Keypad and LCD Interface

1) Physical Interface
2) Keypad
3) LCD (Optrex DMC-24227)
4) Design Structure and FSM
5) Design implementation
6) Hints and cautions
1) Establishing the physical interface: wire wrapping

- Materials needed: wire wrap, wire wrap tool, and a little practice.
- Wire wraps available from the IEEE office at 204a Cory. (Next door)
- Pins are given in chkpt1 specification.
- Wire wrap according to diagram on the right.

2) Keypad

- 4x4 keypad, each pin is connected to a specific row or column.
- Remember to connect a pull-down resistor to each output line of the keypad into your design.
- You will need to cycle through each row and check the columns for any button presses.
3) LCD (Optrex DMC-24227)

- Based off Hitachi HD44780 controller chip.
- We will be using 4-bit mode, 5 by 7 dot matrix

![Fig. 1 Write Operation Timing](image)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min.</th>
<th>Max.</th>
<th>Units</th>
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<tr>
<td>Enable Cycle Time</td>
<td>E cyc</td>
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<tr>
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<td>Enable Rise/Fall Time</td>
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<td>Address Hold Time</td>
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<td>Rdh</td>
<td>Fig. 2</td>
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</table>

- The enable pulse can be created using a 490 Hz clock.
- In the 4-bit mode, the control bytes are sent on consecutive enable cycles. The most significant 4 bits (DB[7:4]) are sent first, followed by the remaining 4 bits of the byte (DB[3:0]).
When sending instructions to the LCD, you will need to remember to send the RS, R/W and enable signals along with the databytes.

eg. RS  R/W  DB7  DB6  DB5  DB4
    0    0    0    0    0    0
    0    0    1    0    0    0
this "Display Off" instruction would be implemented on two enable cycles.

[in 8 bit: you would send 00 0000 1000 with enable]
At start up, (after downloading to the Xilinx chip) the LCD must be initialized before displaying anything.
Remember to clear line whenever you give it a new input.
You can ground R/W since we are not reading from the LCD in this checkpoint.

5) Design Implementation

- **Clock Divider**: a counter can divide clocks by multiples of two.
- Make sure you use BUFG before sending the clock out.
**IPADS & OPADS:**

- Make sure there is always a BUF corresponding to the type of PAD connected.
- Avoid the use of copy and paste in your schematics, ESPECIALLY IPADs and OPADs.

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**6) Hints and Cautions**

- Really sit down and plan your FSM before doing anything in Xilinx. Write it down, draw state diagrams... etc - understand what’s suppose to happen.
- Minimize as much as possible.
- Look at error messages.
- The oscilloscope is your friend!
- Use a potentiometer for the LCD power (if there’s nothing on the screen, give the potentiometer a tweak).