

DIG225-09

IC Synchronous Counters

Name: _____

Class: _____

Objectives

- To construct and demonstrate a synchronous decade counter circuit based on the 74LS160A.
- To construct and demonstrate a synchronous up/down counter circuit based on the 74LS190.
- Explain how a synchronous decade counter circuit works and draw the timing diagram.
- Explain how a synchronous up/down counter circuit works and draw the timing diagram.
- Analyze conditions that could be found in a faulty circuit and apply troubleshooting logic and skills for each of the circuits you build.

Discussion

Counters are found in many common circuits. Digital clocks are basically counters which count the 60Hz from the AC power supply and display it in terms of hours, minutes and seconds. Multiplexer and demultiplexer circuits depend on counters for synchronization.

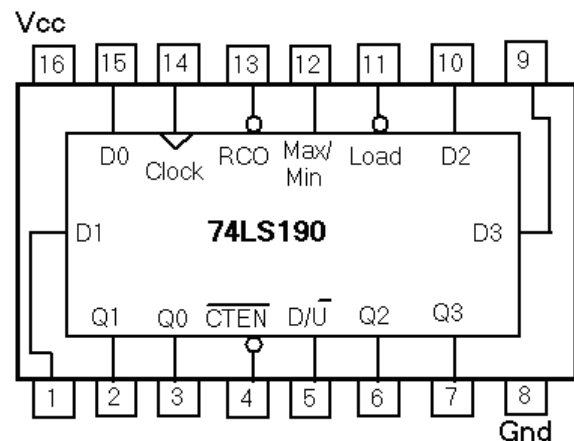
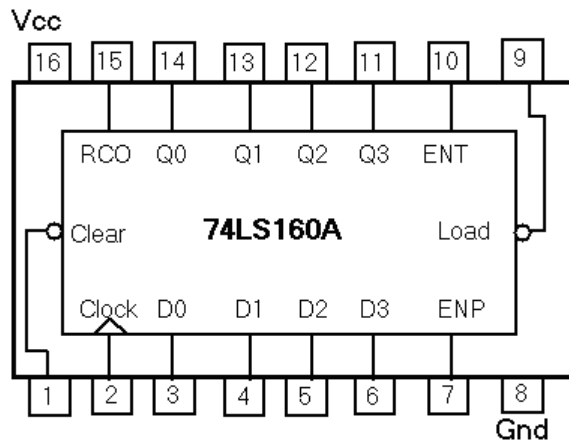
Counters are classified into two major groups:

- Asynchronous, and
- Synchronous

Materials Required

- 74LS160A Synchronous Decade Counter
- 74LS190 Synchronous Up / Down Counter

IC Pinouts



Preparation Questions

1. What is an **asynchronous** counter?

2. What is an **asynchronous** input?

3. What is a **synchronous** counter?

4. What is a **synchronous** input?

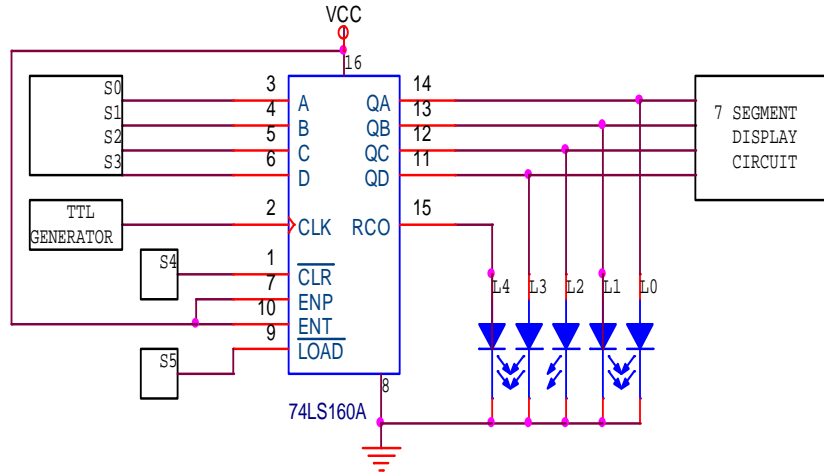
5. What is the **modulus** of a counter?

6. What is an **Up / Down** counter?

7. What is **parallel loading** of a counter?

Procedure

1. Construct the circuit shown here.



2. Complete the following steps before you demonstrate this circuit. When you have completed them, get the instructor signature.

Circuit Demo _____

3. Set all logic switches to zero.
4. Describe the count observed of the 7-segment display.

5. Apply a logic LOW followed by a HIGH on S4.
6. What effect did S4 have?

7. While the circuit is counting, set the logic switches to the BCD code for 6. Does setting the switches affect the counter?

