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Engineering Design Project-II
(UTA 024)

THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

Engineering Design-III
(UTA 014)
Buggy Lab

Dr. Amit Mishra

Index

- Diode (p-n junction)
- Digital Multimeter
- Diode testing

Types of Diodes


Gunn Diode


LED

PIN Diode

Step Recovery Diode

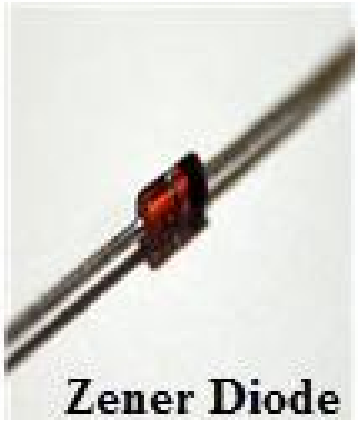

Laser Diode


Photo Diode


Tunnel Diode


Varactor Diode

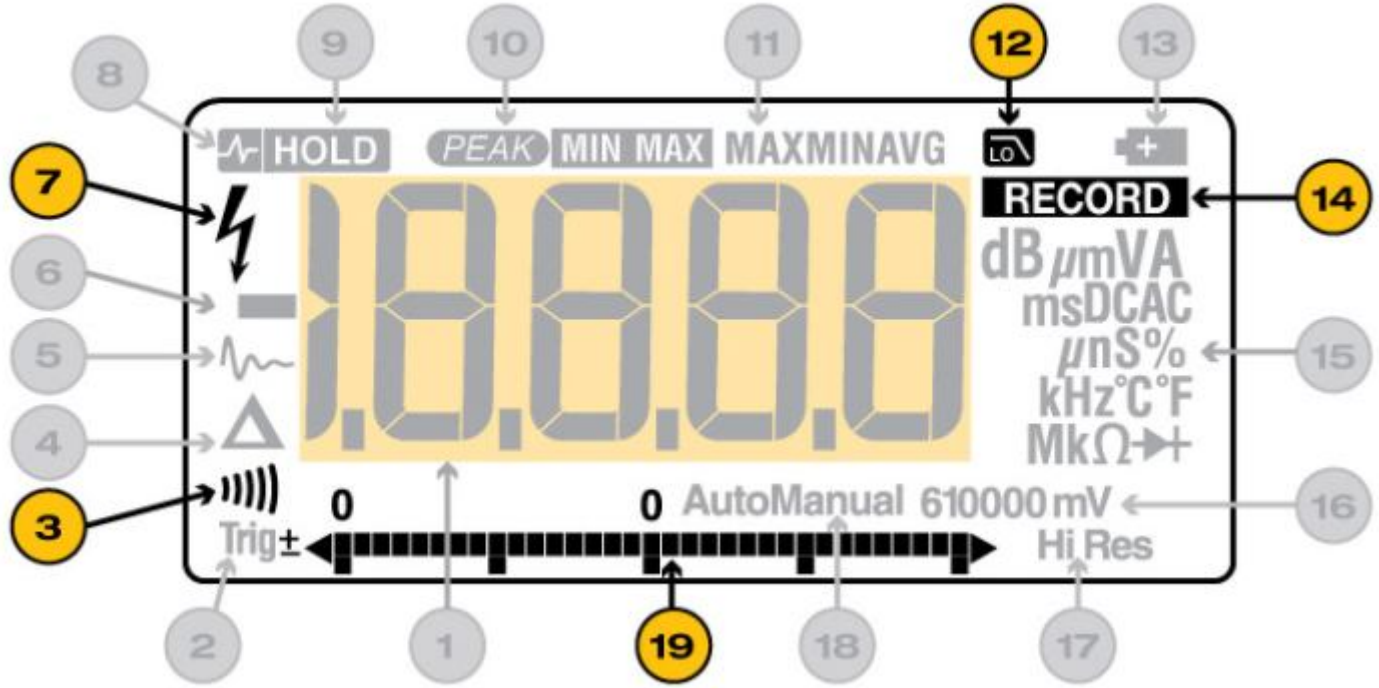

Schottky Diode


Zener Diode

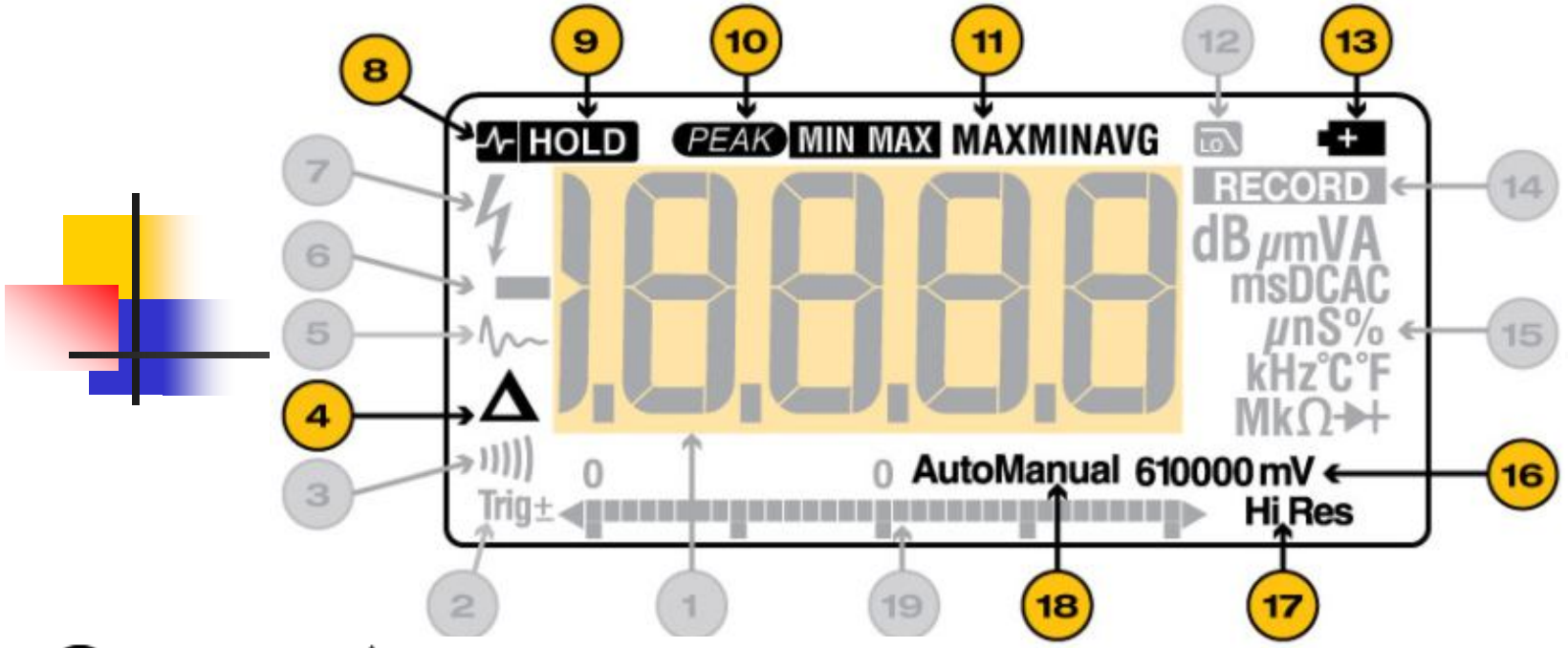
Digital multimeter

Digital multimeter display

1	1.8.8.8.8	Digits
6	▬	Negative reading indicator
15		**Measurement units**

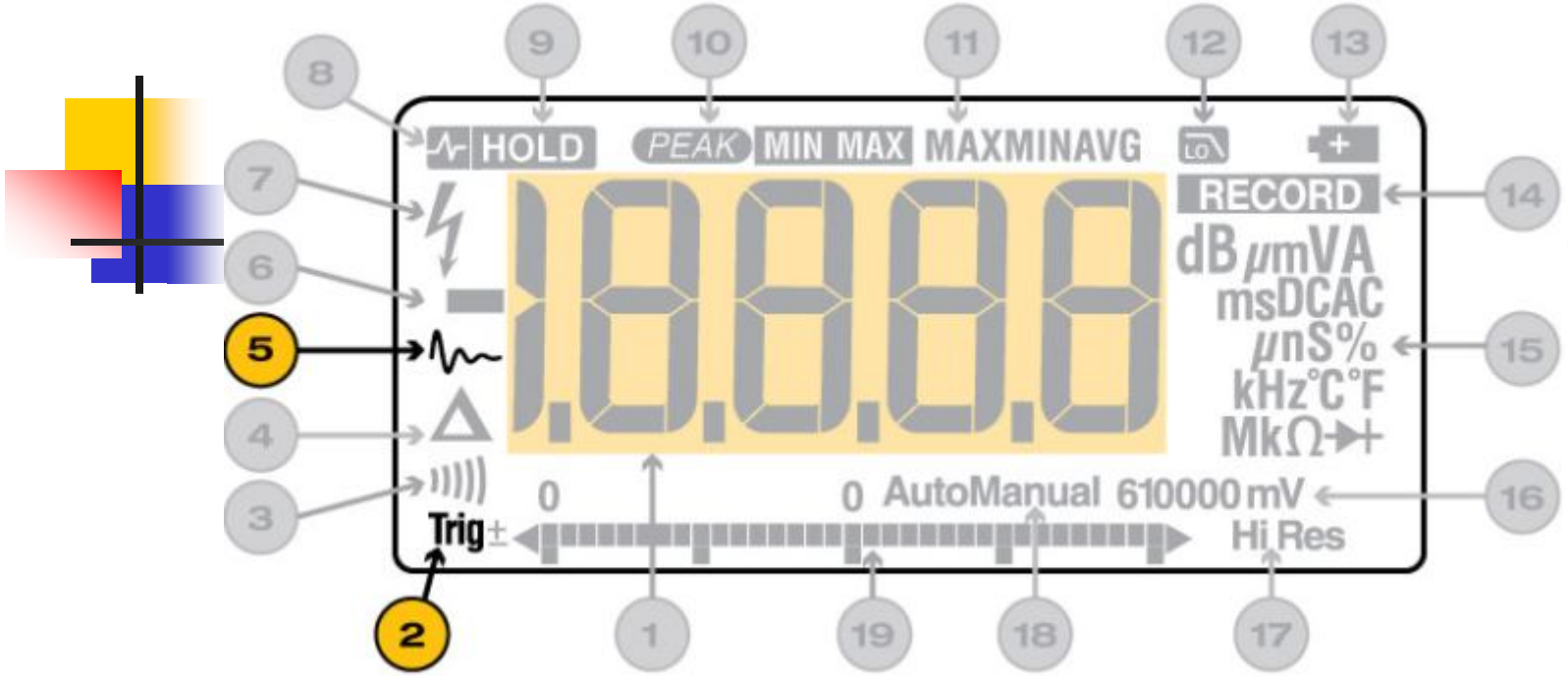


3	)))))	Continuity beeper
7	ϟ	High-voltage input (if 30 V or greater, ac or dc)
12	LO	Low pass filter mode
14	RECORD	Recording mode
19	▬▬▬▶	Analog bar graph



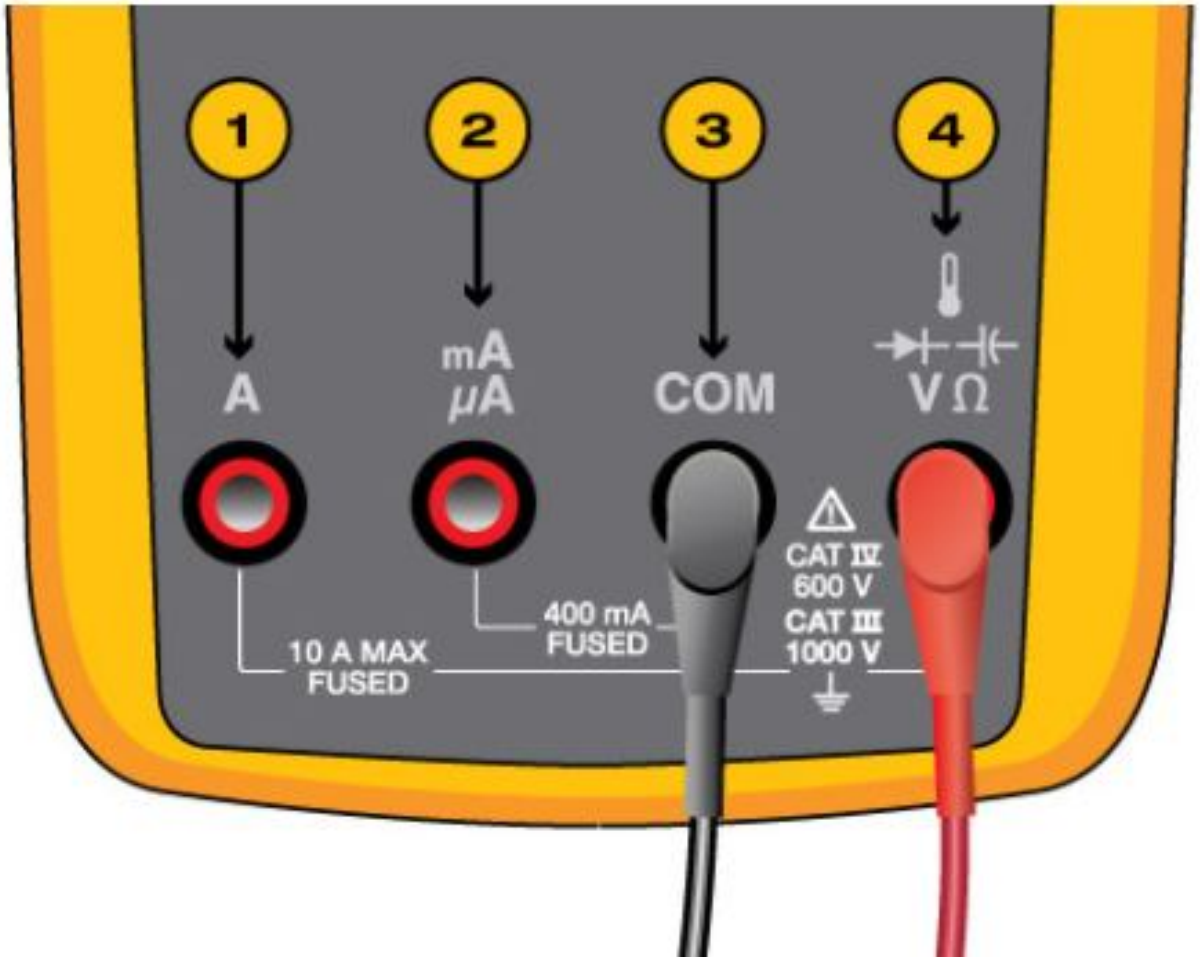
4	Δ	Relative (REL) mode
8		Auto Hold active
9	HOLD	Display hold
10	PEAK	Peak Min Max mode
11	MIN MAX MAXMINAVG	Min Max recording

