ELEC 3300

LAB 1: USE OF EQUIPMENTS

A. OBJECTIVE:

1. To familiarize yourself with the basic equipments and components, power supply, multi-meter, transistors.
2. To understand the power limitation of an IC.
3. To understand the use of transistor as a electronic switch
4. To correlate the knowledge that you learn from previous courses to the real world environment.

B. PRE-LAB ASSIGNMENT:

1. Study the Part D (Power Supply Information).
2. Study the 74LS04 datasheet (available from the course webpage).
3. Study the PN2222 datasheet; note the orientation of Base, Emitter and Collector.

C. INTRODUCTION:

In this lab, you need to familiar yourself with the basic tools of electronics.

- Power Supply – A power supply is to provide power to your circuits, you need to be able to understand the operation modes of the power supply. How does it related to Voltage and Current.
- Multi-meter – A meter to measure the voltage and current of your circuit.
- Transistor – A device normally to amplify the current from the digital logic system.

D. POWER SUPPLY INFORMATION:

The following are the photos for the power supply that is actually used in the lab.

Digital Panel

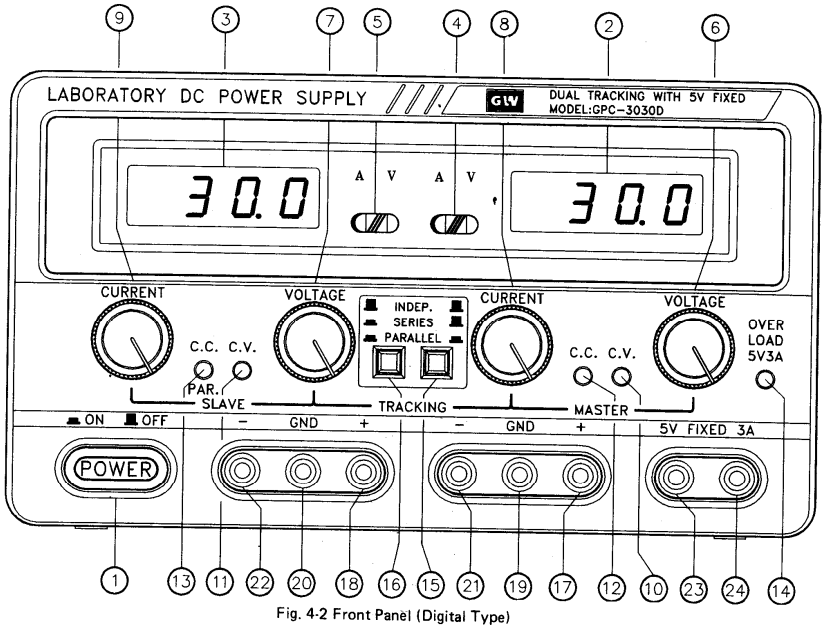


Fig. 4-2 Front Panel (Digital Type)

Analogue Panel

4. PANEL CONTROLS AND INDICATORS

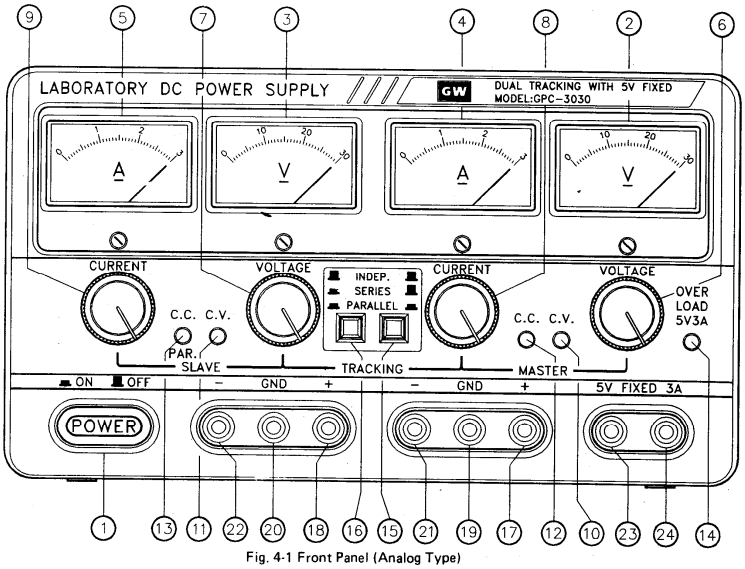


Fig. 4-1 Front Panel (Analog Type)

4-1 Front Panel

① Power switch: ON/OFF the power input.

