National Institute of Technology Karnataka

Computer Science Department

Digital System Project

Multisim simulation of a Soccer Scoreboard

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Multisim simulation of a Soccer Scoreboard

Objective:

This project aims at designing and implementing a circuit using multisim to manage the scoreboard in a game of soccer.

Scope:

The scope of this concept and its implementation is extended to many spheres as it includes 7segment display, counters, timers, comparators and many other digital design components provided by multisim.

Multisim:

Multisim is an electronic schematic capture and simulation program which is part of a suite of circuit design programs, along with NI Ultiboard. It is used for software simulation.

Introduction:

Digital electronics, or digital (electronic) circuits, represent signals by discrete bands of analog levels, rather than by a continuous range. Digital techniques are useful because it is easier to get an electronic device to switch into one of a number of known states than to accurately reproduce a continuous range of values.

Digital electronic circuits are usually made from large assemblies of logic gates, simple electronic representations of Boolean logic functions. An advantage of digital circuits when compared to analog circuits is that signals represented digitally can be transmitted without degradation due to noise.

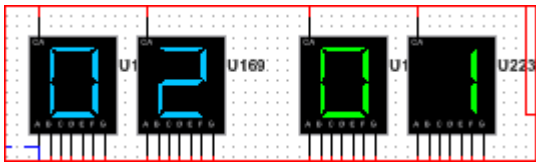
Soccer is a game played between 2 teams. In this project, we assume a soccer game lasts for 45 minutes. Team A and Team B try to make the maximum number of goals in this time, and their scores will be updated correspondingly, which will be displayed via a 7 segment display. The timer of 45 minutes can be halted anytime in between the game though the points will be updated only when the timer is running. The winner team will be displayed to the audience after every change in the scoreboard.

The precision of the game has been maintained by displaying the time in minutes and seconds.

List of Components:

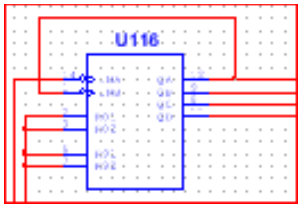
1. 7 segment display

   It is a form of electronic display device for displaying decimal numerals that is an alternative to the more complex dot matrix displays. The purpose of this is to display the scores of Team A and Team B, the time in minutes and seconds as well as the winner team after every modification in the scoreboard (A, B or – in case of a tie in the scores of the 2 teams). It has been constructed using the Hex display component in multisim along with a circuit to simulate it.



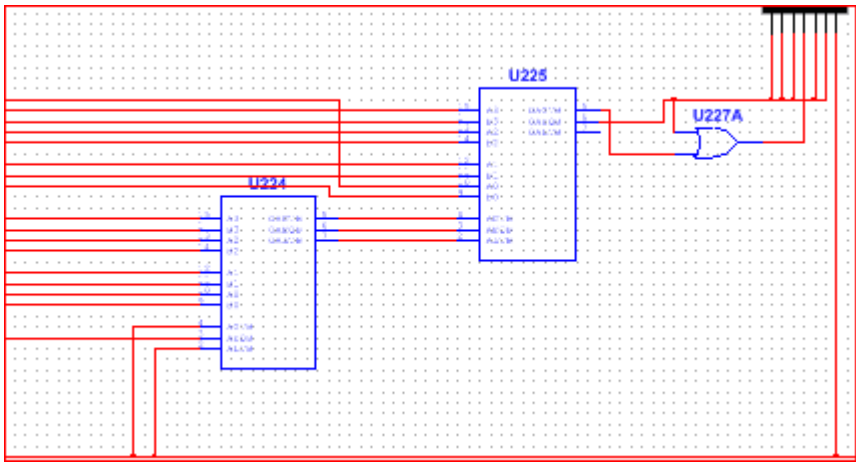
2. Decade Counter

   A decade counter is one that counts in decimal digits, rather than binary. A decade counter may have each (that is, it may count in binary-coded decimal, as the 7490 integrated circuit did) or other binary encodings. It is a binary counter that is designed to count to 1010b (decimal 10). The purpose of this is to increment the digits of the scores of Team A and B. The units digit is incremented from 0 to 9, and then instead of displaying 10, the tens digit gets incremented and the units digit is reset to 0. This decade counter has also been used to design a mod 45 and mod 60 counter for the minutes and seconds of the timer respectively.



