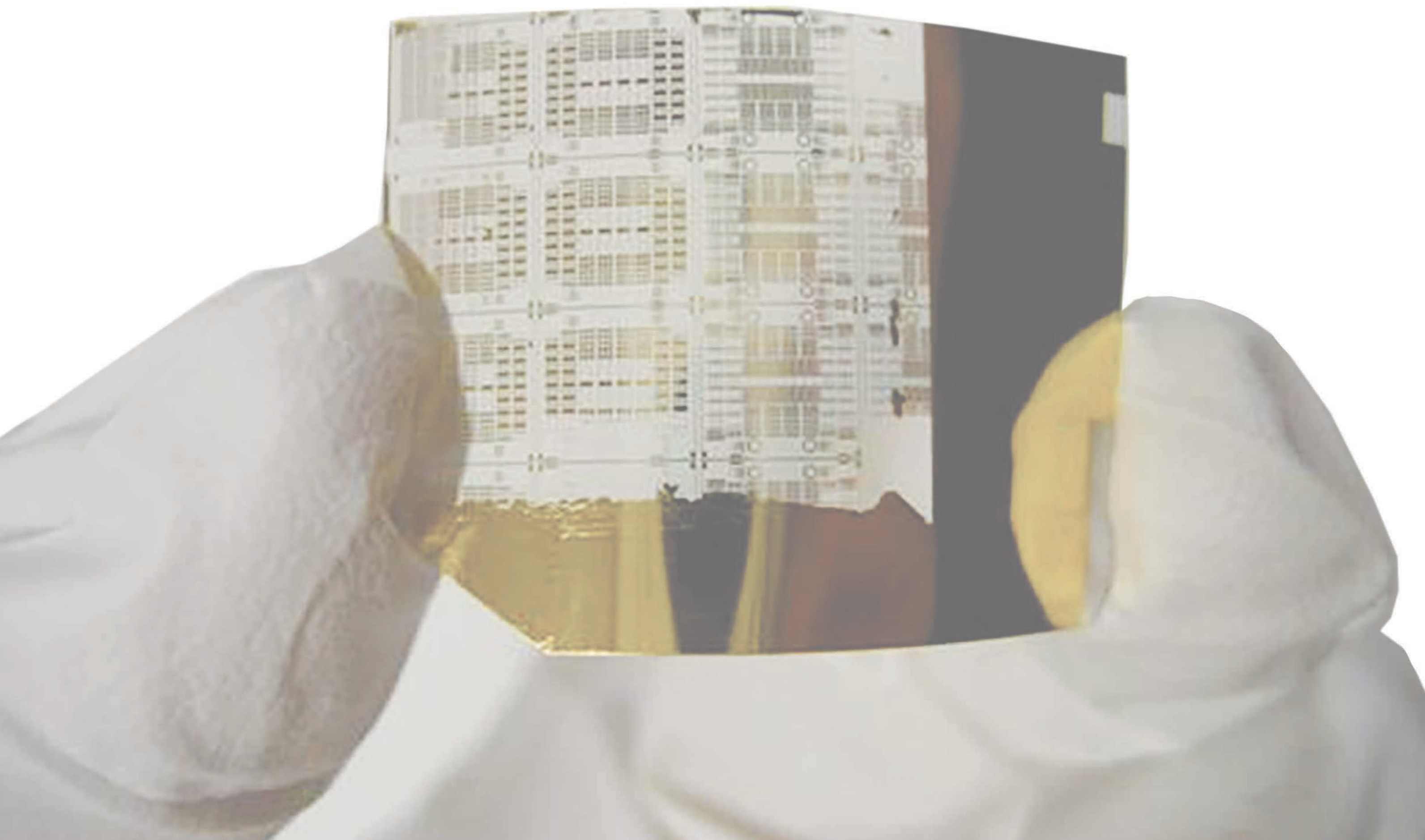
Unit 11

Transferring, Resisting, Storing

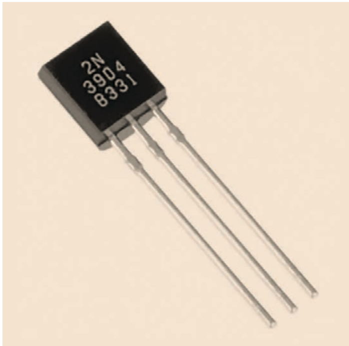


lead in

▶ **The following quotes are all related to a device that is omnipresent in the world of electronics. What is this device? Fill in the gap in each quote to find out. (*Hint:* Use the same word in all gaps.)**

- "If you're thinking of the brain as a computer, the neuron is the ________."
  Carl Schoonover, Associate Research Scientist, Columbia University / Howard Hughes Medical Institute.
- "If you remove a single ________ in the digital computer's central processor, the computer will fail."
  Michio Kaku, Physics of the Future: How Science Will Shape Human Destiny and Our Daily Lives by The Year 2100.
- "The main ingredient of the first quantum revolution, wave-particle duality has led to inventions such as the ________ and the laser that are at the root of the information society."
  Alain Aspect, French physicist noted for his experimental work on quantum entanglement.
- "We tend to credit those who create an idea, not those who perfect it, forgetting that it is often only in the perfection of an idea that true progress occurs. Putting sixty-four ________ on a chip allowed people to dream of the future. Putting four million ________ on a chip actually gave them the future."
  Malcolm Gladwell, author, journalist, and public speaker.

▶ **All quotes refer to *transistors*. Transistors are said to be among the most important inventions ever to be made. Underline in the quotes above words/phrases that illustrate this point.**



▶ **Look at the title of the Unit. *Transferring, Resisting, Storing*. Which of the three functions refer(s) to transistors? The word 'transistor' is the result of an abbreviated combination of two of the above words. Which ones? Who was the first to think of this combination and coin the term? What do you know about the history of the transistor? Match the following statements to help you remember:**

