KNOW YOUR COMPONENTS

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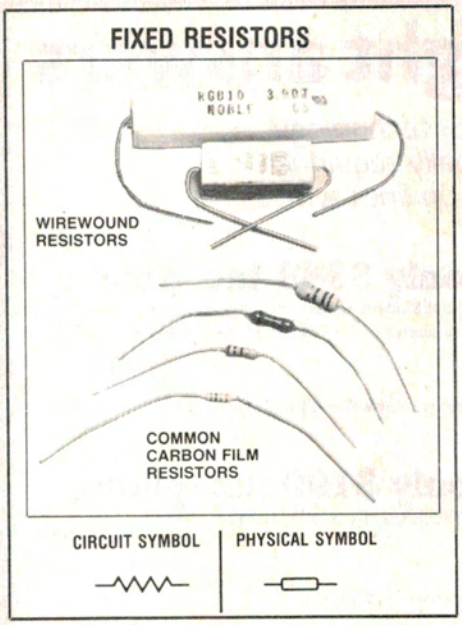
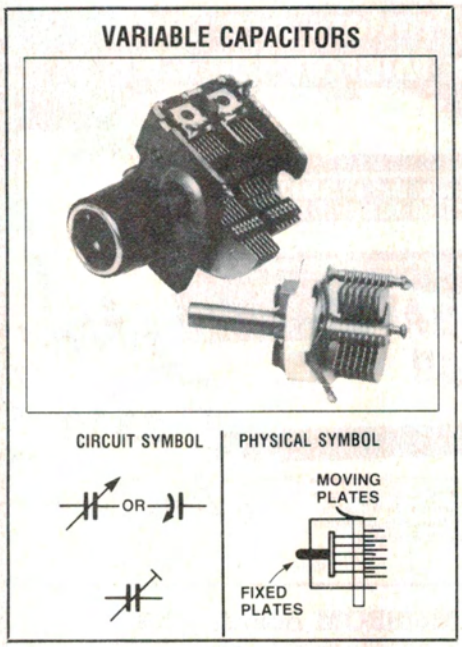
Before you can start to build any electronic projects or gadgets, you need to be able to recognise the components you're going to be using and learn a little about their idiosyncrasies.





THE FIRST HURDLE you'll face when starting out in electronics is recognising the components. At first, it will all seem a little confusing. Resistors, capacitors, potentiometers — they're all pretty straightforward, but the "jargon" will get you. Well, it exists for a good purpose. Jargon is a sort of "shorthand". Hence, potentiometer becomes "pot", electrolytic capacitor becomes "electro", etc. Don't worry about trying to learn it all off by heart first. It's best (and *easiest!*) to pick it up as you go along.

This article will give you a brief introduction to the common components you're likely to meet when constructing projects, so you'll have some confidence that you're picking up the right parts when assembling a project from an article. The panels show pictures of typical components you'll meet, their common circuit symbols and the physical symbols often used in layout and wiring diagrams. This way, you can come back to this article and "dip into" it at any time you feel necessary to familiarise yourself with a particular component or its symbol.

Fixed resistors

One of the most common components. The electrical value of a resistor is measured in *Ohms*. This is indicated on the body of the component by means of coloured bands, each colour used having a value code (and we'll explain it in the next part of the series). Some types have the value printed directly on the body.

As resistors dissipate power, they have a power rating measured in *watts*. Those shown in the picture here have ratings, in ascending order, of 1/8 W, 1/4 W, ½ W, 1 W, 5 W and 10 W. The value of a resistor will have a certain manufacturing *tolerance*, expressed as a percentage. Common types have tolerance of 5% and 10%. More expensive types have tolerances of 2%, 1% and ½%.

Modern general purpose resistors up to 1 W have a carbon film deposited on a tubular ceramic body. Close tolerance types have a special metallic substance glazed on the body. Leads are attached to the ends of the body.

