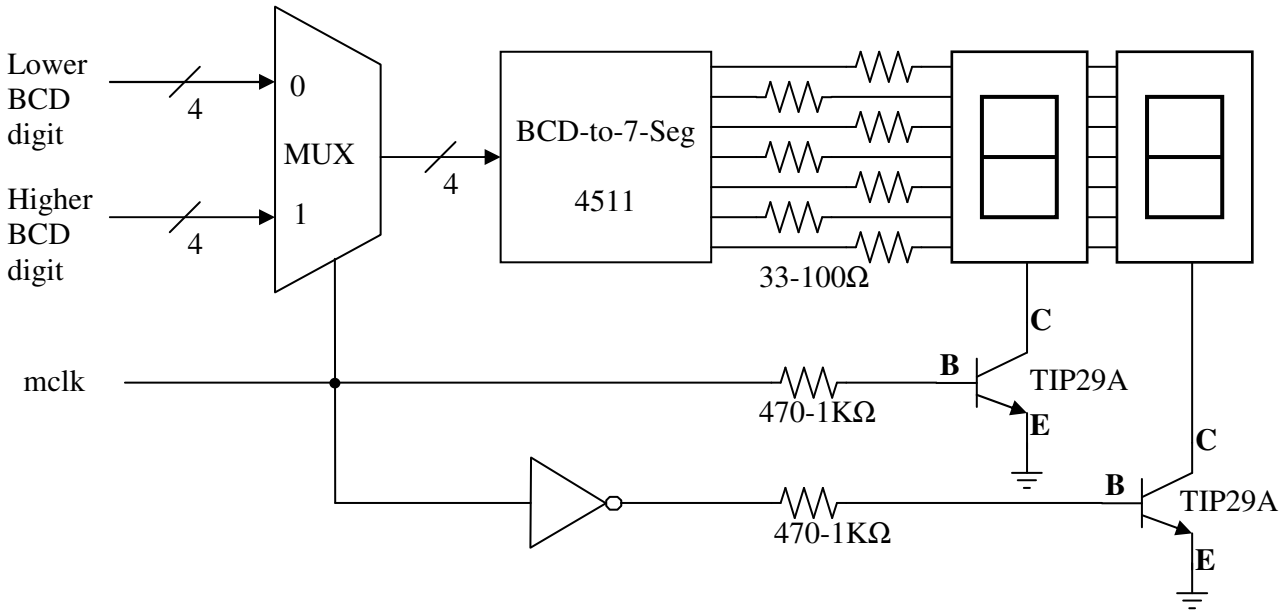
Lab 9 – Application II: Multiplexing Displays ELE202 FALL2007

Objectives
- Learn multiplexing and its use in digital design.
- Learn how to use existing register-level or MSI modules and components.
- Build, and test multiplexing 7-segment displays.

Overview
Multiplexing is a common technique to send multiple information or items through a single media. In digital circuit, multiplexing is to send multiple signals to multiple destinations through a single set of wires. This is accomplished by correctly timed the sequence of which the signals to be sent, and on the receiving end, correctly identify who should received the signal at any given time. In this lab we will send the two BCD digits (from lab 8) to be displayed on two 7-segment displays. Instead of using two dedicated 4511's, we will use only one 4511 in a multiplexing arrangement as shown below. The lower and higher BCD digits as well as mclk are generated from last lab.



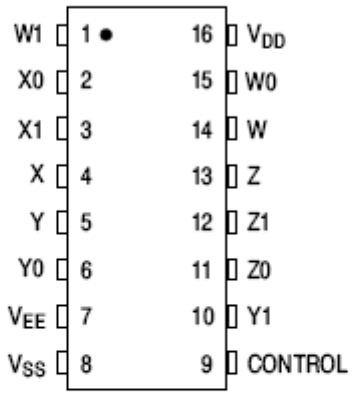
The multiplexer is controlled by the signal mclk. The lower BCD digit is selected when mclk=0. At this time, the TIP29A connected to an inverter is turn-on; effectively turned on the 7-segment display for the lower digit. When mclk=1, the higher BCD digit is selected by the multiplexer and the higher digit 7-segment display is turned on. The result is that the two digits are converted by the same 4511 and displayed in different 7-segment displays in turn. When mclk frequency is high enough, two displays will appear to be on all the time; but in fact only one display is on at any given time. This circuit will consume the power enough to light up only one 7-segment display instead of two. Imaging the saving of such multiplexing technique when you need to use tens or hundreds of LEDs.

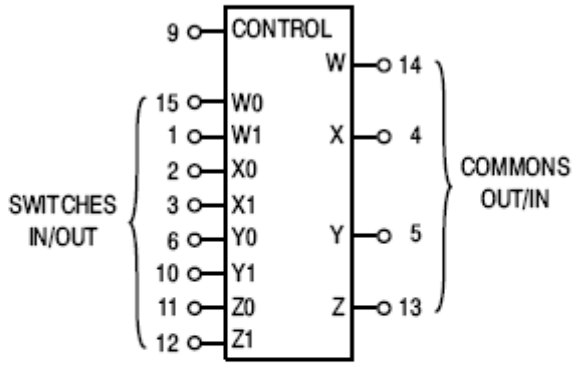
Procedure

Step 1:
The information on the multiplexer, 4551, is shown below as can be found in its datasheet.