8. Apply a logic LOW followed by a HIGH on S5.
9. What effect did S5 have?

10. Observe when L4 indicates a high on pin 15. What is its significance?

11. While the counter is operating normally, connect pin 7 low. What do you observe?

12. Reconnect pin 7 high.

13. While the counter is operating normally, connect pin 10 low. What happens?

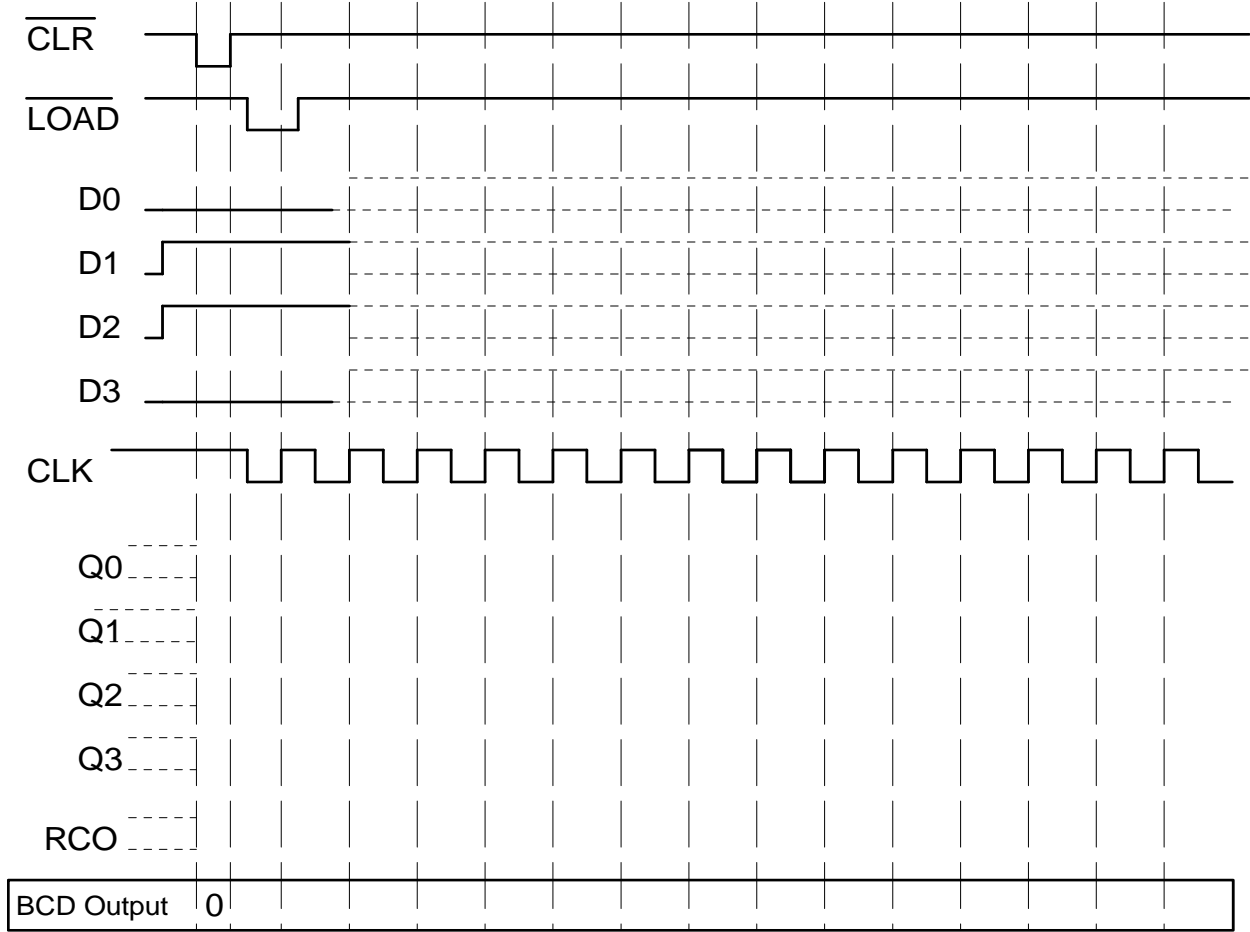
14. Why are pins 7 and 10 tied high?

