CE/CZ1005

Digital Logic

Lab 1 equipment guide

Students are required to view this before doing lab experiment 1

Safety guidelines

- **For your own safety, do not use open-toe footwear in the lab**

- **If you are unsure about using any electrical equipment, please check with the lab supervisors or technicians**

Experiment 1

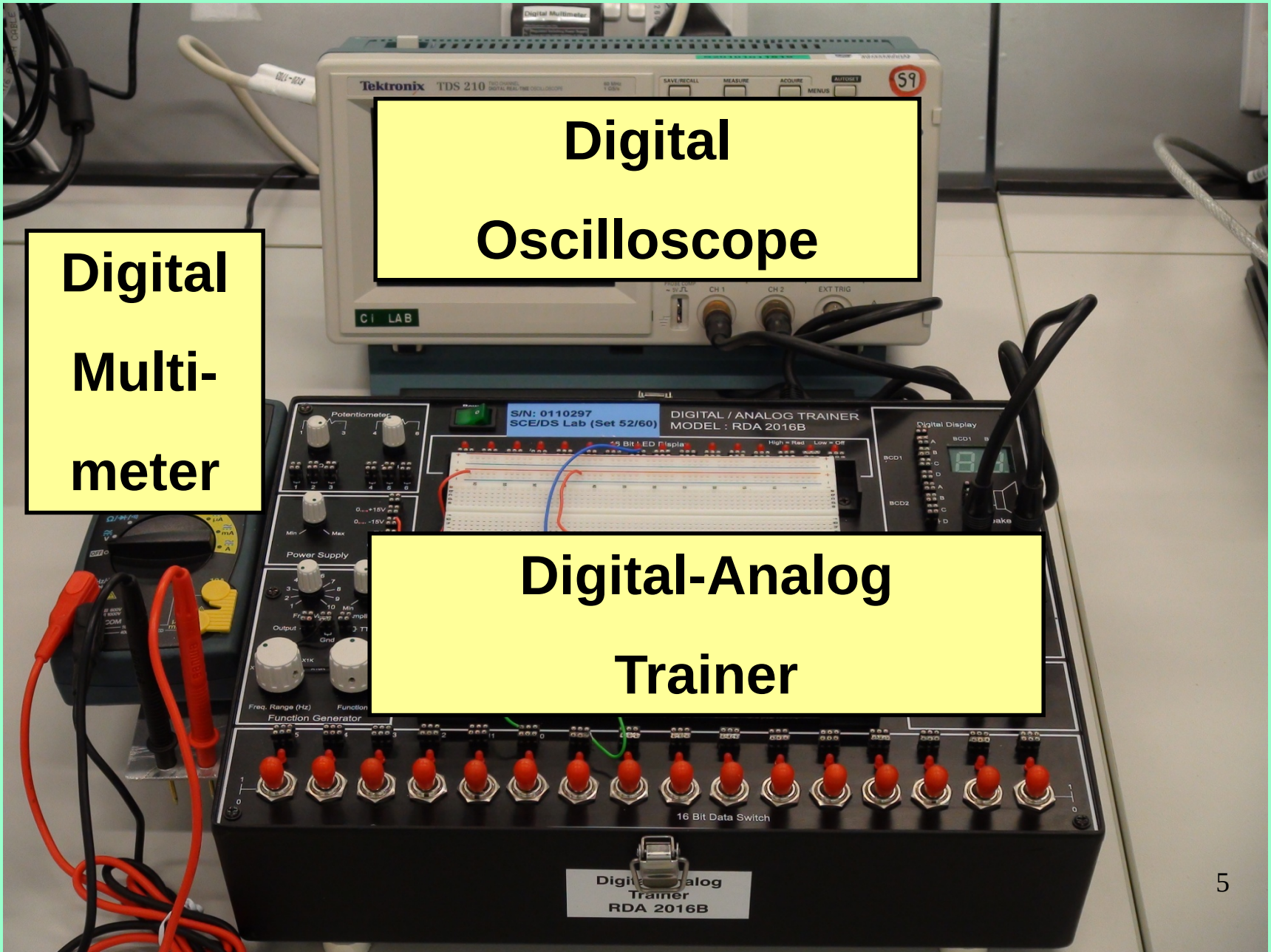
- **In experiment 1, you will be using wires to connect up logic integrated circuits (IC) on a breadboard (or prototype board).**
- **You will use switches to set the logic inputs to 0 or 1, and observer the logic outputs on the LEDs.**

Helpful videos on YouTube

Digital Electronics: Logic Gates - Integrated Circuits Part 1

Introduction to Breadboard (Protoboards), Part 1 of 2

Equipment setup



Digital multimeter

- The digital multimeter can be used to measure current, voltage and resistance
- You will mainly use it to measure DC voltage
- The reading is instantaneous and its usefulness is limited if the voltage level of a signal changes rapidly over time

Digital oscilloscope

- The oscilloscope is used to display the changes in voltage level of a signal over time
- A dual-trace oscilloscope can display two signals at the same time, one on each channel.
- Both the voltage scale and time scale can be adjusted to obtain a display that fits well on the screen – you should try it out during the experiment.

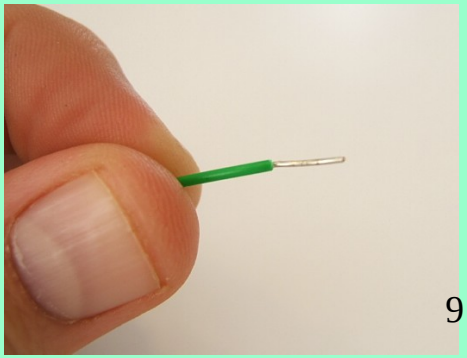
Tools:

wire stripper, wire cutter, IC puller

Always use the correct tool !

Wire cutter and wire stripper

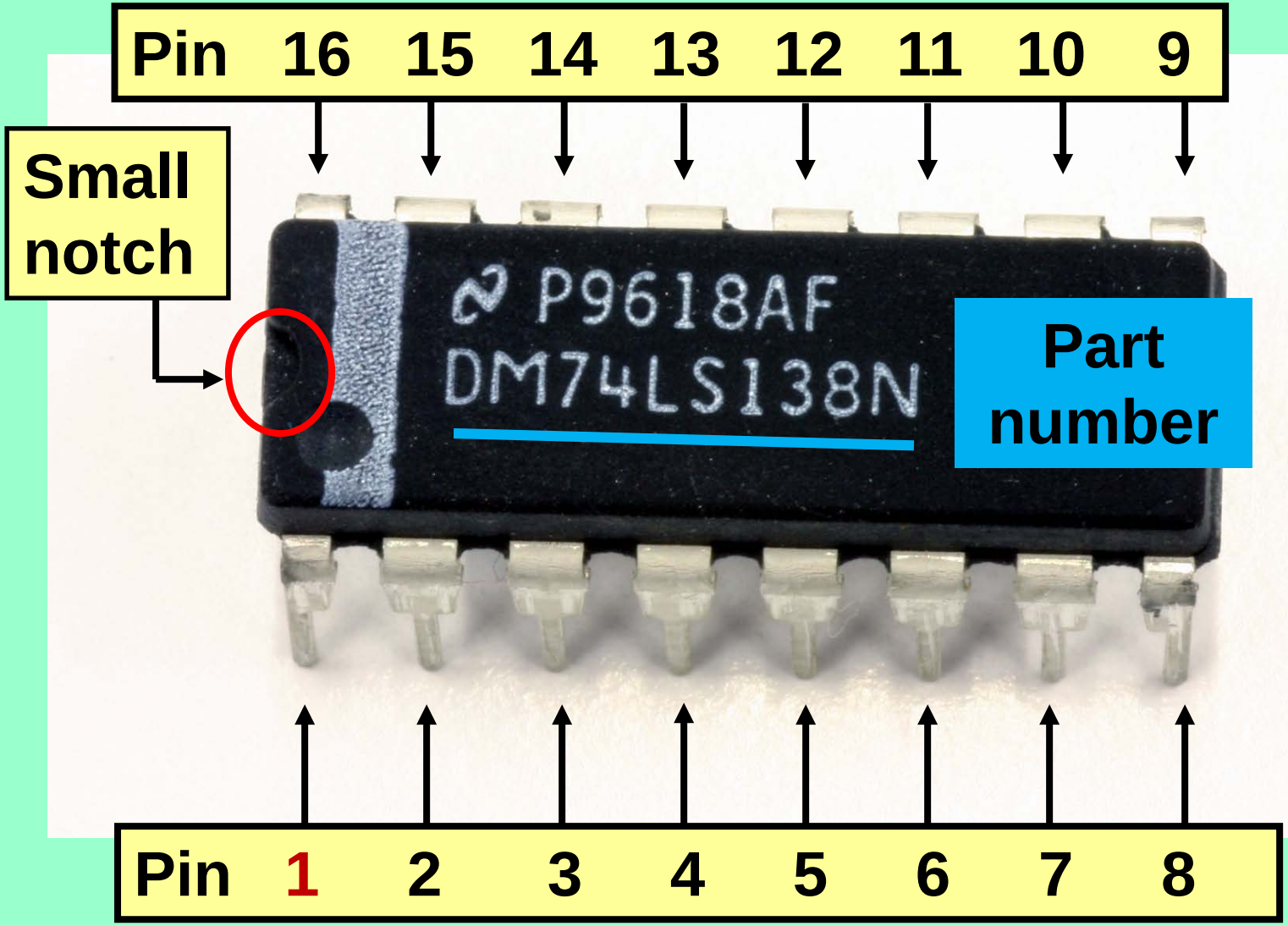
- The wire cutter is used to cut a suitable length of wire
- The wire stripper is used to strip away a section of the rubber insulation on a wire
- Choose the correct hole size that suits the wire diameter – too large, the rubber will not be stripped; too small, the wire will break
- Strip away about 1cm of the insulation to expose the metal wire



