TimeHarp 260

TCSPC and MCS board with PCIe interface

- One or two independent input channels and common sync channel (up to 100 MHz)
- Two models with either 25 ps (PICO) or 250 ps (NANO) base resolution
- “Long range mode” option for PICO model with 2.5 ns base resolution Ultrashort dead time (< 25 ns for PICO model, < 2 ns for NANO model)
- Time tagging with sustained count rates up to 40 Mcps
- 32768 histogram channels
- Adjustable delay on each channel with 25 ps (PICO model) or 250 ps (NANO model) resolution in a range of ± 100 ns
- Multi-stop capability for high counting efficiency at slow repetition rates
- Programmable trigger output
- External synchronization signals for (fluorescence lifetime) imaging or other control events for modules with two detection channels

Applications

- Time-resolved fluorescence and luminescence spectroscopy
- Coincidence correlation, antibunching
- FLIM, FRET, FCS, ...
- Single Molecule Spectroscopy (SMS)
- Quantum optics
- Time-of-Flight (ToF) measurements, LIDAR
- Diffuse optical molecular imaging, optical tomography

The TimeHarp 260 is a compact, easy to use, Time-Correlated Single Photon Counting (TCSPC) and Multi-Channel Scaling (MCS) board for the PCIe interface. It is based on a custom TDC design that offers an ultrashort dead time even at high temporal resolutions. The board is available in two versions with base resolutions of either 25 ps (PICO model) or 250 ps (NANO model). Each version is available with either one or two independent detection channels and an additional common sync input. Each input has an internal adjustable delay with ±100 ns range at either 25 ps resolution (PICO model) or 250 ps resolution (NANO model). All channels including the sync can be used as independent timing channels for coincidence correlation experiments. Alternatively, the common sync input can be used for TCSPC with fast excitation sources in forward start-stop operation at repetition rates up to 100 MHz.
The TimeHarp 260 PICO features a digital resolution of 25 ps and a timing jitter < 20 ps and is therefore well matched to the timing resolution of the majority of common photon detectors. The ultrashort dead time of the TimeHarp 260 PICO of < 25 ns allows very high measurement rates. The histogramming time range of the TimeHarp 260 PICO can be extended up to seconds with an optional “long range mode”. In this mode, the base resolution of the board is switched to 2.5 ns and the dead time reduces to < 2.5 ns. This permits to study dynamics from picoseconds up to seconds with just a single board.
The TimeHarp 260 NANO is designed for ultimately short dead time at a moderate time resolution. Exactly like the PICO model, it can be used for coincidence correlations across all inputs or for TCSPC with light source trigger connected to the sync input. Because of the short dead time and the long histogram range it is particularly suited for classical Multi-Channel Scaler (MCS) applications.

A Time-tagged mode for recording of individual photon events with their arrival time on all channels is available for all models. This mode allows the most sophisticated offline analysis of the photon dynamics. In addition, external marker signals can be included in the data stream to synchronize the device with other hardware such as scanners for e.g. Fluorescence Lifetime Imaging (FLIM), (only supported by versions with two detection channels).
The TimeHarp 260 software for Windows provides functions such as the setting of measurement parameters, display of results, loading and saving of measurement parameters and measurement curves. Important measurement characteristics such as count rate, count maximum, position and peak width are displayed continuously. A library for custom programming, e.g. with LabVIEW is also available as an option. Software upgrades for extended functionality will be available with further product development.

Specifications

	TimeHarp 260 PICO	**TimeHarp 260 NANO**
Input Channels and Sync	Constant Fraction Discriminator (CFD)	Constant level trigger
Number of detector channels	1 or 2 (plus sync)	1 or 2 (plus sync)
Input voltage range	0 mV to -1200 mV optimum: -100 mV to -200 mV	-1200 mV to 1200 mV
Trigger point	falling edge	falling or rising edge
Trigger pulse width	0.5 to 30 ns (rise time max. 2 ns)	> 0.5 ns
Time to Digital Converters		
Time bin width (adjustable)	25 ps, 50 ps, [...], 52.42 µs in “long range mode“: 2.5 ns, 5 ns, [...], 5.242 ms	250 ps, 500 ps, 1 ns, [...], 524.2 µs**
Timing precision*	< 20 ps rms in “long range mode”: < 1 ns rms	< 250 ps rms**
Timing precision / √2*	< 14 ps rms in “long range mode”: < 710 ps rms	< 180 ps rms**
Dead time	< 25 ns in “long range mode“: < 2.5 ns	< 2 ns
Sustained count rate (per channel)	40×10^6 counts/sec	40×10^6 counts/sec
Differential non-linearity	< 2 % peak, < 0.2 % rms	< 2 % peak, < 0.2 % rms
Maximum sync rate	100 MHz	100 MHz
Histogrammer		
Count depth	32 bit (4.294.967.296)	32 bit (4.294.967.296)
Full scale range	819 ns to 1.71 s in “long range mode”: 81.92 µs to 171 s	8.19 µs to 17.1 s**
Maximum number of time bins	32768	32768
TTTR Engine		
T2 mode resolution:	25 ps	250 ps
T3 mode resolution:	25 ps, 50 ps, [...], 52.42 µs in “long range mode“: 2.5 ns, 5 ns, [...], 5.242 ms	250 ps, 500 ps, 1 ns, [...], 524.2 µs**

Operation		
PC interface	PCIe 2.0 x1	
PC requirements	Dual Core CPU (x86 chipset), min. 1.5 GHz CPU clock, min. 1 GB memory	
Operating system	Windows™ 8.1 / 10	
Power consumption	< 15 W (from PC internal power supply)	

* Applies to TimeHarp 260 Nano with base resolution = 250 ps (shipped after 2015). Earlier boards have a resolution of 1 ns but can be returned for an upgrade to 250 ps upon request.

** 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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