MC14551B

PIN ASSIGNMENT





V_{DD} = Pin 16
V_{SS} = Pin 8
V_{EE} = Pin 7

Control	ON
0	W0 X0 Y0 Z0
1	W1 X1 Y1 Z1

NOTE: Control Input referenced to V_{SS}, Analog Inputs and Outputs reference to V_{EE}. V_{EE} must be ≤ V_{SS}.

- This multiplexer was designed to allow passages for both digital and analog signals and therefore an additional power supply terminal, V_{EE}, is added to allow negative voltage swing. Since we are dealing only with digital signals, V_{EE}=V_{SS}=GND and V_{DD}=supply voltage or 9V in our case.
- There are four 2-to-1 multiplexers inside 4511; and all four multiplexers are controlled or selected by one control input (pin 9). In other words, these four multiplexers work in tandem.
- Put the lower BCD digit to the '0' inputs and the higher BCD digit to the '1' inputs. For example:

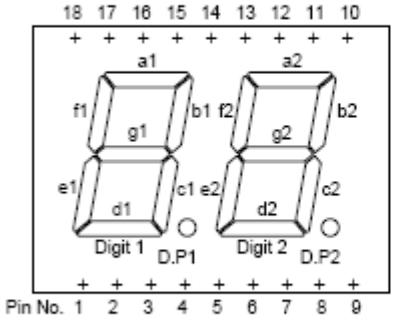
lower BCD digit from 4510	O3	W0
	O2	X0
	O1	Y0
	O0	Z0
higher BCD digit from 4510	O3	W1
	O2	X1
	O1	Y1
	O0	Z1

- Remember, when control=0, we want the multiplexers to select the lower BCD digit.

Step 2:

- Connect the outputs of the multiplexer to the BCD-to-7-segment converter, 4511. Since we have used this circuit in previous lab, you should refer to lab 4 for details.
- We will use the LDD5111-11 common cathode dual 7-segment display for this lab. The pin assignments are shown below. In the multiplexed setting, the same segments from both display are connected to the same 4511 output. For example, segment a of digit 1 (pin 16) and segment a of digit 2 (pin 11) are connected together and to the segment a output of 4511.
- The digit1 is to display the higher BCD digit and digit 2 is for the lower BCD digit. The commons (pins 13 and 14) are to be connected to the transistors in the next step.
- To complete the display, you should also make connection (via resistor) so DP1 is always on.

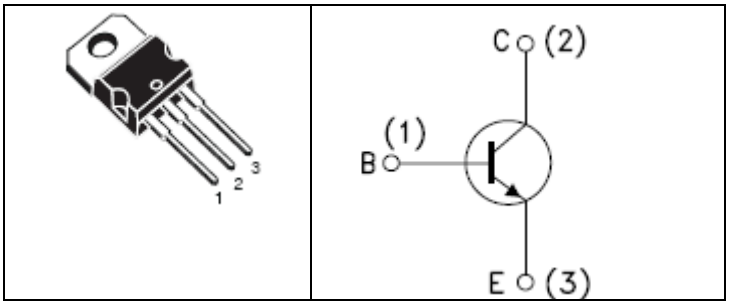
●Pin assignments



Pin No.	Function	Pin No.	Function
1	Segment "e1"	10	Segment "b2"
2	Segment "d1"	11	Segment "a2"
3	Segment "c1"	12	Segment "f2"
4	D.P1	13	Digit 2 Common
5	Segment "e2"	14	Digit 1 Common
6	Segment "d2"	15	Segment "b1"
7	Segment "g2"	16	Segment "a1"
8	Segment "c2"	17	Segment "g1"
9	D.P2	18	Segment "f1"

Step 3:

- We are using two NPN bipolar transistors (TIP29A) for multiplexing the display. These two transistors will act as solid-state switches to be turned on and off by the digital signal mclk.



Step 4:

- Once the circuit is completed, you should connect "mclk" signal to one of the 4520's output. Remember that 4520 will provide us with frequencies ranging from 1280Hz to 10Hz. When you use a low frequency signal for "mclk", you will see the two displays light up in turn. When you use the high frequency signal for "mclk", both displays will appear to be on all the time. In reality, this is an illusion created by turn on the display in turn very rapidly. NOTE: the display will not be as bright.

ELE202 Report Requirement
Lab 9 – Multiplexing Displays

This is a full report submission:

- The report begins with a cover page. It should include the title of the lab, your name, your lab section, and the date the lab was submitted.
- Next, write a short abstract to summarize the lab – this should be 3 sentences or less.
- The main body of your report should include:
    1. The overall block diagram with rectangle boxes indicating counters, etc., at a higher abstractive view No detail connection is shown in this diagram. Do not draw an IC wiring diagram!
    2. Detail schematic of circuits in the lab.
- The last part of your report is a summary of:
    1. The obstacles and observations of the lab. Mention anything you do differently from what were described in this manual.
    2. Lesson learned.