Theme 2:
Introduction to Digital systems

- Power supply integrated circuits
- Connecting microswitches
- Using LEDs to visualize outputs
- Visualization using a common anode display
- Troubleshooting Guide
- Datasheets and additional information

Power supply integrated circuits (I)

- We must feed integrated circuits correctly. The supply voltage required by the circuits in the laboratory is 5V (CMOS, TTL), and we get the power supply, connecting the circuit to Vcc and GND (+5 V to 0V).
- There is a recommended color coding that affects all cables and power connectors:
  - Black for ground terminals (GND, OV)
  - Red for power (Vcc, 5V)

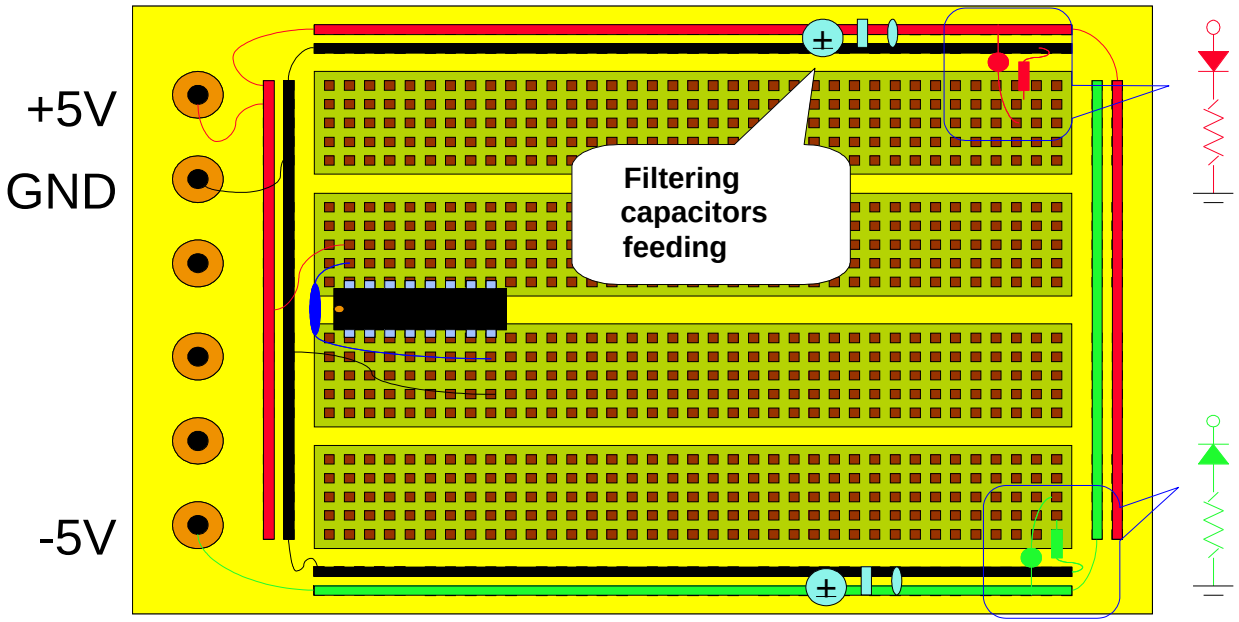
- The exterior strips of the board are connected to the supply voltage, and then (with smaller cables of suitable color), these voltages are connected to the terminals and to the tracks needed.
- To check the power supply you can connect a LED with a current limiting resistor.

Power supply integrated circuits (II)

- Especially in sequential circuits and analog-digital mixed assemblies is important to add decoupling capacitors between power and ground. Typical values can be: 470 uF (be careful with the polarity in electrolytic), 100 nF (plastic), 100 pF (ceramic).
- As a general rule for any installation, you need to connect decoupling capacitors in the power supplies of integrated circuits between terminals + VCC and ground (as close as possible to the pin). A typical value for these capacitors can be 100nF.

Power supply integrated circuits (III)

- Example of a correct supply of an integrated circuit. (Green has been added to the -5V voltage that we never use in the laboratory).

