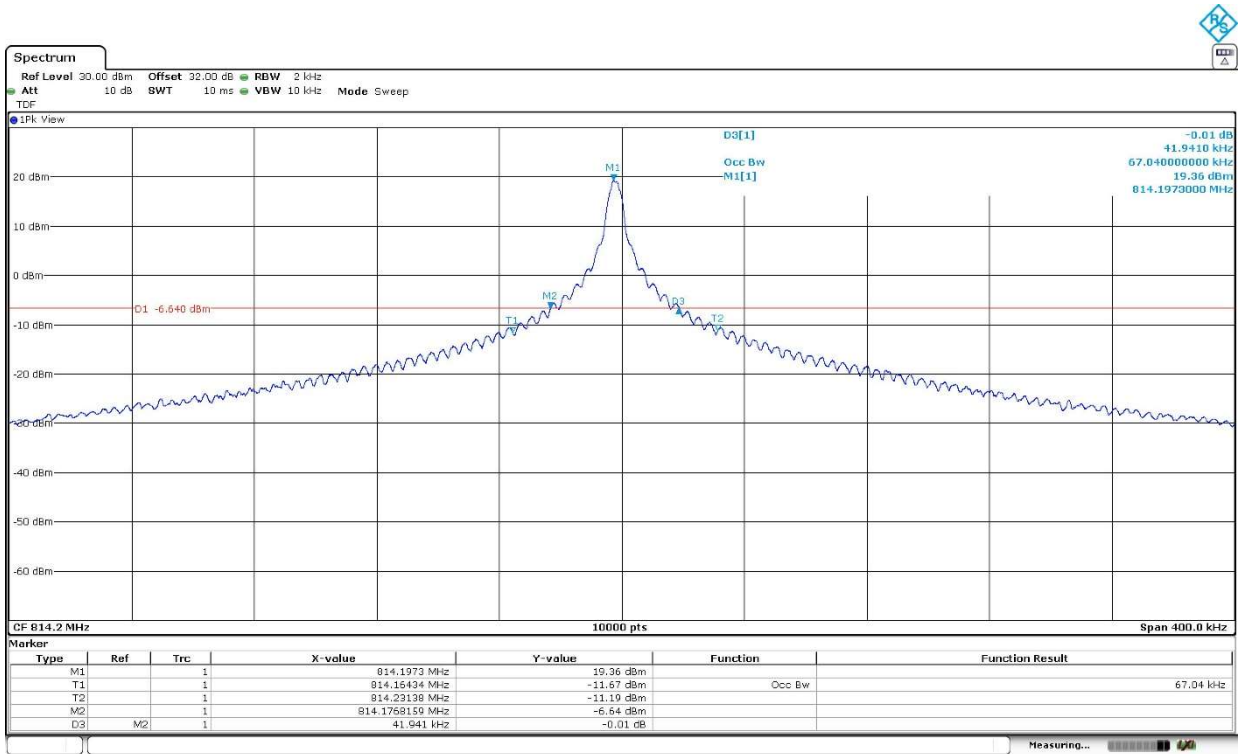


High Channel:

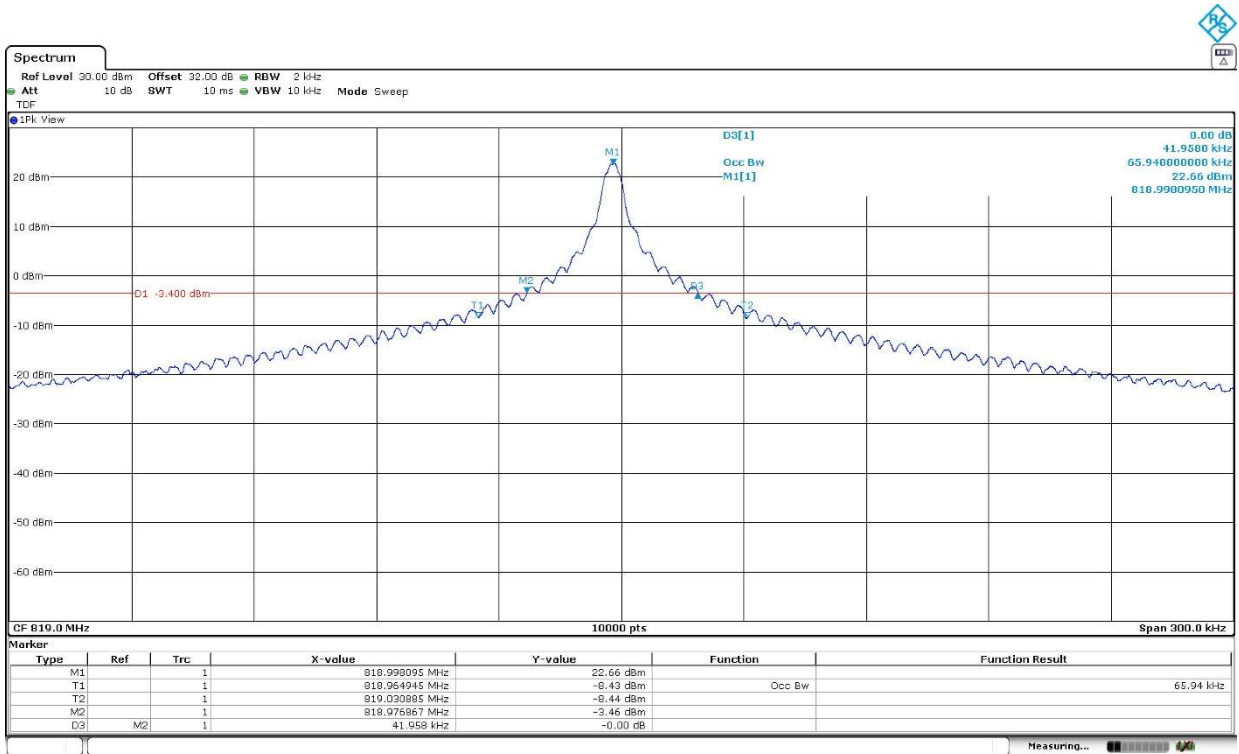


LTE Cat NB1 Band 26. Sub-band 814-824 MHz. Pi/4-QPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23.  
 MSC/TBS=3.

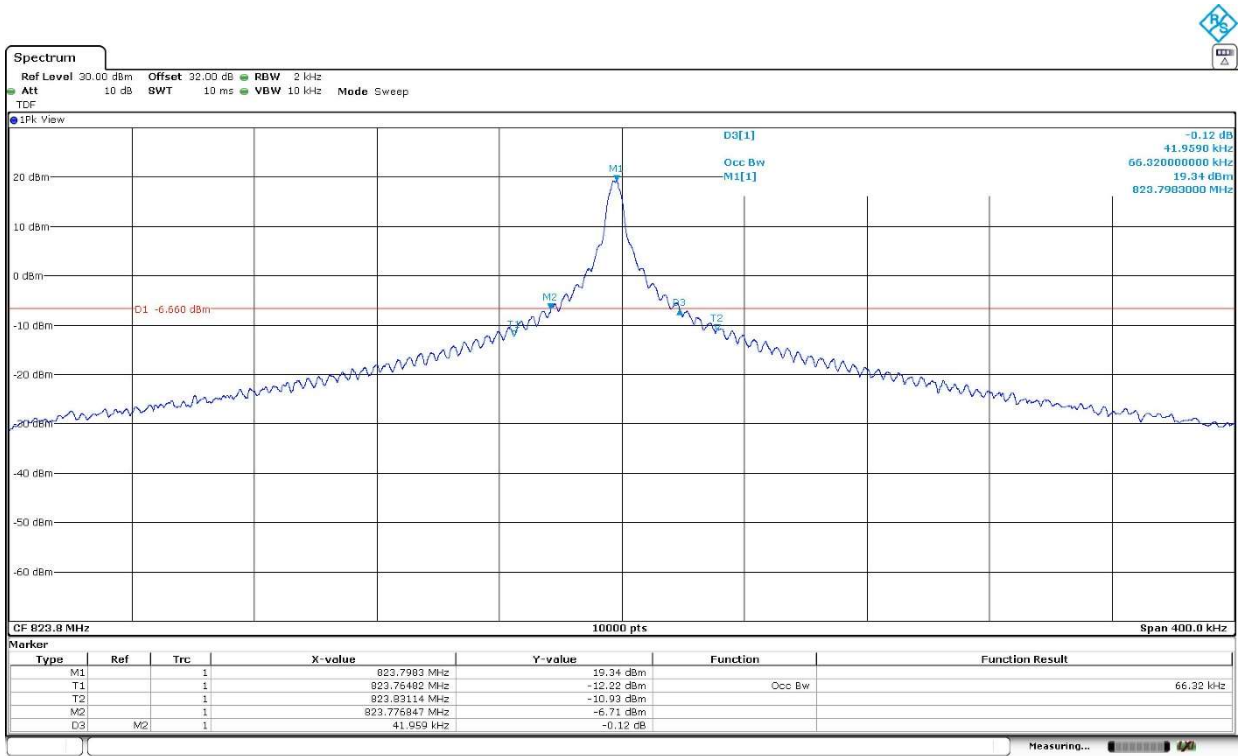
Low Channel:



Middle Channel:



High Channel:



LTE Cat NB1 Band 26. Sub-band 814-824 MHz. Pi/2-BPSK. BW=15 kHz. Tone Number=1. Tone Offset=5. MSC/TBS=0.

