Digital Clock Project Report

INTEGRATED CIRCUIT

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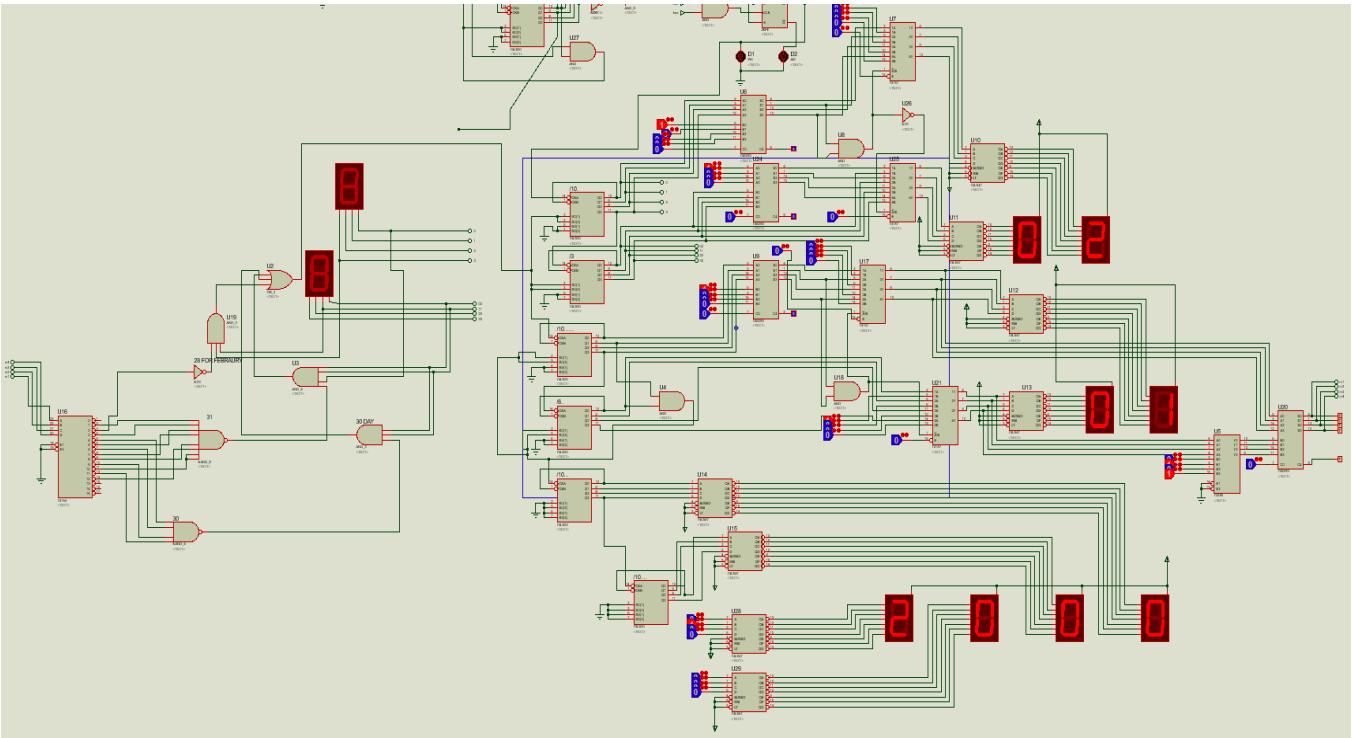
The Main Idea of this Project

A digital clock that displays the time and the date using counters 74LS90 (which start counting at falling edge where its clock turns from high to low), 7-segment decoders and seven segments. As we get a required frequency from timer 555 by changing the values of its capacitors and resistors to make the counter of seconds starts counting every second. And we used 7-segment to display the output of counters.

Displaying the Date

By using 4-bit counters that count from 0 to 9, which start counting when the counter of hours reaches 12 AM, we can count the date. We divided these counters into 2 counters for days, 2 counters for months and 2 counters for years. Where one of the 2 counters represents ones and the other represents tens. And each counter is connected to 7-segment decoder which -by its turn- connected to 7-segment display.



