A-PPI-D

Passive Differential Pulse Inverter

- **Differential pulse-inversion of trigger sources with closed circuits**
- **For trigger signals from pulsed lasers and fast APDs (SPADs)**
- **No power supply required**
- **Offset-drift compensation**
- **Conversion of TTL pulses to negative signals for bh TCSPC modules**

The A-PPI-D is a passive device used to transform positive pulsed signals such as TTL output pulses of detectors or trigger sources into signal pulses suitable for accurate detection with bh TCSPC modules.

Power Supply

Power Supply	passive

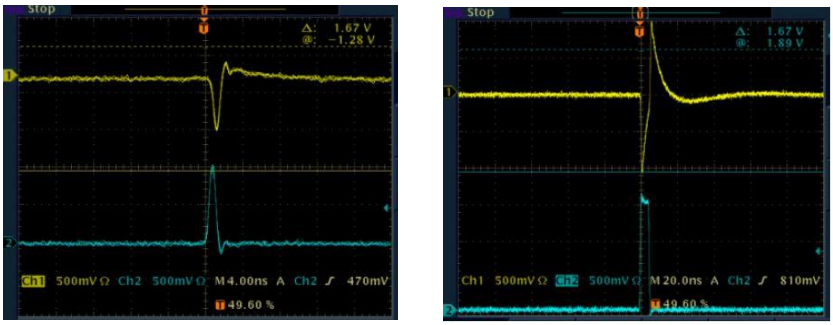
Connectors

Input	50 Ω, SMA female
Output	50 Ω, SMA female

Pulse Inversion

For Triggersignals from pulsed Lasers and fast APDs

Principle	leading or falling edge of incoming trigger pulse is differentiated
Output	50 Ω, SMA female
Output	50 Ω, SMA female
Response to short pulses (< 2 ns)	one inverted pulse (only first edge of input pulse is differentiated)
Response to longer pulses (> 2 ns)	bipolar pulse, first peak is inverted to input pulse (differential of first and second edge of input pulse)



Response of A-PPI-D (yellow curve) to a positive pulse (cyan curve). Left short input pulse with 1 ns pulse width and right long input pulse with 5 ns width.

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How to Use the A-PPI-D Passive Pulse Inverter

The A-PPI-D is a passive device used to transform positive pulsed signals such as TTL output pulses of detectors or trigger sources into signal pulses suitable for accurate detection with bh TCSPC modules (SPC-130, SPC-150, SPC-830, etc.).

The behavior of the A-PPI-D depends on the input pulse duration. Two cases can be distinguished.

Response of A-PPI-D to short pulses

The minimum input pulse width is on the order of 500 ps. For pulses with a width of a few nanoseconds (roughly 0.5 to 4 ns), the A-PPI-D works as a pulse inverter by differentiating the rising edge of the input puse. The amplitude of the output signal depends on the rise time of the input pulses. For typical trigger signals, the amplitude is around 70 percent of the input signal. An example is given in Fig. 1

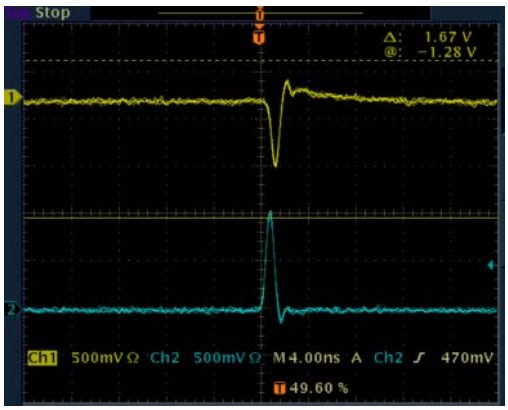

Fig. 1: Response of A-PPI-D to a positive pulse with a width of 1 ns. The output is a single negative pulse. Yellow: A-PPI-D output signal. Blue: input signal to A-PPI-D.

Response of A-PPI-D to longer pulses (> 5 ns)

For longer pulses, the output is the inverted derivative of the input signal. This means that from the rising edge a negative pusle is produced and from the falling edge a posite pulse is generated. See Fig. 2 for an example.

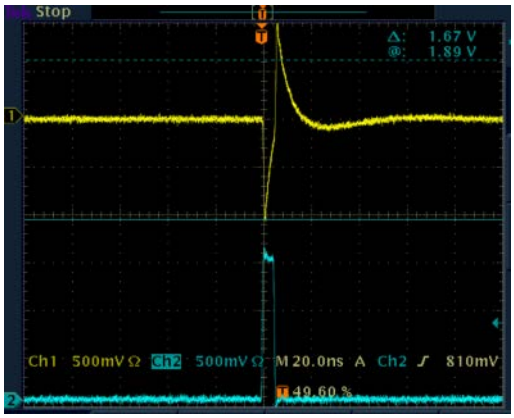

Fig. 2: Yellow: Response of A-PPI-D to a rectangular pulse with a width of 5 ns. Blue: Input signal, 5 ns rectangular pulse. The rising edge of the input results in a negative output pulse; the falling edge results in a positive pulse. In this case, the A-PPI-D delivers the derivative of the input signal. This way, the user can select the required polarity (normally negative).

Notes

1. The fact that both a positive and negative pulse is created does not affect system performance when using A-PPI-D with bh TCSPC modules. The CFD circuit of an SPC module is triggering on the negative part and the short pulse width and a steep edge is advantageous as it gives better time resolution.

2. A-PPI-D has female SMA connectors on both ends. Orientation of A-PPI-D does not affect functionality.
3. The A-PPI-D has 50 ohms impedance.
4. A-PPI-D is AC coupled to the trigger source (input signal). In some cases, it can happen that you don't get output from A-PPI-D even though your trigger signal seems to work. In this case you have to add a 1dB attenuator after the trigger source and before A-PPI-D.