3. Comparators

A digital comparator or magnitude comparator is a hardware electronic device that takes two numbers as input in binary form and determines whether one number is greater than, less than or equal to the other number. The purpose of this is to compare the scores of the 2 teams and display the winner team.



4. Basic Gates

AND, OR, and NOT gates are the basic building blocks of any electronic circuits. They are called the basic logic gates. The purpose of this is to construct the circuit which is going to prelude the 7 segment display, the implementation details of which are explained in the subsequent pages.

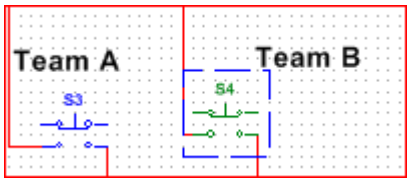
5. Universal Gates

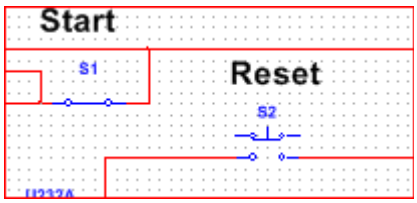
NOR gates alone or alternatively NAND gates alone can be used to reproduce the functions of all the other logic gates.

6. Switches

4 switches have been used. S1 is used to halt the timer. As long as this switch is closed, the timer continues and if we wish to halt the timer, we can open the switch and the timer will freeze. S2 is used as a reset switch. If we click on this switch while the timer is running, then the minutes and

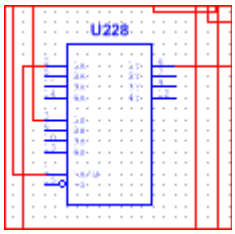
the seconds automatically reset to 00, and the timer stops there. On pressing this switch once again, the timer starts from 00 itself. S3 is used to add a point for Team A. When we press this switch, the score of Team A gets incremented by 1, and same is he function of switch S4 for Team B.





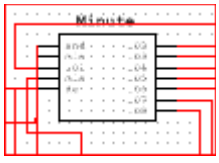
7. Multiplexer

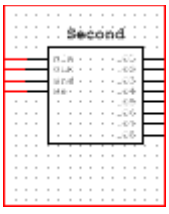
2 Multiplexers are used. One of them is used to halt the timer when the switch is open. The inputs are GND and clock, and the select line is the switch. The output is connected to the clock of the timer. So when the switch is open, its value is 0, and then the output of the 2:1 MUX is GND, and that is fed as the clock. So the timer stops. When the switch is closed, its value is 1. So the output of the MUX is clock and the timer continues. The second 2:1 MUX is used for the purpose that when the reset switch is pressed once, the timer gets reset to 00 and then it stops. Only when the reset switch is pressed again, the timer starts.



8. Counter

The timer has to stop in 2 cases, either when the minute display shows 45 or when it is reset to 00. So to keep track of these 2 cases, an extra counter is used. Mod 45 and mod 60 counters are also used.



