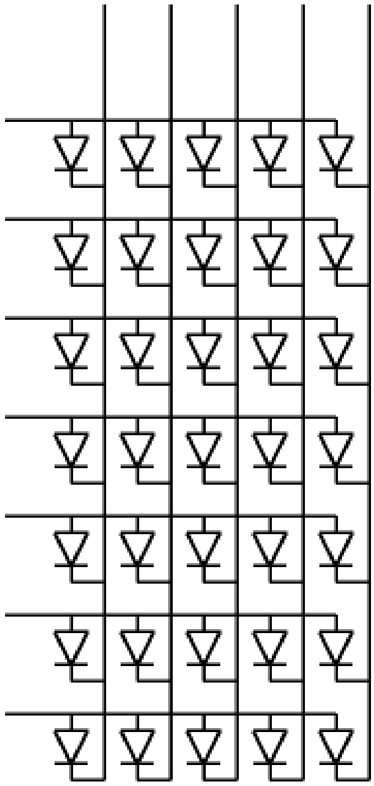
Workshop Four - Framestore for an LED Array

Introduction

This experiment is designed to show the operation of a framestore and introduce the use of a Static Random Access Memory (SRAM).

The design uses the SRAM as a framestore for two 5x7 light emitting diode (LED) arrays. The LED display is made up from individual LEDs which are connected in a grid. Connecting a row (through a current limiting resistor) to the power rail and a column to ground lights the LED where they cross. This means that although each LED can be lit individually, an arbitrary pattern cannot be displayed merely by applying constant voltages to the row and column inputs. Instead, the array must be scanned, preferably at a rate at which the display does not appear to flicker. In this experiment, the pattern to be displayed is to be read from an SRAM.



Components

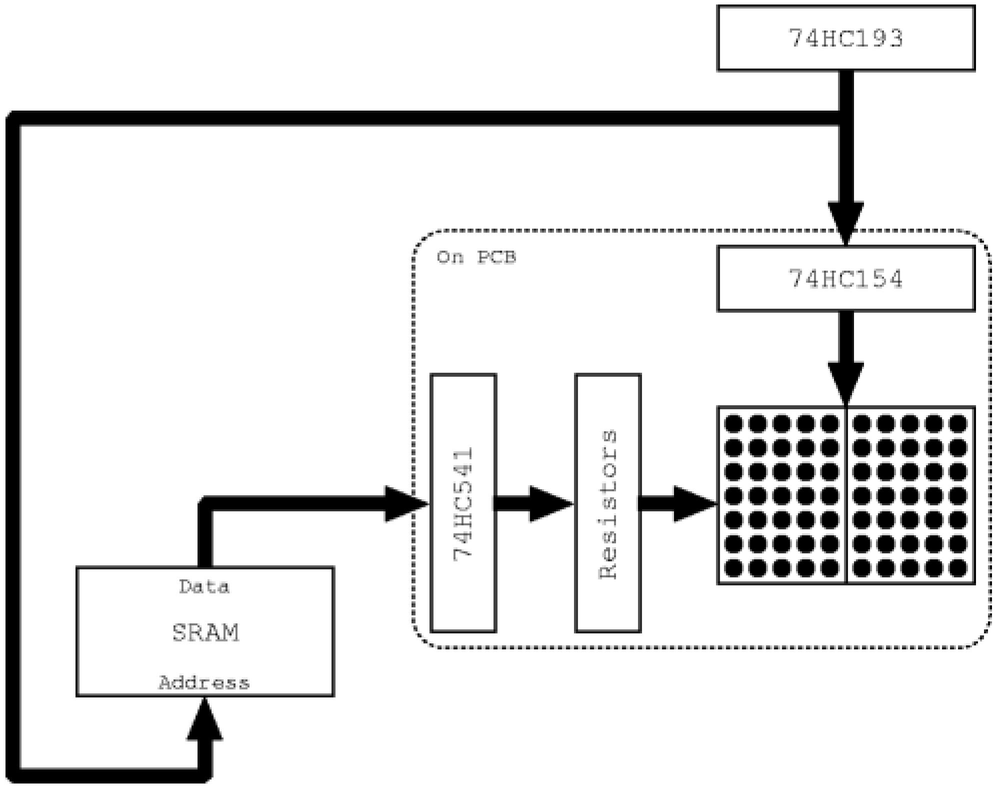
- 1a prototyping box
- connecting wires
- SRAM
- 74HC541 octal tri-state buffer
- 74HC00 quad NAND gates
- 74HC193 4-bit synchronous binary counter
- 74HC74 dual D flip-flop
- Binary-coded rotary switch

Step 1 - Make the LED matrix light up

Task: Use the 74HC193 IC to produce a 4-bit counter. Make sure that the unused input pins are tied appropriately. Use this 4 bit value as the column address for scanning the LED array. Tie the row inputs to logic 1 (the supply voltage).

