

R&S®NRQ6

ACLR 100 MHz (Using FFT Filtering) Application Sheet



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Version 03

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Make ideas real



1 Your Task

This application sheet describes how to perform ACLR measurements on LTE Advanced/5G signals with a bandwidth of 100 MHz.

The R&S NRQ6 frequency selective power sensor has a built-in solution for ACLR measurements, but this function is limited to 20 MHz LTE signals. The limitation is due to the maximum instantaneous bandwidth of 100 MHz total for five channels.

The obvious alternative way would be to replace the ACLR measurement by several separate power measurements at the five frequencies, using the 100 MHz flat filter. Unfortunately, the stopband bandwidth of the 100 MHz flat filter is 160 MHz, due to limited number of FIR coefficients at this high sampling rate. Thus, you would see strong cross-talk of the main channel in the adjacent channels.

This application sheet describes a way to use FFT filtering to realize very steep filters needed for LTE advanced/5G ACLR measurements.

2 Possible Solution

The R&S NRQ6 has some built-in features to perform simple spectral analysis of the I/Q samples. The R&S NRQ6-K1 I/Q data interface option is not required.

These features are accessible by SCPI using the `SENS:TRAC:IQ:FFT:...` node.

Beside the magnitude spectrum displayed with "Signal Check" of the web user interface, the following command measures the power within a dedicated bandwidth by adding up the power in the frequency domain:

```
SENS:TRAC:IQ:FFT:SPEC:ABS:SUM?
```

Without additional parameter, this function calculates the power over the whole set resolution bandwidth.

Adding a numerical parameter reduces the spectral bandwidth considered.

If the command returns `NaN`, the FFT buffer is too large to be processed. Reduce the number of requested I/Q samples to obtain a result.

Example:

Resolution bandwidth is set to 100 MHz.

`SENS:TRAC:IQ:FFT:SPEC:ABS:SUM? ->` The power between -50 MHz and +50 MHz around the carrier frequency is measured.

`SENS:TRAC:IQ:FFT:SPEC:ABS:SUM? 0.9 ->` The power between -45 MHz and +45 MHz around the carrier frequency is measured.

3 How to Configure the R&S NRQ6

Task

Conduct an ACLR measurement with 100 MHz channel bandwidth based on FFT filtering. In the following, the frequency of the main channel (TX channel) is set to 2.1 GHz.

Prerequisites

There is no R&S NRQ6-K1 I/Q data interface option needed. Every R&S NRQ6 can be used.

Configuration

```

::
*RST
::
SENS:FUNC "XTIM:VOLT:IQ"      # Select IQ trace mode
SENS:BAND:RES:TYPE:AUTO OFF  # Turn off automatic selection of filter type
SENS:BAND:RES:TYPE:FLAT     # Set filter type to FLAT
SENS:BAND:RES 100.0e6       # Set 100 MHz as RBW
                             # (which corresponds to 120 MHz sample rate)
SENS:TRAC:IQ:RLEN 120000    # Requesting 120000 I/Q samples (1 ms)
                             # to be used for FFT calculation
                             # (biggest radix 2 number below is
                             # used in fact -> 64k FFT)

```

DC offset calibrating (optional)

In zero-IF mode (RBW>40 MHz), the R&S NRQ6 shows a large DC offset in the middle of the measured frequency band. This DC offset can affect the accuracy of ACLR measurements, especially at low power levels. You can correct this offset by using the DC offset calibration, so-called DC zeroing.

To calibrate the DC offset:

- Allow at least 10 minutes warm-up time before starting the DC zeroing.
- For wired measurements, keep the DUT connected to the RF connector. For OTA measurements, ensure that the antenna is connected to the RF connector of the R&S NRQ6.
- In contrast to zero calibration, you do not need to turn off all test signals for DC zeroing, as long as the measured test signals do not have a large DC component in the IF band. Otherwise, you have to turn off all test signals, before conducting the DC zeroing.
- At each ACLR channel frequency, `FREQ_V`, and for each input attenuation, `ATT_V`, enter the following block of SCPI commands:

```

SENS:FREQ FREQ_V      # "FREQ_V" is center frequency of each ACLR channel
                     # (set to 1.9 GHz, 2.0 GHz, 2.1 GHz, 2.2 GHz and 2.3 GHz)
SENS:INP:ATT ATT_V   # "ATT_V" is set input attenuation (set to 0 dB and 30 dB)
CAL:IQOF:AUTO ONCE  # Start DC zeroing (no need to turn off all test

```

```

# signals, in case the signals do not have a
# large DC component in the IF band)

Or

SENS:FREQ FREQ_V      # "FREQ_V" is center frequency of each ACLR channel
                      # (set to 1.9 GHz, 2.0 GHz, 2.1 GHz, 2.2 GHz and 2.3 GHz)
SENS:INP:ATT ATT_V    # "ATT_V" is set input attenuation (set to 0 dB and 30 dB)
CAL:ZERO:AUTO ONCE   # Start zero calibration (performs DC zeroing
                      # and noise correction as well) but you always
                      # have to turn off all test signals before zeroing.

```

After conducting the DC zeroing in the different frequency and input attenuation settings, the R&S NRQ6 saves the DC offset values and recalls them later depending on the set sensor settings. The saved DC offset values are used as long as you do not reboot the R&S NRQ6

Measuring the main channel power

```

SENS:FREQ 2.1e9        # RF = 2.1 GHz (example)
INIT                  # Trigger measurement
SENS:TRAC:IQ:FFT:SPEC:ABS:SUM? # Gets the power (linear scale)
                        # use "30.0 + 10.0*log10(linear power)" to
                        # get the logarithmic power / dBm

```

Measuring the adjacent channel power

```

SENS:FREQ 2.2e9        # RF = 2.2 GHz for right adjacent channel
INIT                  # Trigger measurement
SENS:TRAC:IQ:FFT:SPEC:ABS:SUM? # Gets the power (linear scale)
                        # use "30.0 + 10.0*log10(linear power)" to
                        # get the logarithmic power / dBm

::
::
# Do the same channel power measurement at 1.9 GHz (lower alternate channel),
# 2.0 GHz (lower adjacent channel) and 2.3 GHz (upper alternate channel).
::

```

Calculate ACLR

ACLR [dB] = Adjacent/alternate channel power [dBm] – main channel power [dBm]

4 Possible Extensions

With the above-mentioned method, all adjacent and alternate channels could be measured resulting in all five power values needed for standard ACLR measurement.

Another extension would be to trigger to an external signal connected to SMA connector denoted as TRG2.

```
::  
TRIG:SOUR EXT2                # Sensor will be triggered by an ext. signal
```

The FFT filtering method delivers very good results with low coding effort. A downside, however, is the long calculation time. It can be reduced by doing several measurements with shorter result length and averaging the readings later in the script.

5 Learn More about the R&S NRQ6

For a detailed description of the capabilities of the R&S NRQ6, read its user manual. The user manual also explains all aspects of remote control features in details.

Also, you can always install our basic driver and tools package called R&S NRP Toolkit. Among various tools, this package supplies an optional SDK (software development kit), which contains many sample programs with full commented source code in various programming languages. On an MS Windows PC, you find the SDK after installation under:

```
C:\ProgramData\Rohde-Schwarz\NRP-Toolkit-SDK\
```

The examples especially for the R&S NRQ6 are under:

```
C:\ProgramData\Rohde-Schwarz\NRP-Toolkit-SDK\NRQ\
```

Download the latest version of the R&S NRP Toolkit at:

https://www.rohde-schwarz.com/software/nrp_s_sn/