Introduction

Two hours per week are allocated for laboratory session in Digital Logic. All laboratory experiments are marked and contributed to 10% of the overall mark for the course.

- Students must attend all scheduled laboratory sessions.
- Students are required to be punctual – latecomers may be refused entry.
- Pre-lab questions must be answered prior to the laboratory session.
- Answer all questions in the sections of the laboratory manual.

Here are some guidelines to help you perform the experiments:

- Read all instructions carefully and carry them all out.
- Ask the demonstrator if you are unsure of anything.
- Don't depend on the Digital kit settings, always measure!
- Record actual results (comment on them if they are unexpected!)
- If required, write up full and suitable conclusions for each experiment.
- If student have any doubt about the safety of any procedure, contact the demonstrator beforehand.
- **THINK** about what you are doing!

Most experiments involve the use of the Digital kit and your breadboard.

The breadboard

In general the breadboard consists of two terminal strips and two bus strips (often broken in the centre). Each bus strip has two rows of contacts. Each of the two rows of contacts are a node. That is, each contact along a row on a bus strip is connected together (inside the breadboard). Bus strips are used primarily for power supply connections, but are also used for any node requiring a large number of connections. Each terminal strip has 60 rows and 5 columns of contacts on each side of the centre gap. Each row of 5 contacts is a node.

You will build your circuits on the terminal strips by inserting the leads of circuit components into the contact receptacles and making connections with 22-26 gauge wire. There are wire cutter/strippers and a spool of wire in the lab. It is a good practice to wire +5V and 0V power supply connections to separate bus strips.

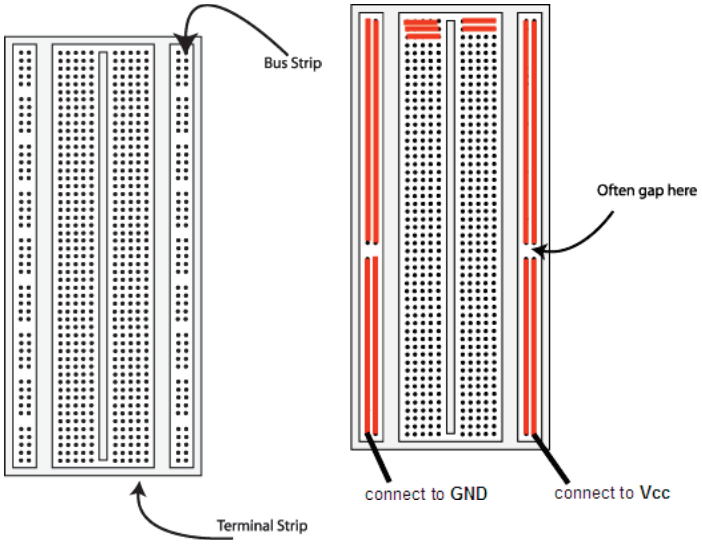


Fig 1. The breadboard. The orange lines indicate connected holes.

The 5V supply **MUST NOT BE EXCEEDED** since this will damage the ICs (Integrated circuits) used during the experiments. Incorrect connection of power to the ICs could result in them exploding or becoming very hot - with the **possible serious injury occurring to the people working on the experiment!**

Building the Circuit

Throughout these experiments we will use TTL chips to build circuits. The steps for wiring a circuit should be completed in the order described below:

- **Turn the power (Digital kit) off before you build anything!**
- **Make sure the power is off before you build anything!**
- Connect the +5V (Vcc) and ground (GND) leads of the power supply to the power and ground bus strips on your breadboard. The +5V supply may be found on the top left of the Digital kit with the black switch at the +5V fixed position. Before connecting up, use a voltmeter to check that the voltage does not exceed 5V.

