

R&S®NRQ6

Fast Pulse Power Measurement Application Sheet



1178824202
Version 02

ROHDE & SCHWARZ
Make ideas real



1 Your Task

This application sheet is related to various pulse measurement tasks with the frequency selective RF power sensor R&S NRQ6. All described scenarios can be summarized under the "Don't miss a pulse" slogan. You want to:

- Measure the pulse power of a well-known number of RF pulses.
- Determine the energy content of a well-known number of RF pulses.
- Count a random/unknown number of RF pulses without missing a single pulse over a long period of time.

2 Possible Solution

The R&S NRQ6 frequency selective power sensor is designed to measure RF power in a wide dynamic range. With its high acquisition speed, large internal memory and sophisticated internal trigger, the R&S NRQ6 is qualified for reliably measure the power of every single pulse of a random pulse train. As long as certain key data is observed, the R&S NRQ6 is an ideal solution to measure pulse power over a relatively long period. The "Don't miss a pulse" target is met when the parameters of a pulse sequence meet the following conditions:

Pulse period	$\geq 2 \mu\text{s}$
Number of pulses	< 128000
Pulse width	$\geq 300 \text{ ns}$
RF level	$\geq -68 \text{ dBm}$

These values are chosen to measure the roof power of every pulse with an uncertainty of $< 1 \text{ dB}$. [Chapter 4, "Possible Extensions"](#), on page 6 describes measurement set-ups where the main attention does not lie on a highly accurate pulse power measurement but (only) on the recognition of pulses. In such cases, the above specifications for the pulse width can be much lower, for example, down to 70 ns.

3 How to Configure the R&S NRQ6

Prerequisites

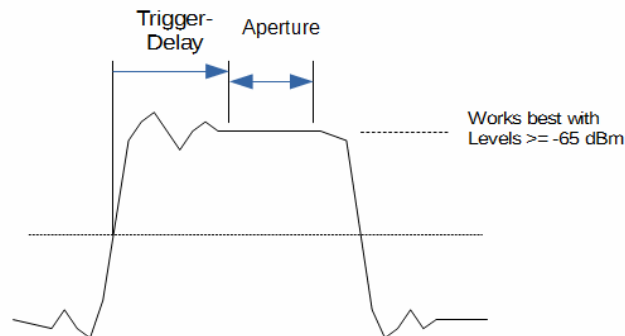
We assume that the R&S NRQ6 has been connected to an appropriate PoE+ Ethernet switch and the network parameters are successfully configured.

The communication between a controlling host and the sensor can take place in any high-level language. For the sake of convenience, this application sheet only shows the transmitted SCPI commands.

There is a suite of sample programs which go along with this application sheet. The programming examples come with full source code and are implemented both in Python and C/C++. On an MS Windows system, see the subfolders of `C:\ProgramData\Rohde-Schwarz\NRP-Toolkit-SDK\NRQ\` for the `DontMissAPulse` examples.

Scenario 1

Measurement of settled pulse roof power. The parameters are chosen for acquiring 1 or more samples in the roof of a pulse. For this pulse power measurement, the 25 MHz NORMAL or 40 MHz FLAT resolution bandwidth filter is selected. Trigger is internal on the rising edge, selected trigger level approx. 2 dB to 3 dB below the expected pulse power. *Not* to include (parts of) the rising edge in the measurement, a 150 ns delay is chosen after the trigger condition. With a pulse width of approx. 400 ns, an aperture time of 120 ns to 150 ns is reasonable to exclude any parts of the falling edge of the pulse.



