Construct A Solar-Powered Varmint Zapper

by Anthony Charlton

Many people enjoy gardening as a hobby. The relaxation of moderate exercise, health benefits, and monetary savings make all forms of gardening pursuits worthwhile. Of course, there are many people who do gardening as a living, too.

If there's one thing we gardeners all have in common, it's the fact we have to contend with various parasites, plant diseases, and "critters" that wish to ruin our gardening work. In this article, we'll explore a very efficient solution to repel the "macro-pests" of your garden. Ranging from raccoons to deer, the electrical circuit following will harmlessly — but effectively — deliver an unwelcome message to destructive animals, whether it be the neighbor's dog, or hungry deer waiting to lunch on your efforts at their four-footed leisure.

Solar Power Recharges Circuit Automatically

The circuit is virtually maintenance-free because of the fact it is powered by a rechargeable battery. That battery is refreshed by a solar panel. This is shown in Figure 1. The circuit uses an average of only 30 to 50 mA because it's operated in a short pulse mode and just fires roughly twice per second. Therefore, you may use any combination of panels which can keep your battery fully charged. We used a pair of discarded Walklight solar panels and a deep-cycle marine battery which was also thrown away. The marine battery had only a fraction of its original capacity, yet it performed adequately with the circuit, and required only one day's trickle charge over the summer because of an extended period of cloudy weather.

Batteries and Charging

Locate your panels in a spot where they are sure to receive the maximum amount of sunlight. In the summertime and early fall before frost, when you will be most likely to operate the circuit, the sun will be closest to its zenith. That's the spot when it's located as near to directly overhead.

Position the solar cells accordingly. Watch for shadows from trees, buildings, etc., as these will cut the power dramatically. (I found a small shadow on a building-sized solar power installation we once did for a fellow cut his power over half!)

Due to the small current needed to recharge the battery, the panels can be located at a distance, and the wire buried, if needed, for cosmetic reasons. Wire chosen for such a use should be rated for underground burial, yet you can use a common cable such as Romex if you don't mind replacing it every few years because it will eventually rot.

Batteries will last for four or five years or more, if you take care of them. If you need to purchase a battery, a small garden tractor battery will work fine. You can find these on sale for about $25.00 However, a used auto battery, which are always thrown out by your local garage, can be had for free or for a couple of dollars. Check its voltage first with your DMM. It should not be below 11.5 volts. If it is, it's likely worthless. A fully charged 12-volt lead-acid battery will run 13.8 volts while it's being trickle-charged, and will read about 12.5-12.9 volts without a charge going in it.

Such batteries should never rise above 14.0-14.4 volts or the electrolyte will boil off, ruining the battery. So your solar array should be conservative; a good ballpark figure would be 100-150 mA for a full-sized auto battery and less for a smaller one. Use ingenuity here and check the battery periodically with your DMM. If the voltage falls, recharge the battery or turn off the circuit to allow the solar cells to do that job for you until its voltage rises. The battery will last much longer that way.

Another precaution is: our battery's manufacturer (Delco) indicates that the battery must be recharged if not used for more than 90 days, and must be recharged when the temperature is at least 60 F. (15.5 C.), so presumably such maintenance applies to all lead-acid batteries to keep them in top shape.

Keep your battery off a cement floor. Put it on wood or fiberglass. Surprisingly, a lead-acid battery will die rather quickly if kept on a cold floor. I believe it's since the electrolyte settles and causes solids to accumulate between the plates, thus causing eventual shorting and destruction of the delicate lead plates within.