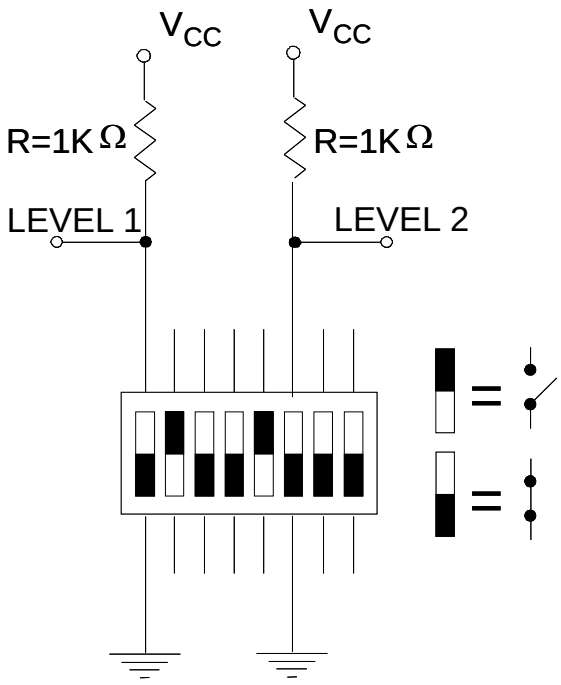


Connecting microswitches (I)

- Microswitches or dual in-line package switch (DIP) are devices that perform shorted or open circuit between its terminals, depending on its position (ON-OFF). we use them, properly connected with other passive components, to generate the appropriate voltages at the inputs of circuits.
- They are mechanical devices, not electrical, therefore need not feeding.
- Normally available in 4 or 8 tablets microswitches can be used to generate as many independent signals.

Connecting microswitches (II)

- In this example two different signals are generated, LEVEL1 and LEVEL2, which will be connected to two different inputs from / to the corresponding circuits.
- If we need more signals, it will be necessary to connect the terminals of the other DIP switches to ground and Vcc (with their corresponding resistances).
- In these assemblies, always **LEVELx** signal is removed from the track to which are connected the resistance and the microswitch.



Conneting microswitches

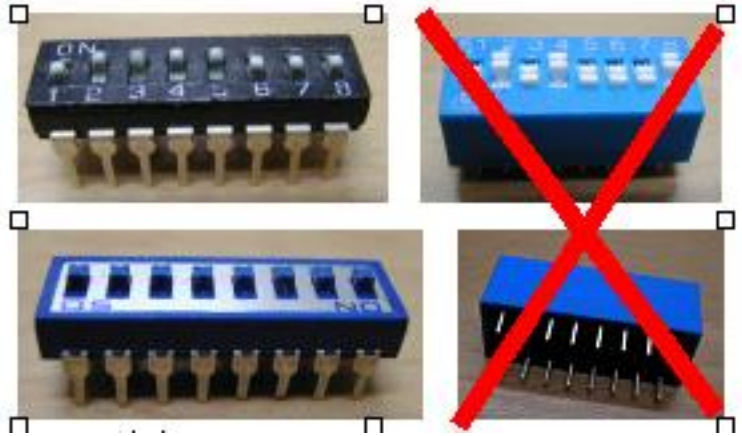
Connecting microswitches (III)

- The value of LEVELx signal will depend on microswitch position.
- When the microswitch is set to "ON", it will be a short circuit and LEVELx will be connected directly to ground, so at that point there it will be 0V.
- In open circuit LEVELx will have Vcc less the voltage falling on the resistance (R * I).
- If resistance is well chosen, this tension will be small enough so that level is interpreted as a high level.
- Typical values of the resistances are 1KΩ.

