HydraHarp 500 NEW

High-Resolution Multichannel Event Timer & TCSPC Unit

- 4 to 16 independent input channels with 1 ps base resolution and common sync channel (trigger rate up 640 MHz)
- Outstanding timing precision of 2 ps RMS for single channel, 3 ps RMS between channels
- Cutting-edge time resolution of 1 ps
- Sustained time tagging with up to 85 Mcps via USB 3.0 & high speed data link through eFPGA interface
- Ultrashort dead time of 680 ps, no dead time across channels
- Multifunctional on-board event filters
- Ref In/Ref Out/PPS In/White Rabbit interface for multi-device synchronization
- Adjustable delay on each channel with 1 ps resolution
- Multi-stop capability for efficiency at slow repetition rates
- Very High Precision Internal Clock Source
- Choice of edge triggers or Constant Fraction Discriminators (CFD) for up to eight channels

Applications

- Time-resolved fluorescence and luminescence spectroscopy
- Fluorescence Lifetime Imaging (FLIM)
- Single Molecule Spectroscopy (SMS)
- Quantum optics
- Time response characterization of optoelectronic devices
- Coincidence correlation / Antibunching
- Time-of-Flight (ToF) measurements /
- Ranging Coincidence Correlation
- Quantum Communication
- Quantum Key Distribution
- Linear Optical Quantum Computation
- Diffuse Optical Tomography
- LIDAR/Ranging/SLR
- Time-Resolved Fluorescence

The HydraHarp 500 is a high-accuracy Event Timer & TCSPC Unit with picosecond timing precision. Featuring versatile trigger methods and multiple interfaces, it is perfectly suited for demanding applications that require many input channels and high data throughput.

Outstanding time resolution and timing precision
The smartly designed time-to-digital converters of the HydraHarp 500 with 1 ps base resolution, a jitter of 2 ps RMS (single channel) and 3 ps RMS (between channels), as well as < 680 ps dead time) allow to fully exploit the count rate limits of TC-SPC, without having to compromise on the time resolution and precision 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).

The HydraHarp 500 also features a very high precision internal clock source with a frequency accuracy of ±300 ppb and a frequency stability of ±10 ppb.

Flexible channel configuration and synchronization
The HydraHarp 500 is equipped with up to 16 identical detection channels and an additional synchronization channel, providing the choice between 4+1 to 8+1 with CFD and edge trigger or 8+1 up to 16+1 with edge trigger only for input and synchronization purposes, adapting to your needs. These channels are synchronized yet independent. The common sync channel which supports up to 640 MHz ensures seamless integration with an excitation source. If no synchronization is required, the sync input can be used as an additional detection channel. This feature facilitates tasks such as coincidence correlation or coincidence counting. The HydraHarp 500 is also ideally suited for performing TCSPC with multiple detectors using forward start-stop operation.

User selectable trigger method
In order to support the widest possible variety of single photon detectors, the HydraHarp 500 provides software-configurable input circuitry. For optimal timing with e.g. Superconducting Nanowire Single Photon Detectors (SNSPD) the inputs can be configured as edge triggers while for best performance with Hybrid Photodetectors (HPD) or Micro Channel Plates (MCP) they can be configured as Constant Fraction Discriminators (CFD). This way the overall system IRF may be tuned to become narrower. The same could not be achieved with a simple level trigger (comparator). Particularly with PMTs and MCPs, constant fraction discrimination is very important as their pulse amplitudes vary significantly.

High data throughput and ultrashort dead time
The design of the HydraHarp 500 allows high measurement rates up to 85 million counts/sec over all channels (up to up to 80 million counts/sec per single channel) and provides a highly stable, crystal calibrated time resolution of 1 ps.
The ultra short dead time of 680 ps when using edge trigger allows to detect multiple photons per excitation cycle even at the highest repetition rates achievable by modern picosecond pulsed lasers (requires a detector from the PMA Hybrid Series).

Adjustable timing offsets for each input channel
The HydraHarp 500 offers 65536 histogram bins per input channel and allows to collect more than 4 billion counts (32 bits) per bin. Each input channel even has an internal adjustable timing offsets (delay) with ±100 ns range at 1 ps resolution. This unique feature eliminates the need for specially adapted cable lengths or cable delays for different experimental set-ups.

Multifunctional on-board event filters
The HydraHarp 500 has user-defineable on-board event filters to efficiently reduce the file sizes and the amount of data sent via the USB interface.

White Rabbit ready event timer
White Rabbit is a fully deterministic, Ethernet-based timing network which provides sub-nanosecond accuracy and precise synchronization of devices over large distances. Thanks to its White Rabbit interface, the HydraHarp 500 is prepared to be used in networks that are based on this emerging technology.

