ELE2EMI - Electronic Measurements and Instrumentation
Laboratory 6 - COUNTERS

September 10, 2007

1 Aim

To gain hands-on experience of using a popular MSI counter (the 74LS163) and a 7-segment LED display.

2 Expectations of your Report

Your lab report should describe all experimental details, including all circuit diagrams, and all observed results. You should also answer all questions.

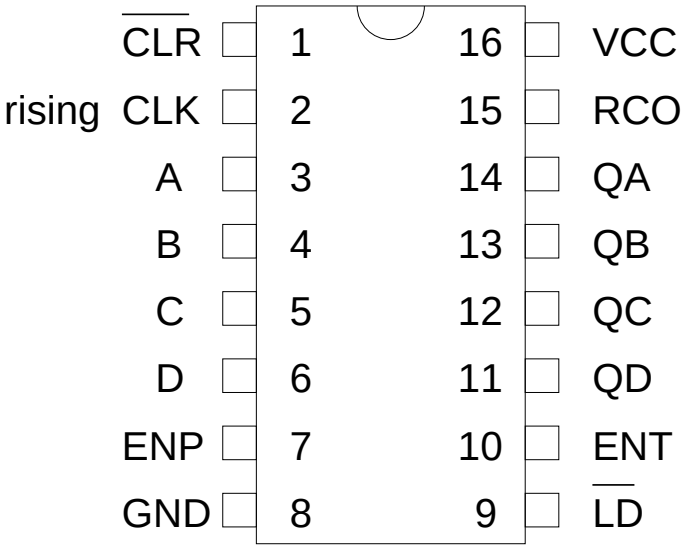
3 Components

3.1 Manifest

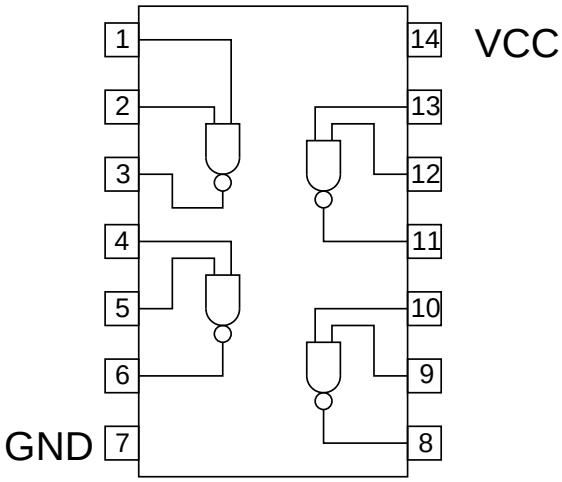
- 2 x 74LS163 counter ICs
- 74LS00 quad NAND gate IC
- 74LS04 hex INVERTER gate IC
- 7446 or 7447 BCD to seven-segment decoder IC
- 8 x 330 ohm resistors
- Seven-segment Common-Anode LED display (MAN72A or equivalent)

