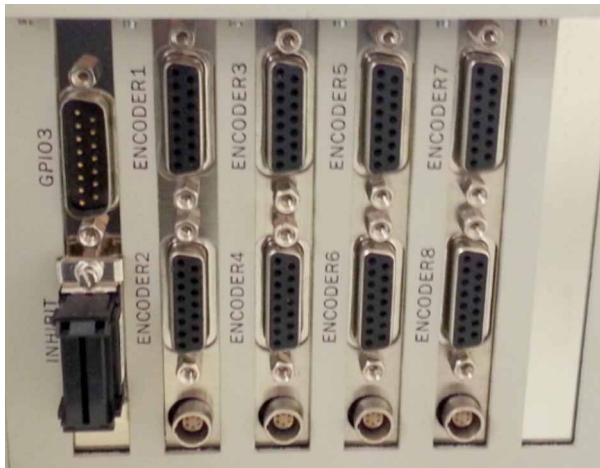


HIGH SPEED POSITION COMPARE OUTPUT

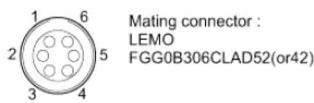
The Newport XPS Controller is an excellent choice for applications that require motion synchronized high speed triggering of external devices. This XPS feature is called PCO (Position Compare Output). PCO generates pulses by comparing actual encoder feedback position with a set of predefined values with <50ns accuracy/latency. The XPS can be configured to operate PCO in three possible modes: Distance Spaced Pulses, AquadB encoder signals, or Time Spaced Pulses.

Setting up PCO hardware

The PCO connectors are located on the rear panel of the XPS controller. There is one PCO connector for every two axes. There are 4 connectors on the CIE boards as shown in the following image. The number of PCO connectors will be dependent on the configuration of your XPS. The configuration shown below is for an XPS-Q8.



PCO
(Position Compare Output)



PIN	Distance spaced pulses or Tim spaced pulses	AquadB signals
1	+5 VL	+5 VL
2	Axis 1: Pulse enable	Axis 1: A
3	Axis 1: Pulse	Axis 1: B
4	Axis 2: Pulse Enable	Axis 2: A
5	Axis 2: Pulse	Axis 2: B
6	GND	GND

There is a +5V output that is available on the PCO connector as it is recommend to pull-up the PCO signal with a 470Ω resistor to allow about 10mA of current which will help with fast transitions of the internal open collector. The max current supply is up to 50mA.

PCO outputs are assigned to LEMO connector on the rear of the XPS (below encoder inputs). Each LEMO connector supports 2 axes. (Newport offers LEMO/Flying Leads cables. Part number: XPS-TG5)

Pulse Width and Encoder Settling Time configuration

The function, `PositionerPositionComparePulseParametersSet` allows configuration of the `PCOPulseWidth` and `EncoderSettlingTime`. This function is only available for Distance Space Pulses or Time Spaced Pulses configurations.

The XPS sets the PCO output duration at 200 nsec by default. This duration can be modified through the function `PositionerPositionComparePulseParametersSet`. The possible values for `PCOPulseWidth` are: 0.2 (default), 1, 2.5 and 10 (μs).

Please note that the only the falling edge of the trigger pulse is precise and only this edge should be used for synchronization from the `PCOPulseWidth` setting.

The second parameter configures the `EncoderSettlingTime`. This applies a filter to the encoder signals for the trigger pulse generation. This should be according to the constraints of the application, in particular speed and encoder resolution, and encoder/position noise. The value of the `EncoderSettlingTime` should not exceed the value for the Encoder resolution divided by the speed. Please note that the `EncoderSettlingTime` adds a nominal delay between the encoder transition and the trigger pulse. The possible values are 0.075 (default), 1, 4, and 12 (μs).

