quTAG MC - Multi Channel

Multi channel variant of the quTAG family.

Key Features

- 1 ps digital resolution
- Up to 32 stop channels in one device
- Synchronization of multiple devices
- Timing jitter down to 10 ps RMS
- USB 3.0 interface
- Cost-sensitive, modular versions available

Applications

- Time-correlated Single Photon Counting (TCSPC)
- Quantum Optics / Information / Communication
- Quantum Key Distribution / Quantum Cryptography
- Fluorescence Lifetime Imaging (FLIM)
- Fluorescence Correlation Spectroscopy (FCS)
- Foerster Resonance Energy Transfer (FLIM-FRET)
- Single Photon Emitter Characterization
- Light Detection and Ranging (LIDAR)

quTAG MC Specifications

Time to Digital Converters	
Digital resolution	1 ps
Timing jitter*1 RMS	down to 10 ps*2
Max. event rate per channel	100 Mcps
Sustained throughput rate	100 M tags/sec
Delay range	-100 ... +100 ns
Delay resolution	1 ps
Min. pulse to pulse separation	10 ns
Differential non-linearity	<1 %

Input channels	
Number of channels	8, 16, 32 & 1 start
Input connectors	SMA
Signal levels	-5 ... +3.5 V
Threshold level resolution	2.5 mV
Edge	rising, falling
Min. input pulse width	1 ns
Impedance	50 Ohms

Output Channels	
Number of channels	2
Signal levels	LVTTL
Delay resolution	10 ps

Marker Inputs	
Number of channels	4
Digital resolution	5 ns
Impedance	470 Ohms

Clock Input	
Frequency	10 MHz*3
Signal level	-5 ... +5 V
Impedance	50 Ohms
Connector	SMA

Clock Output	
Frequency	10 MHz*3
Signal level	LVTTL
Impedance	50 Ohms
Connector	SMA

Operation	
Interface	USB 3.0
Supplied software	GUI, Python, LabView, DLL, command line
Dimensions:	440 x 330 x 75 mm

*1: see measurement method, *2: enhanced jitter values by redistribution of resources & channels, *3: various frequencies

quTAG MC variants

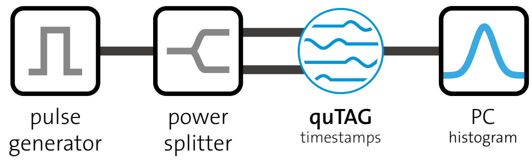
The time taggers of the quTAG family are available with a wide range of timing resolution and channel numbers. Enhanced timing jitter values can be achieved by inter-connecting input channels via software.

The following table shows all quTAG MC versions with varying number of input channels and timing RMS jitter in picoseconds. Achieved timing jitter by interconnecting input channels are listed horizontally.

Versions	32 Ch	16 Ch	8 Ch	4 Ch	2 Ch
MC-40/08			*40*	28.3	20
MC-40/16		*40*	28.3	20	14.1
MC-40/32	*40*	28.3	20	14.1	10
MC-100/08			*100*	70.7	50
MC-100/16		*100*	70.7	50	35.4
MC-100/32	*100*	70.7	50	35.4	25

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 $\mathrm{FWHM} = 2\sqrt{2\ \ln 2}\ \sigma \approx 2.35\sigma$.

Available quTAG MC extensions

Lifetime software extension
The software add-on enables analyzing lifetime measurements on the fly. The software calculates histograms and fits exponential decreases.

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

Clock input*1
The quTAG can be synchronized to an external clock to allow more precise long-term accuracy.

Synchronization of devices*1
This extension allows to synchronize up to 10 devices. Up to 320 equal stop channels of HR version are offered – all sharing the same clock.

Start-channel as input*1,2
The start channel can be converted to another stop channel, allowing one more equal input channel.

Virtual channels & filters*1
The device allows to enable virtual channels or user-defined filters. The filtering is based on hardware and happens inside the device to save USB bandwidth.

Marker inputs - *optional*
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 - *optional*
The two programmable outputs enable conditional measurements, state preparation, gating of detectors, control of shutters and more to synchronise events.

*1: not included in all three quTAG MC-100ps variants, *2: not available for 32 channel variants