ENEL 384
LAB PROJECT - 07/12/2020
SHIFT REGISTERS

University of Regina | Faculty of Engineering and Applied Science

OBJECTIVES

Theory

- Exploring shift registers
- Enabling 7-segment displays with a 74HC164

Practical

- To explore the design & operation of a 74HC164 8 bit serial-in, parallel-out shift register.
- To investigate use cases with a 7-segment display
    - Building a loading screen & other unique symbols.

SAFETY

- As always, students must complete their Risk Assessment and Mitiattn ntrateiy (RAMn) table as part of the Notebook entry for the lab.

Equipment

- Digilent Analog Discovery 2 OR Analog Devices ADALM2000
- Solder-less Breadboard with power supply and wiring kit
- 74HC164 8 bit serial-in, parallel-out shift register
- A common cathode seven segment LED display, other components as required
- 2x270 Ohm Isolated SIP

BACKGROUND

74HC164

- The 74HC164 is an 8-bit shift register which features AND-gated serial inputs. When a clock (CLK) is enabled, input may be pushed into the chip. For every clock pulse, a new value is pushed as we steadily propagate our outputs: QA - QH. Our input is handled by ports A & B - which is our serial input. If either is low, input pushed will be low. As a reminder, we only push when our clock is high. ‘CLR resets the output when given low input. For more information, below is an included datasheet.
- **https://www.alldatasheet.com/datasheet-pdf/pdf/27898/TI/SN74HC164N.html**

- Here is a valuable function table

Inputs				Outputs			
‘CLR	CLK	A	B	QA	QB	...	QH
L	X	X	X	L	L		L
H	L	X	X	QA0	AB0		QH0
H	^	H	H	H	QAN		QGN
H	^	L	X	L	QAN		QGN
H	^	X	L	L	QAN		QGN

7 segment display

- Please refer to Chapter 6 & Lab 6 for a detailed explanation of seven segment displays. The used today consists of 9 pins. However, we will only be using 6 & a 7th to ground. This is a Common Cathode device. An appropriate current limiting resistor must be used in series with each LED to prevent overcurrent damage to the segments. We will be using 270 Ohms. A datasheet is provided on URCourses.

PROCEDURE:

1) Analog Discovery 2/ADALM2000/Breadboard:

a) Following the given schematic, rebuild the circuit. It should be similar to the circuit presented in the prelab
b) After following the given schematic, 6 inputs from our chip should provide input to our 7-segment display. In this lab, we should only care about A-E.
c) Connect the USB test module to our breadboard as instructed in the Prelab/schematic. These should only be DIO0, DIO1, DIO2
d) Verify that the USB test module & power supply have been properly connected.
e) Next, open our USB test equipment application. Included in this lab is a Scopy.ini file, which should prepare pattern generator with A0, A1 & A2.
f) Confirm that A0 is running a number pattern of 1, A1 is running a clock pattern of 1hz, & A2 is running a clock pattern of 10hz. For reference, A0 & A1 consist of our A & B inputs. A2 is our clock.
g) For now, our reset will be wired manually to our 3.3v connection.
h) Power on the power supply.
i) Run our pattern generator.
j) You should see that our 7-segment display runs a circular clock-wise lap. Please verify that this is the case.

2) Observations:

- By now, you should know that the 74HC164 pushes values along a register. Once full, it discards the earliest pushed value. In this case, what are we doing to get the display as it is?
    - Play with the frequency of our clock. This might help visualise what exactly we're pushing. Similarly to a game of snake, the led dies once it touches the originating LED. So, 5 LEDs are lit & 5 LEDs are then turned off before another loop. How are we doing this with SCOPY? Refer to the function table & datasheet.
- Since we are working with a 7 segment display, what applications might a 74HC164 be used for? Looking back at Lab 6 & 7, what are we replacing - what can we do that previous chips cannot? Recall that previous labs used a display to count from 0 to 9.
- Modify the pattern generator. Can you create other animations? Can you improve the existing loop? Write 3 of your favorite combonations, so we can see what you observed.
- Consider experimenting with the DP and G inputs, which would be G & H from our chip.

3) Optional Investigations. Further Exploration:

- How could we implement a latch to delay our output result? As it stands, we need to push each individual value before forming a symbol. Can a latch fix this?
- Can we encode our own symbols with a nucleo 64 board or arduino? For instance, if I wanted my display to show a player's score for a popular whack-a-mole game.
- Build a reset button/switch. How does this improve our circuit when we need to reset or try again?

ANALYSIS:

1) Analog Discovery 2/ADALM2000/Breadboard:

- Students should be able to visualize the information being pushed to our chip & therefore 7 segment display. They should understand how the chip works by observing the datasheet, DIO, DIO2, DIO3 inputs, & associated outputs.

2) Observations:

- Students should:
    - explain the current input & how the chip/display works to create this.
    - Theorize various use cases. How might we use this?
    - Find 3 unique “animations” they can produce by varying the inputs.
    - Experiment with dp & g to grow their understanding.

3) Optional Investigations. Further Exploration:

- These are not mandatory. However,
    - Students may discuss the utility of latches in tandem with our 74HC164
    - Theorize the applications of arduino connections.

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- Note for TA/Lab proffs - do not include in actual lab document
    - Ideally, an arduino would allow for unique/specific clocks & inputs to generate specific symbols. This could be used to display status codes given a certain condition.

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    - Implement a reset switch.

DELIVERABLES:

1) Analog Discovery 2/ADALM2000/Breadboard::

An operational shift register circuit driving a 7 segment display circuit with inputs being generated from the USB test module.

Lab Notebook Entry

Complete a notebook entry for this lab following the standard format.

Analysis results (answers to questions) should be presented such that the student can reference the information in the future. However, analysis can be in whatever format the student chooses – written notes, bullet point, tables, etc.