② Meter: Indicates the MASTER output voltage (Analog type)
Indicates the MASTER output voltage or current (Digital type)

③ Meter: Indicates the SLAVE output voltage (Analog type)
Indicates the SLAVE output voltage or current (Digital type)

④ Meter: Indicates the MASTER output current (Analog type)
A/V selects switch: selects the meter indicates of the MASTER output voltage or current (Digital type)

⑤ Meter: Indicates the SLAVE output current (Analog type)
A/V selects switch: selects the meter indicates of the SLAVE output voltage or current (Digtal type)

⑥ Voltage control: for adjustment of the output voltage of the MASTER supply. Also functions as adjustment control for the maximum output voltage of the SLAVE supply when either parallel or series tracking operation.

⑦ Voltage control: for adjustment of the output voltage of the SLAVE supply when the independent operation.

⑧ Current control: for adjustment of the output current of the MASTER supply. Also functions as adjustment control for the maximum output voltage of the SLAVE supply when either parallel or series tracking operation.

⑨ Current control: for adjustement of the output current of the SLAVE supply.

⑩ C.V. indicator: lights when the MASTER supply is in the constant voltage operation, In either the Series or Parllel Tracking mode, both the MASTER AND SLAVE supplies are in the constant voltage operation.

⑪ C.V. indicator: lights when the SLAVE supply is in the constant voltage operation.

⑫ C.C. indicator: lights when the MASTER supply is in the constant current operation.

⑬ C.C. indicator: lights when the SLAVE supply is int he constant current operation. Also lights when the TRACKING PARALLEL mode is selected.

⑭ Over load indicator: lights when load on 5 volt supply becomes too large.

⑮ ⑯ TRACKING Mode Switches:
Two push-button switches that select INDEP endent mode, series tracking mode, or parallel tracking mode as follows:

a. When both switches are disengaged (out), the unit is in the INDEPendent mode and the MASTER and SLAVE power supplies are completely independent from one another.

b. When the left switch is engaged (in) and the right switch is disengaged (out), the unit is in the TRACKING SERIES mode. In this mode, maximum voltage of both supplies is set using the MASTER VOLTAGE controls (voltage at output terminals of the SLAVE supply tracks the voltage at the output terminals of the MASTER supply). Also, in this mode of operation the positive terminal (red) of the SLAVE supply is connected to the negative terminal (black) of the MASTER supply. This allows the two supplies to be used as one 0 to double rating voltage supply.

c. When both switches are engaged (in), the unit is in the TRACKING PARALLEL mode. In this mode the MASTER and SLAVE supplies are wired together in parallel and both the maximum current and voltage are set using the MASTER controls. The MASTER and SLAVE outputs can be used as two individual (but tracking) power supplies or just the MASTER output can be used as a 0 to rating voltage supply with a 0 to double rating current capability.

⑰ "+" output terminal: Positive polarity output terminal for the MASTER supply.

⑱ "+" output terminal: Positive polarity output terminal for the SLAVE supply.

⑲ "GND" terminal: Earth and chassis ground.

⑳ "GND" terminal: Earth and chassis ground.

㉑ "–" output terminal: Negative polarity output terminal for the MASTER supply.

㉒ "–" output terminal: Negative polarity output terminal for the SLAVE supply.

㉓ "–" output terminal: Negative polarity output terminal for 5V supply.

㉔ "+" output terminal: Positive polarity output terminal for 5V supply.

Further explanation of constant current (CC) and constant voltage (CV) modes

The power supply would only act as a constant voltage or constant current supply (different to a time varying voltage/current supply), but normally would not act as both constant current and constant voltage supply. Therefore either CC or CV, one of the LED indicators will light up to indicate the operation mode.

The power supply would automatically choose between one of the 2 modes. The basic principal for the selection would be the one which gives the power output less than the set power output. And the set power output equals to the tuned voltage× tuned current.

E.g. Set tuned voltage to 30V and current to 3A, maximum values in single mode, the set power is 30V× 3A = 90W. These pair of voltage and current is delivered when a resistor of resistance 10Ω is connected to the output terminals. If the terminals are connected to a resister larger than 10Ω, the power supply cannot operate with the tuned current, as would be making the power larger than the set power output. Instead it would operate in the tuned voltage, as the power output is smaller than the set power, then the power supply acts as a constant voltage supply. The situation is just the reverse if the resistance of the resister is smaller than 10Ω.