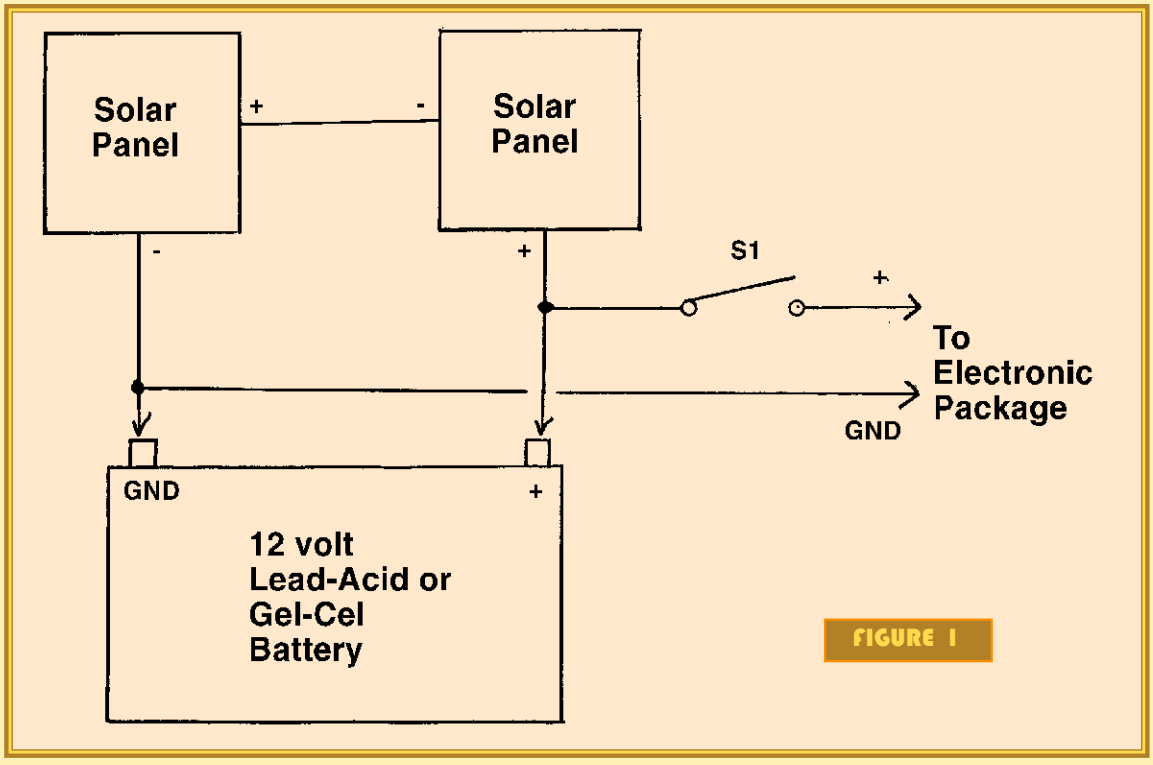
