Digital Fundamental's Lab Notebook

MICHAEL ROEBACK

FALL 2014

EECT112

IVYTECH NORTHEAST

Lab 1: AND / OR Gates

Objective: Design, Simulate, and Build an AND/OR Gate circuit that will light 2 LEDs (one off of the AND Gate, the other off of the OR Gate).

Equipment used @ Station # 7

- NI Elvis II Breadboard: Serial # 1677D3B
- GW INSTEK GDM-8245 DiMM : Serial # CL860237

Parts Used:

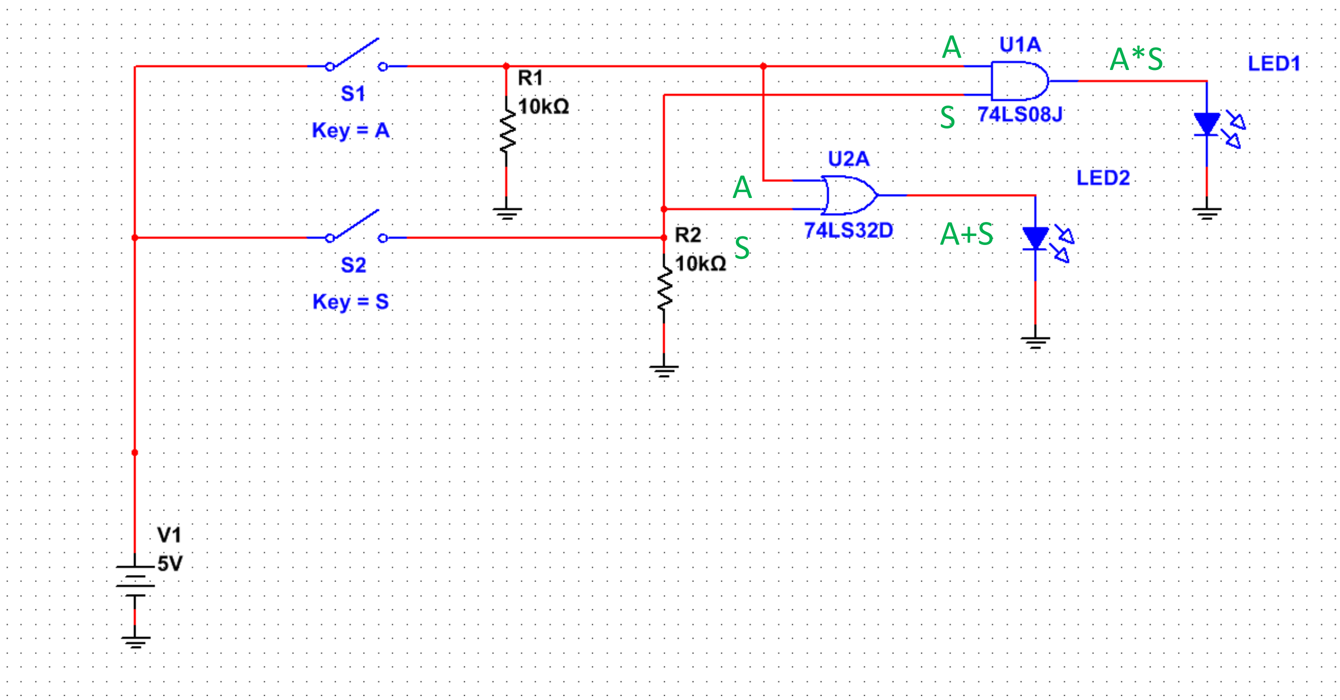
- 74LS08P AND Gate, 74LS32P OR Gate, 8 Pin Dipswitch,
- Various Wires, and 2 10K Resistors (later changed to 1K).

Personal Used: (Team Big Boys)

- David Rogers
- Michael Roeback

Date Assigned: September 12, 2014 **Date Completed:** September 12, 2014

Lab 1: Multisim 13 Simulation



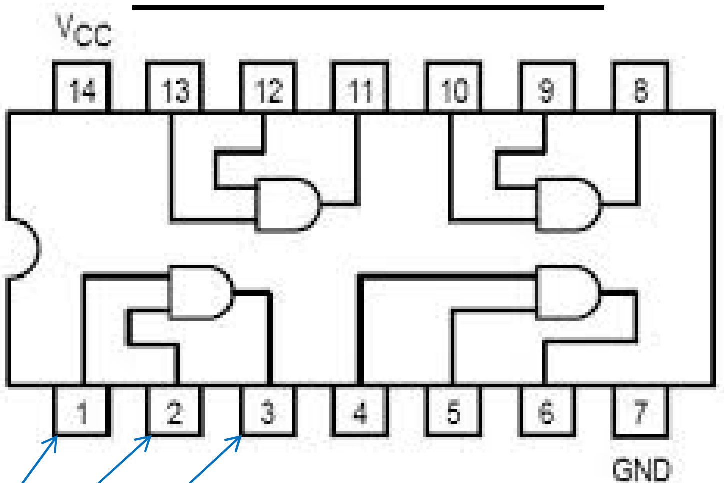
Lab 1: Pre-Building Specifications

		Input V Open	Output V Open	Output V Closed
Power Source 5V(DC):	4.96V			
Resistor 1 (10KΩ):	9.694KΩ	1.14V		
Resistor 2 (10KΩ):	9.735KΩ	1.13V		
Resistor 1 (1KΩ):	0.977KΩ	0.32V	0.05V	3.30V
Resistor 2 (1KΩ):	0.982KΩ	0.32V	0.15V	3.24V

*We ended up having to use 1K resistors due to the Input Voltages on the 10K resistors not falling below 0.8V to signal "low".

Lab 1: Chip Diagrams

74LS08P AND Gate

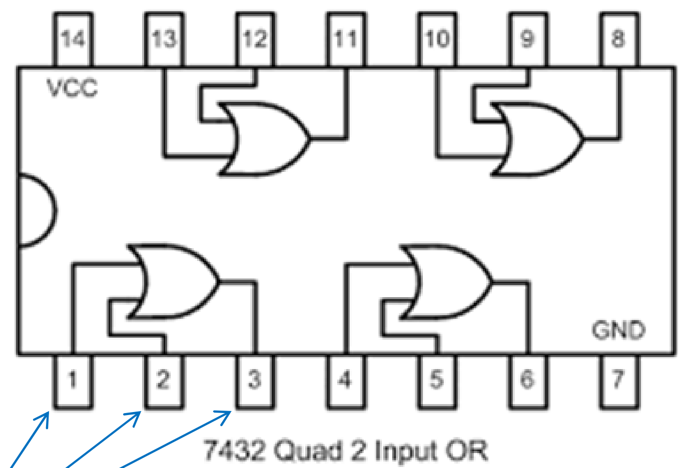


Input “X”

Input “Y”

Output “Z”

74LS32P OR Gate

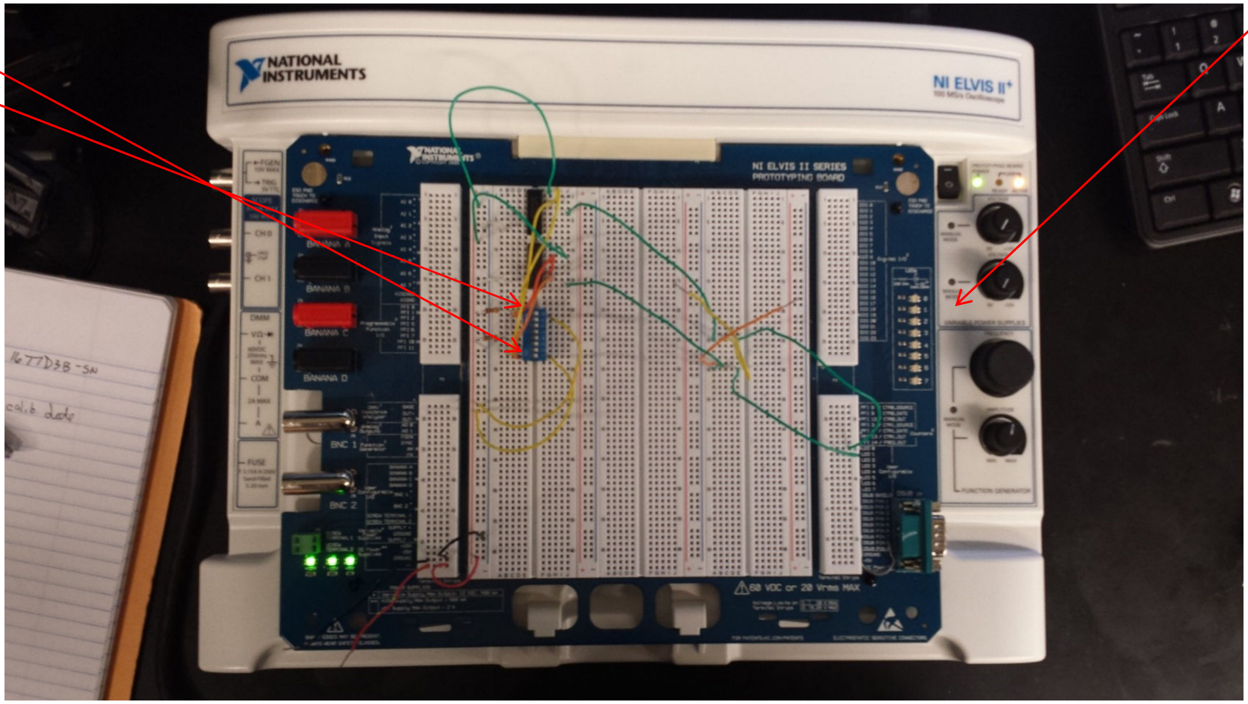


Same as AND Gate

Lab 1: Circuit Built on Elvis II: A = 0, B = 0

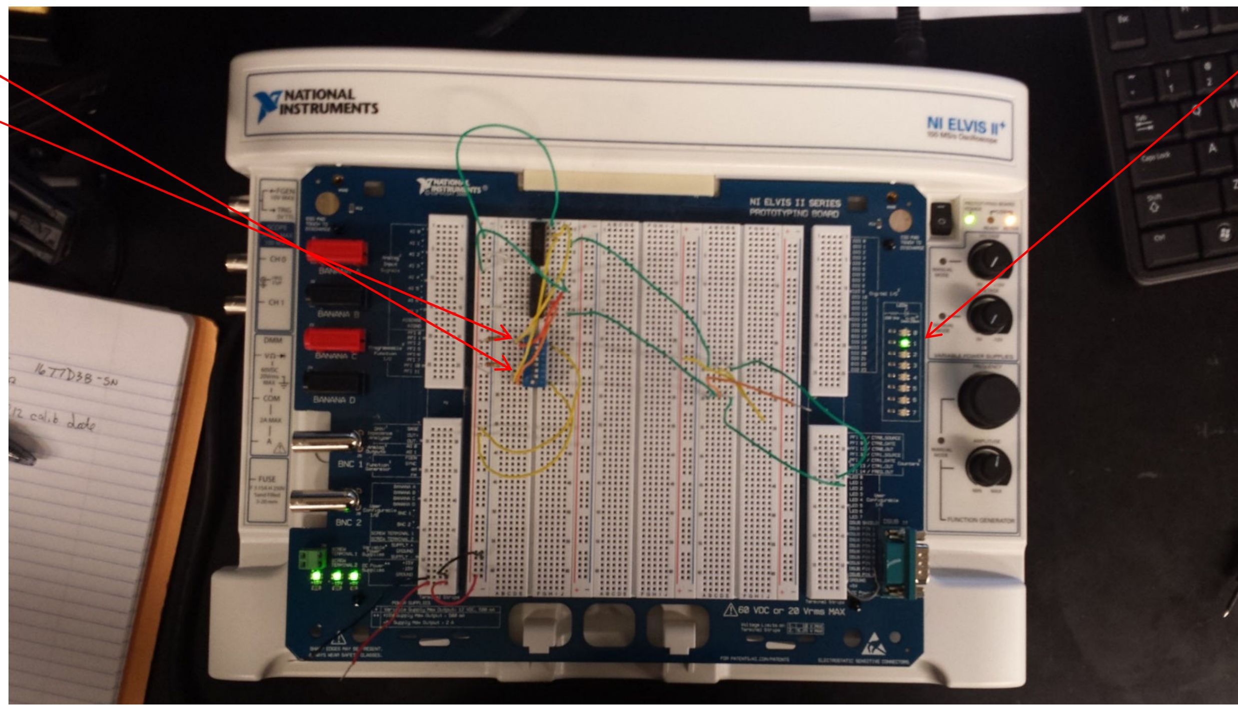
*Switch 1 = A
*Switch 8 = B

No LED's lit.