- Plug the chips you will be using into the breadboard. Point all the chips in the same direction with pin 1 at the upper-left corner. (Pin 1 is often identified by a dot or a notch next to it on the chip pa e)

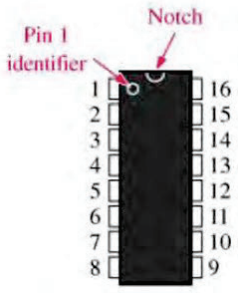


Fig 2. Pin 1 of an IC

- Connect +5V and GND pins of each chip to the power and ground bus strips on the breadboard.
- Select a connection on your schematic and place a piece of hook-up wire between corresponding pins of the chips on your breadboard. It is better to make the short connections before the longer ones. Mark each connection on your schematic as you go, so as not to try to make the same connection again at a later stage.
- Get one of your group members to check the connections, **before you turn the power on**.
- If an error is made and is not spotted before you turn the power on. Turn the power off immediately before you begin to rewire the circuit.
- At the end of the laboratory session, put your hook-up wires and chips in the component tray under your workbench.
- **Tidy the area that you were working in and leave it in the same condition as it was before you started.**

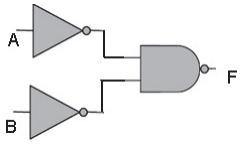
Common Causes of Problems

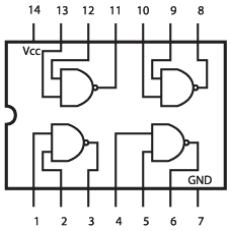
- Not connecting the ground and/or power pins (Vcc) for all chips.
- Not turning on the power supply before checking the operation of the circuit.
- Leaving out wires.
- Plugging wires into the wrong holes.
- Driving a single gate input with the outputs of two or more gates
- Modifying the circuit with the power on.

Please inform the demonstrator if you locate faulty equipment. If you damage a chip, inform the demonstrator in-charge, he/she will replace it with a new one, but you have to bear the cost.

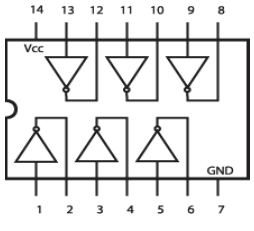
Implementation of a Logic Circuit

Build a circuit to implement the Boolean function $F = \overline{\bar{A}\,\bar{B}}$