Commands:

`PositionerPositionComparePulseParametersSet(PositionerName,PCOPulseWidth,EncoderSettlingTime)` – Sets the Pulse width and Encoder settling time

`PositionerPositionComparePulseParameterGet(PositionerName)` – This commands allows you to query your current setting

Example:

The example will use the XPS default naming of the stage name “Group1” and the default positioner name “Group1.Pos”. Note, the function for setting is allowed when the stage is in the disable state.

```
PositionerPositionComparePulseParametersSet(Group1.pos,0.2,0.075)
PositionerPositionComparePulseParameterGet(Group1.pos)
```

HIGH SPEED POSITION COMPARE OUTPUT

Trigger Resolution

When using PCO with a Digital AquadB encoder, the trigger resolution is equal to the Encoder Resolution that is specified in the stages.ini.

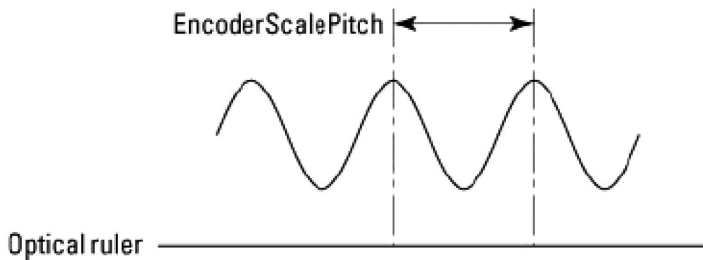
When using PCO with a SinCos Encoder (AnalogInterpolated), the trigger resolution is equal to the Encoder Scale Pitch divided by the interpolation factor.

The interpolation factor is limited by the hardware that is used to interpolate the Sin/Cos signal for PCO mode. The Interpolation Factor value must be defined with one of these values:

20	25	40	50	80	100	160	200
----	----	----	----	----	-----	-----	-----

The default value of the interpolation factor is 20.

AnalogInterpolated Encoder



Example:

The example will use the XPS default naming of a stage name "Group1" and the default positioner name "Group1.Pos". This must be performed during a non-initialization status.

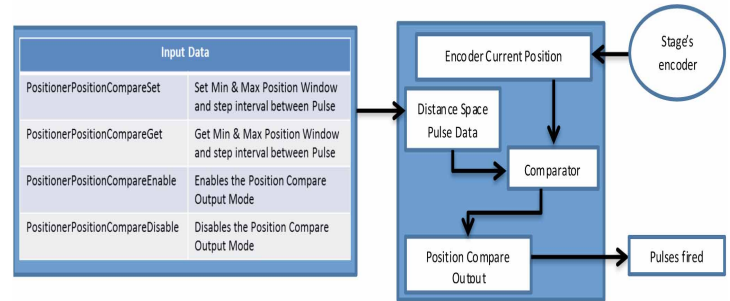
```
PositionerHardInterpolatorFactorSet(Group1.Pos,200)
```

If your stage has a 4µm encoder scale pitch, setting the hard interpolator factor to 200 would set your trigger resolution to 20nm.

Distance Spaced Pulses

In the distance spaced pulse configuration, the first pulse is generated when the positioner enters the defined position window and is then followed by a stream of pulses at fixed distance apart until a predetermined end position is reached.

When setting up this configuration, you will need to know the Positioner Name, Minimum Position, Maximum Position and Position Step to define the function, `PositionerPositionCompareSet()`.



Commands:

```
PositionerPositionCompareSet()
PositionerPositionCompareGet()
PositionerPositionCompareEnable()
PositionerPositionCompareDisable()
```

Example:

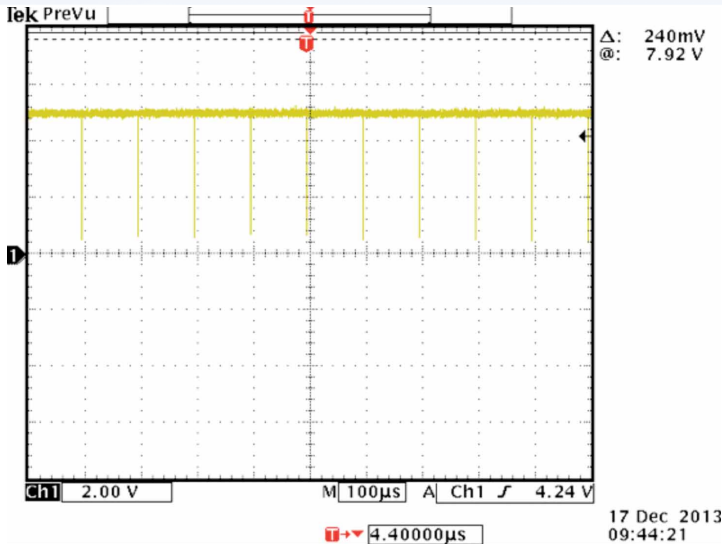
The example will use the XPS default naming of a stage name "Group1" and the default positioner name "Group1.Pos". It is also assumed that the `PositionerPositionComparePulseParametersSet` has been set to default; if a different setting is required, please configure this function first.

```
GroupInitialize(Group1)
GroupHomeSearch(Group1)
PositionerPositionCompareSet(Group1.Pos,5,25,0.002)
PositionerPositionCompareEnable(Group1.Pos)
PositionerPositionCompareGet(Group1.Pos,&MinimumPosition,
&MaximumPosition,&PositionStep,&EnableState)
```

This function returns the parameters previously defined, the minimum position 5, the maximum position 25, the position step 0.002 and the enabled state (1=enabled, 0=disabled)

```
GroupMoveAbsolute(Group1,30)
PositionerPositionCompareDisable(Group1.Pos)
```

HIGH SPEED POSITION COMPARE OUTPUT



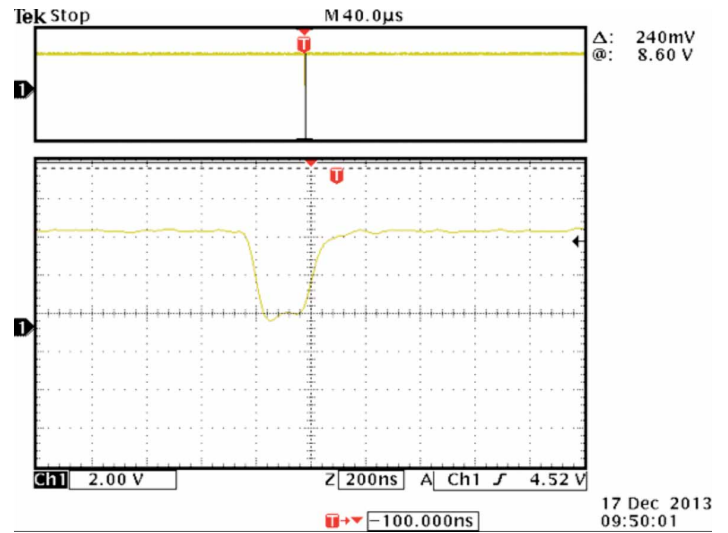
On an oscilloscope, you would be able to see pulses once the stage passes through the predetermined window (5mm – 25mm). The pulses are in incremental of 0.002mm.

Time Spaced Pulses

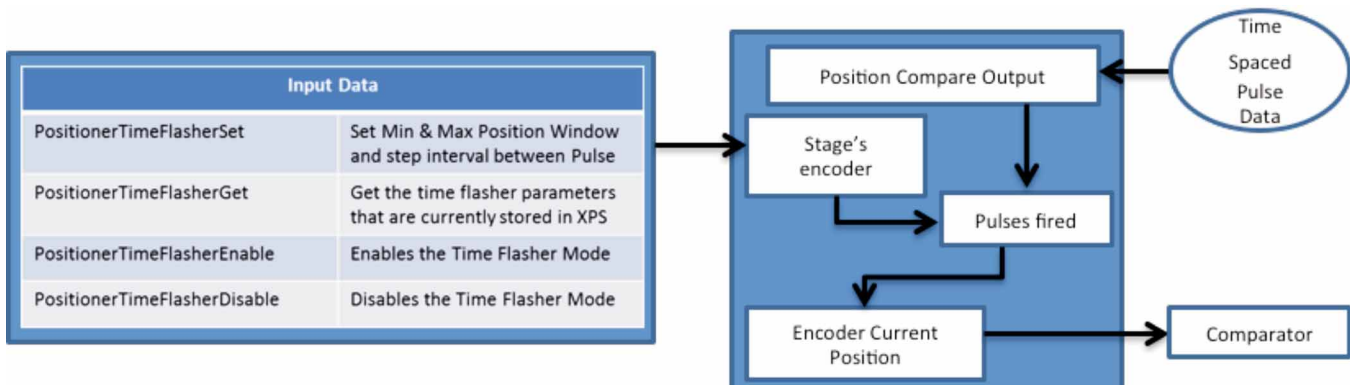
In the Time Spaced Pulses configuration, a first pulse is generated when the motion axis enters the time pulse window. From this first pulse, a new pulse is generated at every time interval until the positioner exits the time pulse window.

When setting up this configuration, you will need to know the Positioner Name, Minimum Position, Maximum Position and Time Interval to define the function, `PositionerTimeFlasherSet()`.

When defining the Time Interval, it should be noted that the value must be greater than or equal to 0.0000004 (0.4µs) and less than or equal to 50 seconds. Furthermore, the time interval must be a multiple of 25ns.



Looking at the pulse closer with the oscilloscope, since the pulse width was set at default, you can see the pulse width duration is at 200ns.



HIGH SPEED POSITION COMPARE OUTPUT

Commands:

```
PositionerTimeFlasherSet()
PositionerTimeFlasherGet()
PositionerTimeFlasherEnable()
PositionerTimeFlasherDisable()
```

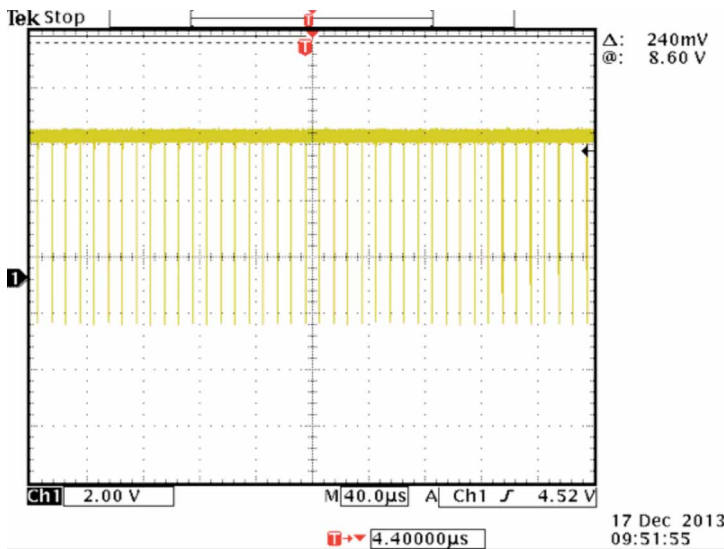
Example:

The example will use the XPS default naming of a stage name "Group1" and the default positioner name "Group1.Pos". It is also assumed that the `PositionerPositionComparePulseParametersSet` has been set to default; if a different setting is required, please configure this function first.

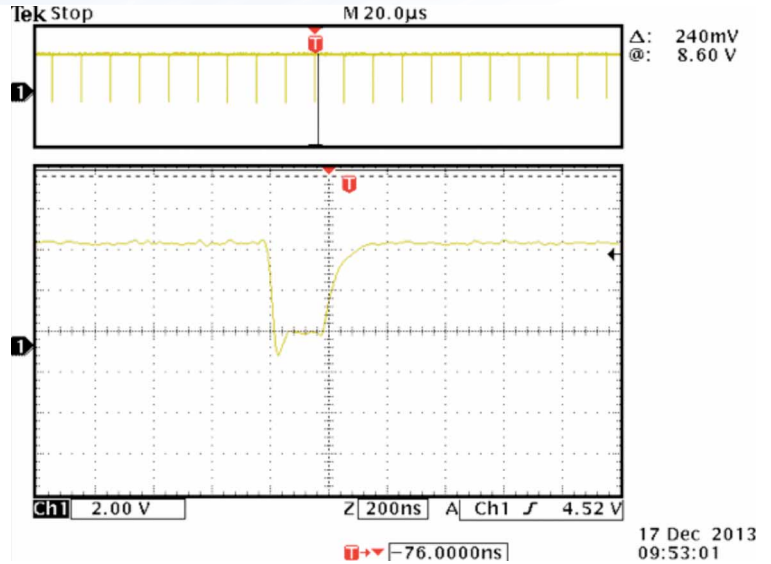
```
GroupInitialize(Group1)
GroupHomeSearch(Group1)
PositionerTimeFlasherSet(Group1.Pos,5,25,0.00001)
PositionerTimeFlasherEnable(Group1.Pos)
PositionerTimeFlasherGet(Group1.Pos,&MinimumPosition,
&MaximumPosition,&PositionStep,&EnableState)
```

This function returns the parameters previously defined, the minimum position 5, the maximum position 25, the time interval 0.00001 and the enabled state (1=enabled,0=disabled)

```
GroupMoveAbsolute(Group1,30)
PositionerTimeFlasherDisable(Group1.Pos)
```



On an oscilloscope, you would be able to see pulses once the stage passes through the predetermined window (5mm – 25mm). The pulses time interval is 0.00002 seconds.



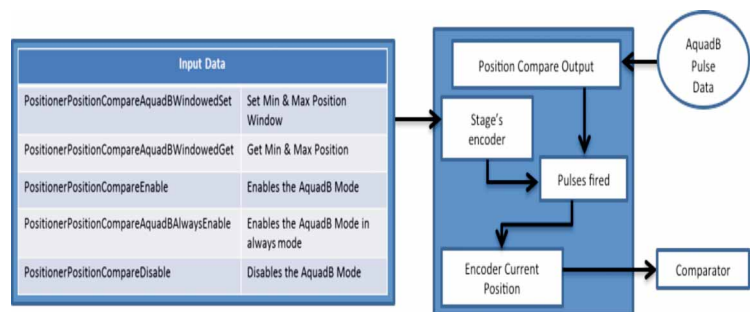
The pulses are outputting at a time interval of 0.00002 seconds and looking a single pulse, since the pulse width remained at the default value, the duration remains to be at 200ns.

AQUADB ENCODER SIGNAL PULSES

In the AquadB configuration, AquadB encoder signals are used to output on the PCO connector. These signals can be configured to produce outputs when the positioner is within a defined position window or outputs continuously at every encoder signal.

When used with a stage with a digital encoder (AquadB), the AquadB signal pulses will be the same as the encoder signals of the stage. When used with a Sin/Cos encoder (AnalogInterpolated), the resolution of the encoder signal will define the signal period of the encoder and the setting of the hardware interpolator by the function.

When setting up this configuration, you will need to know the Positioner Name, Minimum Position and Maximum Position to define the function, `PositionerPositionCompareAquadBWindowedSet()`, unless it is desired to always remain enable, `PositionerPositionCompareAquadBAlwaysEnable()`,



HIGH SPEED POSITION COMPARE OUTPUT

Commands:

```
PositionerPositionCompareAquadBWindowedSet()
PositionerPositionCompareAquadBWindowedGet()
PositionerPositionCompareEnable()
PositionerPositionCompareAquadBAlwaysEnable()
PositionerPositionCompareDisable
```

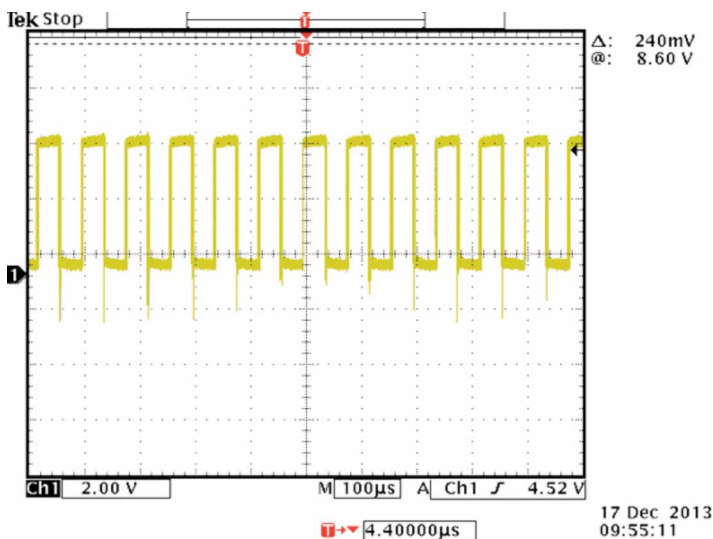
Example:

The example will use the XPS default naming of a stage name "Group1" and the default positioner name "Group1.Pos". It is also assumed that the **PositionerPositionComparePulseParametersSet** has been set to default; if a different setting is required, please configure this function first.

```
GroupInitialize(Group1)
GroupHomeSearch(Group1)
PositionerPositionCompareAquadBWindowedSet
    (Group1.Pos,10,20)
PositionerPositionCompareEnable(Group1.Pos)
PositionerPositionCompareAquadBWindowedGet
    (Group1.Pos,&Minimum
    Position,&MaximumPosition,&EnableState)
```

This function returns the parameters previously defined, the minimum position 5, the maximum position 25 and the enabled state (1=enabled,0=disabled)

```
GroupMoveAbsolute(Group1,30)
PositionerTimeFlasherDisable(Group1.Pos)
```



On an oscilloscope, you would be able to see pulses once the stage passes through the predetermined window (10mm – 20mm). As you can see, the pulses represent an image of the encoder signal.

When using the command **PositionerPositionCompareAquadBAlwaysEnable**, you do not have to set a window and the pulse will remain on and the image will be similar to the above image, but pulses will output throughout the travel of the stage.

VALID SETTING AS A FUNCTION OF SCAN VELOCITY AND PCO PULSE SETTLE TIME

Determine PCO encoder frequency:

AquadB encoder:

$$\text{PCO encoder frequency} = \text{ScanVelocity} / \text{EncoderResolution}$$

Analog Sin/Cos encoder:

$$\text{PCO encoder frequency} = \text{ScanVelocity} * \text{HardInterpolatorFactor} / \text{EncoderScalePitch}$$

HardInterpolatorFactor / EncoderScalePitch

Example: ScanVelocity = 10 mm/s, EncoderScalePitch = 0.004 mm,

$$\text{HardInterpolatorFactor} = 200 \Rightarrow \text{PCO encoder frequency} = 10 * 200 / 0.004 = 500000 = 500 \text{ kHz}$$

Pulse Settling time (µs)	PCO encoder frequency (kHz)			
	25	50	125	>500
0.075			OK	OK
1		OK	OK	
4	OK	OK		
12	OK			

When changing the PCO pulse settling time you must limit the maximum velocity of the stage accordingly otherwise you will lose the PCO position and generate the wrong number of pulses at incorrect positions. As per the above table, if you set the pulse settling time to 4 µs, the maximum PCO encoder frequency needs to be limited to less than $0.25 / 4 \times 10^{-6} = 62.5 \text{ kHz}$.

So, if EncoderScalePitch = 0.004 mm and HardInterpolatorFactor = 200 then the ScanVelocity must $\leq 62.5 \times 10^3 * 0.004 / 200 = 1.25 \text{ mm/s}$, otherwise the PCO will not work properly.