Activity 3.2.3

Asynchronous Counters: Medium-Scale Integration (MSI) Suspend/Reset Counts

INTRODUCTION

Manufacturers of integrated circuits frequently take digital circuit designs, which are commonly implemented with SSI gates, and create equivalent Medium-Scale Integrated (MSI) circuits. The 74LS93 4-Bit Counter is an example of an MSI circuit.

In this activity, we will simulate and analyze a 4-Bit **asynchronous counter** using a 74LS93 4-Bit Counter. We will also explore how to suspend a count and reset a count.

EQUIPMENT

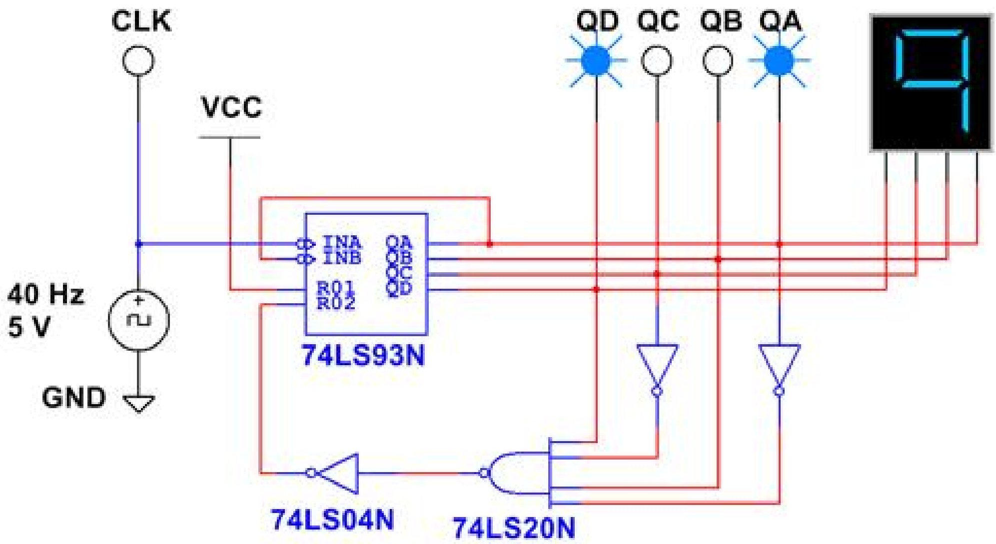
- Circuit Design Software (CDS)

RESOURCES

Asynchronous Counters with MSI Gates

Procedure

1 The circuit shown below is a 4-Bit Binary **Up Counter** implemented with 74LS93 MSI Counter IC. This design counts from 0 to 9 and then repeats.