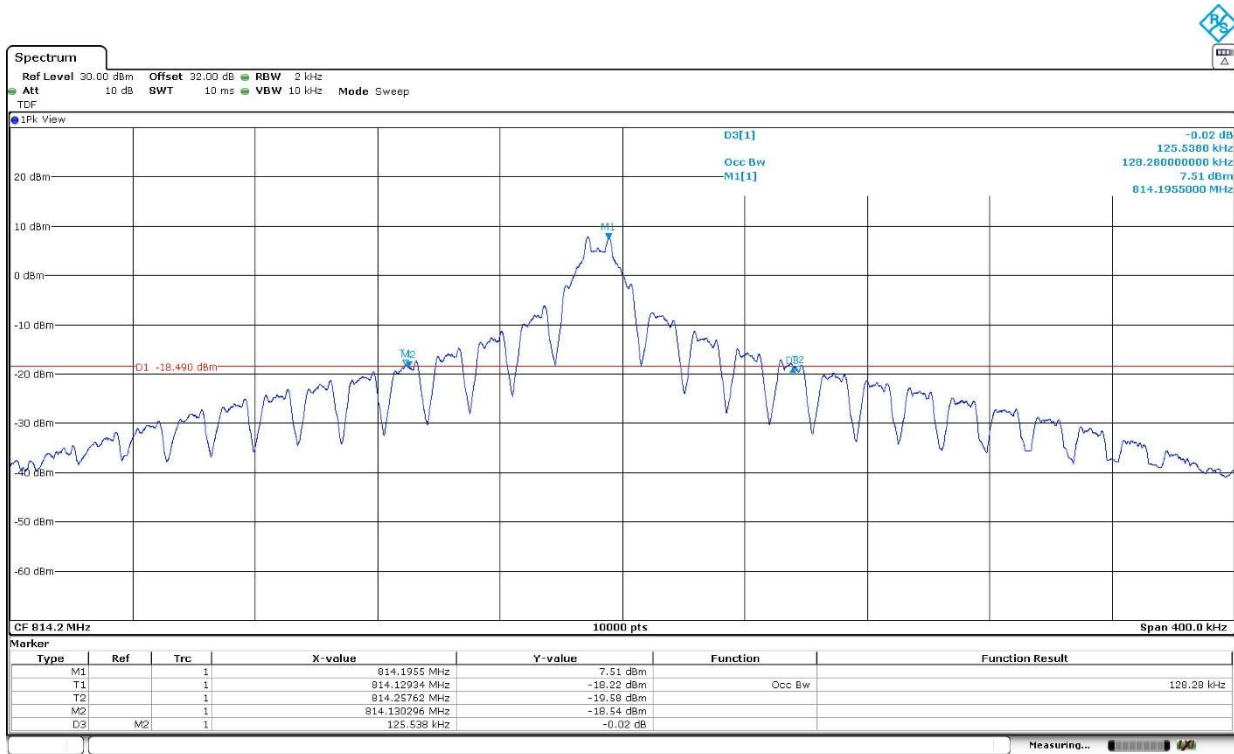
|                               | Low Channel | Middle Channel | High Channel |
|-------------------------------|-------------|----------------|--------------|
| 99% Occupied Bandwidth (kHz)  | 128.28000   | 128.88000      | 128.72000    |
| -26 dBc Bandwidth (kHz)       | 125.53800   | 129.61420      | 126.81800    |
| Measurement uncertainty (kHz) | <±4.67      |                |              |

LTE Cat NB1 Band 26. Sub-band 814-824 MHz. Pi/4-QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0. MSC/TBS=5.

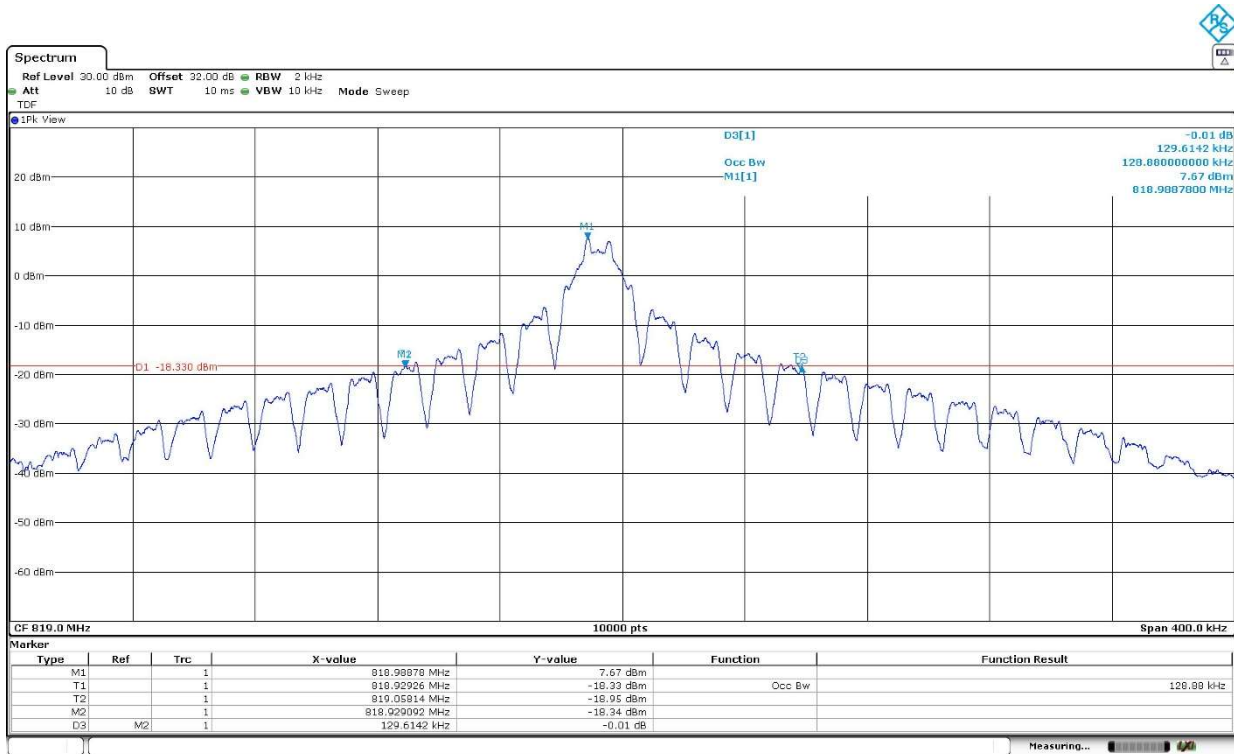
|                               | Low Channel | Middle Channel | High Channel |
|-------------------------------|-------------|----------------|--------------|
| 99% Occupied Bandwidth (kHz)  | 186.72000   | 186.44000      | 186.64000    |
| -26 dBc Bandwidth (kHz)       | 288.98000   | 290.97600      | 290.56700    |
| Measurement uncertainty (kHz) | <±4.67      |                |              |

LTE Cat NB1 Band 26. Sub-band 814-824 MHz. Pi/2-BPSK. BW=15 kHz. Tone Number=1. Tone Offset=5.  
 MSC/TBS=0.

Low Channel:

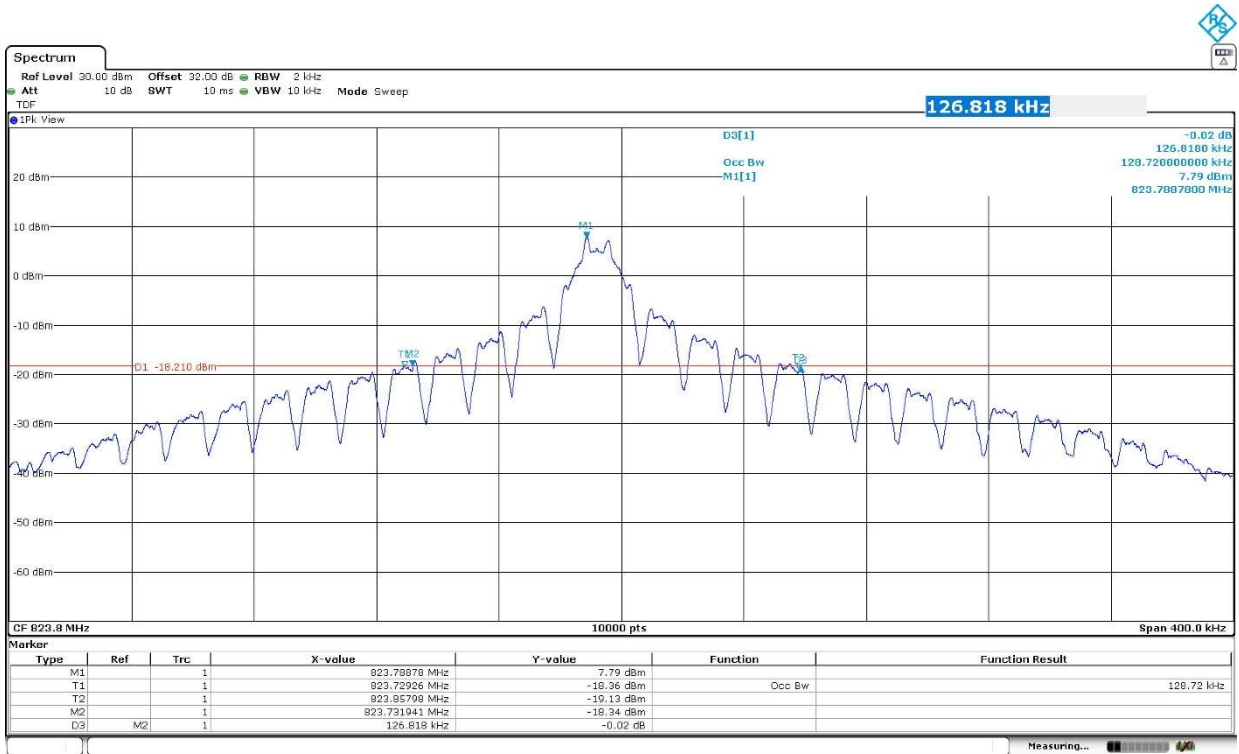


Middle Channel:



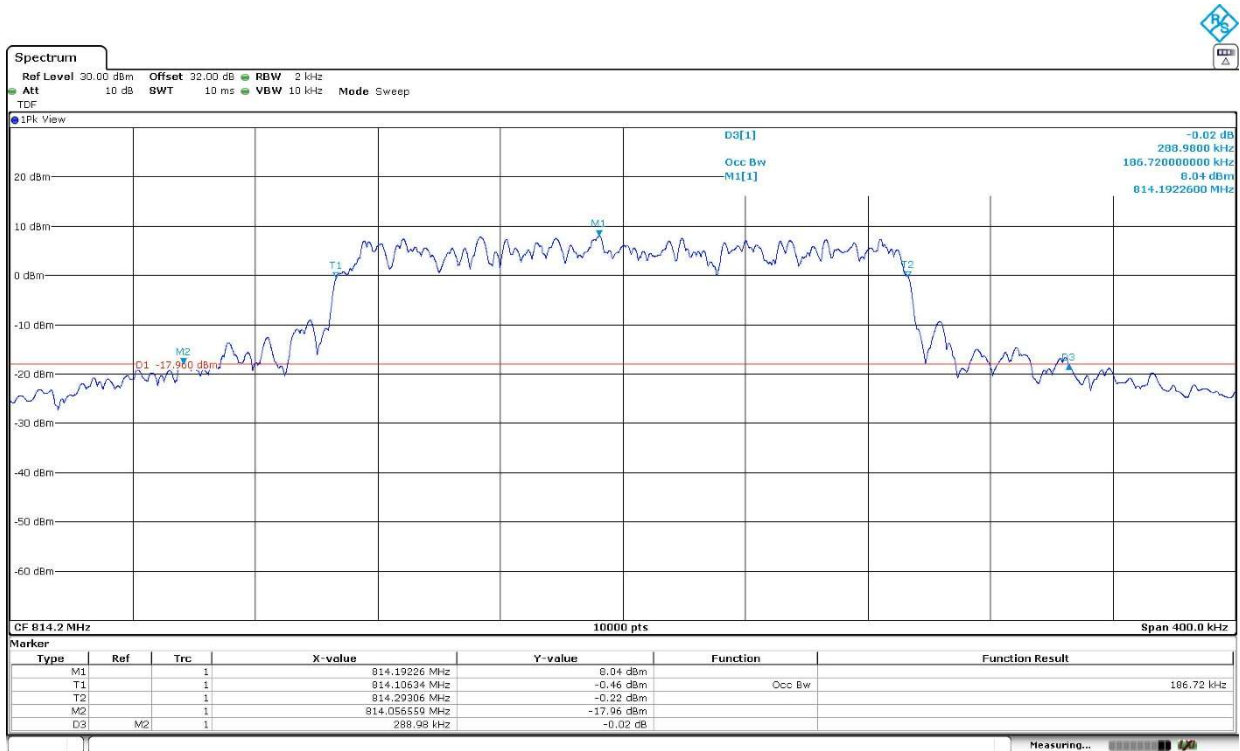


High Channel:

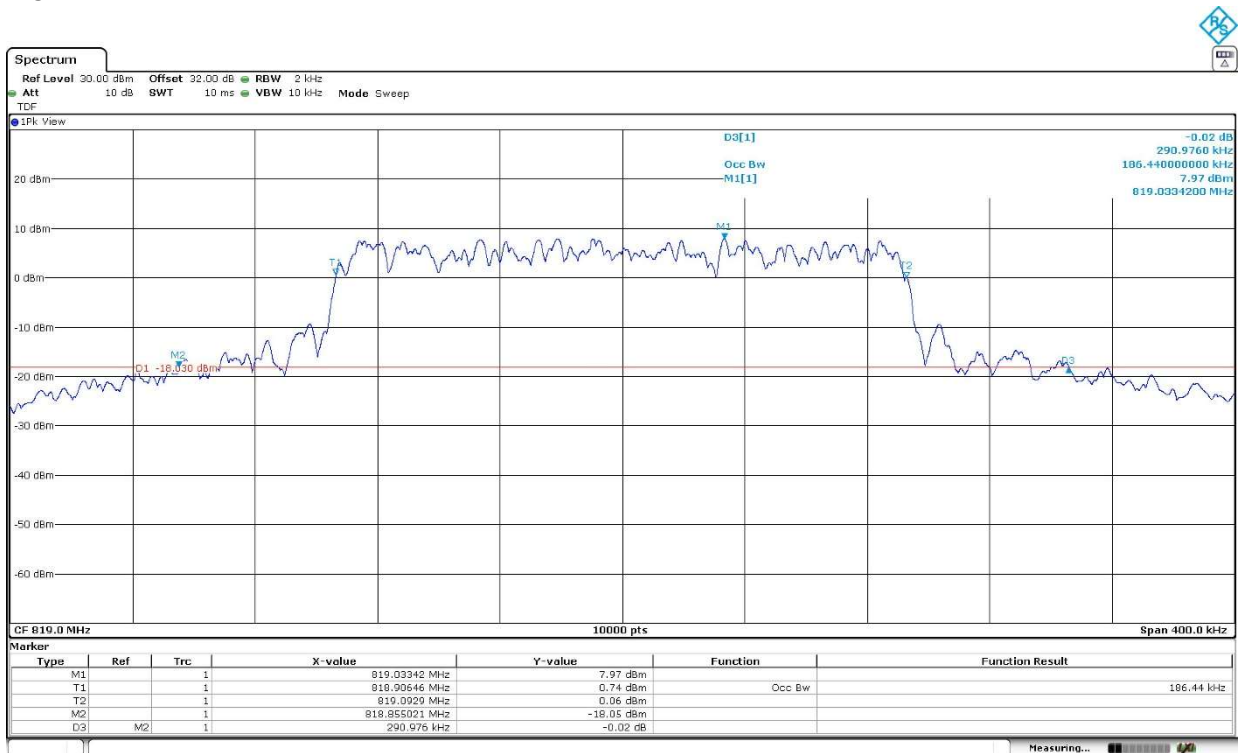


LTE Cat NB1 Band 26. Sub-band 814-824 MHz. Pi/4-QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0.  
 MSC/TBS=5.

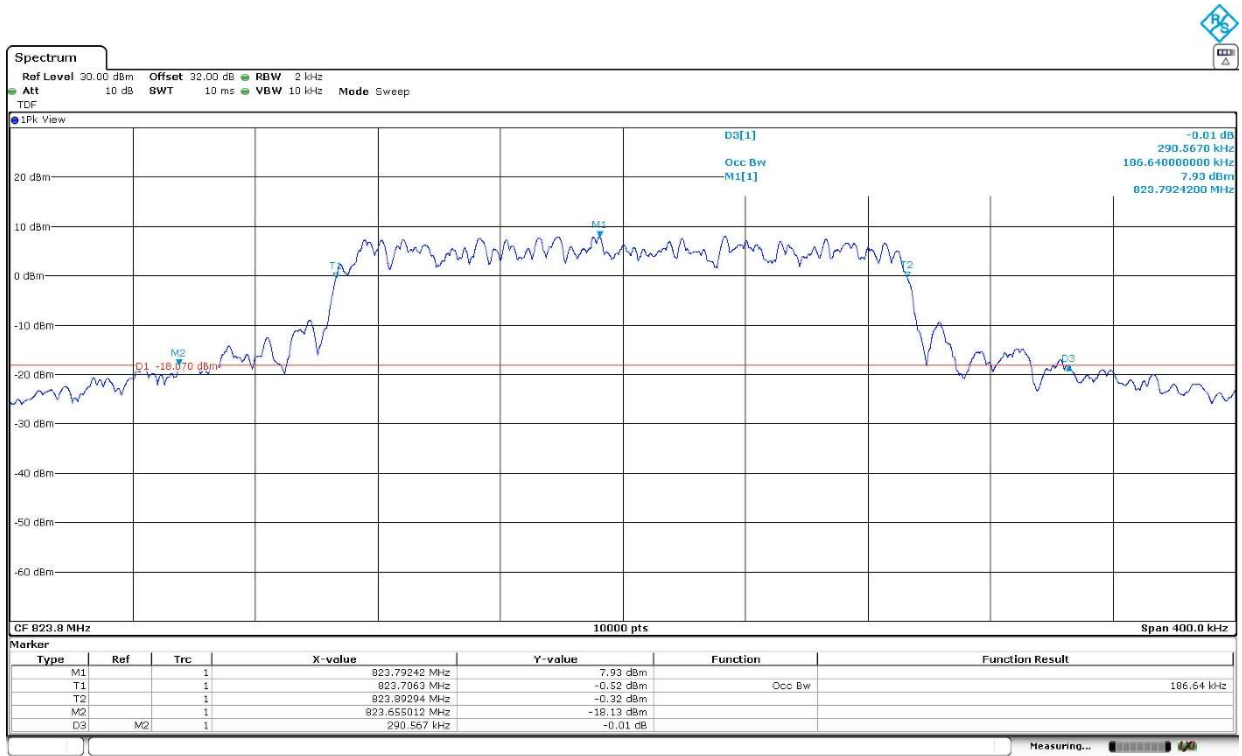
Low Channel:



Middle Channel:



High Channel:



**LTE Cat NB1 Band 26. Cross-rule Channel 824 MHz:**

LTE Cat NB1 Band 26. Cross-rule Channel 824 MHz. Pi/2-BPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=0.