13		Low battery indicator
16	610000 mV	Selected range
17	Hi Res	High-resolution mode
18	AutoManual	Auto or Manual range

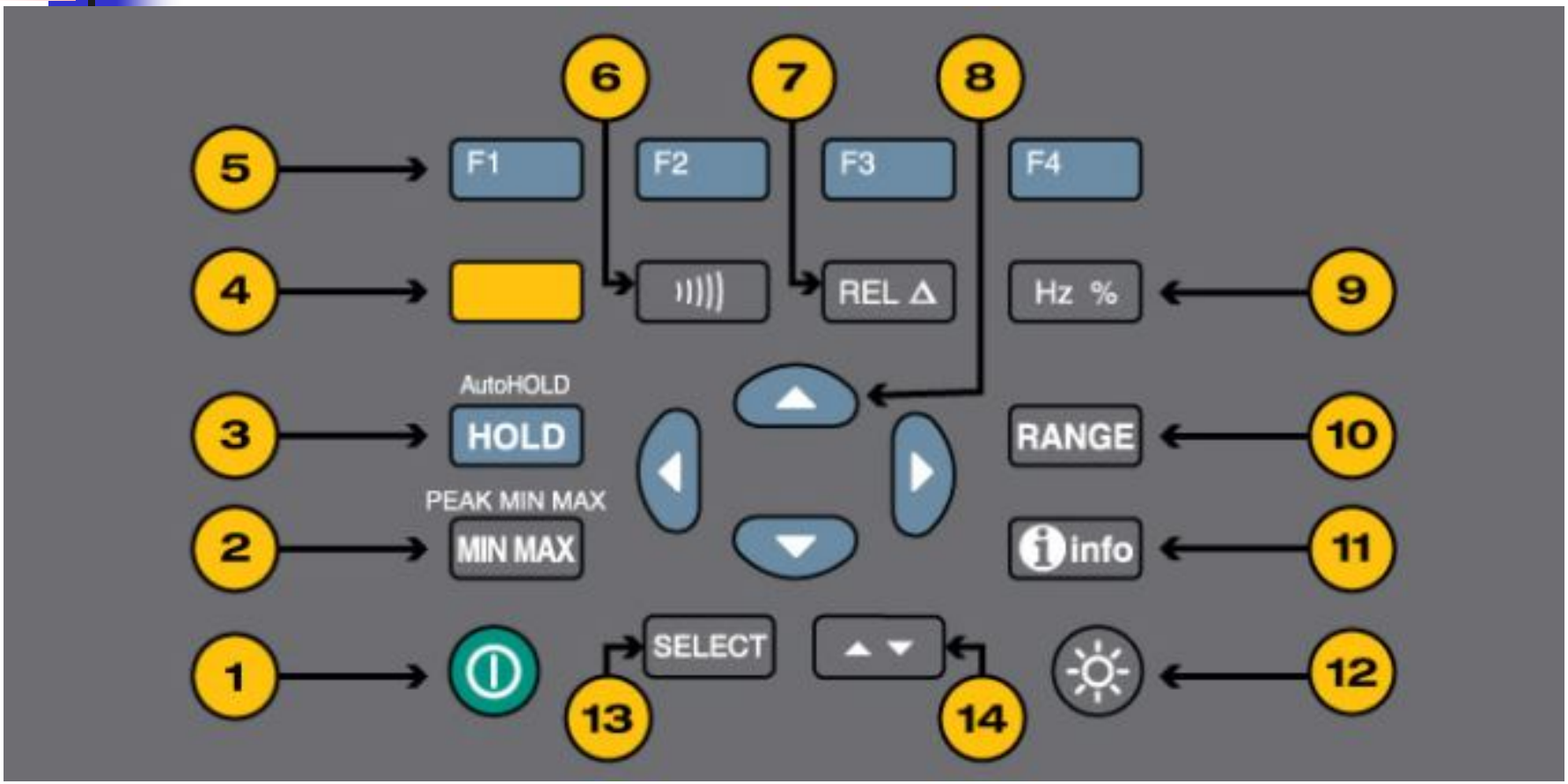


2	Trig	Polarity
5		Smoothing

Digital multimeter jacks

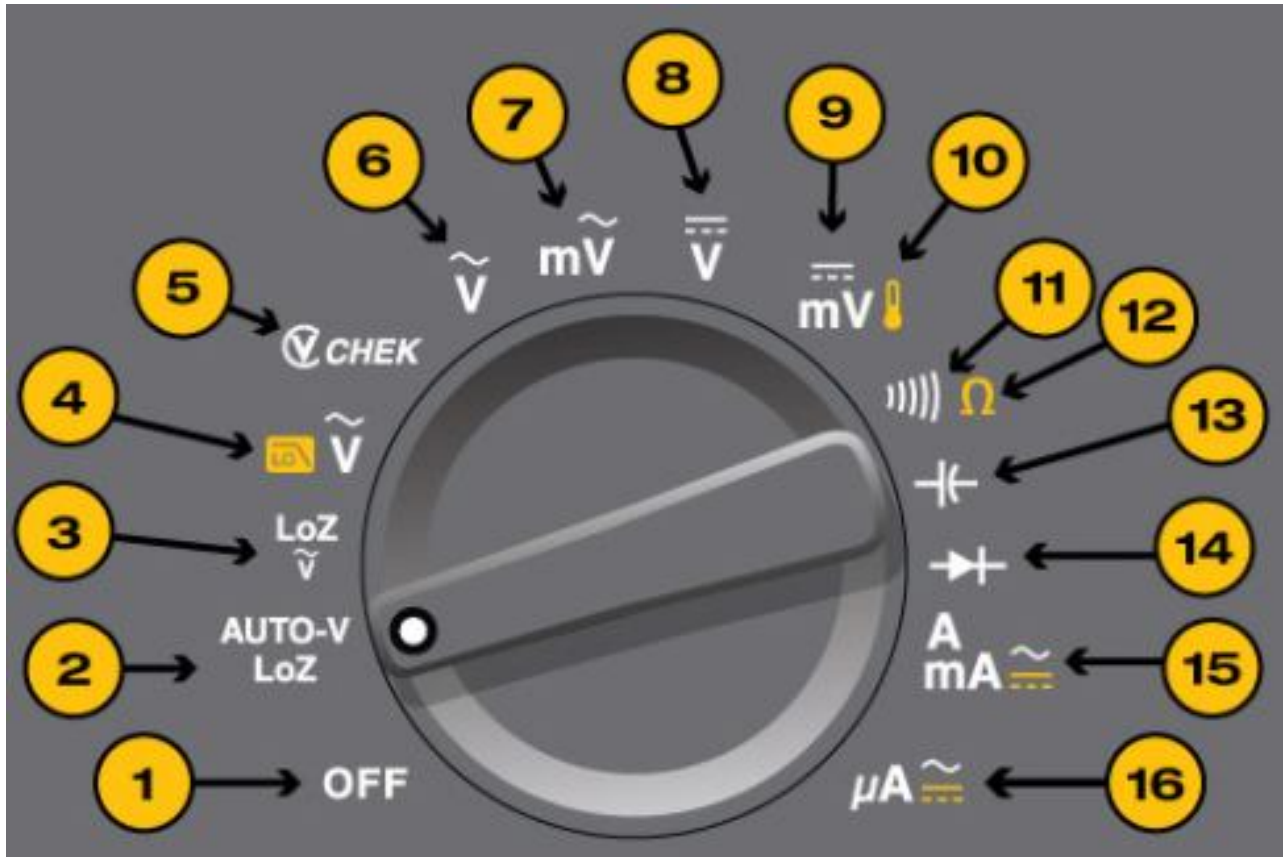


Digital multimeter buttons



1. **On/off button.**
2. **Min Max:** Stores input values; beeps when a value is breached and a new value is set.
   Peak Min Max: Captures intermittent or transient events that occur on a monitored signal; captures the highest value in a very short duration (microseconds).
3. **Hold:** Captures and holds a stable measurement. **AutoHOLD:** Captures a measurement, beeps, and locks the measurement on the display for later viewing. Automatically updates with a new stable reading.
4. **Function button:** Yellow button activates secondary functions shown in yellow icons around the dial (often temperature and capacitance).
5. **Menu buttons:** Activates functions related to the menus in the display.
6. **Audible signal:** Activates continuity beeper.
7. **Relative (REL) mode:** Stores existing reading (a delta) and resets display to zero. Sets a relative reference point to measure against the next reading.
8. **Cursor buttons:** Permit data entry, menu scrolling, display adjustment, and other tasks.
9. **Frequency** and **duty cycle measurement.**
10. **Range:** Switches to manual mode and cycles through all ranges. Autoranging restored when pressed for two seconds.
11. **(i)info:** Displays information about present function or items on the display at the moment the button is pressed.
12. **Brightness:** Switches display backlight between off, low and high.
13. **Select:** (3000 FC only) Selects/deselects the highlighted wireless module in the display. Hold for 1 second to bind all selected modules to the meter and stop the discovery procedure.
14. **Up/down:** (3000 FC only) Moves the highlight in the display to the next wireless module shown in the display.

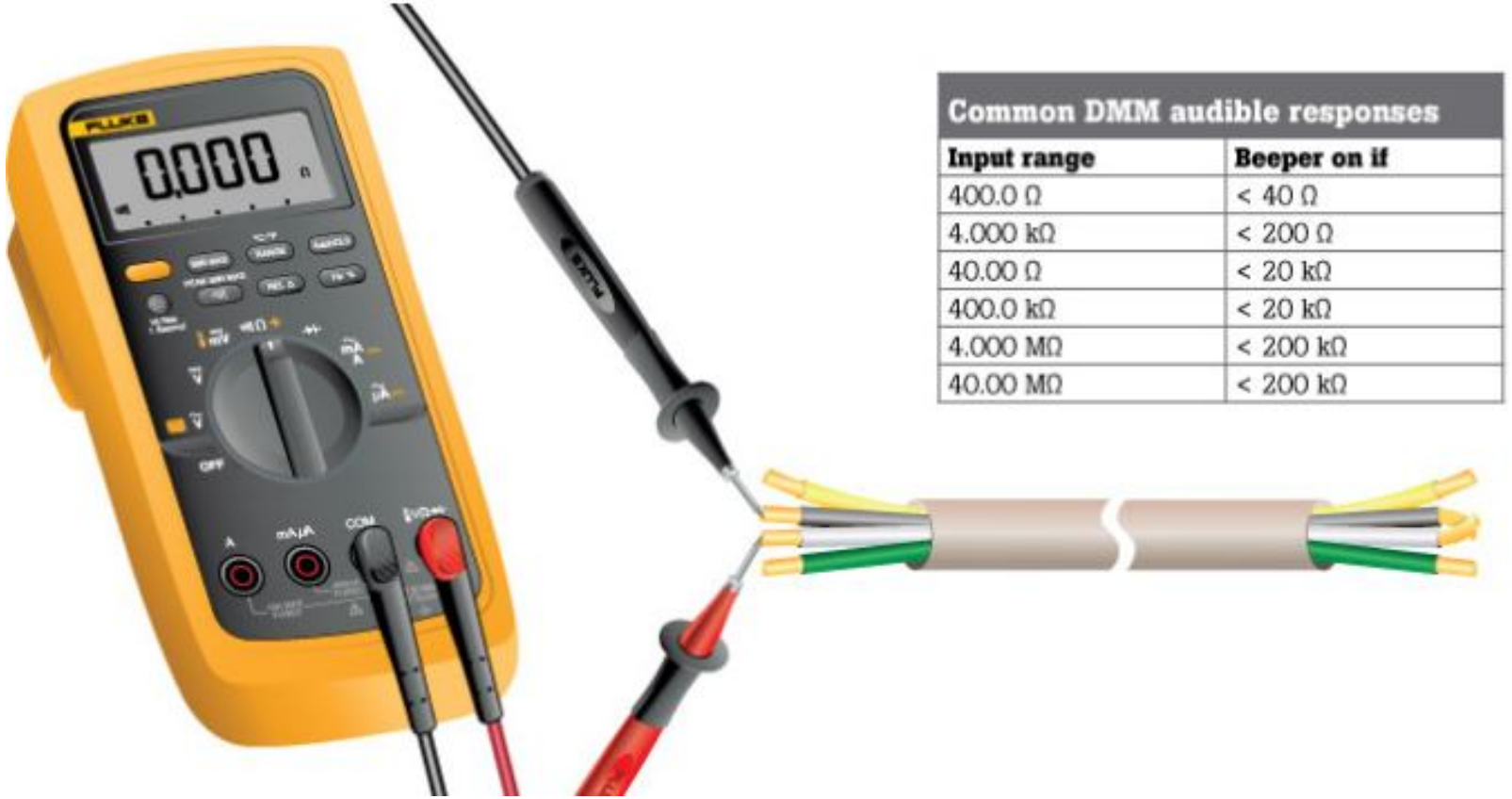
Digital multimeter dial



1	ON/OFF switch
2	AUTO-V/LoZ (prevents false readings due to ghost voltage; found on Fluke 114)
3	ac voltage/LoZ (uses low-input impedance)
4	ac voltage with low pass filter
5	VCHEK™ (permits simultaneous testing for voltage or continuity; found on Fluke 113)
6	ac voltage
7	ac millivolts
8	dc voltage
9	dc millivolts
10	Temperature
11	Continuity (when combined with sound button)
12	Resistance
13	Capacitance
14	Diode test
15	ac, dc amps and milliamps
16	ac, dc microamps

