Application Note AN2128

3-Wire Interface for a 4-Digit LED Display

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Associated Project: Yes
Associated Part Family: CY8C25xxx, CY8C26xxx

Summary

This Application Note describes a method to interface a 4-digit multiplexed LED display to the PSoC device using only 3 IO pins.

Introduction

When a 4-digit LED display has to be driven, a minimum of 8 IO pins is necessary; 4 for display driving and 4 for the BCD outputs. Sometimes this many IO pins may not be available in the processor and the designer is forced to go for a device with more IO pins. This Application Note describes a method to drive a 4-digit LED display with only 3 IO pins. Thus, even while using an 8-pin PSoC device, 3 IO pins are available for other functions.

Block Diagram

Figure 1 shows the block diagram of the set up. The PSoC generates three signals; Clock, Data and Output Enable (OE) to the serial to parallel converter. The lower nibble of the output of the converter is the BCD input to the 7-segment decoder. The higher nibble of the output is used to drive the individual displays.

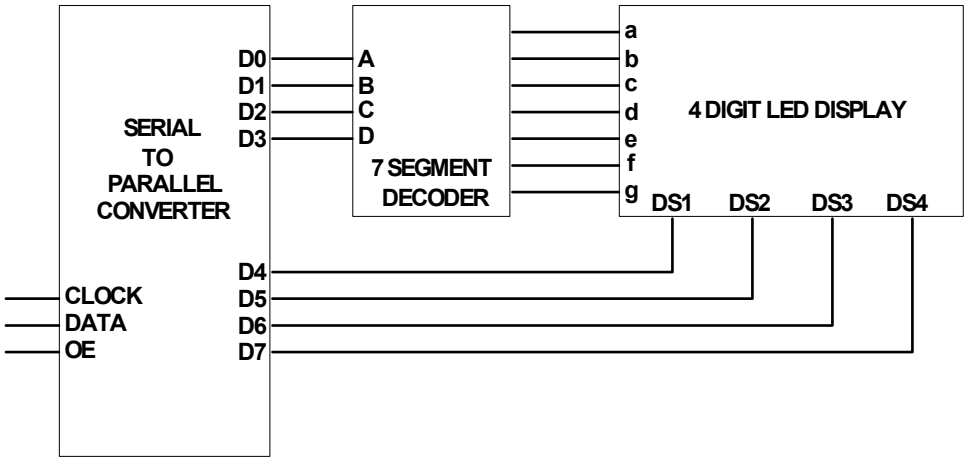


Figure 1. Block Diagram

The Circuit

The circuit is found in Figure 2. The serial to Parallel converter is MC14094B. For every positive transition of the Clock input 'CLK', the Data 'D' is shifted to the first stage of the 8-bit Shift Register. The Output Enable pin 'OE' controls an output latch. When this pin is made low, the output of the latch switches to high impedance state. A positive going pulse on the strobe input latches the contents of the Shift Register to the latch. But in our application, this input is permanently tied to V_{cc}. This makes the latch transparent and the output of the latch always reflects the output of the Shift Register. The output is controlled by the OE input. P0[5] of PSoC is connected to OE. P0[3] is connected to the D. P0[1] is connected to CLK. To shift a value to the converter, the controller first disables the output by pulling the OE pin low. Then it outputs the data bit-by-bit on the Data pin and clocks the converter through the CLK pin. Once all 8 bits have been shifted, the controller enables the output by making OE high.

Q1 to Q4 of MC14094 are fed to the BCD inputs of 74LS47, a BCD to 7 Segment decoder/driver. The output of the decoder drives the segments of a 4-digit multiplexed Common Anode Display.

Q5 to Q8 of MC14094 are used to drive 4 nos. of BC558 PNP transistors that provide the Anode Drive to the individual displays.

