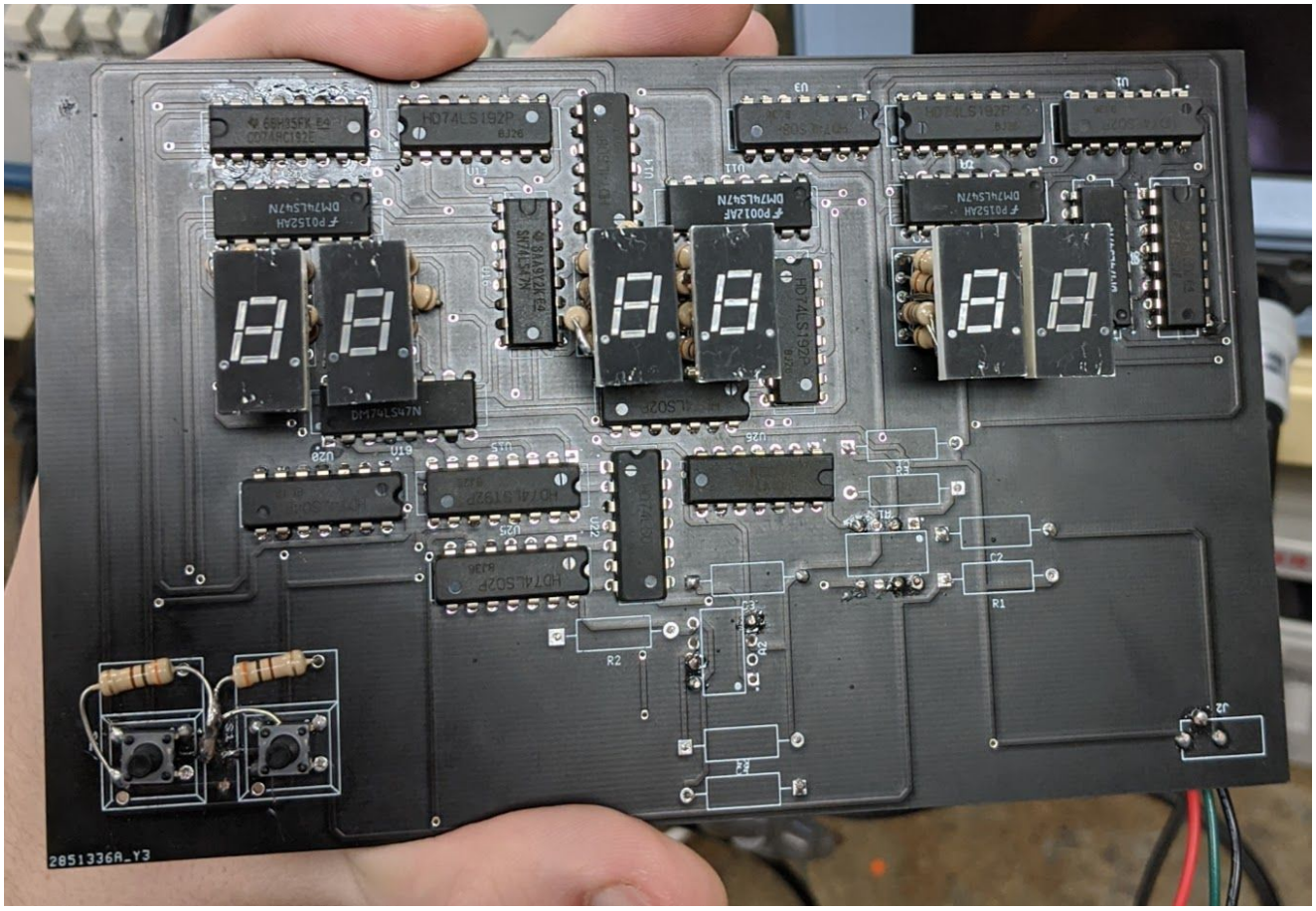
Experiment 44

Creating Hours on the Clock



By: Thomas Buckley, Aidan O'Leary, and Josh Pinoos

2/3/20 - 2/7/20

Objectives:

The objective of this week was to construct the hours' portion of the clock along with a finished box and PCB to have a finished clock that would count time in a 12-hour format.

