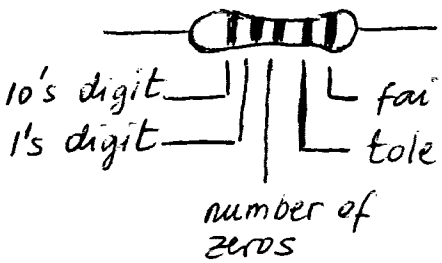
Basic Lab. Information

How to read Resistors



DEFAULT UNIT : Ω

Tolerance Band	color
10%	silver
5%	gold
2%	red
1%	brown
20%	none

Failure Rate	color
1%	brown
0.1%	red
0.01%	orange
0.001%	yellow

First 3 bands: COLOR	VALUE
BLACK	0
BROWN	1
RED	2
ORANGE	3
YELLOW	4
GREEN	5
BLUE	6
VIOLET	7
GRAY	8
WHITE	9

The first two bands ("digits") are arranged in 17 different ways:

10, 12, 15, 18, 20, 22, 27, 30, 33, 39, 47, 51, 56, 68, 75, 82, 91

How to read capacitors

Here things get more difficult.

The first important observation to remember is that the only units commonly used on cap. markings are:

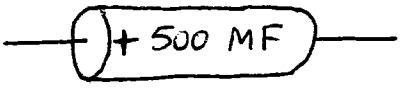
- microfarads = $\mu F = 10^{-6} F$
- picofarads = $pF = 10^{-12} F$

} and often are given for granted!!

Resist any other assumption no matter how tempting or plausible:

BIG CAPS (electrolytic)

These are easy to read, because there is room to write the value on the cap.
You need only have the common sense to assume



that mF or MF stands for μF not milli or Mega Farads

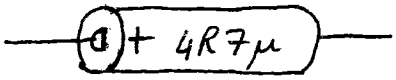
Big capacitances are usually POLARIZED, so you may destroy the cap if you apply the wrong polarity.
A + mark or a − mark is put on one of the terminals.

SMALL CAPS

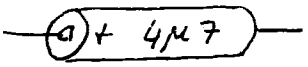
As the caps get smaller the difficulty in reading their markings gets steadily worse.

- Tantalum

These are usually silver colored cylinders. They are also polarized.
Usually a + mark and a metal nipple mark the positive end

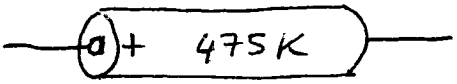


Sometime the unit is used in place of the decimal point



The R marks the decimal place so this is a 4.7 µF cap.

However the same cap could also be marked:

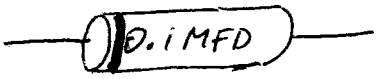


Be careful here the K has nothing to do with "Kilo" it is a tolerance notation (it means ±10%). Another favorite letter for tolerance is M (it means ±20%)

The value of the cap is 47 followed by 5 zeros and the unit (not explicitely given!) is pF → 4700000 pF = 4.7 µF

- Mylar

These are yellow cylinders, pretty clearly marked.



This is a 0.1 μF cap.

Mylar capacitors are not polarized, so do not worry about the black band mark, you can orient them at random.

Unfortunately Mylar caps. have pretty poor characteristics at high frequencies → they behave more as inductors rather than capacitors

- Ceramic (they behave well even at high freq.)
  - Disc

Usually little orange discs. Here things get confusing again !!!

Here the first letter-number-letter is the cap type The M is a tolerance marking (±20%)

1KV means that the cap can stand 1000 V
What about the values ?

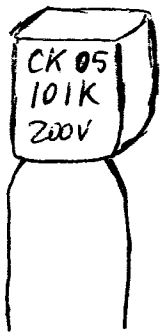
0.02 means 0.02 μF
560 means 560 pF

→ common sense tells you the unit (a cap of 0.02 pF would be to small so the unit must be μF !)

Since the manufacturers of caps charge money for them we would appreciate a little more clarity rather then having them relying so much on the customer common sense! ☺

- CK05

  These are little boxes with their leads 0.2" apart. Therefore, they are handy for insertion into a printed circuit.



