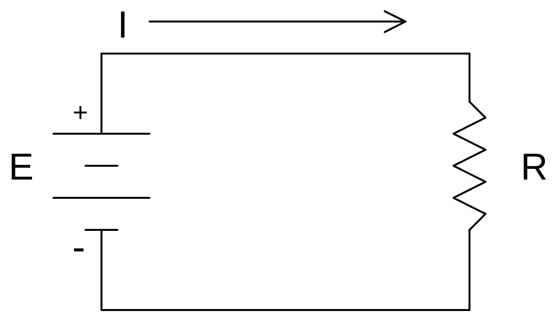
Electricity Fundamentals

Voltage (E): the force which causes electrons to flow in a closed circuit
Current (I): the flow of electrons in a circuit
Resistance (R): the opposition to current flow

Ohm's Law: $E = I \times R$ $I = E / R$ $R = E / I$

By convention, current flows
from positive to negative



Note: lots of folks use "V" instead of "E" for voltage

Kirchhoff’s Current Law

Remember how to find the total resistance of resistors in parallel?

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

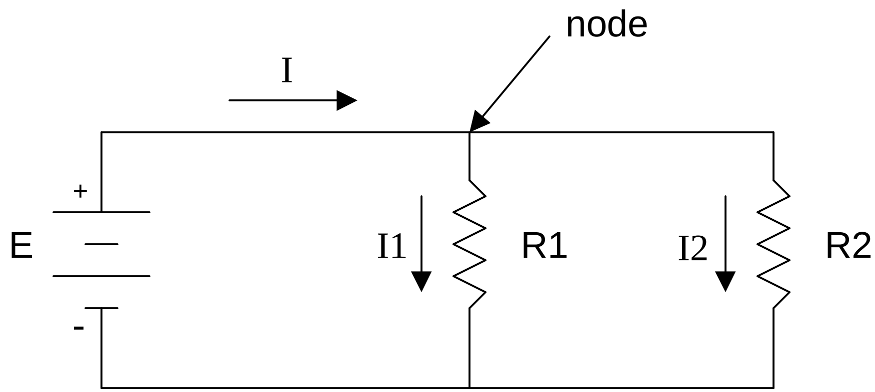
For the circuit below, the same voltage is applied to both R1 and R2. Let’s multiply both sides of this equation by E:

$$\frac{E}{R} = \frac{E}{R_1} + \frac{E}{R_2}$$

But Ohm’s law allows us to write this as:

$$I = I_1 + I_2$$

This is ***Kirchhoff’s Current Law***: the current entering a node in the circuit is equal to the sum of the currents leaving the node. Here, the current I flowing to the node divides. Some flows through R1 and the rest through R2. But the total through both is the same as the total in the circuit.



Kirchhoff's Voltage Law

Remember how to find the total resistance of resistors in series?

$$R = R_1 + R_2$$

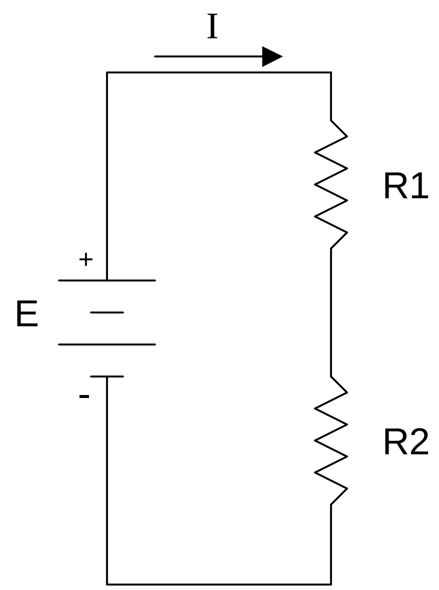
For the circuit below, the same current flows through both R1 and R2. Let's multiply both sides of this equation by I:

$$IR = IR_1 + IR_2$$

But Ohm's law allows us to write this as:

$$E = E_1 + E_2$$

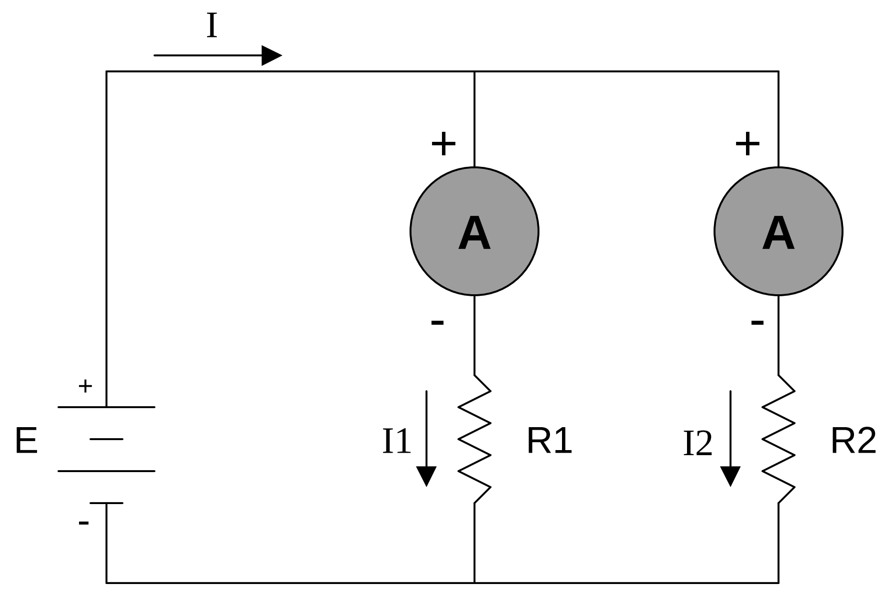
This is ***Kirchhoff's Voltage Law***: the voltage added to the circuit by the battery is equal to the sum of the voltages consumed by the resistors. Here, some of the voltage from the battery is lost in each of the two resistors, and the sum of the voltage lost in the resistors is equal to the voltage of the battery.



Measuring Current

Electric current is always measured by connecting an ammeter *in series* with the component through which you'd like to know the current.

Note that ammeters have *polarity.* Make sure you connect the + and - leads so that the current will flow through the meter from + to -. The + lead is closer to the + terminal on the battery, and the - lead is closer to the - terminal on the battery.



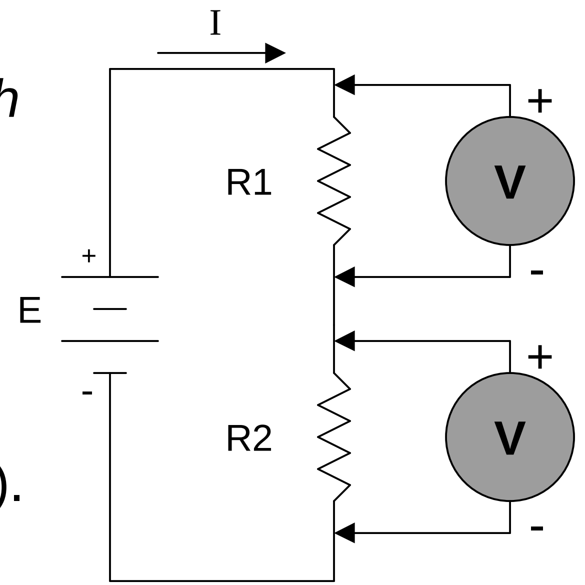
Measuring Voltage

Voltage is measured as either:

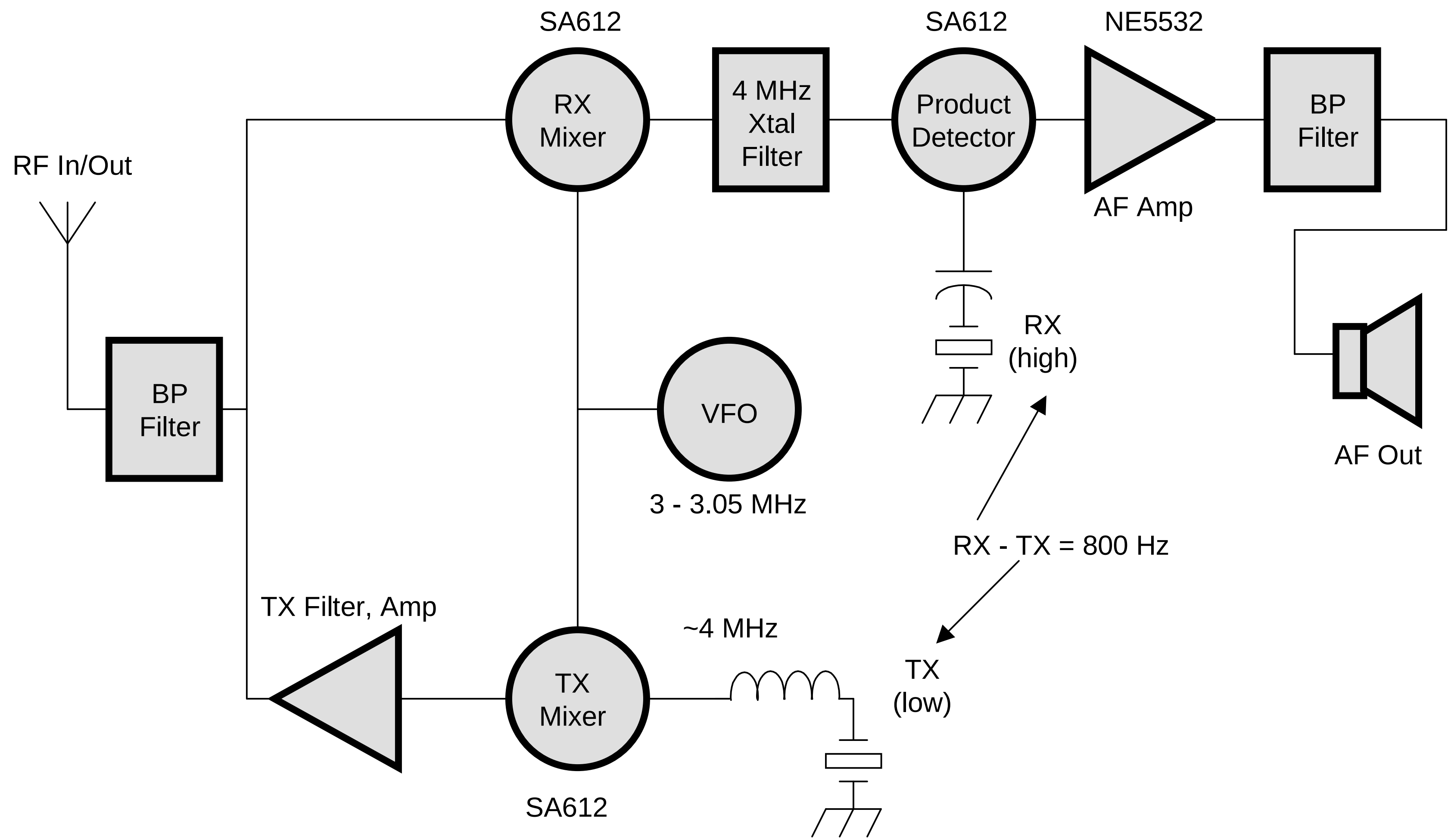
- the voltage drop across a component or part of the circuit, or

- the voltage at a point *with respect to ground*

Always connect the voltmeter *in parallel with* the part of the circuit across which the drop in voltage is being measured. The + lead of the voltmeter is closest to the + terminal on the battery. If measuring with respect to ground, connect the - lead to the circuit ground (the negative terminal of the battery).