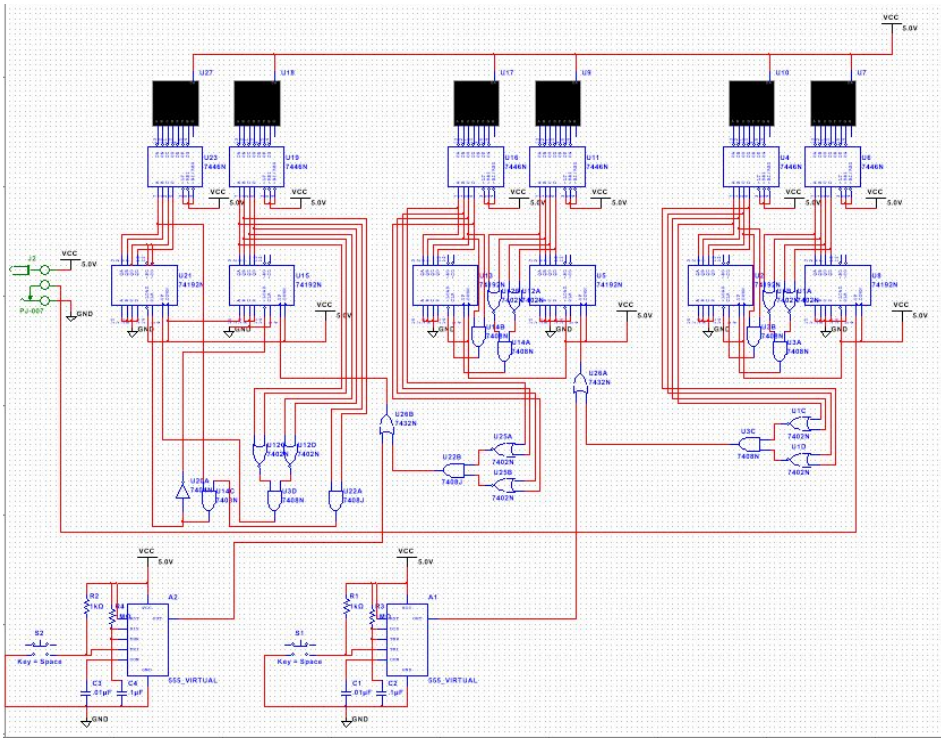
Materials:

- 4 - 7490 - Asynchronous counters
- 2 - 74193 - Synchronous counters
- 6 - LED 7 Segment Displays (FND500)
- 1 - 10:1 Step-Down Transformer
- 1 - 7404 INV Gate
- 1 - 7408 AND Gate
- 1 - Schmitt Trigger (7414N)
- 1 - 5 Volt Voltage Regulator (7805)
- 1 - Zener Diode
- 1 - Bridge Rectifier
- 1 - 20 MHz Crystal Oscillator
- 1 - 300 Ω Resistor
- 1 - 1000 Ω Resistor
- 3 - 0.1uf Disc Capacitor
- 1 - 1,000uf Electrolytic Capacitor

Procedure:

1. To begin this part of the project the multisim was redesigned compared to last week to be manually set as shown below in **Figure 1**.

