HOW TO BUILD
A PIEZOELECTRIC
GENERATOR
CIRCUIT DESIGN

piezoelectric element
HOW MUCH ENERGY IS GENERATED?

The energy stored in a capacitor is given by the equation:

\[
E = \frac{1}{2}V^2C
\]

For our circuit, \(C = 220 \ \mu F\). When the multimeter shows 10 volts across the capacitor, the amount of energy stored is

\[
E = \frac{1}{2}(10 \text{ V})^2(220 \ \mu F) = 0.011 \text{ joules}
\]

If a single tap on the piezoelectric element increases the voltage from 2 V to 2.05 V, the amount of energy generated for each tap is

\[
E = \frac{1}{2}(2.05^2-2^2)(220 \ \mu F) = 0.000022 \text{ joules/tap}
\]
How much energy is 0.000022 joules?

A typical cell phone battery stores ~18,000 joules of energy. If we replaced our capacitor with a cell phone battery to charge, how long would it take to fully charge it?

\[
\frac{18,000 \text{ joules}}{0.000022 \text{ joules/tap}} \approx 820,000,000 \text{ taps}
\]

You would have to press this piezoelectric element almost 1 billion times just to charge your cell phone!

If you tapped the piezo element 3 times every second, it would take 8.66 years to fully charge your cell phone.
HOW CAN WE MAKE A PRACTICAL PIEZOELECTRIC GENERATOR?

Two obvious ways to improve our piezoelectric generator:

1. Use a more efficient piezoelectric material
2. Place the piezoelectric element where it will get pressed very rapidly

If we have a piezoelectric material that can increase the voltage across our capacitor from 2 V to 12 V with a single tap, the amount of energy generated is now 0.0154 joules/tap, 700 times greater than before. It would now only take 1,200,000 taps to charge the cell phone, which could be done in 4.6 days!
HOW CAN WE MAKE A PRACTICAL PIEZOELECTRIC GENERATOR?

The second choice is to place the piezoelectric element where it experiences MANY more deformations. This has been done by placing the elements under sidewalks and roads—places where surface movement vibrations tap the element 10,000 times per second.

If our piezoelectric element could be pressed 10,000 times/second, it would take 22.8 hours to charge.

Finally, if we combined both improvements, the phone battery could be charged in as little as 2 minutes!
CIRCUIT DESIGN

Diode rectifier

Piezo Element

Switch

Capacitor

LED