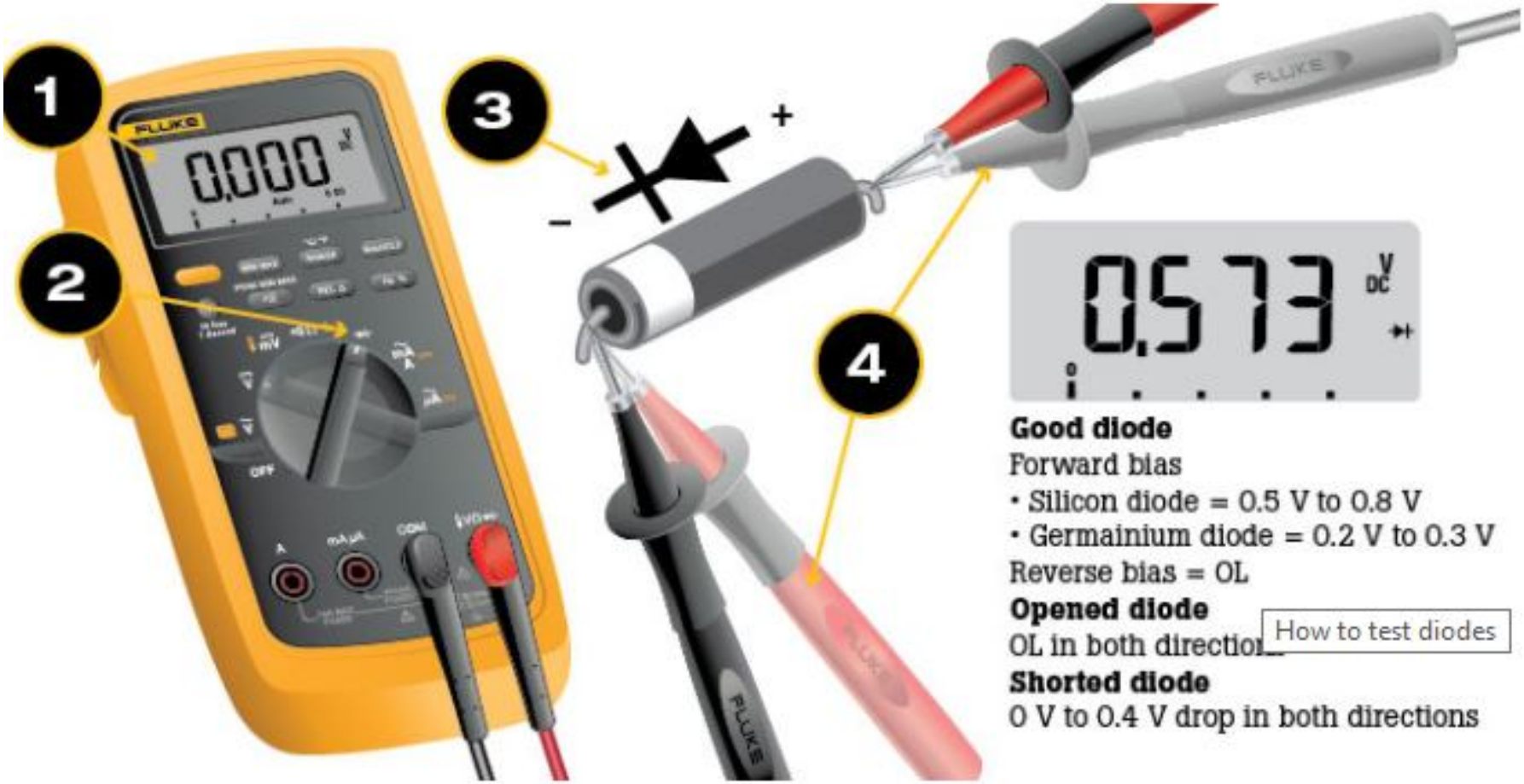
How to test for continuity

How to test for continuity



Common DMM audible responses	
Input range	**Beeper on if**
400.0 Ω	< 40 Ω
4.000 kΩ	< 200 Ω
40.00 Ω	< 20 kΩ
400.0 kΩ	< 20 kΩ
4.000 MΩ	< 200 kΩ
40.00 MΩ	< 200 kΩ

How to test diodes



Good diode

Forward bias

- Silicon diode = 0.5 V to 0.8 V
- Germainium diode = 0.2 V to 0.3 V

Reverse bias = OL

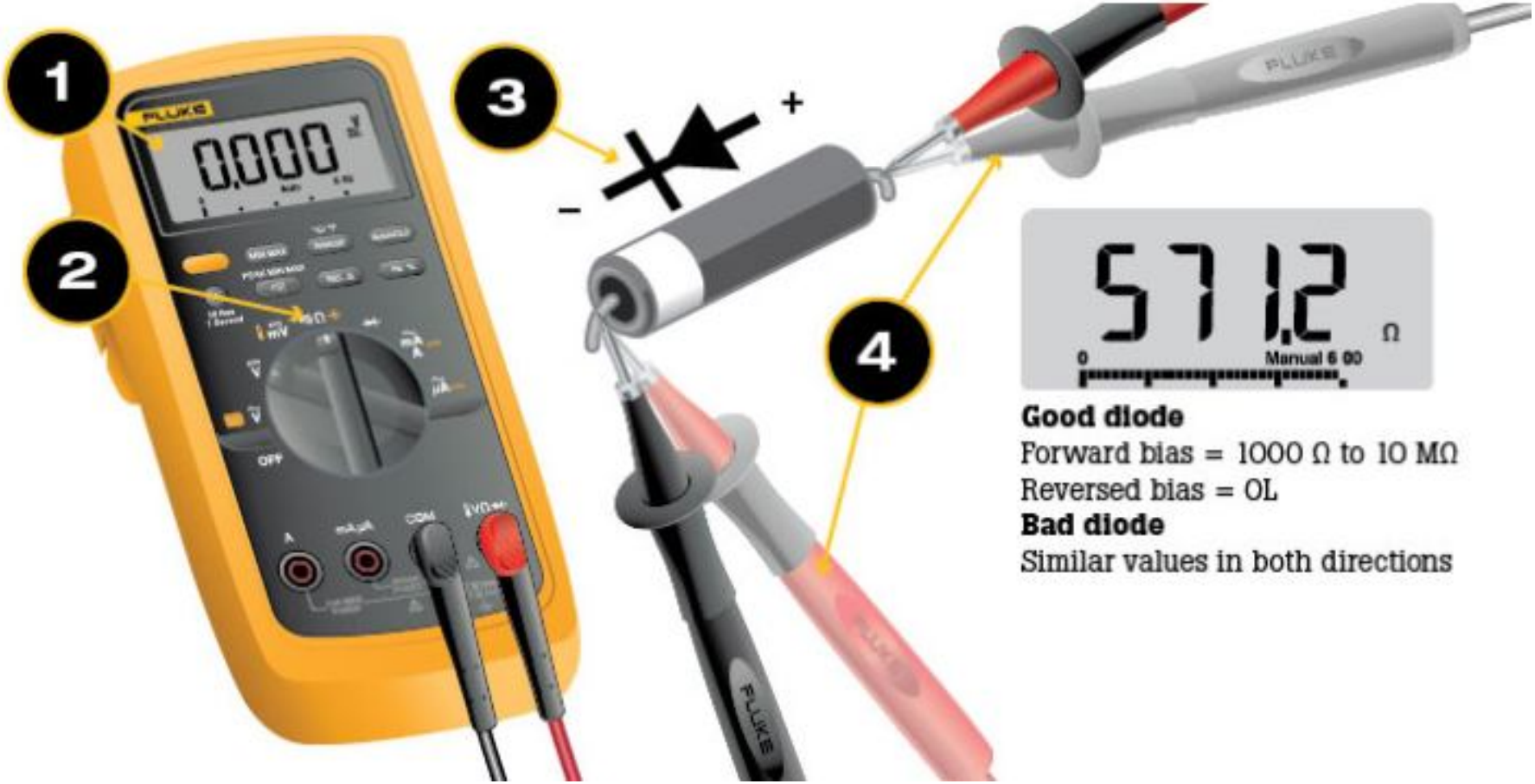
Opened diode

OL in both directions

Shorted diode

0 V to 0.4 V drop in both directions

How to test diodes

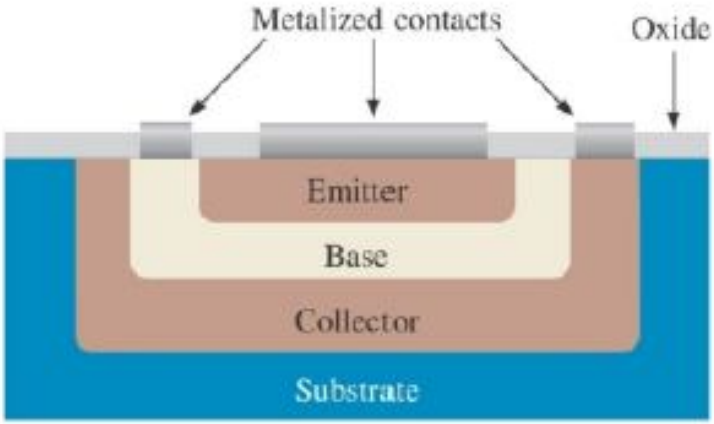


Good diode
Forward bias = 1000 Ω to 10 MΩ
Reversed bias = OL
Bad diode
Similar values in both directions

