Introduction

This app note steps through how to create a digital kitchen timers, complete with a knob, buzzer and a digital display. The system has two GreenPAK™ IC devices, one to keep time and the other to drive the display. The schematic is shown in Figure 1. A button is configured to start, pause, continue and reset the timer. A maximum of 1 hour (or 59 minutes) can be digitally stored.

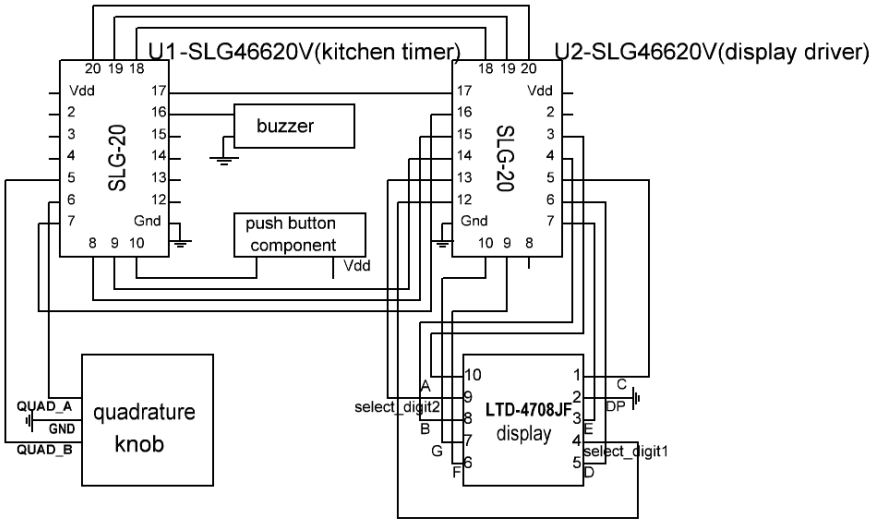

Figure 1. System Level Diagram

The quadrature knob interface is derived from AN-1101 Unclocked Quadrature Decoder.

Storing the Time

The time is stored in two sets of DFFs, one that represents the tens digit and another the ones digit. The DFFs count in binary from 0000 to 1001 (or 0 to 9 in decimal) for the ones digit and from 000 to 101 (or 0 to 5 in decimal) for the tens digit. The maximum storable value is 59.

The ones digit inputs are gated by a 'Wrap' signal and an 'Up/Down' signal. The Wrap signal indicates when the digits have reached 0 or 9 and forces the next value to wrap around to 9 or 0 depending on the counting direction. For the tens digit the wrap occurs when the digits have reached 0 or 5 and forces the next value to be 5 or 0. The Up/Down signal signifies the counting direction which comes from the quadrature decoder.

The 10s digits has an Overflow input. When a wrap occurs in the 1's digit, the 10's digit must count to the next value.

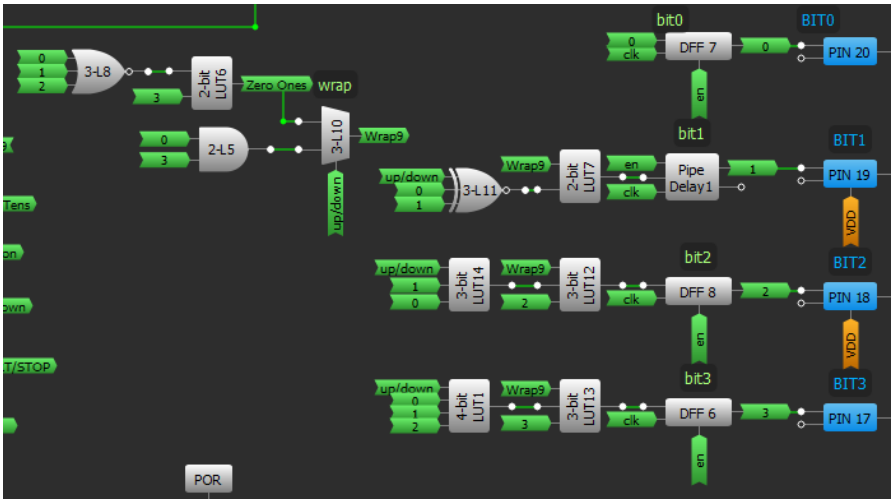

Figure 1. 1s digit counter (Matrix 0)