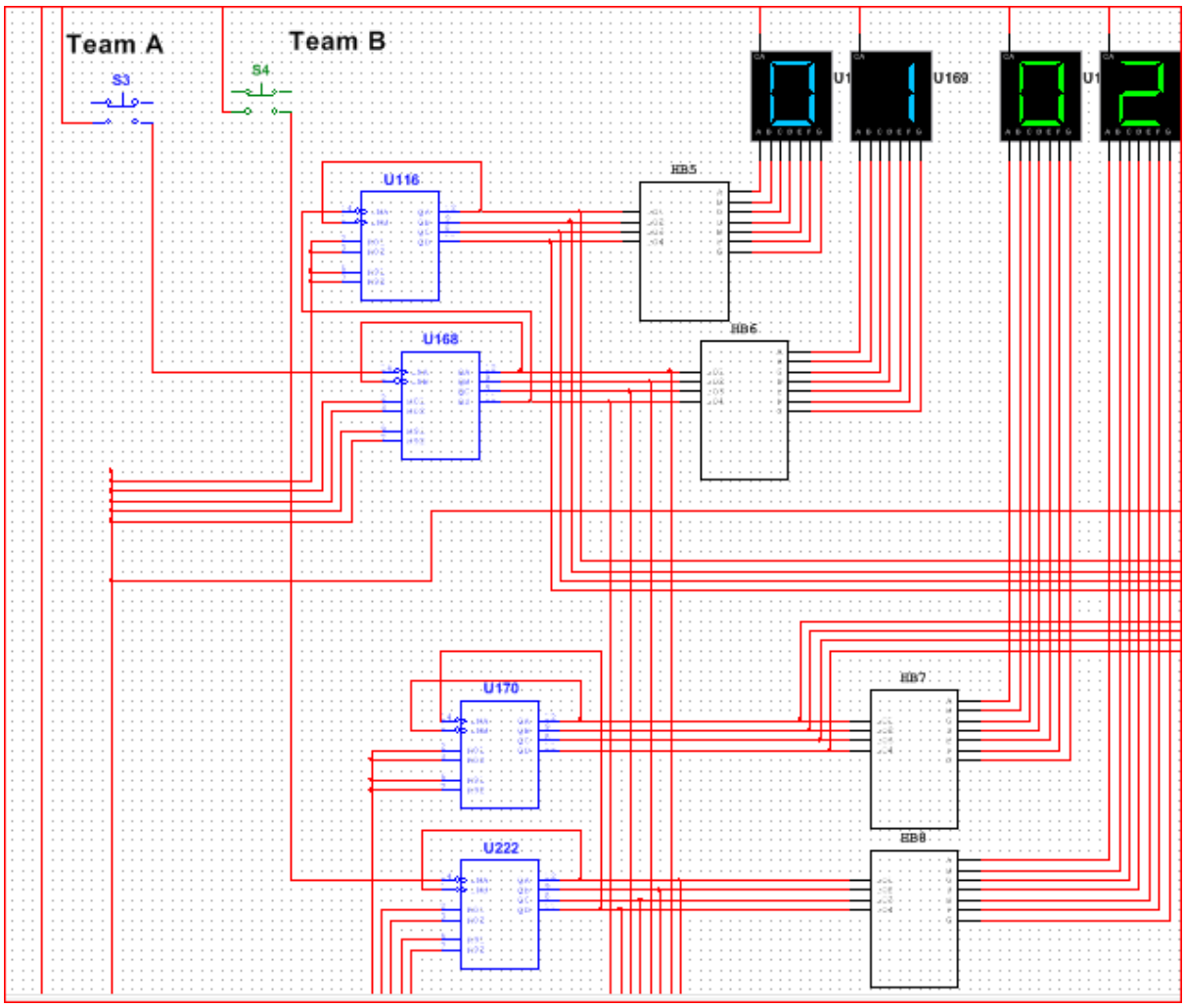


9. Clock

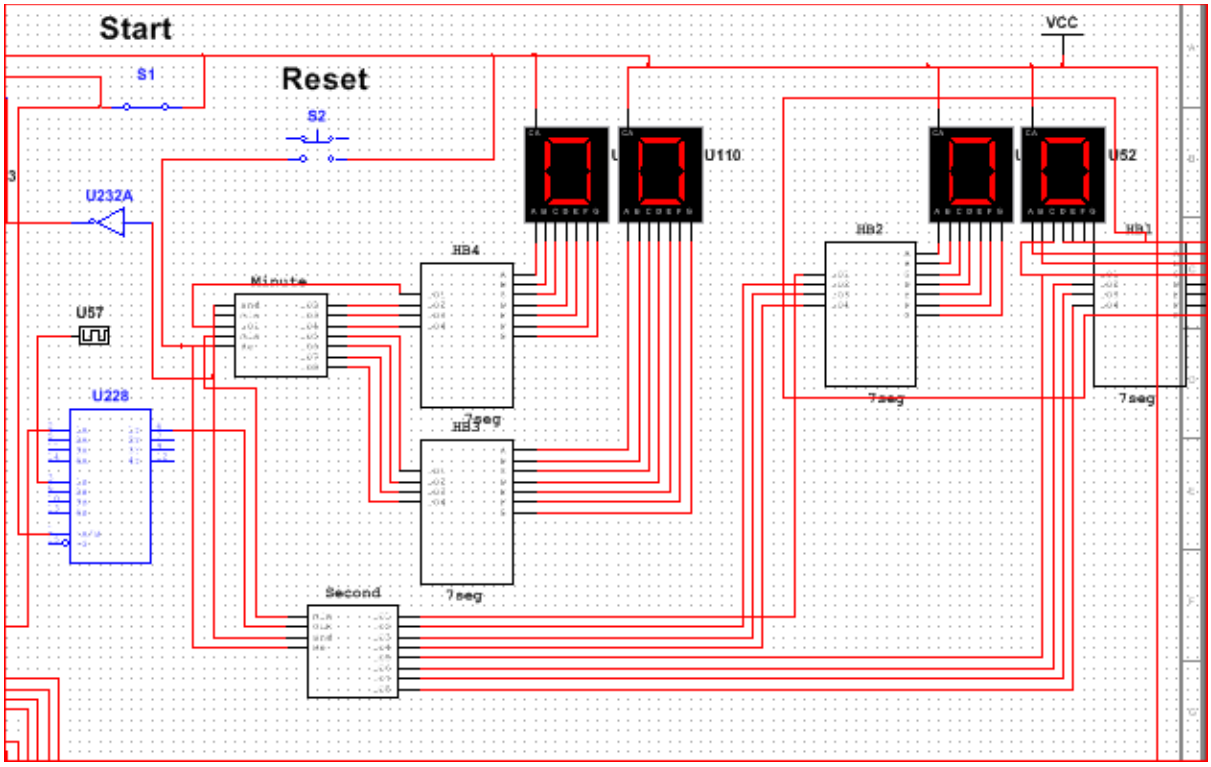
The clock is used for the counters. It is used as input to the MUX, whose output is sent as the clock.

