Encoders

sT-Embed Training

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Topics:

- Encoder Operation
- Absolute & Incremental Encoders
- Encoder Wiring Connections; 4 & 5 Wire
- 4 Wire Encoder Video
- 5 Wire Encoder Example (Requires F28069M board + 5 wire encoder to run the example)

Encoder

The F28069M LaunchPad board has inputs for two quadrature encoders. Quadrature encoders measure rotational angles by counting discrete “ticks”.

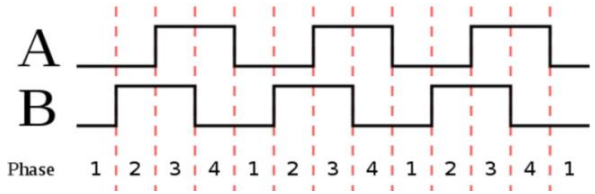
Typically, an encoder will have between 256 to 4000 ticks per revolution.

There are two types of encoders:

- Incremental: Although this type of encoder begins counting “ticks” at power up, it’s information is not accurate until an “index pulse” occurs. The “index pulse” occurs 1x/revolution. When used for motor control, incremental encoders must be rotated initially in “open loop” mode until the “index pulse” is sensed.
- Absolute: This type of encoder begins counting “ticks” at power up and provides accurate angle data immediately.

Encoders have 5 electrical connections: +5v, ground, A, B, index pulse

The A and B outputs consist of discrete values, 1 or 0, and are out of phase by 90 degrees, this allows the direction of rotation to be determined:



Encoder

The F28069M LaunchPad board has encoder peripherals that manage the encoder count value and reset the count value each time an “index pulse” occurs.

The F28069M LaunchPad encoder connections are shown below:

Encoder 2 Connection

Encoder 1 Connection (pin 1 is leftmost pin)

Note1: The square pin (leftmost), labeled EP1A, is the Channel A signal. Moving rightward, the second pin, labeled EP1B, is the channel b signal, the third pin, labeled EP1I, is the index signal, the fourth pin is the 5 volt power signal, and the fifth pin is the ground signal.

Note 2: the rectangular pin (viewed from bottom of LaunchPad board) is always pin 1

Encoder

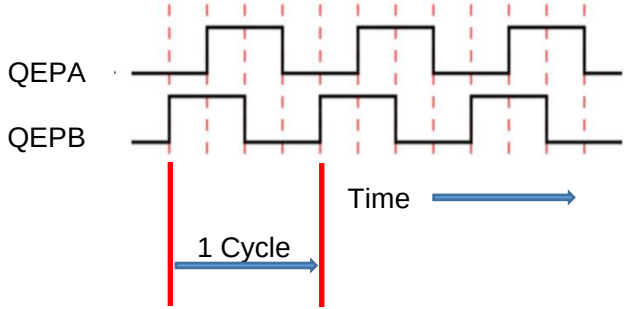
Quadrature encoders measure rotational angle and direction by counting discrete “pulses”.

As a quadrature encoder rotates, two square wave signals are generated, QEPA and QEPB.

CPR = # square wave Cycles Per Revolution of the encoder.

4 transitions per Cycle

PPR = Pulses Per Revolution = 4 * CPR



For example, if an encoder is a 256 CPR, then PPR = 4*256 = 1024

Types of Encoders

There are two types of encoders; incremental and absolute.

The incremental encoder begins counting “pulses” at power up, however, its information is not accurate until an “index pulse” occurs. The “index pulse” occurs 1x/revolution. When used for motor control, incremental encoders must be rotated initially in “open loop” mode until the “index pulse” is sensed.

The absolute encoder begins counting “pulses” at power up and provides accurate angle data immediately.

We will discuss incremental encoders:

There are two wiring configurations for incremental encoders, with and without an index line.

1	Ground
2	Input voltage (Usually 5 volts)
3	Pulse Output - Channel A
4	Pulse Output - Channel B
5	Pulse Output - Index

5 wire connection

1	Ground
2	Input voltage (Usually 5 volts)
3	Pulse Output - Channel A
4	Pulse Output - Channel B

4 wire connection

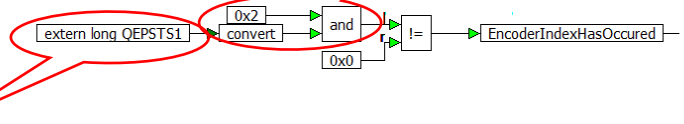
Reading a 4 wire US Digital S4T Single Ended Quadrature Encoder Video

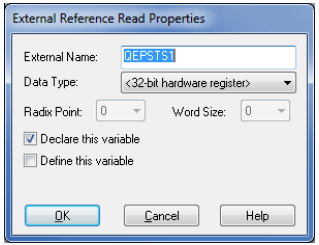
5 Wire Encoder: Detecting the Index Pulse

An incremental encoder begins counting “ticks” at power up, it’s information is not accurate until an “index pulse” occurs. The “index pulse” occurs 1x/revolution. When used for motor control, incremental encoders must be rotated initially in “open loop” mode until the “index pulse” is sensed.

A sT-Embed model to detect the “index pulse” is presented below, In this model, the “index pulse” is named “EncoderIndexHasOccured”

When bit 2 of QEPSTS = 1, the “EncoderIndexHasOccured” digital value is set to 1 and remains there.





QEPSTS is the quadrature encoder status register

NOTE: Some encoders do not have an “index” line, these encoders have a 4 wire connection. Encoders with an “index” line have a 5 wire connection.