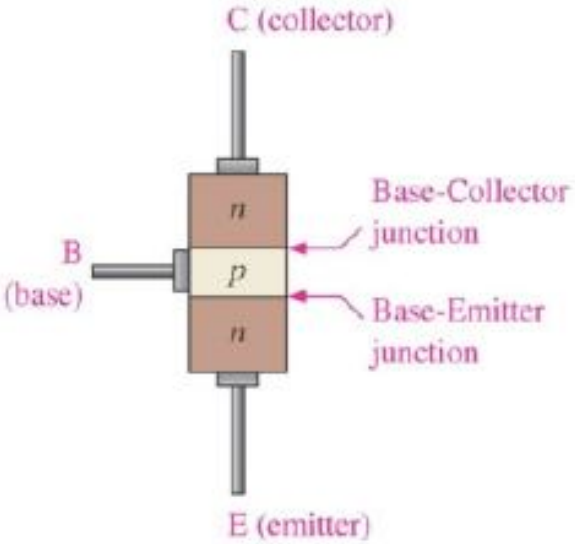
Transistors

Bipolar Junction Transistors (BJTs)

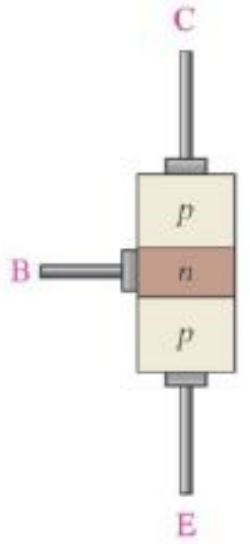
- The bipolar junction transistor (BJT) is constructed with three doped semiconductor regions separated by two *pn* junctions
- Regions are called **emitter**, **base** and **collector**



(a) Basic epitaxial planar structure



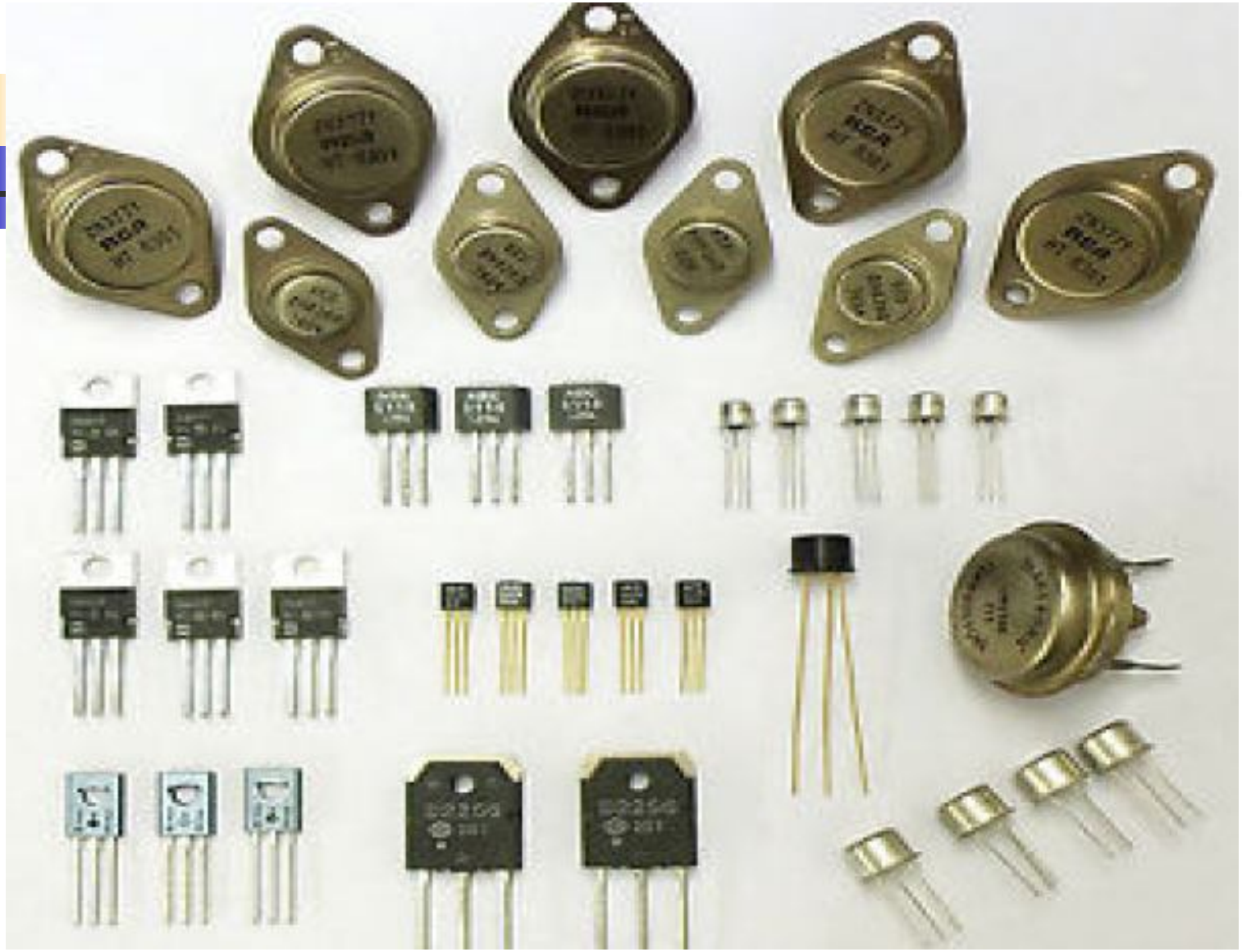
(b) *npn*



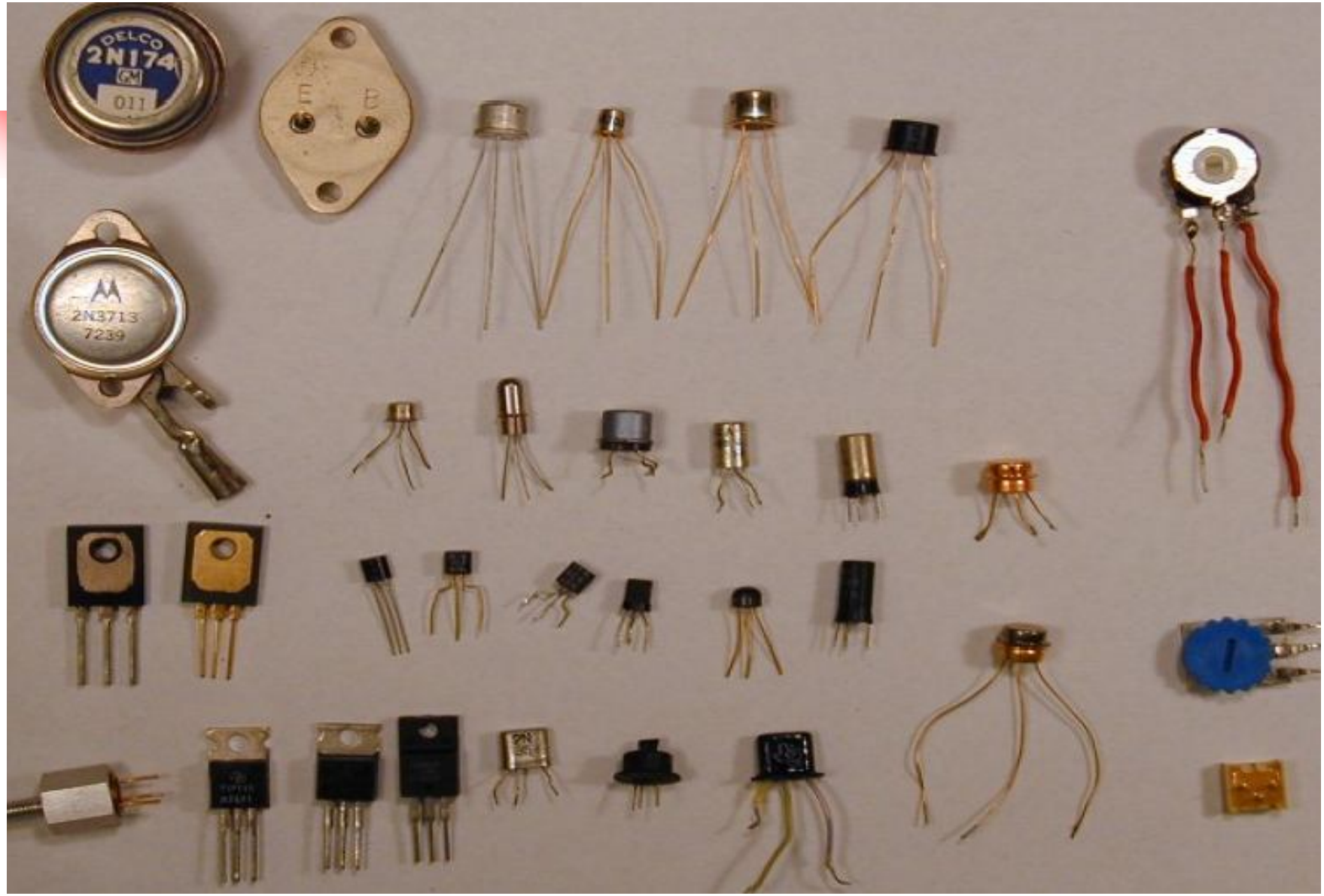
(c) *pnp*

- **Physical structure?**
- **Layers & junctions?**
- **Modes of operation?**
- **Biasing?**
- **Current/voltage controlled device?**
- **Identification and testing of Transistor?**

