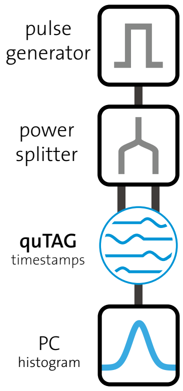
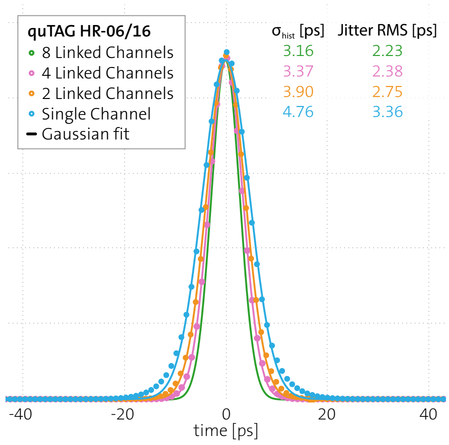
quTAG HR - High Resolution

High resolution variant of the quTAG time tagger

Key Features

- 1 ps digital resolution
- Timing jitter down to 2.4 ps RMS
- Sustained event rate 100 Mcps
- Up to 16 high resolution stop channels
- 3 variants with different number of input channels and timing jitter





quTAG HR Specifications

Time to Digital Converters	
Digital resolution	1 ps
Timing jitter RMS	down to 2.4 ps *1
Max. event rate per channel	25 Mcps
Sustained throughput rate	100 Mcps (USB3.0)
Delay range	-100 ... +100 ns
Delay resolution	1 ps
Min. pulse to pulse separation	40 ns
Differential non-linearity	<1 %

Input Channels	
Number of channels	1 start / 8, 16 stop
Connectors	SMA
Signal levels	-5 ... +3.5 V
Threshold level resolution	0.15 mV
Edge	rising, falling
Min. input pulse width	300 ps
Impedance	50 Ohms
Input divider factors	1, 2, 4, 8

Output Channels	
Number of channels	2
Signal levels	LVTTL
Delay resolution	10 ps
Connector	D-Sub

Marker Inputs	
Number of channels	4
Digital resolution	5 ns
Signal level	LVTTL (5V tolerant)
Timing jitter	2-5 ns
Connector	D-Sub

Clock Input	
Frequency	10 MHz ± 100 ppm *2
Signal level	-6 ... +6 V
Impedance	50 Ohms
Connector	SMA

Clock Output	
Frequency	10 MHz ± 100 ppm
Signal level	LVTTL
Impedance	50 Ohms
Connector	SMA

Operation	
Interface	USB 3.0
Supplied software	GUI, Python, LabView, DLL, command line
Dimensions 1U / 2U	445 x 330 x 50 / 95 mm

*1: enhanced jitter values by redistribution of resources & channels, see table next page, *2: various frequencies, see user defined clock input feature

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quTAG HR variants

The time taggers of the quTAG HR are available in a range of different timing jitter and channel numbers. Enhanced timing jitter values can be achieved by internally combining input channels via software.

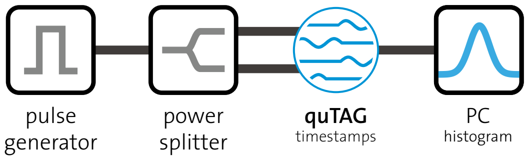
The achievable RMS jitter values with respective numbers of remaining stop channels are shown in the table below for the different quTAG HR variants.

Variant	16 Ch	8 Ch	4 Ch	2 Ch	Height
HR-04/08		4.5	3.2_L	2.4_L	2U
HR-06/08		6.4	4.5_L	3.2_L	1U
HR-06/16	6.4	4.5_L	3.2_L	2.4_L	2U

Linked stop channels reduce the timing jitter. The table shows the three quTAG HR variants and their single channel timing jitter RMS in picosecond with the resuming stop input channels without and with linked channels $_L$.

How we measure the jitter

In order to measure the jitter, we generate an electrical pulse with steep edges. This pulse gets split into two by a power splitter and sent into two different inputs of the quTAG (i.e. start and stop-X or stop-X and stop-Y).



Then we use the quTAG software to generate a start-stop-histogram. We fit a Gaussian function to this histogram and determine RMS and FWHM. The single channel jitter corresponds to $\sigma/\sqrt{2}$ from this two channel measurement, assuming equal Gaussian contributions from both signals. The FWHM can be obtained by the standard deviation with the relation $\mathrm{FWHM} = 2\sqrt{2\ln 2}\,\sigma \approx 2.35\sigma$.

quTAG HR features

Cross-correlation software
This software extension calculates the correlation function needed in Hanbury Brown-Twiss experiments or fluorescence correlation spectroscopy.

Lifetime software
This software enables analyzing lifetime measurements on the fly. The software calculates histograms and fits exponential decays.

Filters & virtual channels
The device allows to enable virtual channels or user-defined filters. Filtering is based on hardware to save USB bandwidth and reduce unnecessary data.

Divider for start and stop channels
This option allows you to enable the divider on the start or all stop channels, allowing higher frequency periodic signals to be recorded.

Clock input
The quTAG can be synchronized to an external 1-100 MHz clock signal via an SMA connector to allow more precise long-term accuracy.

Device Synchronization
Devices can be synchronized by the Sync-Out SMA connector. If an external clock is connected, the Sync-Out signal is phase locked to the input.

Marker inputs Upgrade
The device features marker inputs, inserting timestamps in the timeline. Marker inputs are needed e.g. to read a pixel or line clock in a FLIM setup.

Output channels Upgrade
The two programmable outputs enable conditional measurements, state preparation, gating of detectors, control of shutters, and more to synchronize events.

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