Lab 1: Circuit Built on Elvis II: A = 1, B = 0

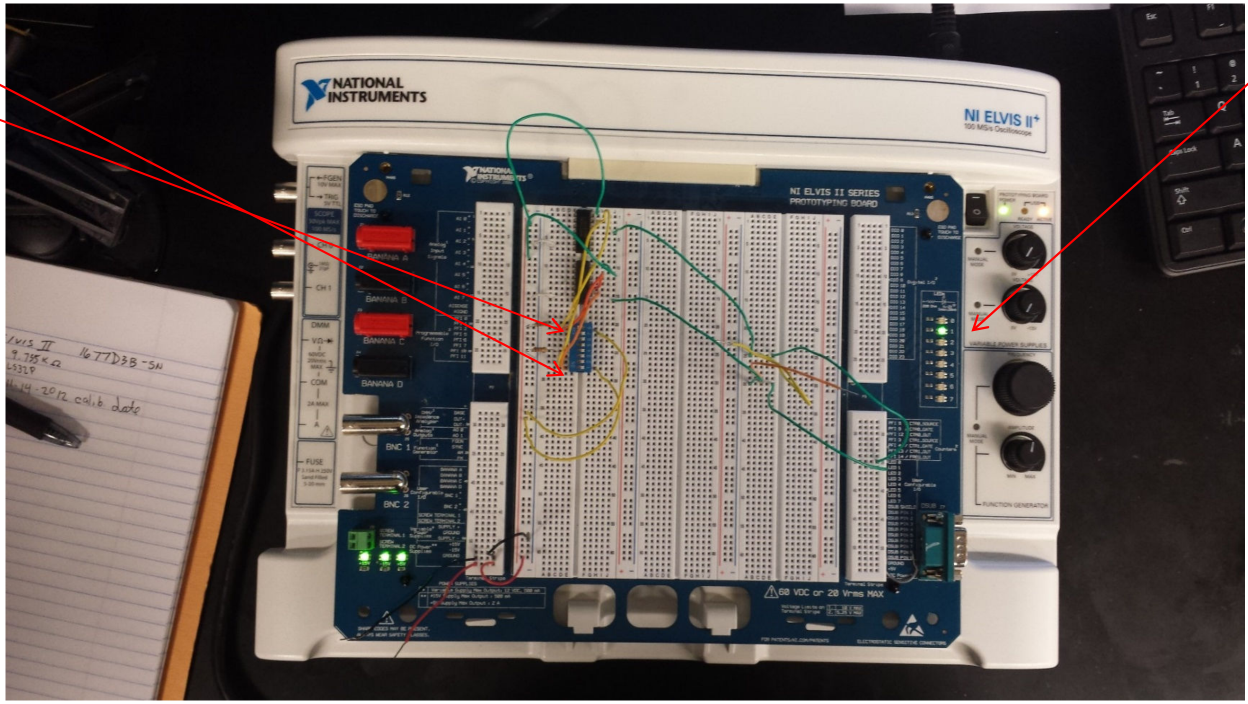
*Switch 1 = A
*Switch 8 = B



Only LED for OR Gate lit.

Lab 1: Circuit Built on Elvis II: A = 0, B = 1

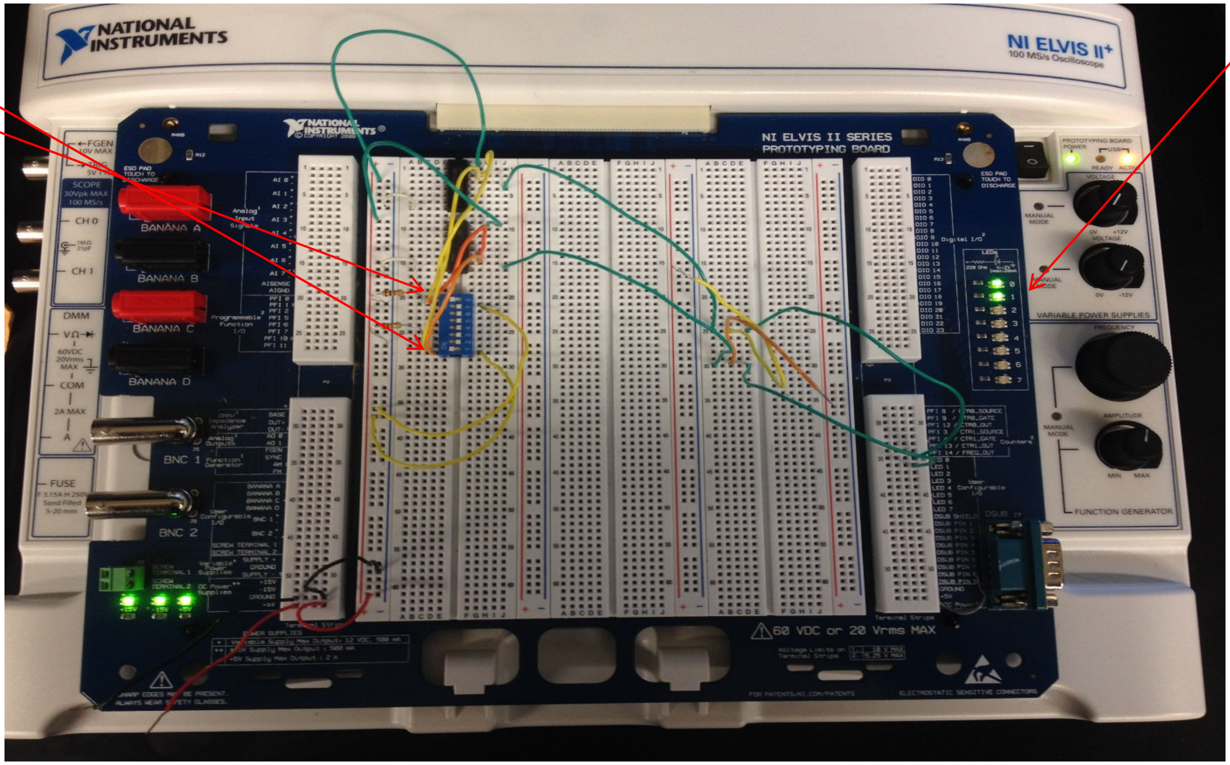
*Switch 1 = A
*Switch 8 = B



Only LED for OR Gate lit.

Lab 1: Circuit Built on Elvis II: A = 1, B = 1

*Switch 1 = A
*Switch 8 = B



Both LEDs for AND Gate and OR Gate lit.

Lab 1: AND / OR Gates

Conclusion: Thought the circuits worked fine in simulation, We ended up having to use 1K resistors in place of the 10k resistors due to the Input Voltages not falling below 0.8V to signal "low". This problem was identified during our early stages of testing the circuits in the laboratory.

Additional Notes: Future circuit builds will consist of 10k resistors in simulation and laboratory prototypes. These will be installed on the power side of circuit and switches will be wired directly to ground as voltage pull downs. This should eliminate the issue we experienced while using the 10k resistors as terminators and the switches for power.

Lab 2: Alternative Gate System:

Objective:

Revise a logic system that contains three separate chips (including 74LS04D Hex Inverter chip, 74LS32D OR Gate chip, and 74LS08D AND Gate chip), into a similar logic system using less chips to save power, space and cost.

Team members assigned with task:

- David Rogers
- Mike Roeback

Date Assigned: September 26, 2014

Date Completed: October 3, 2014

Lab 2: Calculations, Using Logic to Build Logic

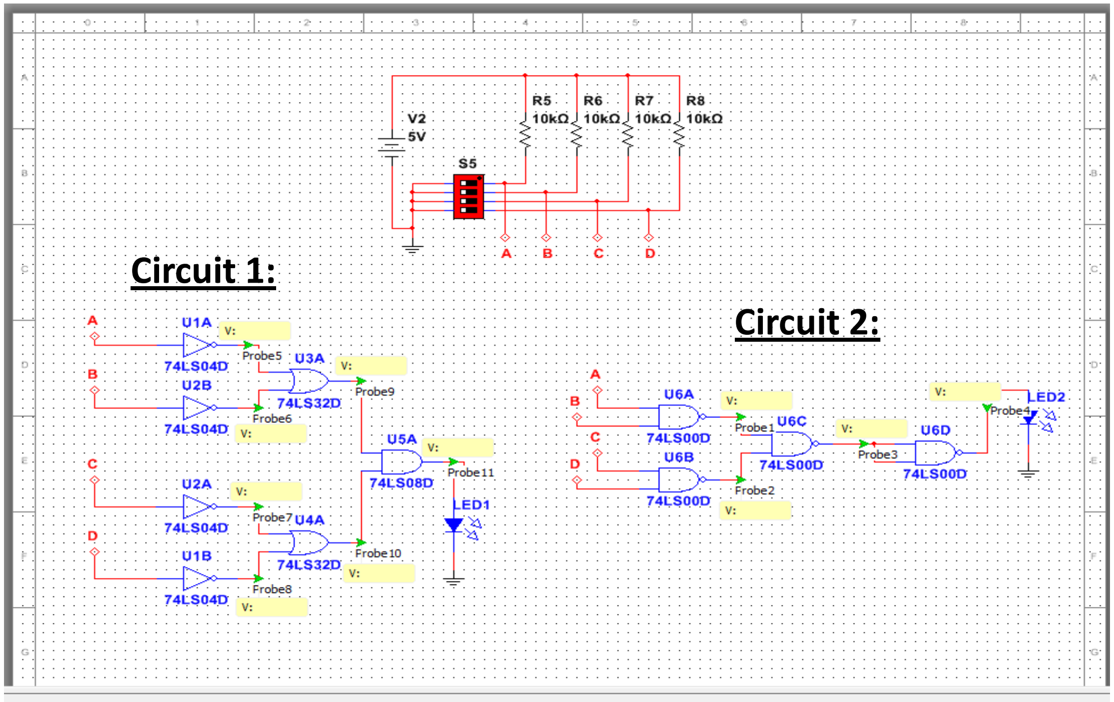
By using the knowledge that:

- Inverting the inputs and outputs of an OR Gate gives it the same function as a NAND Gate and,
- Connecting the inputs of a NAND Gate together gives it the same function as an Inversion Gate

We can convert the existing logic from (A’+B’)(C’+D’) to ((A’+B’)(C’+D’))’’ which equates to an equivalent Gate.

