Controlling the X79000 FlexDAC with a Rotary Encoder

Application Note | October 20, 2004 | AN1231.0

Author: Carlos Martinez

Overview

The X79000 is a 12-bit Digital to Analog converter (DAC) with a built-in voltage reference, a selectable output voltage range, an output buffer, an up/down input control, and non-volatile analog output settings. These features make it useful in a number of applications. When coupled with a rotary encoder and some simple logic, this one device provides a number of interesting solutions.

With an optical or magnetic rotary encoder on the shaft of a motor that moves a mechanical arm or valve, the analog output of the DAC provides non-contact positioning information or an analog feedback for position control. With a simple, low cost, mechanical rotary encoder, the DAC functions as a programmable voltage reference for either one-time calibration or in-system trimming.

With the Up/Down interface of the X79000, the DAC is moved up (if $\overline{CS}$ is HIGH) by the rising edge of the UP input, while the DOWN input is LOW. The DAC is moved down (if $\overline{CS}$ is HIGH) by the rising edge of the DOWN input, while the UP input is LOW. The X79000 has a CLR input that resets the DAC value to the low end of the output range and it has an OE input to enable the output. Saving the output value of the DAC, or changing the output voltage range, requires a command over a serial (SPI) interface.

A rotary encoder consists of two switches that are 90 degrees out of phase. The switches, shown in Figure 1, open and close as the encoder shaft rotates. This low cost mechanical switch requires external debounce components, but optical or magnetic rotary encoders would not require the external resistors and capacitors.

The basic operation of the circuit derives from the quadrature output of the rotary encoder (as shown in Figure 2.) When the encoder rotates clockwise the B switch is LOW on the rising edge of the A switch. When the encoder rotates counter clockwise, the B switch is HIGH on the rising edge of the A switch.

A complete circuit for the X79000 control is shown in Figure , but simply, to convert the rotary encoder output to the UP/DOWN interface, the A output triggers one of the two one-shot multivibrators in a 74HC123 device. This output pulse becomes either the UP or DOWN control as determined by the B output of the rotary encoder. Q1 simply serves as an inverter. The resulting output waveform is seen in Figure 3.

A push button provides a reset input to the DAC. This could correspond to a microswitch indicating end of travel on a mechanical arm controlled by a motor.

The Panasonic rotary encoder has 24 positions per rotation. For the 4096 position DAC, the encoder rotates 171 turns for the full range of the DAC. Note that the X79000 default resolution is 12-bits, but it also can be programmed so each Up/DOWN pulse controls the LSB for 8-bit or 10-bit D/A operation.

Because the output range is programmable and non-volatile, there is great flexibility in a particular application. For example, the factory default condition has an output range of 0.151V to 2.42V, with a step size of about 0.5mV. However, the designer can set up the DAC with an output range of 1.815 to 2.42V, with a step size of about 0.15mV. Or, external references can be used for other limits or better accuracy.