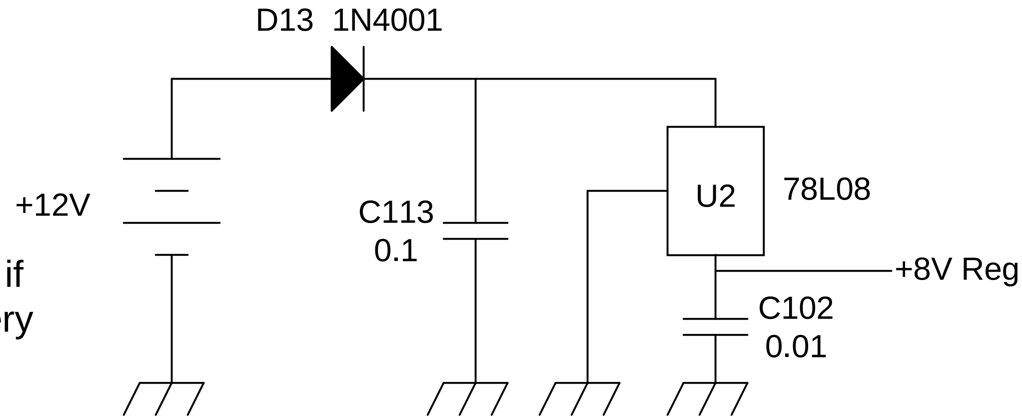


SW+40 Block Diagram



SW+ Voltage Regulation

Q: What would happen if we hooked up the battery backwards?



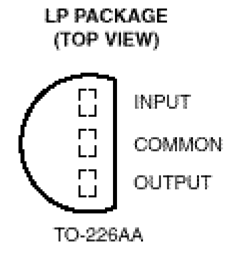
The 78L08 voltage regulator accepts a range of input voltages and produces a fixed 8-volt output which is very stable. Capacitors C113 and C102 act to provide a path to ground for any RF component in the voltage line from other parts of the circuit.

Note: capacitance values given on schematics as decimals are usually in µF, while those given as integers are usually given in pF. Example: “0.1” is 0.1 µF, while “47” is 47 pF (remember, 1,000,000 µF = 1 F, and 1,000,000 pF = 1 µF).

78L08 Specifications

recommended operating conditions

		MIN	MAX	UNIT
Input voltage, V_I	µA78L02C, µA78L02AC	4.75	20	V
	µA78L05C, µA78L05AC, µA78L05Q, µA78L05AQ	7	20	
	µA78L06C, µA78L06AC	8.5	20	
	µA78L08C, µA78L08AC	10.5	23	
	µA78L09C, µA78L09AC	11.5	24	
	µA78L10C, µA78L10AC	12.5	25	
	µA78L12C, µA78L12AC, µA78L12Q, µA78L12AQ	14.5	27	
	µA78L15C, µA78L15AC	17.5	30	
Output current, I_O			100	mA
Operating virtual junction temperature, T_J	µA78LxxC through µA78LxxAC	0	125	°C
	µA78LxxQ and µA78LxxAQ	−40	125	



Minimum Input Voltage: 10.5 Volts

Maximum Current Draw: 100 mA

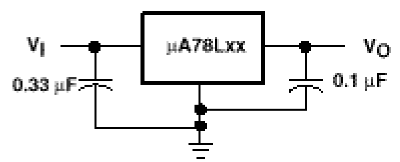
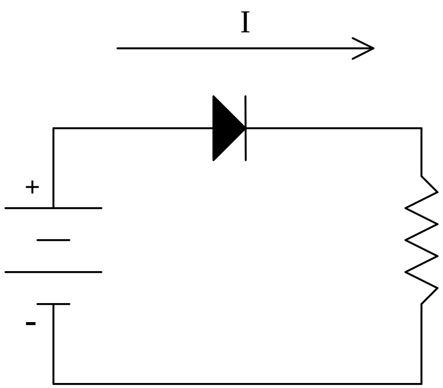


