Electronic materials and components-Classes of component

The first task is always to recognize the specific component and package from the many different types of both. There are so many that the task is not always either easy or obvious, and information about a component has to be extracted from a number of sources. One way we can make the task simpler is to divide components into different categories, the broadest division being into the two categories of passive devices and active devices.

Passive devices

Passive devices cover a vast range of components whose electrical characteristics are usually independent (within limits) of any applied voltage. Primarily these are resistors, capacitors and inductors and derivatives of these such as potentiometers, variable capacitors, and transformers. Each of the main component types is classified in a number of ways, often by reference to the materials used and the construction methods employed by the manufacturer.

Examples are given in Table 1.

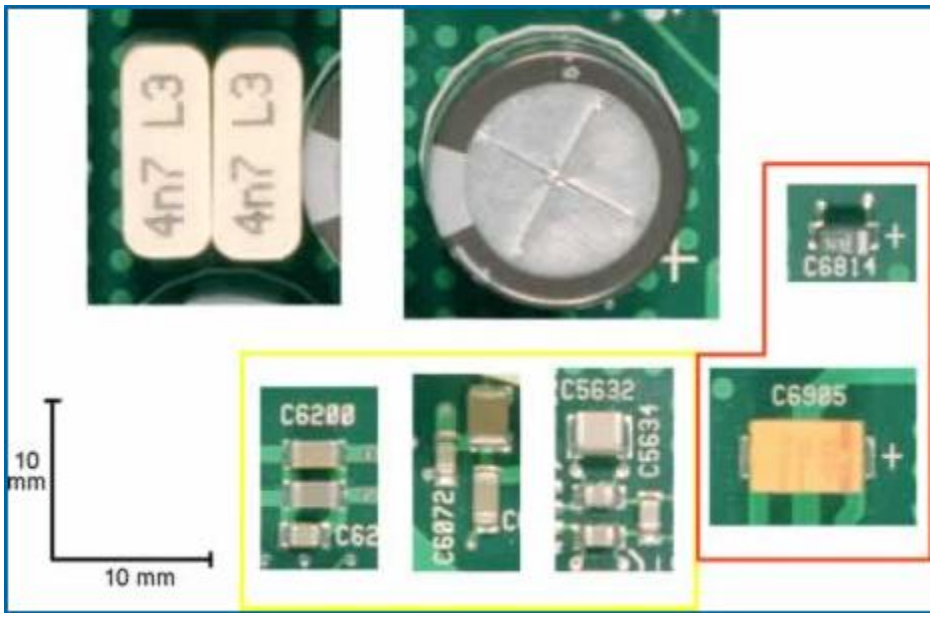
Resistors are circuit elements made from materials that are poor conductors, and consequently resist the flow of current. Resistors may be made from coils of wire (wire-wound), from powdered carbon and a glue-like binder (carbon composition) or from a thin coating of material on an insulating base, either cylindrical (film or oxide types) or flat (chip types).

Capacitors derive their name from their capacity to store charge, and are used in a circuit to damp out rapid changes in voltage. They consist of two conducting surfaces separated by an insulator (the 'dielectric'), with a lead connected to each surface. To create the values of capacitance needed for practical circuits, one needs conducting surfaces which are both very large and very close together, and separated by a material with a high 'dielectric constant'. To pack sufficient surface area into a small volume, capacitors usually have a rolled or stacked internal structure. If a constant voltage is applied to a capacitor, only a very small 'leakage current' will flow once the capacitor has fully charged.

Inductors are coils of wire with many turns, often wound around a core made of a magnetic material, like iron or ferrite. Current flowing through the inductor produces a local magnetic field in which energy is stored. This field creates an induced current in the inductor in a direction which resists any change in the current flowing in the circuit. Inductors are thus used in circuits to prevent any rapid changes in current.

Table 1: Some passive device classifications

Capacitors (usually classified by dielectric material)			
disc ceramic	multilayer ceramic	silvered mica	
polystyrene	polypropylene	polyester	polycarbonate
solid tantalum	aluminium electrolytic		
Sometimes capacitors are classified by their application:e.g. Class X1 (X2, Y1, Y1) for mains suppression components			
Resistors (usually classified by resistive material)			
carbon composition	carbon film	wire-wound	
metal film	metal glaze	metal oxide	
chip - thick film	chip - thin film		



Different types and sizes of capacitors

Other passive devices include filters of various types, and switches and connectors. Note that the distinction between passive components and electromechanical devices such as relays and mounting hardware can sometimes become blurred.

