BUILD AN AUTOMATIC LINE VOLTAGE REGULATOR

When your line voltage nosedives, this circuit gives a 6-volt boost

BY HERBERT ELKIN *

DO YOUR lights go dim, does your TV picture shrink and lose brightness, or are your ac appliances acting as though they're just plain tired? You may be living in an area subject to "brownouts" (low power-line voltage), and the solution to your troubles could well be some form of voltage regulation.

The automatic line voltage regulator described in this article will automatically raise power-line voltage by about six volts whenever it drops below a preset level. When the line voltage returns to normal, the compensation automatically drops out. (See Fig. 1.)

Circuit Operation. Filament transformer *T1* is connected with its 6.3-volt secondary in series with the primary so that the two voltages add. Relay *K1* taps an output from the primary alone or from the combined windings. The remainder of the circuit senses the output voltage and sets (or resets) *K1* to switch the extra winding in or out as needed.

As can be seen from Fig. 1 and the waveforms of Fig. 2, capacitor *C1* follows the swings of the fraction of the power-line voltage developed across the *R2* portion of voltage divider *R1-R2*. Potentiometer *R2* is adjusted so that the peak voltage across *C1* just reaches the firing level of neon lamp *I1* when the voltage across *R1-R2* reaches the level where automatic compensation is not required. The neon lamp breaks down and applies a positive pulse to the gate of *SCR1*, causing the SCR to turn on and hold relay *K1* in the position that directs the normal line voltage to the output. The SCR, then turns off when the power-line voltage passes through zero. The neon lamp fires on each positive half cycle, allowing its glow to be used as a "normal" line voltage indication. During the negative half cycles, diode *D1* clamps *C1* to circuit ground, thus keeping the neon lamp "off" and preventing the negative pulse from being applied to the SCR gate.

Because its drive switches on and off at power-line frequency, relay *K1* would normally "chatter". Capacitor *C4*, connected across the relay coil, prevents this problem as it charges when the SCR fires to provide both filtering (due to rectification of the ac voltage by *SCR1*),

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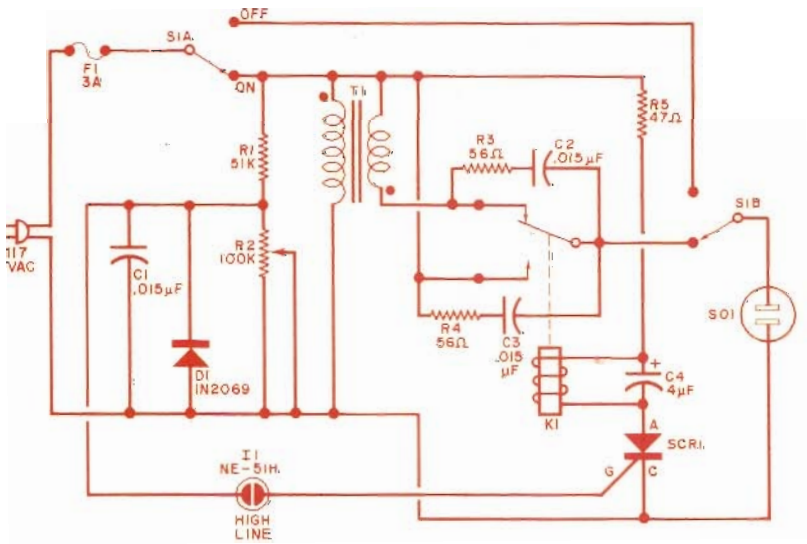


Fig. 1. When line voltage drops, K1 adds the 6.3-V secondary of T1 in series with the line to raise the output at S01.