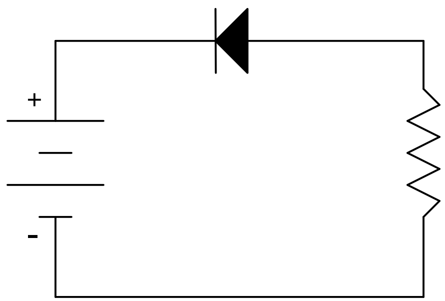
Figure 1. Fixed Output Regulator

Source: Texas Instruments

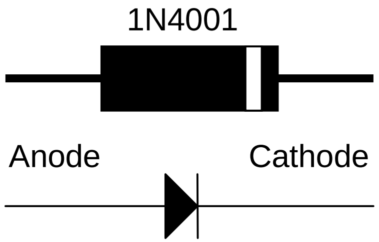
Diode Basics

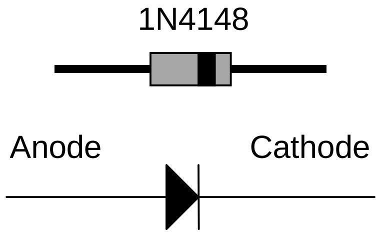


Forward bias--current flows!
(low resistance)

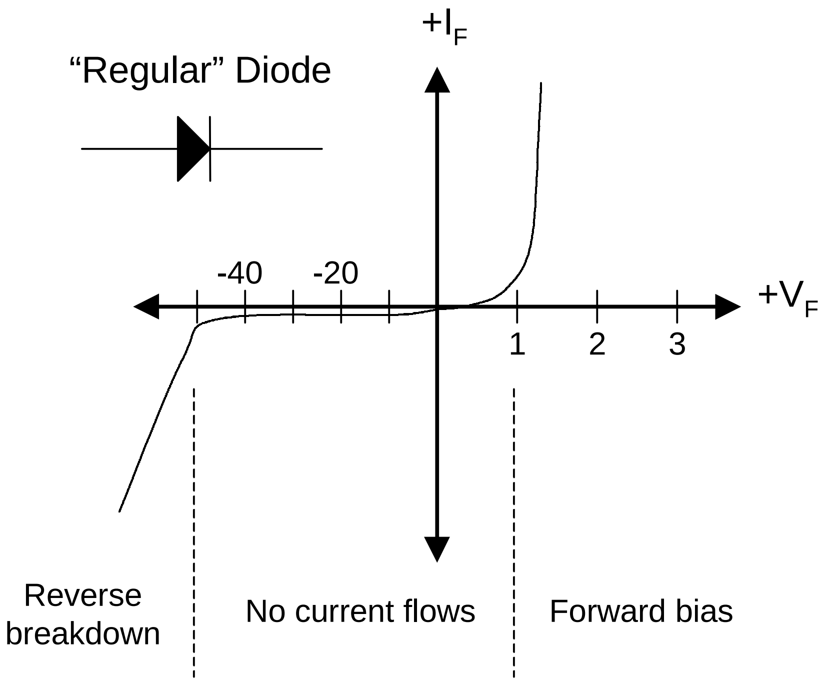


Reverse bias--no current flows
(high resistance)

