

MultiHarp 160

Multichannel Time Tagging & TCSPC Unit

- Up to 64 independent input channels with 5 ps base resolution
- Common sync channel (trigger rate up to 1200 MHz)
- Timing precision of < 20 ps RMS (single channel)
- Ultrashort dead time of 650 ps, no dead time across channels
- Level triggers on all channels
- Sustained time tagging with up to 85 Mcps via USB 3.0
- Hardware access to data stream via external FPGA interface with up to 1678 Mcps
- Hardware histogrammer with 65536 time bins per channel
- Multifunctional on-board event filters
- Ref In/Out, PPS In and White Rabbit interface for multi-device synchronization
- Multifunctional on-board event filters
- Adjustable delay on each channel with 5 ps resolution
- Multi-stop capability for efficiency at slow repetition rate

Applications

- Quantum optics & photonics
- Quantum key distribution
- Photonic quantum computing
- Detector testing
- Diffuse optical tomography
- LiDAR & SLR
- Time-of-flight measurements
- Time-resolved photoluminescence



The MultiHarp 160 is designed as a plug-and-play Time Tagging and Time-Correlated Single Photon Counting (TCSPC) unit which is optimized for applications that require a large number of fast and precise timing channels. The high quality and reliability of the MultiHarp 160 is reflected by our unique 5-year limited warranty.

Scalable up to 64 input channels

The number of input channels can be scaled to your needs: the main unit (MultiHarp 160 M) provides 16 of them and can be expanded with up to three extension units (MultiHarp 160 X1-3). Each extension unit adds 16 channels to the event timer, thus providing a choice of 16, 32, 48 or 64 synchronized input channels. The MultiHarp 160 M also features a synchronization channel as a timing reference for all 16 to 64 input channels. This synchronization channel supports sync rates of up to 1.2 GHz for periodic signals. The data from all input channels are combined into a single data stream that is accessible via the USB 3.0 interface. No additional synchronization tools are required.

All channels of the MultiHarp 160 – including the common sync input – can be used as detector inputs, e.g., for coincidence correlation or coincidence counting. The MultiHarp 160 is also perfectly suited for performing TCSPC with multiple detectors using forward start-stop operation. Here, the common sync channel allows for synchronization with the excitation source.

Fast and precise event timing

The MultiHarp 160's smartly designed time-to-digital converters (5 ps base resolution, < 650 ps dead time) allow fully exploiting the count rate limits of TCSPC, without having to compromise on the time resolution for many modern single photon detectors. With its ultrashort dead time, multiple photons per excitation cycle can be detected even at the highest repetition rates achievable by modern picosecond pulsed lasers (requires a detector from the PMA Hybrid Series).

Each input channel also features easily accessible parameter settings, including the trigger parameters as well as programmable timing offsets and hold-off times.

Multifunctional on-board event filters

The MultiHarp 160 has user-definable on-board event filters to efficiently reduce the file sizes and the amount of data sent via the data interfaces (USB, external FPGA interface).

Data interface for external FPGA boards

For applications with high count rates at multiple input channels, the data read-out speed and/or data processing speed by the computer is the major bottleneck. This bottleneck can be bypassed by reducing the data size that is sent to the computer. Such a data reduction is for example done in the histogramming mode of the MultiHarp 160, where TCSPC histograms sent to the computer are calculated out of the arrival times of the input signals by the unit's hardware itself.

To enable the greatest possible flexibility, the time tagging data stream of the MultiHarp 160 can be accessed by external FPGA boards with FMC or SFP connectors via dedicated FPGA interfaces (referenced as “EFI REAR” and “EFI SFP”, respectively). This way, you can tailor the method of data preprocessing to your specific application.

White Rabbit ready time tagger

White Rabbit is a fully deterministic, Ethernet-based timing network which provides ps-precise synchronization and sub-nanosecond accuracy of devices over large distances. Thanks to its White Rabbit interface, the MultiHarp 160 is ready to be integrated into set-ups that are using this emerging technology.

Easy-to-use software included, custom programming supported

package that providing all important functions such as setting measurement parameters, displaying results, loading/saving of measurement parameters and measurement curves. Important measurement data, including count rate, count maximum, position and peak width are continuously displayed. A comprehensive online help system eases the user into fully employing the capabilities of the MultiHarp 160.

A library for custom programming, e.g., with C, C#, LabVIEW, Matlab, and Python is included. An advanced high-level API package for Python called “snAPI” is also available. It readily provides many real-time analysis methods such as histogramming, intensity and coincidence time traces, FCS and $g(2)$ correlation. Alternatives for advanced T2 data collection and analysis are the SymPhoTime 64 and QuCoo software suites offered by PicoQuant. SymPhoTime 64 is focused on typical life science applications while QuCoo is oriented towards typical quantum optics applications.