INTERRUPTOR	LEVELx
OPEN CIRCUIT(OFF)	HIGH
SHORT CIRCUIT(ON)	LOW

Connecting microswitches (IV)

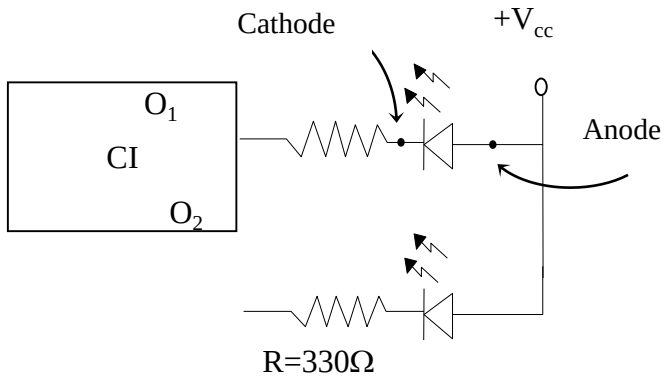
- In the figure are examples of microswitches suitable or not for use in breadboards.
- In the figure (a) the pins hooked well because they have the same design of integrated circuits.
- The pins in the figure (b) are more suited to be soldiers.



a) b)

Using LEDs to visualize outputs (I)

- **LEDs (Light Emmiting Diodes) are used to display the value of a digital output.** They are diodes that emit light when an appropriate level of current flows through them.
- They be connected as shown in the figure: the anode (the longest terminal) of the diodes to Vcc and the cathode output to the integrated circuit through a resistor.
- In this case we are viewing the value of two different outputs O1 and O2 simultaneously.



Connection of the LEDs

Using LEDs to visualize outputs (II)

- A certain level of potential difference will be required between terminals in order to have the current flowing through one diode and that only occur when the output of the integrated circuit has a low level, as summarized in table .
- The purpose of the resistance is to limit the current flowing through the diode.
- We will use resistors of 330 Ω.

SALIDA	LED
0	Encendido
1	Apagado

Visualization using a common anode display (I)

- When it is necessary visualize numbers we will use displays.
- In our case we will use 7-segment displays, devices with 7 LEDs with the form and arrangement suitable to represent the digits when we activate different combinations of diodes.

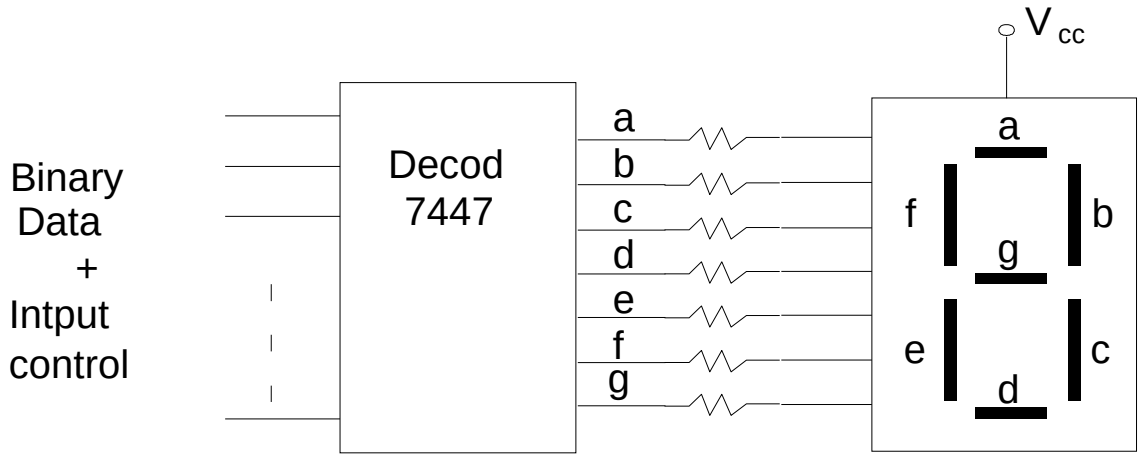
- They can be of two types:
  - Common anode: anodes of all diodes are connected to each device. One of the terminals of the display will be the anode (common to all LEDs) and the other pin will be the cathode of each diode.
  - Common cathode: in this case the cathodes of all diodes are joined.

Visualization using a common anode display (II)

- Regarding how to connect a display in the circuit, as occurs when employ any isolation diode, **a resistor must be connected to each of the LEDs to limit the current passing through them.**
- The common terminal must be connected to the proper voltage, depending on the type.
- As normally we will dispose of the binary data to display, it is necessary to use a decoder to obtain the excitation signals of the segments.
- The decoders will be different for displays of common anode and common cathode.