Pin numbers on an IC device

- Place device with printed part number (e.g. DM74LS138N) facing upright
- Look for small notch on the short edge of the device
- Pin number begins from 1 (bottom-left) and increment in **anti-clockwise direction**
- See next page

Reading pin numbers on an IC

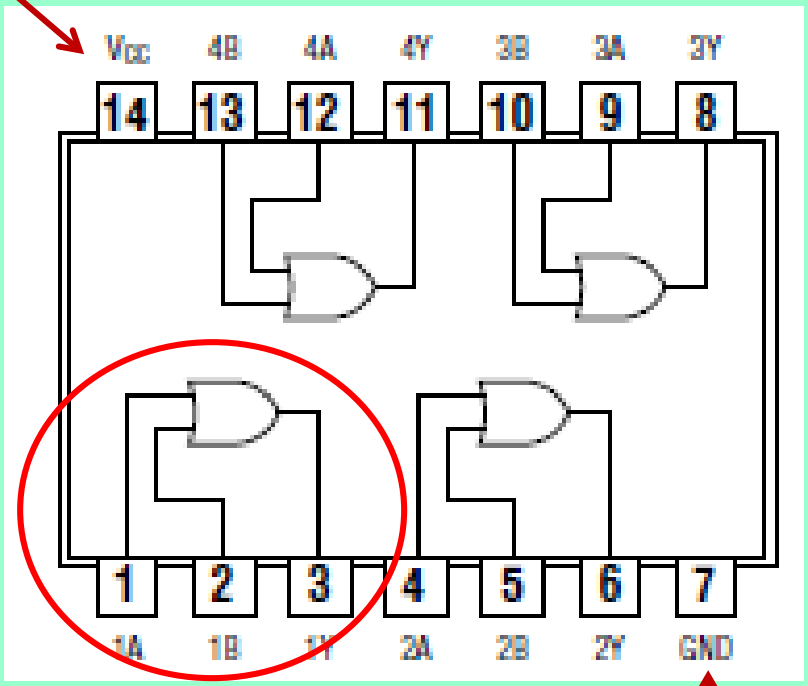


Reading Pin numbers and functions on an IC device from data sheet. E.g. 7432

If we use pins 1 and 2 as **inputs**, then **output** is at pin 3.

Vcc and **GND** must be connected to power supply and ground respectively.