The Date Circuit

The Counter of the Date

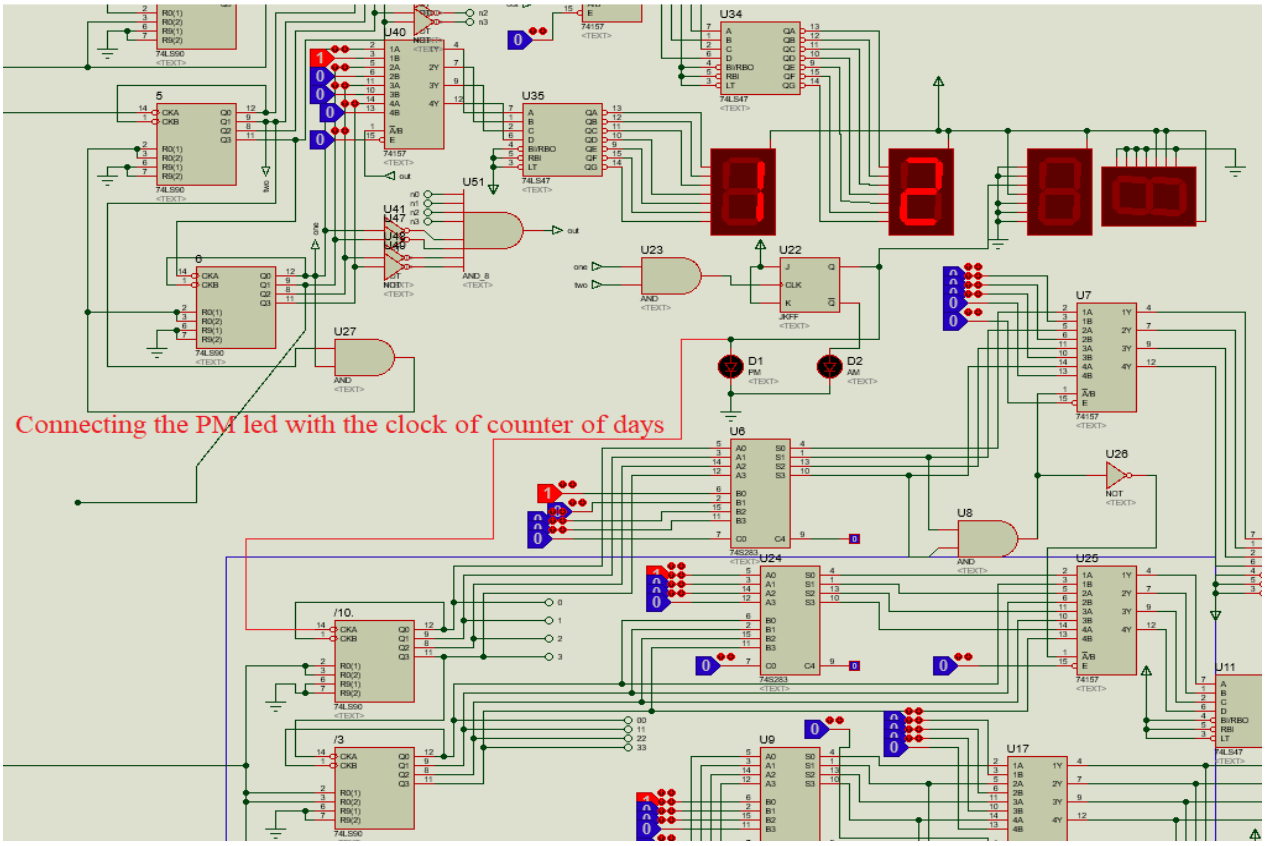
Before talking about the counter of the days, we want to understand how the counter hours works?...

Time counters works with 12 hours system with using two leds, one refers to AM and the other to Pm. The counter of hours resets when it reaches 12, where the ones counter reaches

to 2 and the tens counter reaches to 1 (we will take later about how the counter resets at wanted number). Each time the counter resets, that means there is 12 hours have been gone.