Logic Circuit (Main and Sub-circuits)

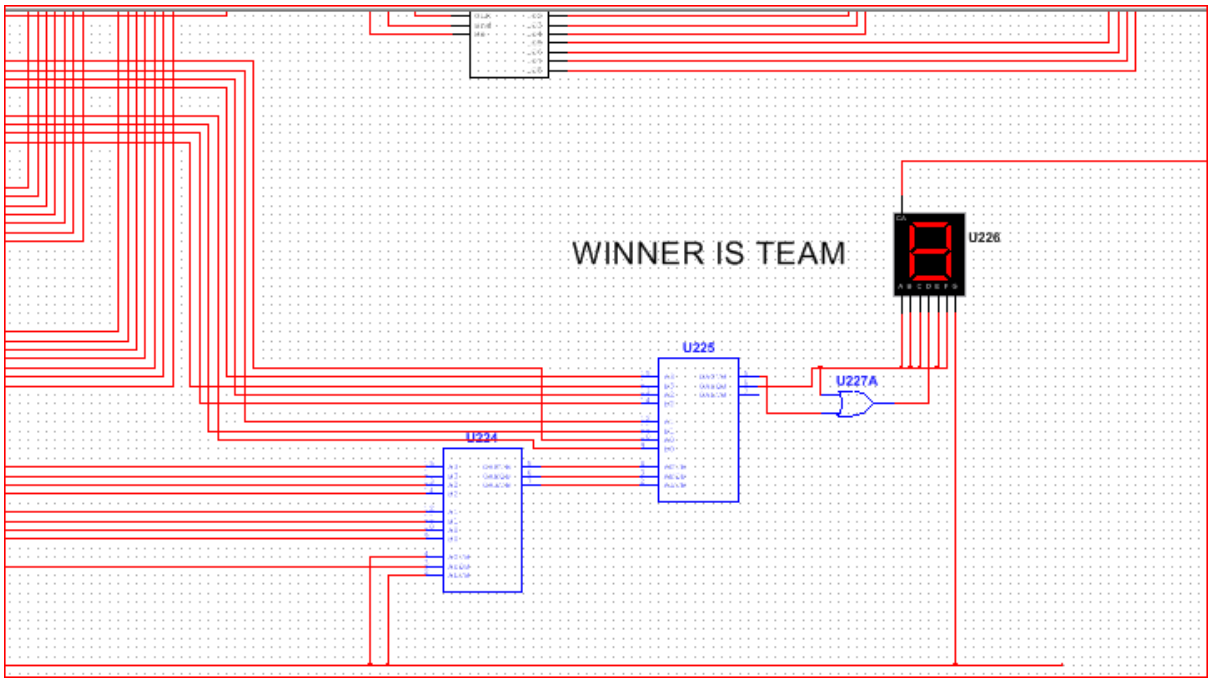
The different parts of the logic circuit are:



This shows the score of the 2 teams A and B. To increment the score of team A, switch S3 is pressed, and to increment the score of team B, switch S4 is pressed. There are decade counters used for each digit of the score, so that when the value reaches 9, it gets reset to 0. The circuit used before the display is the circuit for implementing the 7 segment display.