Quad 2 Input 74LS00



Hex 74LS04 Inverter

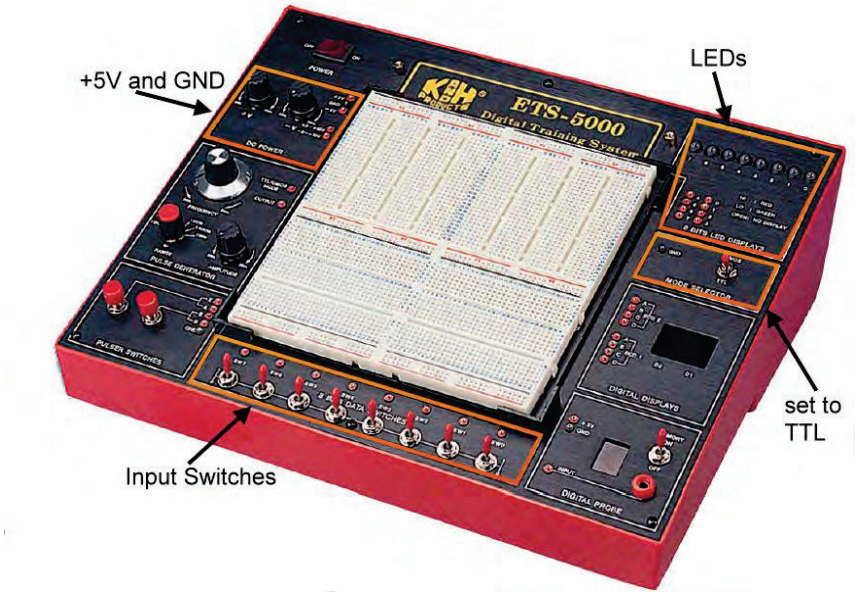


Fig 3. ETS 5000 Digital Training Systems

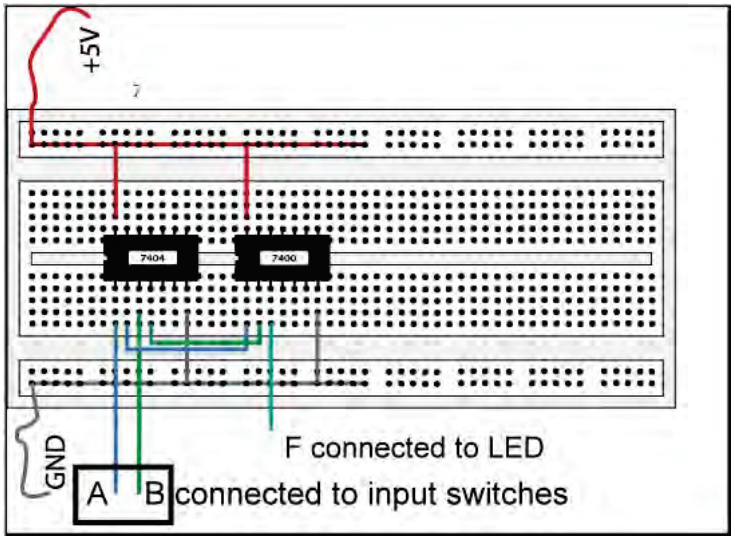
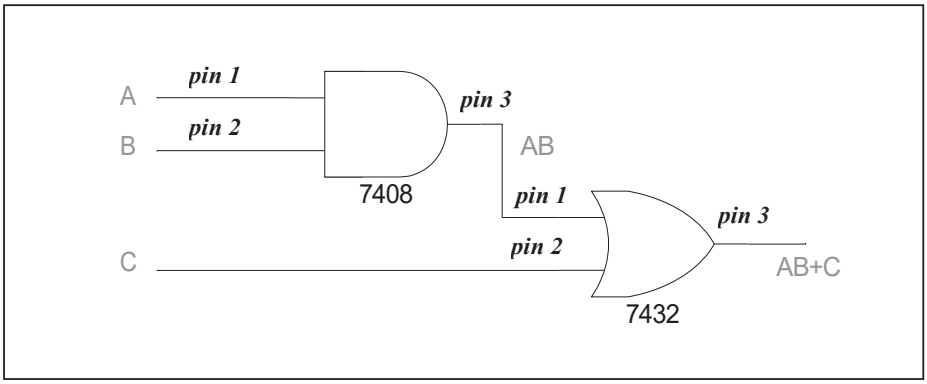


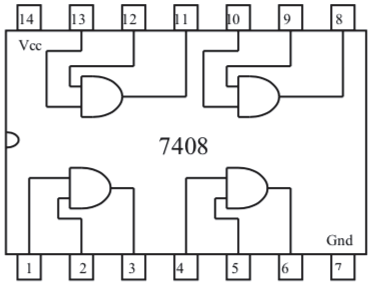
Fig 4. The complete designed and connected circuit, LED switches, +5V and GND from ETS 5000 Digital Training Systems

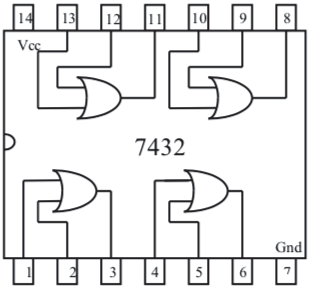
Sometimes the chip manufacturer may denote the first pin by a small indented circle above the first pin of the chip. Place your chips in the same direction, to save confusion at a later stage. Remember that you must connect power to the chips to get them to work.

Another example how to make a circuit connection on a breadboard from a schematic diagram

1. Label all the pins of an ICs that will be use in the lab. Refer to the pin out of an ICs







2. Put the ICs on the breadboard and connect the selected pin by using a wire. **Don't forget that each IC must be connected to the power supply**. Vcc connected to 5V and Gnd connected to Gnd of a digital kit. All input connected to a switch and all output connected to the LEDs.