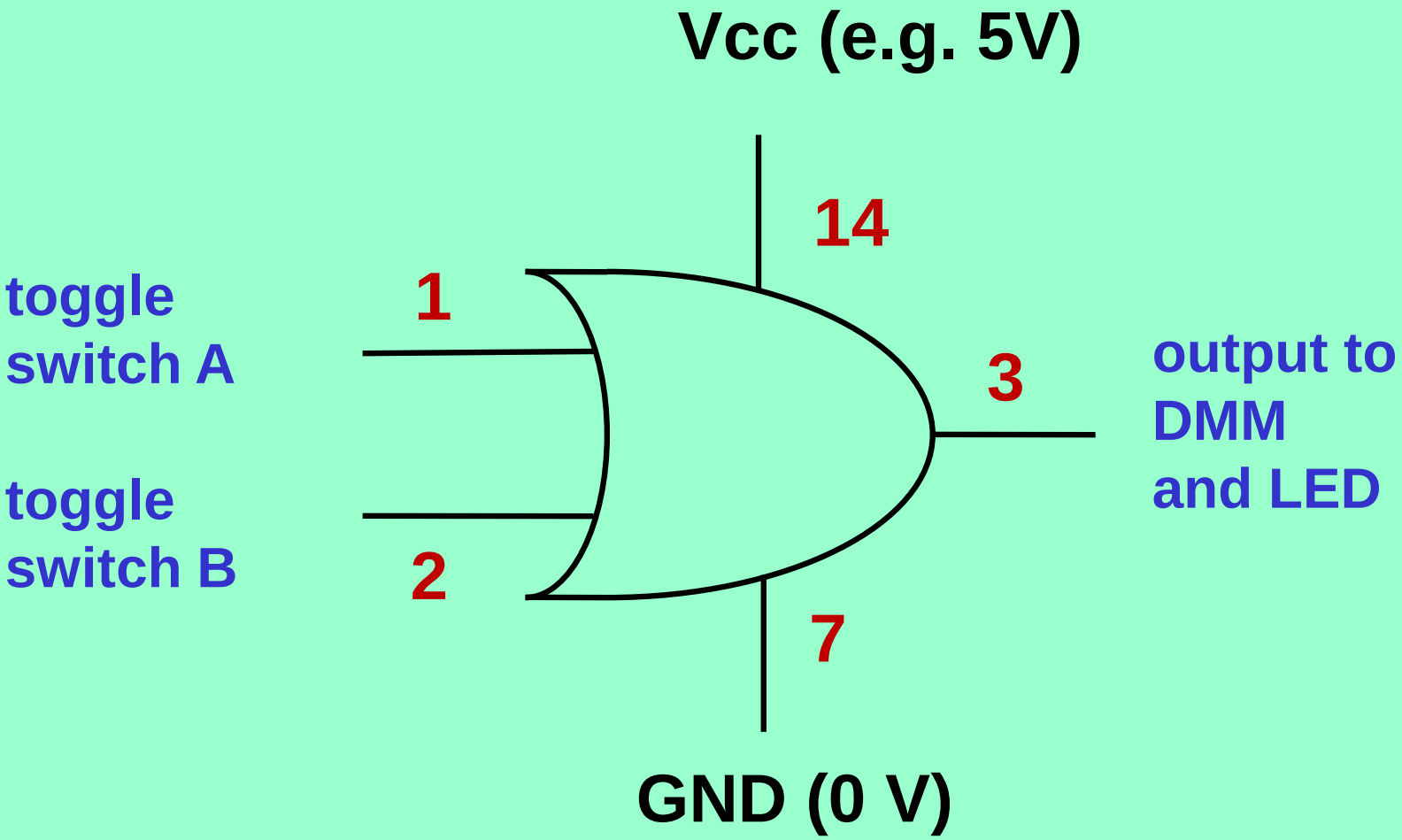
e.g. 5 V



ground

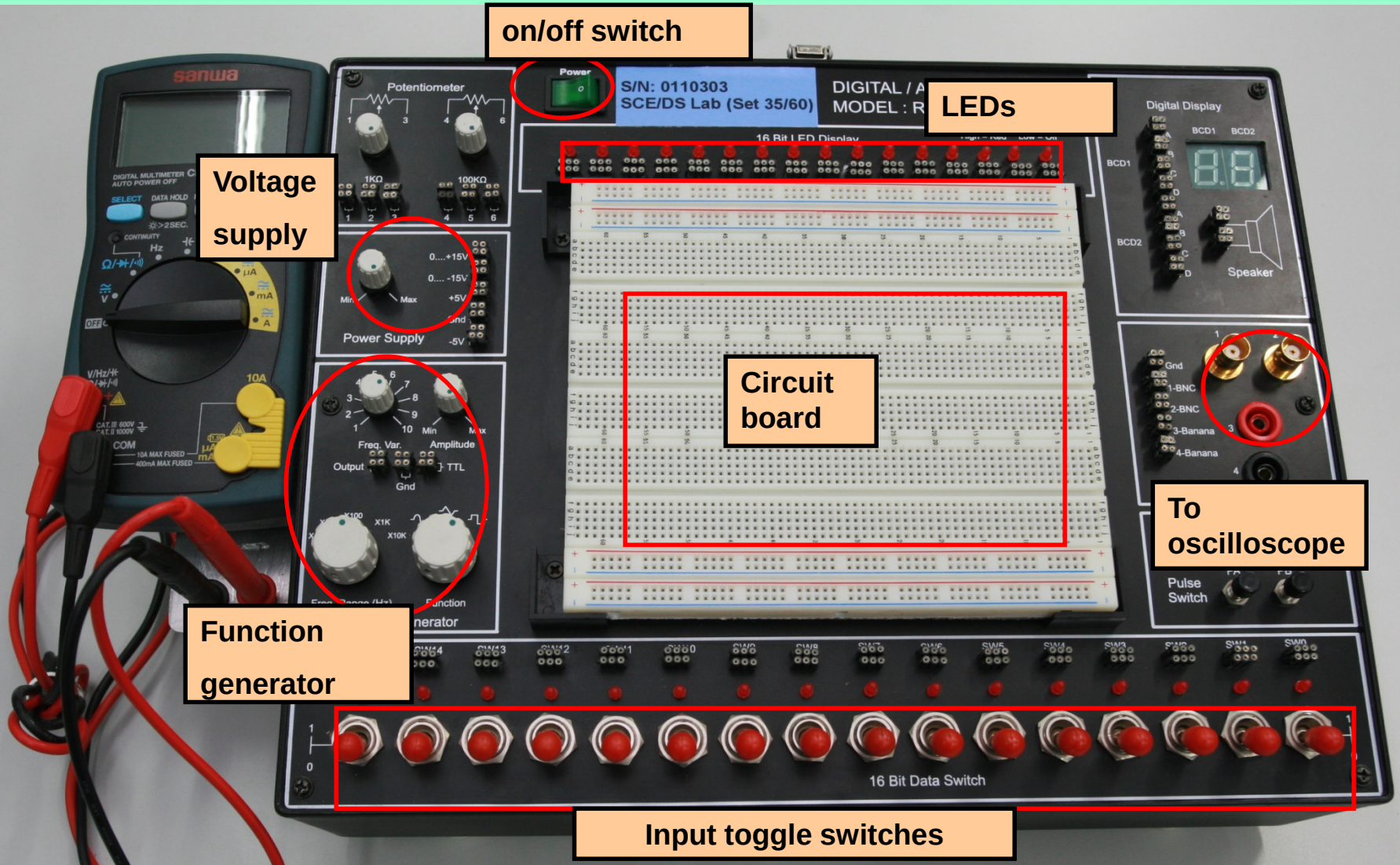
Circuit connection diagram

- **One pair** of Vcc-GND for each IC (not each gate on the same IC)
- Toggle switch provides logic inputs 0 & 1
- DMM (digital multimeter) measures voltage of logic output.
- LED (light emitting diode) lights up if logic output is 1
- Diagram is useful for making connections and troubleshooting when circuit does not work
- See next page



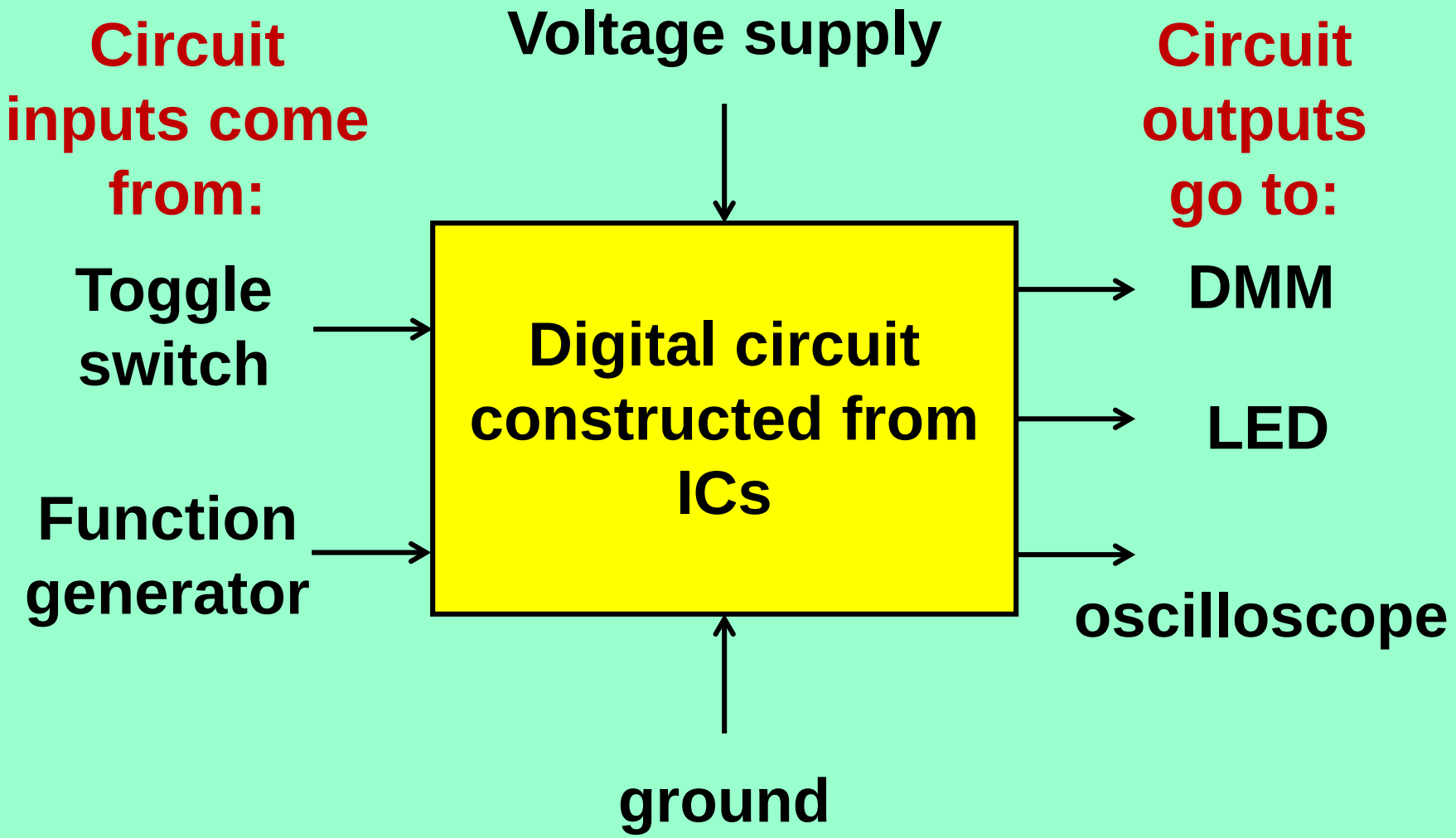
Circuit connection diagram complete with pin numbers & labels

Digital-Analog Trainer

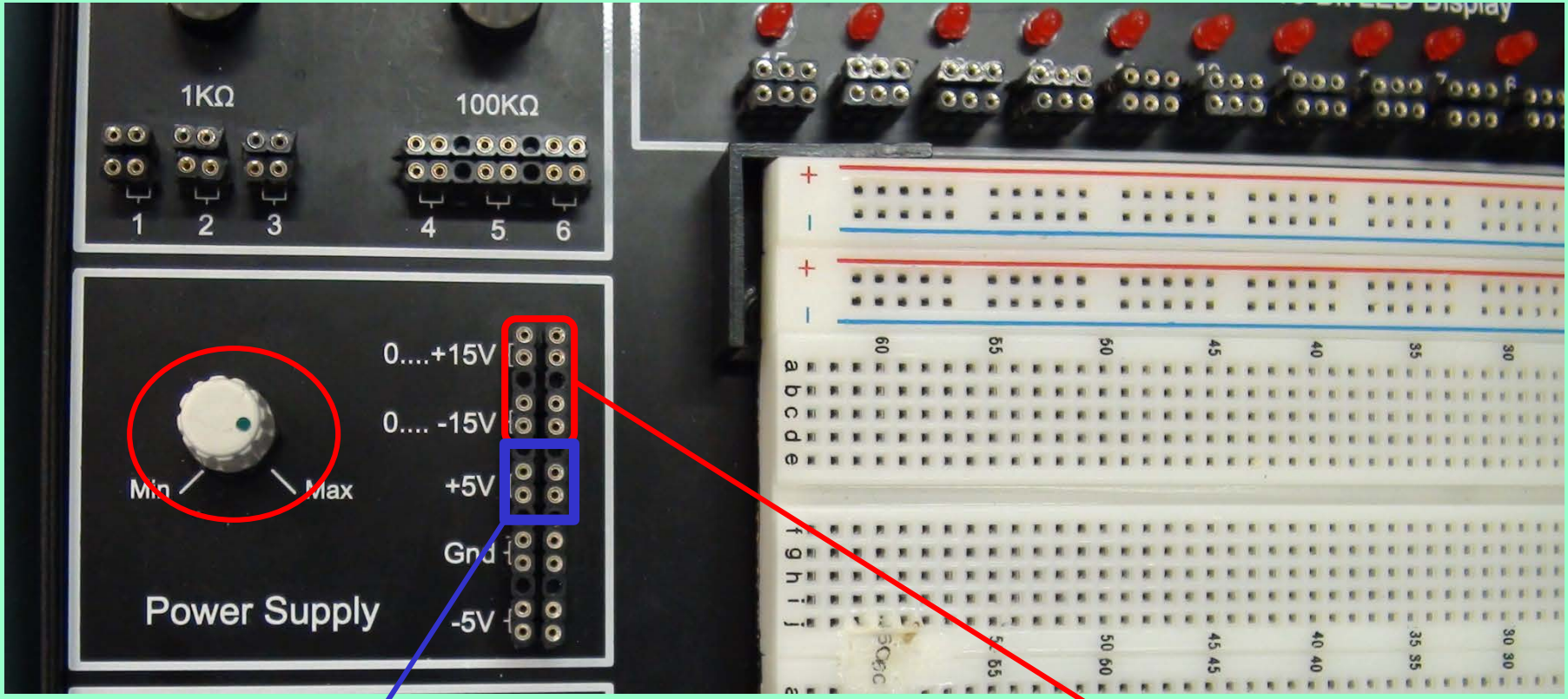


Digital-Analog Trainer

- Voltage supply provides electrical power to the ICs
- Toggle switches provide logic inputs 0 & 1 to the circuit
- LED (light emitting diode) lights up if the logic output is 1
- Function generator provides time-varying logic input to the circuit
- Oscilloscope displays the time-varying logic output