Data interface for external FPGA boards
For applications with high count rates at multiple input channels, the data read-out speed and/or the 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 HydraHarp 500, where TCSPC histograms sent to the computer are calculated out of the arrival times of the input signals by the hardware itself.
To enable the greatest possible flexibility, the time tagging data stream of the HydraHarp 500 can be accessed by an external FPGA board via a dedicated FPGA interface. This way, the method of data preprocessing can be tailored to the specific application.

Easy-to-use software included, custom programming supported
The HydraHarp 500 comes with a Windows software package that provides 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 HydraHarp 500.
A library for custom programming, e.g., with LabVIEW is also included. A relatively advanced high-level API package for Python called “snAPI” is also available. It readily provides many real-time analysis methods such as histograming, intensity and coincidence time traces, FCS and g(2) correlation. Alternatives for advanced T2 data collection and analysis are the SymPhoTime and QuCoa software suites offered by PicoQuant. SymPhoTime is focused on typical life science applications while QuCoa is oriented towards typical quantum optics applications.
The HydraHarp 500 is fully compatible with UniHarp. This sleek, powerful, and intuitive graphical user interface is designed to revolutionize the way you interact with PicoQuant’s TCSPC and Time Tagging 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 photonics, life science, materials science, and quantum optics. 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

	HH500-S	HH500-M
Input Channels and Sync	Individiual software adjustable CFD or edge trigger on all inputs	Edge Trigger on all inputs
Number of detector channels (in addition to Sync input)	4 (Base model) for HH500-S; 5-8 (Base model + channel upgrades)	8 (Base model) for HH500-M ; 9-16 (Base model + channel upgrades)
Trigger edge	CFD: falling edge / Edge Trigger: falling or rising edge, software adjustable	
Input voltage operating range (pulse peak into 50 Ohms)	-1500 mV to 1500 mV	
Input voltage max. range (damage level)	- 2000 mV to 3000 mV	
Trigger pulse width	> 250 ps	
Trigger pulse required rise/fall time	≤ 20 ns	

Time to Digital Converters	
Minimum time bin width	1 ps
Timing precision*	3 ps rms typ.
Timing precision / √2*	2 ps rms typ.
Dead time	680 ps for edge trigger, 4.2 ns with CFD
Adjustable dead time	> 160 ns in steps of min 1 ns
Adjustable programmable time offset for each input channel	± 100 ns, resolution 1 ps
Differential non-linearity	<6% peak, <0.9% rms (over full measurement range)
Maximum sync rate (periodic pulse train)	640 MHz
Histogrammer	
Count depth	32 bit (4 294 967 295 counts)
Maximum number of time bins	65 536
Full scale time range	65 536 ps – 549.7 ms
Acquisition time	1 ms - 100 h
Peak count rate per input channel	1.5 × 10^9 cps for burst durations up to 1000 events
Total sustained count rate, sum over all input channels	85 Mcps
TTTR Engine	
T2 mode resolution	1 ps
T3 mode resolution	1 ps, 2 ps, 4 ps, 8 ps, …, 4.19 µs [2**n]
FiFo buffer depth (records)	64 M events
Acquisition time	1 ms to 100 hours
Peak count rate per input channel	1.5 × 109 cps for burst durations up to 1000 events
Sustained count rate per input channel**	80 Mcps
Total sustained count rate, sum over all input channels**	85 Mcps
Trigger Output	
Period	programmable, 0.1 µs - 1.678 s (0.596 Hz - 10MHz)
Pulse width	10 ns
Baseline level	0 V typ.
Active level (pulse peak)	0.6 V typ. (50 Ohm)
External Marker Inputs	
Number	4
Input type	< 50 ns rise/fall time, > 50 ns at HIGH (> 1.7 V) or LOW (< 1.1 V) max 5 V
External Synchronisation	
Ref. IN	10 MHz, 100 MHz, or 500 MHz 200 … 1500 mV p.p. 50 Ohm; AC coupled

Ref. OUT	Default: 10 MHz 1000 mV 50 Ohm; DC coupled
PPS IN	1 s, LVTTL
White Rabbit interface	Connector for SFP module
Operation	
PC interface	USB 3.0 (5 Gbps)
PC requirements	Dual core CPU or better, min. 2 GHz CPU clock, min. 4 GB memory
Operating system	Windows 10/11
Power consumption	< 50 W; Indoor use only, Max. 2000 m above sea level
Dimension	
Size	305 × 240 × 95 mm
Weight	2.5 kg

* 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 √(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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