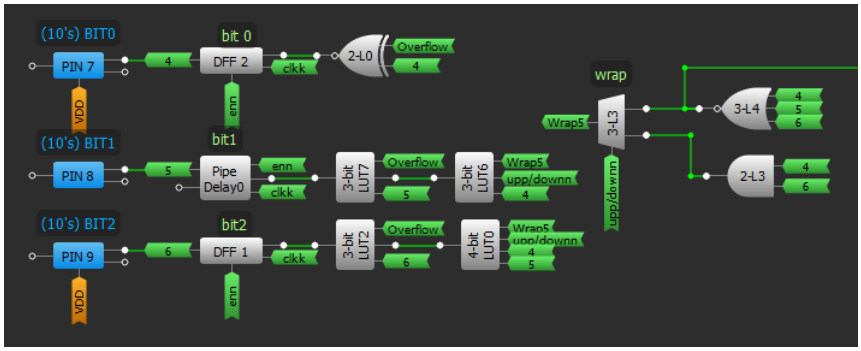

Figure 2. 10s digit counter (Matrix 1)

Quadrature Decoder

The quadrature knob is a 3-pin device where two outputs A and B are pulled up to the supply and the third pin to GND. These two outputs A and B will pulse low sequentially depending on the direction the knob is turning. For clockwise, A will go low first, followed by B and for counter clockwise, B will go low first, followed by A. Based on this information, we can detect what direction the knob is turning.

This design is a variant of AN-1101 Unclocked Quadrature Decoder and includes a deglitch filter to eliminate contact bounce. The decoder outputs a short pulse that occurs at each CW rotation (3-bit LUT1) and either a CW or CCW rotation (3-bit LUT5). A clockwise rotation will cause a 330us one-shot on 'Up/Down' while both a clockwise and counter clockwise rotation will cause a 240us one-shot on 'Clock'. The difference in length allows DFF inputs to settle.

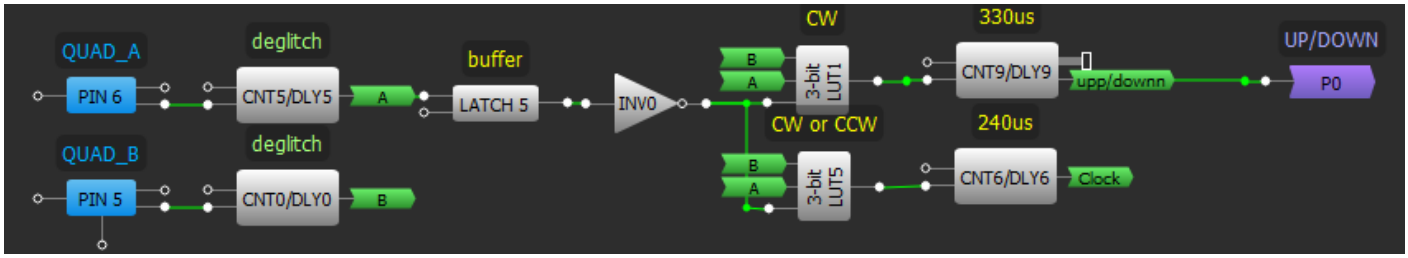

Figure 3. Quadrature Decoder

3-bit LUT1

IN3	IN2	IN1	IN0	OUT
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0

3-bit LUT5

IN3	IN2	IN1	IN0	OUT
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0

Figure 4. CW (3-bit LUT1) and CW or CCW (3-bit LUT5) Properties

Button Logic

The BUTTON PIN#10 input starts, pauses, continues and resets the timer. The device initializes to the Pause state, where the timer can be set. By pressing BUTTON, the state will toggle between Pause and Start. In the Start state, the UP/DOWN signal is forced low and the 1 minute counter CNT2/DLY2 begins. Toggling the Pause/Start DFF can pause and continue the timer.

To reset the timer, hold the button for 2 seconds. A one-shot resets all timer DFFs and resets the state of the device to Pause. See Figures 5 and 6.