For most applications, 5% or 10% tolerance resistors are perfectly adequate. Higher-power resistors employ a wire element wound on a former and sometimes encapsulated in a heat-resistant case (as in the picture).

Resistor values are available in a "preferred series": 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82. This is the "E12" series, which provides 12 values in the decade from 10 to 100. The decade below goes 1, 1.2, 1.5 ... etc. It's too expensive and unnecessary to produce values in even steps right through a range from one Ohm to millions of Ohms. The E6 series has six values in a decade, the E24 has 24 values, etc. The tolerance range of each value just overlaps (the maximum tolerance of one value overlaps the minimum tolerance of the next highest, etc). The E12 series is the most common range for both 5% and 10% tolerance types.

Variable resistors

Variable resistors are used to vary circuit performance — ie: as volume controls, tone controls, etc. A variable resistor comprises a resistance element having a moving contact which can be set anywhere between the end limits. There are two basic forms — the *potentiometer* (or pot) and the *trimpot*.

Potentiometers are made for *rotary* operation or *linear slide* operation (slide pots). The rotary types have a shaft which can be rotated for about 240-270 degrees of a full circle. Trimpots are either of the rotary type or multi-turn linear type. They come in two mounting styles — vertical or horizontal. Some types have the element "open", others enclose it.

Rotary pots can be *ganged*, with two units operated from the one shaft (as shown in the picture here), or have concentric shafts (one inside the other), allowing both controls to be separately operated by two knobs, one inside the other (often seen on car radios). Ganged pots are often found in stereo amplifiers.

Pots generally come in three or four values per decade: 10, 20 (and 25) and 50. Or — 1, 2 (or 2.5) and 5, etc. Trimpots are generally available in E6 series values (10, 15, 22, 33, 47, 68).

Most pots can tolerate about half a watt of power being dissipated in them, trimpots much less than that. If any appreciable power has to be dissipated by a pot, then *wirewound* types are used. These have a resistance wire element wound on a former, the moving contact passing over the wire wound on the former.

Common rotary pots have a 23 mm diameter body and a 6.5 mm diameter shaft. Sometimes the shaft has a "flat" on it, to allow the fitting of "press-fit" knobs which require no securing ("grub") screw. Some pots have a 16 mm diameter body and either a 4 mm or 6.5 mm diameter shaft. These are used where space is at a premium. Most potentiometers have "lug" connectors (as in the illustration) for soldering leads to, while some have pins which permit mounting the pot directly on a printed circuit board.

Fixed capacitors

Along with resistors, capacitors are amongst the most common components used in electronics. There is a positively *huge* range of varieties and types, but the ones most commonly encountered are: *polyester* capacitors (one of the "plastic" types), *ceramic* capacitors, *electrolytic* capacitors and *tantalum* capacitors (the last two are related). All capacitors have a *voltage* and *tolerance* rating. The capacitance is given in fractions of a *Farad* (further explained in a later chapter); pF, nF, µF.

Polyester (sometimes called "poly" type) capacitors consist of a thin plastic coil with a thin film of metal deposited on either side. This is "wound up" and leads attached to the two separate metal films. The assembly is then encapsulated in an epoxy material, usually coloured with a dye. The most common ones are coloured green and for that reason are commonly called "greencaps". They come in values from around 1 nF up to about 10 µF.

As they are generally required to be mounted on printed circuit boards, the leads come out one side at either end of the body: "radial" leads (see the illustration). Less commonly, the leads come straight out the ends of the body ("axial" leads). They are generally available in the E12 series of values (10, 12, 15, 22 ... etc). Voltage ratings vary from 50 V to 630 V. In use, a voltage rating is usually specified. The tolerance rating of commonly available poly capacitors is 10%, although 5% and 2% types are seen.

Ceramic capacitors consist of a disc or plate of ceramic with a metal film deposited on either side. Some types have alternate layers of metal/ceramic/metal/ceramic/metal ... etc, with alternate layers connected. Leads are attached to come out one side for convenient pc board mounting. They are available generally in the E12 series of values from under 1 pF up to 100 nF.