Given that our pulses are at an RF of 2.4 GHz, the R&S NRQ6 is prepared with the following commands:

```
*RST # Reset the power sensor
*CLS # Clear Status subsystem
*IDN? # Query device identification (optional)
SENS:FUNC "POW:AVG" # Select power average measurement mode
SENS:FREQ 2.4e9 # RF = 2.4 GHz

SENS:BAND:RES:TYPE:AUTO OFF # Configuring resolution bandwidth filter
SENS:BAND:RES:TYPE NORMAL # Manual selection for 25 MHz NORMAL filter
SENS:BAND:RES 25.0e6 # ::

SENS:INP:ATT:AUTO OFF # De-activation of input attenuation
SENS:INP:ATT 0 # ::

TRIG:SOUR INT # Internal trigger
TRIG:LEV -68 DBM # @ -68 dBm
TRIG:DEL 150.0e-9 # Mask rising edge & possible overshoot
SENS:POW:AVG:APER 120.0e-9 # Measurement window length 120 ns

BUFF:STAT ON # We expect 95000 pulses...
```

```

BUFF:SIZE 95000           # configuring buffer size and
TRIG:COUN 95000           # trigger count for that number of pulses

CAL:ZERO:AUTO ONCE;*OPC?  # Zero calibration. Especially important for
                           # RBW filter >= 50 MHz. In the present case
                           # this is optional

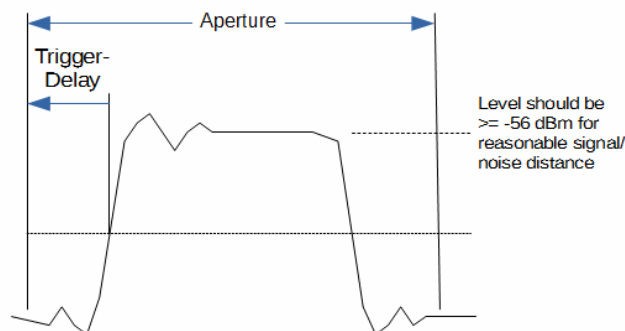
INIT:IMM;*OPC?            # Starting measurement. This will be ready
                           # after the occurrence of 95000 pulses
                           # (as configured before)

FORM:DATA REAL,64         # We want binary results...
FETCH?                     # Reading the results (95000 'double' values)

```

Scenario 2

This measurement is similar to scenario 1. However, instead of pulse roof power, we are interested in the overall energy content of every pulse (Energy = AveragePower * Time). Different to scenario 1, we need the average power of the whole pulse, including rising and falling edge portions. Hence, we work with a small negative trigger delay and also select an aperture time long enough to contain the whole pulse and a bit beyond.



The selection of negative trigger delay and aperture time depends on the pulse form. Ideally, we can acquire at least 25 ns before the rising edge and up to 100 ns beyond the falling edge of the pulse.

For the correct signal evaluation, we chose the NORMAL filter characteristic for a 100 MHz resolution bandwidth filter. **Note:** For resolution bandwidths ≥ 50 MHz and very low signal levels of < -55 dBm, it is essential to execute always a zero calibration directly before starting a measurement. A zero calibration compensates any DC offset of the output of the zero IF mixer.

The parameters for this scenario are chosen for acquiring the average power of pulses which are 200 ns in length. Acquisition starts 50 ns before the rising edge and ends 50 ns after the falling edge, resulting in an aperture of 300 ns in total. RF is set to 2.4 GHz.

```

*RST                       # Reset the power sensor
*CLS                       # Clear Status subsystem

```

```

*IDN?                # Query device identification (optional)
SENS:FUNC "POW:AVG"  # Select power average measurement mode
SENS:FREQ 2.4e9      # RF = 2.4 GHz

SENS:BAND:RES:TYPE:AUTO OFF # Configuring resolution bandwidth filter
SENS:BAND:RES:TYPE NORMAL # Manual selection for 100 MHz NORMAL filter
SENS:BAND 100.0e6    #   ::

SENS:INP:ATT:AUTO OFF # De-activation of input attenuation
SENS:INP:ATT 0      #   ::

TRIG:SOUR INT       # Internal trigger
TRIG:LEV -66 DBM    # @ -66 dBm
TRIG:DEL -50.0e-9   # Pre-trigger delay to get full pulse
SENS:POW:AVG:APER 300.0e-9 # Measurement window length 300 ns, means
                          # 50 ns + 200 ns + 50 ns
                          # = pre-trigger + pulse width + settle time

BUFF:STAT ON        # We expect 100000 pulses...
BUFF:SIZE 100000    # configuring buffer size and
TRIG:COUN 100000    # trigger count for that number of pulses
{switch OFF the RF signal before executing Zero Calibration}

CAL:ZERO:AUTO ONCE;*OPC? # Zero calibration. Especially important for
                          # RBW filter >= 50 MHz

{switch ON the RF signal again}

INIT:IMM;*OPC?      # Starting measurement. This will be ready
                          # after the occurrence of 100000 pulses
                          # (as configured before)

FORM:DATA REAL,64   # We want binary results...
FETCH?              # Reading the results (100000 'double' values)

```

The corresponding sample program has to multiply every resulting average power value with the aperture time to get the final energy content of every measured pulse.

