ECE 301 Digital Electronics

**Introduction & Binary Numbers**

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**OBJECTIVE**

To become familiar with building and testing digital logic circuits on the ET-1000 Trainer.

**PREPARATION**

None.

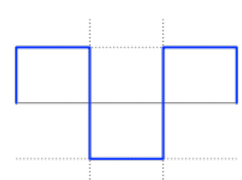
**PROCEDURE**

1. Measure the output voltages of the variable and fixed DC supplies on the ET-1000 trainer using the multimeter. Refer to Appendix I on how to connect and setup the voltmeter. The +5 volt supply must be within ±5% of its nominal value to avoid the possibility of destroying the integrated circuits.

2. The following two steps are intended to develop your ability to assemble circuits on the ET-1000 trainer and to introduce you to the binary representation of numbers. If you feel like saying "I don't understand", don't fret, this is quite normal as you are not expected to under- stand all the details of this lab today. But by the end of the semester you will have come full circle and you will or at least should understand this lab in its entirety.

3. The 74LS161 is a TTL binary counter and will increment the binary number at outputs $Q_0$, $Q_1$, $Q_2$, and $Q_3$ and each time the input CP (clock pulse) transitions from a logic 0 to a logic 1 value. Assemble the circuit according to the following table. Verify that the circuit counts from 0 to 15 as displayed on the logic indicators each time the binary switch is toggled from a 0 to a 1.

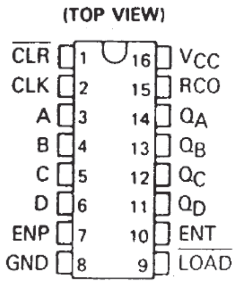
4. Connect the square wave signal to the clock input of your circuit instead of the logic switch and adjust the frequency of the square wave to 1 cycle per second (1 Hertz, 1 Hz) by adjusting both the frequency control (FREQ) and the multiplier control (FREQ MULTIPLIER) to 1 and verify that the circuit still counts correctly.



**OPTIONAL** 3 (*i.e.,* no penalty will be incurred if the step is omitted.)

The following use of an oscilloscope may help to reveal the timing relationship between outputs $Q_0$, $Q_1$, $Q_2$, and $Q_3$ of the counter and the clock (and also be an enjoyable diversion). Connect an oscilloscope probe from channel X to the square wave signal and then using the dual-trace capability of the oscilloscope examine the outputs $Q_0$, $Q_1$, $Q_2$, and $Q_3$ of counter with channel Y of the oscilloscope. You may want to increase the frequency to 1 KHz to allow for a better display on the oscilloscope.

**CIRCUIT CONNECTIONS**




NC—No internal connection

| 74LS161 Connections | | |
|---|---|---|
| pin # | To | Signal |
| 1 | 16 | Clear-bar (tie high to enable) |
| 2 | Logic Probe | CP (Clock Pulse) in |
| 3 | N.C. | A-in, no connection |
| 4 | N.C. | B-in, no connection |
| 5 | N.C. | C-in, no connection |
| 6 | N.C. | D-in, no connection |
| 7 | 1 | ENP, enable P (tie high to enable) |
| 8 | Gnd | 0 Volt (ground) of power supply |
| 9 | 16 | Load-bar (tie high to disable) |
| 10 | 7 | Enable T (tie high to enable) |
| 11 | $L_3$ | $Q_3 = Q_D$ = MSB |
| 12 | $L_2$ | $Q_2$ |
| 13 | $L_1$ | $Q_1$ |
| 14 | $L_0$ | $Q_0 = Q_A$ = LSB |
| 15 | N.C. | Ripple Carry Out |
| 16 | $V_{cc}$ | +5 Volt of power supply |

## typical clear, preset, count, and inhibit sequences

Illustrated below is the following sequence:

1. Clear outputs to zero ('161 and 'LS161A are asynchronous; '163, 'LS163A, and 'S163 are synchronous)
2. Preset to binary twelve
3. Count to thirteen, fourteen fifteen, zero, one, and two
4. Inhibit