PARTS LIST

C1,C2,C3—0.015-μF, 400-volt ceramic capacitor
C4—4-μF, 250-volt electrolytic
D1—1N2069, 1-ampere, 200-PIV rectifier
F1—3-ampere, slow-blow fuse with holder
I1—NE-51H neon lamp assembly (Dialco 95-0463-0931-211 or similar)
K1—2pdt, 48-volt, 2500-ohm relay (Sigma 62R2-48DC-SCO or similar)
R1—51,000-ohm, ½-W, 10% resistor
R3,R4—56-ohm, ½-W, 10% resistor
R5—47-ohm, ½-W, 10% resistor
R2—100,000-ohm, multi-turn pot.
S1—2pdt switch
SCR1—4-ampere, 200-PIV silicon controlled rectifier
T1—6.3-V 3-A, filament transformer
Misc.—Ac receptable (SO1), terminal strip, suitable enclosure, spacers, mounting hardware, etc.

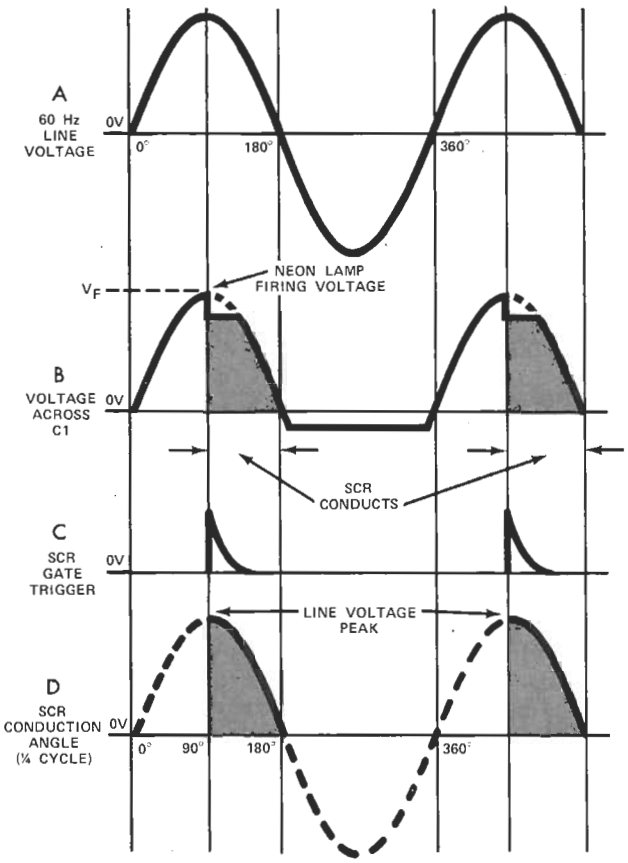
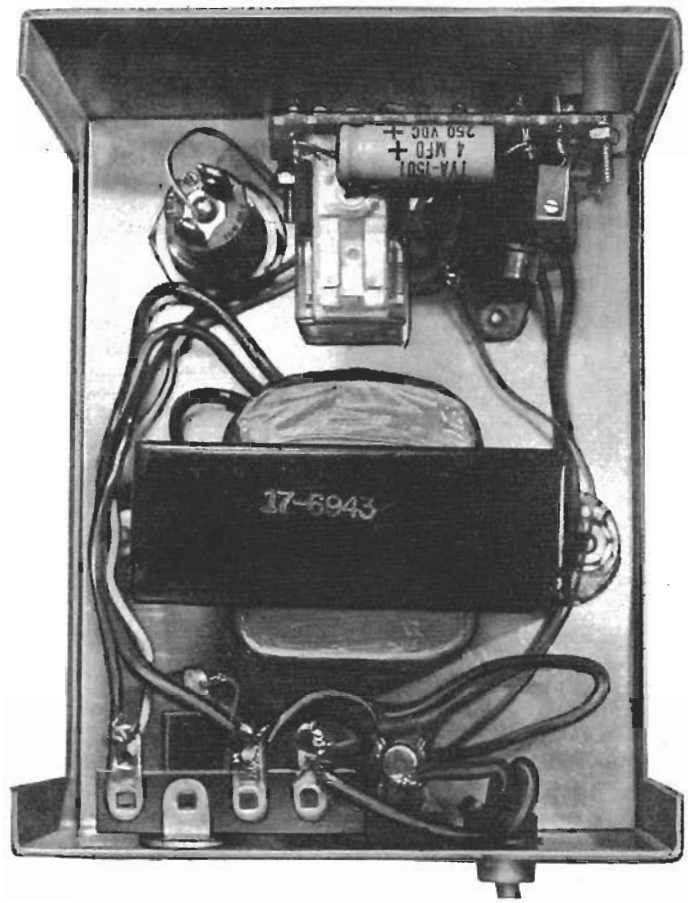