5 Wire Encoder Test Model – Hardware Setup

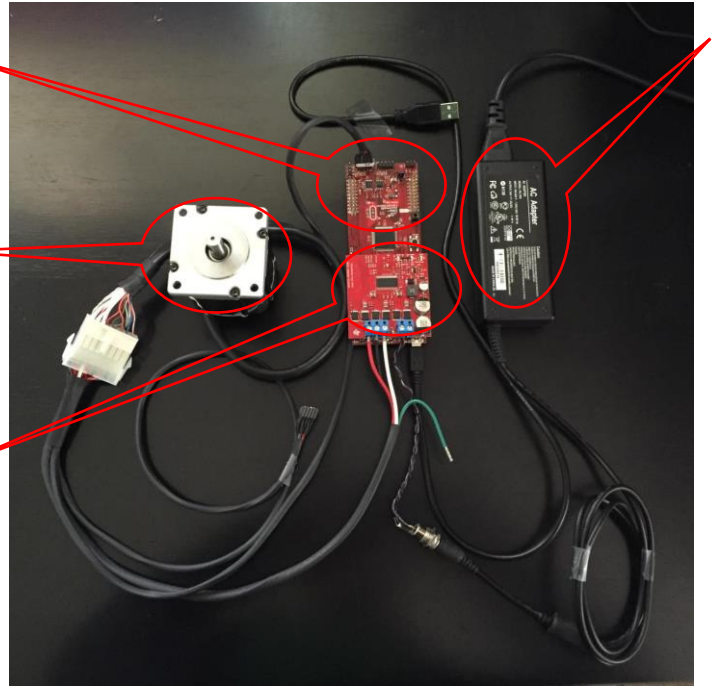
This example illustrates how to read a 5 wire encoder. The encoder is integrated into the Teknic servo motor and connected to the F28069M LaunchPad as shown in the following photo.

TI LAUNCHXL-F28069M

NOTE: J1 and J2 MUST be disconnected as the board is receiving power from the 24V power supply and not the USB

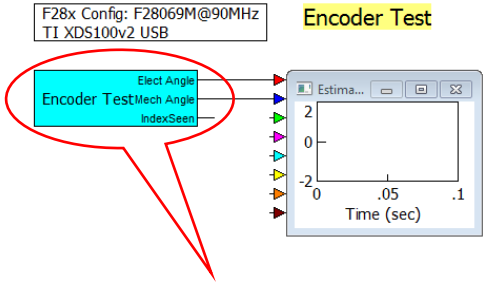
Teknic M-2310P-LN-04K Low voltage servo motor with 5 wire encoder
http://www.ti.com/tool/lvservomtr

TI BOOSTXL-DRV8301
http://www.ti.com/tool/boostxl-drv8301

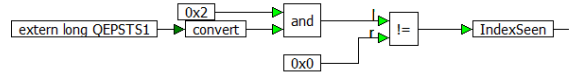


24V, 3A
power supply

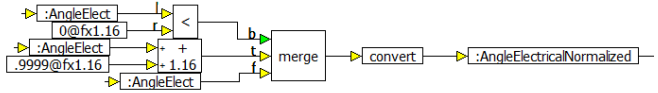
5 Wire sT-Embed Encoder Test Model



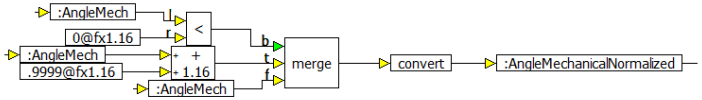
The following model “Encoder Test” is used to read the built in encoder on an 8 pole PMSM Teknic M-2310P-LN-04K Low voltage servo motor. The model detects the “Index pulse” and measures the electrical and mechanical angles. “Time Step” = .0001 sec.



= “Index Pulse”



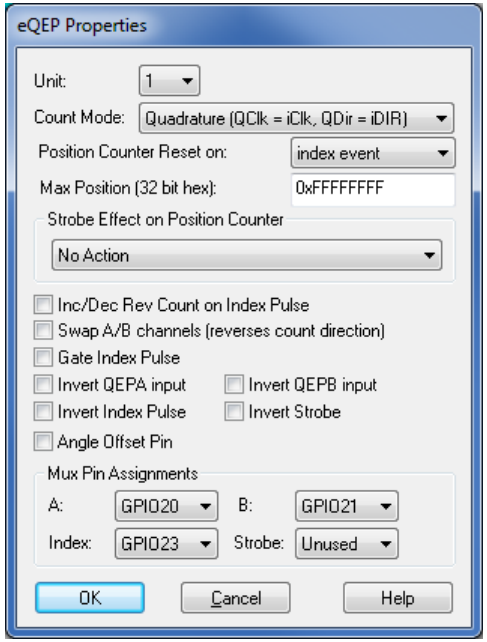
“AngleElectricalNormalized” = normalized (0-1 = 0-360 degrees) electrical angle



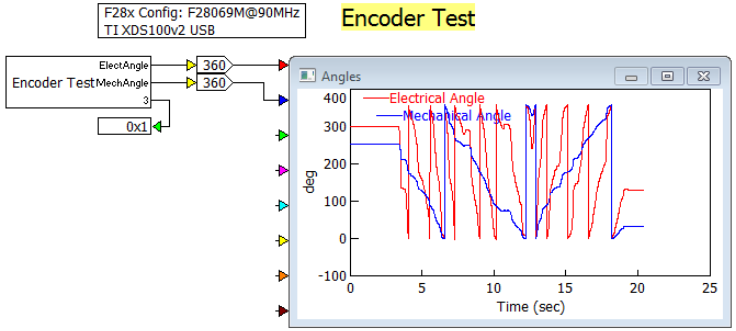
“AngleMechanicalNormalized” = normalized (0-1 = 0-360 degrees) mechanical angle

5 Wire Encoder – eQEP Properties & Results

The eQEP1 Properties are presented below:



Manually turning the PMSM motor shaft produces the following time history results



View Source Model in sT-Embed View Debug Model in sT-Embed

End of Section

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