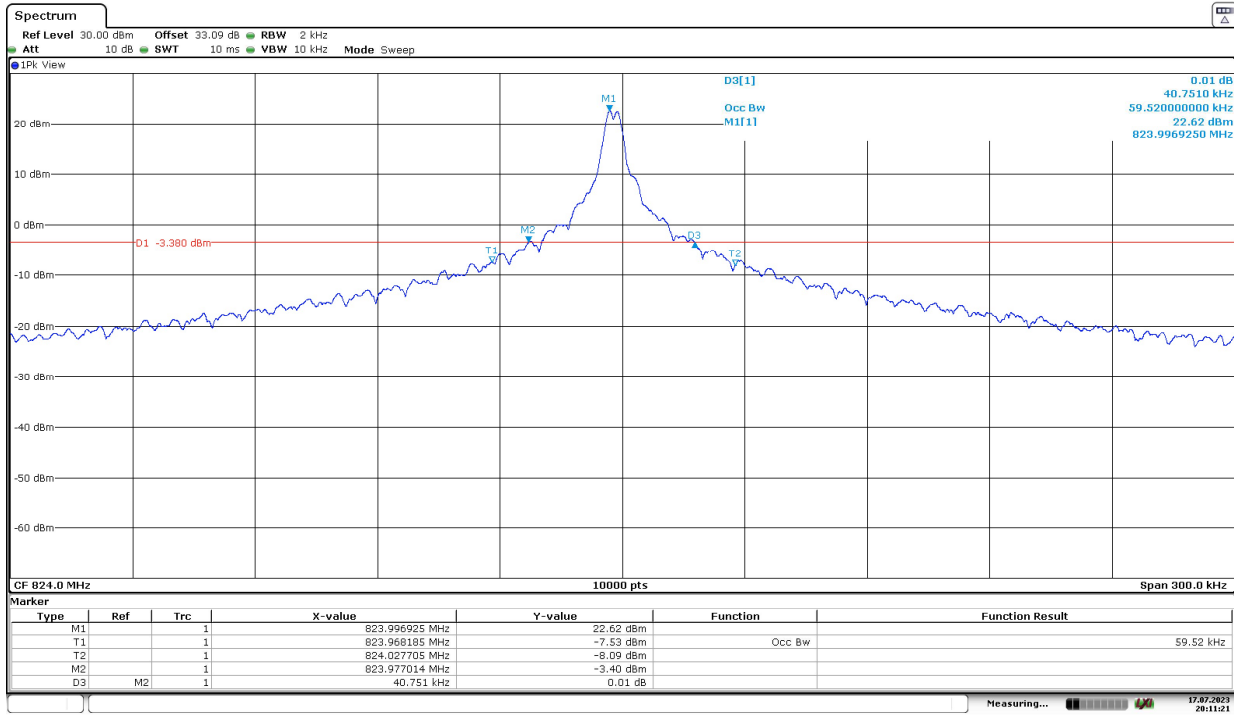
|                               | Single Channel |
|-------------------------------|----------------|
| 99% Occupied Bandwidth (kHz)  | 59.52000       |
| -26 dBc Bandwidth (kHz)       | 40.75100       |
| Measurement uncertainty (kHz) | <±4.67         |

LTE Cat NB1 Band 26. Cross-rule Channel 824 MHz. QPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=3.

|                               | Single Channel |
|-------------------------------|----------------|
| 99% Occupied Bandwidth (kHz)  | 65.28000       |
| -26 dBc Bandwidth (kHz)       | 41.74410       |
| Measurement uncertainty (kHz) | <±4.67         |

LTE Cat NB1 Band 26. Cross-rule Channel 824 MHz. Pi/2-BPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=0.

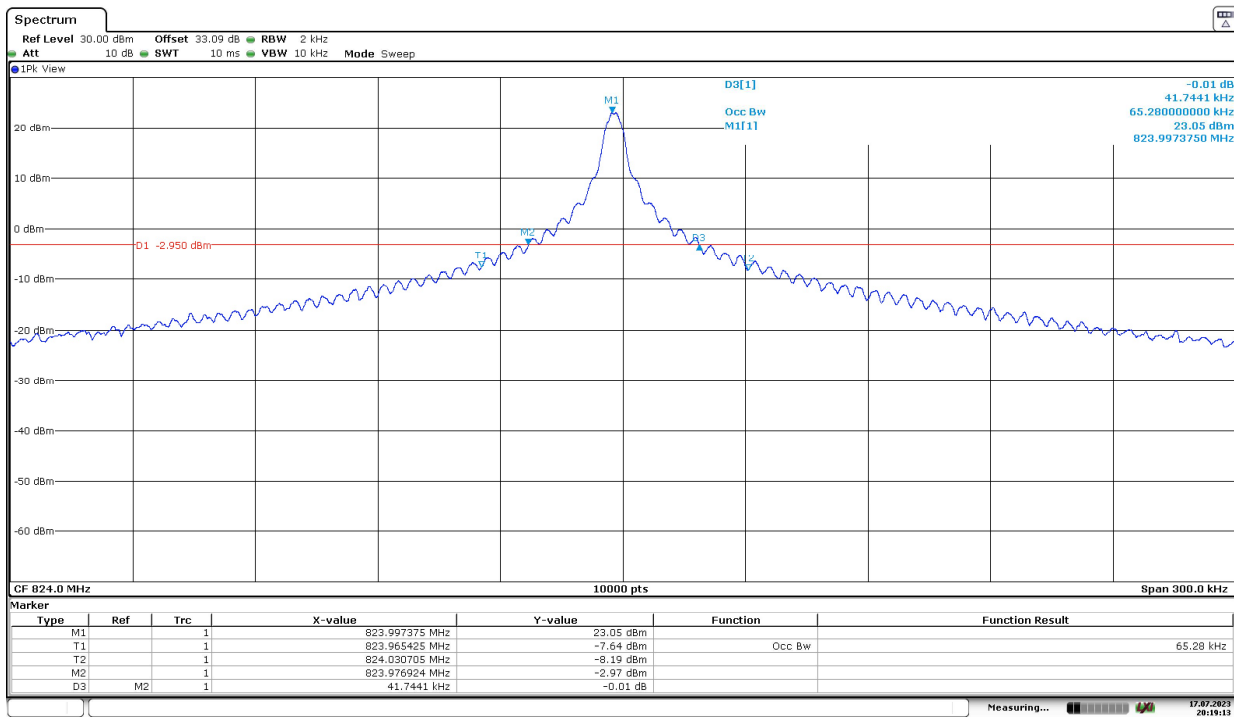
Cross-rule Channel 824 MHz:



Date: 17.JUL.2023 20:11:22

LTE Cat NB1 Band 26. Cross-rule Channel 824 MHz. Pi/4-QPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=23. MSC/TBS=3.

Cross-rule Channel 824 MHz:



Date: 17.JUL.2023 20:19:14

LTE Cat NB1 Band 26. Cross-rule Channel 824 MHz. Pi/2-BPSK. BW=15 kHz. Tone Number=1. Tone Offset=5. MSC/TBS=0.

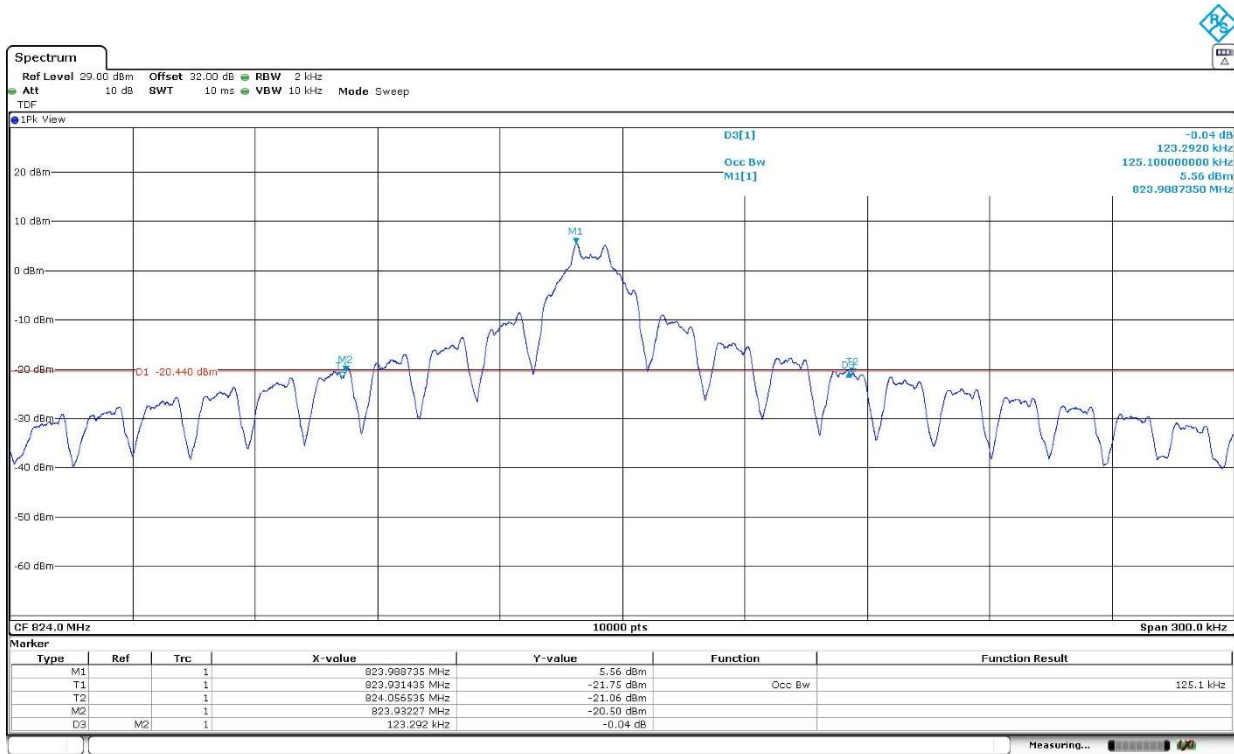
|                               | Single Channel |
|-------------------------------|----------------|
| 99% Occupied Bandwidth (MHz)  | 125.10000      |
| -26 dBc Bandwidth (MHz)       | 123.29200      |
| Measurement uncertainty (kHz) | <±4.67         |