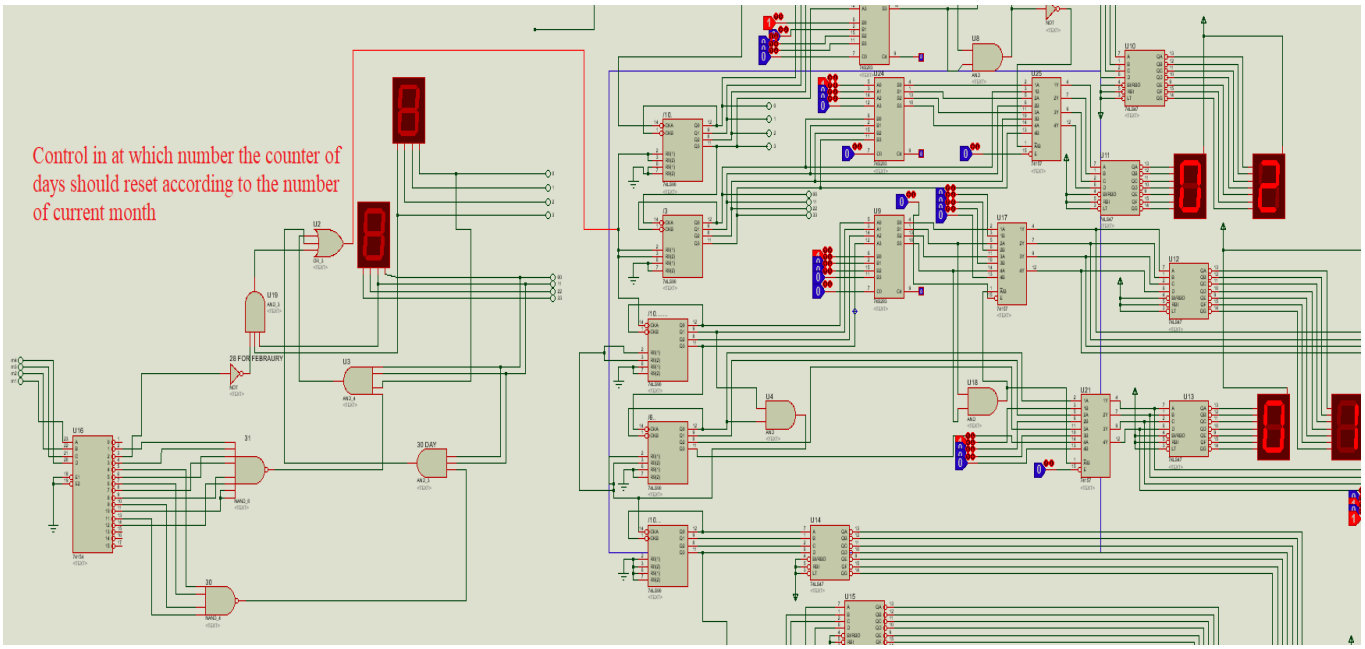
Whereas in the beginning, the PM led is off and when the counter of hours resets, the PM led turns on until the counter of hours resets again at that time the PM led turns to off again. Whereas the PM led turns on then off that means there are 24 hours have been gone.

For counting days, as 74LS90 counter starts counting at falling edge where its clock turns from high to low, so we connect the output of PM led with the clock of the counter of days. When the counter of hours resets for second time, whereas the PM led turns to off, the counter of days counts one time. And this repeats each time the counter of hours counts 12 for AM time and 12 for PM time that is 24.