15. What's the purpose of the LOAD function?

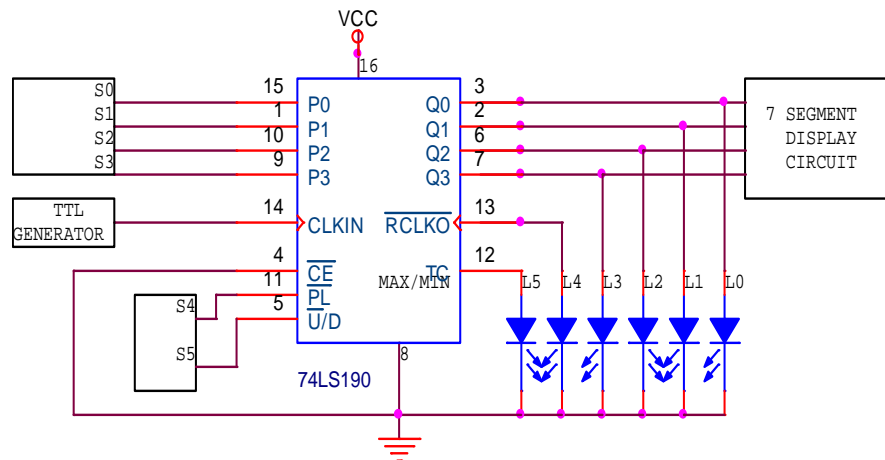
16. How could the RCO be used to create a cascaded counter circuit?

17. Complete the following timing diagram. You may have to be a little creative to obtain all the waveforms. For instance, you may decide to slow the clock down even further to have a chance to record the various outputs.

Timing Diagram for the 74LS160A



18. Construct the circuit shown here.



19. Complete the following steps before you demonstrate this circuit. When you have completed them, get the instructor signature.

Circuit Demo _____

20. Set the logic switches to 0000 then apply power.

21. When are LED's L4 and L5 being lit?
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-

22. While the counter is operating normally, set the logic switches to binary 5. Does setting the switches during counting affect the outputs?
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23. With the switches still set to 5, apply a logic LOW followed by a HIGH on S4. What do you observe?
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24. Apply a logic LOW on S5. What do you observe?
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25. Apply a logic LOW on S5. While S5 is LOW, apply a logic LOW followed by a HIGH on S4. What do you observe?
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26. What is the terminal count of the 74LS190 in UP mode? _____

27. What is the terminal count of the 74LS190 in DOWN mode? _____

28. During the entire procedure, pin 4 was tied to ground. If we didn't need it for counting up or counting down, describe an application that would use pin 4.

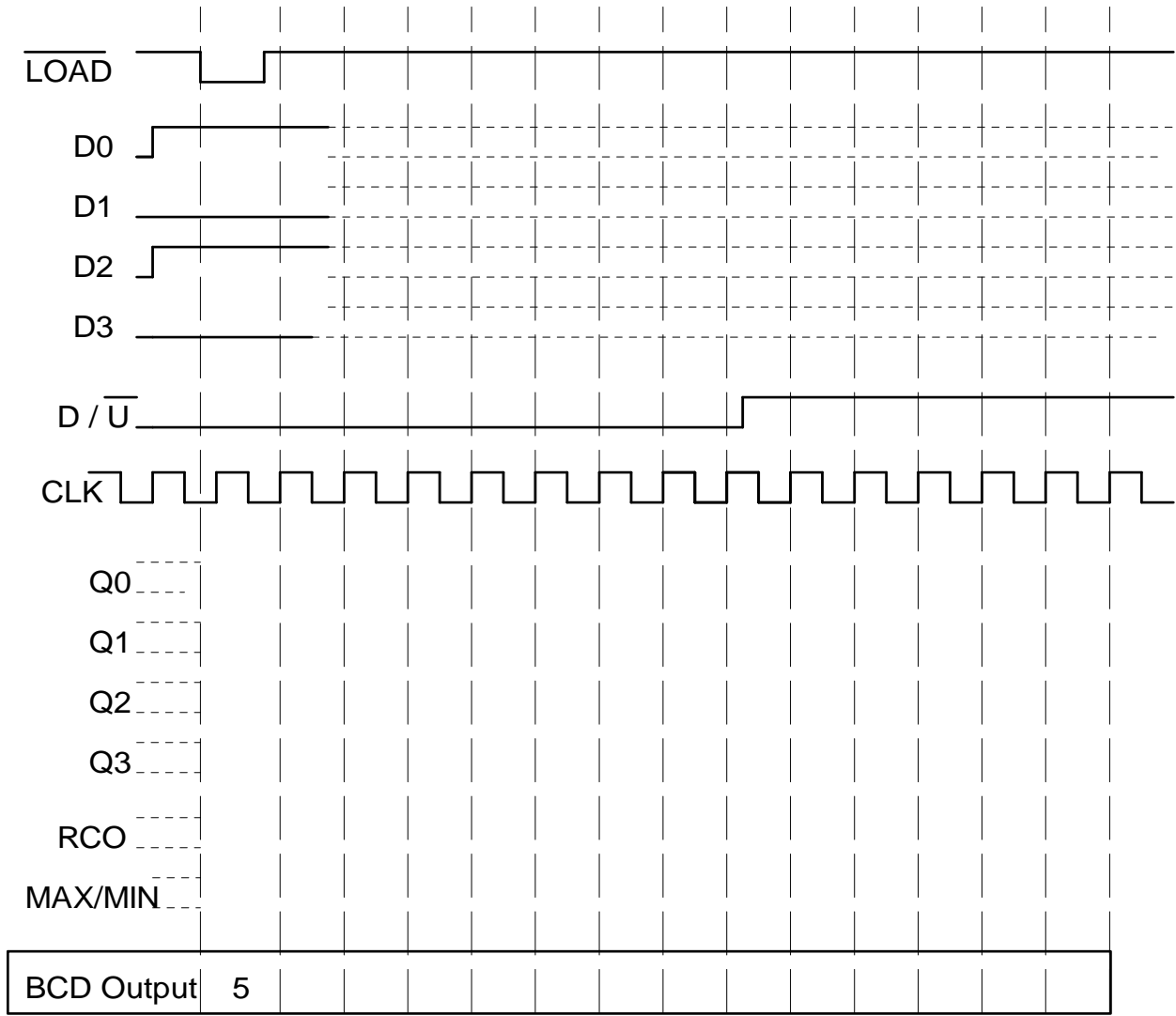
29. What was the purpose of the Max / Min output?