LTE Cat NB1 Band 26. Cross-rule Channel 824 MHz. Pi/4-QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0. MSC/TBS=5.

|                               | Single Channel |
|-------------------------------|----------------|
| 99% Occupied Bandwidth (MHz)  | 186.48000      |
| -26 dBc Bandwidth (MHz)       | 288.30900      |
| Measurement uncertainty (kHz) | <±4.67         |

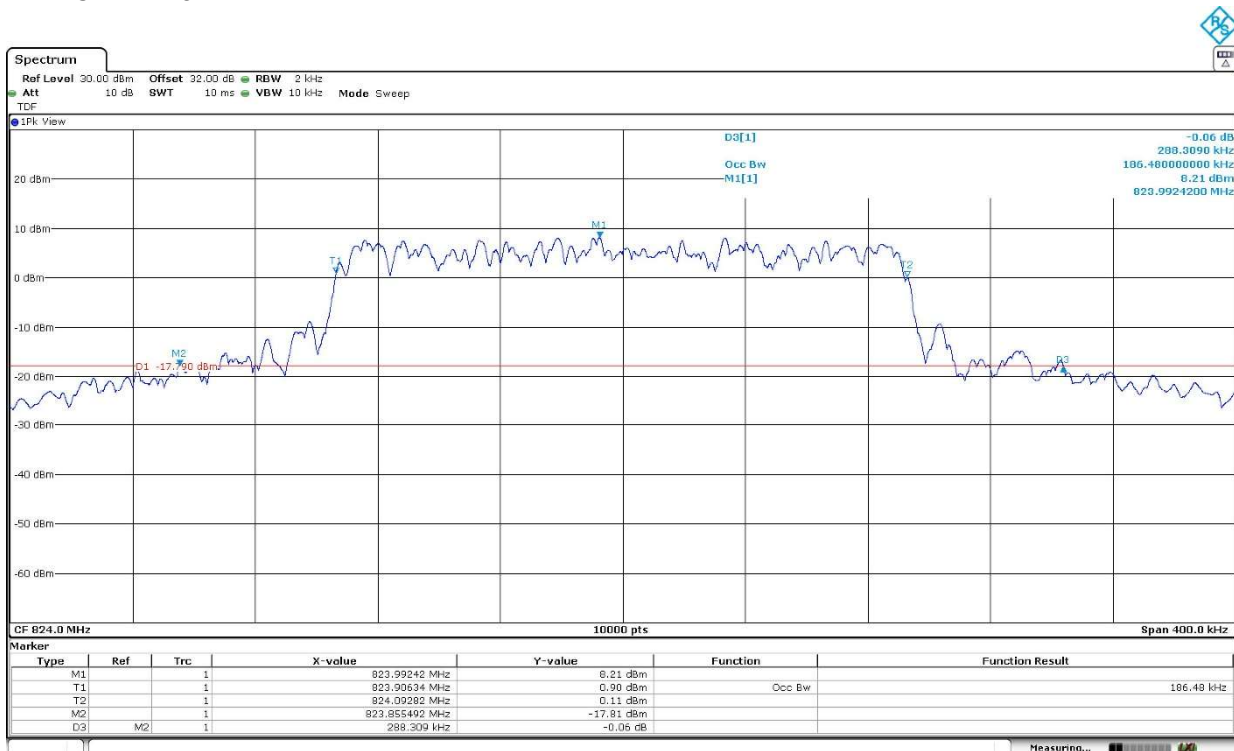
**LTE Cat NB1 Band 26. Cross-rule Channel 824 MHz. Pi/2-BPSK. BW=15 kHz. Tone Number=1. Tone Offset=5. MSC/TBS=0.**

Cross-rule Channel 824 MHz:



**LTE Cat NB1 Band 26. Cross-rule Channel 824 MHz. Pi/4-QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0. MSC/TBS=5.**

Cross-rule Channel 824 MHz:



## Spurious emissions at antenna terminals

### Limits

FCC §2.1051. Measurements required: Spurious emissions at antenna terminals.

FCC §90.543 (e) (2) (3) & (5):

(e) For operations in the 758-768 MHz and the 788-798 MHz bands, the power of any emission outside the 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, in accordance with the following:

(2) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than  $65 + 10 \log (P)$  dB in a 6.25 kHz band segment, for mobile and portable stations.

(3) On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, by at least  $43 + 10 \log (P)$  dB.

(5) Compliance with the provisions of paragraph (e)(3) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30 kHz may be employed.

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  $116 \log_{10}(f/6.1)$  decibels or  $50 + 10 \log_{10}(P)$  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  $43 + 10 \log_{10}(P)$  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.

### Method

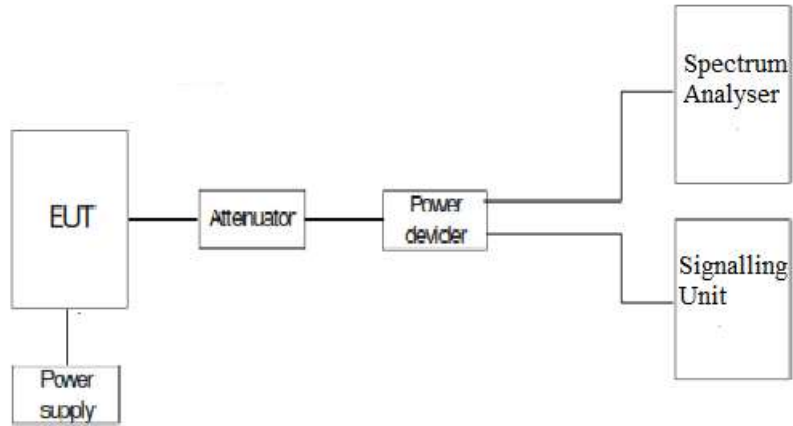
The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50 Ohm attenuator and a power divider.

The spectrum was investigated from 9 kHz to 18 GHz for 3G Band IV and from 9 kHz to 8 GHz for LTE Band 13. 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 Resource Blocks and modulation which is the worst case for conducted power was used.



### Test Setup



## Results

Test performed on the worst-case modulation, RB Size and RB Offset for each LTE band.

### LTE Cat NB1 Band 26. Sub-band 814-824 MHz:

A preliminary scan determined the worst-case:

Pi/2-BPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=11. MSC/TBS=0.

The next results are for this worst-case configuration,

#### **Frequency range 9 KHz - 10 GHz:**

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

### LTE Cat NB1 Band 26. Cross-rule Channel 824 MHz:

A preliminary scan determined the worst-case:

Pi/2-BPSK. BW=15 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=0.

The next results are for this worst-case configuration,

#### **Frequency range 9 KHz - 10 GHz:**

- Middle Channel: No spurious frequencies detected at less than 20 dB below the limit.