Depending on the ceramic material used, and the application, ceramic capacitors are available in voltage ratings from 50 V to 3 kV (or more!). Size varies considerably. Common types for non-critical applications will have a tolerance variation of as much as 50%. Other common types have a 5% or 10% tolerance specification. The type you need will usually be specified. More about this subject in later chapters.

Electrolytic capacitors manage to squeeze a hell of a lot of capacitance into a small package. Instead of ceramic or plastic, they use a special chemical internally. Because of this they are *polarised* and **must only be connected the correct way around.** The case usually indicates which lead is positive and which is negative.

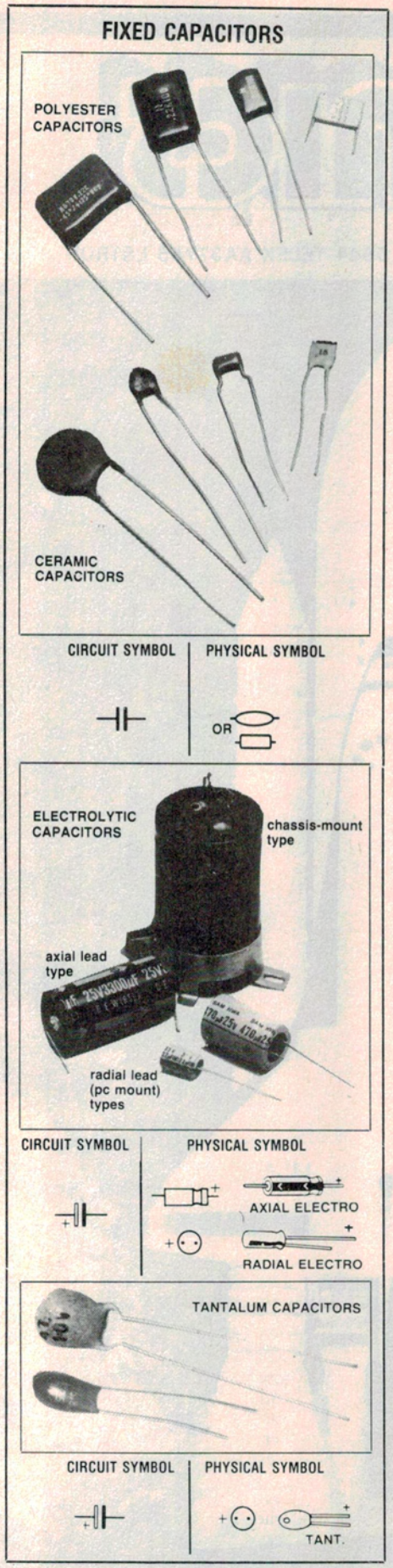
They are commonly available in the E6 range of values, though not all values in the range are widely stocked. In general, they have a wide tolerance — usually ±20% or more. Values available range from about 1 µF to 10 000 µF or higher. Both axial lead and radial lead types are generally available. A variation worth special mention is the "low leakage" (or LL) type for use in some critical applications. Voltage ratings for electrolytics vary from 6 V to 500 V. If substituting, always use a higher-voltage one of the same value.