Ready for simulation

Lab 2: Multisim Circuit:



Lab 2: Simulation Testing

Both, the original and new equivalent, circuits were built in Multisim.

Testing within the simulation environment proved the calculations were correct.

Ready for laboratory prototype build and testing.

Lab 2: Universal NAND Gates:

Materials used:

- NI Elvis II Breadboard (SN: 1677D3B).
- 4 - 10KΩ Resistors
- 1 – AND Gate (74LS08D), 1 – NAND Gate (74LS00D), 1 – OR Gate (74LS32D), 1 – Inverter Gate (74LS04D), 1 – 8 Pin Dipswitch.
- DMM – GW Instek GDM – 8245 (SN: L860237).
- Various Wires

Lab 2: Universal NAND Gates:

Pre – Building Specifications:

		Switch , Label
Power Source 5V(DC):	4.97V	
Resistor 1 (10KΩ):	9.770KΩ	1 , "A"
Resistor 2 (10KΩ):	9.753KΩ	3 , "B"
Resistor 3 (10KΩ):	9.746KΩ	5 , "C"
Resistor 4 (10KΩ):	9.756KΩ	7 , "D"

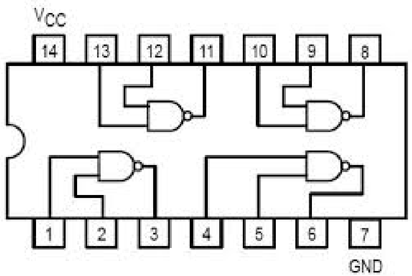
Post Build High/Low Measurements*:

		"High" with LED	"Low" with LED
Circuit 1 =	Not OR/AND Gates	3.23 V	.13 V
Circuit 2 =	NAND Gate	3.27 V	.13 V
		"High" w/o LED	"Low" w/o LED
Circuit 1 =	Not OR/AND Gates	4.41 V	.13 V
Circuit 2 =	NAND Gate	4.45 V	.13 V

*As shown with the resulting output voltages, the new NAND Gate equivalent circuit is more efficient.

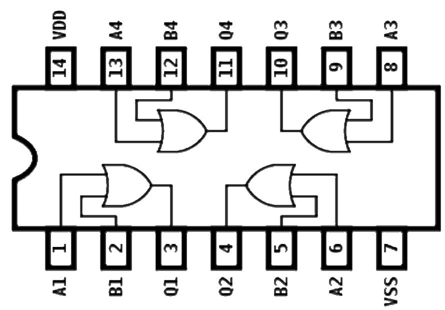
Lab 2: Universal NAND Gates:

<u>Circuit 2:</u>

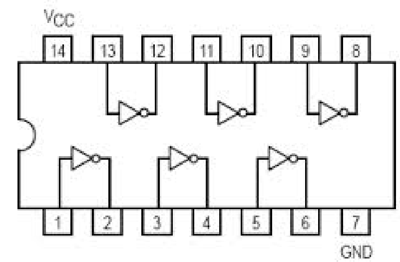


74LS00D – NAND Gate:

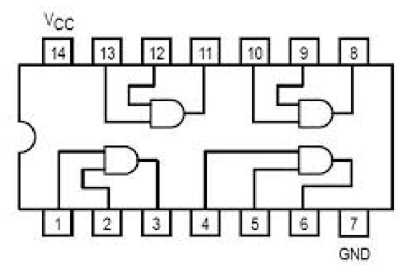
<u>Circuit 1:</u>



74LS32D – OR Gate

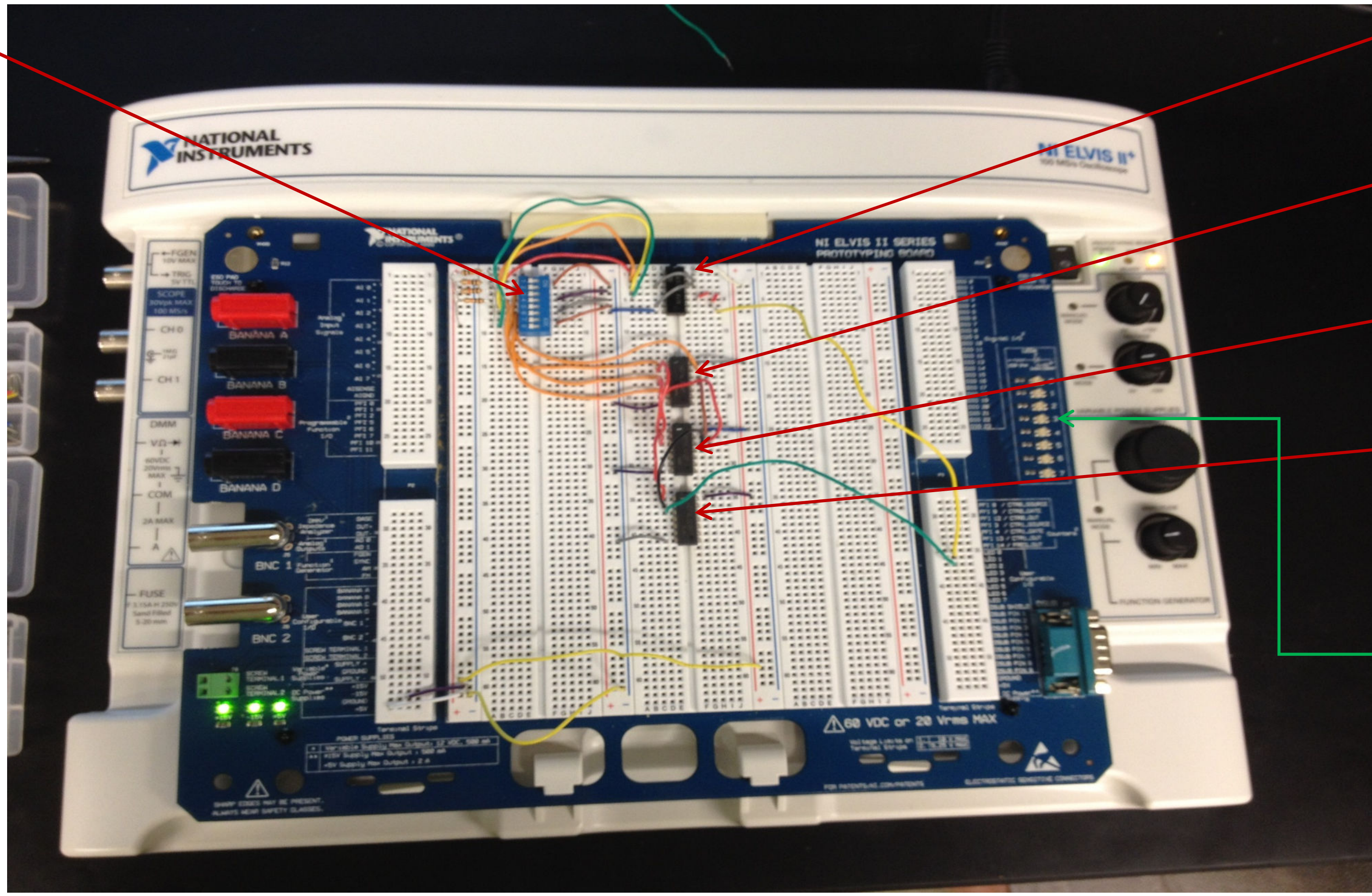


74LS04D – Hex Inverter Gate



74LS08D – AND Gate

Lab 2: Universal NAND Gates:



8 Pin Dipswitch

NAND Gate

Hex Inverter Gate

OR Gate

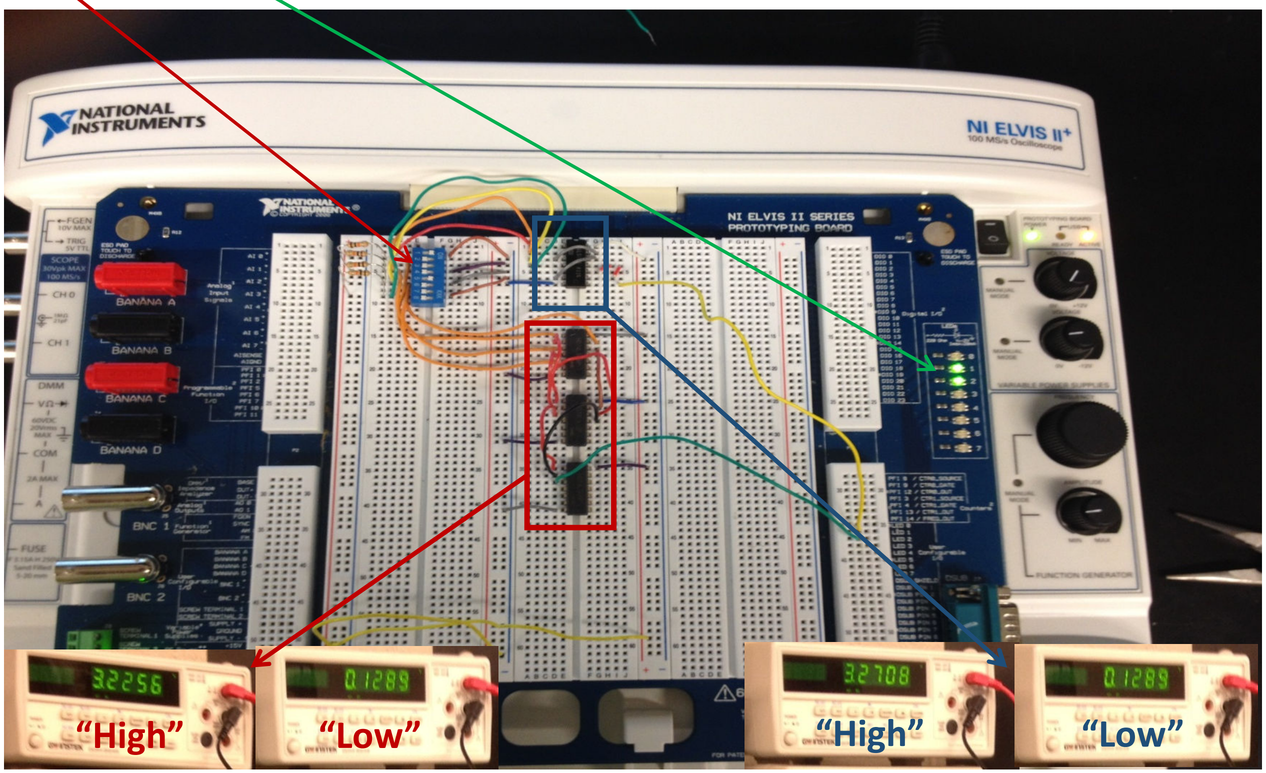
AND Gate

*LED's – Not lit because all switches closed. A,B,C,D = 0

Lab 2: Universal NAND Gates:

Measurements with LED's.

A,C = 1. Both LED's lit. (All other "High" and "Low" combos rounded to same).



Circuit 1

Circuit 2

Measurements w/o LED's

Circuit 1

"High"

"Low"

Circuit 2

"High"

"Low"

Lab 2: Universal NAND Gates:

Conclusion:

Throughout this lab, it has been demonstrated how universal NAND Gates are. The ability of using only one chip saves space, energy and money.

Additional Observations:

We did notice that the "high" output voltages were significantly lower with the LED's attached (3.27V & 3.23V), compared to not having the LED's attached (4.45V & 4.41V). We believe this was caused by a voltage drop across the LED's.

