New Peripherals Tips 'n Tricks

The Complementary Waveform Generator (CWG), Configurable Logic Cell (CLC), and the Numerically Controlled Oscillator (NCO) Peripherals

TIPS 'N TRICKS INTRODUCTION

Microchip continues to provide innovative products that are smaller, faster, easier to use and more reliable. Flash-based PIC® MCUs are used in a wide range of every day products from smoke detectors to industrial, automotive and medical products.

The PIC16(L)F150X and PIC10(L)F32X families of devices with on-chip configurable logic cells, merge all the advantages of the PIC MCU architecture and the flexibility of Flash program memory, with the functionality of a configurable digital logic cell. Together, they form a low-cost building block with resource savings and external component reduction.

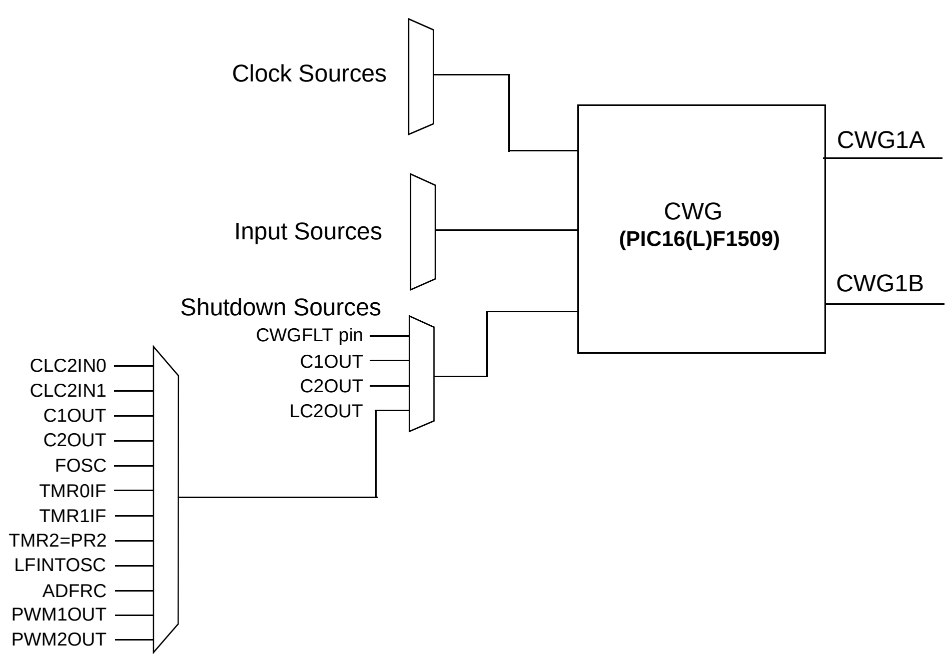
The flexibility of Flash and an excellent development tool suite, including a low-cost In-Circuit Debugger, In-Circuit Serial Programming™ (ICSP™) and CLC Configuration Tool GUI, make these devices ideal for just about any embedded control application.

The following Tips 'n Tricks can be applied to a variety of applications to help make the most of digital logic functions using a PIC MCU with on-chip configurable logic.

TIP 1: EXTENDING AUTO-SHUTDOWN CONDITIONS/INPUTS FOR THE CWG

Have you ever found yourself in a situation where your PWM application needs more auto-shutdown conditions, other than the software driven ones, due to resource limitations? Here is a solution. The Complementary Waveform Generator (CWG) has two auto-shutdown condition inputs: the CWG1FLT pin for external conditions, and the output from the Configurable Logic Cell (CLC), LCxOUT -> LC2OUT. Use the CLC to your advantage. By selecting the CLC output as an auto-shutdown source, all of the inputs to the CLC are available as auto-shutdown conditions for your CWG (Figure 1).