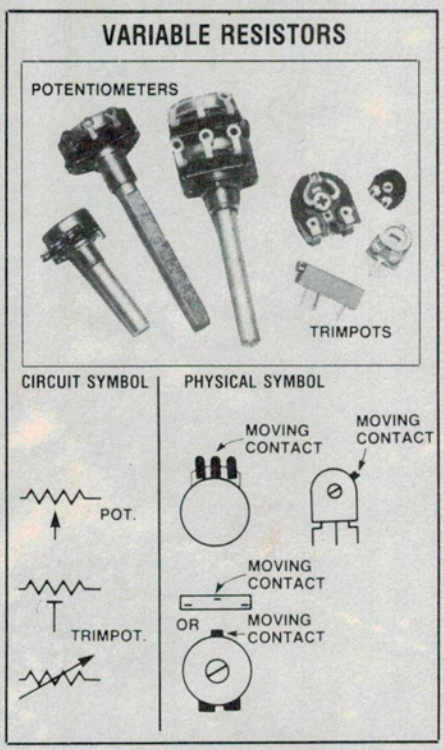
Tantalum capacitors are made from a mineral called "tantalite" (tantalum pentoxide). This type packs even more capacitance in a small package than electrolytics of the same size, but their voltage rating is generally lower. They are generally available in the same values as electrolytics, but have closer tolerance and perform better in certain applications.

Tantalums have generally lower voltage ratings than electrolytics, ranging from 3 V to 35 V for common types. Like electrolytics, **they're polarised and can only be connected one way around.** Some types have the value marked on the body, others employ a colour code.

Most capacitors have their value marked on the body, sometimes in a code — but we'll explain them in a later chapter.

You can always substitute a higher-voltage capacitor of the same value in a circuit, but not one with a lower voltage rating. Hence, if a capacitor is specified as, say, 100n/50 V, a 100n/100 V capacitor may be employed. But watch out that it will physically fit, as higher voltage capacitors are usually larger. ▶



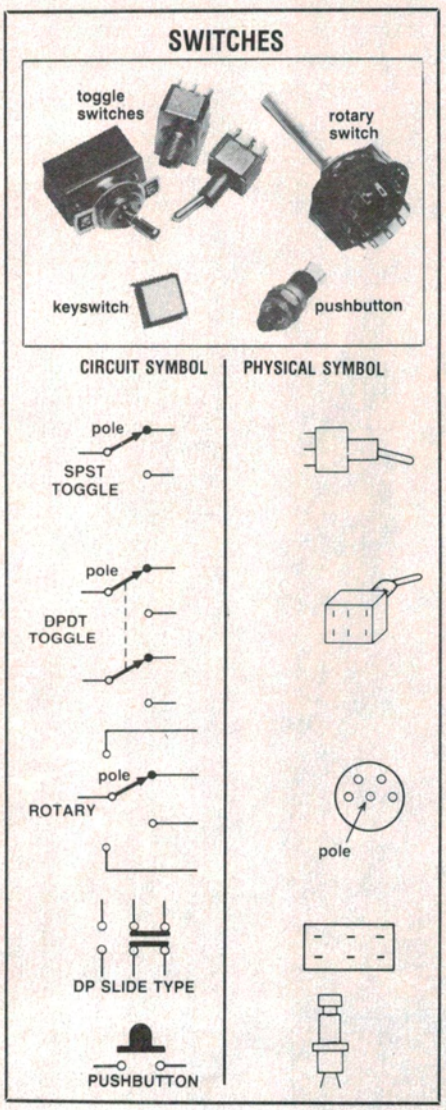


Variable capacitors

These are used generally in "tuned" circuits to vary the circuit's frequency of operation or to select frequencies. They consist of a set of "fixed" plates, mounted on a frame, and a set of "moving" plates fixed to a shaft which is rotated to vary the capacitance. Some types are ganged, with two or more sets of fixed plates in the frame and two or more sets of moving plates attached to the one shaft. This type is commonly seen in radios and tuners where several circuits have to be tuned in step with one another.

"Trimmer" types are also available, intended for presetting adjustment of a circuit. They generally employ similar construction principles but are adjusted by a flat-bladed tool.

Variable capacitors of differing varieties and constructions are available in values from around 10 pF to around 400 pF maximum capacitance.



Switches

Switches used in electronics come in a positively *enormous* range of types, styles, sizes and contact ratings. There are *toggle switches*, operated by a small lever, *rotary switches*, operated by a shaft which moves a "pole" contact from one fixed contact to the next, *pushbuttons* and *keyswitches*, and even *slide* switches.