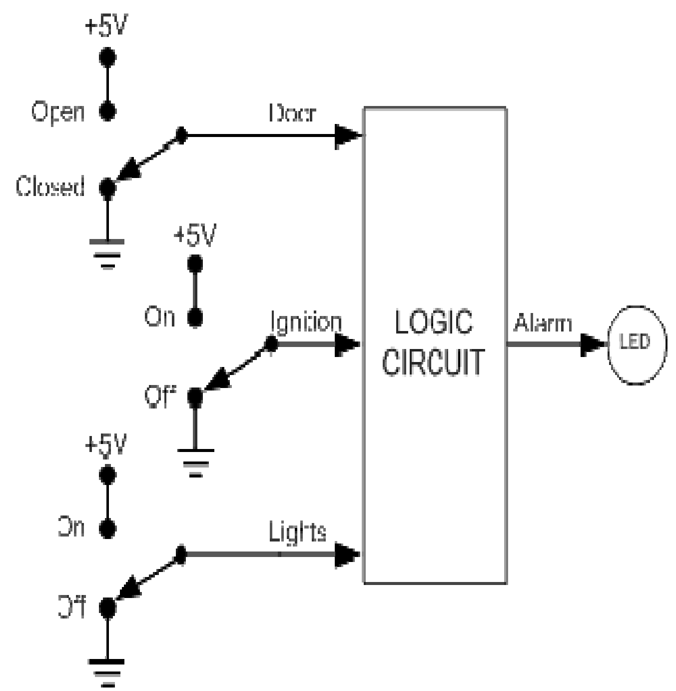
Lab 3: Midterm Exam Problem 13 Part A

Objective:

To the right is a diagram for an automobile alarm circuit used to detect certain undesirable conditions. The three switches are used to indicate the status of the door by the driver's seat (D), the ignition (I), and the headlights (L).

Design the logic circuit with these three switches as inputs so that the alarm will be activated whenever either of the following conditions exists. Start with a truth table, find the Boolean equation, simplify, then prove using Multisim.

i. The headlights are on while the ignition is off.
ii. The door is open while the ignition is on.



Personal Used:

- Michael Roeback

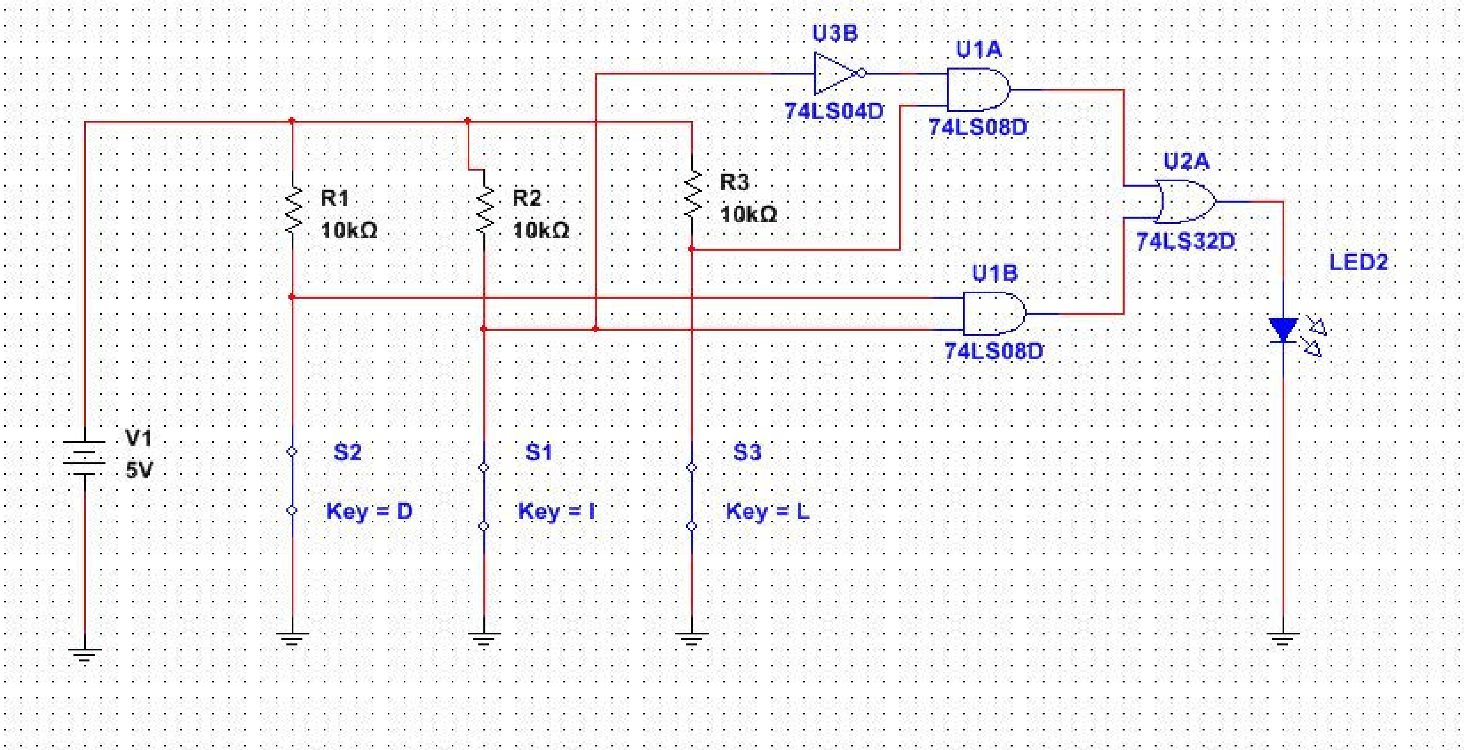
Date Assigned: October 17, 2014 **Date Completed:** October 17, 2014

Lab 3: Truth Table & Boolean Calculations

Midterm_Lab_Truth_Table				
D=A	I=B	L=C	AL=X	Products
D	I	L	AL	
0	0	0	0	
0	0	1	1	D'I'L
0	1	0	0	
0	1	1	0	
1	0	0	0	
1	0	1	1	DI'L
1	1	0	1	DIL'
1	1	1	1	DIL

Factoring the Sum of the Products
(D'I'L)+(DI'L)+(DIL')+(DIL)
I'L(D'+D)+DI(L'+L)
I'L(1)+DI(1)
AL=(I'L)+(DI) or (B'C)+(AB)=X

Lab 3: Simulation Build (Multisim)



Lab 3: Midterm Exam Problem 13 Part B

Finally, build the circuit in the lab using the NI Elvis Protoboard and demonstrate compliance with your truth table and Multisim results. Take pictures for your digital portfolio. <u>Turn in with this exam</u> (1) a printout of your Multisim circuit, (2) a truth table hand drawn or from Excel, and (3) your final Boolean expression used for Multisim.

Lab 3: Midterm Assignment:

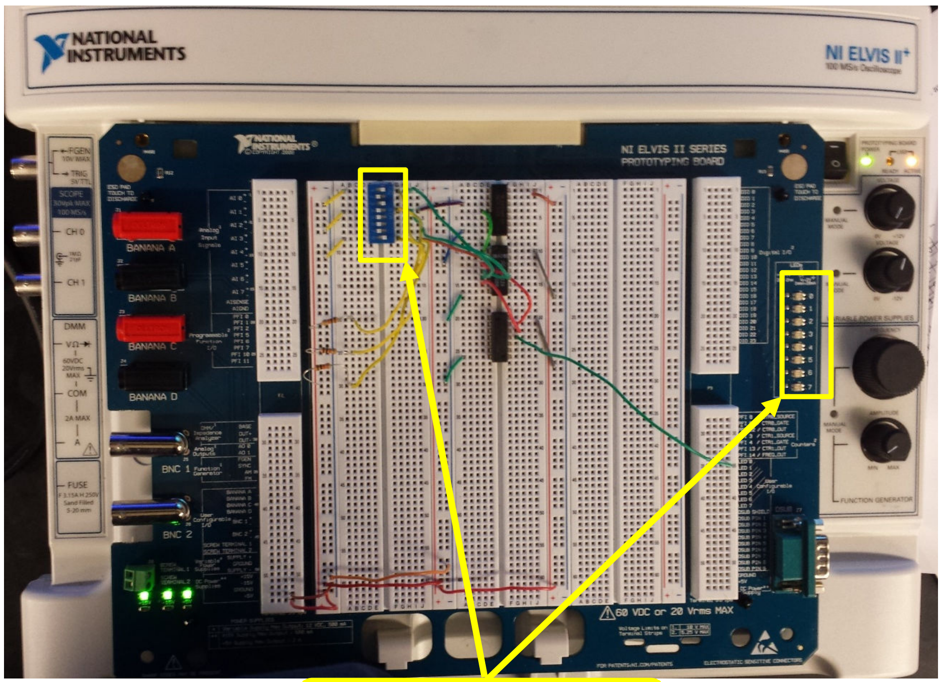
Materials used:

- NI Elvis II Breadboard (SN: 1677D1).
- 4 - 10KΩ Resistors
- 1 – AND Gate (74LS08D), 1 – NAND Gate (74LS00D), 1 – OR Gate (74LS32D), 1 – Inverter Gate (74LS04D), 1 – 8 Pin Dipswitch.
- DMM – GW Instek GDM – 8245 (SN: CL860332).
- Various Wires

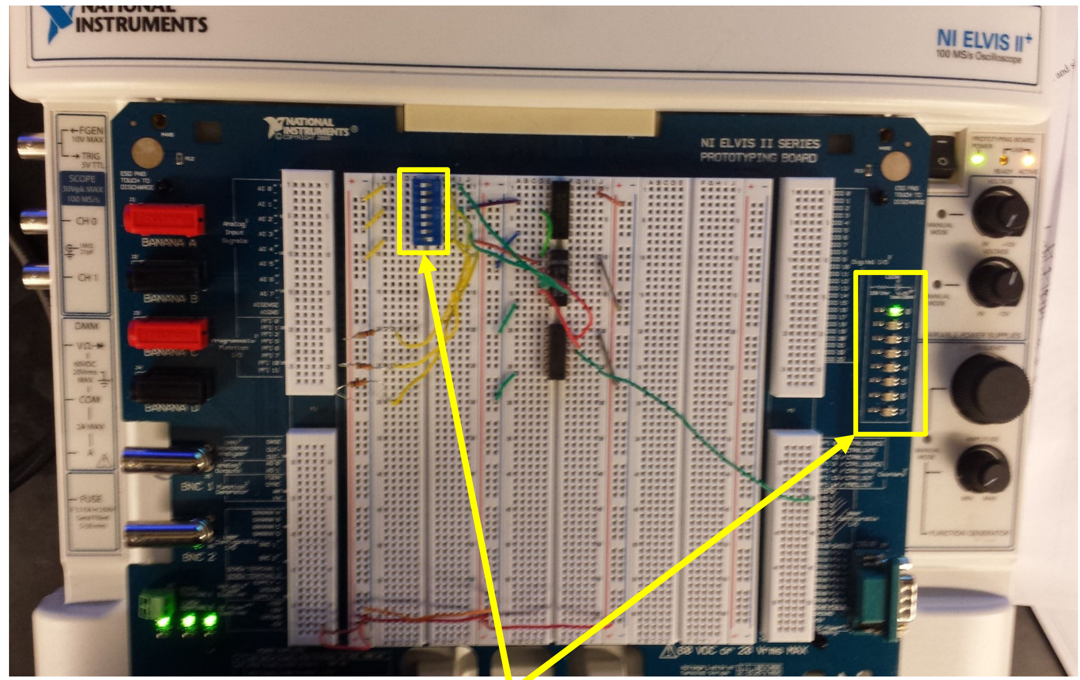
Lab 3: Midterm Assignment

Pre - Build Specifications				Switch, Label
Power Source (5V) =		4.96	VDC	
Resistor 1 (10kΩ) =		9.86	kΩ	1,A
Resistor 2 (10kΩ) =		9.76	kΩ	4,B
Resistor 3 (10kΩ) =		9.77	kΩ	8,C
Post - Build Output (VDC)				
Low=	0.163	High w/LED=	3.23	
		High w/o LED=	4.36	