Applications for using Power Supply:

As a first example, configure the output voltage of the power supply to −15V to +15 V using the series tracking mode.

1. Set the tracking buttons to the option choosing the series connection. This is actually the series tracking mode. Internally the configuration is as Figure 2 on the right.
2. Tune the voltage knob in the right for the value of 15V. You will see the display in the left also follows the one in the right. Therefore the output voltage has a difference of 30V between the 2 terminals
3. Connect either the '−' of the master output or the '+' of the slave output as the ground to the circuit to create a common ground
4. Then the '+' of the master supply would be 15V higher then the common ground, and the '−' of the slave supply would be 15V lower than the common ground.

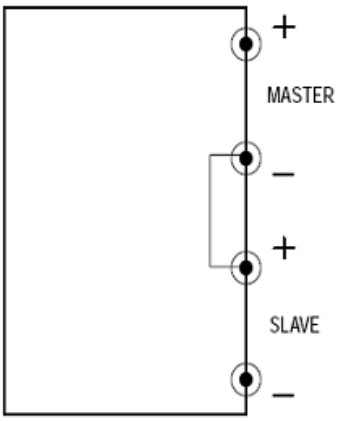


Figure 2 : Series Tracking Inside config

As a second example, configure the output current of the power supply to 4 A.

1. Set the tracking buttons to the option choosing the parallel connection. This is actually the parallel tracking mode. Internally the configuration is as Figure 3 on the right.
2. Tune the current knob in the right for the value of 2A. You will see the display in the left also follows the one in the right. Therefore the total output current is 4A.
3. The two output terminals would be '+' of the master output, and the '−' of the slave output.

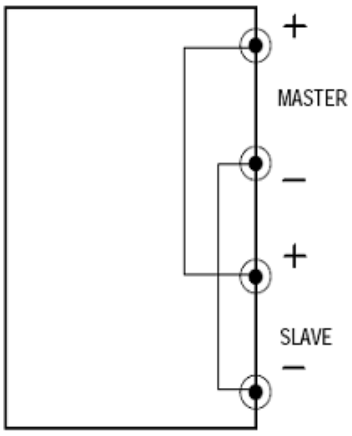


Figure 3: Parallel Tracking Inside config

ELEC 3300

LAB 1 : USE OF EQUIPMENTS

ACTIVITY SHEET

Name : _____ Student number : _____ LAB Session : _____

A. Power Supply:

1. Consider the independent mode and the master supply only. In order to set the maximum power supply, you need to
   I. Set the maximum voltage to 5V by the voltage knob under an open circuit condition.
   II. Shorting the output and set the maximum current to 0.2A by the current knob.

   What is the maximum Power that would be delivered by the power supply using above configuration?

   Ans: _____

   Using the 100Ω resistor to answer the following questions

   Now, connect the 100Ω resistor to the corresponding outputs, which mode (CC or CV) is the power supply operates in?

   Ans: _____

   What is the current drawn from the power supply? How can you know that?

   Ans: _____

   Calculate the power that would be dissipated by the 100Ω resistor.

   Ans: _____

   Using the 10Ω resistor to answer the following questions

   Now, connect the 10Ω resistor to the corresponding outputs, which mode (CC or CV) is the power supply operates in?

   Ans: _____

   What is the current drawn from the power supply? How can you know that?

   Ans: _____

   Calculate the power that would be dissipated by the 10Ω resistor.

   Ans: _____

2. Keep the same setting but change the resistor to a copper wire to connect the 2 output terminals, this time, which mode, CC or CV mode is the power supply operates in?

   Ans: _____

3. Configure the Power Supply to series mode and output −10V to +10V, connect a 470Ω resistor to the output terminals, set appropriate current so that the Power Supply operates in CV mode. Measure the voltage, current and hence the power delivered to a 470Ω resistor.

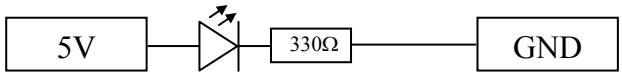
Ans: _____

Check point 1, time for finishing Part A: _____

B. Digital Circuit:

1. Consider the independent mode and the master supply only. Set the voltage to 5V by open circuit, set current to 0.2A by shorting the outputs.