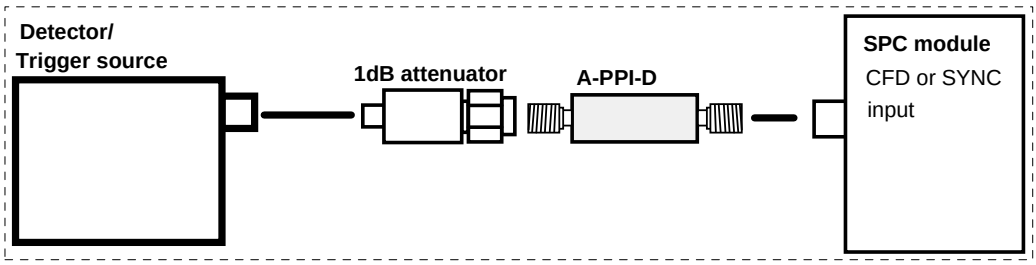

Fig. 3: If the trigger source does not work without a ground return path through the connected parts, a 1dB attenuator can be inserted . Such an attenuator with SMA connectors is available from bh.

A-PPI-D vs. A-PPI

The A-PPI-D passive pulse inverter is the successor of A-PPI. In contrast to the A-PPI-D, the A-PPI is a simple pulse inverter which means it is not differentiating and always creates a negative output pulse only.

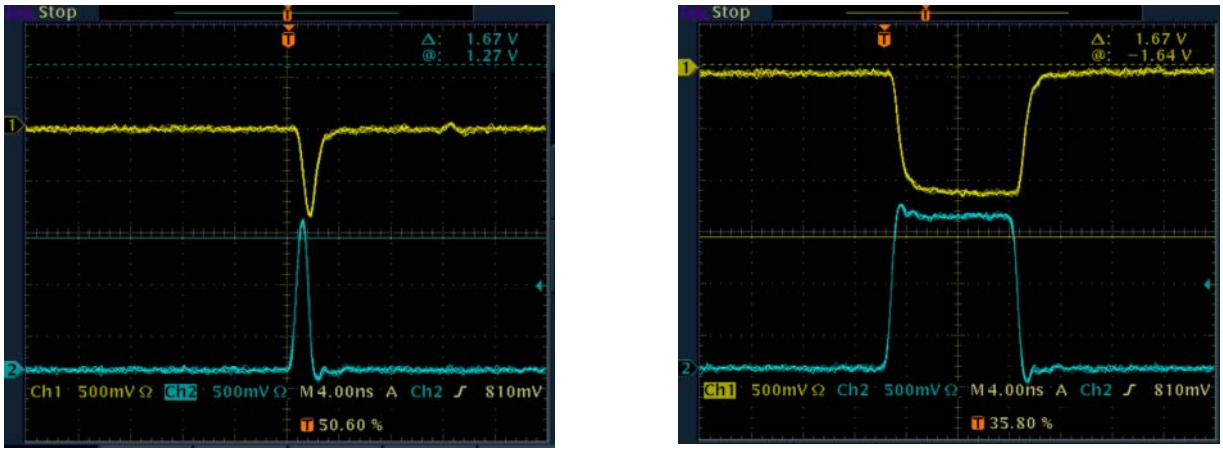

Fig. 4: Response of A-PPI to input signals with different pulse width. Left: 1 ns pulse width; right: 10 ns pulse width.

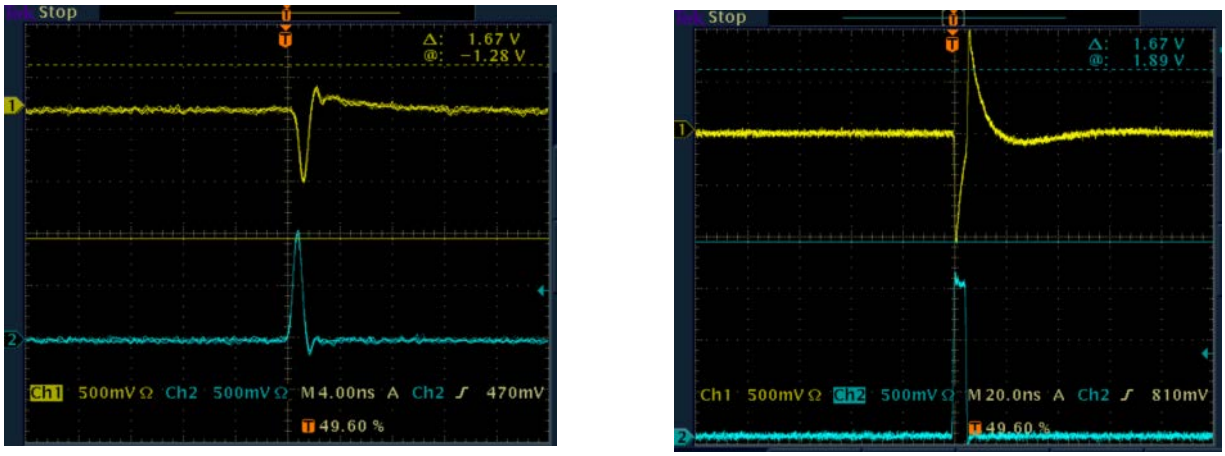

Fig. 5: Response of A-PPI-D to input signals with different pulse width. Left: 1 ns pulse width; right: 5 ns pulse width. In contrast to the A-PPI (Fig. 4) the A-PPI-D builds the derivative of the input for longer pulse widths which results in a double-peak structure.