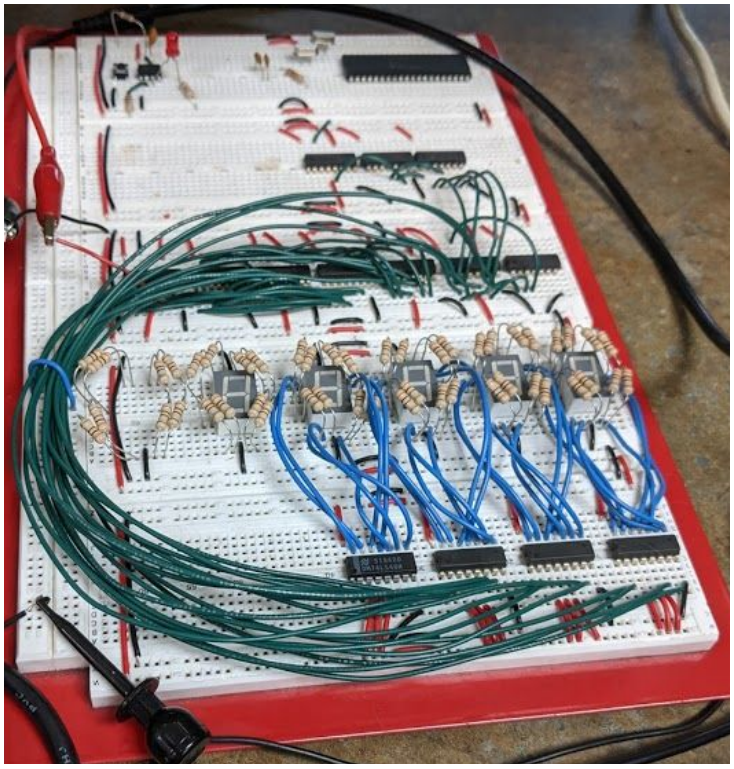
Figure 1



2. The minutes and seconds portion of the clock were simply reused as only additions to this project needed to be made. The whole circuit is powered by a 5-volt power supply that gets its voltage supply right from the wall and uses a Schmitt trigger along with a Zener diode to filter out the negative side of the sine wave supplied. This 5 Volt DC 60hz square wave is sent to a DIV10 chip, and then the output of that was connected to a DIV6 chip effectively outputting a 1-pulse per second 5-volt square wave. This wave pulse helps the clock count the seconds that have passed as each second is represented by one square wave.

3. This pulse would enter the first digit of the seconds unit of time and as the first digit is a mod 10 counter that counts from 0 to 9 the counter. Once the counter hits 10 it resets to 0 while a pulse is fed into the input of the second counter (the tens portion of the seconds unit) which is a mod six that counts from 0 to 5. Once the mod six counts to 6 it resets back to 0 and sends another pulse to the next phase of the circuit which repeats the first phase but receives a pulse every minute instead of every second. Once the minutes count up to 60 pulses it resets and a pulse is sent to the hours' portion of the clock. The hours' portion counts from 1 to 13 and resets at 13 and goes back to a 1 being shown on the hours' portion. The physical model is shown in **figure 2** and works exactly like the multisim model.

Figure 2



4. A debouncer is used along with buttons to set the time of the clock manually. Each press adjusts the minutes and hours respectively and adds a one to the counter.

5. Next, the components' physical size was measured in order to get them to fit on the ultiboard designed in **Figure 3**. The board has a place for the seven segments and the adjustment buttons. The actual board is shown in **Figure 4**, and the components were soldered onto the board and tested to ensure that it worked.