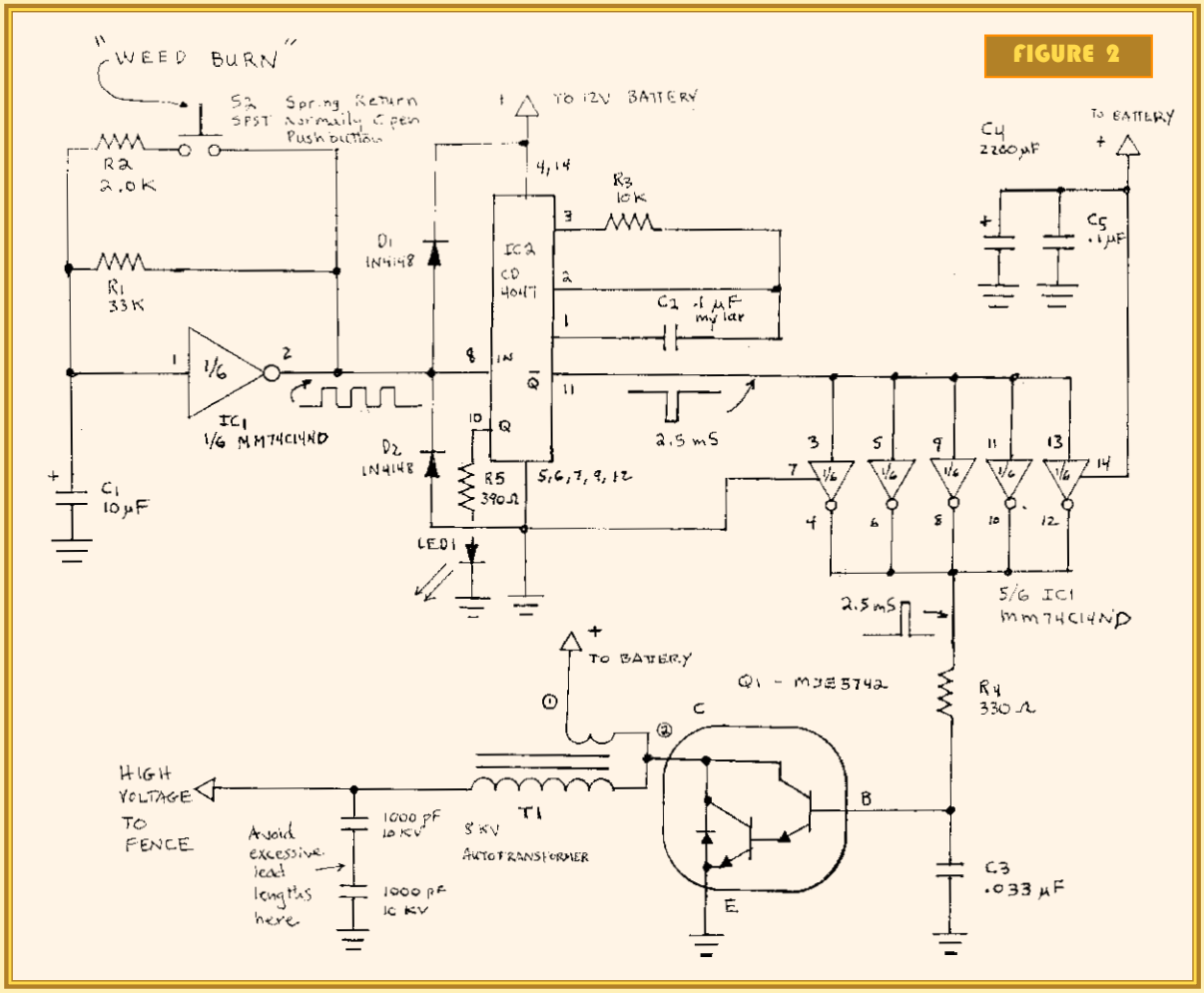