Circuit inputs come from:
Voltage supply
Circuit outputs go to:
Toggle switch
Digital circuit constructed from ICs
DMM
LED
Function generator
oscilloscope
ground

Digital-Analog Trainer – Power Supply



These outputs supply a voltage that is fixed at 5 volts. You will use these in the experiment.

These outputs supply a voltage that can be adjusted between 0 to 15 volts using the knob. You will not use these in the experiment.

Digital-Analog Trainer – Function Generator

This knob adjusts the frequency of the waveform, e.g. 700 Hz, 800Hz, etc.

e.g.

2 X10=20Hz

8 X100=800Hz

5 X1K=5KHz

These gives a square wave (adjustable frequency) within the TTL voltage range. You will use this in the experiment.

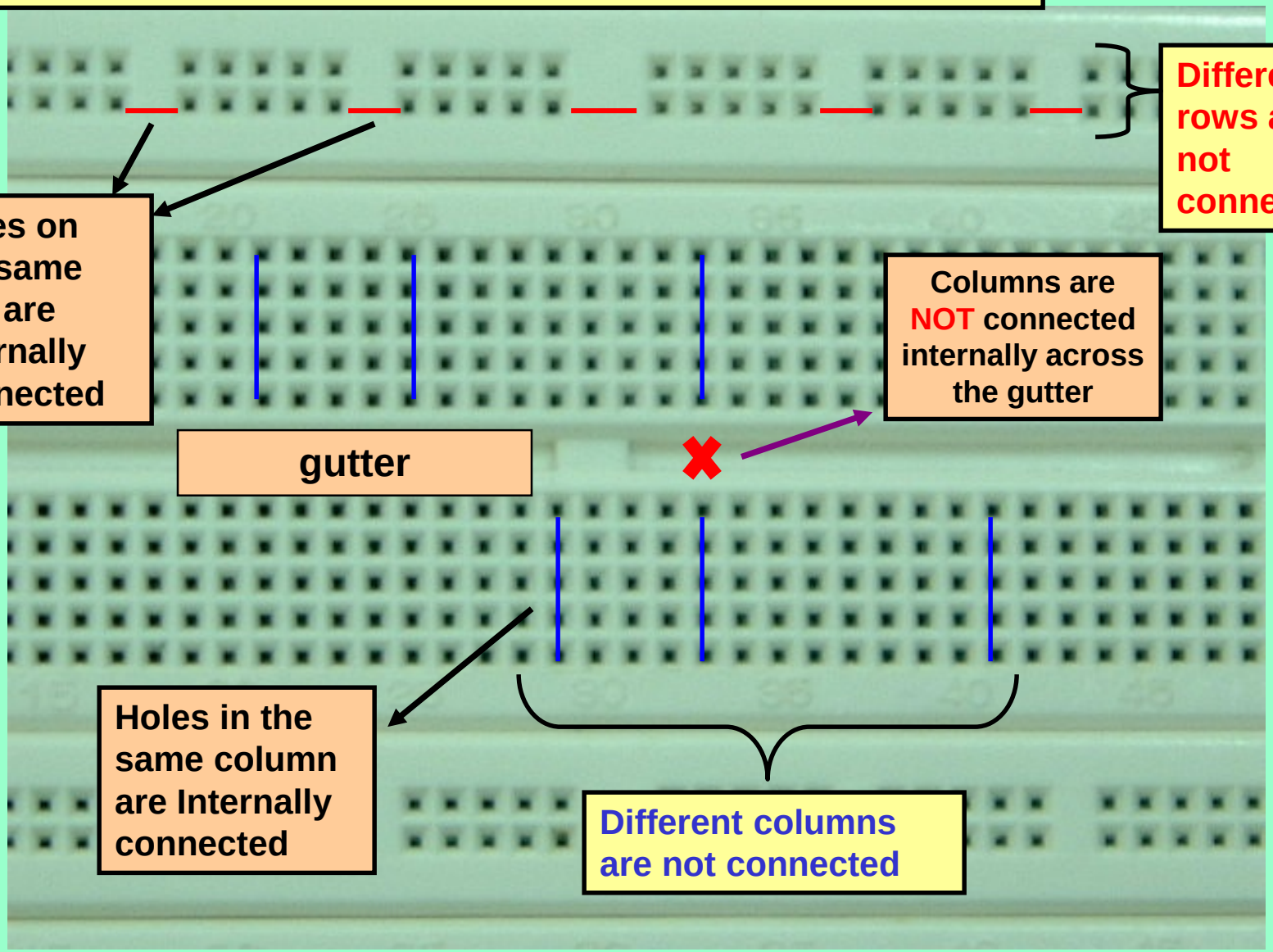
This knob multiplies the frequency by 10, 100 or 1000 times, etc.

Digital-Analog Trainer – Function Generator

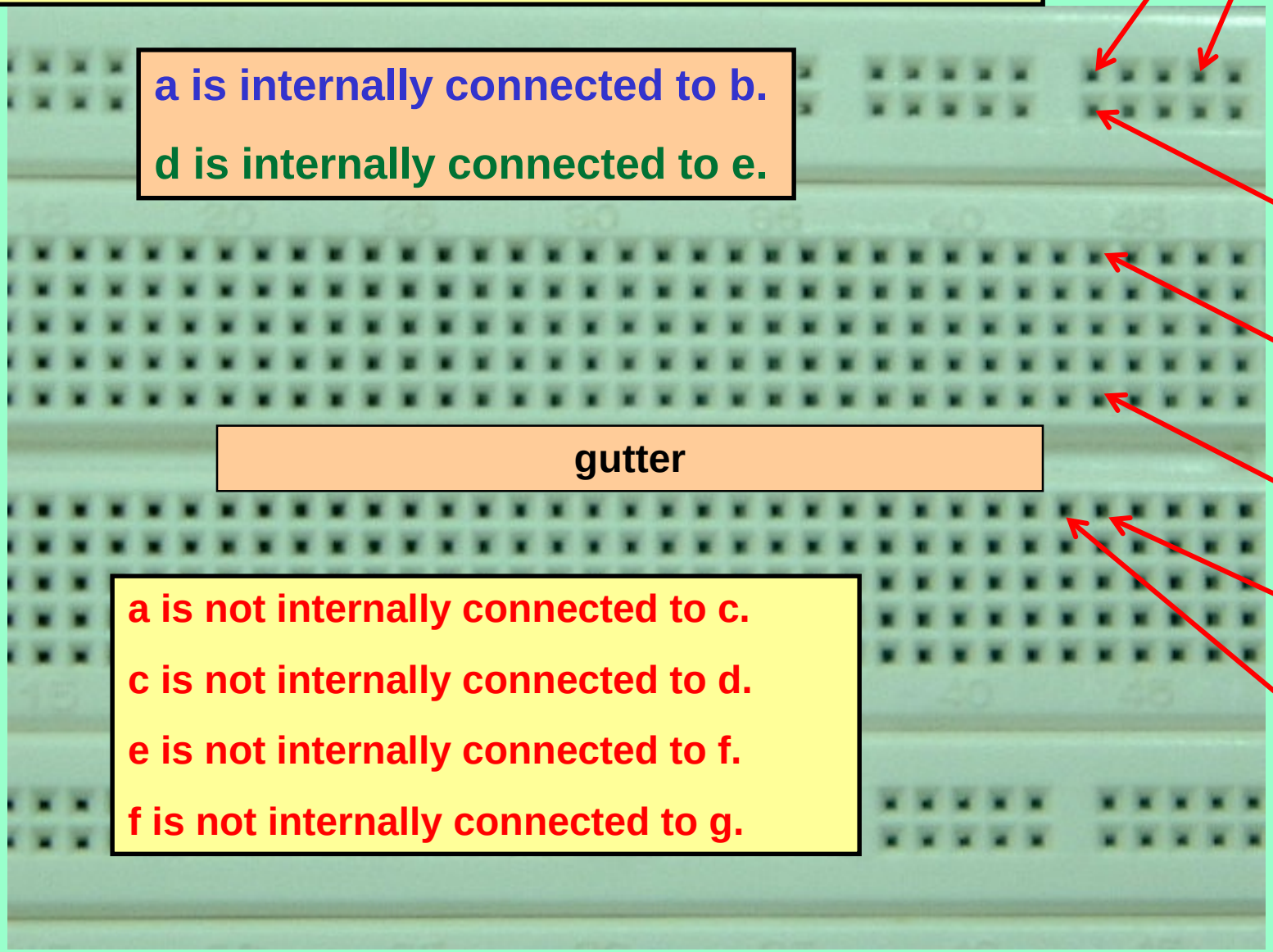
These gives the selected waveform (sine, triangular or square) with adjustable amplitude. You will not use these in the experiment.