The MultiHarp 160 is fully compatible with UniHarp. This sleek, powerful, and intuitive graphical user interface is designed to revolutionize the way you interact with PicoQuant's Time Tagging & TCSPC electronics. It provides seamless access to advanced measurement classes such as timetrace, histogram, unfold, raw, and correlation (including FCS and g^2) while simplifying data acquisition and analysis for researchers in quantum optics, materials science, life science and metrology. The GUI provides a streamlined interface to configure, initiate, and monitor your time tagger, ensuring every photon count is captured with precision. With intuitive parameter-setting tools UniHarp puts full control at your fingertips.

Specifications

Input Channels and Sync	
Number of detector channels (in addition to sync input)	16 (main unit) 32 (main unit + first extension unit) 48 (main unit + first and second extension unit) 64 (main unit + first, second, and third extension unit)
Input voltage operating range (pulse peak into 50 Ohms)	-1200 mV to 1200 mV
Input voltage max. range (damage level)	± 2500 mV
Trigger edge	Level trigger: falling or rising edge, software adjustable
Input pulse width	> 0.4 ns (rise/fall time max. 20 ns)
Time to Digital Converters	
Minimum time bin width	5 ps
Timing precision	< 28 ps RMS
Timing precision / $\sqrt{2}$ *	< 20 ps RMS
Dead time	< 650 ps (can be increased via software up to 160 ns in steps of 1 ns)
Adjustable programmable time offset for each input channel	± 100 ns, resolution 5 ps
Differential non-linearity	< 5 % peak to peak, < 1 % rms (over full measurement range)
Max sync rate (periodic pulse train)	1.2 GHz
Histogrammer	
Count depth	32 bit (4 294 967 295 counts)
Full scale time range	328 ns to 2.74 s (depending on chosen resolution: 5, 10, 20, ..., 41943040 ps)
Maximum number of time bins	65536
Peak count rate per input channel	1.5×10^9 counts/sec for 2048 events
Total sustained count rate, sum over all input channels	MultiHarp 160 M: 332×10^6 counts/sec (166×10^6 counts/sec per row of 8 input channels) MultiHarp 160 X1, X2, X3: 332×10^6 counts/sec (166×10^6 counts/sec per row of 8 input channels)
TTTR Engine	
T2 mode resolution	5 ps
T3 mode resolution	5, 10, 20, ..., 41943040 ps
FiFo buffer depth (records)	268 435 456 events
Peak count rate per input channel	1.5×10^9 counts/sec for 2048 events
Total sustained count rate, sum over all input channels**	80×10^6 counts/sec via USB 3.0 interface
Trigger Output	
Period	programmable, 0.1 μ s to 1.678 s (0.596 Hz to 10 MHz)
Pulse width	10 ns typ.
Baseline level	0 V typ.
Active level (pulse peak)	-0.7 V typ. (50Ohm)

External Market Inputs	
Number	4
Input type	LVTTL, < 50 ns rise/fall time, > 50 ns at HIGH or LOW (max. 5 V for 1 µs), software adjustable hold-off
External Synchronisation	
Ref. IN	10 MHz 200 ... 1500 mV p.p. 50 Ohm; AC coupled
Ref. OUT	Default: 10 MHz White Rabbit mode: 31.25 MHz 1400 mV p.p. 50 Ohm; AC coupled
PPS IN	1 s, LVTTL
White Rabbit interface	connector for SFP module
FPGA data Interface	
Throughput T2/T3 mode (EFI REAR)	200 × 10 ⁶ events/sec
Throughput T2/T3 Mode (EFI SFP)	156 × 10 ⁶ events/sec
Throughput T2 Direct Mode (EFI REAR only)	200 × 10 ⁶ events/sec per row of 8 input channels + 78 × 10 ⁶ events/sec for SYNC input
Latency T2 mode	4.5 µs to 5.0 µs
Latency T3 mode	4.5 µs to 5.5 µs
Latency T2 Direct Mode (EFI REAR only)	Sync: 1.7 µs to 1.8 µs Others: 0.8 µs to 1.2 µs
Operation	
PC interface	USB 3.0
PC requirements	Dual Core CPU or better, min. 2 GHz CPU clock, min. 4 GB memory
Operating system	Windows 10/11
Power consumption	max. 150 W
Operation environment	Indoor use only
Operation altitude	Max. 2000 m above sea level
Dimensions	
MultiHarp 160 X (main unit)	incl. feet and handles 285 × 425 × 100 mm
MultiHarp 160 X (extension unit)	incl. feet and handles 285 × 425 × 62 mm

* In order to determine the timing precision it is necessary to repeatedly measure a time difference and to calculate the standard deviation (rms error) of these measurements. This is done by splitting an electrical signal from a pulse generator and feeding the two signals each to a separate input channel. The differences of the measured pulse arrival times are calculated along with the corresponding standard deviation. This latter value is the rms jitter which we use to specify the timing precision. However, calculating such a time difference requires two time measurements. Therefore, following from error propagation laws, the single channel rms error is obtained by dividing the previously calculated standard deviation by $\sqrt{2}$. We also specify this single channel rms error here for comparison with other products.

** Sustained throughput depends on configuration and performance of host PC.



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