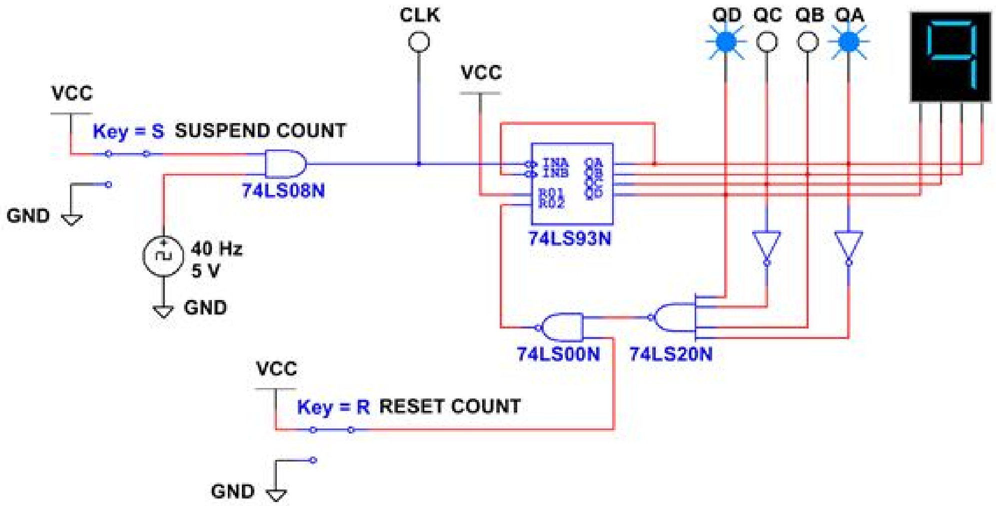
4-Bit Binary Up Counter

a. Using the CDS, enter the 4-Bit Binary Up Counter. Add a four-channel oscilloscope to monitor the signals QD, QC, QB, and QA. Run the simulation and capture a full count cycle (0–9) of the signal. Verify that the circuit is working as expected. If the results are not what you expected, review your circuit and make necessary corrections.
b. Make the necessary modification to this circuit to change the count limit to C (1100). Run the simulation and verify that the circuit is working as expected. If not, review your circuit, make necessary corrections, and retest.

2 The circuit below is the same as the 0–9 4-Bit Binary Up Counter implemented in step 1, with a few modifications.

First, a Single Pole Double Throw (SPDT) switch (S) and a 2-input AND gate were added to the clock input. This modification provides a means for the count to be suspended.

The second modification, the addition of a second (SPDT) switch (R) and a 2-input NAND gate, provides a means to reset the count to zero.



Modified 4-Bit Binary Up Counter

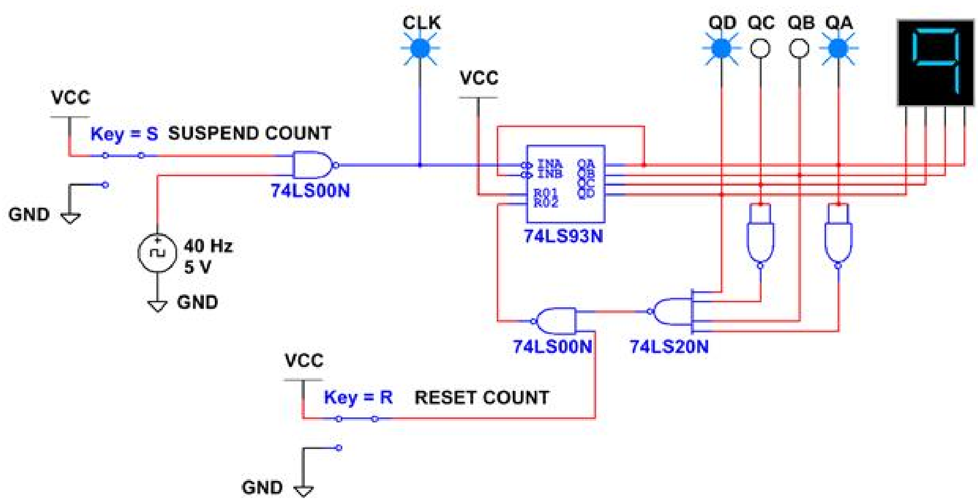
a. Using the CDS, enter the Modified 4-Bit Binary Up Counter.
b. With the switches (S) and (R) set to 5V, start the simulator. Verify that the circuit is working as expected. If the results are not what you expected, review your circuit and make necessary corrections. You may need to adjust the simulation speed to observe the outputs changing.
c. With the simulation running, toggle the switch (S) switch to GROUND.
   What effect does this have on the output?
   Toggle switch (S) back to 5V.
   What effect does this have on the output?
d. With the simulation running, toggle the switch (R) switch to GROUND.
   What effect does this have on the output?
   Toggle switch (R) back to 5V.
   What effect does this have on the output?

CONCLUSION

1 What are the advantages of implementing an asynchronous counter with the 74LS93 integrated circuit versus using discrete flip-flops and gates?

2 Are there any disadvantages to using the 74LS93 integrated circuit?

3 The circuit shown below is functionally equivalent to the counter simulated in step 2 of the procedure. Why is this implementation a better solution?



Proceed to problem