This is the timer where the minutes part has been constructed using a mod 45 counter, and the seconds part has been constructed using a mod 60 counter. The outputs of these are again fed to the circuit for the 7 segment display. There is a 2:1 MUX used In this part. The inputs are GND and clock. The select line is switch S1. So when S1 is closed, its value is 1, and the output of MUX is clock. This is connected to the clock of the counters. When switch is open (value is 0), output of MUX is GND and the clock gets halted.



This circuit contains 2 comparators, which compare the scores of team A and B and display the winner team after each modification of the scoreboard. It uses 7 segment display.

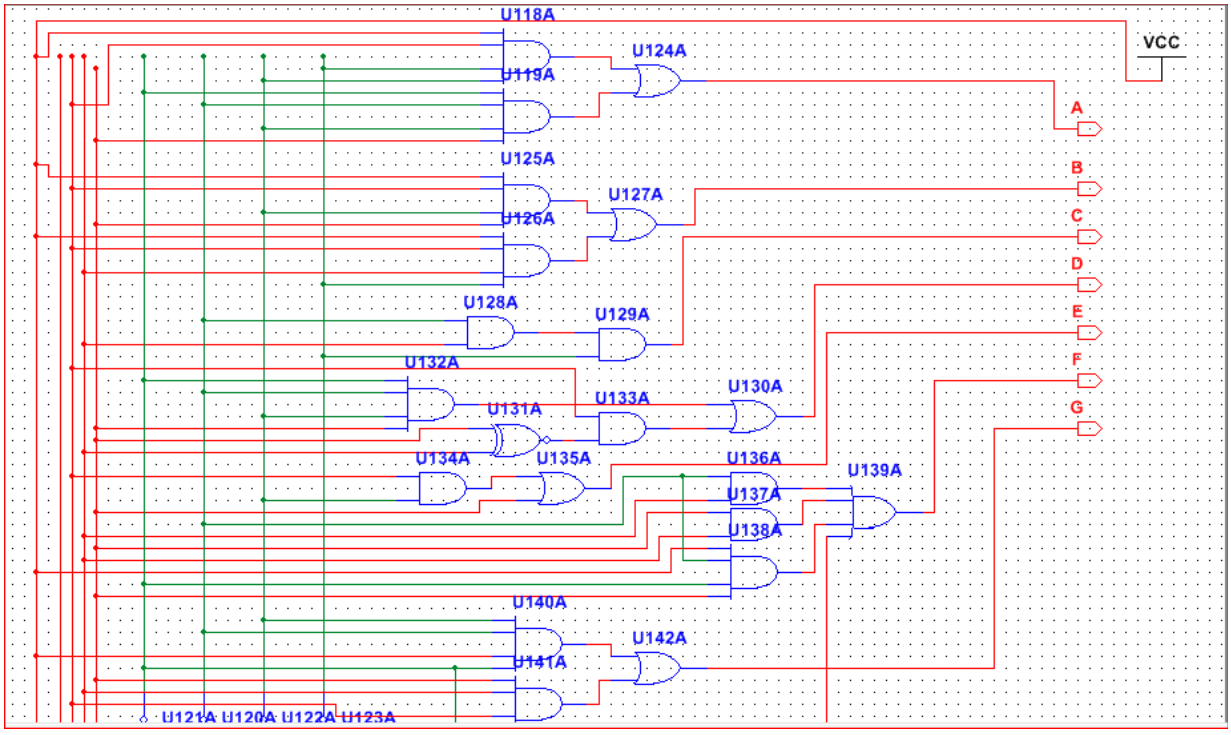
Implementation Details

The circuit used for the 7 segment display was created with the following table.

w	x	y	z	a	b	c	d	e	f	g
0	0	0	0	0	0	0	0	0	0	1
0	0	0	1	1	0	0	1	1	1	1
0	0	1	0	0	0	1	0	0	1	0
0	0	1	1	0	0	0	0	1	1	0
0	1	0	0	0	0	0	1	1	0	0
0	1	0	1	0	1	0	0	1	0	0
0	1	1	0	0	1	0	0	0	0	0

0	1	1	1		0	0	0	1	1	1	1
1	0	0	0		0	0	0	0	0	0	0
1	0	0	1		0	0	0	0	1	0	0

These values have been implemented using K-maps and the expressions for a,b,c,d,e,f,g were formed accordingly. The combined circuit of these was made and represented as the sub-circuit of the 7 segment display.