Fig. 2. Waveform at (A) is line voltage; (B) is voltage across C1; (D) is SCR conduction angle.



Interior photo of the prototype regulator. Components can be mounted on pc or perf board.

and relay-coil holding current when the SCR is off.

The networks consisting of *R3-C2* and *R4-C3* form arc-suppression circuits to minimize relay contact pitting, while *R5* limits SCR surge current to a safe value. Using the parts shown in Fig. 1, appliances drawing up to 350 VA can be controlled. For higher power, a larger transformer and a relay with heavier contacts can be used. Make sure that fuse *F1* is a slow-blow type to accommodate any turn-on surge currents. To bypass the compensation circuit, switch *S1* can be set to OFF.

Construction. With the exception of transformer *T1*, output socket *SO1*, neon lamp assembly *I1*, and on/off switch *S1*, all components can be mounted on a small pc board—or a perf board, using point-to-point wiring. The board can be mounted in any type of enclosure that can accommodate all of the components. The line cord exits through a grommetted hole.

A terminal strip with *nongrounded* lugs must be used for the transformer leads and ac power connections. If a metal enclosure is used, it is important that it be isolated from *both* sides of the power line to prevent a shock hazard.

The windings of *T1* can be phased using the setup shown in Fig. 3. Temporarily connect one secondary lead to one side of the primary as shown. Very carefully (to avoid shock), measure and note the voltage appearing across the transformer primary alone. This is the line voltage. Then measure the voltage across the combined primary/secondary and note that it is 6.3 volts higher. If the voltage indication is *less* than the noted line voltage, phasing is incorrect. Exchange the two secondary leads and repeat the above test. When the combined voltage is higher than the line voltage, you know that the transformer leads are properly phased.

Calibration. To adjust the low-voltage trip point, a source of variable line voltage is required. (A Variac or similar device will do.) Adjust the power-line input for 110 volts—or whatever voltage you wish the relay to trip at—and connect an ac voltmeter across the contacts of *SO1*. Vary potentiometer *R2* until neon lamp *I1* glows and note that as this happens the relay is activated, which means that the voltage is not boosted, and the ac voltmeter across *SO1* registers 110 volts.

Carefully rotate *R2* until the neon lamp just extinguishes and the relay de-energizes. The ac voltmeter across *SO1* should move up to approximately 116.3 volts. Slowly increase the input voltage level until the neon lamp lights and note that the ac voltmeter indicates about 112 volts. Set the trip point wherever you want it to occur.

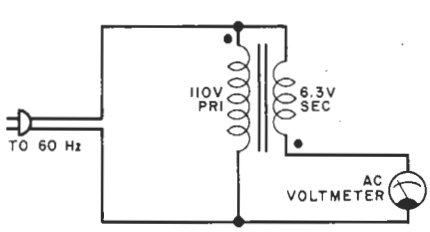


Fig. 3. Meter should read 6.3 V above line with transformer connected as shown.

In Conclusion. This project represents a simple, inexpensive way to provide some compensation for low power-line voltage. Its regulation is somewhat coarse, but is sufficient for most home appliances. Note that, since relay *K1* interrupts power briefly while switching in the booster winding, the circuit may not be suitable for use with sensitive devices such as computers or digital clocks. ◇