Here the reading is
100 pF
↓
10 followed by 1 zero and the unit is pF (see table *)
again K is ±10% tolerance

ONE MORE note:
sometime pF is marked as μμF

Capacitance Tolerance codes	
M	±20%
K	±10%
J	±5%
G	±2%
F	±1%
D	±0.5%
C	±0.25%
B	±0.1%
A	±0.05%
Z	±0.025% ← For precision caps or +80%, −20% for big filter capacitors
N	±0.02%
P	+100%, −0% ← for big filter capacitors

TABLE *

Capacitor Third Digit	Multiplier
0	1
1	10
2	100
3	1000
4	10000
5	100000
6	not used
7	not used
8	0.01
9	0.1

DIELECTRIC CODE

The first letter can be: Z, 4, X

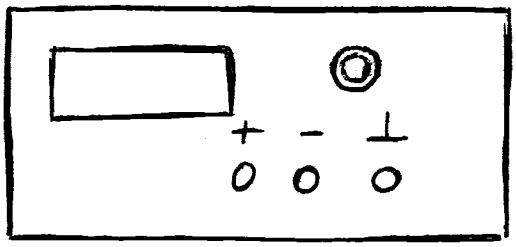
The number can be: 2, 4, 5, 6, 7

The second letter can be: A, B, C, D, E, F, P, R, S, T, U, V

For more info on caps markings see: manufacturers data sheets

Power Supplies

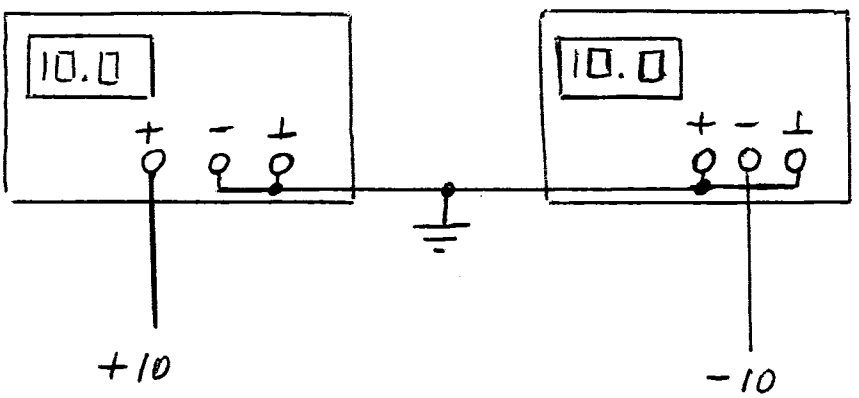
- Single Output Power supplies (TYPICAL)

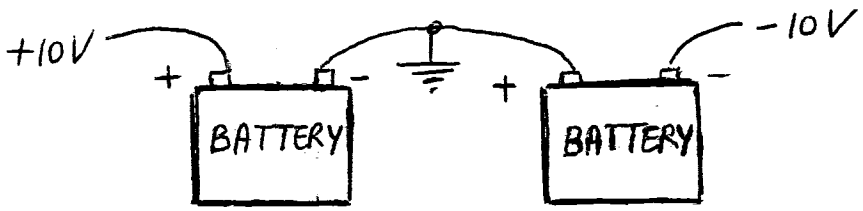


Setting the supply to have a $V_{+-} = 20V$ does not mean that $V_+ = 20V$ and $V_- = 0V$ unless V_- is connected to the ground ⊥ terminal

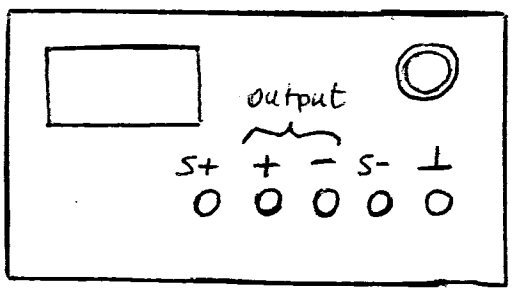
If you want to obtain a voltage of $-20V$ you can set the supply to have a $V_{+-} = 20V$ and connect V_+ to the ground terminal
At this poin $-20V$ is available at the V_- terminal

Since the power supply has a single output we can obtain only one voltage at the time (e.g. either $+20$ or -20).
If we want to use an op. amp. that requires dual rail (e.g. $V_{CC} = +10$ and $V_{EE} = -10V$) we need two single output power supplies.