FIGURE 1: EXTENDING THE CWG'S AUTO-SHUTDOWN SOURCES

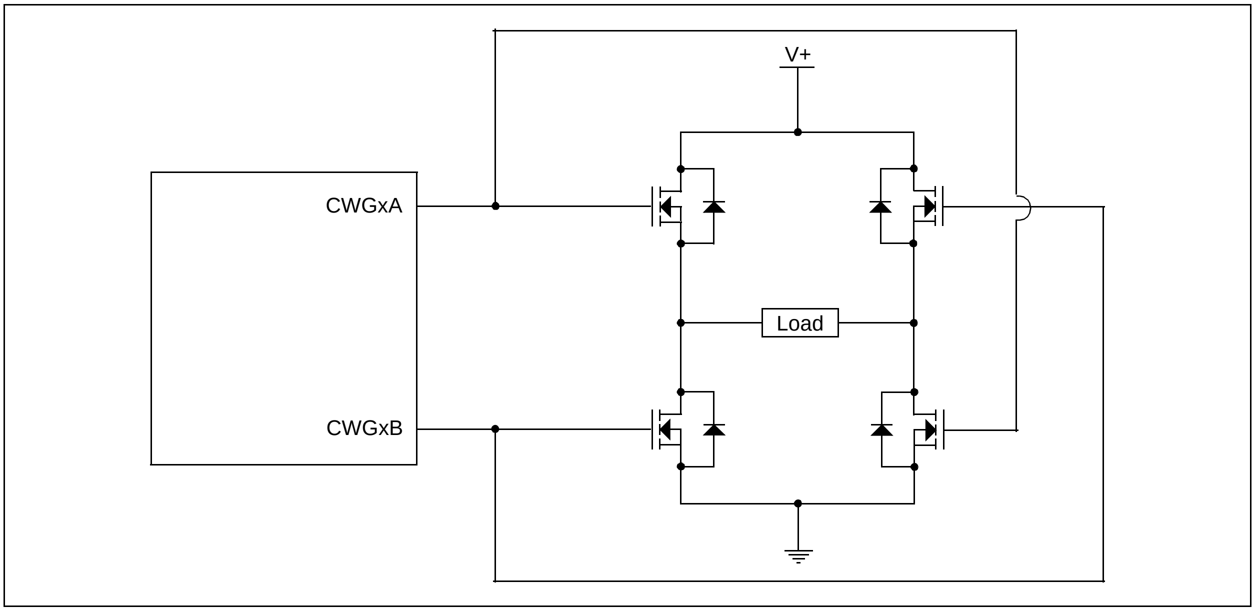


TIP 2: DRIVING A HALF-BRIDGE OR A FULL-BRIDGE DRIVE CIRCUIT USING THE CWG

Do not think a high pin count microcontroller is needed to drive a half-bridge or full-bridge motor drive circuit. It can be done using the PWM in conjunction with the CWG module.

Setup the PWM module to output the desired drive signal to the CWG input. Now, configure the CWG to output the drive signal, and its complement, with the appropriate dead-band delay, to provide for non-overlapping output signals that drive the motor drive circuit, thus preventing shoot-through current. See Figure 2 for an illustration of a CWG driving a full-bridge drive circuit.