3.2 Pinouts

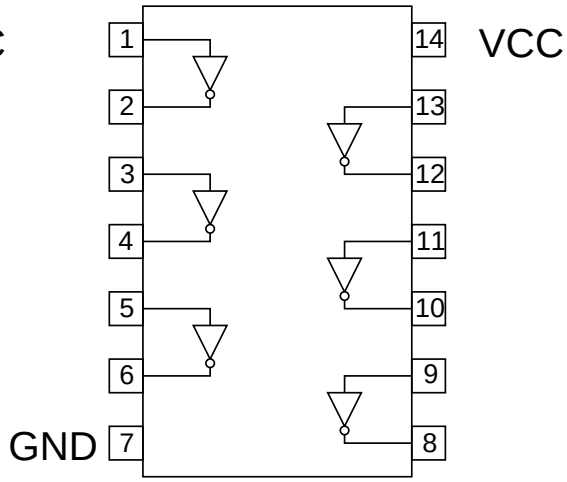
74LS163



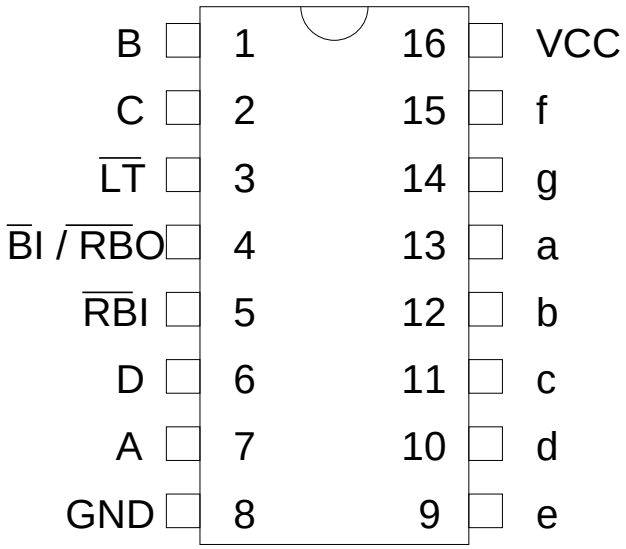
74LS00



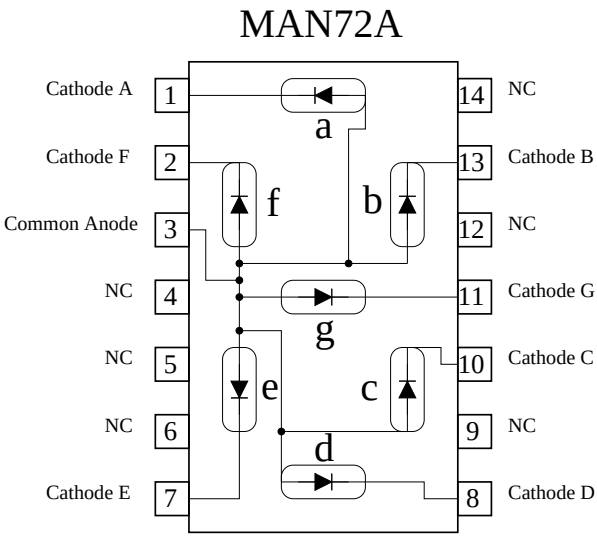
74LS04



7446 or 7447

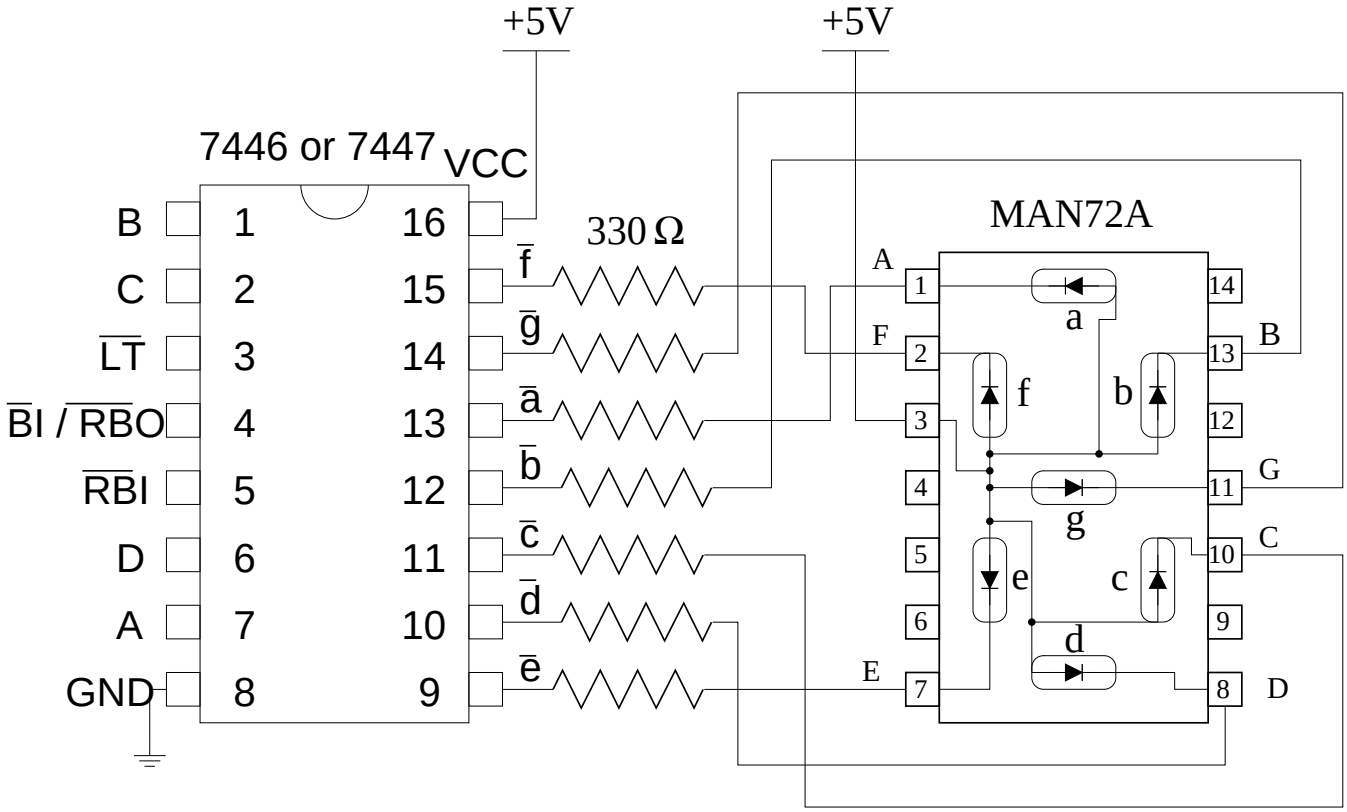


MAN72A



4 The BCD to 7-segment decoder circuit

Construct the circuit below, using 330Ω resistors.



- Note that the resistors between the decoder's outputs and the display's inputs are used to limit the current, and hence the brightness (and temperature) of the LEDs.

