# TechNote



## Triggering optoNCDT 1700

### Definition of terms

Triggering is a term that is often used in measurement technology and includes all the means of initiating a measurement or a controlled data output. In order to reduce the system load on any following monitoring and control units, a permanent measurement output is not used. Instead the sensor waits for a signal from outside specifying the time for a measurement, therefore initiating the data output. Often the triggering is started through an external signal.

The optoNCDT 1700 can be triggered both via the edge as well as via the level of the trigger signal. The following are implemented as trigger conditions:

Rising edge (positive edge).
Falling edge (negative edge).
High level (H level).
Low level (L level).

### Edge triggering

After the triggering edge, provided by an initiator switch or a PLC, the analog output is updated or if digital output has been selected, only a digital measurement is output via the RS422 interface (see Fig. 1). In between these points the analog output is held fixed (sample and hold), see Fig. 2.

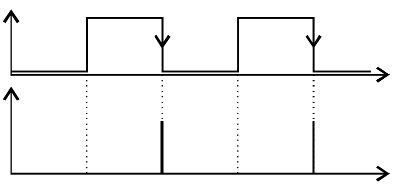

Fig. 1: Falling trigger edge (top) and digital output signal (bottom)

### Level triggering

This type of trigger, sometimes also known as gating, causes the sensor to output measurements until the trigger condition is satisfied, see Fig. 2.

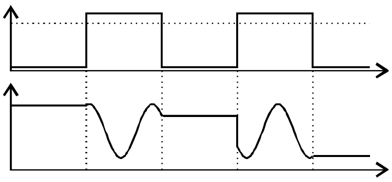

Fig. 2: High trigger level (top) and analog output signal (bottom)

### Trigger pulse values

The trigger pulse duration $t_i$ must be at least one cycle period (= 1 / measuring rate). With a slower measuring rate the trigger pulse duration must therefore also be extended (e.g. from $t_i$ = 400 µs at a measuring rate of 2.5 kHz to $t_i$ = 3.2 ms at a measuring rate of 312.5 Hz).

The necessary level adaptation to the LVDS specification (see Fig. 3) of the sensor occurs via the triggerBOX 1700 which permits trigger levels from 2.4 V to 24 V. Furthermore, it is equipped with a

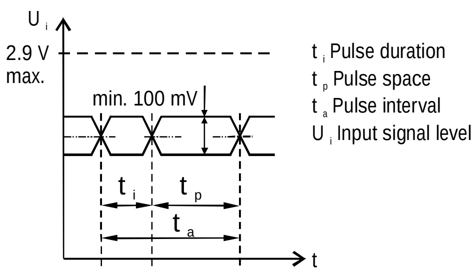


Fig. 3: Trigger signal time characteristics

## Time offset of trigger and output signal

The sensor subdivides the processing and output of the measurements into cycles. Assuming a maximum measuring rate of 2.5 kHz 400 µs is taken up with cycles for exposure, reading in, computation and controlling. A total period of approx. 1.6 ms passes before the first measurement is available at the output. Since the processing occurs sequential in time and parallel in space, the next measurement is available at the output after a further 400 µs.

The sensor time pattern therefore requires a chronological interval between two consecutive trigger signals of at least four cycles with edge triggering or five cycles for level triggering (see Fig. 4, Table 1). Thus a measurement is not output which was valid four cycles ago, but instead the measurement object position is acquired exactly at the time of the trigger. Consequently, a maximum trigger frequency of 625 Hz occurs for a measuring rate of 2.5 kHz.

There remains a time uncertainty of a maximum of one cycle, because the sensor continues operating in its cycle sequence and the trigger edge can be located within the first cycle, i.e. from the start to the end of the first cycle. The trigger input is interrogated within this period. This leads to a minimum length of the trigger pulse of at least one cycle.