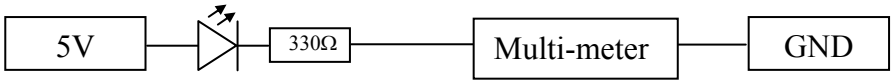
2. In your breadboard build the following circuit.



From your knowledge of the other courses, assume the LED is an ideal diode with a 0.7V for forward bias, what should be the current flowing through the 330Ω resistor?

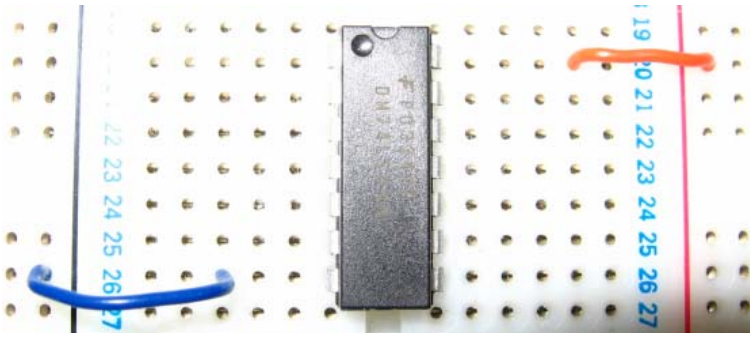
Ans: _____

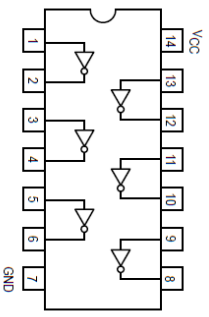
Now, measure the exact current through the 330Ω resistor using a desktop multi-meter, what is the reading?



Ans: _____

Now, consider a 74LS04 IC.





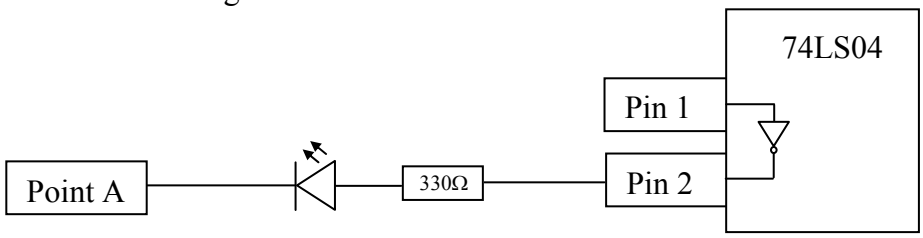
3. Connect pin 1 to GND, measure the voltage at pin 2. What is the voltage at pin 2?

Ans: _____

4. Connect pin 1 to 5V, measure the voltage at pin 2. What is the voltage at pin 2?

Ans: _____

5. Now, make the following connections:



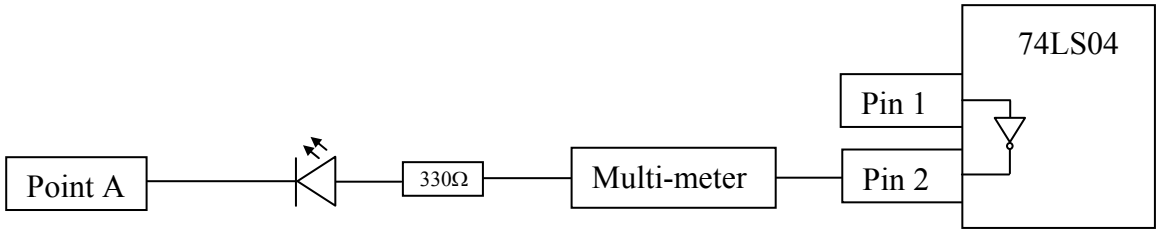
In order to light up the LED, what should Pin 1 and Point A connected to?

Ans: Pin 1 connected to _____ , Point A connected to _____

In this example, the power that lights up the LED comes from where?