Question 1: Calculate the power consumption of each resistor, assuming that each LED has a 1.5 V drop and that each output of the 7446 (or 7447) decoder is at 0.2 V.

Experiment 1: Use all sixteen (16) combinations of BCD input logic levels to verify that your circuit works properly. Record the observed displays into the following table.

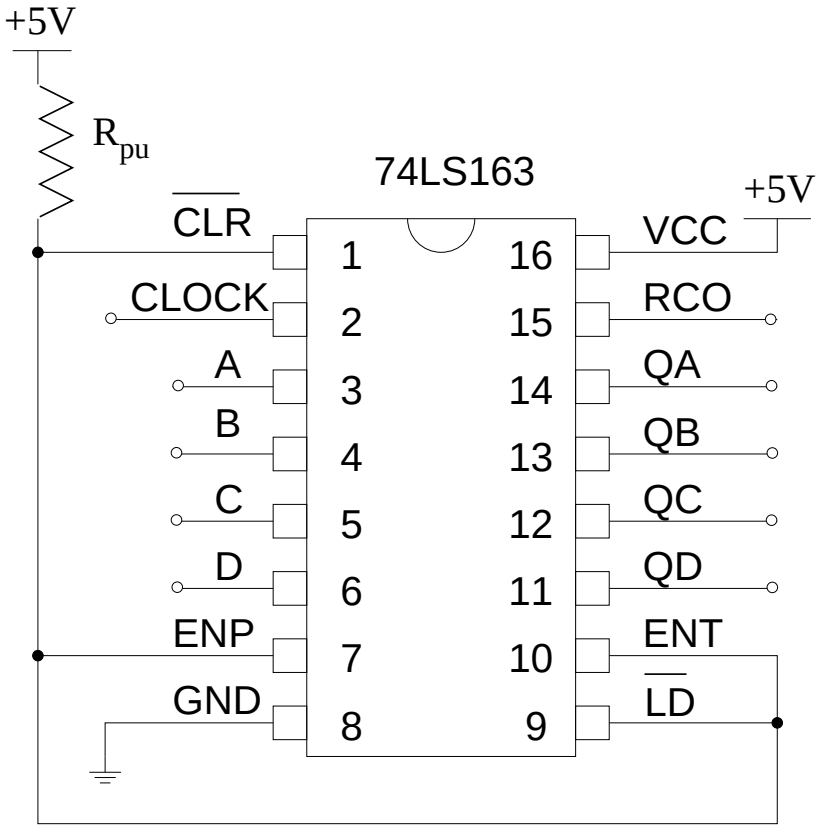
Advice: To save time, it is recommended that you change only one input at each step, by testing the combinations in **Gray code** order as listed in the table.