This knob selects the type of waveform: sine, triangular or square.

Bread board (or circuit board)



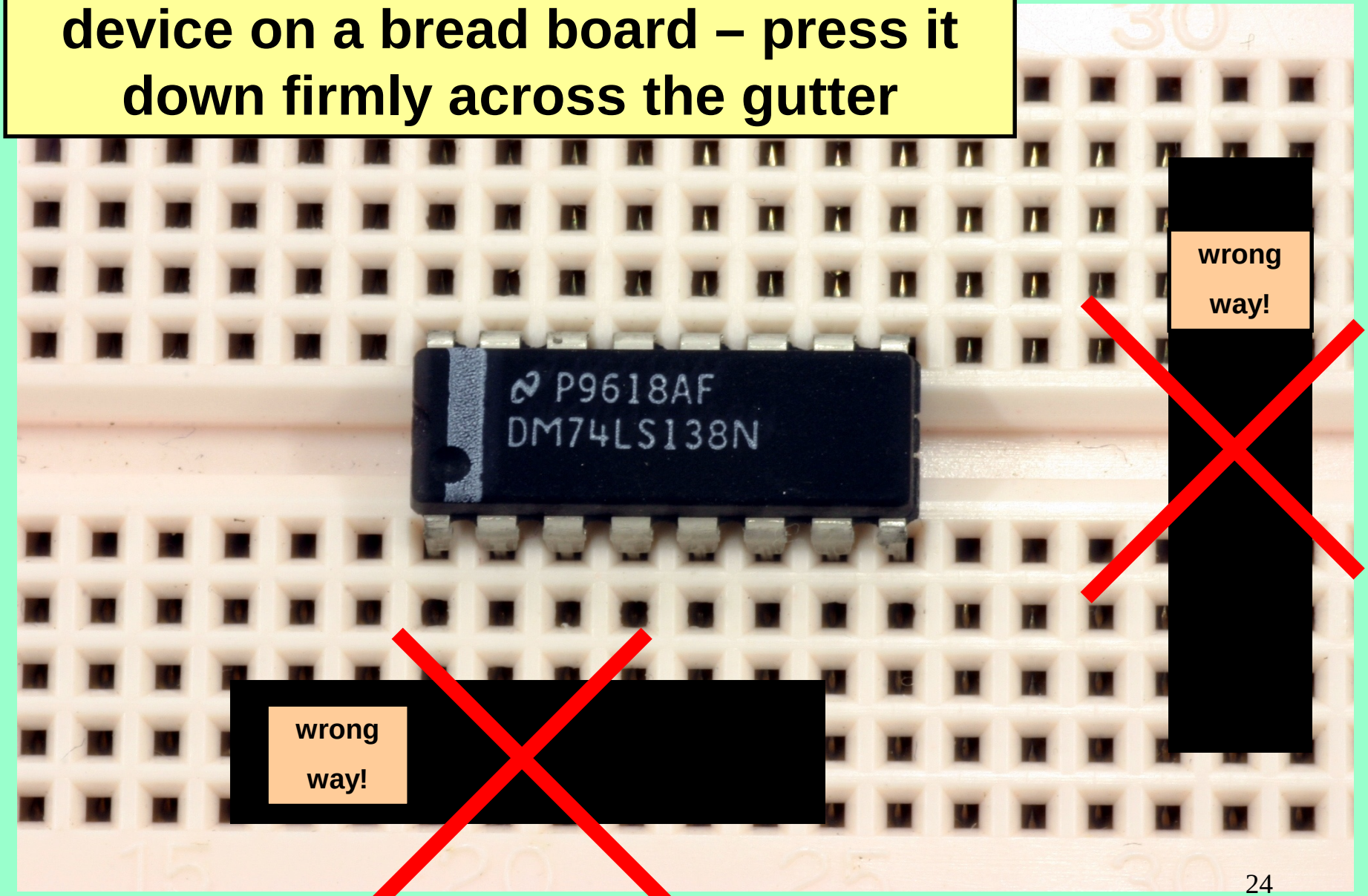
For example:


a is internally connected to b.
d is internally connected to e.
gutter
a is not internally connected to c.
c is not internally connected to d.
e is not internally connected to f.
f is not internally connected to g.
a
b
c
d
e
f
g