Lab 3: Gates Functioning Correctly



Active / Untriggered

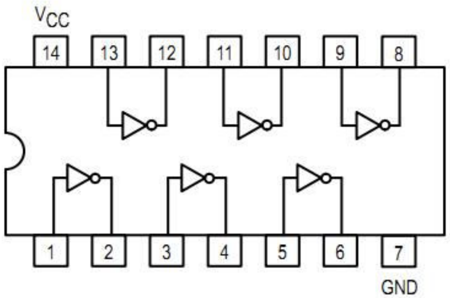


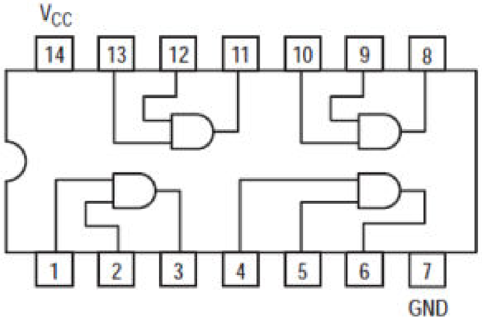
Active / Triggered (Drivers Door Open / Ignition On)

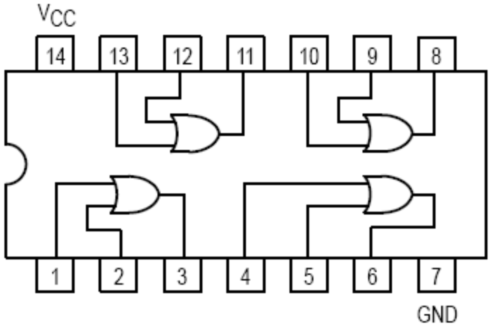
Lab 3: Midterm Assignment Completion:

Conclusion:

Given the input parameters and expected outputs, a system of gates can be designed and configured to set a warning alarm off when necessary. Circuit worked correctly in all alarm modes.







Lab 4: Binary Counter

Objective:

1. Convert 4-bit D-Flip Flop binary counter to single package BCD counter.
2. Update Multisim to use TTL chips available in lab for BCD counter and 7-Segment Decoder/Driver.
3. Use NI Elvis II+ to build 4-bit binary counter with hex 7-segment display

Equipment: used @ Station # 5

- NI Elvis II Breadboard: Serial # 1677D1E
- GW INSTEK GDM-8245 DiMM : Serial # CL860332
- Tektronix Oscilloscope TDS-220

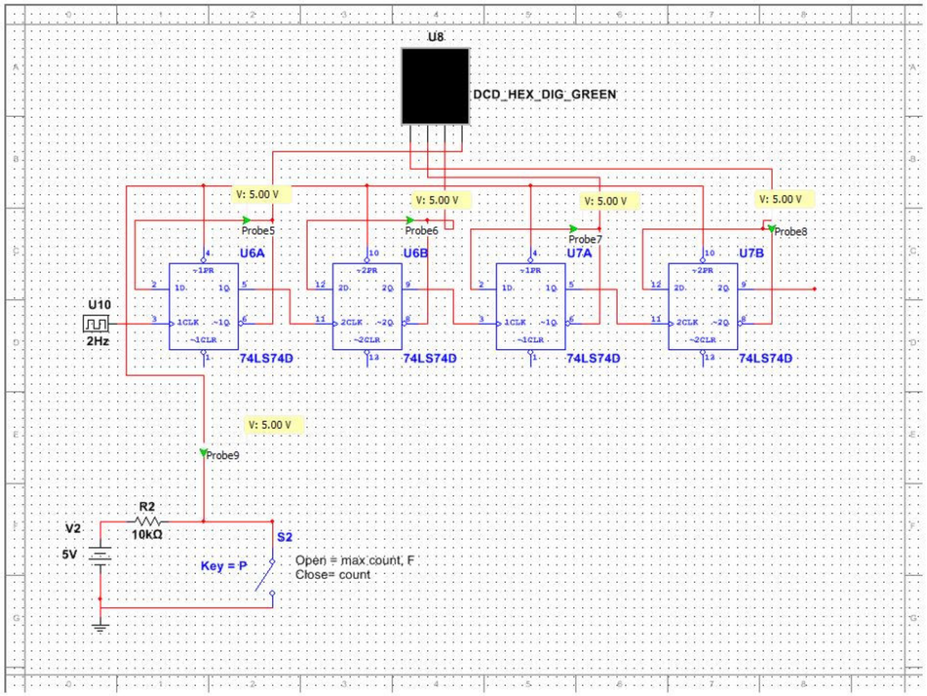
Personal Used: (Team Big Boys)

- David Rogers
- Michael Roeback

Date Assigned: October 31, 2014

Date Completed: November 7, 2014

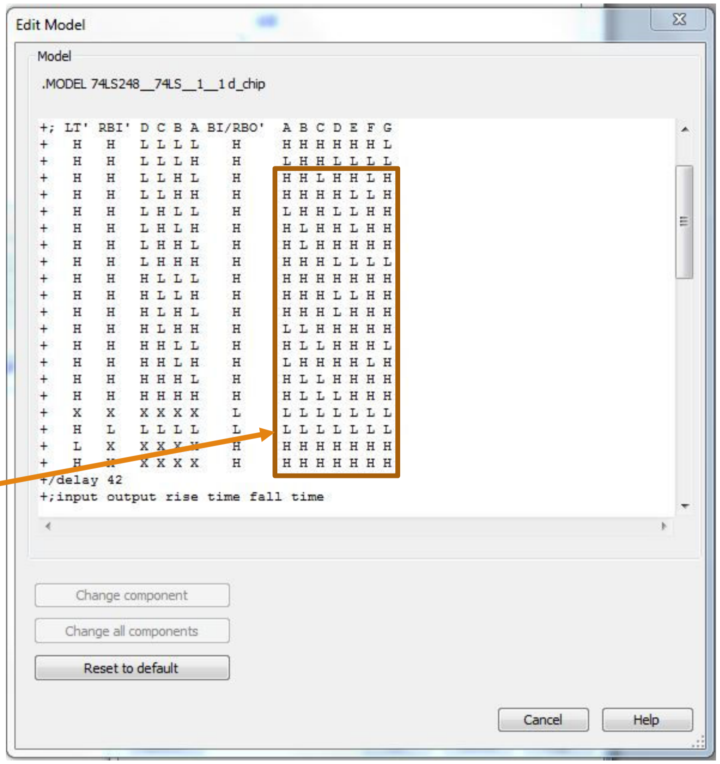
Lab 4: 4-bit D-Flip Flop Binary Counter



Lab 4: Convert 4-bit D-Flip Flop Binary Counter to Single Package BCD Counter.

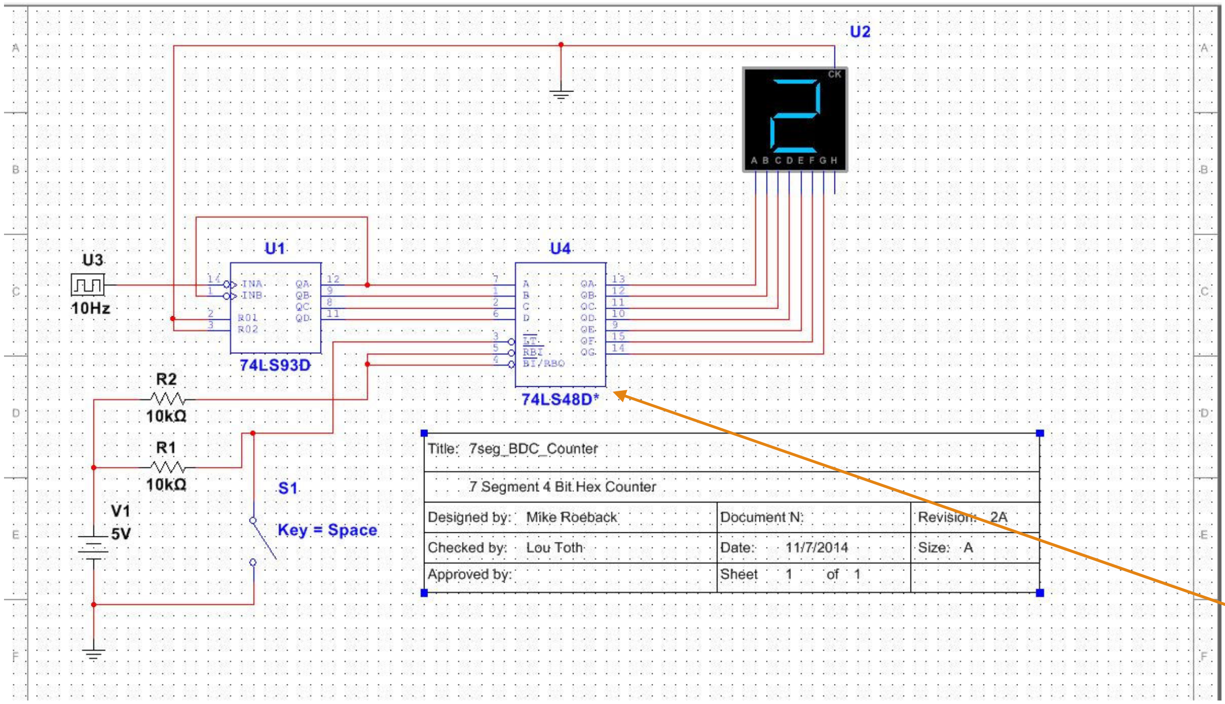
Observation:

After several failed attempts to get counter to display correctly in simulation, the stored chip parameters were altered and the results were successful.



Outputs Altered so Counter would Displayed Correctly.

Lab 4: Completed MultiSim Circuit

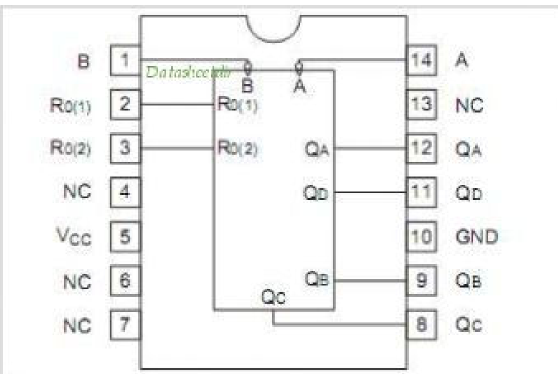


Parts Used:

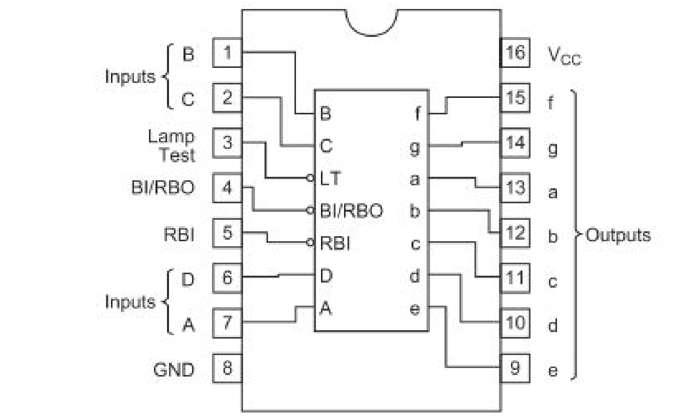
74LS93D Counter
74LS48D Decoder/Driver
MAN74 Display
8 Pin Dipswitch
Various Wires
(2) 10K ohm Resistors
100 ohm Resistor

*Asterisk indicates the Alteration.