Types of Transistors



Types of Transistors



Transistor Outline (TO) Package Types

	TO-3		TO-66		TO-254
	TO-5		TO-72		TO-257
	TO-8		TO-92		TO-258
	TO-18		TO-126		TO-259
	TO-36		TO-202		TO-264
	TO-39		TO-218		TO-267
	TO-46		TO-220		
	TO-52		TO-226		

TO-3 Package

The TO-3 or TO3 is a type of 'metal can' package that is capable of high-power dissipation commonly used by power transistors, SCR's and other high-power semiconductor devices

The TO-3 is made entirely of metal, with the microchip mounted on its metal can base and then covered with a metal cap. TO-3 packages are designed to accommodate large heat sinks to increase their power handling capability. If necessary, the heat sink may be electrically isolated from the TO-3 package using mica or ceramic insulator pads that are inserted between the TO-3 body and the heat sink.

A typical power transistor packaged in a TO-3 package has two protruding terminals (one for the base and the other for the emitter), with the collector using the TO-3's body itself as its terminal for direct thermal conduction to the heat sink. Although most TO-3 packages have 2 or 3 protruding terminals only, TO-3's with higher lead counts do exist.

Advantages of the TO-3 package include: 1) excellent power handling capability, 2) high durability, 3) ease of mounting, and 4) hermetic sealing that protects the chip from environmental factors. Disadvantages of the TO-3 package include its relatively higher cost and larger size than other packages.

Table 1. Properties of a Typical TO-3

Base Size (Length x Width x Thickness)	Cap Diameter	Cap Height	Lead Length	Lead Pitch
39.3 mm x 26.6 mm x 1.7 mm	22.2 mm	5.7 mm	11.7 mm	10.9 mm

Figure 1. Example of a TO-3 Package

TO-92 Package

The TO-92 is a small type of plastic-molded package commonly used for housing discrete devices such as transistors and thyristors as well as IC's with low lead counts such as voltage regulators.

The TO-92 has a flat front face that is marked with the device name or number, while its back is semi-circular in shape (see Fig. 1). Since it is most often used in transistor packaging, the TO-92 usually has three leads, all of which protrude from the bottom of the package. The typical distance between leads of the TO-92 is 1.27 mm or 0.5 inch.

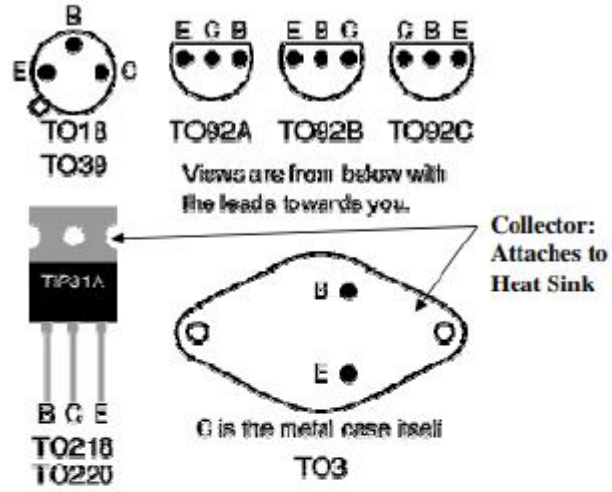
The main advantages of the TO-92 package are its low manufacturing cost and its small size. Unfortunately, this low cost and small size means that it is not designed to dissipate much heat and can not be used on devices that have high power consumption.

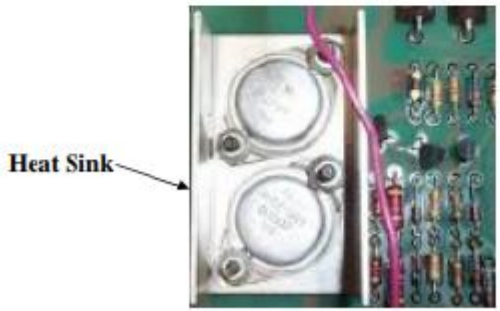
Table 1. Properties of a Typical TO-92

Plastic Body Size (H x W)	Body Thickness	Lead Width	Lead Thickness	Lead Length
4.58 mm x 4.58 mm	3.86 mm	0.46 mm	0.38 mm	14.47 mm