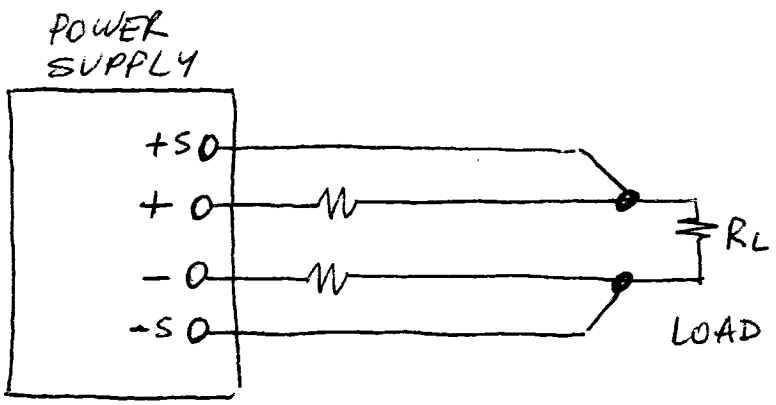


- single output power supplies (FANCY)



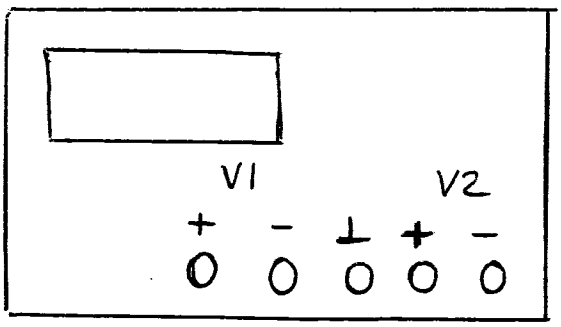
No matter the many terminals it can still provide only one output voltage.
The terminals S+ and S− are called sensing terminals. Their purpose is to make sure that the voltage provided is "regulated" on the load not at the input

terminals.

