**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

**quTAG MC Specifications**

<table>
<thead>
<tr>
<th>Time to Digital Converters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital resolution</td>
<td>1 ps</td>
</tr>
<tr>
<td>Timing jitter RMS</td>
<td>down to 10 ps</td>
</tr>
<tr>
<td>Max. event rate per channel</td>
<td>100 Mcps</td>
</tr>
<tr>
<td>Sustained throughput rate</td>
<td>100 M tags/sec</td>
</tr>
<tr>
<td>Delay range</td>
<td>-100 ... +100 ns</td>
</tr>
<tr>
<td>Delay resolution</td>
<td>1 ps</td>
</tr>
<tr>
<td>Min. pulse to pulse separation</td>
<td>10 ns</td>
</tr>
<tr>
<td>Differential non-linearity</td>
<td>&lt; 1 %</td>
</tr>
</tbody>
</table>

**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

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

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

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

**Clock Output**
- Frequency: 10 MHz
- 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

Disclaimer: The information contained herein is subject to change without notice. qutools shall not be liable for technical or editorial errors or omissions contained herein.
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 interconnecting 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.

<table>
<thead>
<tr>
<th>Versions</th>
<th>32 Ch</th>
<th>16 Ch</th>
<th>8 Ch</th>
<th>4 Ch</th>
<th>2 Ch</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC-40/08</td>
<td>40</td>
<td>28.3</td>
<td>20</td>
<td>14.1</td>
<td>10</td>
</tr>
<tr>
<td>MC-40/16</td>
<td>40</td>
<td>28.3</td>
<td>20</td>
<td>14.1</td>
<td>10</td>
</tr>
<tr>
<td>MC-40/32</td>
<td>40</td>
<td>28.3</td>
<td>20</td>
<td>14.1</td>
<td>10</td>
</tr>
<tr>
<td>MC-100/08</td>
<td>100</td>
<td>70.7</td>
<td>50</td>
<td>35.4</td>
<td>25</td>
</tr>
<tr>
<td>MC-100/16</td>
<td>100</td>
<td>70.7</td>
<td>50</td>
<td>35.4</td>
<td>25</td>
</tr>
</tbody>
</table>

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

**Synchronization of devices**
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**
The start channel can be converted to another stop channel, allowing one more equal input channel.

**Virtual channels & filters**
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 synchronize events.

---

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

---

DISCLAIMER: The information contained herein is subject to change without notice. quotools shall not be liable for technical or editorial errors or omissions contained herein.

---

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