Ans: Power comes from: _____

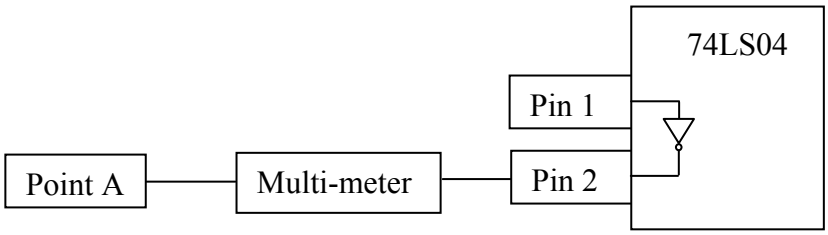
Now, use a multi-meter to measure the current. Please note the +ve and –ve terminals of the multi-meter.



What is the current shown in the multi-meter? Is the current flowing out from Pin 2 or flowing into the Pin 2?

Ans: Current read: _____ Direction: _____ Pin 2

Now, try to directly connect pin 2 through the multi-meter to Point A, measure the current again. Is the current flowing out from Pin 2 or flowing into the Pin 2?

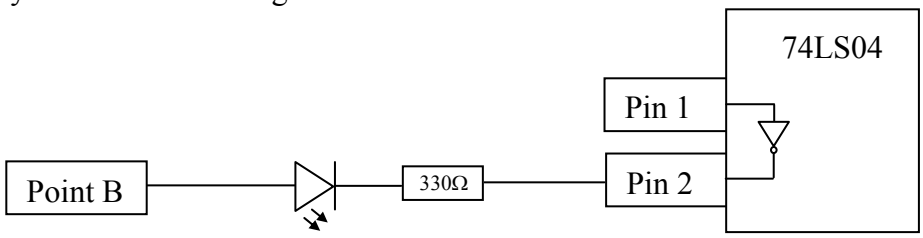


Ans: Current read: _____ Direction: _____ Pin 2

From the above, deduce the maximum power you can get from Pin 2?

Ans: Maximum Power: _____

6. Now, try to make little changes:



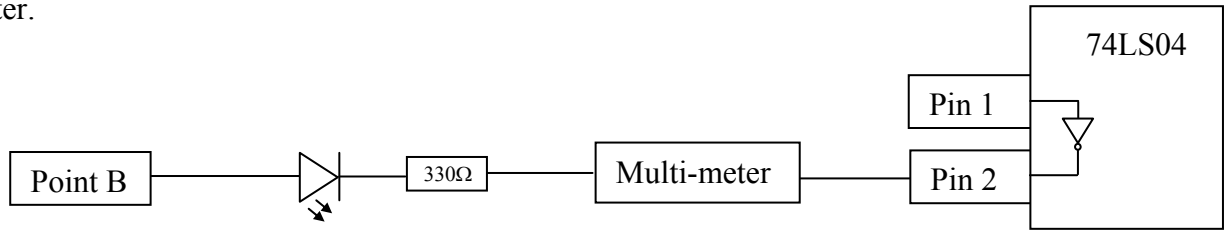
In order to light up the LED, what should Pin 1 and Point B connected to?

Ans: Pin 1 connected to _____ , Point B connected to _____

In this example, the power that lights up the LED comes from where?

Ans: Power comes from: _____

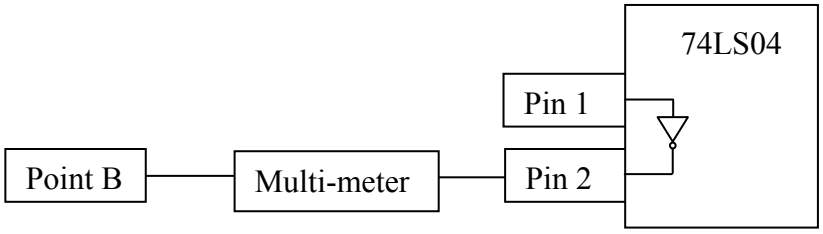
Now, use a multi-meter to measure the current. Please note the +ve and –ve terminals of the multi-meter.



What is the current shown in the multi-meter? Is the current flowing out from Pin 2 or flowing into the Pin 2?

Ans: Current read: _____ Direction: _____ Pin 2

Now, try to directly connect pin 2 through the multi-meter to Point B, measure the current again. Is the current flowing out from Pin 2 or flowing into the Pin 2?



Ans: Current read: _____ Direction: _____ Pin 2

Does Pin 2 allow all the current from Point B flowing into it?