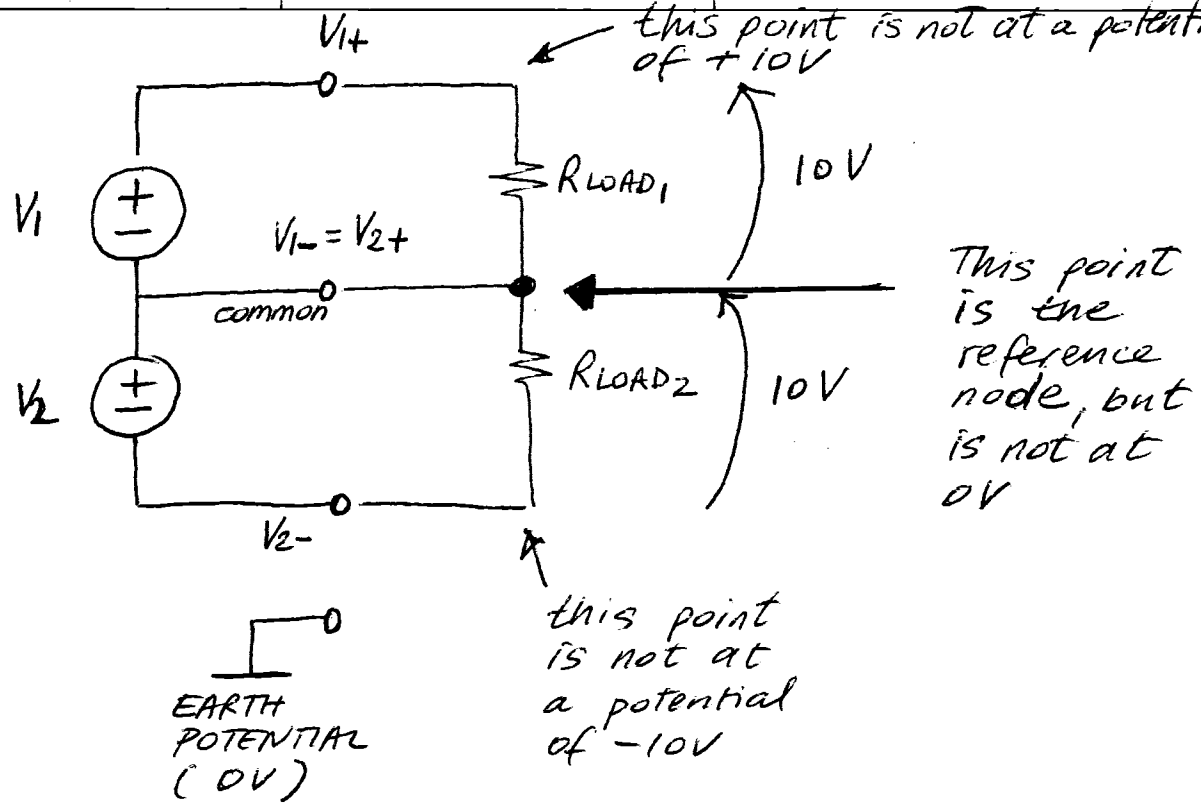


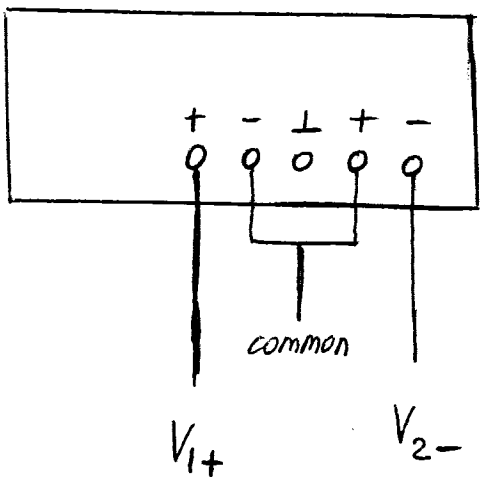
Be careful DUAL OUTPUT RANGE power supply means that the range is dual not the output !!!

- **double output power supplies (TYPICAL)**

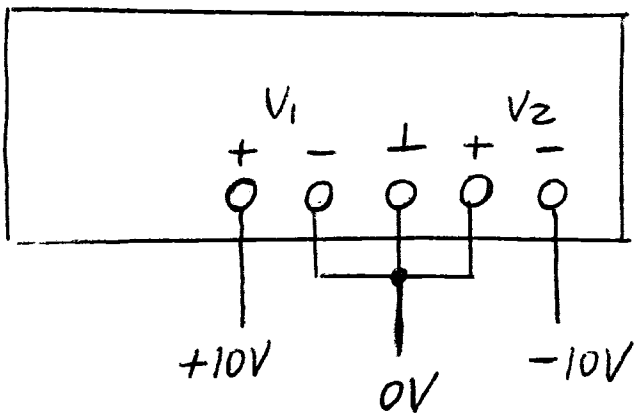


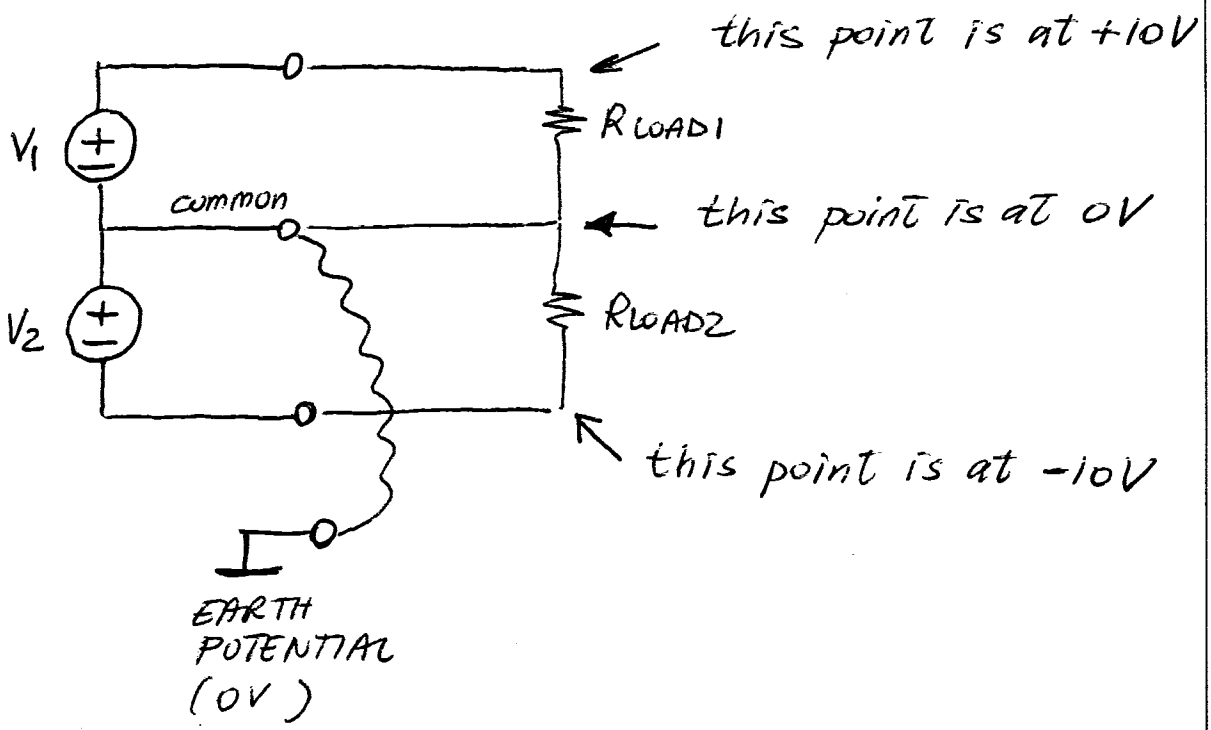
In this case since I have two outputs if we want to use an op. amp. that requires dual rail (eg. $V_{CC} = +10V$ and $V_{EE} = -10V$) one power supply is enough.
let's see how to make connections.