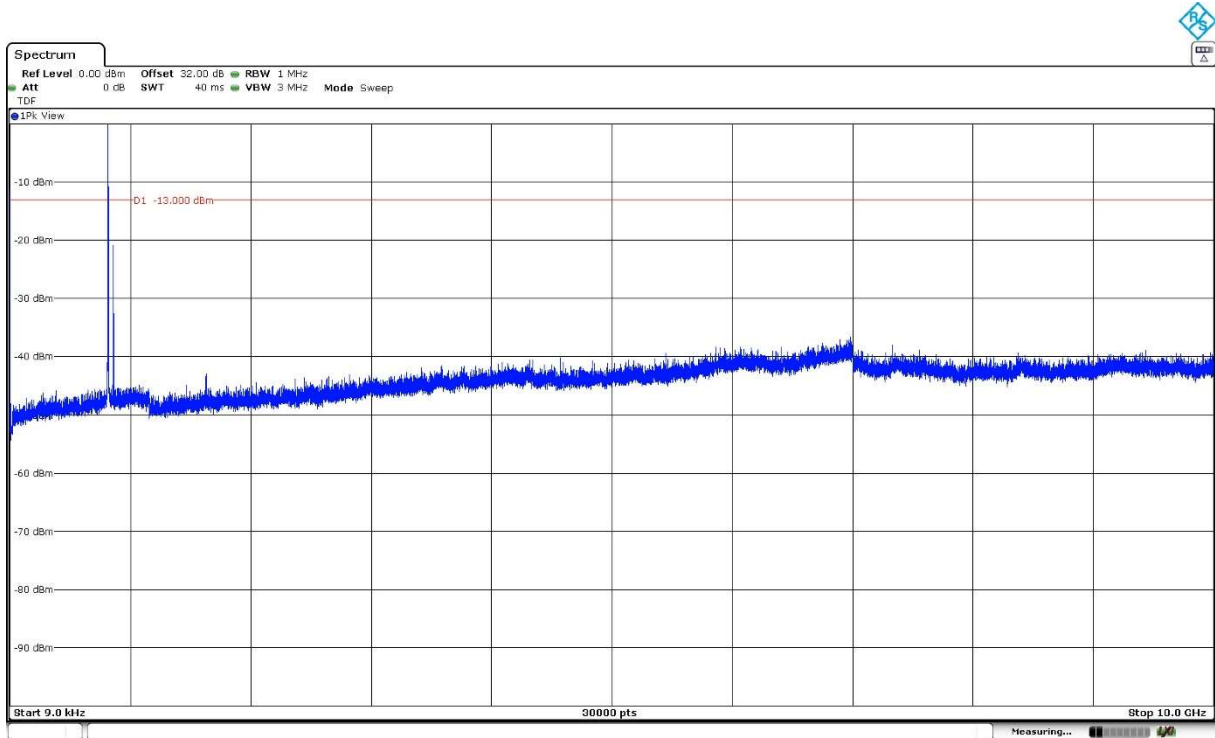
## Verdict

PASS

**LTE Cat NB1 Band 26. Sub-band 814-824 MHz:**  
Offset=11. MSC/TBS=0.

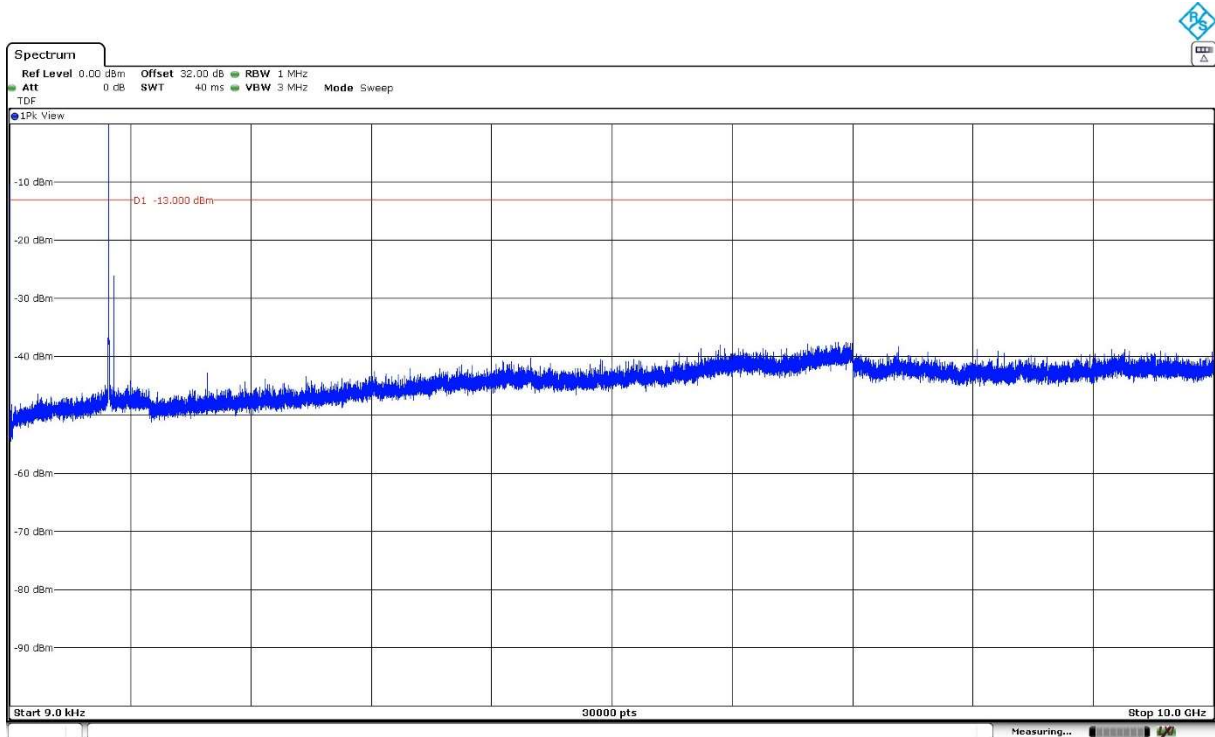
Pi/2-BPSK. BW=3.75 kHz. Tone Number=1. Tone

Low Channel:



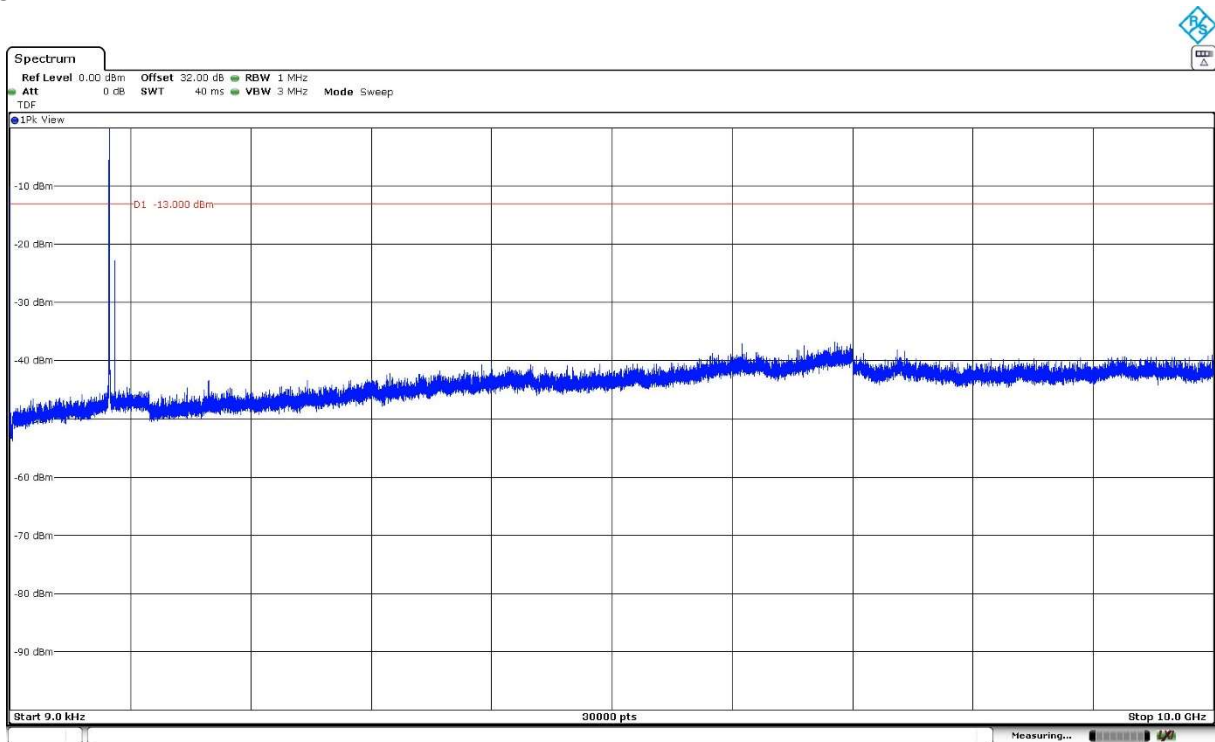
The peak above the limit is the carrier frequency.

Middle Channel:



The peak above the limit is the carrier frequency.

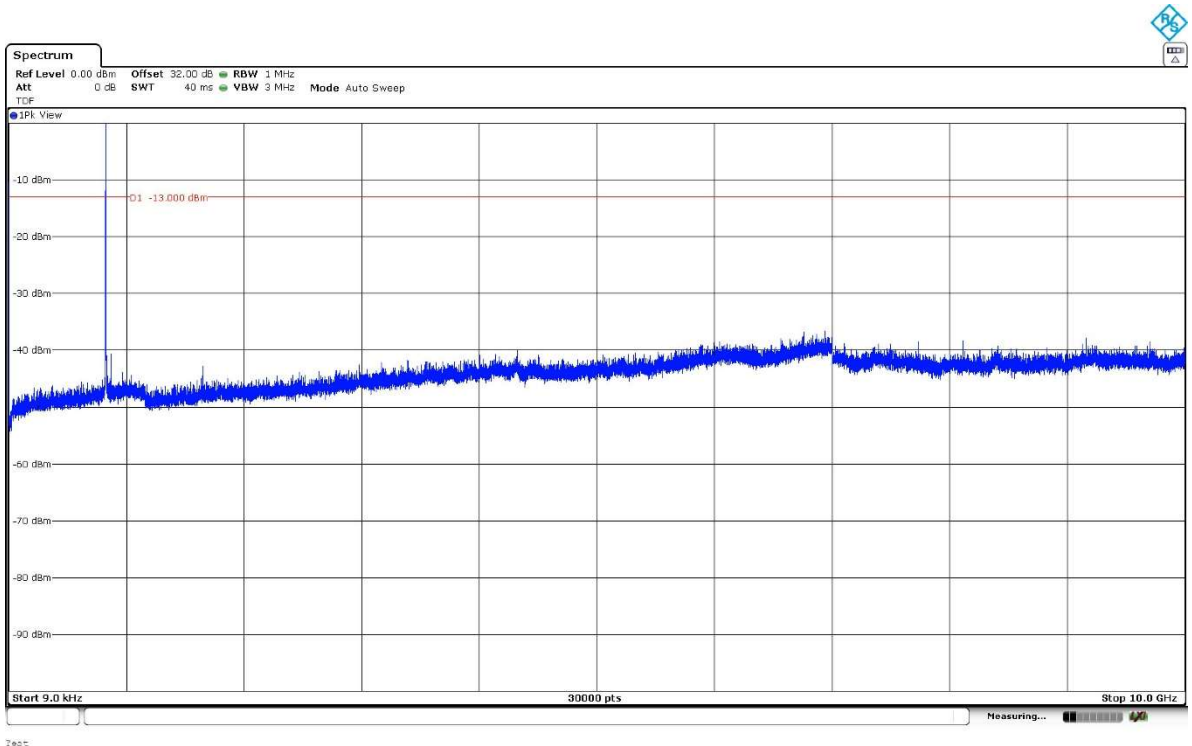
High Channel:



The peak above the limit is the carrier frequency.

**LTE Cat NB1 Band 26. Cross-rule Channel 824 MHz:** Pi/2-BPSK. BW=15 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=0.

Single Channel:



The peak above the limit is the carrier frequency.

## Spurious Emissions at Antenna Terminals at Block Edges

### Limits

#### \* FCC §2.1051 and §22.917:

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.

Compliance with these rules is based on the use of measurement instrumentation employing a reference bandwidth as follows:

In the spectrum below 1 GHz, instrumentation should employ a reference bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

#### \* 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  $116 \log_{10}(f/6.1)$  decibels or  $50 + 10 \log_{10}(P)$  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  $43 + 10 \log_{10}(P)$  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.

#### \* RSS-132. Clause 5.5:

Mobile and base station equipment shall comply with the limits below.