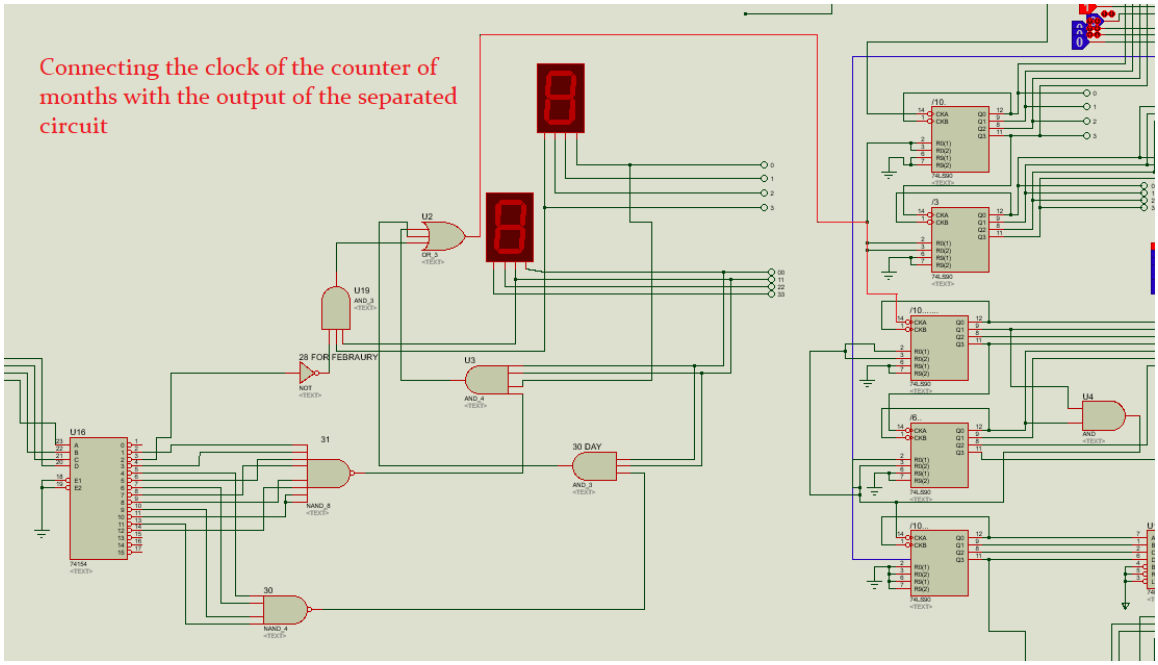
Connecting the clock of the ones counter of days with the output of PM led.

Every month differs from other month in its number of days, there is a month has 30 day and a other month has 31 day. So to know at which day the counter of days should reset, we used a separate circuit that test at which month the counter of months is and tests the number of day that the counter of days displays. Then according the number of days is this month, the circuit sends a pulse to the counter of days to reset at the last day in this month.



Connecting the counter of days with the controlling circuit to reset at the end of the current month.

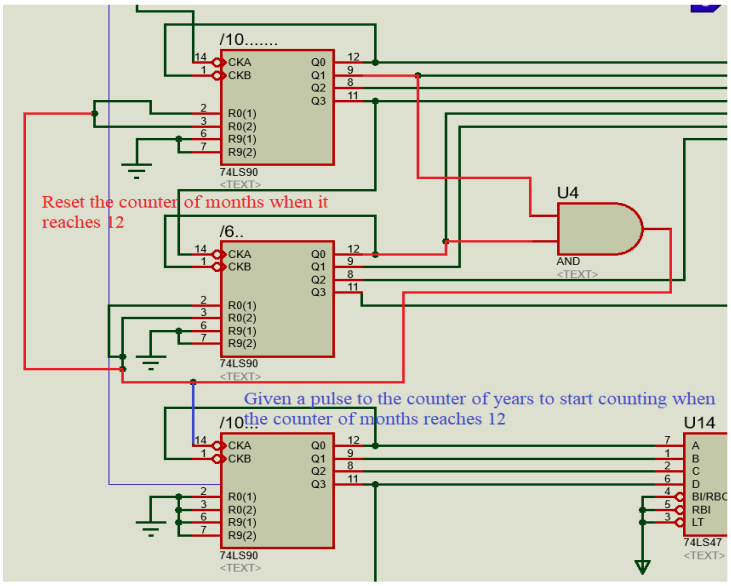
For counting months, we want to make this counter to count one time when the counter of days resets. So we connected the clock of the counter of months with the output of the separated circuit whereas the counter of days reaches to the last day in the current month, it resets and the counter of months starts counting one time. And this repeats until the counter of months reaches 12 then the counter of years starts counting.



Connecting the clock of the counter of months with the output of the separated circuit.

For counting years, first we installed the hundred place to display zero and the thousand place to display 2, where we want to count from 2000 to 2099, so the tens place and ones place are changeable from zero to 9.

The counter of years starts counting one time when the counter of months reaches to 12, so we connected a AND gate to get a pulse given to the counter of years when the counter of months reaches 12, its inputs are the second bit of the ones counter of months (which represents two) and the first bit of the tens counter of months (which represents one), and its output connected to the clock of the ones counter of months.



