

# Synchronizing Position Synchronized Output (PSO) with Mode-Locked Lasers

Many lasers are limited to firing pulses based on an internal clock source and cannot be asynchronously triggered from an external signal such as from Aerotech's Position Synchronized Output (PSO) feature. One approach to working with this laser type is to set the pulse width of the PSO output to be the same as the period of the laser clock signal to ensure that the PSO output is active at the laser input sample time (usually the rising or falling edge of the clock). In practice, however, the frequencies of the PSO and laser clock vary based on tolerances of the devices used to synthesize the clock. This variability will result in missed pulses when the PSO output width is shorter than the laser clock period, or in extra pulses when the output width is longer than the clock period.

To address this issue Aerotech has added the ability to synchronize the start of the PSO output pulse with the laser clock signal. This capability is currently supported on the Ndrive HPe and Ndrive HLe products and will be added to the Nmark CLS in version 4.06. For the Ndrive HPe and Ndrive HLe, the clock signal is connected to the differential RS-422 AUX encoder SIN+/SIN- signals. The AUX encoder must be configured as an input by setting the EncoderDivider parameter on the drive to "0". The Nmark CLS must be modified at the factory (Engineering Special) to support the laser clock sync operation. In the future this capability will be available on the standard product. For the Nmark CLS the input signal is 5V TTL compatible.

The commands required to enable laser clock synchronization functionality are listed below:

```
PSOOUTPUT <Axis> PULSE EXTSYNC  
PSOPULSE <Axis> TIME <TotalTime>, <OnTime> DELAY <DelayTime>
```

The `PSOOUTPUT EXTSYNC` command enables the external clock input mode while the `PSOPULSE DELAY` value specifies the timing of the output pulse relative to the rising edge of the laser clock. The `PSOPULSE DELAY` value is optional and can be set to 0 if desired.

Using this feature will result in a decrease in the positional accuracy of the spot placement as the PSO output signal is delayed until the next rising edge of the laser clock. The maximum decrease in spot placement accuracy is proportional to the linear speed of the axes (in units/second) multiplied by the summation of the laser clock period and the `PSOPULSE DELAY` in seconds. For example, assume the programmed speed is 100 mm/s, the clock frequency is 200 kHz and the `DelayTime` is 2.5  $\mu$ s. The maximum pulse placement error would be calculated as follows:

$$100 \text{ mm/s} \cdot (1/200000 + 0.0000025) = 100 \text{ mm/s} \cdot (0.0000075) = 0.75 \text{ } \mu\text{m}$$

Pulse placement accuracy will vary from a minimum defined by the `DelayTime` setting to a maximum value calculated from the combined `DelayTime` and clock period (as shown above).

Figure 1 shows the timing of the PSO output pulse relative to the laser clock along with the effect of the `DelayTime` setting.

If multiple output pulses are required, the `PSOPULSE ONTIME` should be increased to span multiple laser clock sampling events.

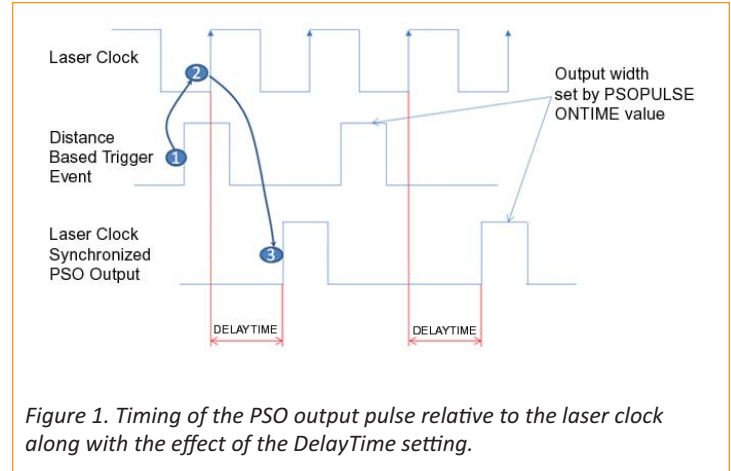


Figure 1. Timing of the PSO output pulse relative to the laser clock along with the effect of the `DelayTime` setting.

Figure 2 shows an approximation of the wiring interface between the laser, Ndrive HPe and Nmark CLS products. Consult the system documentation for detailed information on wiring connection points.

### Summary

By using the PSOOUTPUT EXTSYNC command it is possible to synchronize the PSO output on an Ndrive HLe, Ndrive HPe or Nmark CLS with an external clock source. The user should be aware of the impact on spot placement accuracy due to the delay in the laser output relative to the desired firing location. Finally, the clock source from the laser may need to be modified to support the input specifications of the connected drive (RS-422 for Ndrive HPe/HLe and 5V TTL for Nmark CLS).

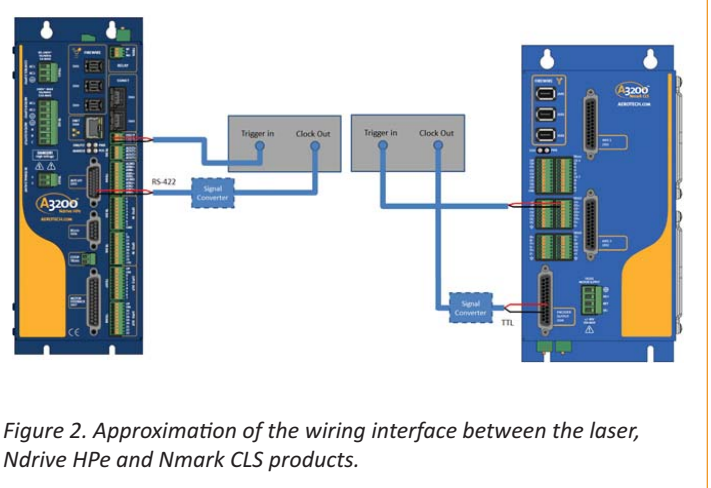


Figure 2. Approximation of the wiring interface between the laser, Ndrive HPe and Nmark CLS products.