Figure 3

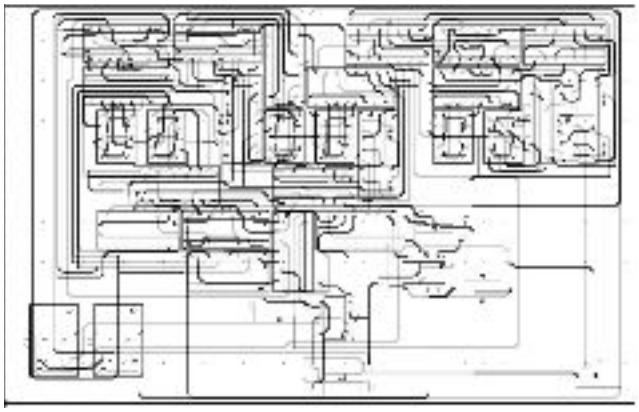
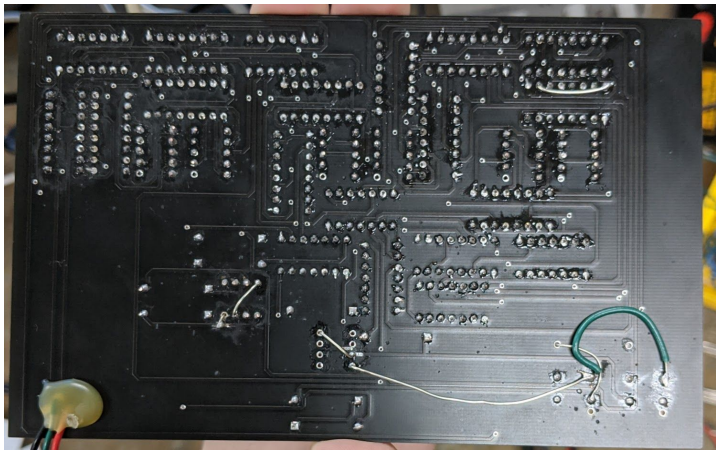
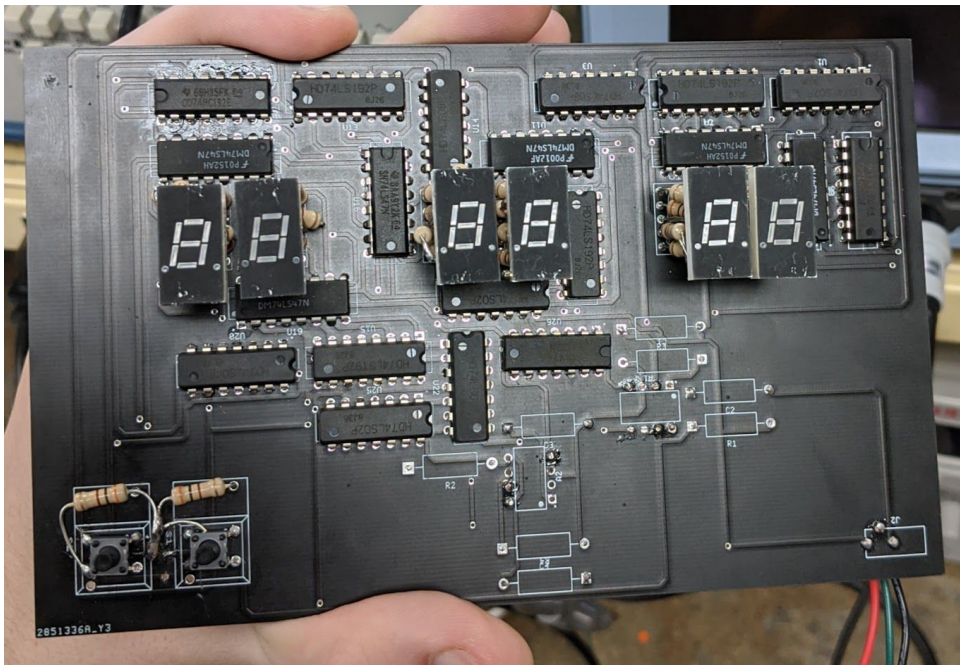


Figure 4





6. A box was made using the dimensions of the board as shown in figure 5.

Figure 5

Discussion:

At first, we were planning on using the circuit design from last week but we changed it to a design that we could manually adjust the hours and minutes. The PCB design, once created, was sent to the circuit board company JLCPCB for manufacturing. This was done to keep a higher level of accuracy on the board traces then using the etching machine in the shop. Once the board was received we found that the wrong footprint for the seven segments was used so we soldered resistors to the pins of the seven-segment displays

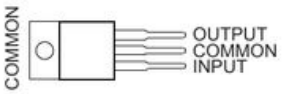
Conclusion:

A 60 Hz signal sent through a Zener diode and Schmitt trigger can be converted to a 1 pulse per second signal using DIV chips, which have internal JK flip-flips to create a ripple counter and effectively divide the frequency as each JK is added which is needed in the circuit that powers the clock. The power supply takes the 60 Hz wave then divides it by 60 A wall outlet is usable not only for powering the entire project, but also to provide a 60 Hz frequency for timing, along with avoidance of errors from dirty input signals. The one pulse per second represents the ticking of a clock as it counts the time in 1-second intervals. The pulse will keep inputting pulses into the first 7490 mod 10 counter which will input into the next counter when it resets at binary 10, representing 10 seconds. The next mod 6 will reset once 60 pulses total has passed, representing that a min had passed. This process repeats for the next set of two counters using the reset signal from the previous counter to add to its value. The clock will count up to 60 minutes before resetting the minutes and seconds while sending a pulse to the hours. The hours' segment will take this pulse and count up from 1 to 12 and will reset back to 1. These actions together create a fully working clock that will count time in a 12-hour format.

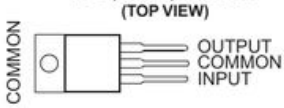
FEATURES

- ±1% Output Tolerance at 25°C
- ±2% Output Tolerance Over Full Operating Range
- Thermal Shutdown
- Internal Short-Circuit Current Limiting
- Pinout Identical to µA7800 Series
- Improved Version of µA7800 Series

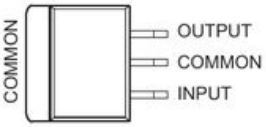
KC (TO-220) PACKAGE
(TOP VIEW)



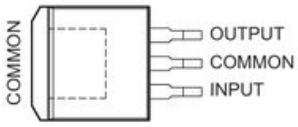
KCS (TO-220) PACKAGE
(TOP VIEW)



KTE PACKAGE
(TOP VIEW)



KTT (TO-263) PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

Each fixed-voltage precision regulator in the TL780 series is capable of supplying 1.5 A of load current. A unique temperature-compensation technique, coupled with an internally trimmed band-gap reference, has resulted in improved accuracy when compared to other three-terminal regulators. Advanced layout techniques provide excellent line, load, and thermal regulation. The internal current-limiting and thermal-shutdown features essentially make the devices immune to overload.

ORDERING INFORMATION

T_J	V_O TYP (V)	PACKAGE(1)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 125°C	5	PowerFLEX™ – KTE	Reel of 2000	TL780-05CKTER	TL780-05C
		TO-220 – KC	Tube of 50	TL780-05CKC	TL780-05C
		TO-220, short shoulder – KCS	Tube of 20	TL780-05KCS	TL780-05
		TO-263 – KTT	Reel of 500	TL780-05CKTTR	TL780-05C
	12	TO-220 – KC	Tube of 50	TL780-12CKC	TL780-12C
		TO-220, short shoulder – KCS	Tube of 20	TL780-12KCS	TL780-12
	15	TO-220 – KC	Tube of 50	TL780-15CKC	TL780-15C
		TO-220, short shoulder – KCS	Tube of 20	TL780-15KCS	TL780-15

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FAIRCHILD SEMICONDUCTOR™

September 1986
Revised July 2001

DM7446A, DM7447A
BCD to 7-Segment Decoders/Drivers

General Description

The DM7446A and DM7447A feature active-LOW outputs designed for driving common-anode LEDs or incandescent indicators directly. All of the circuits have full ripple-blanking input/output controls and a lamp test input. Segment identification and resultant displays are shown on a following page. Display patterns for BCD input counts above nine are unique symbols to authenticate input conditions.

All of the circuits incorporate automatic leading and/or trailing-edge, zero-blanking control (RBI and RBO). Lamp test (LT) of these devices may be performed at any time when the BI/RBO node is at a HIGH logic level. All types contain an overriding blanking input (BI) which can be used to control the lamp intensity (by pulsing) or to inhibit the outputs.

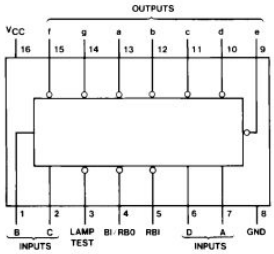
Features

- All circuit types feature lamp intensity modulation capability
- Open-collector outputs drive indicators directly
- Lamp-test provision
- Leading/trailing zero suppression

Ordering Code:

Order Number	Package Number	Package Description
DM7446AN	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
DM7447AN	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

Connection Diagram



FAIRCHILD SEMICONDUCTOR™

August 1986
Revised March 2000

DM74LS90
Decade and Binary Counters

General Description

Each of these monolithic counters contains four master-slave flip-flops and additional gating to provide a divide-by-two counter and a three-stage binary counter for which the count cycle length is divide-by-five for the DM74LS90.