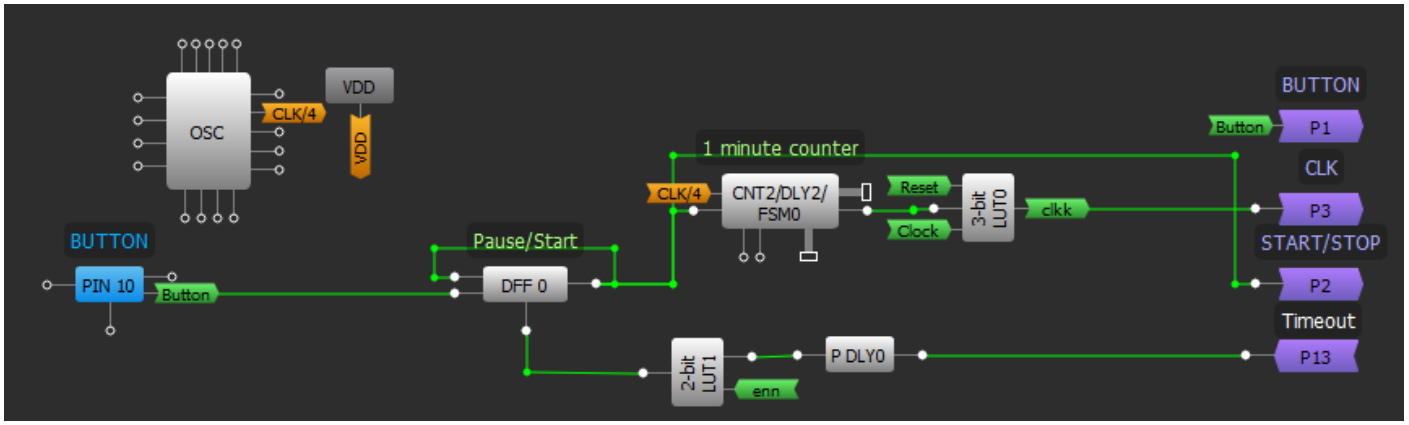

Figure 5. Button and Pause/Start DFF

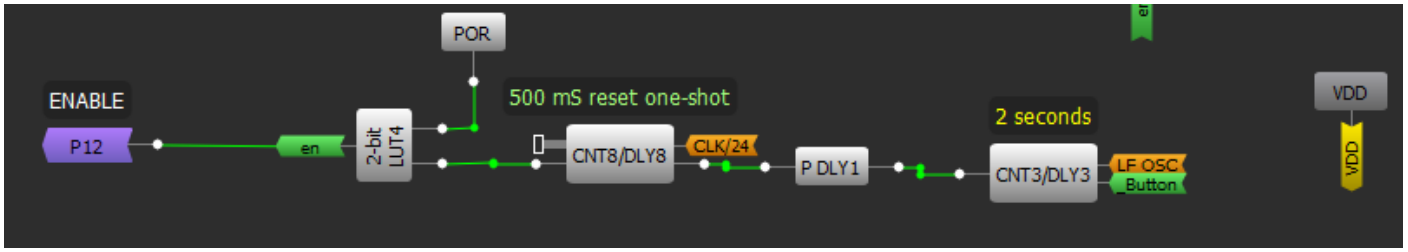

Figure 6. 5 second triggered 500mS Reset One-Shot

Buzzer Timeout

When the timer reaches zero, the device enters a Reset Timeout where the buzzer output is enabled and the counter stops at zero. The Buzzer will buzz once every 3 seconds for 250ms. During the 250ms, the buzzer is driven rail-to-rail at 3.125kHz. After the timeout, the Pause/Start DFF is reset to the Pause state (See Figure 6). Alternately, the user can manually toggle the DFF which will end the Reset Timeout.