Figure 1. Example of a TO-92 Package

Identification of Transistors : Through data sheets

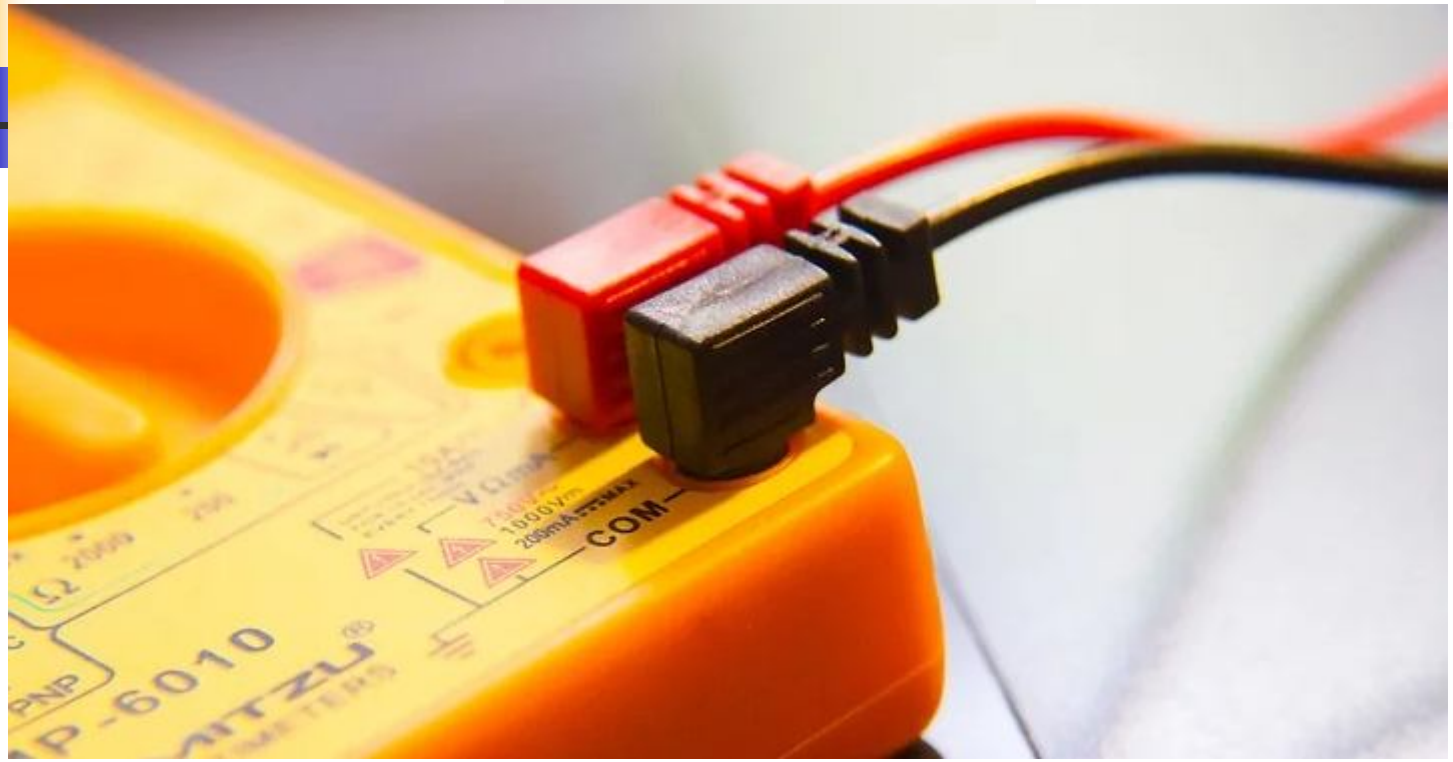




Collector Gives off Most Heat

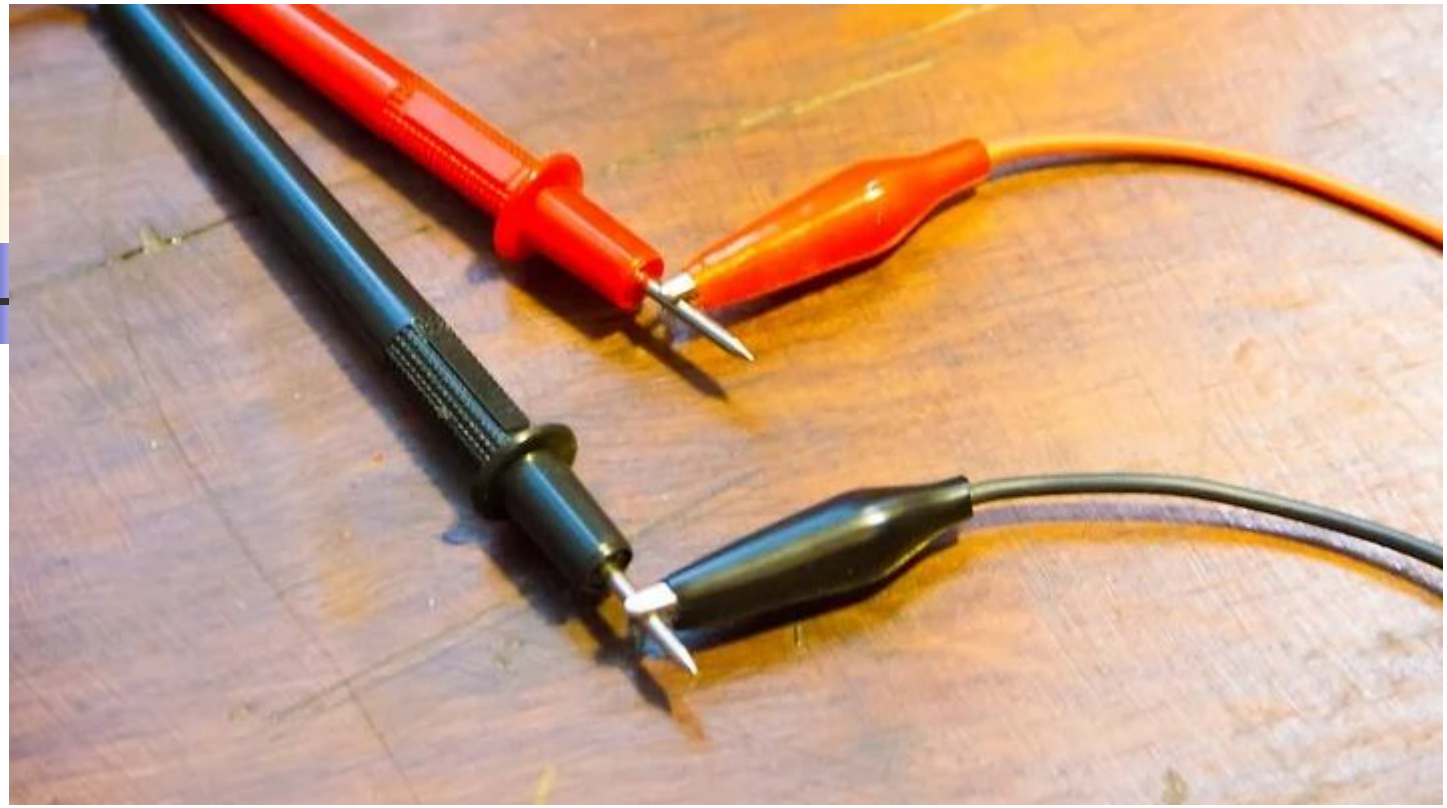
Transistors Testing

Setting Up the Multimeter



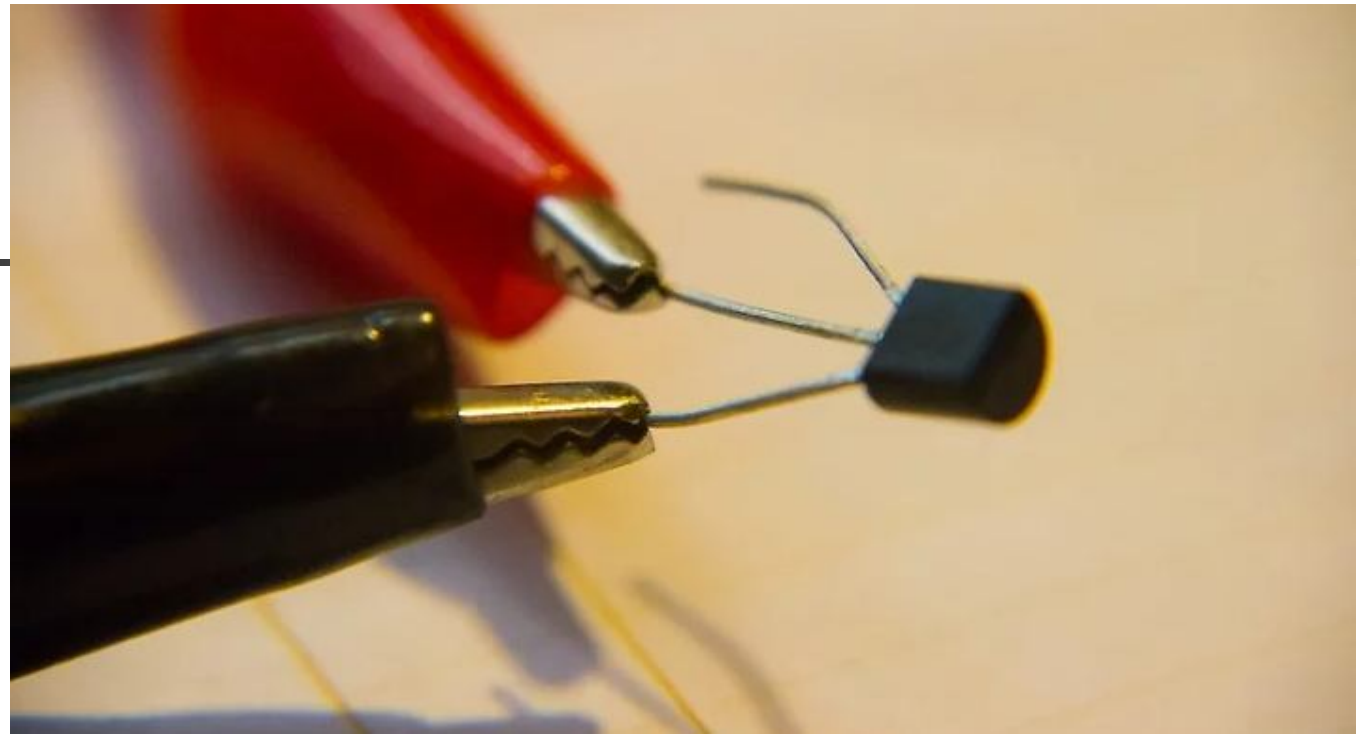
1 **Insert the probes into the multimeter.** The black probe goes into the common terminal and the red probe goes into the terminal marked for testing diodes.

2 Turn the selector knob to the diode test function.



3 Replace the probe tips with alligator clamps.

Testing When You Know the Base, Emitter and Collector