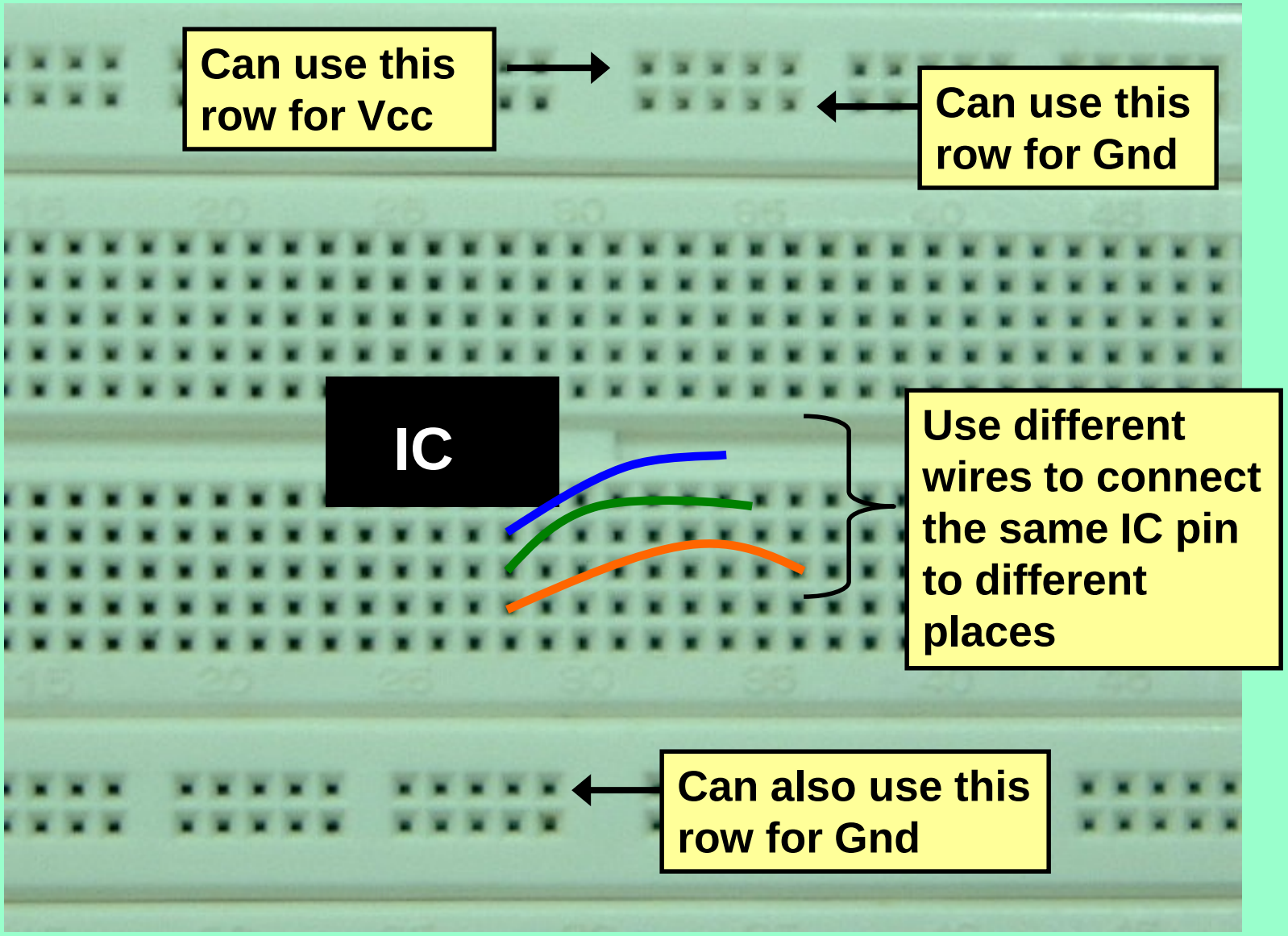
Rows and columns on a bread board

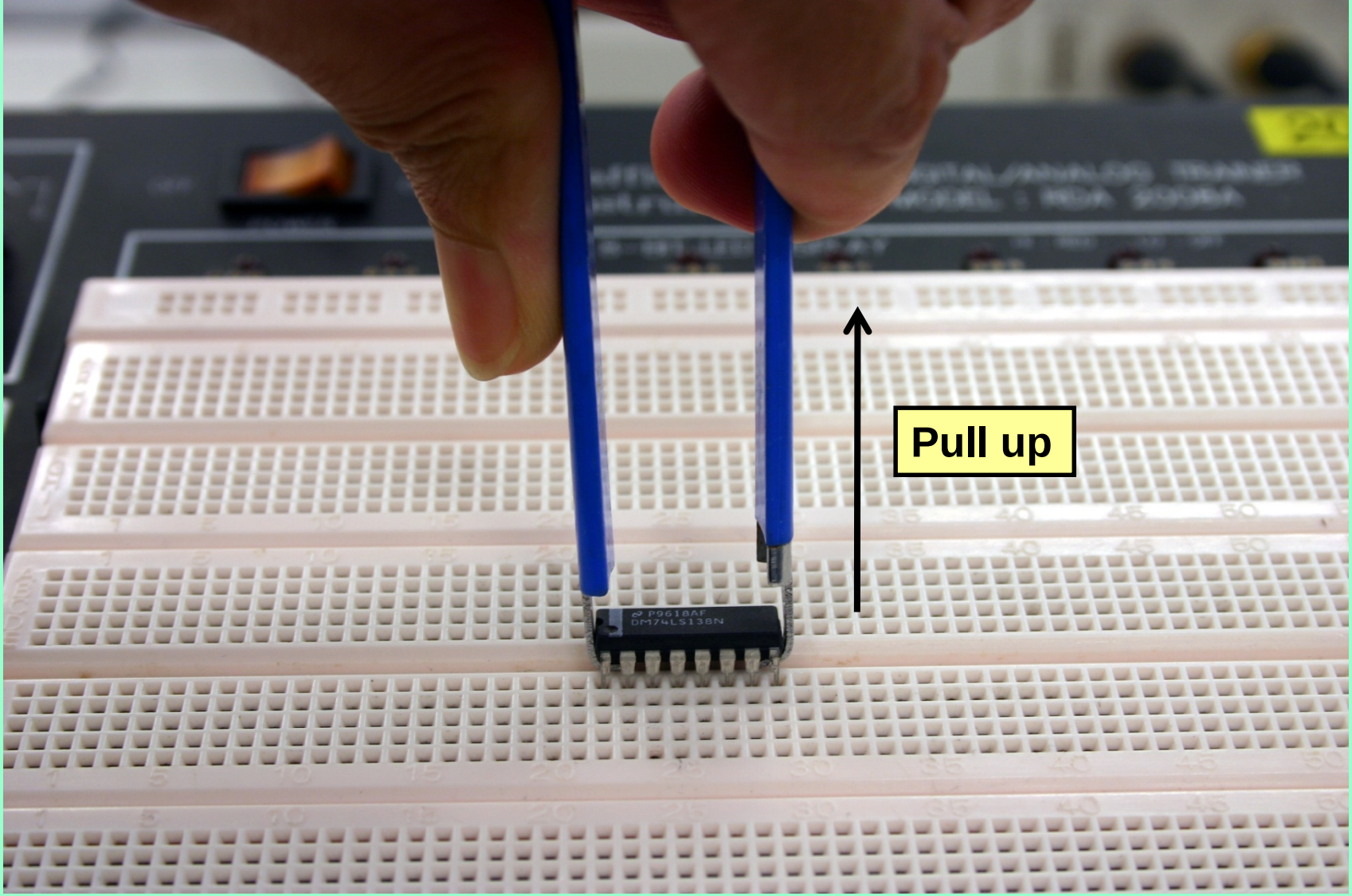
- Holes on the same row are internally connected to each other
- One row may be used for Vcc, the other row may be used for GND.
- Holes on the same column are internally connected to each other (but not across the gutter)
- Neighbouring columns (or rows) are not connected

The correct way to place an IC device on a bread board – press it down firmly across the gutter



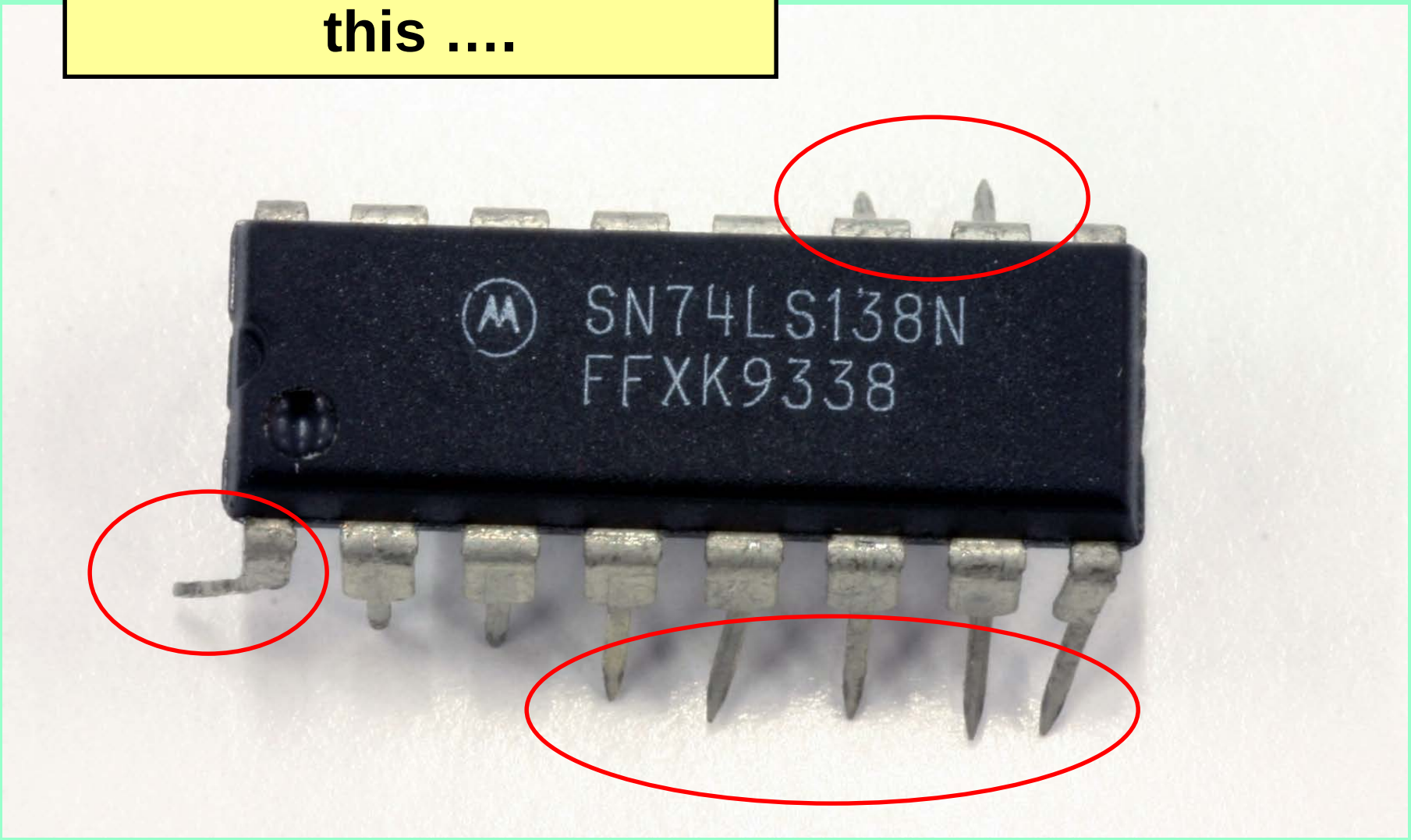
Use wires to connect the left and right rows