FIGURE 1

How High Voltage is Generated

Figure 2 shows the circuit. T1 is called an AUTOTRANSFORMER not because it's used in cars, but because of the winding pattern. When the switching transistor Q1, connects the common winding of T1 to ground, T1's large inductance stores energy in the primary and the



iron core laminations as a magnetic field. When the transistor turns off, the magnetic field has no current to sustain itself, and it nearly instantly collapses. The collapsing magnetic field produces a series of oscillations called a decaying ringing waveform that develops a high induced voltage in the secondary. Thus, T1 acts more like an inductor than a transformer but, of course, combines the characteristics of both.

T1's HV output is available at two locations. First is the thick green wire. Second is the laminated iron core itself. One does not usually use the core as an output, however. You can get shocked, although not dangerously. Insulate the core with silicone RTV if it may be exposed to moisture or if a shock potential bothers you. Reverse the primary windings if the circuit doesn't produce enough HV.

Unique PWM Circuit

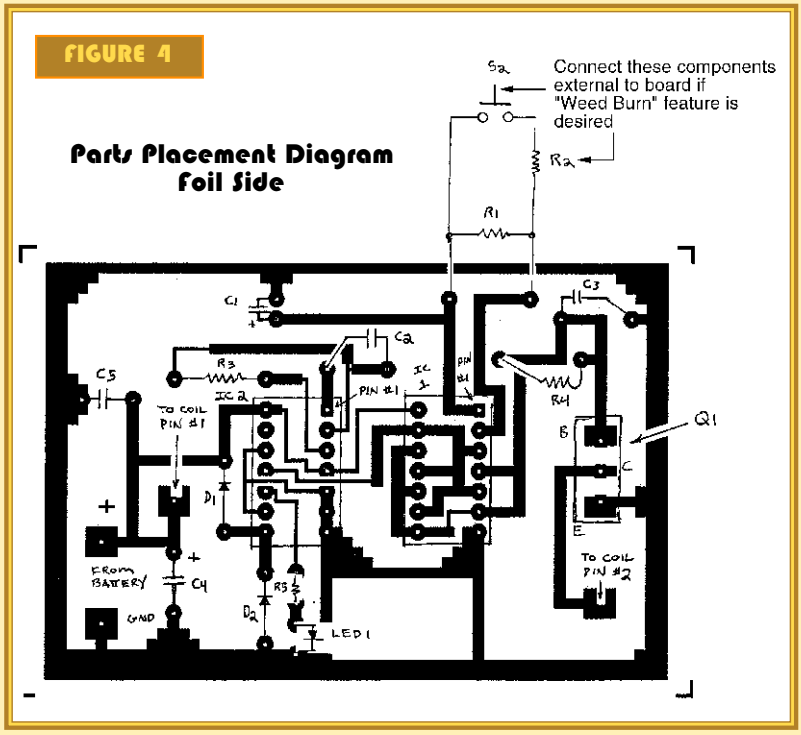
The PWM (Pulse Width Modulated) circuit uses a fixed frequency oscillator consisting of one gate of a 74C14N (or CD4584 is a good substitute) hex inverting Schmitt Trigger integrated circuit. Its frequency is normally determined by the values of R1 and C1, and as shown in Figure 2, output is about two squarewave pulses per second. The signal goes into one of IC2's trigger inputs.

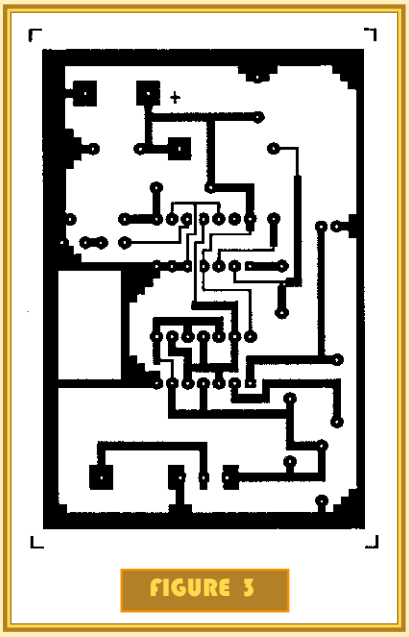
IC2 is a monostable multivibrator, and produces a brief negative pulse equal to 2.48 R * C where R is in megohms and C in microfarads. With the values shown, determined by R3 and C2, the pulse width is a narrow 2.5 milliseconds. Protection diodes D1 and D2 are used at IC2's input to prevent it from being destroyed by stray HV. Use the 1N4148 diodes shown because they operate so quickly; just in a few nanoseconds of switching time.

The negative output from the NOT Q pin of IC2 is a 2.5 mS pulse, and is inverted by the remaining five paralleled gates of IC1. This creates a positive pulse of 2.5 mS which has its current amplified by the additional gates. That makes sure the transistor turns on completely. Q1 is a Darlington transistor which can switch highly inductive loads without failure because of its intrinsic protection diode and the fact it has an extraordinarily high breakdown voltage of 800 volts. Q1 is available from such vendors as Mouser Electronics. Substitutions are not recommended for Q1.

A feature has been added to show the circuit is operating. An LED is connected to the Q output of IC2 through a current limiting resistor. This output produces a very narrow pulse whose on time is 2.5 milliseconds, like a mirror image of the NOT Q output. Whenever the Q output goes high, the LED is flashed on. Use an ultra-bright LED so you can see it clearly in the daytime.