All switches have a *pole* contact. This is a moving contact that can be set to link up with one or more fixed contacts. A switch with a single pole and one fixed contact is termed a "single-pole/single-throw", or **SPST**, switch. One with two fixed contacts, where the pole can be set from one to the other, is called a "single-pole, double-throw", or **SPDT**, switch. With two poles and one pair of contacts — it's a **DPST** switch; and with two poles and two pairs of contact, it's a **DPDT** switch. Less common types may have three poles. Some types come with a "centre off" position.

Rotary switches may have from one to six poles on a single "bank" (one wafer with all the poles and contacts). Multiple-bank rotary switches are also available.

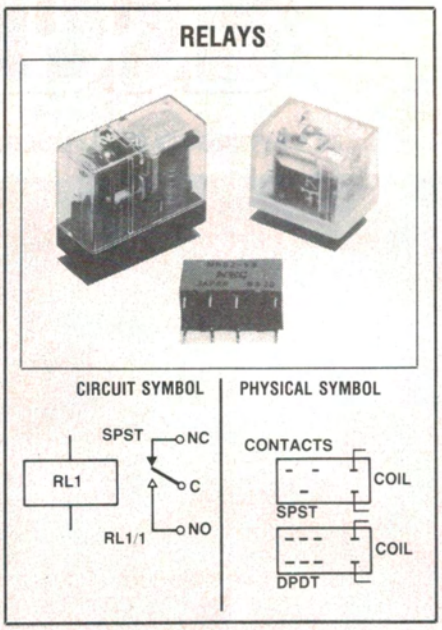
Pushbutton switches may have *momentary operating* contacts or *push-on/push-off* operation. Some have *normally open* contacts (push to close the contacts), while others have *normally closed* contacts (push to open). These are sometimes abbreviated to NO and NC, respectively. Keyswitches are similar.

Slide switches may have few or many pole contacts and several operating positions so that the pole may be switched to one, two or more contacts.

"But which is the pole and which are the contacts?" The wiring diagram for a project will generally indicate the appropriate connections. You can sort it out for yourself with a simple "continuity checker" or a multimeter set to the "Ohms" or "continuity" range — more about that in a later chapter.

Switches have an operating voltage rating and a contact current rating. Neither should be exceeded. Generally, the commonly available toggle switches are rated from 100 V/1 A up to 250 V/10 A. Common rotary switches may be rated to switch up to 100 V at up to 1 A, although they are not generally used for switching high voltages or large currents. Pushbuttons and keyswitches are not rated to switch substantial voltages or currents, and the same goes for slide switches.

Note that *some* switches, particularly rotary types, may have "make-before-break" or "break-before-make" contacts. In the former, the pole will contact the next fixed contact before breaking with the previous fixed contact. Such types are found in audio applications where this action prevents "clicks" or "plops" when changing functions. The break-before-make type completely disconnects the pole when moving from one fixed contact to the next. Unless specified otherwise, the break-before-make type is generally used.



Relays

Relays are simply electrically operated switches. In a relay, an electromagnet operates a set of contacts when a current is passed through it. Like switches, they have contact sets which may be single-pole, double-throw (SPDT), DPDT, etc. Those with double-throw contacts are also referred to as "change-over" types.

Relays coils are generally rated to operate at a certain voltage, drawing a specified current. Sometimes only the coil resistance is specified. Always stick to the specified coil rating, unless an alternative is given. Substitutes *may* be made, but you need to know what you're doing. Leave that until you've had a little experience.

The contacts on relays have a voltage and current rating, just like switches. Stick to the specification when building projects, if you can. Note, however, that relays with a similar coil rating but higher contact ratings may be substituted.

Relays are available in a wide variety of sizes, ratings, contact sets and physical arrangements. There are socket-mounting types (sometimes called "cradle" relays after the style of socket), chassis-mounting types and printed circuit mounting types.

... to be continued.