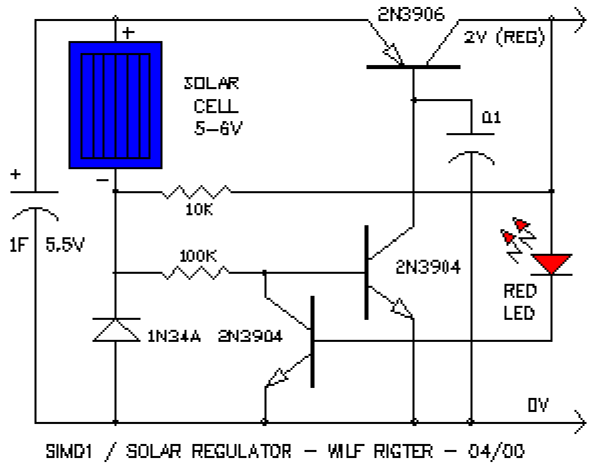
SIMD1 / SOLAR REGULATOR

The SIMD1 was enhanced in the Solar Regulator version which supplies a constant 2V after triggering and permits driving LEDs without using current limiting resistors with constant brightness. Note that you can use this Low Drop Out (LDO) linear regulator for various applications but like all linear regulators it is "lossy". This is not a problem for controlling LEDs since they would otherwise use "lossy" resistors but for motors it is a different story.

Try this new SIMD1 / Solar Voltage Regulator for use with blinking LED circuits (pummers). It turns on when it gets dark, just like a D1 but the output voltage is regulated to about 2V (depending on the reference LED Vf).

The SIMD1 / solar regulator circuit draws no current during charging and when turned on, it draws less than 100uA with a maximum 10ma output current. The regulator provides constant LED brightness during the discharge and turns off when 1F solar capacitor voltage drops below the LED turn on voltage.
The LED used for voltage reference in the solar regulator feedback loop and the LEDs used for the flasher must be the same high efficiency type to match the forward voltage specs. This circuit is ideal for supplying voltage to a Bicore or

74HC14 LED flasher since it eliminates the LED current limiting resistors and greatly reduces current consumption of the HC flasher circuits.



One interesting alternative would be to substitute a 5V NiCad (4 cell) battery for the 1F super cap which acts to increase the storage capacity many fold for use with flag waver motors, pendulums, etc. With higher load current, the 100K resistor may be replaced with 20K for up to 50 ma output current. The quiescent current of the regulator remains very low and is proportional to the load current for high efficiency operation during discharge.

CHARGING

The solar cell charges a 1F capacitor through a 1N34A Germanium diode to a maximum voltage of 5.5V. While the charging current flows through the diode the voltage at the cathode (stripe) is about 100 mV negative with respect to the 0 V line. This negative voltage is applied through a 100K resistor to the base of a

2N3904 NPN transistor Q1 and holds that transistor off. This cuts off the base current for the 2N3906 transistor (PNP) Q2 and the output of the regulator will be zero volts.

SWITCHING

Rapid switching is very important in this type of circuit because a circuit that is half on draws power, draining the capacitor, but performs no useful work. On the SIMD1/ Solar Regulator, the output snaps on and off.

At the end of the charging cycle, when the light on the solar cell decreases, the negative terminal of the solar cell starts to become more positive than the 0V line. The base of the NPN Q1 must be at about +500 mV (positive) with respect to the emitter which is connected to the 0 V line, before it turns on and turns on the rest of the regulator. That usually happens in the evening but can be simulated by cupping your hand in front of the solar cell.

When Q1 turns on, the PNP transistor 2N3906 - Q2 receives base current and it starts to turn on. The regulator output voltage at the collector of Q2 increases to about + 2V when the red LED starts to turn on and to supply current to the base of NPN transistor 2N3904 - Q3. When Q3 turns on it "robs" base current from Q2. This in turn controls the base current for Q2 and the regulator output will stabilize at +2 V. The 10K resistor from the regulator output to the negative terminal of the solar cell provides positive feedback to the regulator turn on by loading the solar cell down so that it's output voltage drops even more and the regulator "snaps" on. Note that the red LED is used for reference voltage only and does not actually light up.

DISCHARGING

The output voltage at the collector of Q2 remains at 2V while the voltage on the main capacitor can range from a full charge at 5.5V to 2.1V at the end of the discharge cycle. If no load is attached to the regulator the capacitor voltage will drop very slowly because of leakage and a small amount of current required for the active regulator (<50 uA). When a HC chip like a 74HC240 or 74HC14 is powered from the 2V regulated output, the current for that chip is also very low.

If the HC chip has a LED connected to the output which the same type of LED that is used for reference, then the current will be limited by a small voltage drop on the HC driver output. Since the regulated voltage is constant the brightness of the LED is also constant.

When the voltage on the 1F cap drops below 2V, the regulator reference LED turns off and the base currents of Q1 and Q2 increase discharging the remaining charge on the cap and turning any attached circuit rapidly off. At some point the voltage of the solar cell even in dim light is higher than the remaining charge on the capacitor and if there is sufficient light (usually in the morning) the charging cycle repeats all over again. If the Sun is bright and thesolar cell was shielded by your hand, then exposing the solar cell to the bright sunlight generates enough power to turn the regulator off and force the circuit back into the charging cycle.

Parts list for basic circuit			
Part	Solarbotics	Digikey	Radio Shack
Storage capacitor	various	various	various
Solar cell	various	N/A	N/A
2N3904 Transistor	$0.15, #TR3904	$0.26, #2N3904-ND	$0.07, #900-5456

The Power Saver Flasher uses capacitive output coupling to produce brighter shorter flashes and has a much lower average current drain than standard bicore or 74HC14 flashers. The PS Flasher with one LED circuit (2 LEDs) runs all night from a 1F cap charged to 5.5V. Up to 12 LEDs can be controlled with one 74HC14 flasher and probably would run for 2 hours from a full charge. Use a range of timing resistors between 1M and 4.7M for each oscillator to give a random light show appearance.

Source: http://www.solarbotics.net/library/circuits/se_noct_SIMD1SR.html