A word about values

Resistor values are measured in ohms (symbol Ω, the Greek capital letter omega). The ohm is a low value, so usually you met kΩ (kilohms = thousands of ohms) and MΩ (Megohms = millions of ohms).

Capacitor values are measured in farads (symbol F), but practical capacitors have values which are many orders of magnitude smaller: μF (microfarad = one-millionth of a farad); nF (nanofarad = one-thousand-millionth of a farad); pF (picofarad or 'puff' = one-million-millionth of a farad).

Inductor values are measured in henrys (symbol H), but practical inductors have much smaller values. You will encounter mH (millihenry = one-thousandth of a henry) and μH (microhenry = one-millionth of a henry) and occasionally nH (nanohenry = one-thousand-millionth of a henry);.

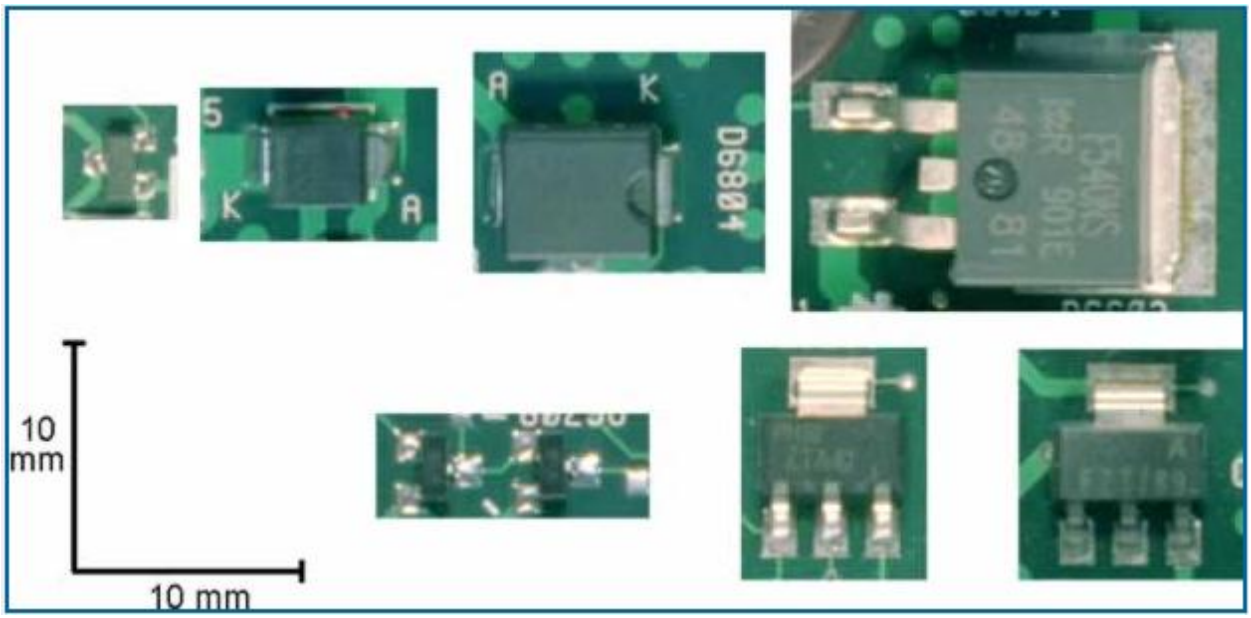
Active devices

An active device has been defined as one which can produce power gain, that is, the output signal has higher power than the input signal. Transistors and integrated circuits of every type meet this definition, whereas, strictly speaking, most diodes do not. However, the fact that diodes use the same basic semiconductor technology as transistors means that they are usually considered as being active devices.

Within each main category there are sub-divisions, often classified by the technology and/or materials used or the circuit function performed. Examples of common broad sub-divisions are given in Table 2.

Diodes		
small signal	rectifier	
zener	Schottky barrier	varactor
Transistors		
small signal (audio, RF, low noise, switching, etc.)		power
bipolar	FET	
silicon	gallium arsenide	
Integrated Circuits		
analogue:linear, operational amplifiers	digital:TTL, CMOS, ECL (logic families)	
microprocessors and peripherals	memory	

Different sizes of package for diodes (top) and transistors (bottom)



Discrete components and integrated circuits

There is however a second way of 'dividing the cake', into discrete (i.e. single) or integrated devices. This classification most often applies to active devices, where a number (often many thousands) of circuit elements are realised within one piece of silicon. The term monolithic (literally 'one stone') distinguishes such components, as against multi-chip, where the package performs the function of integration.

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