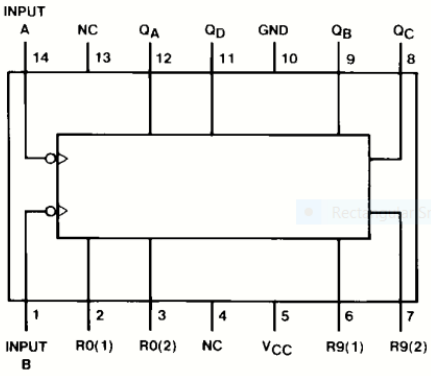
Connecting an AND gate to get a pulse given to the counter of years when the counter of days reaches 12.

Reset The Counter

According to the datasheet of 74LS90 counters, there are two resistors R0(1) & R0(2). If these resistors connected with the ground, the counter resets automatically at 9. By connecting these resistors with high voltage, the counter resets manually.

74LS90 Connection Diagram and Reset Truth Table

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			

Connection Diagram Reset/Count Truth Table of 74LS90 counters

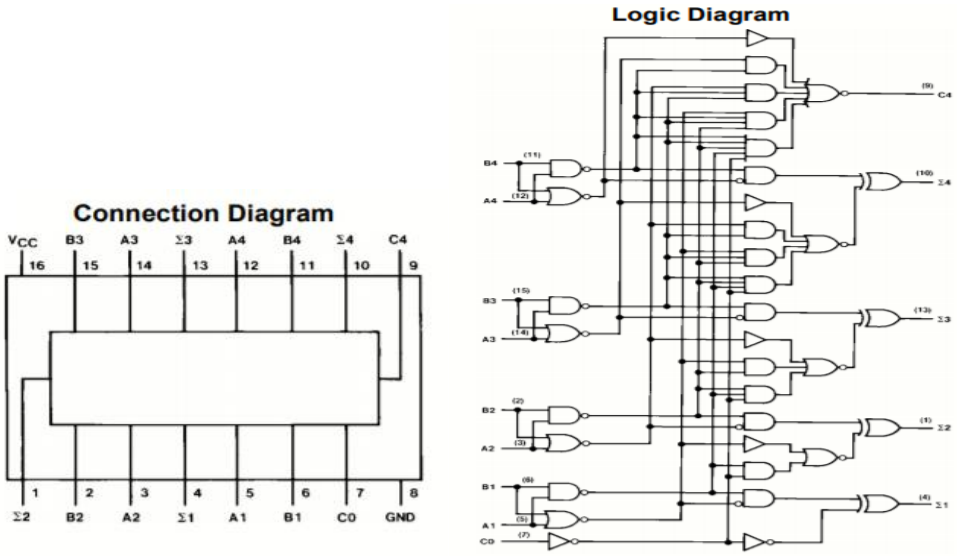
So in the counter of days, we connected the output of controlled circuit, which controls at which day should the counter of days resets, with these resistors to get them a pulse when the counter of days reaches to the end of the current month.

And in the counter of months, we connected the output of AND gate, which its inputs are the second bit of the ones counter of months (which represents two) and the first bit of the tens counter of months (which represents one), with these resistors to get them a pulse when the counter of months reaches 12.

Problems We Faced

(1) The counters of days and months must starts counting from 1 not zero. So we added 74S283 4-Bit Binary Adder to add 1 with the output of the counter.

74S283 Connection Diagram, Truth Table and Logic Diagram



Function Table

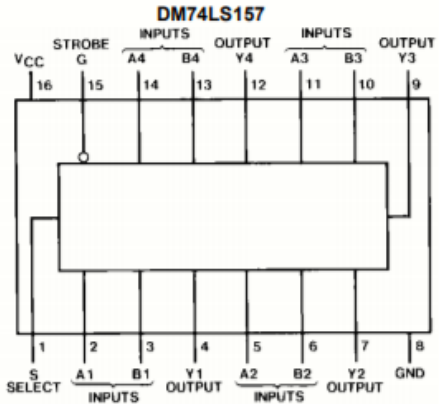
Input				Output					
				When CO = L			When CO = H		
						When C2 = L			When C2 = H
A1 / A3	B1 / B3	A2 / A4	B2 / B4	Σ1 / Σ3	Σ2 / Σ4	C2 / C4	Σ1 / Σ3	Σ2 / Σ4	C2 / C4
L	L	L	L	L	L	L	H	L	L
H	L	L	L	H	L	L	L	H	L
L	H	L	L	H	L	L	L	H	L
H	H	L	L	L	H	L	H	H	L
L	L	H	L	L	H	L	H	H	L
H	L	H	L	H	H	L	L	L	H
L	H	H	L	H	H	L	L	L	H
H	H	H	L	L	L	H	H	L	H
L	L	L	H	L	H	L	H	H	L
H	L	L	H	H	H	L	L	L	H
L	H	L	H	H	H	L	L	L	H
H	H	L	H	L	L	H	H	L	H
L	L	H	H	L	L	H	H	L	H
H	L	H	H	H	L	H	L	H	H
L	H	H	H	H	L	H	L	H	H
H	H	H	H	L	H	H	H	H	H