Scenario 3

In this measurement scenario, we are interested in counting the number of pulses which occur. Our main interest is not the evaluation of the absolute power of every single pulse. Since the primary goal is not the absolute pulse power measurement, we can cope with much shorter pulses. Since rise & fall times and overshoots are not relevant, pulse widths can be as short as 25 ns.

This scenario uses the buffered mode of the power average measurement like in the previously mentioned measurements. However, we merely use the R&S NRQ6 as an RF trigger source and/or RF pulse counter. The R&S NRQ6 is configured as shown here:

```

*RST                                # Reset the power sensor
*CLS                                # Clear Status subsystem
*IDN?                               # Query device identification (optional
SENS:FUNC "POW:AVG"                # Select power average measurement mode
SENS:FREQ 2.4e9                     # RF = 2.4 GHz

SENS:BAND:RES:TYPE:AUTO OFF        # Configuring resolution bandwidth filter
SENS:BAND:RES:TYPE NORMAL          # Manual selection for 25 MHz NORMAL filter
SENS:BAND:RES 40.0e6                #   ::

SENS:INP:ATT:AUTO OFF              # De-activation of input attenuation
SENS:INP:ATT 0                      #   ::

TRIG:SOUR INT                       # Internal trigger
TRIG:LEV -66 DBM                    #   @ -66 dBm
SENS:POW:AVG:APER 50.0e-9          # Measurement window length 50 ns

BUFF:STAT ON                        # Configure max. buffer size...
BUFF:SIZE 128000                    #   Later the buffer will be emptied
TRIG:COUN 128000                    #   continuously and the number of contained
                                   #   results will be counted

CAL:ZERO:AUTO ONCE;*OPC?           # Zero calibration. Especially important for
                                   #   RBW filter >= 50 MHz. In the present case
                                   #   this is optional

FORM:DATA REAL,64                  # We want to read out the results in binary

INIT:CONT ON                        # Starting continuous measurement mode.
                                   #   From here we continuously check whether
                                   #   the buffer contains any measurements at all,
                                   #   and read-out and count the results...

{loop}
  SENS:POW:AVG:BUFF:COUN?          # Any measurements?
  SENS:POW:AVG:BUFF:DATA?          #   If yes, read results and count them...
{endloop}

INIT:CONT OFF                       # Finally, stop the continuous measurement mode.

```

4 Possible Extensions

The configuration of scenario 3 could be enhanced with the corresponding trigger delays and appropriate aperture time as used in scenario 1. In this case, we not only *count* the number of RF pulses, but we also measure the roof power of every pulse:

```

::
TRIG:DEL 100.0e-9                  # Mask rising edge & possible overshoot.

```

```

# Values depend on the pulse characteristics
SENS:POW:AVG:APER 50.0e-9 # Select appropriate measurement window length
::

```

Another extension of scenario 3 could be to use the sensor as a high-speed trigger source on the RF pulses. We can configure the SMA type external trigger connector on the back of the R&S NRQ6 as an output for the trigger condition. Thus, the R&S NRQ6 internally triggers on the RF pulse and outputs the trigger on the corresponding connector.

```

::
TRIG:SOUR INT # Sensor will trigger on the RF signal
TRIG:LEV 1.0e-8 # @ -50 dBm
::
TRIG:SEND:PORT EXT2 # Output a trigger pulse on ext. connector
TRIG:SEND:STAT ON # whenever an internal signal trigger occurs.
# Trigger pulse has a length of 100 ns
::

```

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:

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