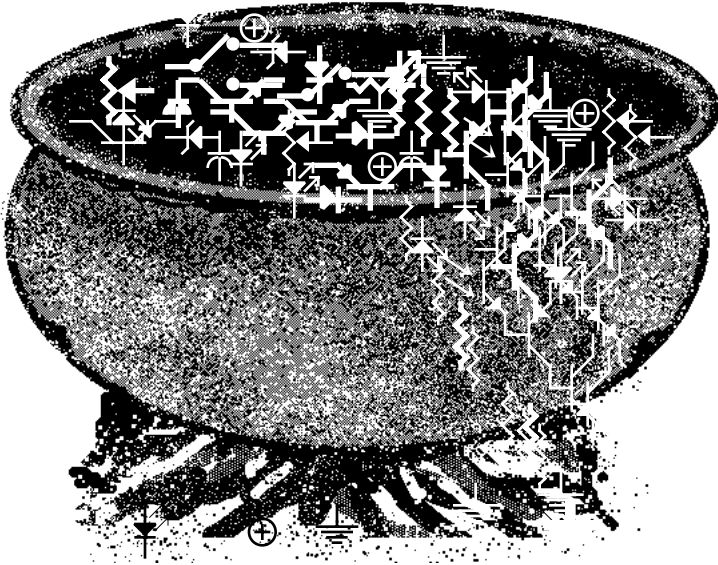# *Homebrew*

## Shunt Regulator

### Chris Greacen

Wind, hydro and photovoltaic panels can sometimes produce more electricity than our batteries can store. Overcharging batteries increases water loss in the electrolyte, decrease battery life; and is potentially more dangerous. Under charge, the voltage of a fully charged battery system can rise to levels which will fry 12 Volt electronics (including some inverters) attached to the system.

There are two basic kinds of regulators: series regulators and shunt regulators. Both regulators have a sensing circuit which regulates current flow into batteries when the voltage exceeds a threshold level. Series regulators work by switching off current from the charging source (panels, etc) when the voltage climbs too high. With the charging source disconnected like this the battery voltage sinks to its standing voltage (lower than its voltage under charge). Series regulators are simple, but they have two disadvantages: first, not all power potentially produced by the power source is used. When the load is switched off, generators used in hydro or wind systems can spin more quickly than they are designed for and destroy themselves. This does not apply to solar cells - running Pvs open circuit, or short circuit for that matter, does no harm.