Visualization using a common anode display (III)

- In laboratory practice we will use the common anode displays and decoder 7447 connected as shown in the figure, with 330 Ω resistors



Visualization using a common anode display (IV)

- If there are no sheets on the display characteristics, it is necessary to ascertain what corresponds each pin diode.
- The following is a general method for common anode displays, which will be readily extrapolated to display common cathode voltage values exchanging.
- We must first find the common terminal (anode). Normally you can do by simple visual inspection of the bottom of the display, which is usually semi-transparent, seeing where they join the diodes, and following that track until its pin / pins are.
- In the connected pin located above 1.5 volt power supply, and a current limiting small enough to avoid burning the diode. ·

Visualization using a common anode display (V)

- With the ground of the power supply we must touch each pin of the display, and write down which LED lights. That touch must be done quickly, because if the current limit of the power supply is not enough can damage the diode.
- To increase security, it can be performed through a limiting resistor.
- We should consider that maybe there are any pin connected to diode and also it is possible (depending on model) that the common terminal corresponds with several pins. In this case the pins are connected internally, so only one of them will have to be connected to Vcc.

Troubleshooting Guide (I)

- Once connected the circuit according to the data sheet it is likely that initially it doesn't work correctly. The most typical causes are (in order of frequency):
  - There a poor connection
  - Some of the components are damaged
  - The breadboard is giving problems (bad connection, for example)
  - Some equipment is faulty (highly unlikely)

- **If the design was well done, the connections are correct, and the components worked well, the circuit would be performing the function for which it was designed.**

Troubleshooting Guide (II)

- To find the fault will check the following, in this order:
- 1) Check the power to all circuit components
  - Verify, in the first place that between the power and ground track there are 5V, and then, circuit by circuit, between pin Vcc and its ground there are 5V. **This is checked directly on the pins of the circuit, not the track that they are tapped, taking great care not to make shorts.**
  - If any of the circuits does not have the correct values, check if it is a problem with the thin wire that carries the voltage you value corresponding to the track, and if not, can be a problem with the insert plate.
- 2) Check for a false connection (cables, resistance to touch, etc.)

Troubleshooting Guide (III)

- 3) If the supply voltage falls from 5V to connect the circuit, may be due to:
  - There is a short somewhere. It may be due to a faulty circuit, a poor contact between component leads, or some misplaced wire. Discovering the cause may require circuit disconnect all connecting circuits and cash them one by one to find the causes of the low voltage.
  - The power supply is incorrectly configured and it is limiting current. The limit to be increased to provide enough current to the circuit (you will notice that the tension will be adequate, and the corresponding light will go off, if any). Limit be increased slowly, and stop if the value is too large for the size of the circuit, because if the problem is not that, the excess current is flowing through the circuit somewhere and can damage any component.

Troubleshooting Guide (IV)

- 4) In the case of a **combinational circuit**, it is likely that the output of the circuit is correct sometimes, but not others. In that case, an input of a combination circuit that produces an erroneous output will be introduced, and will proceed as follows:

- On the circuit diagram on paper will be written the values that should be (theoretically) all outputs and inputs of all integrated circuits (for that combination of inputs).

- Measures will be carried out on the circuit, starting with those integrated into the inputs that are connected and moving towards the exit:

Troubleshooting Guide (V)

- Verifying that each circuit has also been receiving correct entries: we will check (at the pins of the circuit, not the courts) that the value in the entry is correct. If not, there is a problem with the cable that carries the value at that point (may be wrong party punch or even inside) or it could be a problem with the track of the insert plate.

- Once assured that the circuit receives the correct input, the output should be expected. If not, it may be because the circuit is broken, or because the output is connected to the output of another circuit (rather than input), making the other choice is the value that is imposing. In this case, it can destroy the device.

Datasheets and additional information

- The data sheet contain the information the manufacturer provides on each device, including all your data on it, as the pinout (function of each pin), power limitations, physical characteristics of the circuit, etc..

- In the laboratory, is provided the necessary circuitry features, but if you do not have them, can be downloaded as pdf files from the websites of the manufacturers, and even relatively easy to locate by searching the google.