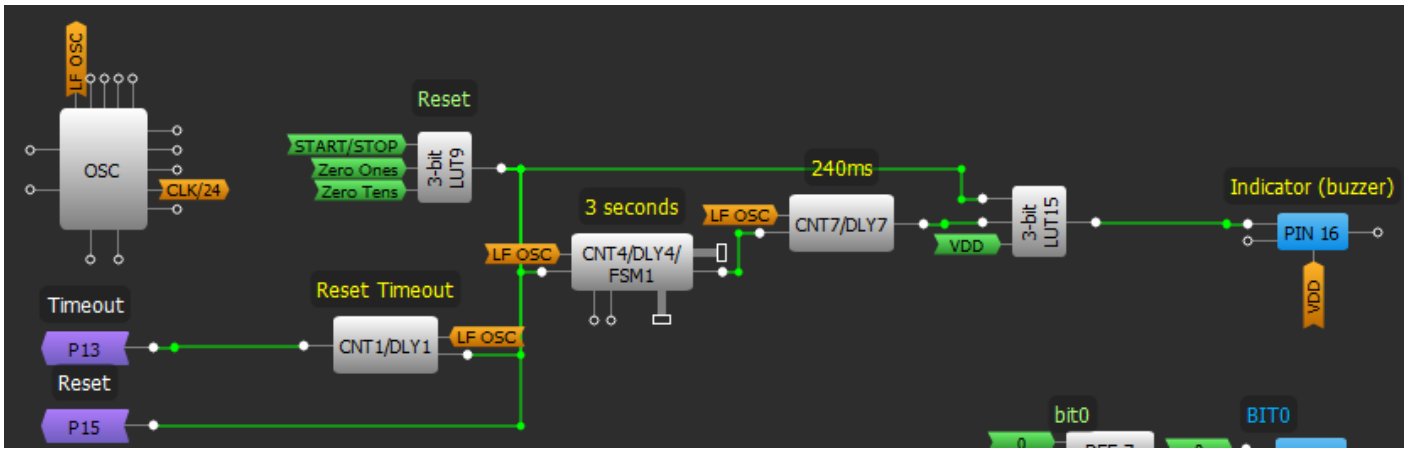

Figure 7. Buzzer and Reset Timeout

Kitchen Timer LED Driver

A second GreenPAK IC contains enough internal circuitry to implement and drive a 2-digit a 7-segment display.

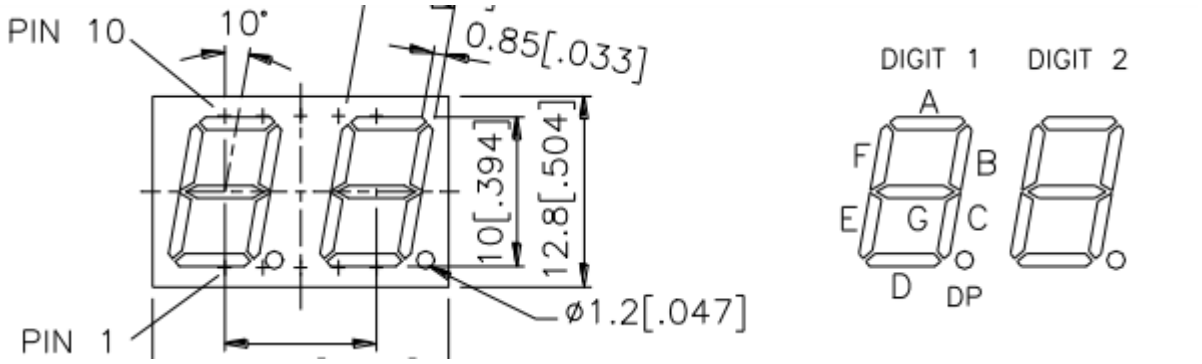

Figure 8. LTD-4708JF display

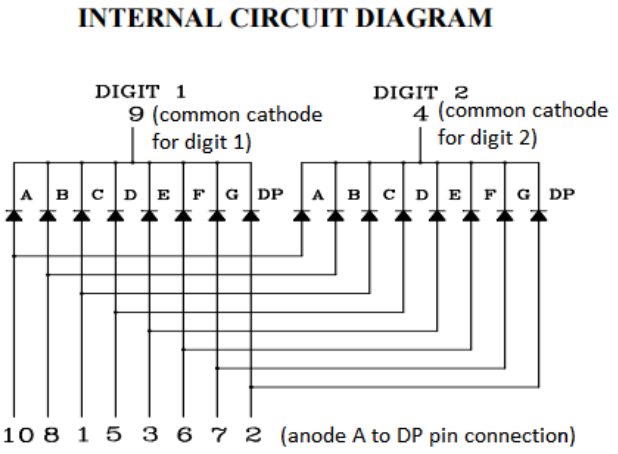

Figure 9. LTD-4708JF Pin Connection

The 7-segment displays with common cathode are connected to the 2-chip, kitchen timer + display driver, GreenPAKs as shown in the figure below.

The timer chip counts to 59 minutes thus Digit 1 can be any from 0 to 5 and digit 2 any of 0 to 9. The display chip will know which outputs (bit or (10's) BIT) is coming to the display inputs based on select pins: output pin 12, connected to pin 4 of the display, and pin 13, connected to pin 9 of display. As shown on Figure 2, for LTD-4708JF display Pin 4/Pin 9 is common cathode for Digit 1/Digit 2, which must be low to activate. The driver activates first one digit than the other with the frequency around 1.02 kHz so an eye cannot see the blinking.