1 **Determine which leads are the base, emitter and collector.** The leads are round or flat wires extending from the bottom of the transistor. They may be labeled on some transistors or you may be able to determine which lead is the base by studying the circuit diagram.

2 **Clamp the black probe to the base of the transistor.**

3 **Touch the red probe to the emitter.** Read the display on the multimeter and note whether the resistance is high or low.

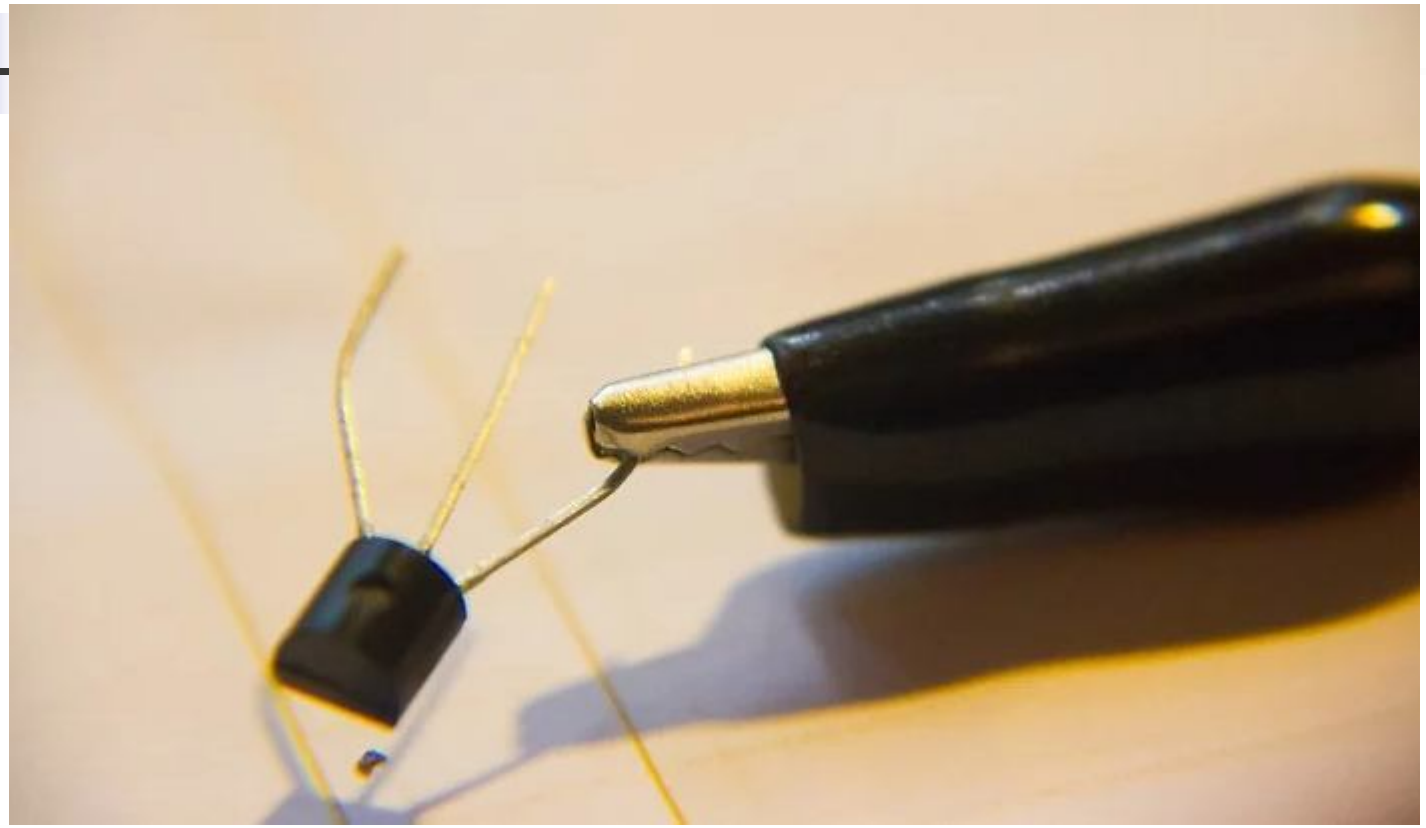
4 **Move the red probe to the collector.** The display should give the same reading as when you touched the probe to the emitter.

