

Core Technical Principles

Understanding a systems approach when designing

A: A systems approach explained

To work out how any product containing electronics works, you need to ask the following questions:

1. What does the product do? (what is the **output**?)
2. How does it do it? (what is the **process**?)
3. What happens to allow this to work? (what is the **input**?)



A simple systems diagram

These three elements of input, process and output are what is called a systems approach to designing.

B: Input devices

Input devices are electrical or mechanical sensors that use signals from the environment such as light levels, temperature and pressure and convert them into signals that can be passed into processing devices or components.

Light dependent resistor (LDR)

- LDRs are light sensors - they detect changes in light levels
- In brighter light, the resistance of an LDR falls - this allows circuits to be turned on or off when it gets light or dark
- For example, LDRs are often used in automatic night lights where the light is turned on when it gets dark

Uses: street lamps, clock radios, night lights, mobile phones (to turn the flash on automatically if light levels are low when using the camera)



Thermistor

- Thermistors are temperature sensors - they detect changes in temperature
- There are two types of thermistor: those with a resistance that increases with temperature increase and those with a resistance that falls with temperature increase
- Thermistors are used in systems to regulate temperature

Uses: toasters, coffee makers, central heating systems, refrigerators, freezers, hair dryers



B: Input devices

Switches and pressure sensors

There are a variety of switches that can be used to input signals to processing devices. They can be used to sense when objects apply pressure to them. This is useful when:

- You want to turn something on
- An object has reached as far as you want it to travel
- You want to start something by pressing with your finger
- You want to know if something has closed
- You want to stop a machine if a safety guard is opened
- Pressure pad switches can be used in alarm systems, automatic door operation, patient bed monitoring, seat occupancy detection, etc



Microswitch



push to make switch



pressure pad switch

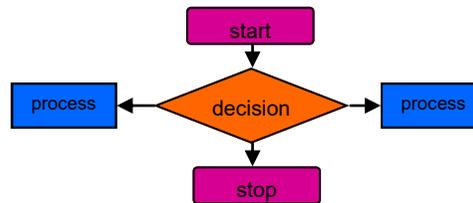


rocker switch

C: Processes

Electronic processes can be carried out by many components, but they are frequently performed by microcontrollers.

- Microcontrollers are small computers within a single integrated circuit
- The circuit contains a processor core, memory and programmable input and output capability
- They can be used as counters and timers for decision making
- Microcontrollers are mass produced in huge numbers by automated systems that reduce the cost of each individual one
- Microcontrollers need to be programmed to perform a particular function. This can be done by creating a flow chart with instructions



Uses: car engine control systems, remote controls, office machines, medical devices, toys and most electronic products

D: Outputs

The output of an electronic system is generally the part that people are aware of. Whether it is light, sound or movement, the principle of operating whatever device is used is the same.

Lamps and Light Emitting Diodes (LEDs)

- These turn electricity into light
- Lamps have poor energy efficiency
- LEDs have very good energy efficiency



A lamp



LEDs

Buzzers

- These make a noise
- They fall into two types: electromechanical and piezoelectric



electromechanical buzzer



piezoelectric buzzer

Uses: alarm clocks, timers

E: Video and web-links

- GCSE bitesize: <https://www.bbc.com/bitesize/guides/z6kr97h/revision/1>

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F: Key words

- System diagram: a diagram that breaks down an operation into its three main component parts: input, process and output. More complex systems may have more than one input, process and output
- Process devices: these handle information received and turn outputs on and/or off
- Input device: electrical and mechanical sensors that use signals from the environment and convert them into signals that can be passed into processing devices and components
- Microcontroller: a small computer within a single integrated circuit (IC)
- Output: this sends out information, heat, light, sound or mechanical movement to the environment the system is operating in

Revision Checklist

I understand a systems approach to designing

I know how to draw and interpret a systems diagram

I can identify inputs, processes and outputs in systems

Test yourself

1. Name the three blocks that make up a system.
2. Name two output devices and state the type of output signal that they produce.
3. Explain what a light dependent resistor does.
4. Give examples of products that contain microcontrollers.
5. Discuss why microcontrollers are used so frequently in products.
6. Name the three blocks that make up a system.