1. The term 'transistor' dates	**a)** an American electrical engineer of Bell Laboratories.
2. It is derived	**b)** and sold about 150,000 units.
3. It was called so because	**c)** was the world's first commercially produced transistor radio.
4. The three American physicists credited	**d)** it took over many functions of the vacuum tubes (known as "valves" in Great Britain).
5. The term is believed to have been coined by John Robinson Pierce (1910-2002),	**e)** with the invention of the first transistor in 1947-48 are William Shockley, John Bardeen, and Walter Brattain.
6. After the device was invented in 1947,	**f)** back to 1948.
7. The Regency TR-1, released in 1954,	**g)** it transfers electrical currents across a resistor.
8. It was put on sale for US$49.95 (the equivalent of approx. 500 in year-2020 US dollars)	**h)** from the words *transfer* and *resistor*.

Reading

▶ **It has often been said (and is repeated in the Lead-in section, too) that the invention of the transistor is considered one of the most important turning points in the history of technology (and the history of humankind, for that matter). Why? Discuss.**

Below are a number of possible explanations. Tick the one(s) you think answer(s) the question:

- Transistors replaced the bulky and unreliable vacuum tubes in the construction of electronic equipment and, as a result, electronic devices now occupy less space and use less power.
- The invention of the transistor has led to the creation of personal computers, whose impact on our modern world is priceless.
- Transistors have minimized environmental troubles.
- Much of the progress in the past 60 years is due to the transistor.
- Transistors enable computers to take on more complex tasks, thus increasing our productivity and enhancing our knowledge of the world.
- Transistors have helped us tackle social problems, such as world hunger, racial prejudices, and gender equality.