In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least  $43 + 10 \log 10 p$  (watts).

### Method

The EUT RF output connector was connected to a spectrum analyzer 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 path loss of the connection between the output terminal of the EUT and the input of the spectrum analyzer.

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

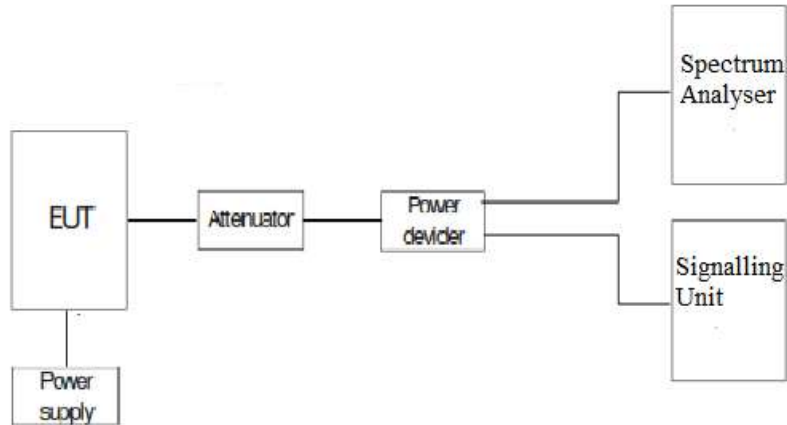
As stated in FCC part 22.917 / RSS-132 Clause 5.5, in the 1 MHz bands immediately outside and adjacent to the frequency block or band a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

Measurement Limit:

At  $P_o$  transmitting power, the specified minimum attenuation  $43 + 10 \log_{10} p$  (watts) becomes:

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

**Test Setup**



**Results**

**LTE Cat NB1 Band 26. Sub-band 814-824 MHz:**

Preliminary measurements determined the worst-case. Results attached are for this worst-case configuration.

|   |   |   |   |
|---|---|---|---|
| LTE Cat NB1 Band 26   | Pi/2-BPSK<br>BW=3.75 kHz<br>Tone Number=1<br>Tone Offset=0<br>MSC/TBS=0 | Pi/2-BPSK<br>BW=15 kHz<br>Tone Number=1<br>Tone Offset=0<br>MSC/TBS=0 | QPSK<br>BW=15 kHz<br>Tone Number=12<br>Tone Offset=0<br>MSC/TBS=5 |
| Maximum measured level at <u>Low Block Edge</u> at antenna port (dBm) | -19.79  | -28.04  | -25.21  |

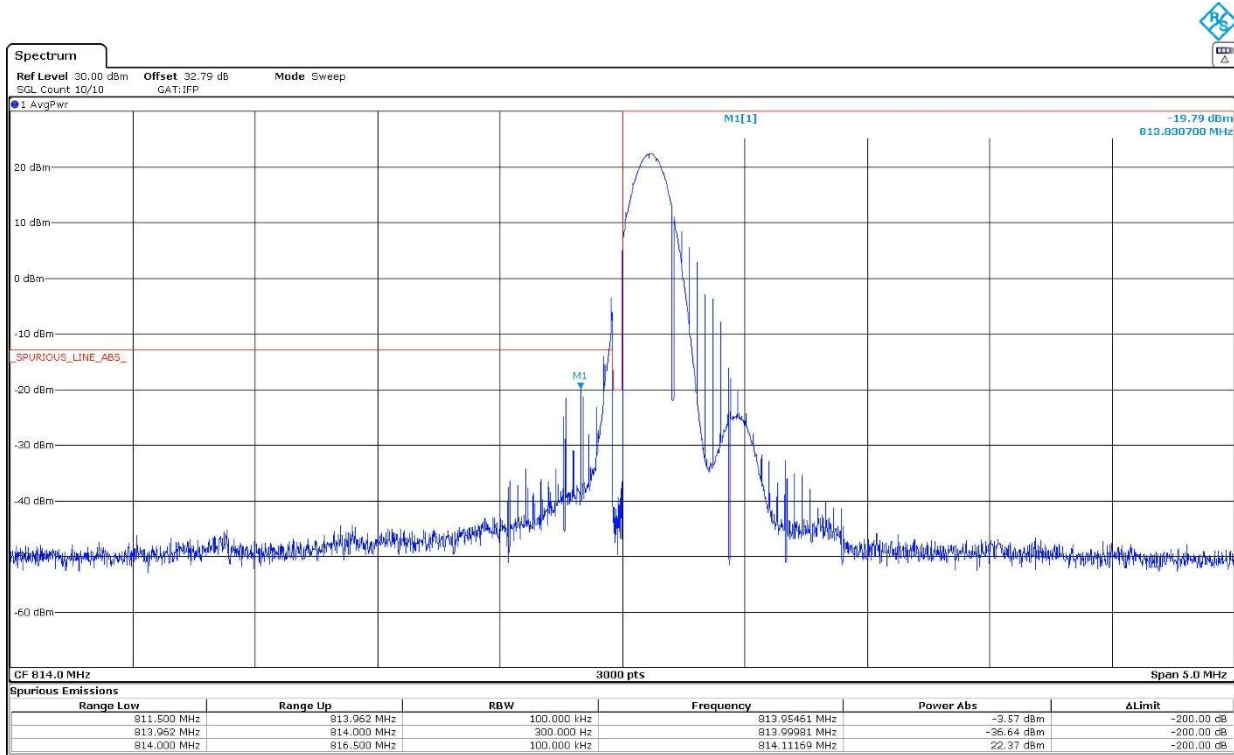
|  |  |  |   |
|--|--|--|---|
| LTE Cat NB1 Band 26  | Pi/2-BPSK<br>BW=3.75 kHz<br>Tone Number=1<br>Tone Offset=47<br>MSC/TBS=0 | Pi/2-BPSK<br>BW=15 kHz<br>Tone Number=1<br>Tone Offset=11<br>MSC/TBS=0 | QPSK<br>BW=15 kHz<br>Tone Number=12<br>Tone Offset=0<br>MSC/TBS=5 |
| Maximum measured level at <u>High Block Edge</u> at antenna port (dBm) | -26.02   | -26.55   | -14.66  |