All of these counters have a gated zero reset and the DM74LS90 also has gated set-to-nine inputs for use in BCD nine's complement applications.

To use their maximum count length (decade or four bit binary), the B input is connected to the Q_A output. The input count pulses are applied to input A and the outputs are as described in the appropriate truth table. A symmetrical divide-by-ten count can be obtained from the DM74LS90 counters by connecting the Q_D output to the A input and applying the input count to the B input which gives a divide-by-ten square wave at output Q_A.

Features

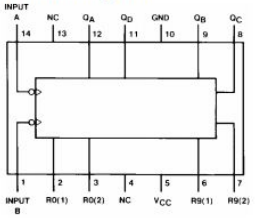
- Typical power dissipation 45 mW
- Count frequency 42 MHz

Ordering Code:

Order Number	Package Number	Package Description
DM74LS90M	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150 Narrow
DM74LS90N	N14A	14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

Connection Diagram



Reset/Count Truth Table

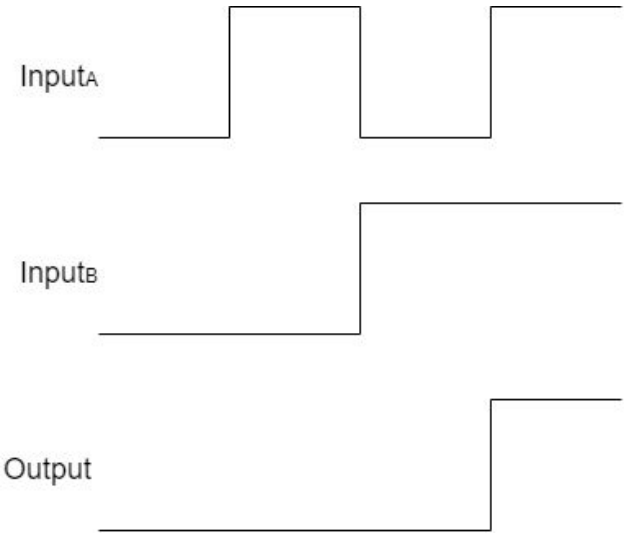
Reset Inputs				Output			
R0(1)	R0(2)	R9(1)	R9(2)	Q_D	Q_C	Q_B	Q_A
H	H	L	X	L	L	L	L
H	H	X	L	L	L	L	L
X	X	H	H	H	L	L	H
X	L	X	L	COUNT			
L	X	L	X	COUNT			
L	X	X	L	COUNT			
X	L	L	X	COUNT			

AND Gate

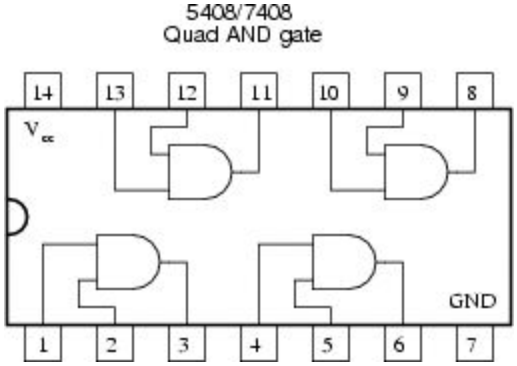
AND Gate Truth Table

Real World (5V Vcc)			Multisim		
$Input_A$	$Input_B$	Output	$Input_A$	$Input_B$	Output
0	0	0.1	L	L	L
5	0	0.1	H	L	L
0	5	0.1	L	H	L
5	5	4.3	H	H	H
Boolean equation: $A\ B = X$					