▶ **While discussing, you can also take into account what Steve Wozniak, cofounder of Apple and designer of the Apple I and Apple II computers, once said:** ***The Internet really is the biggest innovation in history. It's more important than the computer, even more important than the transistor.*** **Do you agree?**

▶ **You are going to read a text on transistors. The text is divided into two parts, each of which goes with a number of activities.**

▶ Activity 1: **The first paragraph of Part One mentions five common applications of the transistor. Do you know what each of them involves? Match the applications on the left with the explanations provided on the right:**

1. amplification	**a)** opening or closing a circuit or diverting energy from one part of a circuit to another
2. switching	**b)** increasing the strength of a signal fed into an electronic device by obtaining power from a source other than the input signal
3. voltage stabilization	**c)** a circuit that produces alternating current of a certain frequency
4. signal modulation	**d)** feeding constant voltage current to electrical gadgets like air conditioners and computers to protect the devices against voltage fluctuations
5. oscillator	**e)** imposing an input signal that carries information onto a carrier wave

▶ Activity 2: **While you read Part One, underline phrases in the text that are synonymous with the ones listed below:**

1. *the most important element or part of sth* ____________________

2. *controls and is responsible for the function of* ____________________

3. *(efforts that) have not brought about the desired result* ____________________

4. *and by that means regulating the electricity that passes* ____________________

5. *equipment that became out of date a long time ago* ____________________

6. *most of the time being included* ____________________

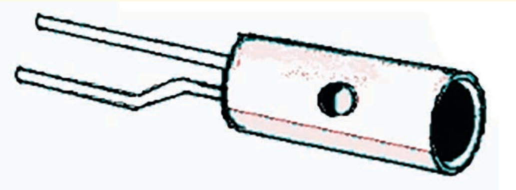
PART ONE

For more on semiconductors, see Units 9 & 10.

A transistor is a semiconductor device that uses a small amount of voltage or electrical current to control a larger change in voltage or current. Because of its fast response and accuracy, it may be used in a wide variety of applications, including amplification, switching, voltage stabilization, signal modulation, and as an oscillator. The transistor is the fundamental building block of both digital and analog circuits — the circuitry that governs the operation of computers, cellular phones, and all other modern electronics. Transistors may be packaged individually or as part of an integrated circuit chip, which may hold thousands of transistors in a very small area.

Introduction

Modern transistors are divided into two main categories: bipolar junction transistors (BJTs) and field effect transistors (FETs). Application of current in BJTs and voltage in FETs between the input and common terminals increases the conductivity between the common and output terminals, thereby controlling current flow between them.



First commercially available point-contact transistor

The term "Transistor" originally referred to the point contact type, but these only saw very limited commercial application, being replaced by the much more practical bipolar junction types in the early 1950s. Ironically both the term "Transistor" itself and the schematic symbol most widely used for it today are the ones that specifically referred to these long-obsolete devices; attempts at introducing more accurate versions have come to nothing.

In analog circuits, transistors are used in amplifiers (direct current amplifiers, audio amplifiers, radio frequency amplifiers), and linear regulated power supplies. Transistors are also used in digital circuits where they function as electronic switches, but rarely as discrete devices, almost always being incorporated in Monolithic Integrated Circuits. Digital circuits include logic gates, random access memory (RAM), microprocessors, and digital signal processors (DSPs).

Types

Transistors are categorized by:

- Semiconductor material: germanium, silicon, gallium arsenide, silicon carbide
- Structure: BJT, JFET, IGFET (MOSFET), IGBT, "other types"
- Polarity: NPN, PNP, N-channel, P-channel
- Maximum power rating: low, medium, high
- Maximum operating frequency: low, medium, high, radio frequency (RF), microwave. (The maximum effective frequency of a transistor is denoted by the term f_T, an abbreviation for "frequency of transition." The frequency of transition is the frequency at which the transistor yields unity gain).

Ball grid array

- Application: switch, general purpose, audio, high voltage, super-beta, matched pair
- Physical packaging: through hole metal, through hole plastic, surface mount, ball grid array.

  Thus, a particular transistor may be described as: *silicon, surface mount, BJT, NPN, low power, high frequency switch.*