Lab 4: Pin Outs for NI Elvis II+ Build

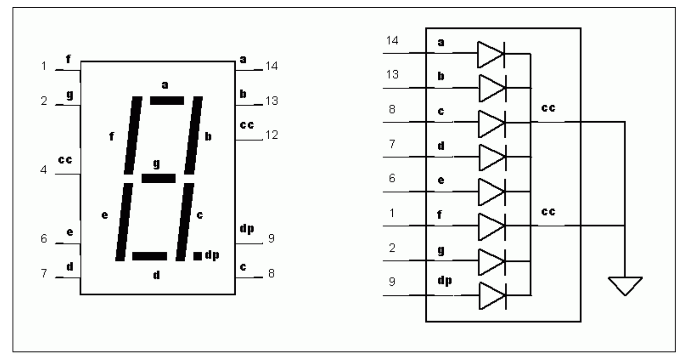


74LS93D



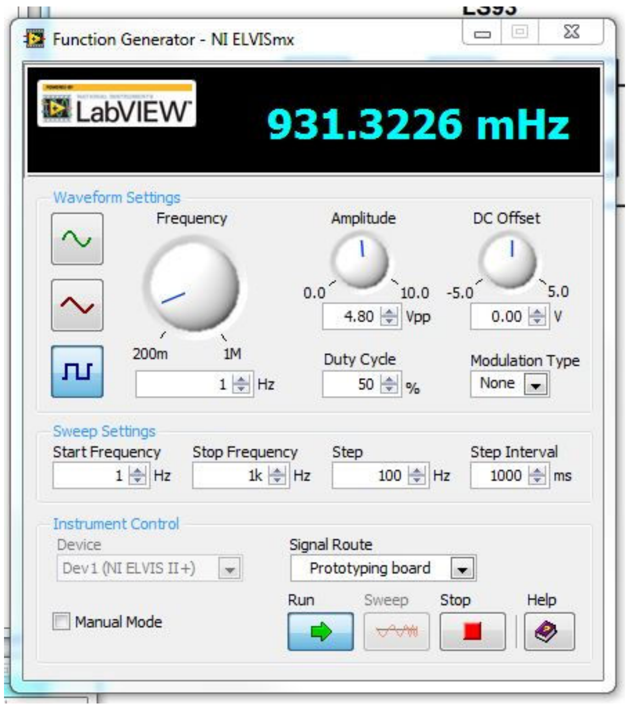
(Top view)

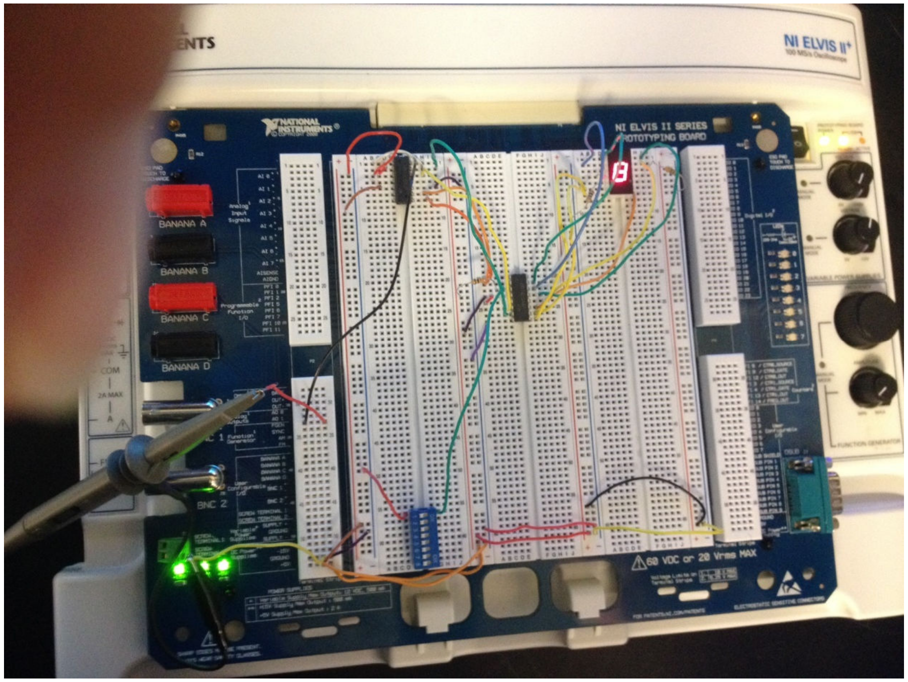
74LS48D



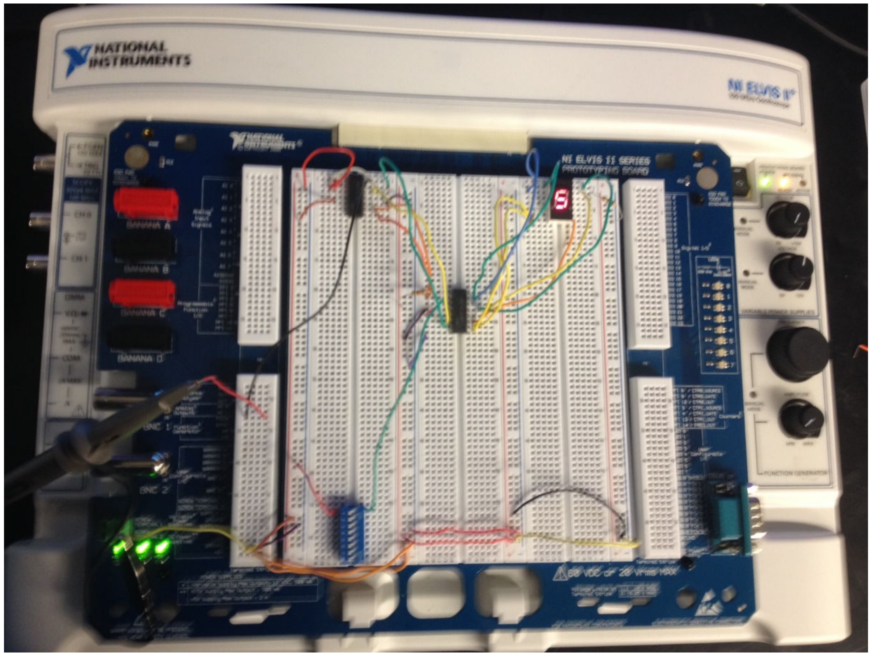
MAN74

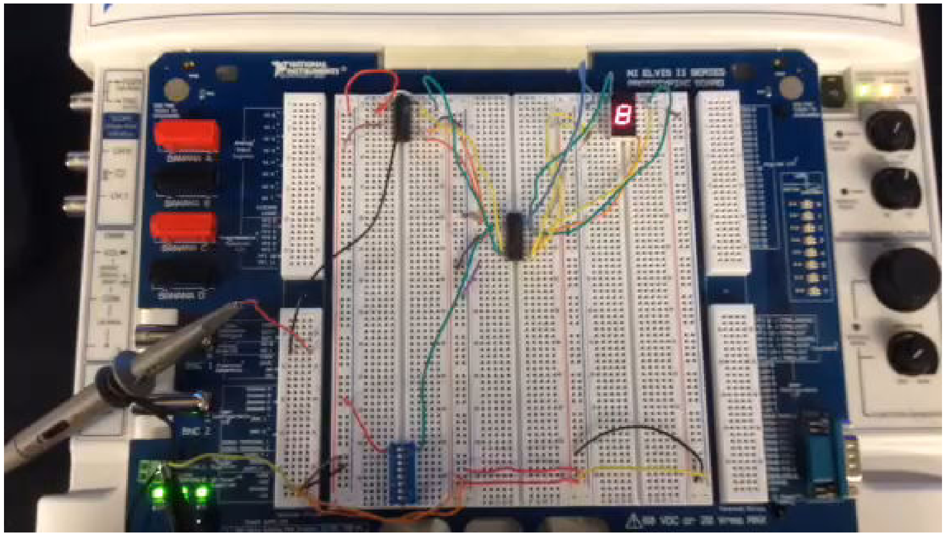
Lab 4: NI Elvis II+ Build Operational





Lab 4: Operational Picture and Video





Lab 4: Semi-Successful

Conclusion:

- Bench top Oscilloscope was used to confirm the Elvis Function Generator was working correctly due to doubts caused by malfunctioning IC chips.
- After a couple of the components (74LS48D IC Chips and Display) were swapped out due to failures, the counter worked but the display was intermittently accurate.

Lab 5: Basic Stamp Experiment #1, Exercise #2

Objective:
- LED Blinking Circuit, from Industrial Control Student Workbook Version 1.1. The circuit has a single input button and a single output LED. Write a program for when the pushbutton is pressed, blink the LED five times over 10 seconds then stop and wait for another press of the pushbutton.

Equipment: used @ Station # 6
- Basic Stamp 2.0 Board
- GW INSTEK GDM-8245 DiMM : Serial # CL860260

