TB091

Quadrature Encoder Simulator Using the PIC10F2XX

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INTRODUCTION

Motor control systems commonly deploy Quadrature Encoders (Q.E.) to provide speed and position feedback. This technical brief describes how to simulate a 3 signal Q.E. using any 6-pin PIC10F2XX device. It also facilitates a variable frequency control which can be used to speed up/down the rate of output signal pulses.

THEORY

The most common type of incremental encoder uses two output channels (A and B) to sense position. Using two code tracks with sectors positioned 90° out of phase, the two output channels of the Quadrature Encoder indicate both position and direction of rotation. If A leads B, for example, the disk is rotating in a clockwise direction. If B leads A, then the disk is rotating in a counter-clockwise direction.

By monitoring both the number of pulses and the relative phase of signals A and B, you can track both the position and direction of rotation. Speed can also be determined by monitoring the pulse rate.

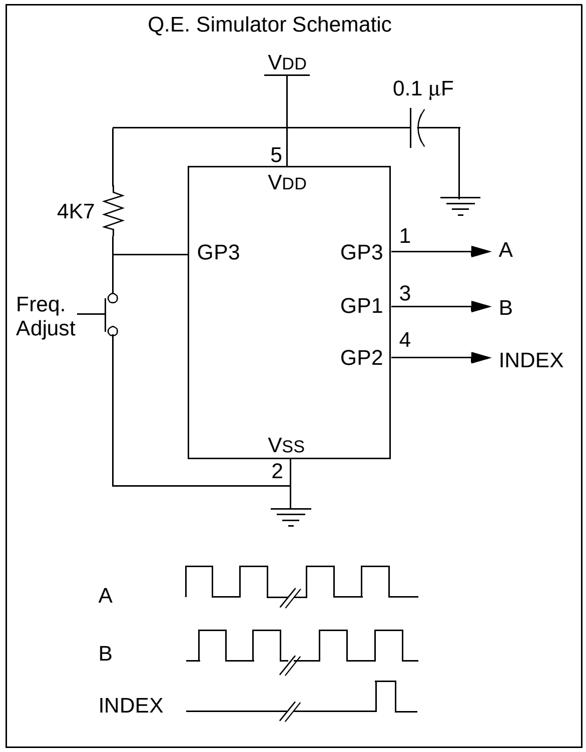
Some Quadrature Encoders also include a third output channel called a zero, index or reference signal, which supplies a single pulse per revolution. This single pulse is used for precise determination of a reference position.

EXAMPLE HARDWARE

The PIC10F2XX GPIO port is configured for 3 outputs which produce the Q. E. Simulator. The pulses generated are Phase A, Phase B and Index.

One input is reserved for frequency adjustment. The lone input is controlled via a push button from V_{DD} to ground.

