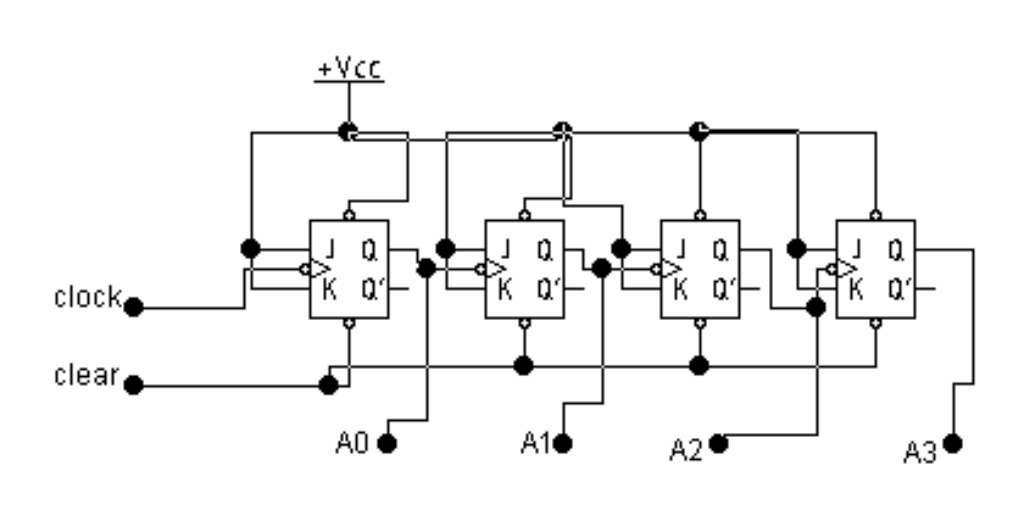
Lab 7: Counters

In this experiment, you will construct and test various ripple and synchronous counter circuits.

Preparation:

1. Ripple Counter

a. Construct a 4-bit binary ripple counter using two 7476 IC's. Connect all asynchronous preset inputs to logic-1, all clear inputs to a switch, and connect the count-pulse to another switch. Check the counter for proper operation.



b. Modify the counter so that it will count down instead of up. Check that each input pulse decrements the counter by 1.

2. Synchronous Counter

Construct a synchronous 4-bit binary counter and check it for proper operation. Use two 7476 IC's and one 7408 IC.

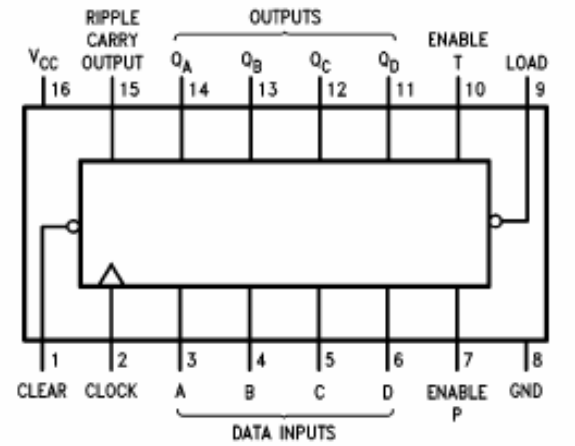
3. Decimal Counter

Design a synchronous BCD counter that counts from 0000 to 1001. Use two 7476 IC's and one 7408 IC. Test the counter for the proper sequence and determine whether it is self-starting .This is done by initializing the counter to each of the six unused states by means of the preset and clear inputs The application of pulses must transfer the counter to one of the valid states if the counter is self –starting.

4. *Binary Counter with Parallel Load*

IC type 74161 is a 4-bit synchronous binary counter with parallel load and asynchronous clear input. The pin assignment is shown below. The counter works as follows (see the functional table below):

- When the load signal is enabled, the four data inputs are transferred into the internal flip-flops, *QA* through *QD*, with *QD* being the most significant bit.
- There are two count–enable inputs called *P* and *T*. Both must be equal to 1 for the counter to operate. If either *P* or *T* goes to 0, the output does not change.
- The internal flip-flops are triggered by the positive transition of the clock pulse.
- The load input is enabled when equal to 0 (i.e.; active low). For the load input to work, the clear input must equal to 1.
- The carry-out output equals to 1 when all four data outputs equal to 1.



clear	clock	load	count	function
0	X	X	X	Clear outputs to 0
1	↑	0	X	Load input data
1	↑	1	1	Count to next binary value
1	↑	1	0	No change in output

Show how the 74161 IC together with a 2-input NAND gate can be made to operate as a synchronous BCD counter that counts from 0000 to 1001. Do not use the clear input. Instead, use the NAND gate to detect the count of 1001, which then causes all 0's to be loaded into the counter.

Lab Work:

1. Build the circuits you designed in part 1 of the preparation and check their operation.
2. Build the circuit of part 2 and check its operation.
3. Build the circuit you designed in part 4 and check its operation.

Questions:

1. Sketch the timing diagram for the outputs of 4-bit asynchronous counter which performs modulo 10 counting.
2. Using the 74161 counter IC, show how this chip can be used to count from 0 to 12.