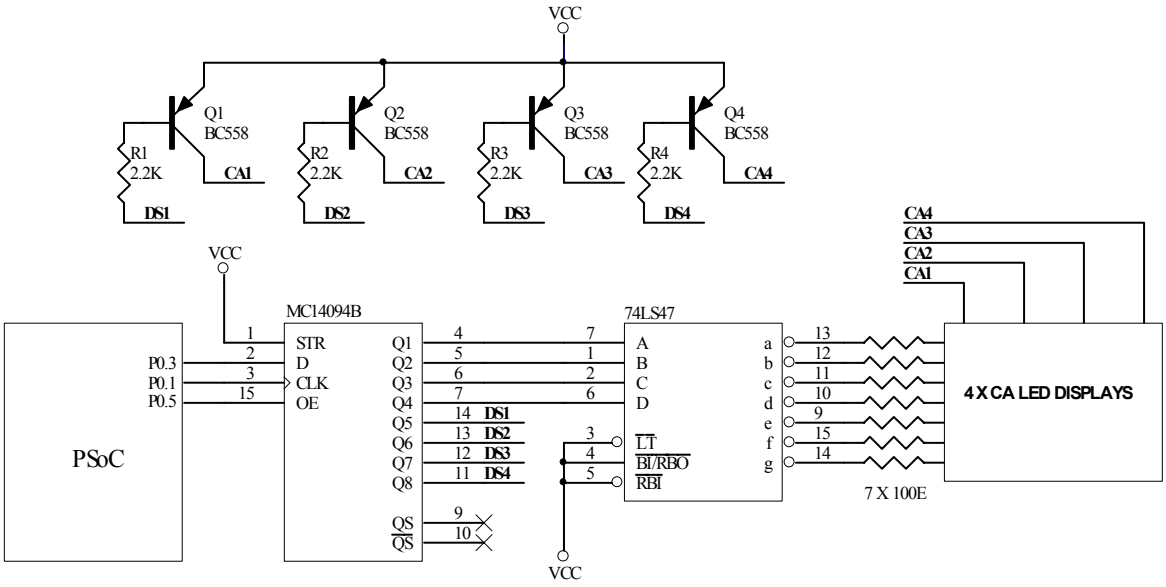


Figure 2. Schematic Diagram

The Software

The display driver routine is called from a timer interrupt. The interrupt is generated by an 8-bit timer module named, 'DisplayTimer', that is clocked by the 32 kHz internal clock. The period is set to 32. So a timer interrupt is generated every 1 ms. The software updates the displays one by one every 1 ms. The refresh rate of the display can be modified by changing the period value of DisplayTimer.

Following is the algorithm of display driver. The flowchart of the program is found in Figure 3.

1. Check the variable digitId and find out which display has to be updated.
2. Load the BCD Value of the respective display to the lower nibble of Accumulator.
3. Update digitId to point to next digit.
4. Clear the respective Display Select bit in the upper nibble of Accumulator.
5. Disable Output of the Serial to Parallel Converter.
6. Shift the content of Accumulator to the Converter.
7. Enable Output of the Serial to Parallel converter.

The display driver is in the file *display.asm*. The constants are declared in the file *constants.inc*.