Weeds will reduce the effectiveness of any fence charger. Too many of them will render any charger completely ineffective. To help eliminate a light growth of weeds touching the fence wire, the high voltage pulse rate may be greatly sped up by pressing S2. This will inject approximately 30 pulses per second into your fence's wire, thus shocking weeds with a strong dose of electricity which will cause them to wither in a day or two. Note S2 is wired to connect up a rela-





tively small value resistor, R2, across R1. This speeds up the rate of the oscillator and thus the switching rate of T1. Hold the button down for 10 to 20 seconds whenever necessary. Allow a minute or two to pass between the weed burn mode to allow Q1 to cool off. Of course, if the weeds are too thick you'll have to cut them manually. Watch out nobody comes into contact with your fence when using this feature or they will receive a strong shock.

Installing The Fence Charger

We are combining very high and very low voltages, plus CMOS ICs with this circuit. To help fabricate the circuit, a life-size PC board pattern is provided in Figure 3 and a parts placement guide in Figure 4. A good earth ground or service (house) ground is required to prevent static build-up and the malfunction or destruction of the ICs. Actually, we found the CMOS chips worked much better than TTL types, since their noise immunity is higher, typically being 0.45 times the supply voltage. TTL chips, such as 555 timer based oscillators, caused a great deal of trouble with T1 breaking into self-sustaining and unwanted oscillations. Plus they can't operate at 12 volt levels of voltage.

To hook up the project, a length of spark plug wire or high-voltage wire is good to connect the project to your fence. NOTE: Don't use a plug wire with a graphite core because of its high resistance. The wire must have a metal wire core and be of low resistance.

To insure effective "zapping" of varmints, an adequate return path must be established in the earth. Our garden has a perennially moist nature, so it is okay to just use a long steel fence post for the return path. You may have to improvise if your soil is dry. Conductive material like a long copper wire buried in the soil, or a stretch of 1/2" hole galvanized hardware cloth (a heavy-duty wire woven in a fly-screen pattern), will establish a ground in dry soil. The drier your soil, however, the larger the return ground you will need. This is so the current can get through the varmint's fur effectively.

Shock Wire Placement

Wires at different heights must be utilized to protect your garden. Pests such as rabbits or raccoons require two or more strands spaced at 3" and 8" above the ground. Be sure the animal can't get under the wire, or they'll get to your garden. Deer need a strand at about 2 feet and at 3 to 3.5 feet, so they won't step over or lean into your garden. Use common sense with your local varmint. This project will effectively electrify about 2,000 total feet of fence. Rocks too, will cut the power to the fence. Dig them out or use improvised PVC piping to insulate the wires from touching the rocks, especially if they get wet a lot.

Conclusion

Whatever your varmint, use your ingenuity and try and think like the animal in order to best install your solar-powered fence charger. Use it with respect, and you will enjoy unmolested garden delights from here on in! You also will find the same pest won't return after it gets zapped a time or two! **NV**

Note to readers — *Anthony Charlton, the author of this article and also The Laser Experimenter column, passed away on September 22nd.*

Parts List

R1 - 33,000 ohms
R2 - 2,000 ohms
R3 - 10,000 ohms
R4 - 330 ohms
R5 - 390 ohms
IC1 - #MM74C14-ND Hex CMOS Schmitt Trigger
IC2 - #CD4047BE-ND Monostable multivibrator
Q1 - MJE5472 transistor, or similar
LED1- Superbright LED of any color
C1 - 10 uF aluminum electrolytic capacitor
C2 - 0.1 uF Mylar or polyester capacitor
C3 - 0.033 uF ceramic disc capacitor
C4 - 2,200 uF aluminum electrolytic capacitor
C5 - 0.1 uF ceramic disc capacitor
T1 - 8 KV Autotransformer (see note below)

Misc: Two 14-pin IC sockets, solar panels as depicted in text, 12-volt battery, fencing wire and associated sundries, SPST switch, optional HV capacitors

NOTES

Parts prefixed with a pound sign (#) are **Digi-Key** part numbers

The special 8,000 VAC autotransformer **(T1)** is available from:

Images Company
P.O. Box 140742
Staten Island, NY 10314
Ph: **(718) 698-8305**
FAX: **(718) 982-6145**

Price is $27.45 postpaid. Includes data.

You may add the two optional 10 KV, 1,000 pF capacitors to the circuit, shown in Figure 2, to increase its shock power. They are also available from Images Company.