H = HIGH Level, L = LOW Level
Note: Input conditions at A1, B1, A2, B2, and C0 are used to determine outputs Σ1 and Σ2 and the value of the internal carry C2. The values at C2, A3, B3, A4, and B4 are then used to determine outputs Σ3, Σ4, and C4.

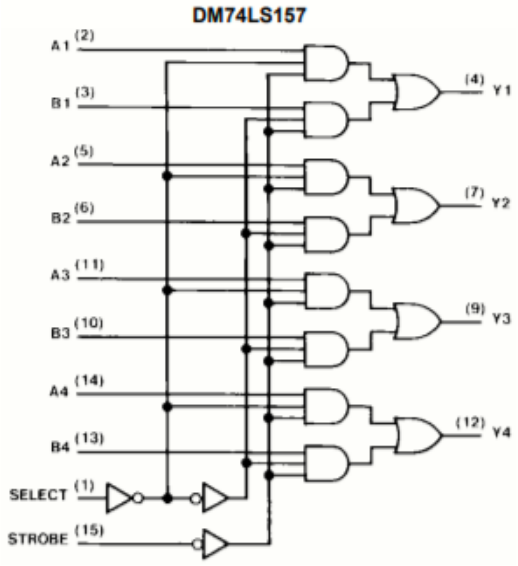
(2) Here there is another problem, when the counter reaches to 9, the output of the adder is 10 (the input of the 7-segmant). But the 7-segmant cannot display number 10, so we used 74LS157 2 to 1 Mux.

74LS157 Connection Diagram, Truth Table and Logic Diagram

Connection Diagram



Logic Diagram

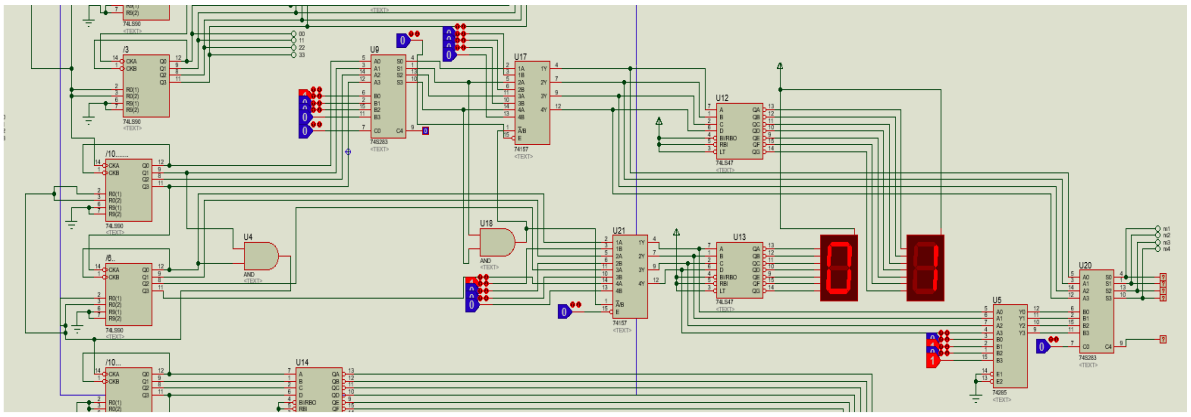


Function Table

Inputs				Output Y
Strobe	Select	A	B	DM74LS157
H	X	X	X	L
L	L	L	X	L
L	L	H	X	H
L	H	X	L	L
L	H	X	H	H

In 74LS157 2 to 1 Mux, strobe bit works as a switch. If strobe bit is high, the output of the multiplexer is low. And if strobe bit is low, the output of the multiplexer depends on its enable.

For the counter of months, Mux outs the input of the adder if its enable is low. But if its enable is high, it displays zero on the ones seven segment and one on the tens seven segment.