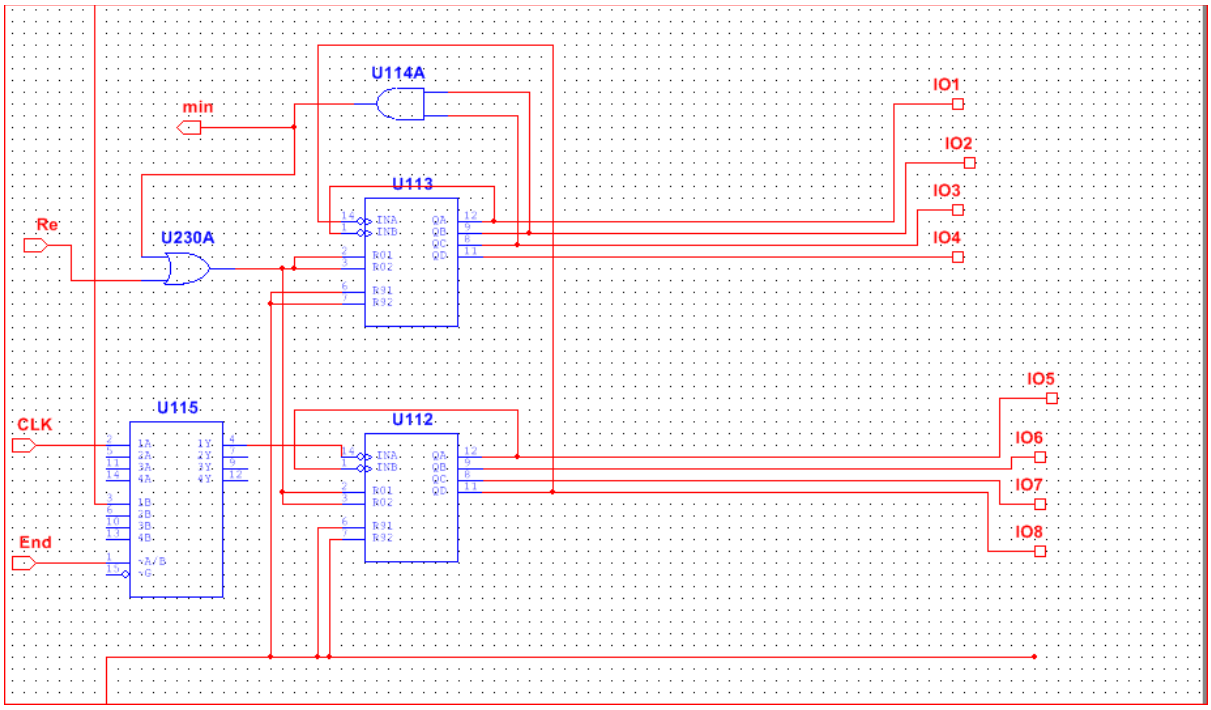


This is the sub-circuit used.