Pin 2/ DP pin of the display is for the dot and it is connected to ground, it is always inactive.

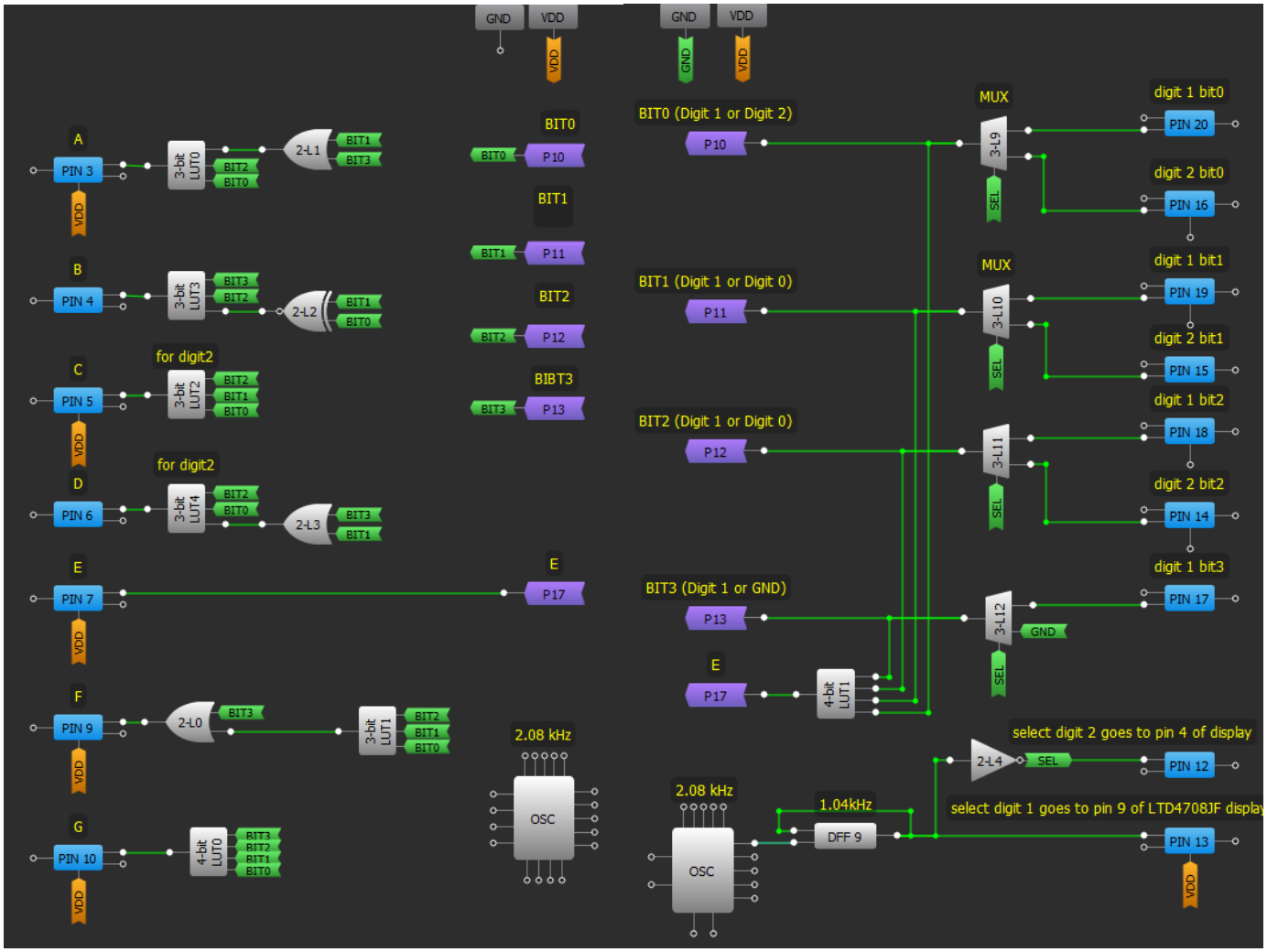

Figure 11. GreenPAK Design

Conclusion

We created a fully functional kitchen timer, with start/pause/reset features, buzzer output and 7-segment driver. The maximum storable value is 59 because we are limited by the number of resettable DFFs. Suggested improvements include adding an indicator LED to represent the different modes, as well as optimizing the design to fit into smaller GreenPAK devices which will lower cost and board space.

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