30. How is the RCO output different from the Max / Min output?

31. How would this counter have functioned in your circuit if pin 5 was internally open?

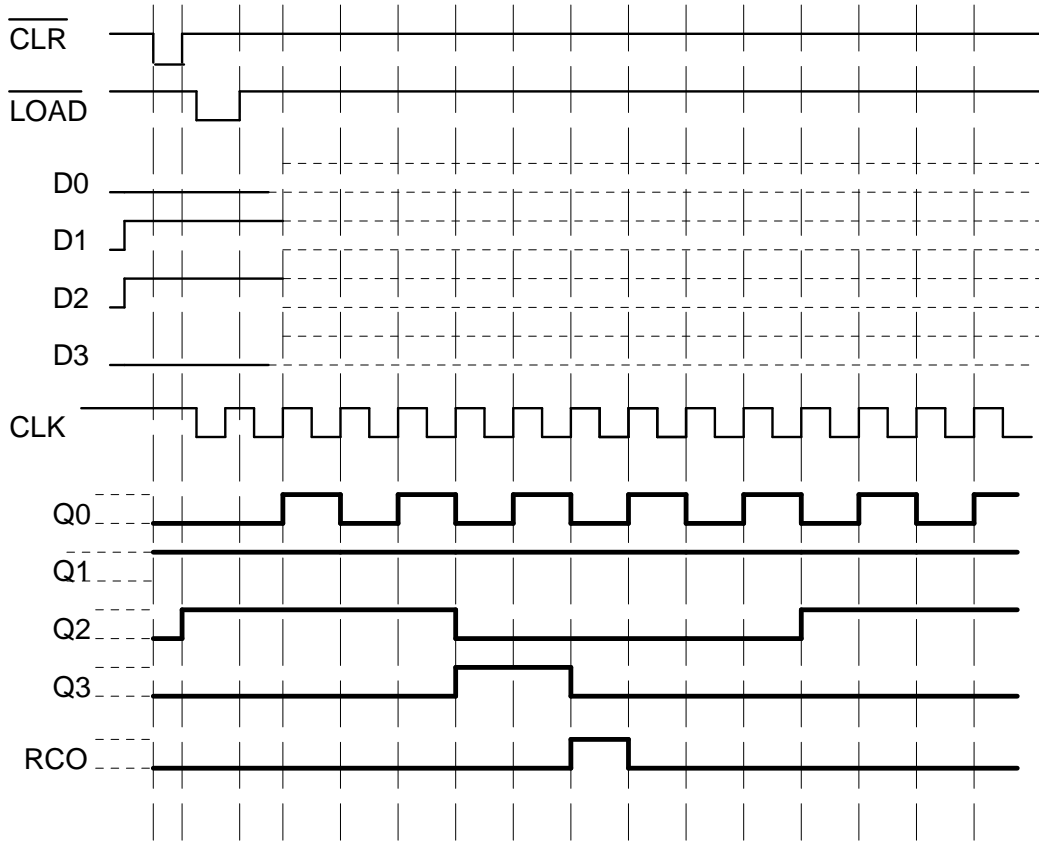
32. Complete the following timing diagram. You may have to be a little creative to obtain all the waveforms. For instance, you may decide to slow the clock down even further to have a chance to record the various outputs.

Timing Diagram for the 74LS190



Troubleshooting

33. Suggest a possible fault for the 74LS160A circuit constructed in this lab if it produces the following outputs:



Fault: _____