FIGURE 2: CWG DRIVING A FULL-BRIDGE DRIVE CIRCUIT



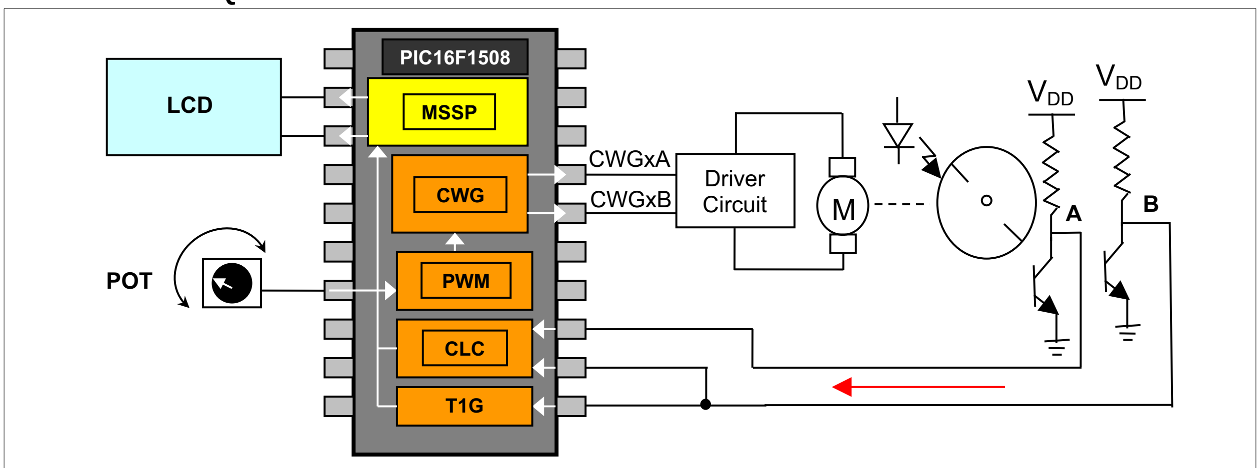
TIP 3: MEASURING DC MOTOR SPEED AND POSITION USING A QUADRATURE DECODER

Rotary encoders are typically used to provide direct physical feedback of motor position, and/or speed. A rotary encoder consists of a rotary element attached to the motor that has a physical feature, measured by a stationary component. The measurements can yield motor speed and sometimes can provide a motor position. Rotary encoders are built using many different technologies. The most common type is an optical rotary encoder. The optical rotary encoder is used in computer mice that have a ball. It is built with an encoder disc that is attached to the motor. The encoder disc has many radial slots cut into the disc at specific intervals. An LED and a photo detector are used to count the slots as they rotate. The speed of rotation can be determined by timing the rate of the slots' revolutions.

Sensing motor position requires a second LED and photo detector. The second sensor pair is mounted so the output pulse is 90° out of phase from the first pair. The two outputs represent the motion of the encoder disc as a quadrature modulated pulse train.

In this application example, the PWM module is used to generate a signal, controlled by an external potentiometer, then configuring it as an input to the CWG to drive a motor drive circuit. As the motor turns, spinning a disk with slots cut into it allowing light from a LED to shine through and on two photo transistors (A and B). As the light hits the photo transistors, a logic '0' is read on the input pin of the microcontroller. Therefore, as the input from photo transistor B is read into the microcontroller, the time calculated between every other falling edge (via Timer1 gate) of the input pulse signal corresponds to the speed of the motor. Now, with photo transistor A 90° from transistor B, you can determine the direction of the motor by using the CLC to determine which photo transistor was turned on first. See Figure 3.

FIGURE 3: QUADRATURE DECODER SIMPLIFIED SCHEMATIC



TIP 4: MANCHESTER DECODING USING THE CLC AND NCO

If a EUSART can be used for Manchester encoding, a Configurable Logic Cell (CLC) and a Numerically Controlled Oscillator (NCO) can be used for Manchester decoding.

This tip presents a method to decode a Manchester encoded signal using four CLCs and the NCO to separate the SPI data signal from a SPI clock signal. See Figure 4. After selecting a microcontroller with four CLCs and an NCO, such as the PIC16F1509, configure the CLC1 to input the Manchester encoded data signal into a D flip-flop that is clocked by the inverse of the clock out signal that you are separating. See Figure 5. The inverted output of this flip-flop is the output data you are decoding. Next, configure the CLC2 to XOR the non-inverted output of CLC1 with the encoded data signal from the input of CLC1. See Figure 6. This XOR output establishes the positive edge to which the output data is derived. Use this XOR output to clock the CLC3. See Figure 7. Setup CLC3 using a logic high input and output CLC3 to the input of CLC4, which AND-Ors it to the internal oscillator frequency (F_{OSC}) of the microcontroller and the clock out signal from the NCO.

See Figure 8. The output signal of CLC4 is then used to clock the NCO accumulator. This makes the NCO output signal the clock frequency to establish the proper timing (the beginning and end of the data signal) to decode the data output signal. See Manchester Decoder Signal Diagram (Figure 9).

FIGURE 4: MANCHESTER DECODER SIMPLIFIED BLOCK DIAGRAM

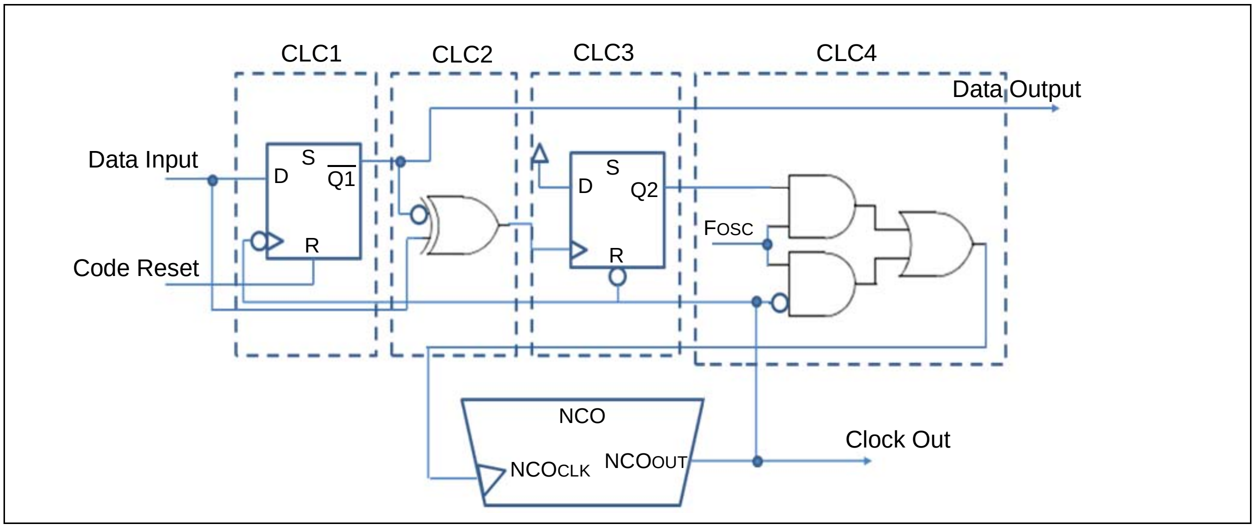


FIGURE 5: CLC1 SETUP

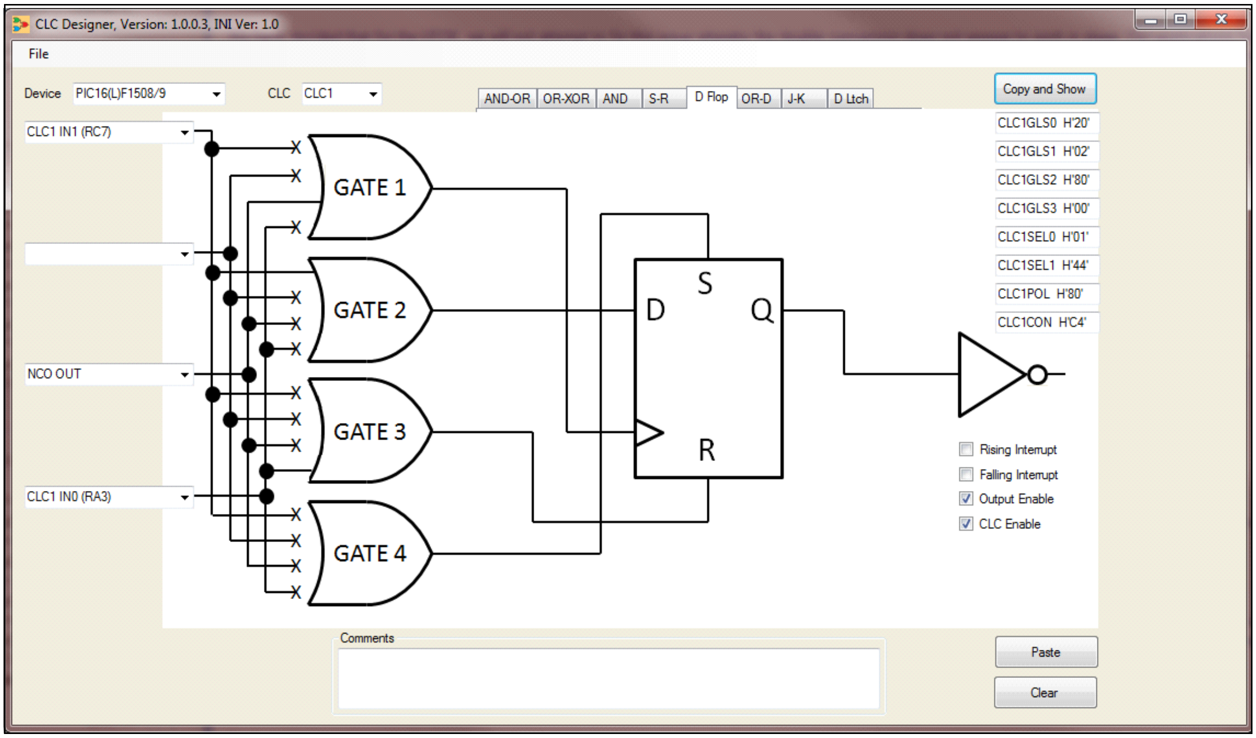


FIGURE 6: CLC2 SETUP

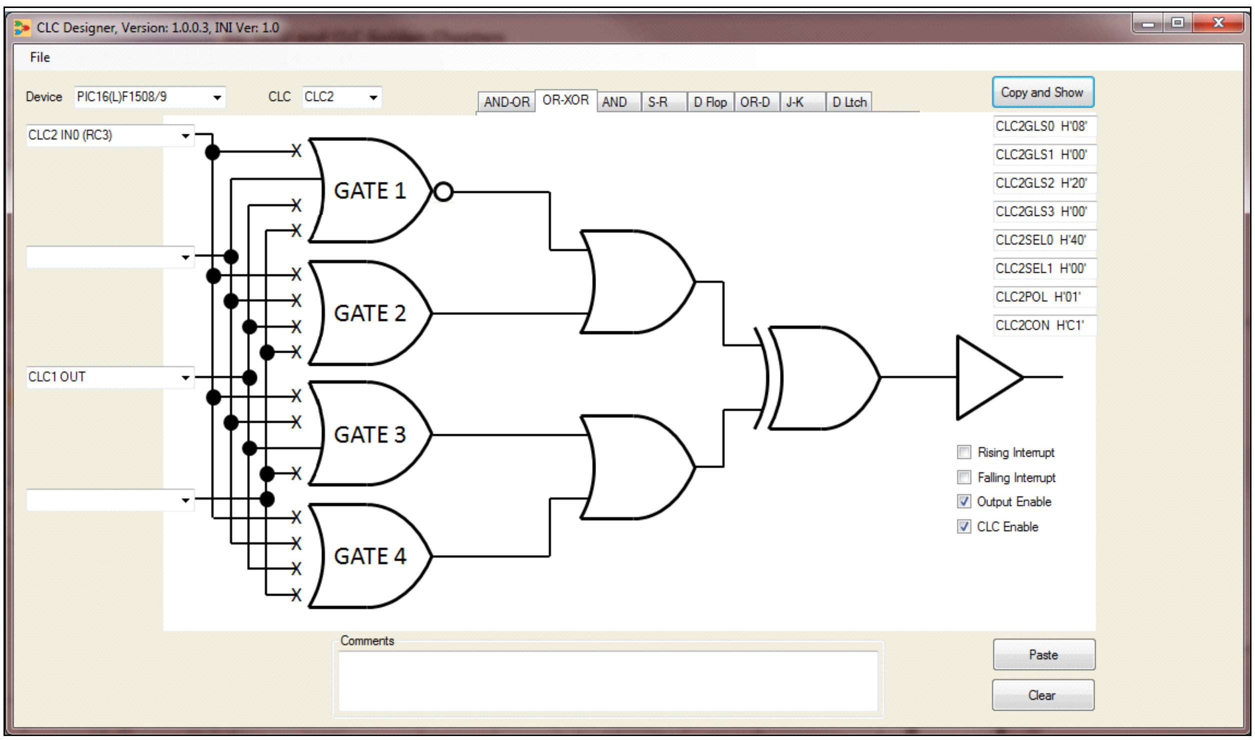


FIGURE 7: CLC3 SETUP

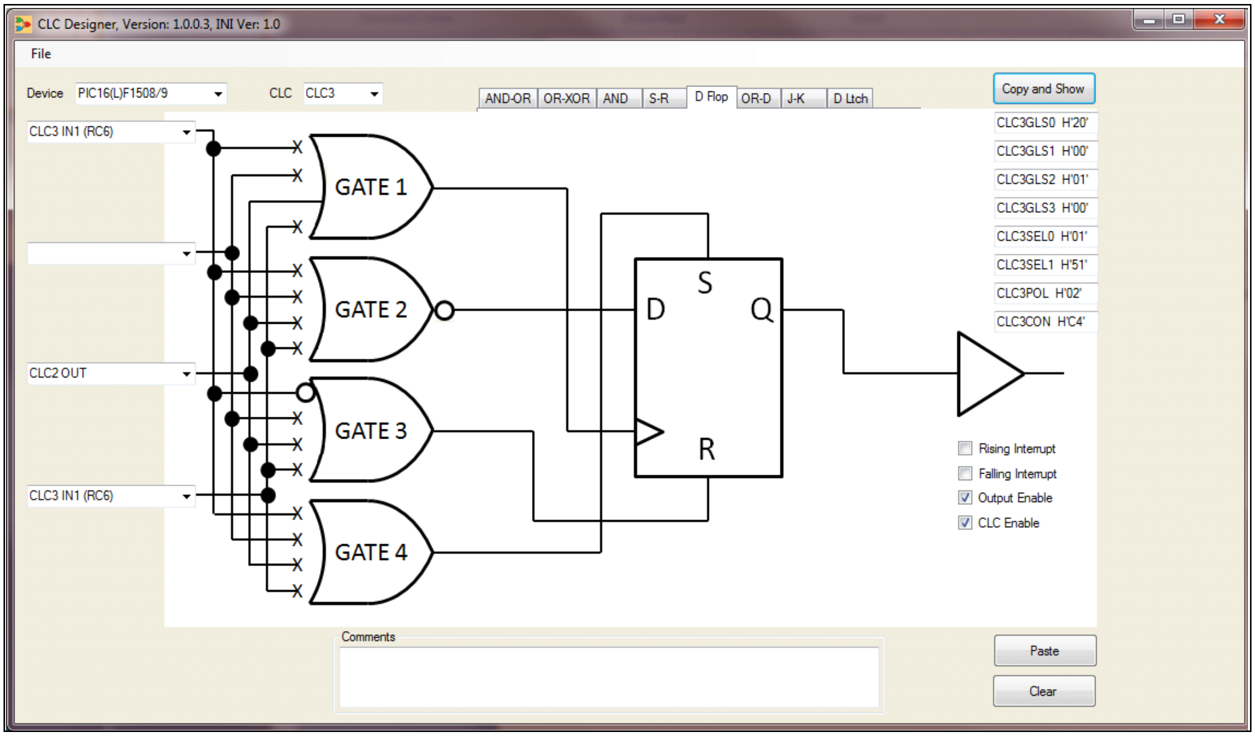


FIGURE 8: CLC4 SETUP

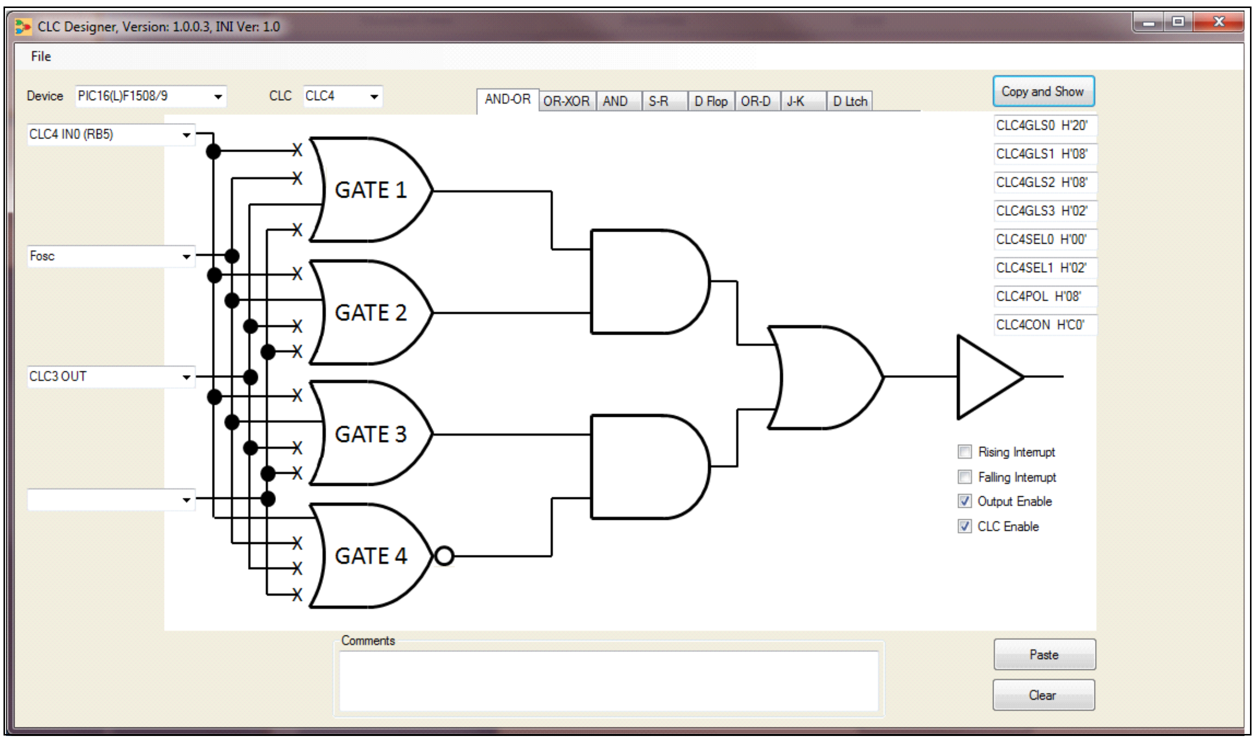
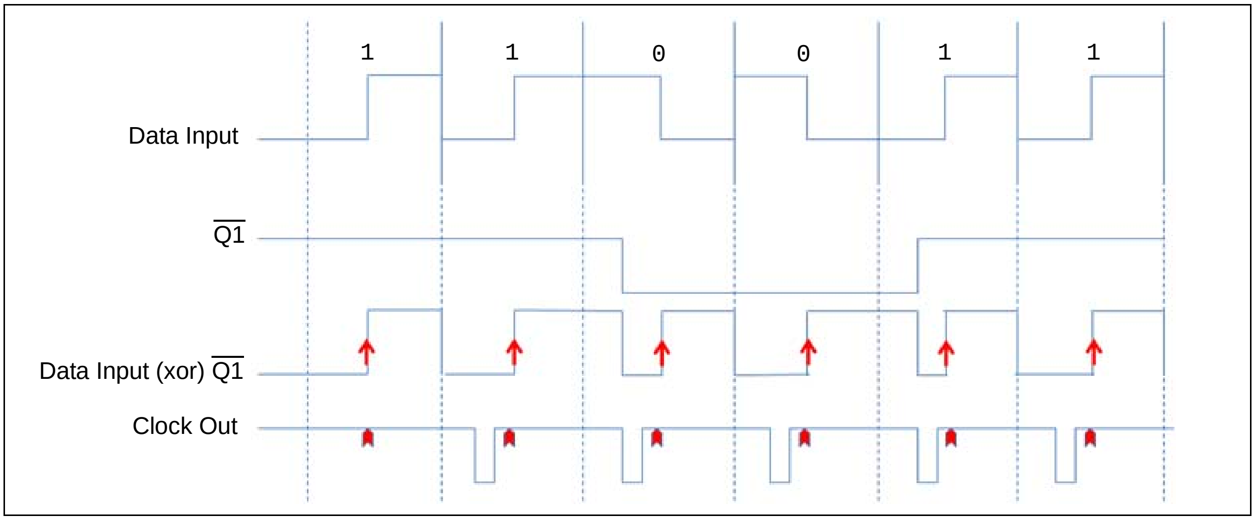


FIGURE 9: MANCHESTER DECODER SIGNAL DIAGRAM



RESOURCES

[1] *Configurable Logic Cell (CLC) Configuration Tool User's Guide*, DS41597 at www.microchip.com

[2] Configurable Logic Cell (CLC) Configuration Tool GUI software at www.microchip.com

[3] Device data sheet for the specific device you are using, at www.microchip.com

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