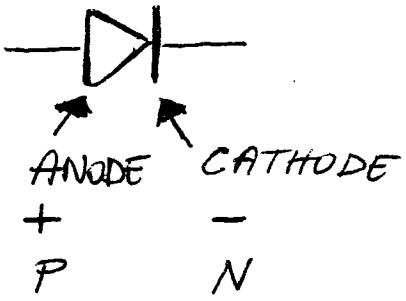


In order to have V_{1+} at +10V and V_{2-} at −10V the common must be connected to <u>earth</u> potential





How to check diodes



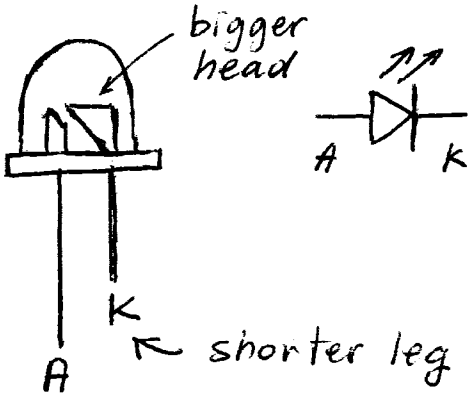
the resistance "from anode to cathode" is very small

the resistance "from cathode to anode" is very high

↖ you can use a ohm-meter to figure out A and K

↖ the black band marks the cathode

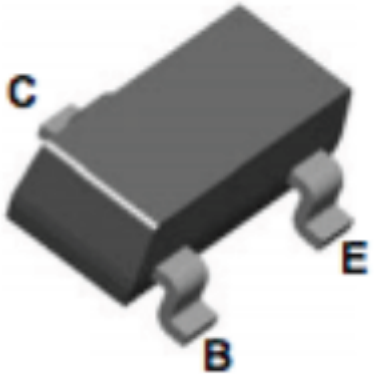
LIGHT EMITTING DIODES (LEDs)



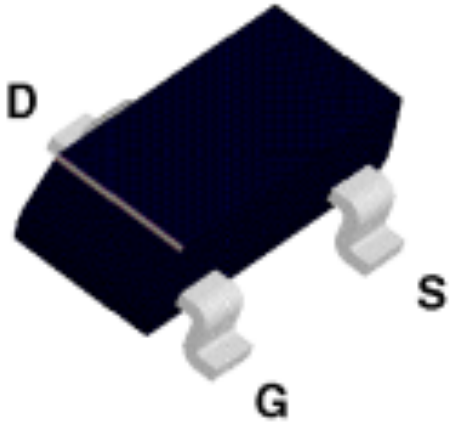
Do not connect diodes directly to a battery or power supply → they will be destroyed because too much current will pass through them

BIPOLAR TRANSISTORS

E B C



FIELD EFFECT TRANSISTORS



D G S

Lab. Notes:

Typically the first 2-3 letters in an IC part number designate the manufacturer so are totally "irrilevant"

MC	=	motorola
AD	=	analog devices
SN	=	Texas Instruments
LM	=	Texas Instruments
CA	=	Intersil
MAX	=	maxim Integrated
μA	=	Fairchild
BB	=	Burr Brown
DM	=	Fairchild
ST	=	STMicroelectronics
LTC	=	Linear Technology

...

MC14066B	Quad Analog Switch	} example of equivalent ICs
74HC4066	Quad Analog Switch	

MC14516B	Binary up/down counter	} example of equivalent ICs
HEF4516B	Binary up/down counter	
CD4516B	Binary up/down counter	
74HC4516	Binary up/down counter	

Check the data sheets !! carefully !!