Shunt regulators work by diverting the power from the batteries into some other load. In effect they waste electricity, but wasting electricity is much better than overcharging batteries - or destroying electronics. Of course if you do have a way to put those electrons to a good use, by all means do it - run the washing machine or vacuum cleaner.
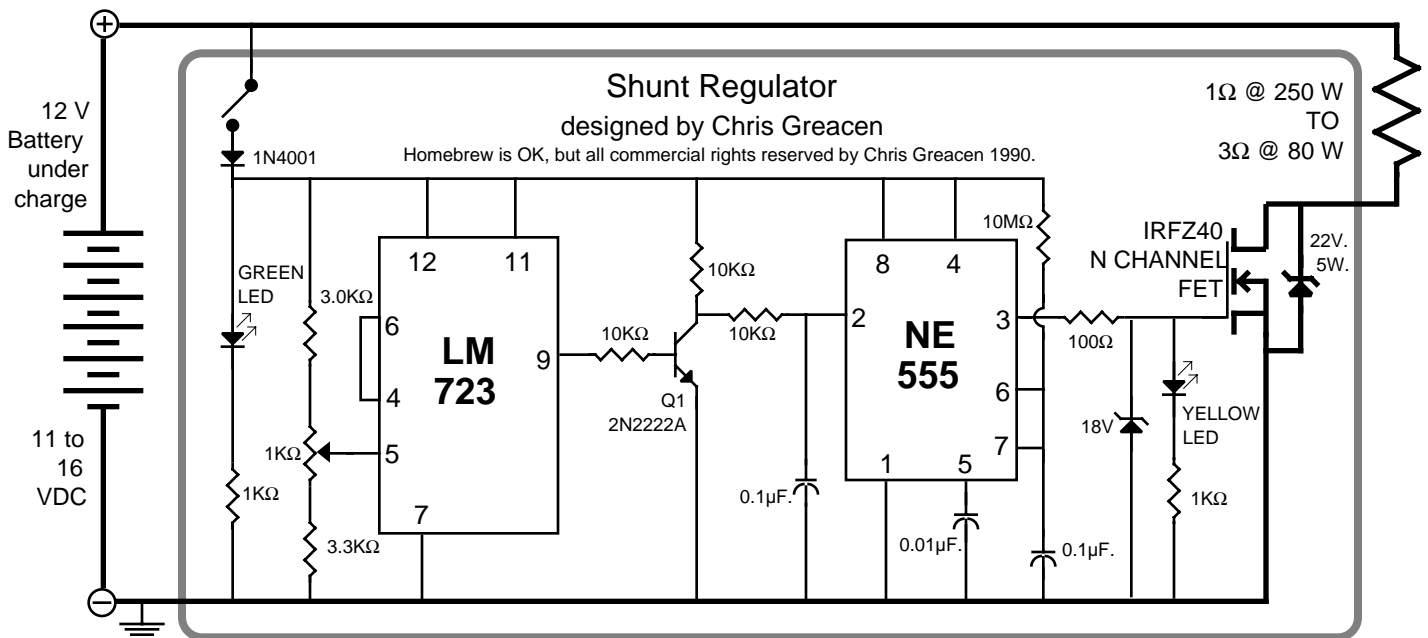
What follows is a working, simple shunt regulator. With a proper load, this shunt regulator can regulate up to 15 Amps (more than 3 Kyocera J-48 PV panels on a very sunny day).

### How it Works

The threshold voltage is determined by the potentiometer on the voltage divider into pin 5 of the 723 (refer to the schematic). When this voltage exceeds the 723's internal reference voltage (pin 6), pin 9 goes high saturating Q1. The 10kΩ resistor and 0.1μF capacitor assure that the power FET does not make the ON-OFF-ON transition too fast. When the capacitor on pin 2 is discharged to 1/3 Vcc the 555 is triggered and pin 3 stays high for a time period determined by the resistor to Vcc and capacitor to ground on pins 6 and 7: time ≈ 1.1RC ≈ 1.1 seconds. Pin 3 feeds the gate of the FET, protected against over voltage (Vgatemax= 20 Volts) by an 18 Volt zener. When the gate goes high the FET conducts, sending full current through the shunt load. A 5 Watt, 22 Volt zener diode protects against voltage spikes from inductive loads. The two LEDs help see what the electronics are doing. The green LED is on whenever power is on. The amber LED lights whenever the regulator is diverting power to the load.

### Construction and use information

In the schematic dark lines indicate high current carrying wires. To avoid overheating on these use 16 gauge or larger wire. For a load



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I suggest using high wattage power resistors since reliability of the load is the primary consideration. Using a bunch of car tail lights in parallel would also provide a good load since chances are excellent they will not burn out at once.  Here is an example for determining resistance and wattage. Suppose the maximum current I wanted to regulate was 15 Amps at 15 Volts. Since R = V/I we need a resistance of 15 Volts/15 Amps = 1.0 Ω. Wattage is given by P = IV. P = 15 Amps * 15 Volts = 225 Watts.  To be safe, I'd use 250 Watts.

When hooking up your regulator make sure the system's voltage is below 16 VDC since the NE555 is rated at a maximum 16 Volts. The regulator will regulate voltages from 12.0 to 15.8 Volts. When hooking up your shunt regulator it is a good idea to hook up the load first and make sure there are no short circuits.

**Access:**

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**For Power resistors:**

Hosfelt Electronics Inc. 2700 Sunset Boulevard, Steubenville, OH 43952; tel 1-800-524-6464