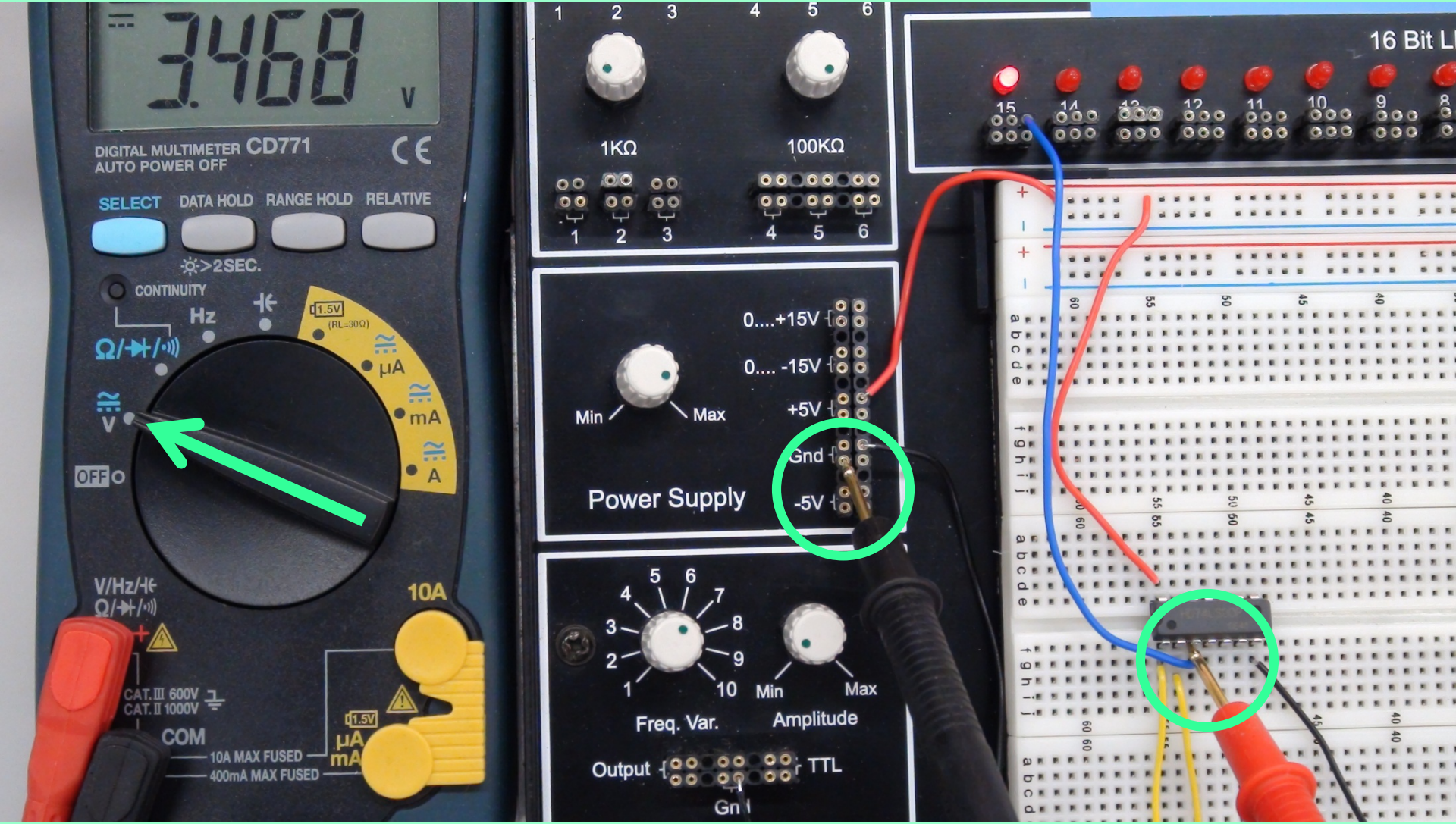


The correct way to remove an IC device from the bread board

Otherwise, you'll get this ….