FIGURE 1: EXAMPLE SCHEMATIC



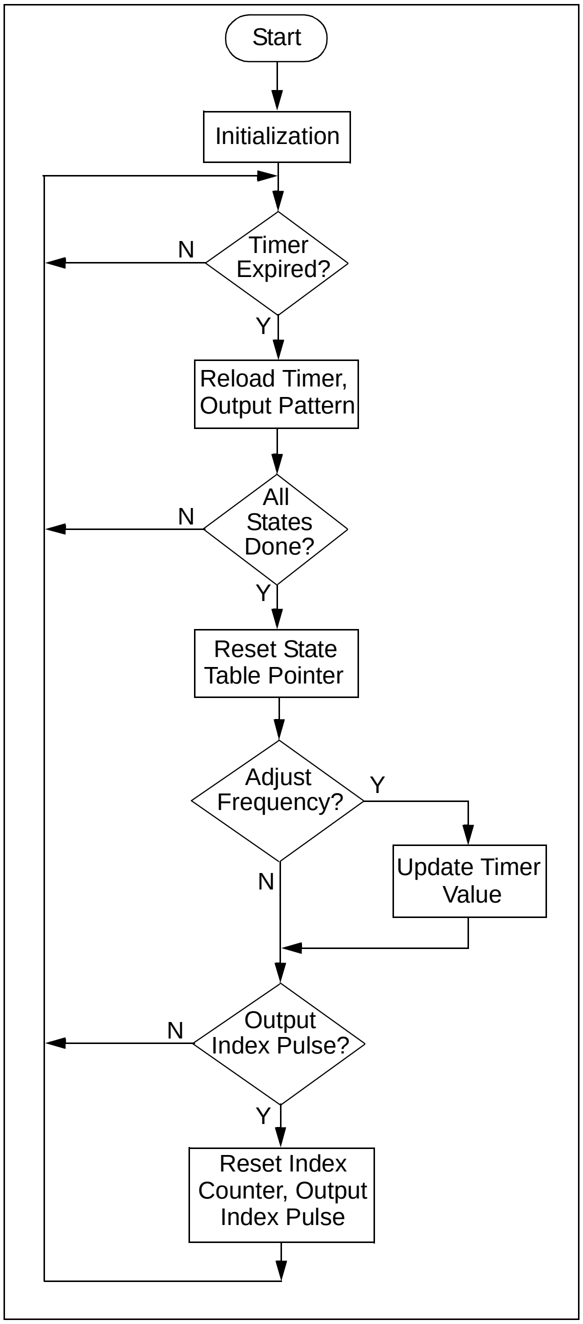
Note:	Figure 1 also illustrates the relative timing of the output pulses. To reverse the direction of the Q.E. Simulator, simply swap the connections to Phase A & B outputs.

EXAMPLE SOFTWARE

The software is a simple repeating loop which, after initialization of variables and general configuration, cycles through four tests as follows:

1. Timer expired – tests for the timer expiring
2. All states done – tests if each state from the state table is output prior to the next test
3. Adjust frequency – monitors the external switch for presses
4. Output Index pulse – tests if an index pulse is required

FIGURE 2: FLOWCHART



The output patterns for Phase A & B are broken down into four states as described in Table 1.

TABLE 1: STATE TABLE

State	Phase A O/P	Phase B O/P
1	1	0
2	1	1
3	0	1
4	0	0

When each of these states is output to the GPIO port in turn, this gives output pulses displaced by 90 degrees. Each state in the table is cycled in sequence. The frequency of the output pulses is determined by gating with the timer expiration. The state table is implemented in Flash memory and is accessed via a call to the TABLE routine.

After all the states are output, a check is performed to see if an output frequency adjustment is required, (i.e. the debounced switch is pressed). If a change is required, the *time_delay* variable is modified. It is then loaded into the Timer which governs the frequency. The limits *time_delay* is constrained by are set by the constants MIN_DELAY and MAX_DELAY, allowing control of the maximum and minimum frequency output.

Finally, a test is performed to determine if an index pulse is needed. In this example, the variable *index* holds the desired rate for the index pulse. It is initialized using the constant INDEX_PULSE.

Upon completion of the index pulse generation, (if needed), the code loops back to begin the four tests again.

With the minimum and maximum timer values used, the output frequency can be adjusted from 200 Hz to 4 kHz with an index pulse every 200th phase pulse.

Encoders usually output an index pulse every revolution, so this system simulates a speed range of 60 to 1200 revolutions per minute.

> **Note:** The external switch should be pushed and held until the desired frequency setting is reached. There is a cyclical log response where the frequency will speed up to a maximum and then reduce to the minimum.

CONCLUSION

This Technical Brief illustrates how to simulate a Q.E. on the PIC10F2XX, but the system could be easily adapted for simulation of other motion feedback components such as crankshaft or camshaft timing discs and Hall-Effect sensors. Indeed, any simple device which outputs synchronous/asynchronous patterns could be simulated by modification of the state table and adjustment of the timer delay.

NOTES:

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