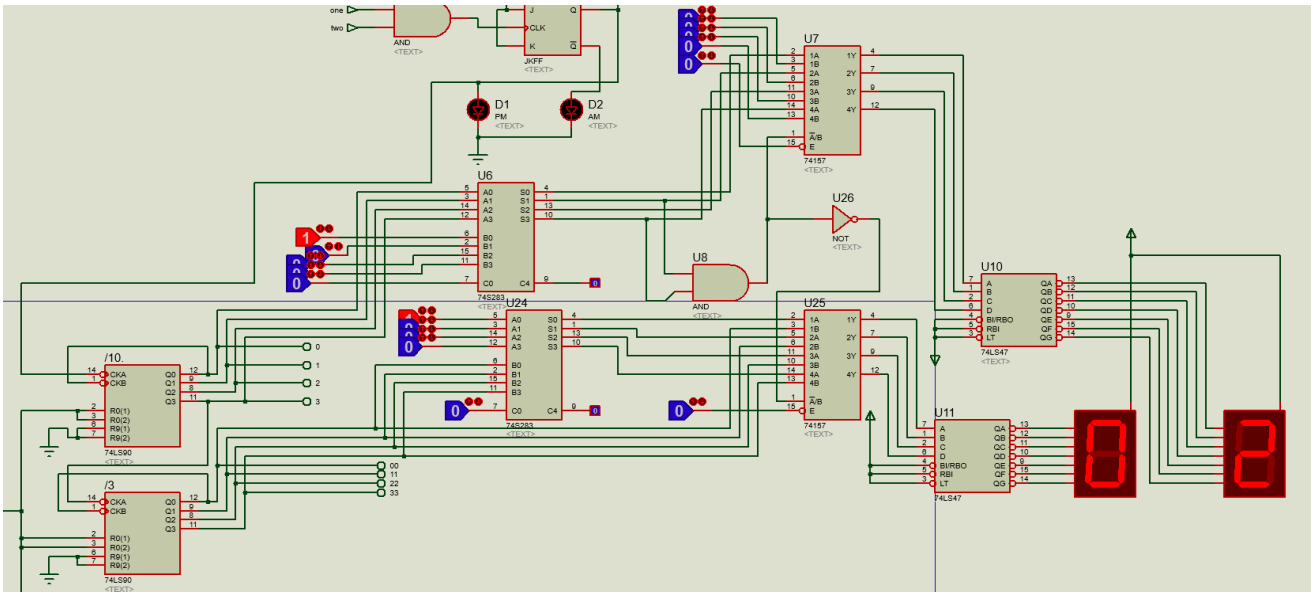


The counter of months

For the counter of days, the counter starts counting until it reaches 30 or 31 so we added two multiplexers, one for the ones counter and the another for the tens counter,.

The first Mux outs the input of the adder (which connected with the ones counter) if its enable is low. But if its enable is high, it displays zero.

The second Mux outs the input of the other adder (which connected with the tens counter of days) if its enable is low. But if its enable is high, it outs the input of the tens counter without adding 1.