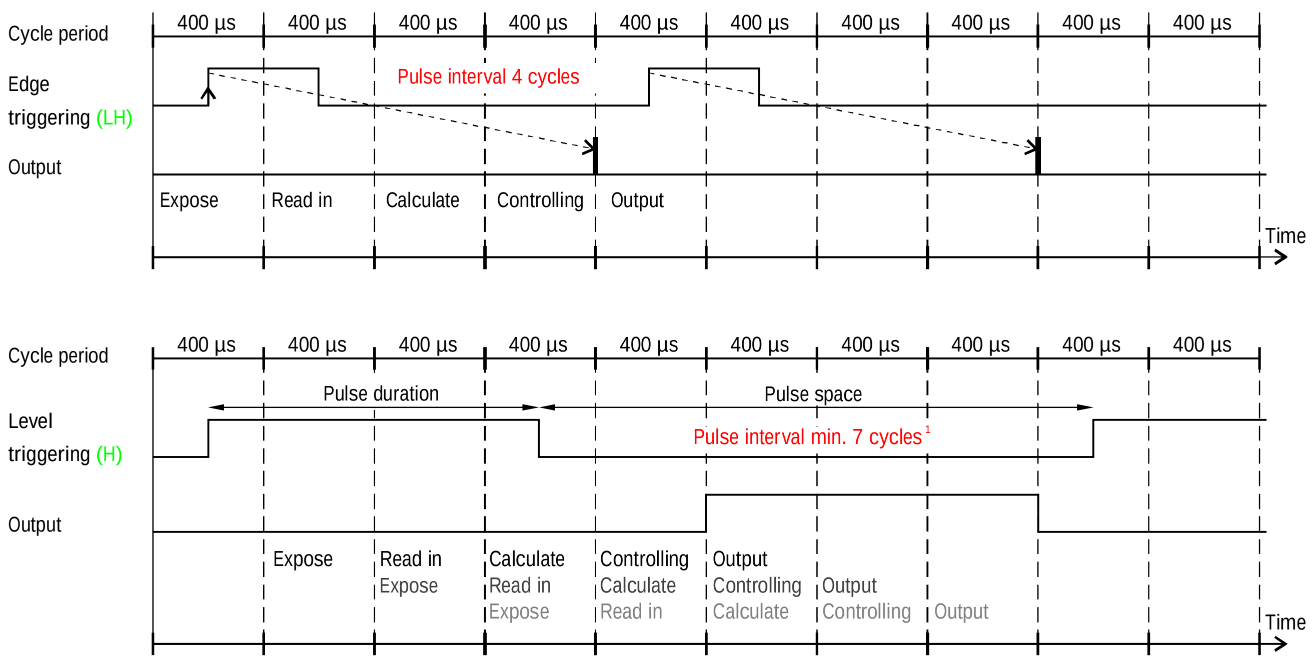


Fig. 4: Time interval with edge (top) and level triggering (bottom), measuring rate = 2.5 kHz

1) Times for an example of a pulse duration of 3 cycles. See Table 1 for a general consideration of the time.

| | Edge triggering | Level triggering | | |
|---|---|---|---|---|
| Pulse duration $t_i$ | 1 cycle = 0.4 ms | 1 cycle = 0.4 ms | 2 cycles = 0.8 ms | n cycles = n * 0.4 ms |
| Pulse space $t_p$ | 3 cycles = 1.2 ms | 4 cycles = 1.6 ms | 4 cycles = 2.0 ms | 4 cycles = 1.6 ms |
| Pulse interval $t_a$ | 4 cycles = 1.6 ms | 5 cycles = 2.0 ms | 6 cycles = 2.8 ms | n+4 cycles = (n * 0.4 ms) + 1.6 ms |
| Trigger frequency $f_T$ | $f_T = f_M / 4$ = 625 Hz | $f_T = f_M / 5$ = 500 Hz | $f_T = f_M / 6$ = 416 Hz | $f_T = f_M$ / n+4 = (2500 Hz / n+4) |

Tab. 1: Minimum pulse values and maximum trigger frequency

## Application

A real measurement application with triggering is, for example, the bridging of gaps with single parts on a convey belt (Fig. 5). Only measurements for a certain range of positions are to be examined more closely. The trigger signal (green) starts the measurement in the sensor. The time offset of the trigger signal and output signal of the sensor (blue) can be seen clearly on the oscilloscope. The sensor needs this time for the internal processing and output of the measurement results. Encoders are also suitable as trigger signal sources. Rotary transducers can be found in all numerically controlled industrial systems. The rotational speed or the closeness of the pulses from the encoder is a direct measure of a linear change, e.g. of a conveyor belt. If an encoder, for example, supplies 1,000 pulses per revolution and if the internal processing time of 1.6 ms in the sensor is taken into account, then the encoder may revolve with a maximum of 0.625 revs. /s (37.5 rpm) so that the maximum trigger frequency for the measuring rate of 2.5 kHz is not exceeded.

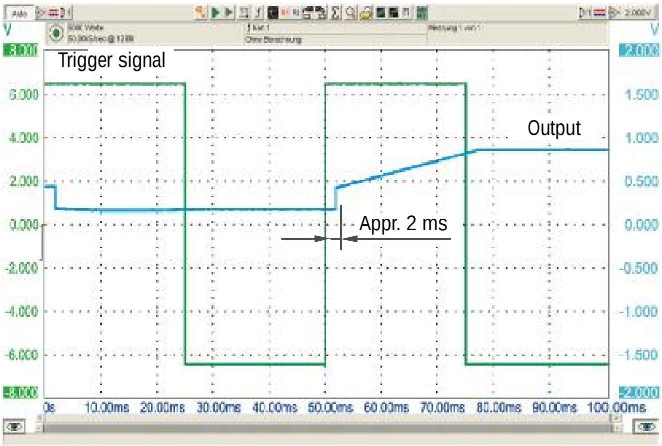


Fig. 5: Time offset between the trigger signal (green, high level) and the analog output signal (blue), measuring rate = 2.5 kHz.

## Summary

Edge triggering supplies single measurements on the output of a sensor and therefore replaces sampling operation. Also, the usual memory overflow with continuous measurement is also prevented. This ensures an exact assignment between the measurement and the time. If the sensor is then combined with the triggerBOX, taking into account the maximum trigger frequencies, an economically practicable measurement unit is produced for production and process automation.

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