AND Gate Timing



AND Gate IC Pinout



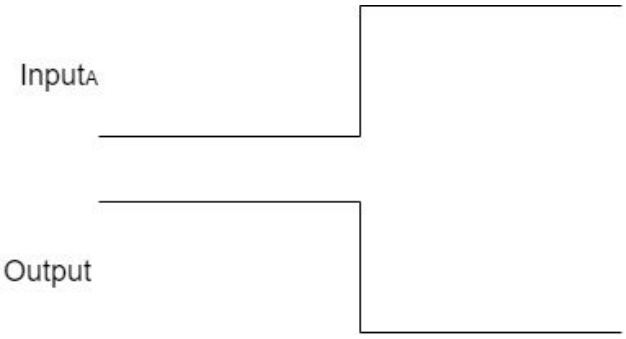
AND Gate Symbol

INV Gate

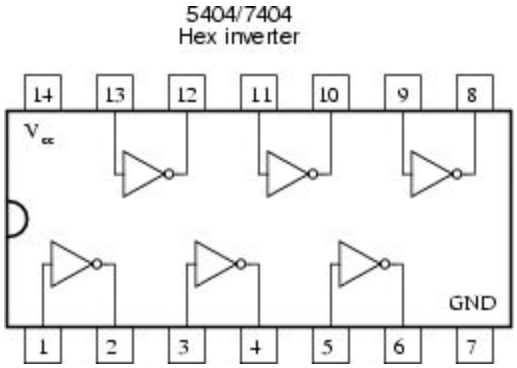
INV Gate Truth Table

Real World (5V Vcc)		Multisim	
$Input_A$	Output	$Input_A$	Output
0	5	L	H
5	0.1	H	L
Boolean equation: $\overline{A} = X$			

INV Gate Timing



INV Gate IC Pinout



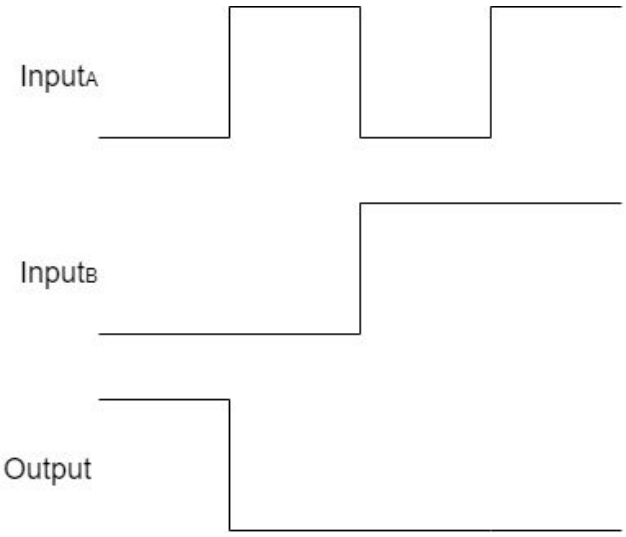
INV Gate Symbol

NOR Gate

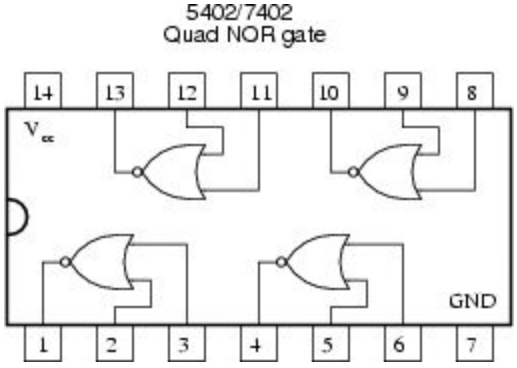
NOR Gate Truth Table

Real World (5V Vcc)			Multisim		
$Input_A$	$Input_B$	Output	$Input_A$	$Input_B$	Output
0	0	4.3	L	L	H
5	0	0.1	H	L	L
0	5	0.1	L	H	L
5	5	0.1	H	H	L
Boolean equation: $\overline{A + B} = X$					

NOR Gate Timing



NOR Gate IC Pinout



NOR Gate Symbol