Ans: _____

Check point 2, time for finishing Part A& B: _____

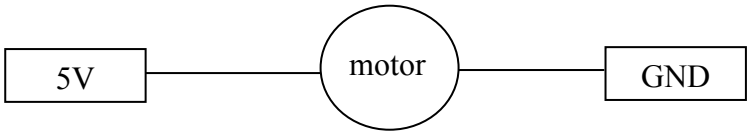
C. Transistor as an amplifier

1. Consider the independent mode and the master supply only. Set the voltage to 5V by open circuit, set current to 0.3A by shorting the outputs.

2. Measure the resistance of the motor

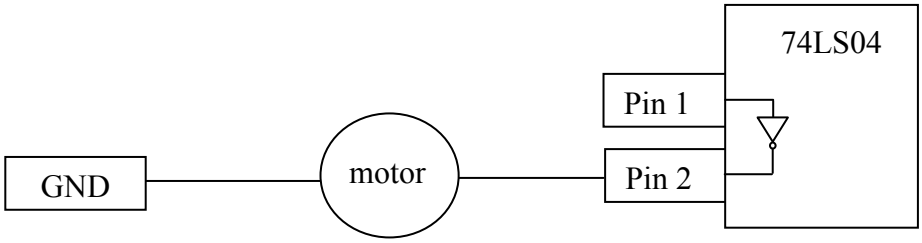
   Ans: Resistance of the motor _____

3. Connect the 2 wires of the motor directly to the power supply. Read the voltage and current reading from the power supply.



   Ans: Voltage: _____ Current: _____

4. Use the circuit that you build from Part B, make the following connections:

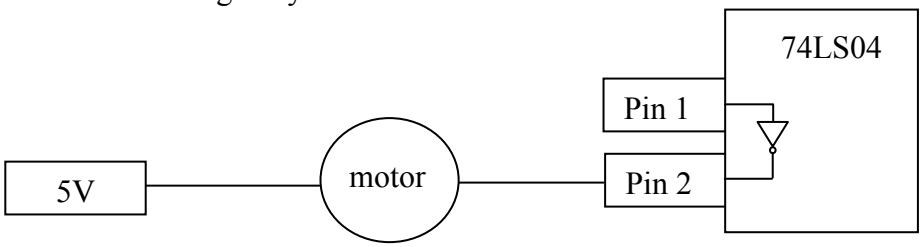


   Will the motor turn when you connect the Pin 1 to GND? Please explain

   Ans: _____

   _____

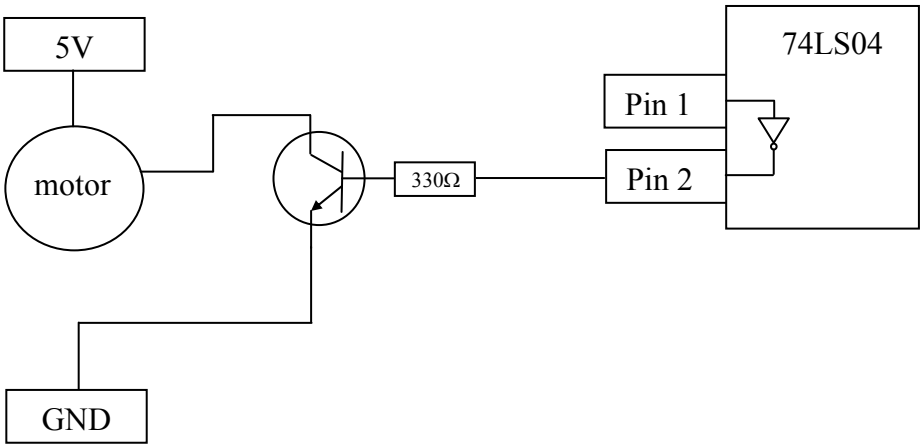
5. Now, make a little change to your circuit:



   Will the motor turn when you connect the Pin 1 to 5V?

   Ans: _____

6. Modify your circuit as follows:



Will the motor turn when you connect the Pin 1 to GND? Please explain

Ans: _____

_____

Will the motor turn when you connect the Pin 1 to 5V? Please explain

Ans: _____

_____

When the motor is on, read the current from the power supply.

Ans: _____

In this example, the power that makes the motor move comes from where?

Ans: Power comes from: _____

What is the role of Pin 1 of 74LS04 in this example?

Ans: _____

Check point 3, time for finishing Part A & B & C: _____

TA's signature verifying activity completion: _____