# **Transistor**

The transistor is an electronic device used for amplification, switching, stabilizing, and modulating of electric voltage or current. Transistors are basic building blocks in computers, automotive technology, consumer products, telecommunications and so on.

The first transistor was created in 1948 by American physicists J. Bardeen, W. Shockeley and W. Brattain in the Bell Laboratories using the Germanium crystal. The modern transistors are built using silicon technology.



a) first transistor



b) modern transistors

## **Transistor types**

Transistors can be classified into several categories:

- Material used in the during fabrication:
  - o silicon (most used)
  - o gallium-arsenide
  - $\circ$  germanium
- > Internal structure:
  - bipolar (junction transistor)
  - unipolar (field-effect transistor)
- > Polarity:
  - bipolar PNP (arrow pointing inside)
  - o bipolar NPN (arrow pointing outside)
  - o P-channel FET
  - o N-channel JFET
- > Power rating:
  - Low power
  - High power
- > Switching speed:
  - Low frequency
  - High frequency





# **Bipolar transistor**

A bipolar transistor consists of a PNP or NPN combination with one type of semiconductor sandwiched between two opposite types to form two opposite junctions. Of three electrodes, one end is the **emitter** (E) to supply electrons or hole-charges to the **base** (B) in the middle; the **collector** (C) at the opposite end receives the emitter charges by injection from the base.



# **Transistor circuits**

#### **Common-emitter circuit**



Most commonly used bipolar transistor circuit. The base current is small and the input impedance is fairly high. The common-emitter circuit has a lower cutoff frequency than does the common-base circuit, but it gives the highest power gain of the three configurations.

In this circuit, the output (collector) current phase is opposite to that of the input (base) current.

#### **Common-collector circuit**



The common-collector transistor amplifier, sometimes called an emitter-follower amplifier, has high input impedance and low output impedance.

The cutoff frequency of common-collector circuit is the same as in the common-emitter amplifier. The input and output currents are in the phase.

The transistor in this circuit has a lower amplification than the example above.

### **Common-base circuit**



The input circuit of a common-base amplifier must be designed for low impedance. The optimum output load impedance may range from a few thousand ohms to 100 k $\Omega$ , depending on the circuit. The phase of the output (collector) current is the same as that of the input (emitter) current.

The parts of these currents that flow through the base resistance are likewise in phase, to the circuit tends to be regenerative and will oscillate if the current amplification factor is greater than one.

# **Unipolar transistor**

The unipolar transistor relies on an electric field to control the shape and hence the conductivity of a channel of one type of charge carrier in a semiconductor material. It is also referred to as the field-effect transistor or FET transistor.

# **Types:**

- > Transistor controlled by an electric field with a gate terminal (JFET)
- > Transistor controlled by an electric field with an oxide-insulated gate
  - MIS-FET (metal-insulator-semiconductor)
  - MOS-FET (metal-oxide-semiconductor)
- > Transistor controlled by an electric field with Schottky barrier (MESFET)

# VOCABULARY

amplification – zosilňovanie operational amplifier – operačný zosilňovač charge carrier – nosič náboja considered – uvažovaný, zvažovaný semiconductor – polovodič sandwiched – obložený, *tu:* vrstvený invention – vynález, výmysel coined – razil, *tu:* presadzoval

# Note:

Bell Telephone Laboratories needed a generic name for the new invention: "Semiconductor Triode", "Solid Triode", "Surface States Triode", "Crystal Triode" and "Iotatron" were all considered, but "transistor," coined by John R. Pierce, won an internal ballot. The word transistor was obtained by combining words **TRANS**fer and res**ISTOR**.