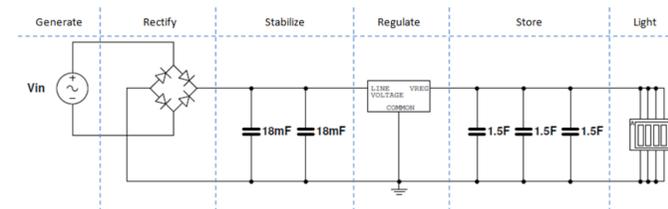


Abstract

Power 2π is a mobile bicycle generator which directly employs Faraday's Law in order to power a safety light. Strong neodymium magnets on each wheel spoke pass by an iron-core solenoid, generating electromotive force (EMF) and inducing current. The resulting power is then rectified, regulated and stored before being fed into an LED bicycle light.

Design



Generate:

The solenoid is comprised of 200ft of 30AWG magnet wire wound around a soft iron core. These specifications were chosen to balance the competing effects of inductance and internal resistance.

$$L = \frac{N^2 \mu A}{l}$$

N = number of turns
 μ = permeability
 A = cross section of solenoid
 l = length of coil

$$R = \frac{\rho L}{A}$$

ρ = resistivity
 L = length of wire
 A = cross section of solenoid

Rectify:

A full bridge rectifier converts the generator's AC input to a positive DC signal, effectively adding the positive and negative components.

SR102 Schottky diodes were used to construct the rectifier since their .55V drop is significantly lower than a typical diode's .7V forward drop.

Stabilize:

Two 18mF capacitors in parallel average out the rectifier's output to provide the regulator with a stable input.

Regulate:

A SWADJ3 step-down adjustable switching regulator sets its output to a constant voltage. A 2.8V output can be chosen for a slightly faster charge time or a slower rider. A 3.0V output can be chosen for a brighter light and a more advanced rider.

Store:

Three 1.5F supercapacitors in parallel are used to store power not dissipated by the bicycle light. During longer bike rides, this stored energy can be used to sustain the light when the bike is temporarily slowed or stopped, such as at intersections.

A supercapacitor's typical charge time is 1-10 seconds vs. 10-60 minutes for a comparable lithium-ion battery. Additionally, a supercapacitor draws only what it needs, without danger of overcharging.

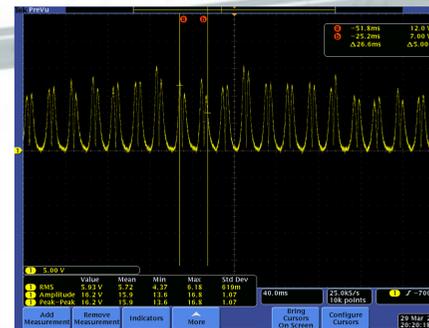
Light:

A white Schwinn, 4LED safety headlight serves as a load, and makes the rider's presence known to nearby vehicles and pedestrians.

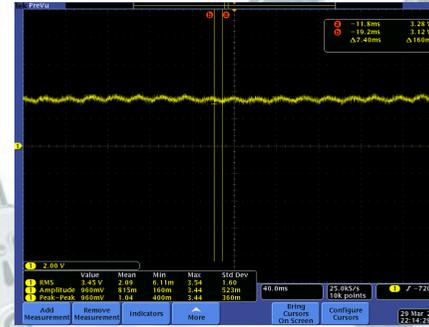
Results



Generated signal



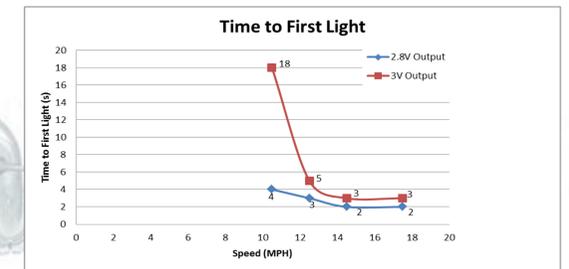
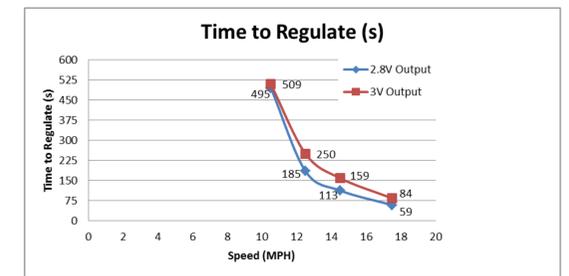
Rectified signal



Capacitor-stabilized signal



Regulated voltage



The time it takes for the light to turn on is directly related to the speed the bicycle is traveling and the output voltage setting of the regulator. Initially, the light that is generated has a blinking behavior, which will eventually stabilize to an unwavering beam once the regulator turns on. This behavior benefits the cyclist because it enables the light to turn on within seconds, without having to wait for a long-charge period. Once the regulated voltage is reached, excess power is stored in the supercapacitors. When the bicycle is briefly stopped, at an intersection for example, this stored power can be drawn on to keep the light powered and the rider safe.

The permeability of iron is approximately 6000 times that of air, greatly increasing the inductance of the solenoid!