

# POLARITY – STUDY

## Integrated Circuit Polarity

Integrated circuits (ICs) might have eight pins or eighty pins, and each pin on an IC has a unique function and position. It's very important to keep polarity straight with ICs. There's a good chance they'll smoke, melt, and be ruined if connected incorrectly.

Through-hole ICs usually come in a dual-inline package (DIP) – two rows of pins, each spaced by 0.1" wide enough to straddle the center of a breadboard. DIP ICs usually have a **notch** to indicate which of the many pins is the first. If not a notch, the IC might have an etched **dot** in the casing near pin 1.

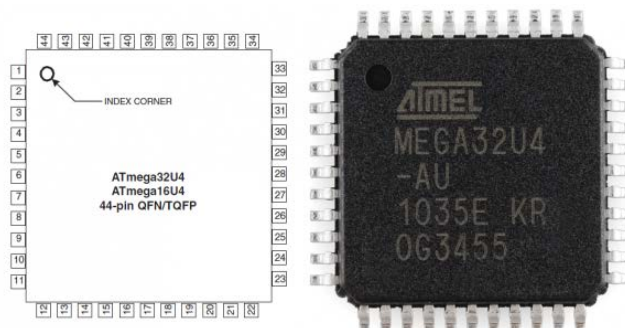


*An IC with both a dot and a notch to indicate polarity. Sometimes you get both, sometimes you only get one or the other.*

For all IC packages, pin numbers increase sequentially as you move counter-clockwise away from pin 1.



Surface-mount ICs might come in QFN, SOIC, SSOP, or a number of other form-factors. These ICs will usually have a **dot** near pin 1.

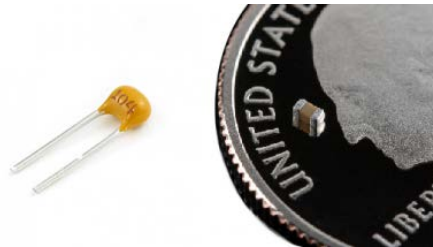


An [ATmega32U4](#) in a TQFP package, next to the datasheet pinout.

## Electrolytic Capacitors

Not all [capacitors](#) are polarized, but when they are, it's *very* important not to mix their polarity up.

Ceramic capacitors – the small (1 $\mu$ F and less), commonly yellow guys – are **not** polarized. You can stick those in either way.



*Through-hole and SMD 0.1 $\mu$ F ceramic capacitors. These are NOT polarized.*

Electrolytic caps ([they've got electrolytes](#)), which look like little tin cans, **are polarized**. The negative pin of the cap is usually indicated by a “-” **marking**, and/or a **colored strip** along the can. They might also have a **longer positive leg**.

Below are [10 \$\mu\$ F](#) (left) and a [1mF](#) electrolytic capacitors, each of which has a dash symbol to mark the negative leg, as well as a longer positive leg.



Applying a negative voltage for an extended period to an electrolytic capacitor results in a briefly exciting, but catastrophic, failure. They'll make a *pop*, and the top of the cap will either swell or burst open. From then on the cap will be as good as dead, acting like a short circuit.

## Other Polarized Components

### Batteries and Power Supplies

Getting polarity right in your circuit all starts and ends with getting the [power supply](#) connected correctly. Whether your project's getting power from a [wall-wart](#) or a [LiPo battery](#), it's critical to make sure you don't accidentally connect them backwards and apply -9V or -4.2V to your project accidentally.

Anyone that's ever replaced batteries knows how to find their polarity. Most batteries will indicate the positive and negative terminals with a "+" or "-" symbol. Other times it might be red wire for positive and a black wire for negative.



An assortment of batteries. Lithium polymer, coin cell, 9V alkaline, AA alkaline, and AA NiMH. Each has some way to represent positive or negative terminals.

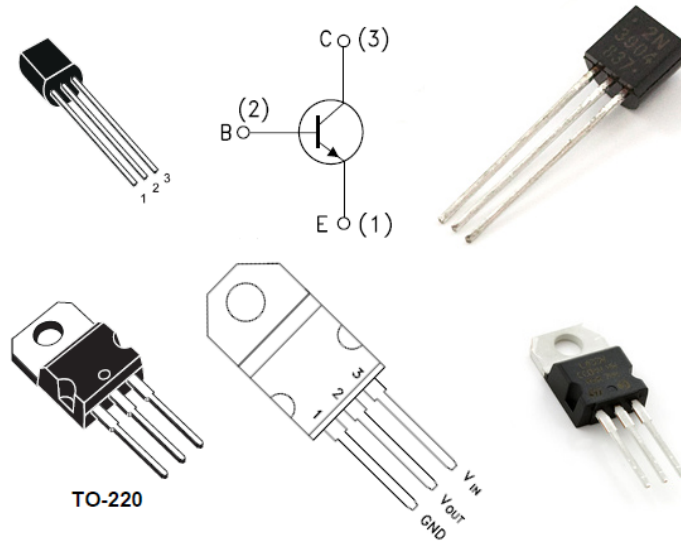
Power supplies usually have a standardized connector, which should usually have polarity itself. A barrel jack, for example, has two conductors: outer and inner; the inner/center conductor is usually the positive terminal. Other connectors, like a JST, are **keyed** so you just can't connect them backwards.



For extra protection against reversing power supply polarity, you can add reverse polarity protection using a diode, or a MOSFET.

## Transistors, MOSFETs, and Voltage Regulators

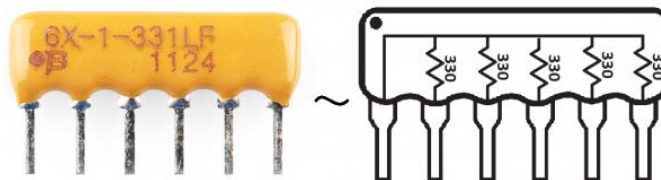
These (traditionally) three-terminal, polarized components are lumped together because they share similar package types. Through-hole transistors, MOSFETs, and voltage regulators commonly come in a TO-92 or TO-220 package, seen below. To find which pin is which, look for the flat edge on the TO-92 package or the metal heatsink on the TO-220, and match that up to the pin-out in the datasheet.



Above, a 2N3904 transistor in a TO-92 package, note the curved and straight edges. A 3.3V regulator in a TO-220 package, note the metal heatsink on the back.

Etc.

This is just the tip of the polarized-component iceberg. Even non-polarized components, like resistors, can come in polarized packages. A resistor pack – a grouping of five-or-so pre-arranged resistors – is one such example.



A polarized resistor pack. An array of five 330Ω resistors, all tied together at one end. The dot represents the first, common pin.

Fortunately, every polarized component should have some way to inform you which pin is which. Be sure to always **read the datasheets**, and check the case for dots or other markers.

Source : <https://learn.sparkfun.com/tutorials/polarity>