Decimal	D	C	B	A	Display	Decimal	D	C	B	A	Display
0	0	0	0	0		8	1	0	0	0	
1	0	0	0	1		9	1	0	0	1	
2	0	0	1	0		10	1	0	1	0	
3	0	0	1	1		11	1	0	1	1	
4	0	1	0	0		12	1	1	0	0	
5	0	1	0	1		13	1	1	0	1	
6	0	1	1	0		14	1	1	1	0	
7	0	1	1	1		15	1	1	1	1	

5 The 74LS163 Counter IC

5.1 Free running mode

The 74LS163 can be configured in what is called *free running mode* as shown below.



Experiment 2: Connect the 74LS163's outputs to the 7-segment decoder and display circuit that you constructed in the previous section. Used a **very low frequency** (less than **four** (**4**) Hertz) square wave as the clock.

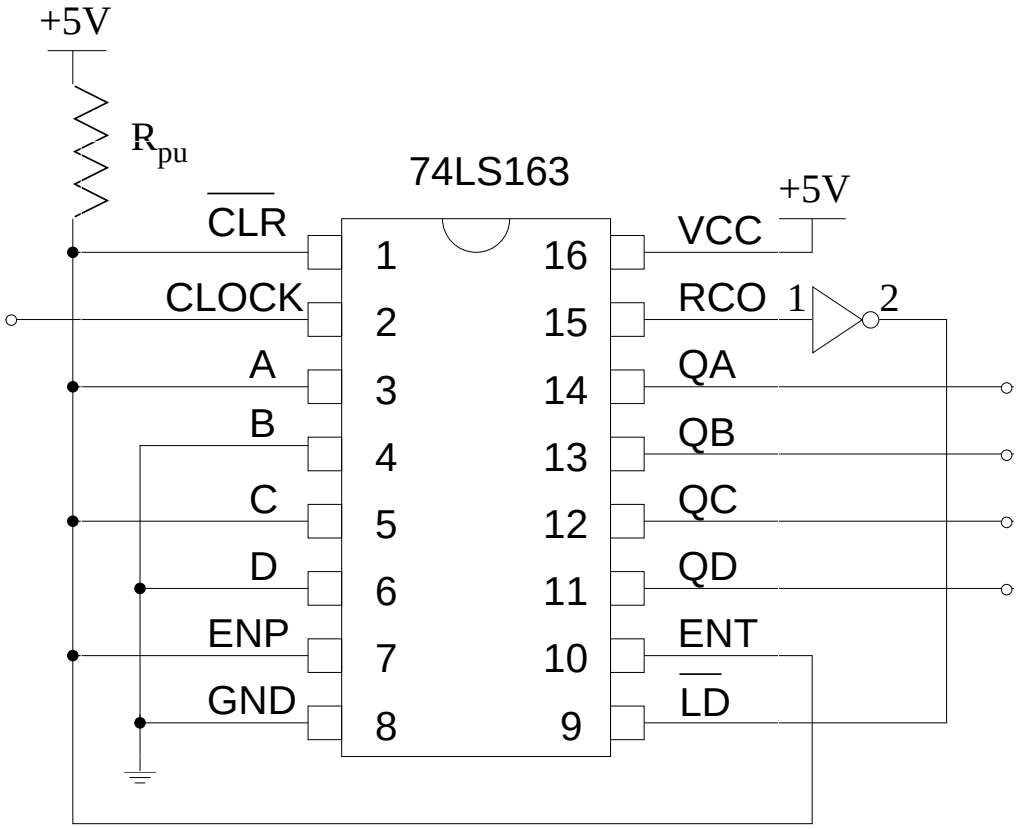
Question 2: The slowest setting on some frequency generators is ten (10) or twenty (20) Hertz. If you use two 74LS163 counters, how may you use one of them to divide that frequency by eight (8) fold? By sixteen (16) fold? (You will need to do this in order to have a chance of seeing the counting sequence, so make sure that you answer this question correctly.)