5 Remove the black probe and clamp the red probe to the base.

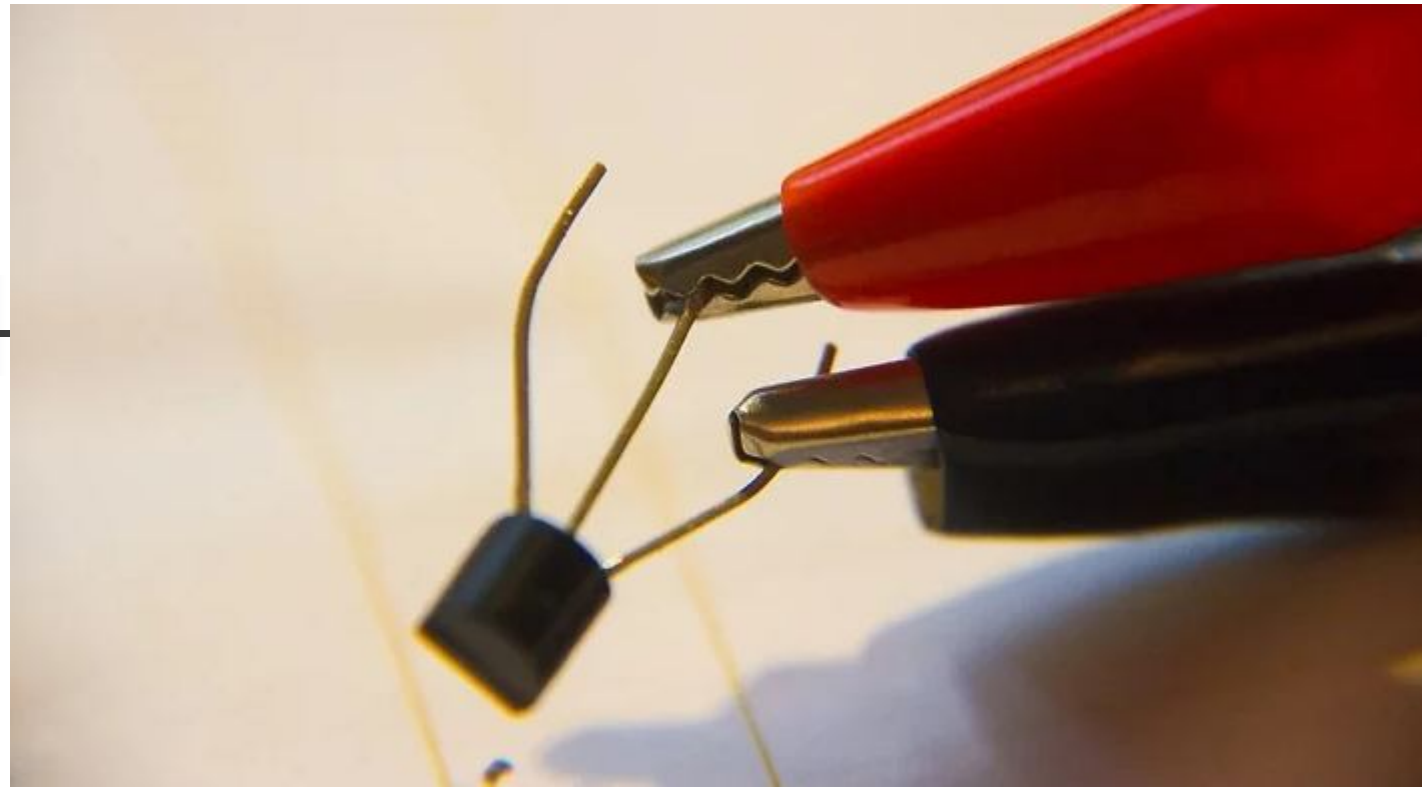
6 **Touch the black probe to the emitter and collector.** Compare the reading on the multimeter's display to the readings you got previously.

- If the previous readings were both high and the current readings are both low, the transistor is good.
- If the previous readings were both low and the current readings are both high, the transistor is good.
- If both readings you receive with the red probe are not the same, both readings with the black probe are not the same, or the readings don't change when switching probes, the transistor is bad.

Testing When You Don't Know the Base, Emitter and Collector

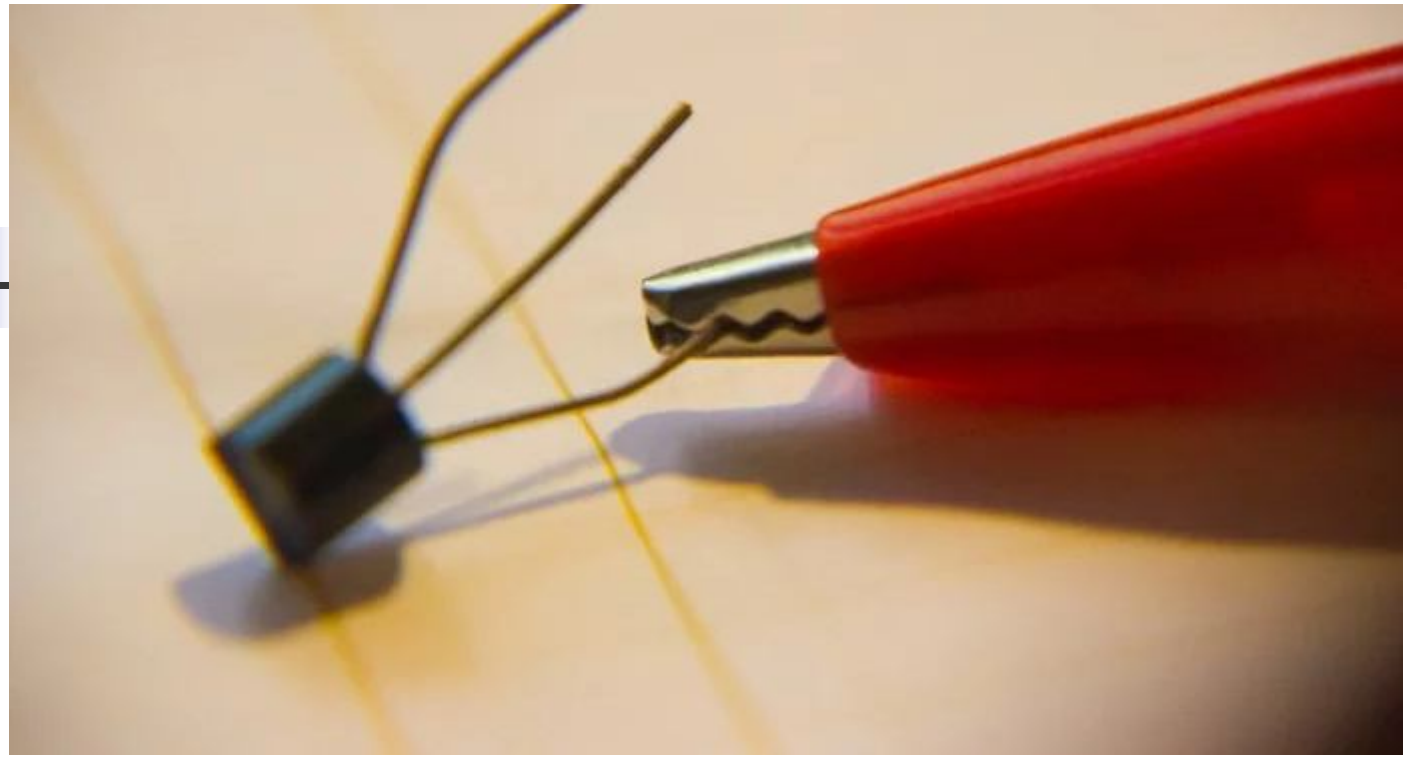


1 Clamp the black probe to 1 of the leads of the transistor.



2 Touch the red probe to each of the other 2 leads.

- If the display shows high resistance when each of the leads are touched, you have found the base (and you have a good NPN transistor).
- If the display shows 2 different readings for the other 2 leads, clamp the black probe to another lead and repeat the test.
- After clamping the black probe to each of the 3 leads, if you don't get the same high resistance reading when touching the other 2 leads with the red probe, you either have a bad transistor or a PNP transistor.



3 Remove the black probe and clamp the red probe to 1 of the leads.

Thanks !