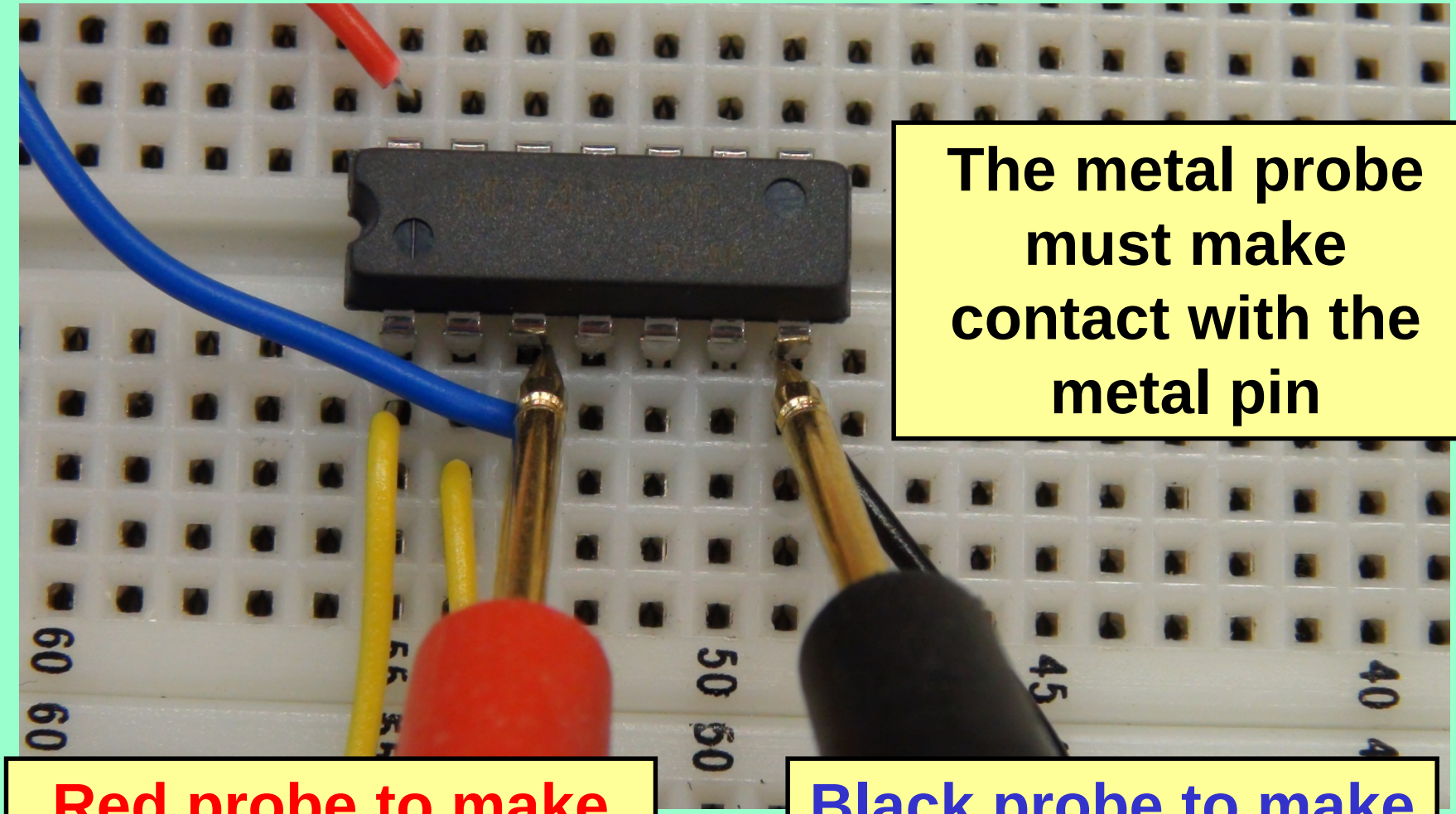


Set DMM (digital multimedter) to measure voltage



Use metal probes to measure voltage

A close-up view of the DMM probes

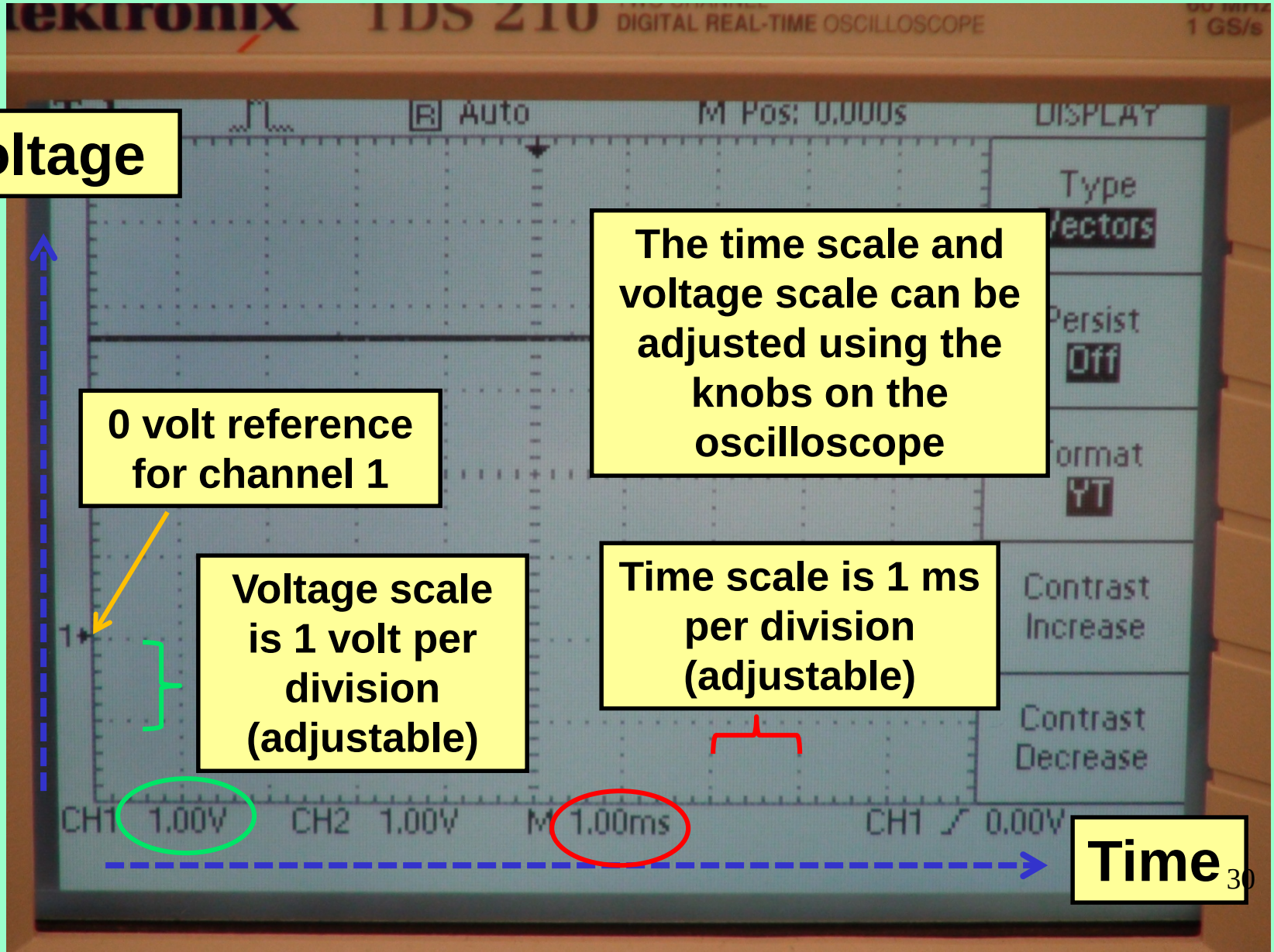


The metal probe must make contact with the metal pin

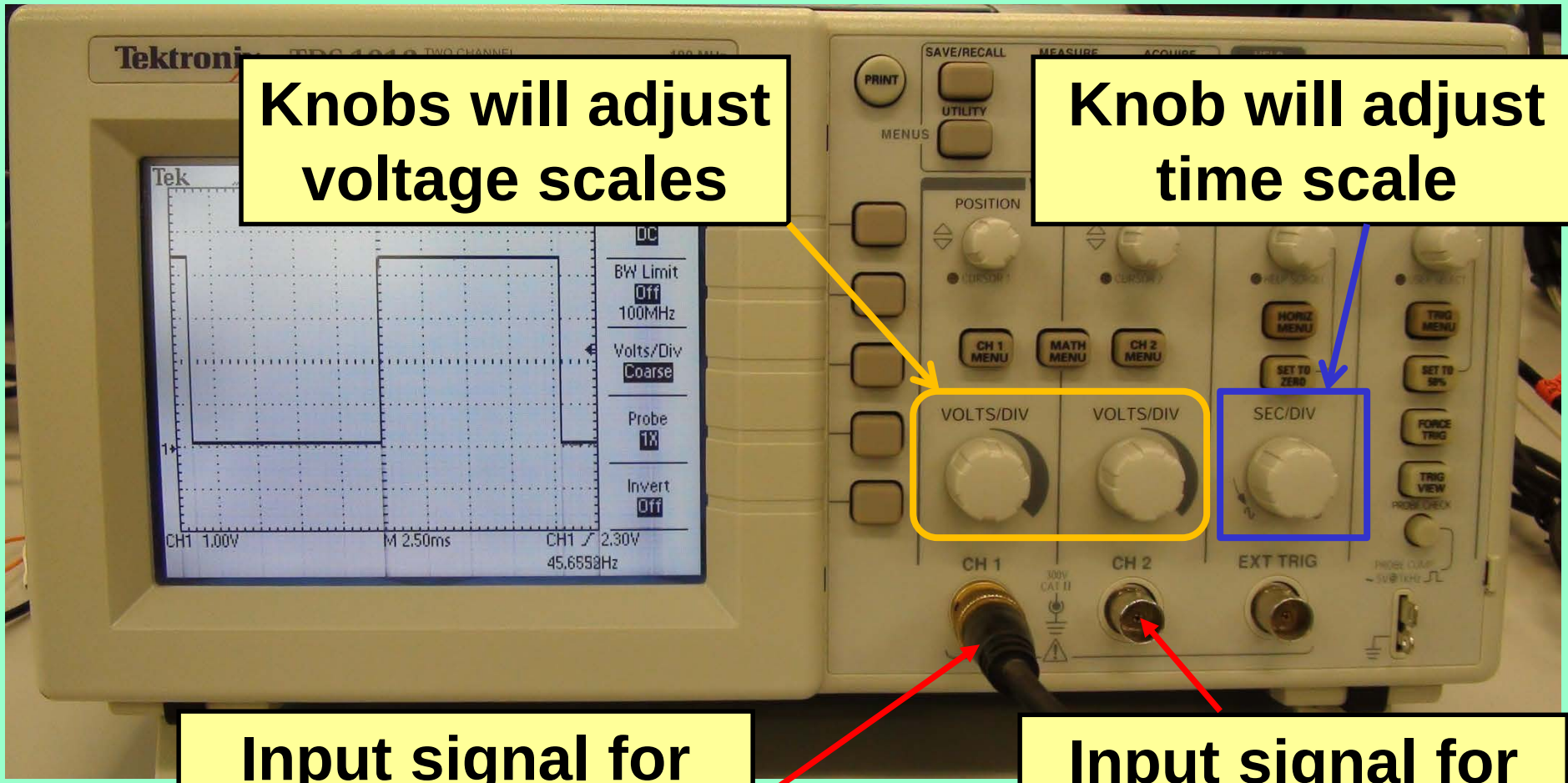
Red probe to make contact with IC pin

Black probe to make contact with GND

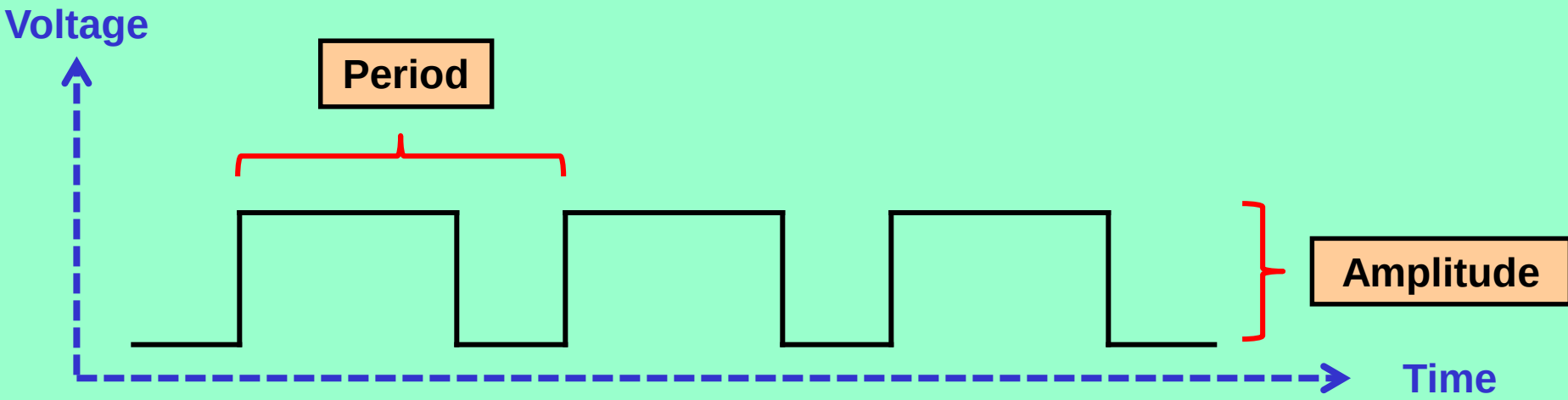
Digital oscilloscope



Sending signals to display on the digital oscilloscope



Periodic square wave and frequency



Frequency = 1/Period

e.g. if period = 1s, then frequency = 1Hz

if period = 0.5 ms, then frequency = 2kHz

Can the pins on an IC be connected together?

pins	Vcc	Gnd	input	output
Vcc	Yes	No	Yes	No
Gnd		Yes	Yes	No
input			Yes	Yes
output				No

A logic output should be determined by its input(s), not by externally connecting it to something else.