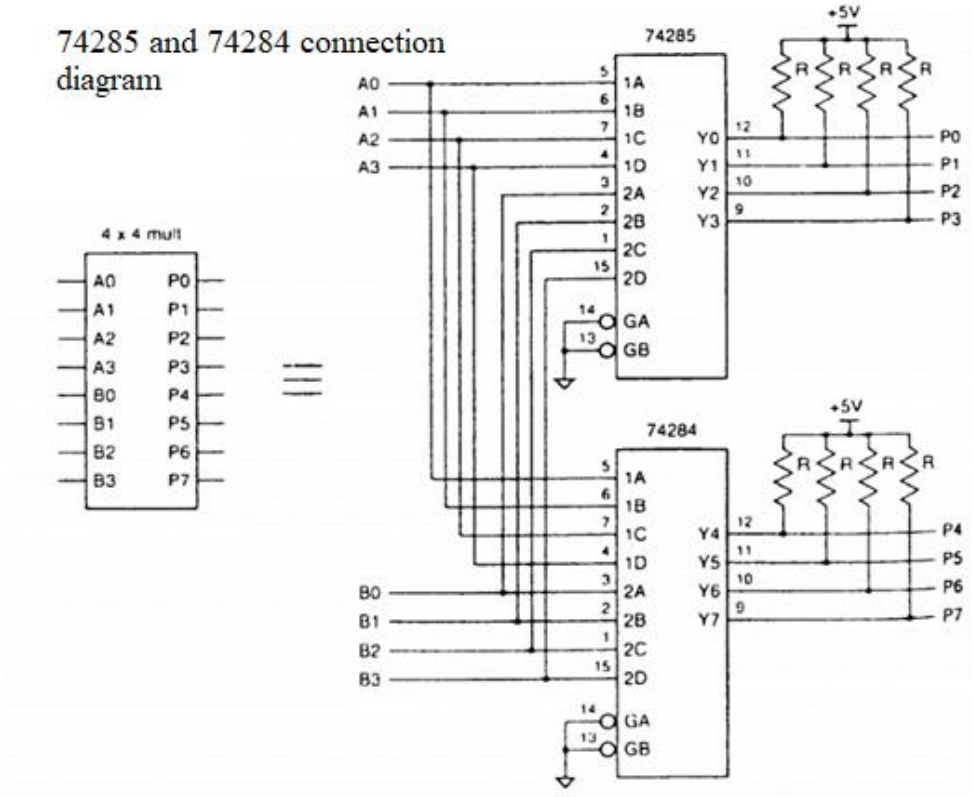


The counter of days

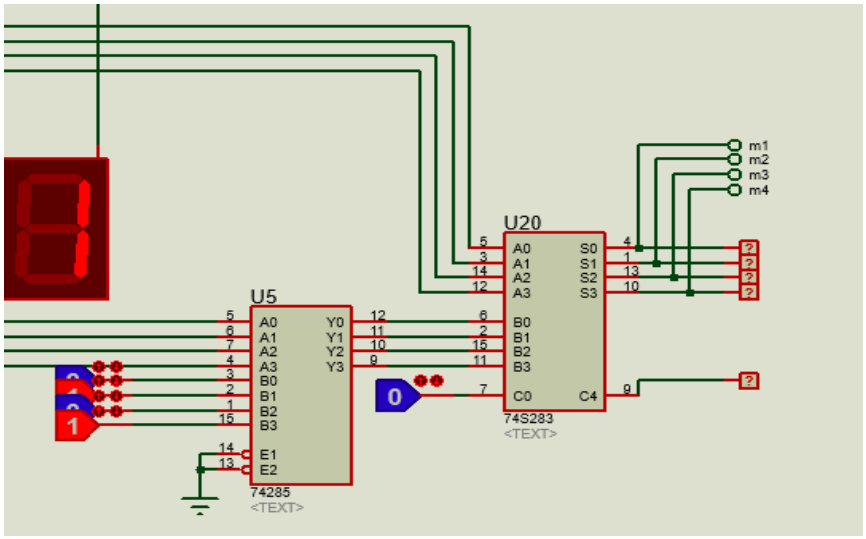
(3) To make the separate circuit (which controls in which day the counter of days should reset) reads the number of month, we used a decoder that its inputs are binary. But the number of the month represented as BCD number, so we connected a 74285 Multiplier to multiply 10 with the output of the tens counter of months then add it with the output of the one counter of months using 4-bit Adder.

Here, we could convert the number of month from BCD number to binary number.

74285 Connection Diagram, Truth Table and Logic Diagram



In this connection, we did not need to use a 74284 Multiplier as the largest number which 12 can be represented in 4 bit.



Connecting a 74285 Multiplier with the output of the tens counter of months.

Datasheets

74LS90 Counter Datasheet

https://drive.google.com/file/d/1vCNccZcSn9S_OO7hYd2CwmJRpHN-xQGP/view?usp=sharing

74S283 4-Bit Binary Adder Datasheet

https://drive.google.com/file/d/17xtmSZob1n-XFZ3jHhmElOb75JFKrj--/view?usp=sharing

74LS157 2 to 1 Multiplexer Datasheet

https://drive.google.com/file/d/1ySKzXUMMKSopk2vJZ4Ar_QcgfpNYQ8zo/view?usp=sharing

74285,74284 Multiplexer Datasheet

https://drive.google.com/file/d/100SUh3dHnF5uzxdXBjxhGSmcsS_Yc76u/view?usp=sharing