Personal Used: (Team Big Boys)
- David Rogers
- Michael Roeback

Date Assigned: November 14, 2014 **Date Completed:** November 14, 2014

Lab 5: Flow Chart and Code Entry

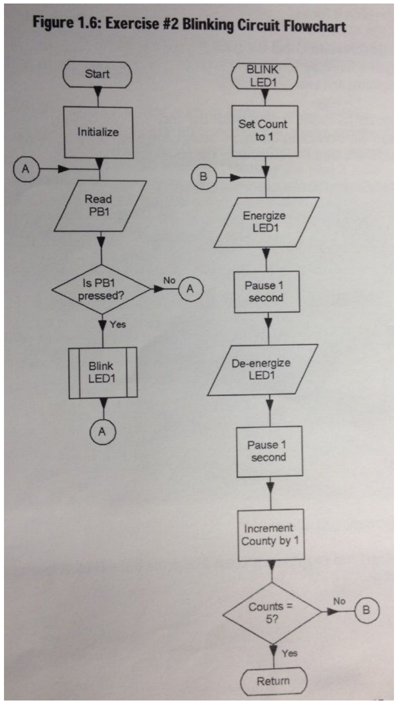


Figure 1.6: Exercise #2 Blinking Circuit Flowchart

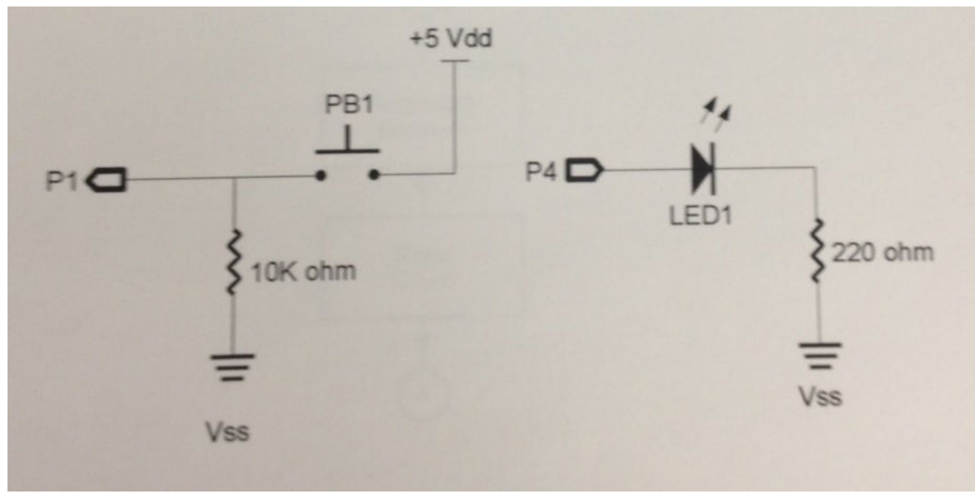
Code Matches Flowchart

```
' {$STAMP BS2}
'PROGRAM 1.1; BLINKING LED EXAMPLE
Cnt   VAR  Byte                'VARIABLE FOR COUNTING
PB1   VAR  IN1                 'VARIABLE FOR PB1 INPUT
LED1   CON   4                'VARIABLE FOR LED1 OUTPUT

INPUT 1                       'SET PB1 AS INPUT
OUTPUT   4                    'SET LED1 AS OUTPUT

LOW LED1                      'TURN OFF LED

Start:
  IF PB1 = 0 THEN Start       'NOT PRESSED? GO BACK TO LOOP
  GOSUB Blink_LED1            'IF IT WAS PRESSED THEN PERFORM SUBROUTINE
GOTO Start                    'AFTER RETURN, GO BACK TO START

Blink_LED1:                   'SUBROUTINE TO BLINK LED 5 REPETITIONS
  FOR Cnt = 1 TO 5            'SETUP LOOP FOR 5 COUNTS
    HIGH LED1                 'TURN ON LED
    PAUSE 1000                'WAIT 1 SECOND
    LOW LED1                  'TURN OFF LED
    PAUSE 1000                'WAIT 1 SECOND
  NEXT                        'REPEAT LOOP UNTIL DONE

RETURN                        'RETURN BACK TO AFTER GOSUB CALL
```

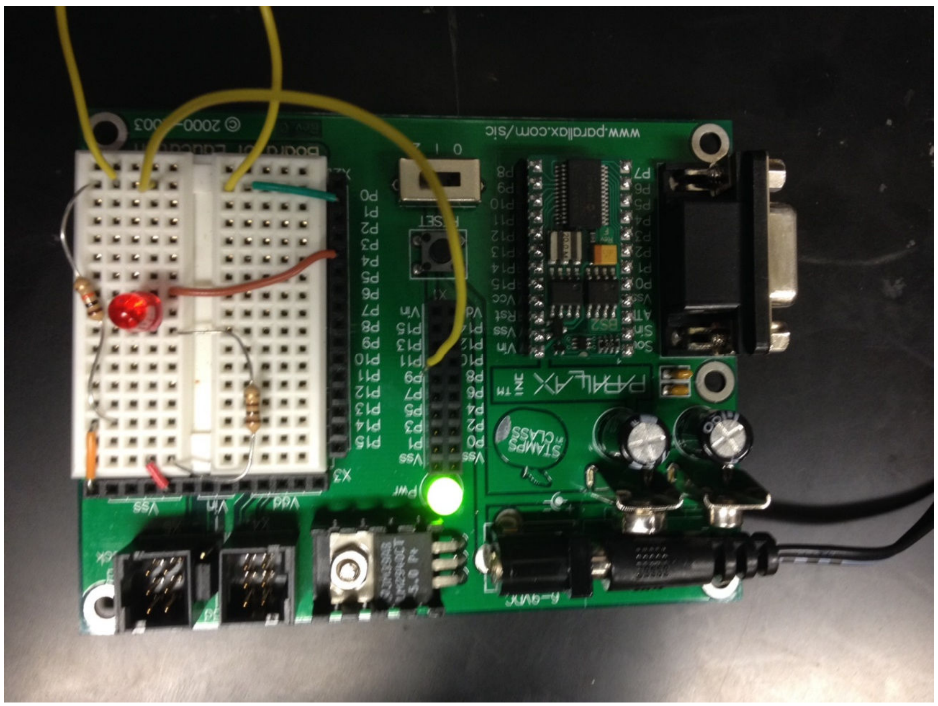
Lab 5: Schematics and Setup

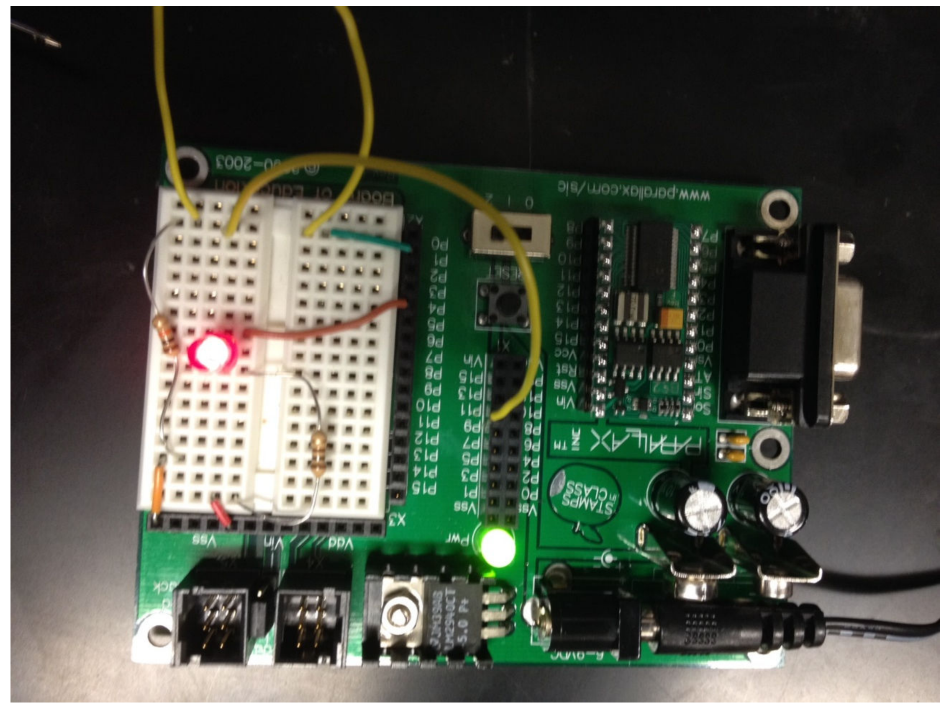
Parts Used:

(1) LED, green
(2) 220-ohm resistors
(1) 10K-ohm resistor
(1) Pushbutton
(1) 10K-ohm multi-turn potentiometer
(1) 1 uF capacitor
(Miscellaneous) jumper wires



Lab 5: Completed Build





Lab 5: Operational Basic Stamp Board

Observations:

- After building the board and burning the EPROM, it failed to show any signals of operation.
- Borrowed a working board from another test group and burned our teams program on it to find the program was written and the setup used was working correctly.
- Troubleshot several boards and marked bad ones.
- Acquired a working Basic Stamp 2.0 board.
- Swapped out 220 ohm resistors for 100 ohm to brighten LEDs.

Conclusion:

- Setup burns correctly.
- Objective was met with 100% success.

Lab 6: Basic Stamp Experiment #1, Exercise #3

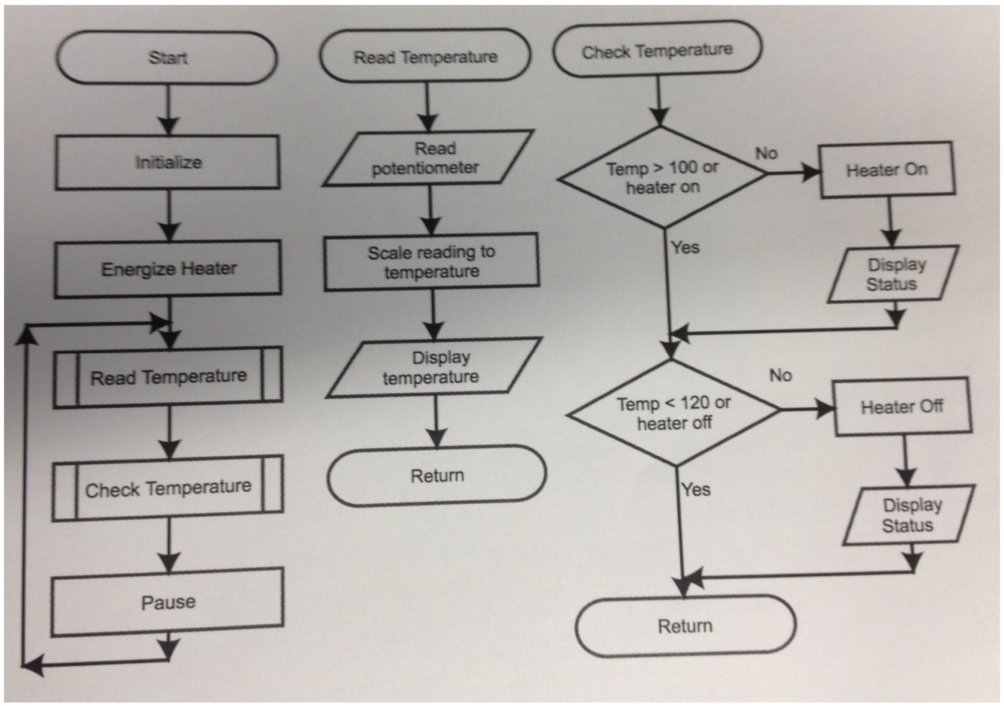
Objective:
- Analog Data Input, from Industrial Control Student Workbook Version 1.1. Write a program to simulate process control of a Heater Control using an RC network with a capacitor and potentiometer. Temperature is monitored and a heater is energized below 100 degrees and de-energized above 120 degrees. The potentiometer will represent a temperature sensor and the LED will represent the heater being energized. Will use the Debug window to display our temperature and status of the heater.

Equipment: used @ Station # ?
- Basic Stamp 2.0 Board
- GW INSTEK GDM-8245 DiMM : Serial # ?