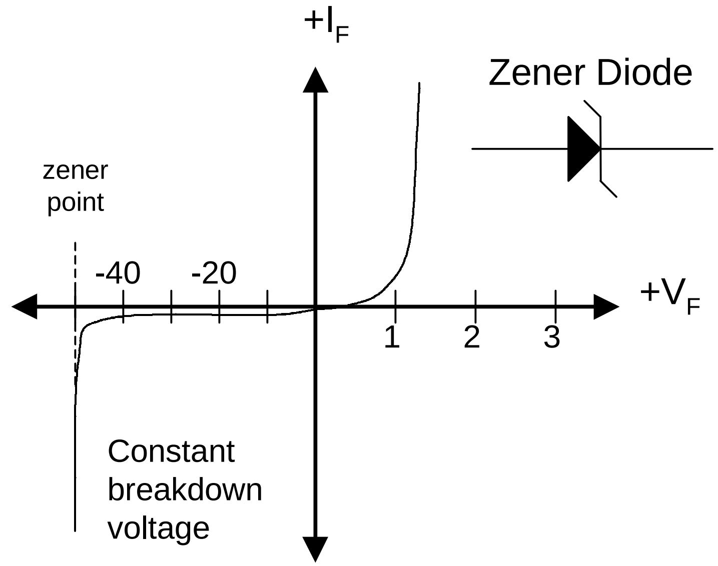




Diode Characteristics



Conduction begins when forward bias is applied which exceeds a fairly low threshold (0.5 - 1 V). If reverse bias is applied, no current flows until reverse bias voltage exceeds the breakdown voltage, at which point current increases with reverse voltage.

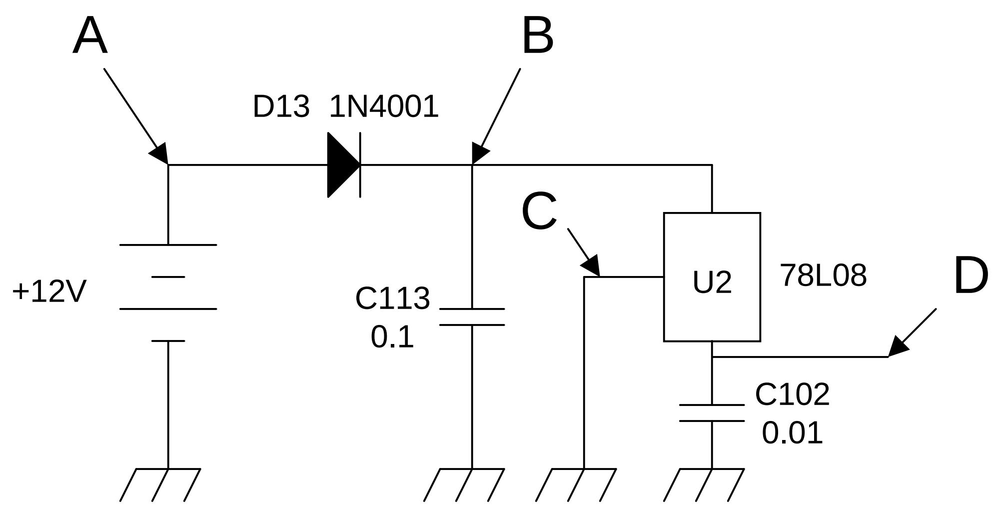


Zener diodes work like "regular" diodes except that when the reverse breakdown voltage is reached, the zener diode will allow conduction but will keep the voltage drop across it constant. Zener diodes are usually reverse-biased in circuits to take advantage of this characteristic. Zener diodes are manufactured with a variety of values of breakdown (or zener) voltages.

Quiz

What will be the voltage at points A, B, C, and D?
What will be the voltage drop across U2?
What will be the current through C102?

When you finish constructing this part of the circuit, measure these voltages. Are they what you expected?



Construction

- Inventory all the parts in your kit--contact NN1G if you’re missing any parts
- Install the following components:
  - C102, C113
  - D13, U2 (make sure you observe correct polarity!)
  - Connector J4
  - connect the 5.5mm/2.1mm coaxial jack to the wiring harness matching J4 (observe correct polarity--see NN1G’s instructions)
- Test:
  - Apply 12 -15 V power to J4
  - Measure voltage at D13’s cathode--should be less than the input voltage by around a half a volt or so
  - Measure voltage at pin 1 of J2’s location on the PC board (we haven’t installed J2 yet) -- should be 8.0 V