If the connections are correct, you should see a sequence on the display from 0 to blank, in the order given in the table you completed in the previous section.

Question 3: Suppose there is a door that allows one person to enter or leave at a time. Describe a system that can be used to count this event.

5.2 Loading the initial count

The initial state of the counter can be set using the load (LD) control and the A to D inputs as shown below. This example is a modulo 11 counter with counting sequence from 5 to 15. Use the same IC as in the previous subsection, and one inverter from the 74LS04.



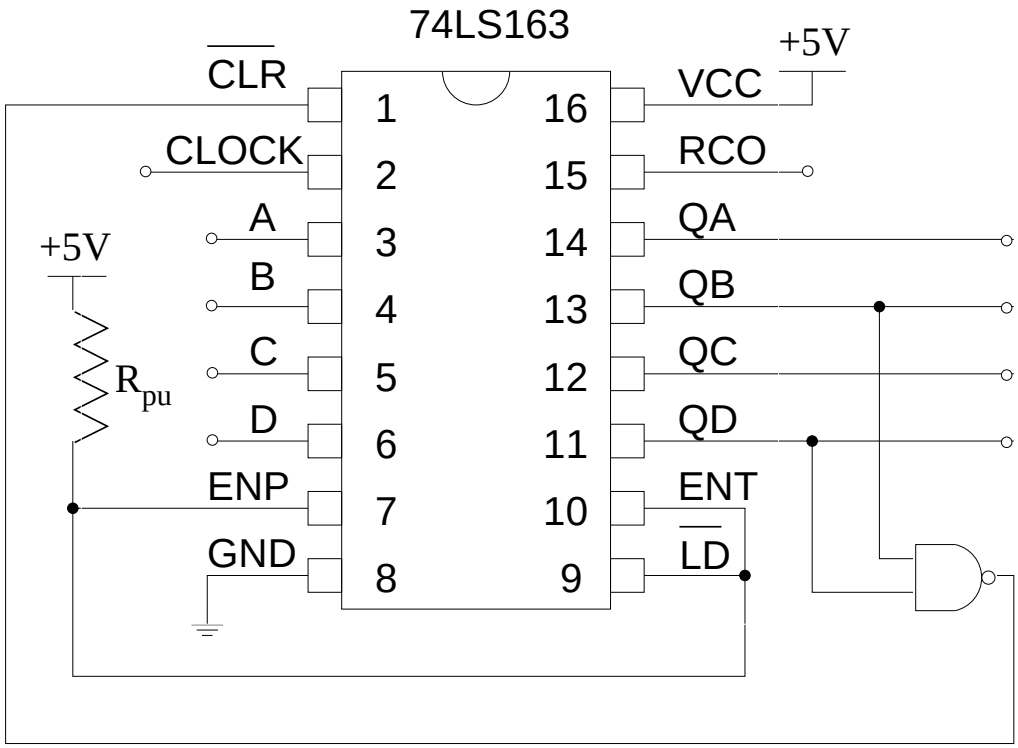
Experiment 3: Test your circuit.

Question 4: Explain the functions of pin 1 (CLR) and pin 9 (LD).

Question 5: Design (but do not build) a circuit that has a counting sequence from 8 to 15.

5.3 A third counter

Experiment 4: Construct the counter shown below.



Question 6: Observationally, what is the counting sequence of this counter?

Question 7: Explain why it counts according to this particular sequence.

5.4 Design a fourth counter

Experiment 5: Design, construct and test a counter that counts from 3 to 9 then repeats.

5.5 Bonus Extension

Experiment 6: Design, construct and test a counter with counting sequence 0 to 99 (decimal).