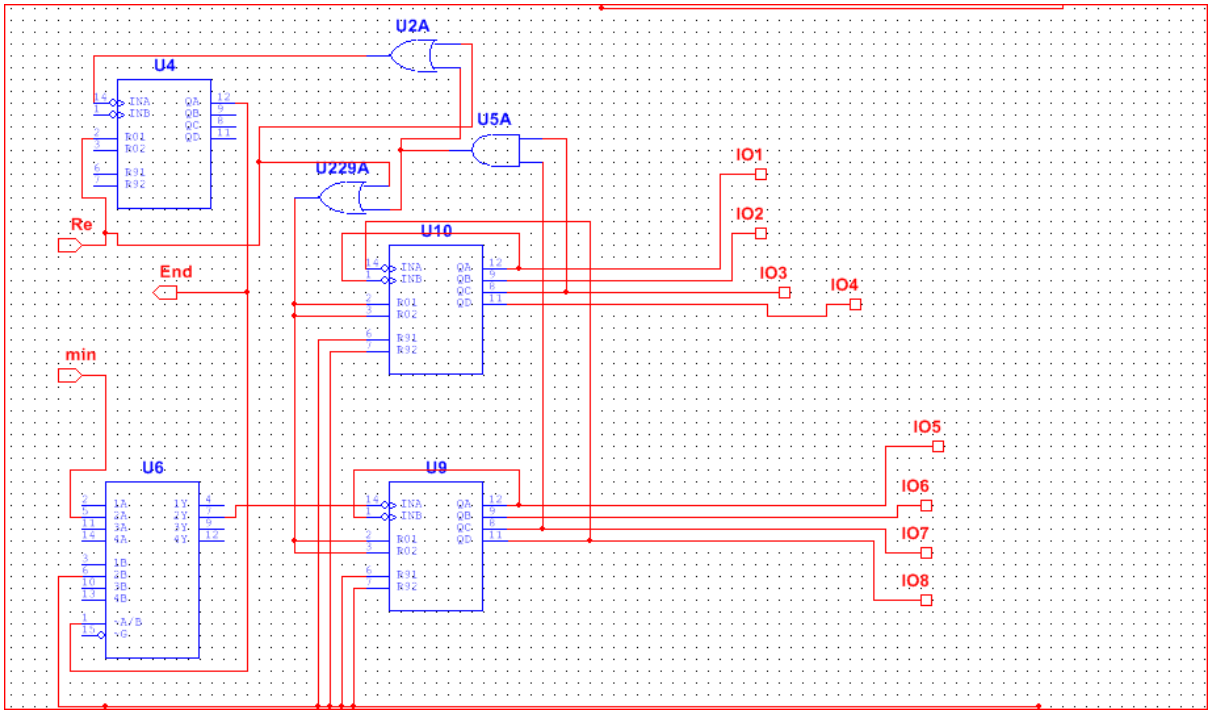
Timer Logic

In the timer, the minutes display counts from 00 to 45, and the seconds display counts from 00 to 60. The more significant output of the second display acts as the clock to minute display while the standard clock is used for the clock of the second. The seconds and minutes display logic uses a mod-60 and mod-45 counter respectively. The Mod-60 counter is made of a mod-6 and a mod-10 counter cascaded. The mod-6 counter is triggered only after 10 cycles of the mod-10 counter. All these counters use the default multisim decade counter available in its memory library.

Mod-60 counter sub circuit



Mod-45 counter sub circuit



Switch logic

Switch S1 is used to pause the timer. When it is pressed once, the timer halts, and when pressed again, it continues counting from the stopped time itself. Switch S2 is used for the reset of the timer. When this switch is pressed once, the timer gets reset to 00 and halts. Only when it is pressed again the timer starts counting from 00. Switches S3 and S4 are used to increase the scores of Team A and B respectively. Every time the switch is pressed, the score gets incremented by 1 and is displayed on the 7 segment display.

Comparator Logic

The 4-bit comparator used here compares the present scores of Team A and B, and displays the output. If the score of A is more than that of B, then it displays ‘A’, if the score of B is more than A, then it displays ‘B’, and if their scores are equal, then it displays ‘-‘, via the 7 segment display.

Multiplexer Logic

A 2:1 MUX is used in 2 places. Firstly, its used to halt the timer when the switch S1 is pressed. The inputs to the MUX are GND and Clock, the select line is the switch S1, and the output is fed to the clock of the timer. So when the switch is open, its value is 0, and the output of the MUX is GND, so the clock of the timer halts. When the switch is closed, the output of the MUX is clock, and that goes to the clock of the timer, and so it continues at its normal pace. The second MUX is used so that when the switch S2 is pressed, the timer should reset to 00, and halt. Only when it is pressed again, it should start counting from 00.

Merits of the design

1. Multisim enables us to implement various components like 7segment display, counters, multiplexers, comparators, switches and many more. This design has been created using the above mentioned components. It provides a visual picture of a scoreboard, the timer and also how the winner team changes after every modification in the scoreboard.

2. We are able to understand the procedure involved behind the working of these different components and the respective connections made.

3. The 7segment display which enables the score, the time and the winner team to be displayed in different colours and formats makes the design visually appealing.

4. It is a systematic design which has been appropriately labelled to provide a clear picture of this concept.

Demerits of the design

1. It looks complicated, and hence difficult to understand.

2. The various connections make the design look confusing enough to understand without any explanation.

List of References

1. Wikipedia

2. Tutorials on multisim