Personal Used: (Team Big Boys)
- David Rogers
- Michael Roeback

Date Assigned: November 14, 2014 **Date Completed:** November 14, 2014

Lab 6: Flow Chart and Code Entry



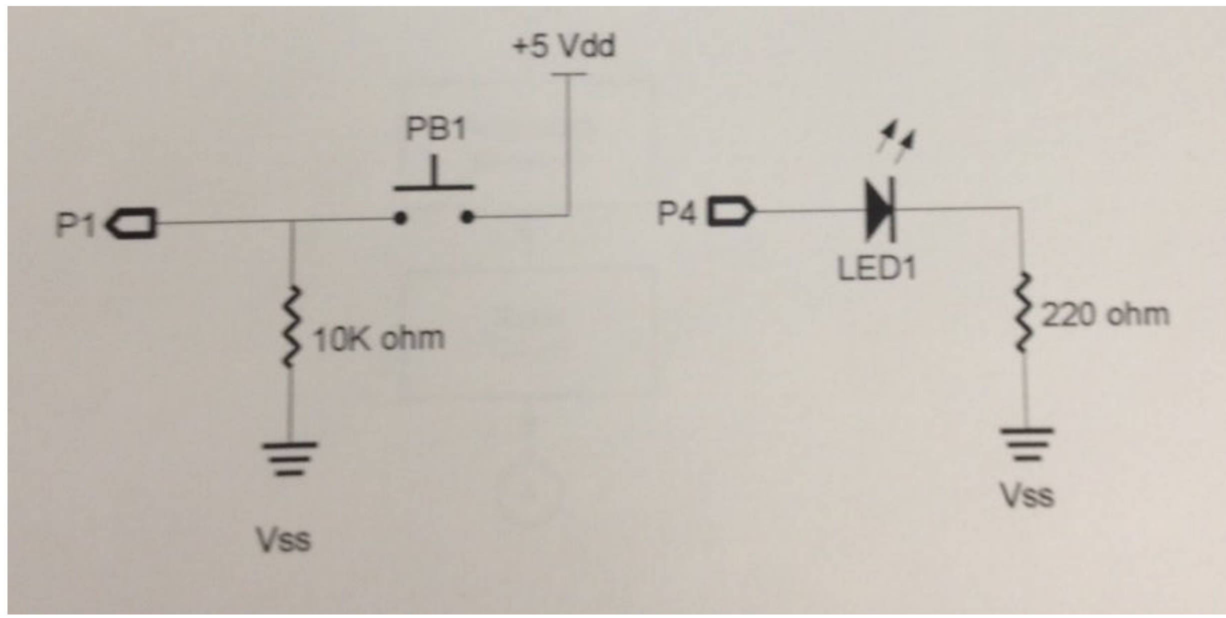

```
' {$STAMP BS2}
'Progam 1.2,  Simple Heater
LED1  VAR OUT4                          'LED1 is on P4
RC  CON 7                               'RC network is on Pin 7
Temp  VAR Word                          'Pot is on variable to hold results

OUTPUT  4                               'Setup LED as Ouptput
LED1  = 1                               'Energize initially

Main:
  GOSUB ReadTemp                        'Read Pot value as temperature
  GOSUB CheckTemp                       'check temp to setpoint
  PAUSE 250
GOTO Main

ReadTemp
  HIGH RC                               'Read Pot
  PAUSE 10
  RCTIME RC, 1, TEMP
  Temp = Temp/30                        'Scale the results down,
                                        'store as temperature
  DEBUG "Temp = ",DEC Temp, CR
RETURN

CheckTemp:                              'If Temp > 100, or heat already on,
                                        'check if should be off
  IF  (Temp > 100) OR (LED1 = 1) THEN CheckOff
  LED1 = 1                              'If not, then energize and display
  DEBUG "The Heater energized", CR

CheckOff:                               'If Temp < 120 or heat is off already, all done
  IF (Temp < 120) OR (LED1 = 0) THEN CheckDone
  LED1 = 0
  DEBUG "The Heater de-energized", CR
CheckDone:
RETURN
```

Lab 6: Schematics and Setup

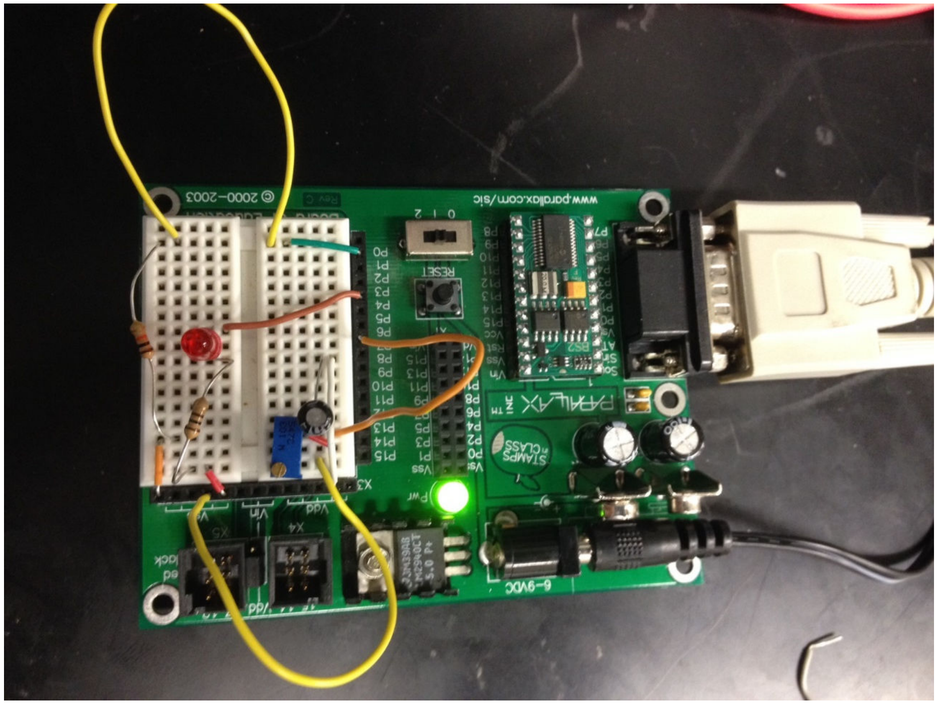
Parts Used:

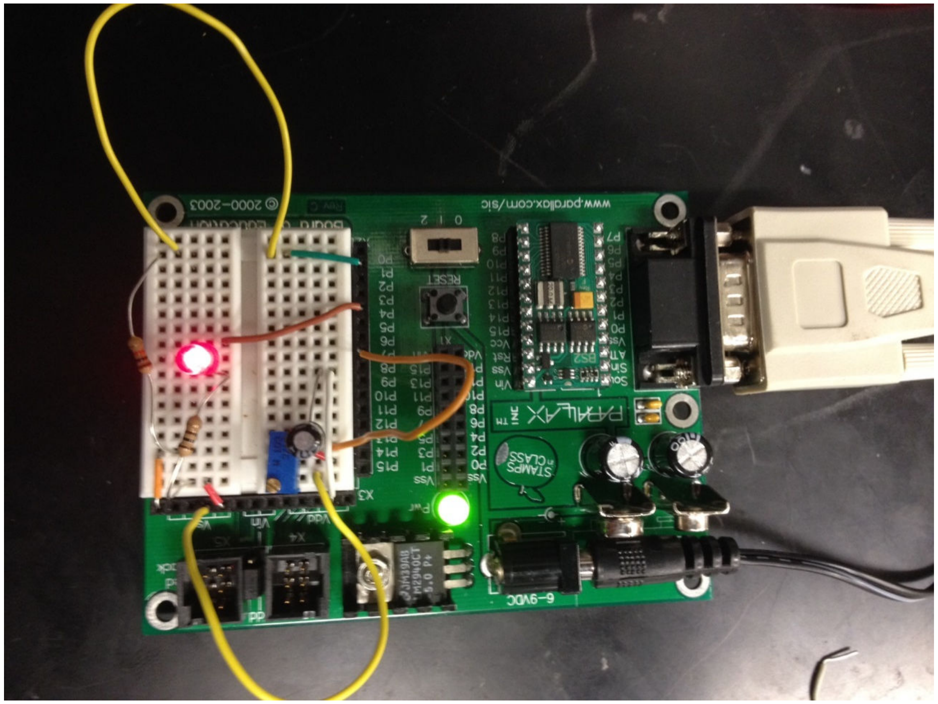
(1) LED, green
(2) 220-ohm resistors
(1) 10K-ohm resistor
(1) Pushbutton
(1) 10K-ohm multi-turn potentiometer
(1) 1 uF capacitor
(Miscellaneous) jumper wires

(1) 1 uF capacitor
(1) 10K potentiometer

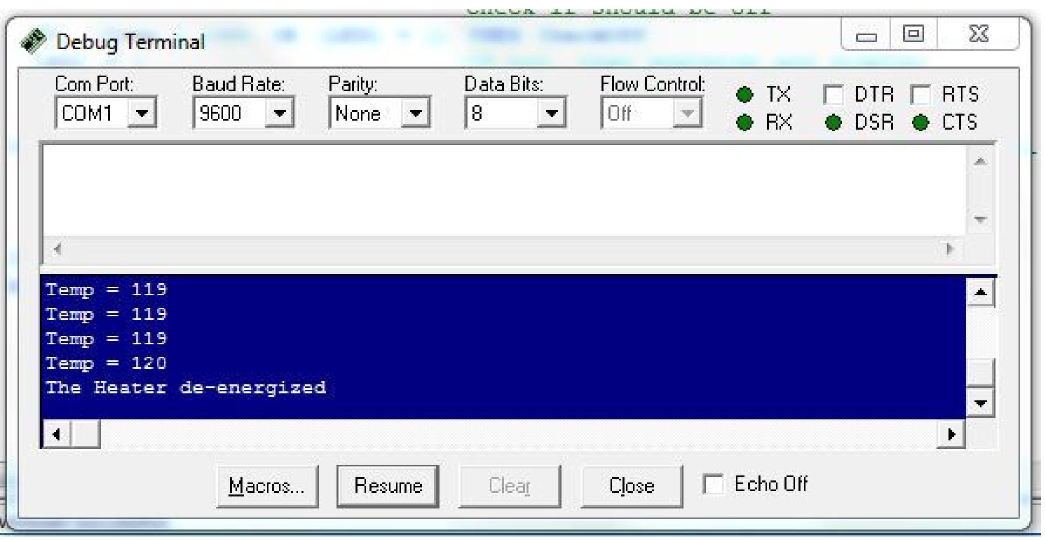


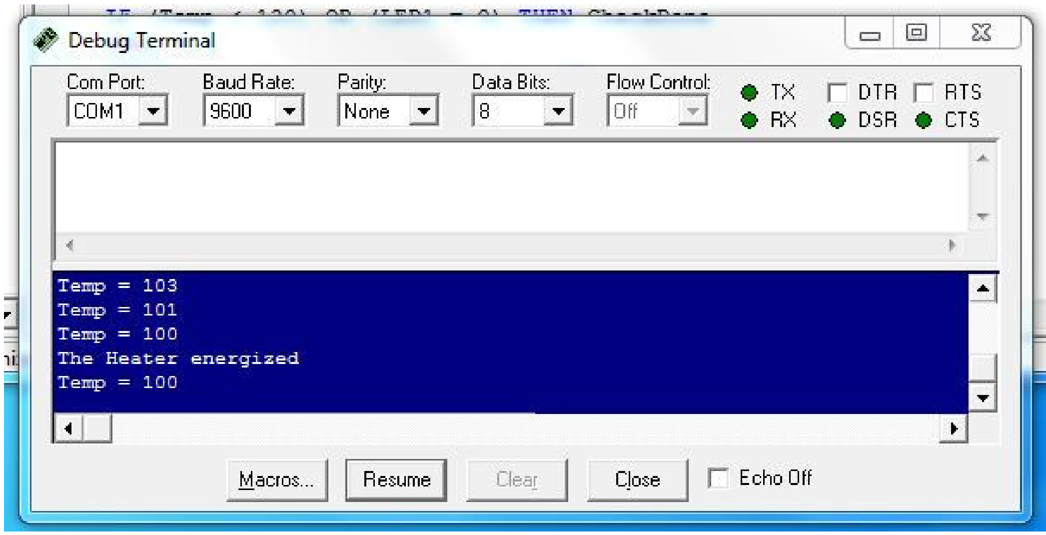
Lab 6: Completed Build





Lab 6: Operation Monitoring Through Debugging Screen.





Lab 6: Thermostat Completion

Observations:

- Due to the difficulty locating a 10k ohm Potentiometer a 1k ohm was used in its place. Unfortunately, it wasn't capable of the necessary range needed to fully actuate the circuit.
- After scavenging a 10k ohm Potentiometer off of an existing built basic stamp board, the thermostat reacted with 100% accuracy.
- Swapped out 220 ohm resistors for 100 ohm to brighten LEDs.

Conclusion:

- Heater energizes below 100 degrees and de-energized above 120 degrees. Debugging screen confirm successful operation of circuitry.