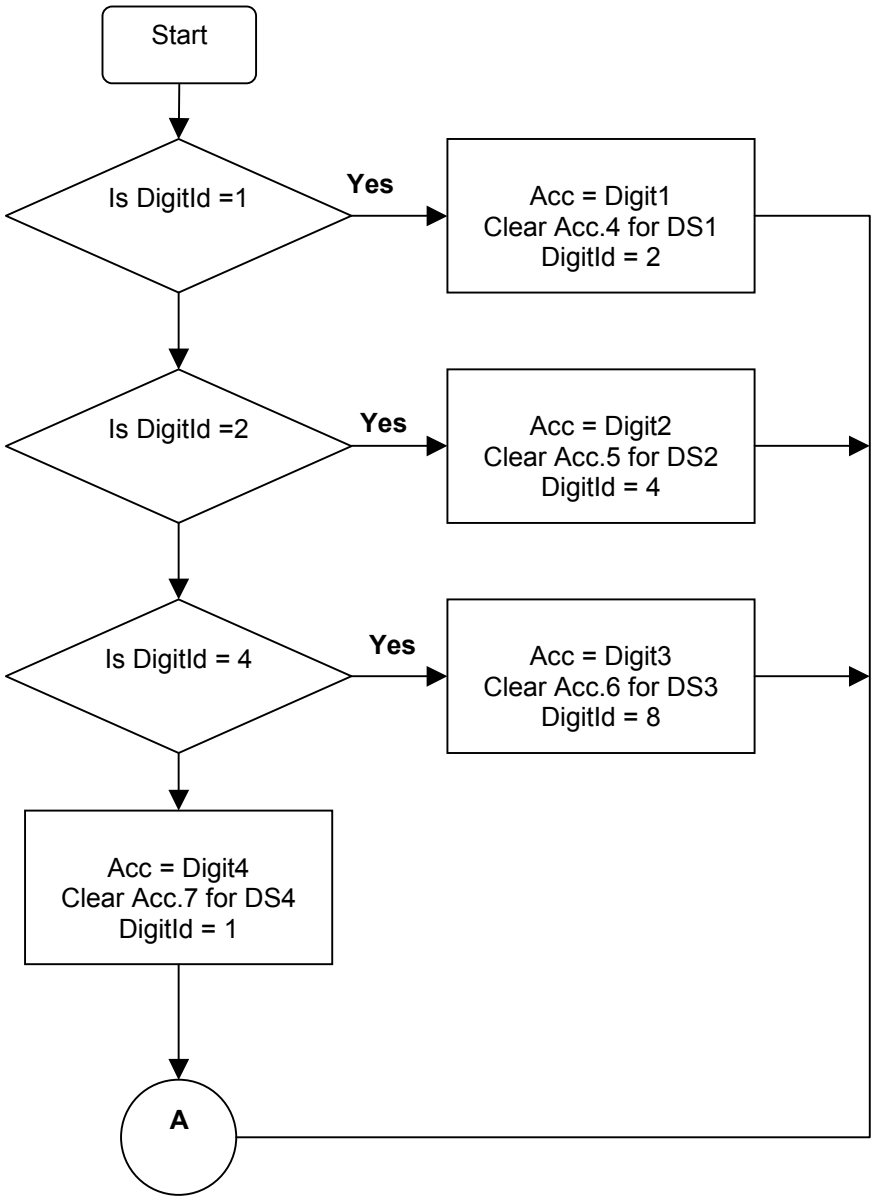
Interfacing a Keyboard, Too

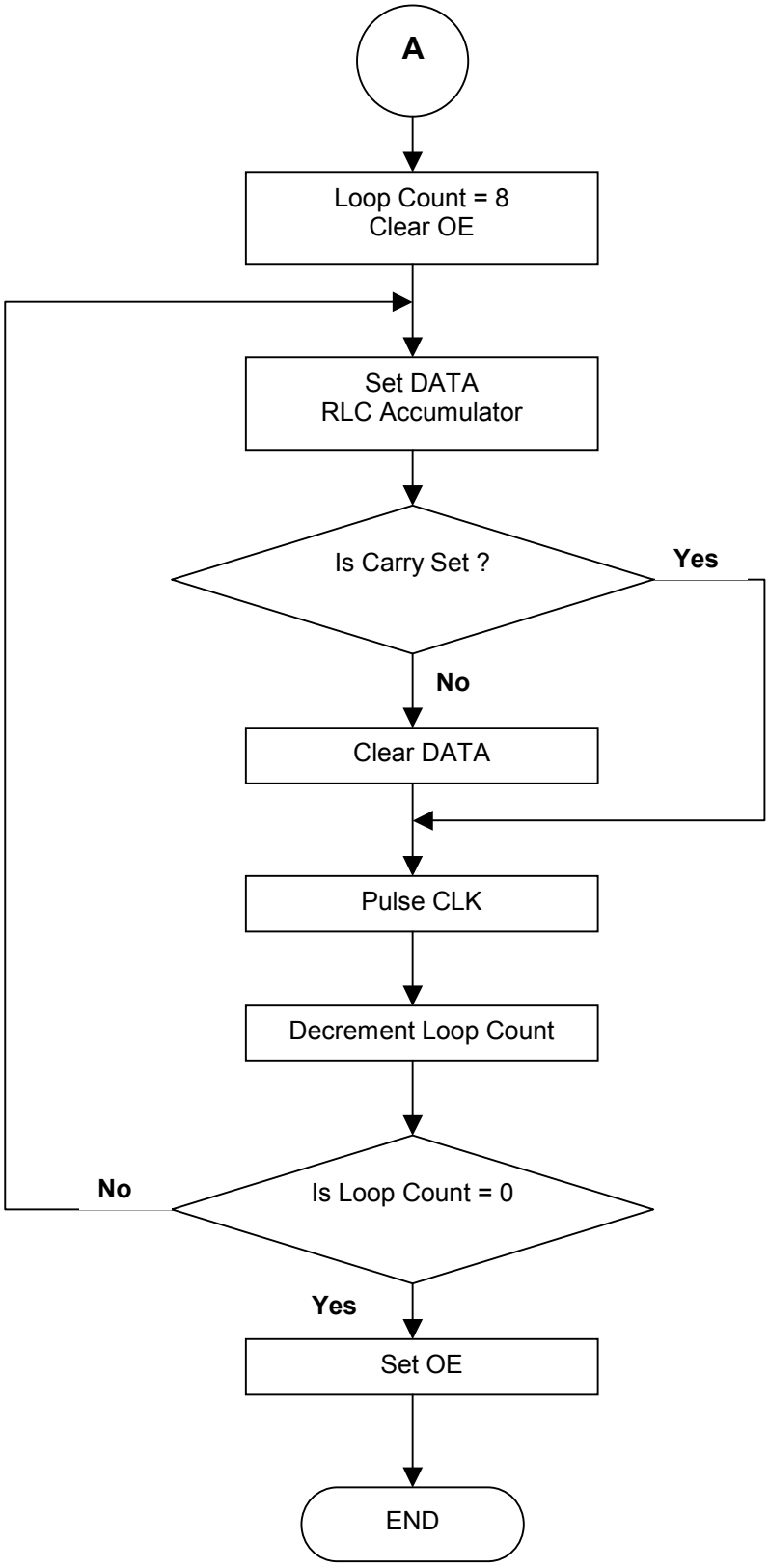
By using only 3 digits of display and CA4 to drive a 2-key keypad, during the scan time of the fourth digit P0[3] and P0[1] can be used as input pins to read the status of 2 keys.

A Complete Application

A complete application would be using an 8 pin PSoC to monitor an analog voltage. 2 pins can accept the input analog voltage. One pin can drive a relay. 3 pins can drive a 3 digit LED Display and read from a 2 Key Keypad. Using the two keys a set point can be modified. The relay can be switched On when the input voltage exceeds the set point.

Figure 3. Flowchart




A
Loop Count = 8
Clear OE
Set DATA
RLC Accumulator
Is Carry Set ?
Yes
No
Clear DATA
Pulse CLK
Decrement Loop Count
Is Loop Count = 0
No
Yes
Set OE
END

About the Author

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Background:	M. Ganesh does freelancing R&D work for various manufacturing industries. He obtained his diploma in Electronics and Communications Engg. in 1992. He has his own consultant firm called Omega Electronics & Consultants where they develop products for instrumentation and process control. He also develops and transfers technologies for manufacturing companies.
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