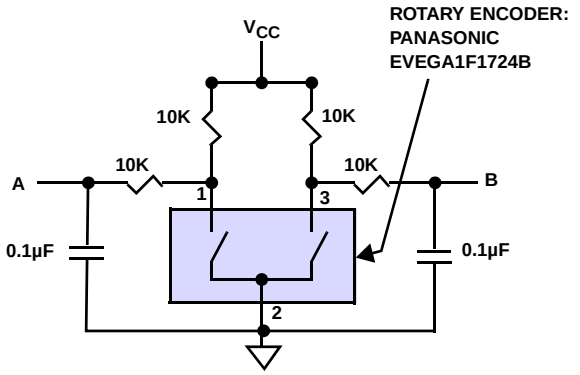


FIGURE 1. MECHANICAL ROTARY ENCODER CIRCUIT

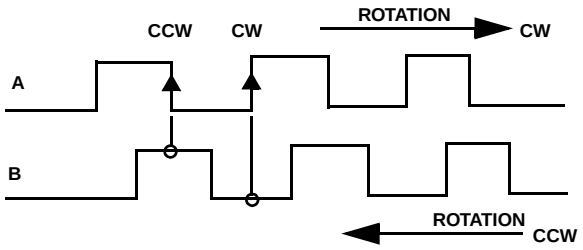


FIGURE 2. ROTARY ENCODER OUTPUT

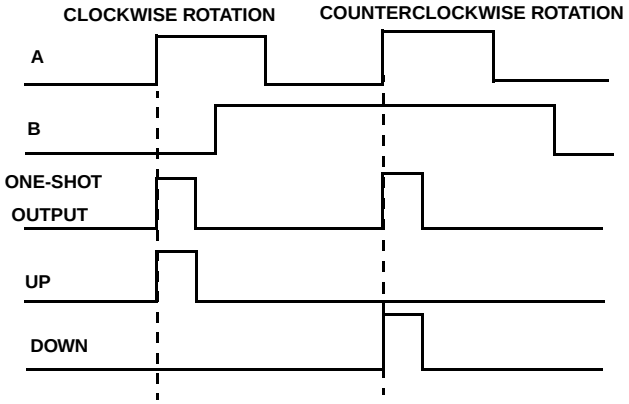
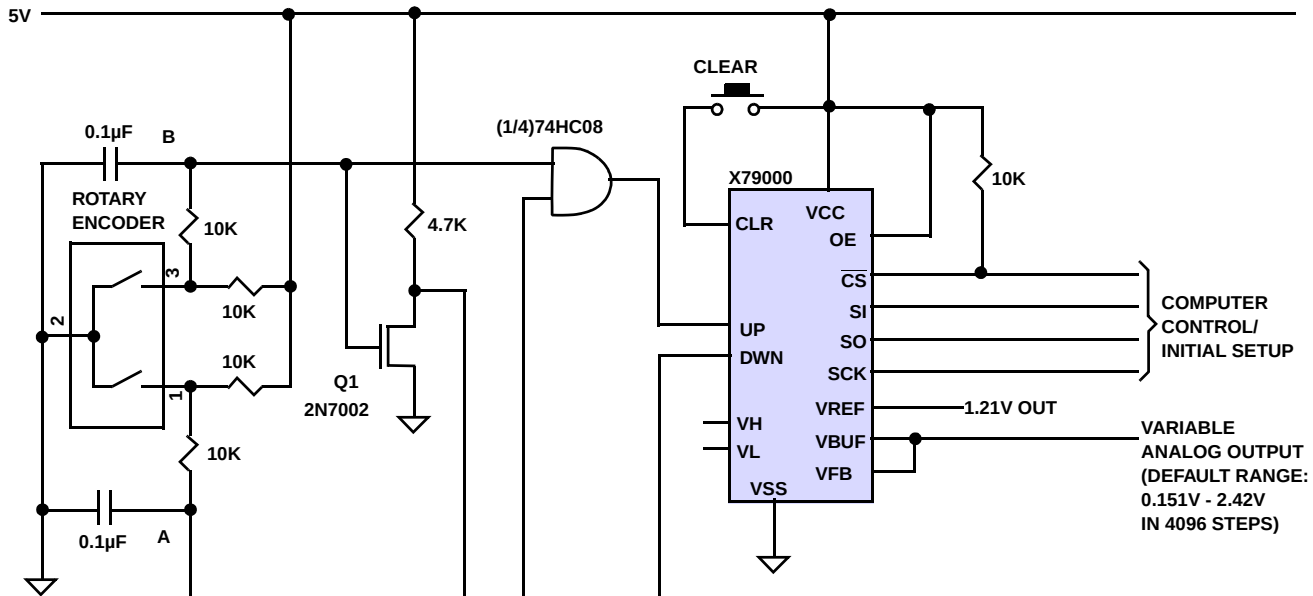
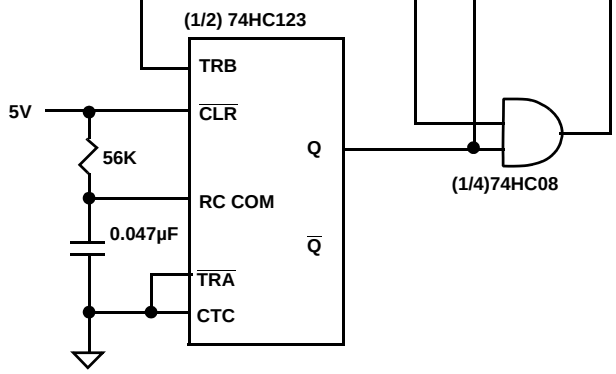


FIGURE 3. CONTROL OUTPUT GENERATED FROM ROTARY ENCODER





Output Voltage Range. Select one limit from each column. Max. selection must be greater than Min. selection. Programmed via SPI port.

OUTPUT VOLTAGE (SELECTABLE MINIMUM LIMIT)	OUTPUT VOLTAGE (SELECTABLE MAXIMUM LIMIT)
EXTERNAL (VL)	EXTERNAL (VH)
151mV	605mV
605mV	1.21V
1.21V	1.815V
1.815V	2.42V
2.42V	3.025V

FIGURE 4. CIRCUIT DIAGRAM