Step 2 - Connect the SRAM to the LED matrix

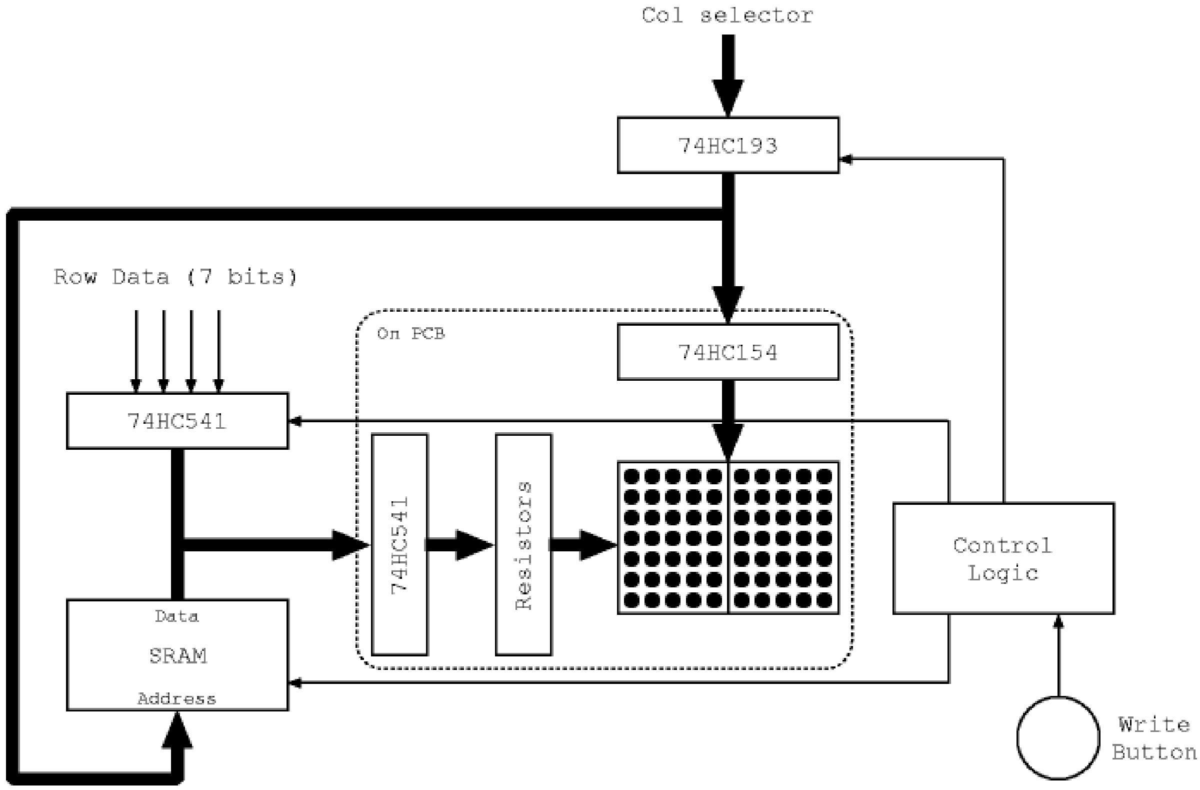
Task: Use the same 4-bit value as the address for the SRAM and connect the data output from the SRAM to the rows of the array, making sure that the CS, OE and WR pins are tied appropriately to fix the chip in read mode. Unused address pins should be connected to ground.



Your circuit should now display the random contents for SRAM on the array. Turn your power supply on and off several times to see if the pattern changes.

Step 3 - Add an SRAM write circuit

Task 1: The next part of this experiment is to add some circuitry to allow values to be written into the SRAM. The complete circuit should look something like this:



Connect the output of the 74HC541 octal buffer to the data bus, and use seven toggle switches as its input. Now connect the column selector (binary coded rotary switch) to the input of the binary counter. When complete, you should be able to write the data from the toggle switches into the SRAM at the address supplied by the column selector. This should only happen when a write button is pressed.

Task 2: Design the control circuit using a 74HC74 and a 74HC00 chip. The behaviour is as follows: as the write button (use the debounced switch) is pressed, the value from the rotary switch should be loaded into the binary counter. The value from the row switches should be driven onto the data bus, and the write pin on the SRAM chip should be pulsed. Inputs to the control circuit will be the clock and the write button. It needs to produce three outputs: an enable signal for the octal buffer, a write pulse for the SRAM and a load signal for the counter. Start by producing a timing diagram showing the clock oscillating and the switch being pressed. Fill in what you want the outputs to do as the switch is pressed and goes high. You might like a demonstrator to check before proceeding to the final design.

Tips:

- The write button should be synchronised with the clock before it is used. This can be done by passing it through a latch.
- The SRAM data bus now has another driver, a 74HC541 octal buffer. Care should be taken to ensure that the SRAM and the buffer do not drive this bus at the same time.
- In order to write into the SRAM, its write pin should be pulsed low. Remember to ensure that the address inputs do not change during the write operation and that the data input must be valid at the end of write operation but do not need to be valid at the start.
- The load of the binary counter is asynchronous. The output value changes immediately, and does not wait for the next rising edge of the clock.

- The column selector needs 4 x 4K7 pull-down resistors on its outputs.

Optional Bonus Step

Implement a "clear display" button which writes zeros into the SRAM.

Assessment

Ticking criteria: Write up your experimental data and final design, and then answer the following questions. Demonstrate that your circuit works correctly: you should be able to specify a column on the LED array with the column selector and the data pattern for that column with the toggle switches. Pressing the write button should make the pattern permanent.

Once your work has met the **Common Ticking Criteria** (see Introduction), get your work ticked by an assessor. Remember that you need to hand in this assessed exercise as part of your portfolio of work (see the Head of Department's notice).

Note: because this workshop is a little tricky, one tick is awarded for completing steps 1 and 2 and question 1, and the other tick for step 3 and question 2.

Questions

1. Each LED in the matrix can draw a maximum current of 5mA. What is the maximum current that the two LED arrays can draw during the operation of the frame store?
2. What would happen if the write button was not synchronised?

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