Measurement uncertainty (dB): <math>\pm 2.76</math>

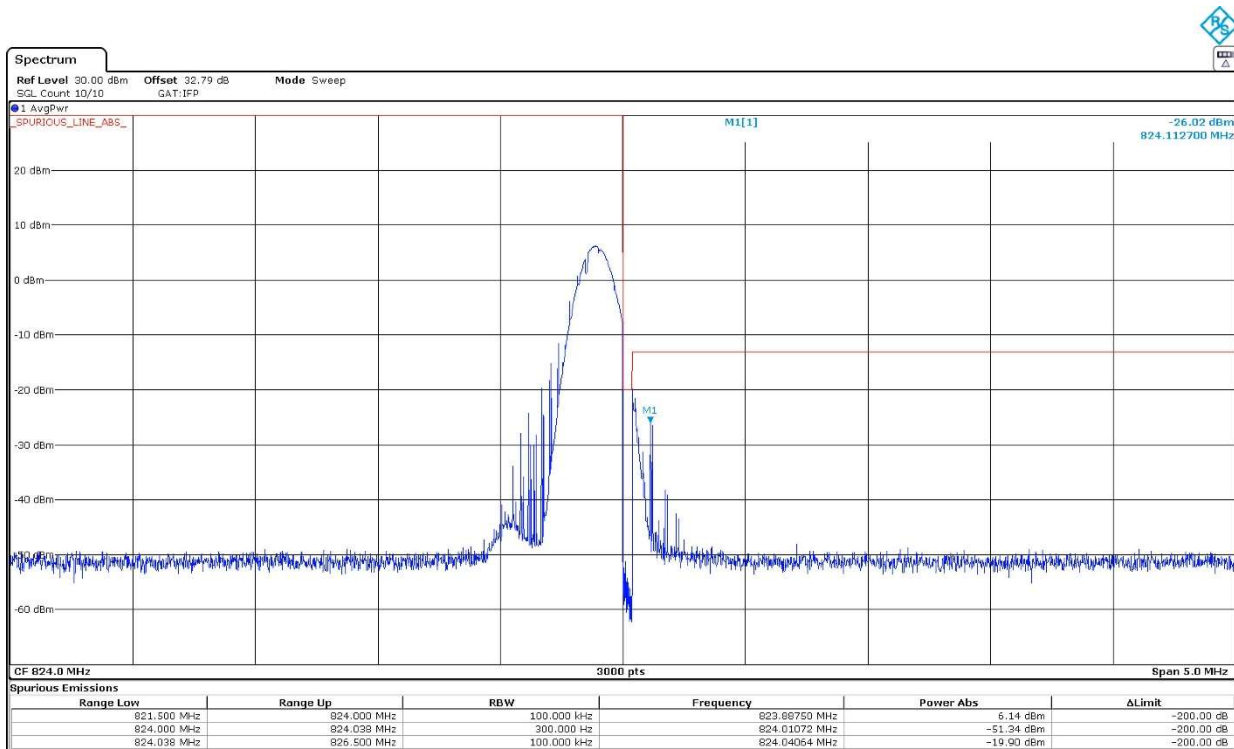
**Verdict**

Pass

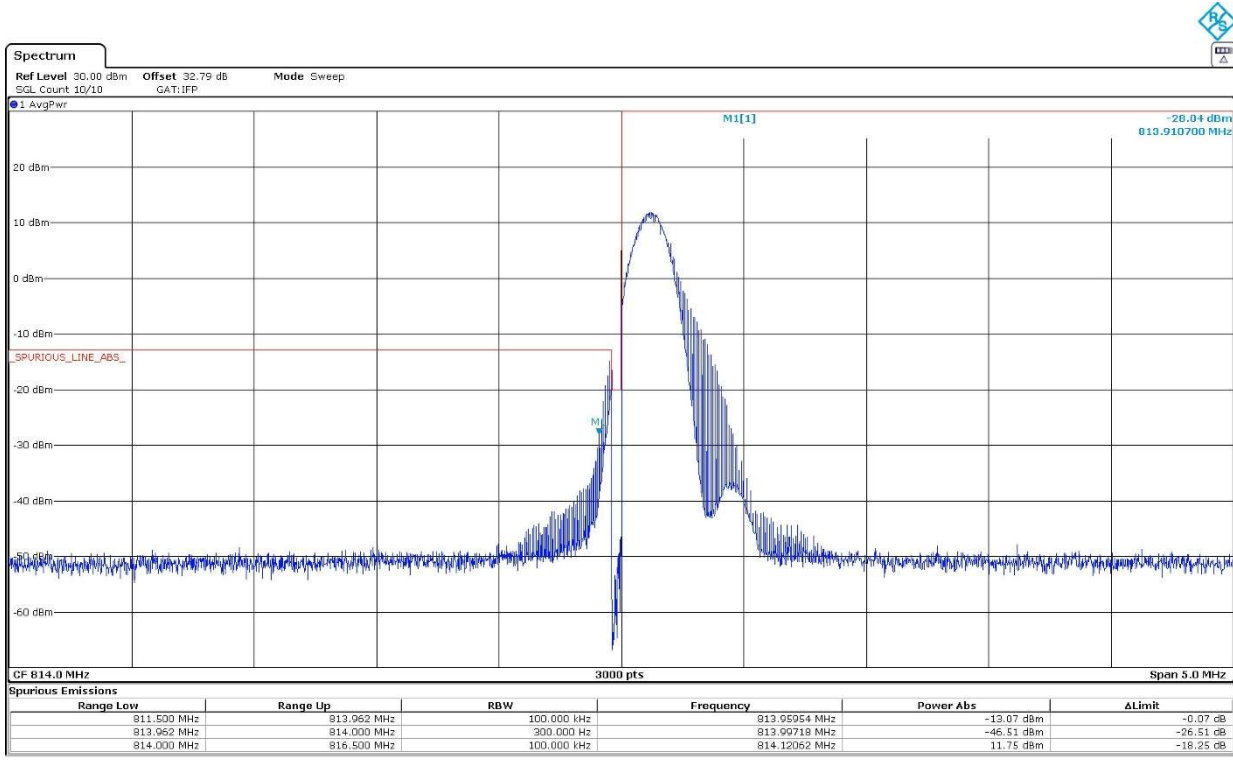
**LTE Cat NB1 Band 26. Sub-band 814-824 MHz. EA MASK: Pi/2-BPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=0. Low Channel:**



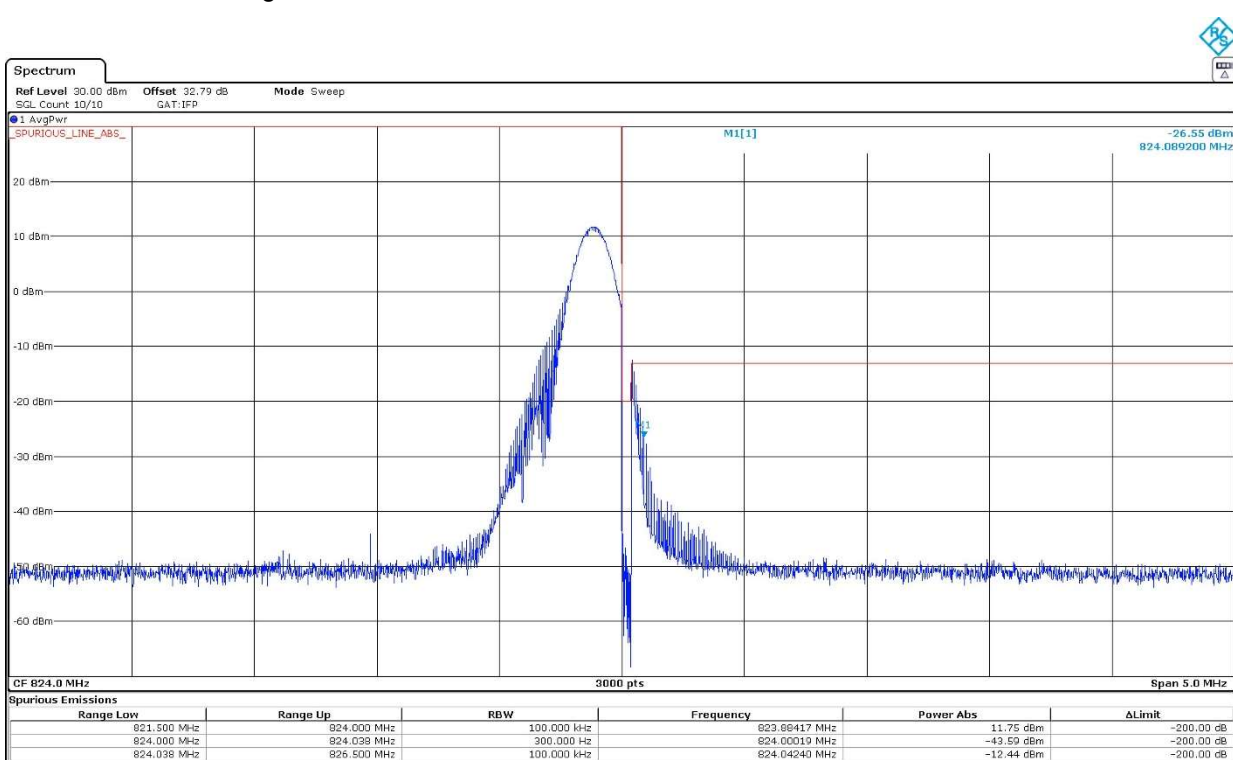
**LTE Cat NB1 Band 26. Sub-band 814-824 MHz. EA MASK: Pi/2-BPSK. BW=3.75 kHz. Tone Number=1. Tone Offset=47. MSC/TBS=0. High Channel:**



LTE Cat NB1 Band 26. Sub-band 814-824 MHz. EA MASK: Pi/2-BPSK. BW=15 kHz. Tone Number=1. Tone Offset=0. MSC/TBS=0. Low Channel:

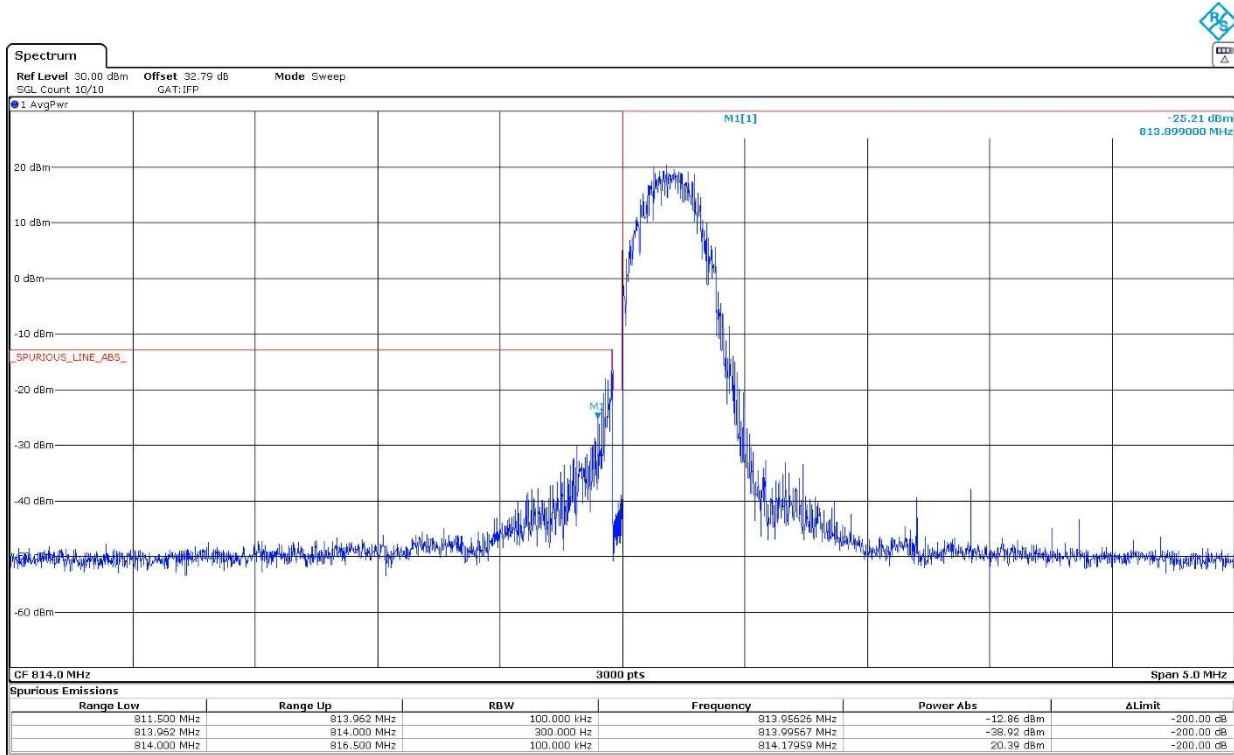


LTE Cat NB1 Band 26. Sub-band 814-824 MHz. EA MASK: Pi/2-BPSK. BW=15 kHz. Tone Number=1. Tone Offset=11. MSC/TBS=0. High Channel:





LTE Cat NB1 Band 26. Sub-band 814-824 MHz. EA MASK: QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0. MSC/TBS=5. Low Channel:



LTE Cat NB1 Band 26. Sub-band 814-824 MHz. EA MASK: QPSK. BW=15 kHz. Tone Number=12. Tone Offset=0. MSC/TBS=5. High Channel:

