# Using Quadrature Encoders/ Decoders For X/Y Positioning and Rotation

## *What is a Quadrature Encoder?*

A quadrature encoder is device used to sense position and rotation by converting displacement into digital pulses. Consisting of a disk with coded patterns of opaque and transparent sectors that is attached to a rotating shaft, a quadrature encoder converts rotating patterns into two pulse output signals, A and B. When counted, these pulses determine position.

The phase difference between output signal A and output signal B determines the direction of rotation. For example, if pulse output A leads pulse output B, as shown in Figure 1, the shaft is rotating in the clockwise direction. Conversely, if pulse output B leads pulse output A, the shaft is rotating in the counter-clockwise direction.

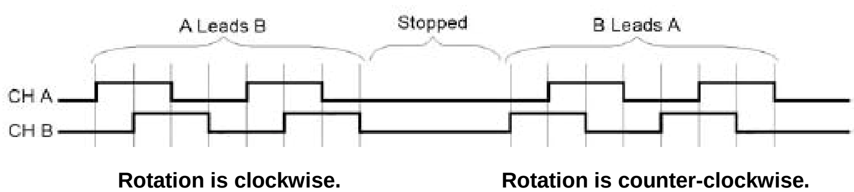


**Figure 1: Direction of Rotation**

# What is a Quadrature Decoder?

A quadrature decoder, such as those available on the DT9836 module, takes the output signals (A, B, and Index) from the quadrature encoder as inputs and converts these signals into a numerical value that can be used to determine position, distance, velocity, and other functions.

The clock output signal contains one pulse for each pulse transition on input signals A and B. For example, if signals A and B each have 5 pulse transitions, the quadrature decoder generates a clock output signal containing 10 pulses.

Figure 2 shows the timing diagram of each of these signals that the DT9836 module uses.

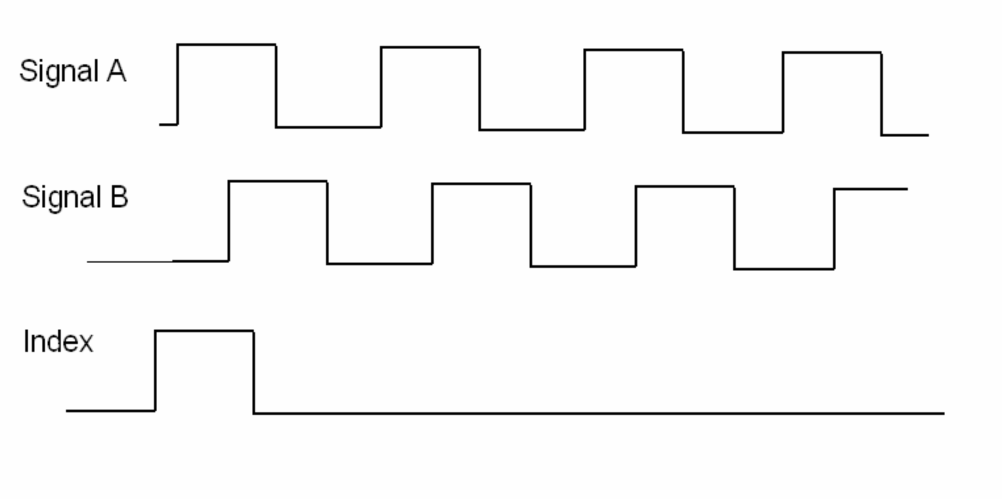


**Figure 2: Timing Diagram of the Quadrature Encoder Output**

# *Setting Up Your System For X/Y Positioning*

For X/Y positioning applications, you will need two quadrature encoders (one for the X-plane and one for the Y-plane) and a DT9836 Series module with two available quadrature decoders (one for each plane).

Referring to Figure 3, set up your system as follows:

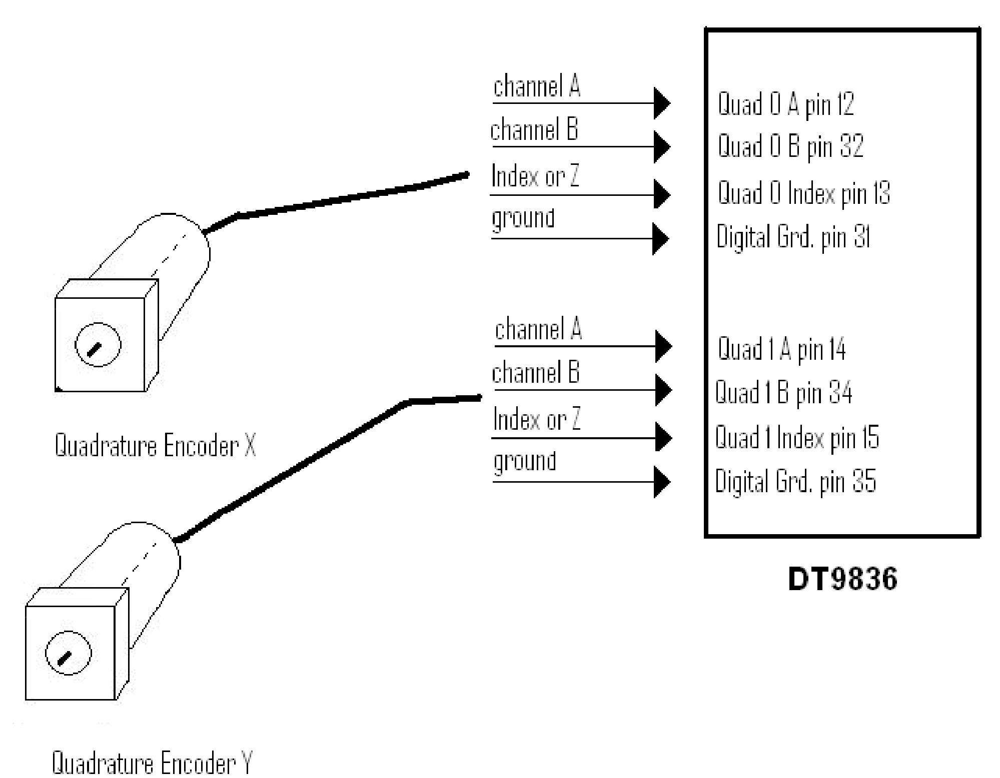


**Figure 3: Signal Wiring Diagram**

**Note:** In this configuration, quadrature decoder 0 controls the X-position, and quadrature decoder 1 controls the Y-position.

Other signal connections may be required for the quadrature encoders and decoders; refer to the documentation for these devices for more information.

1. Connect pulse output signal A from quadrature encoder 1 to pulse input signal A of the DT9836 module, pin 12 (quadrature decoder 0, A).
2. Connect pulse output signal B from quadrature encoder 1 to pulse input signal B of the DT9836 module, pin 32 (quadrature decoder 0, B).
3. Connect the Index output signal from quadrature decoder 1 to pin 13 of the DT9836 module.
4. Connect pulse output signal A from quadrature encoder 2 to pulse input signal A of the DT9836 module, pin 14 (quadrature decoder 1, A).
5. Connect pulse output signal B from quadrature encoder 2 to pulse input signal B of the DT9836 module, pin 34 (quadrature decoder 1, B).
6. Connect the Index output signal from quadrature decoder 2 to pin 15 of the DT9836 module.
7. In software, configure the operation mode of quadrature decoders 0 and 1 on the DT9836 module.
8. Using software, start the decoders.
9. The software automatically sets the initial value of each quadrature decoder to 0.
10. Read the values of quadrature decoders 0 and 1, determining position and rotation.
11. You can also read the Index value.

## Determining Position

The X-position corresponds to quadrature decoder 0. Therefore, if the value of quadrature decoder 0 increments, the X-position moves to the right by the number of counts read. If quadrature decoder 0 decrements, the X-position moves to the left by the number of counts read.

The Y-position corresponds to quadrature decoder 1. Therefore, if the value of quadrature decoder 1 increments, the Y-position moves up by the number of counts read. If quadrature decoder 1 decrements, the Y-position moves down by the number of counts read.

Figure 4 shows this movement.

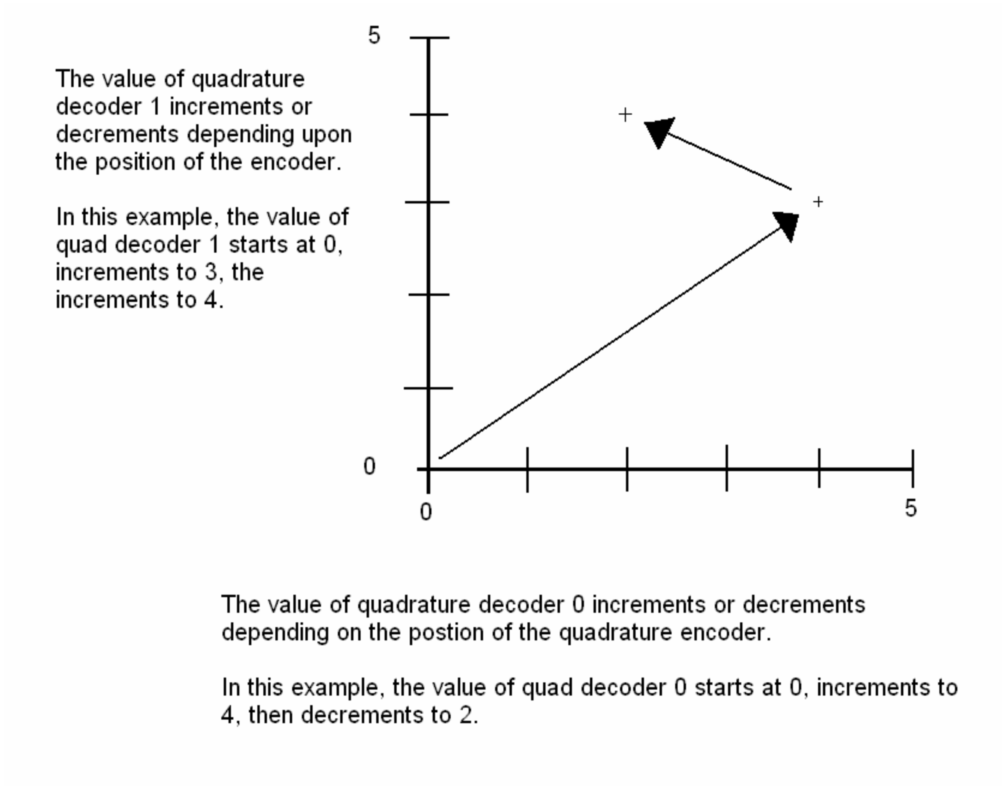


**Figure 4: X/Y Movements Using the Value of Quad Decoders 0 and 1**

# *Determining Rotation*

To determine the rotation of the quadrature encoder, use the following formula:

$$\textit{Rotation degrees} = \frac{\underline{\textit{Count}}}{4 * N} \times 360 \text{ degrees}$$

where *N* is the number of pulses generated by the quadrature encoder per rotation.

For example, if every rotation of the quadrature encoder generated 10 pulses, and the value read from quadrature decoder 0 is 20, the rotation of the quadrature encoder is 180 degrees (20/40 x 360 degrees).