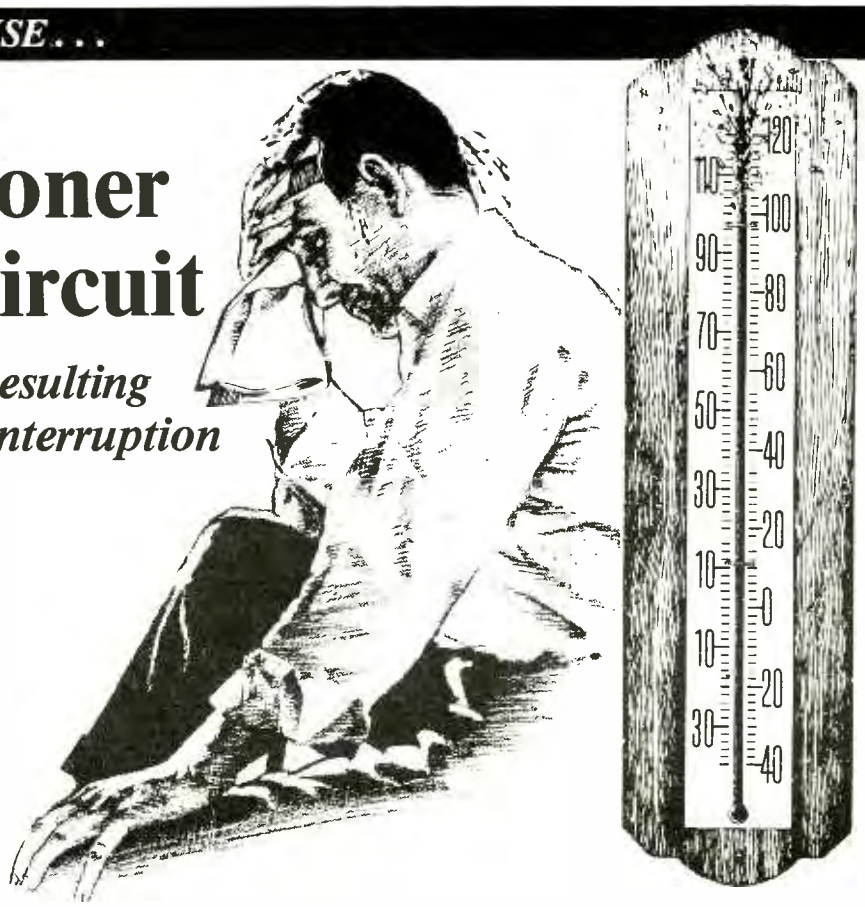
Air-Conditioner Protection Circuit

Prevents motor burnout resulting from momentary power interruption



By Dan Becker

Many home and industrial air conditioners—and some refrigerators—are not equipped to safely handle momentary interruptions in line voltage. Such an interruption can burn out an expensive compressor.

This damage is caused by excessive start-up pressure in the condenser coil restraining the electric compressor motor. The latter never gains the momentum necessary to shift into the lower current running phase. Under these conditions, the compressor motor does not pull enough current to activate a circuit breaker, but the motor does, unfortunately, draw enough current to cause it to rapidly overheat and burn out.

The circuit described here will protect any appliance requiring a line voltage post-interrupt delay. If you live in an area where power interruptions are frequent, this protection device can extend and electrical appliance's service life.

About The Circuit

The air conditioner protection circuit, shown schematically in Fig. 1, is designed around two key elements. Triac *Q2* allows the ac line voltage to be switched on or off. The 555 timer, used for *IC2* is the other key element. The circuit is designed to monitor the ac line for interruptions. Should the power fail, a preset, adjustable, delay will begin when power is restored. In addition, the circuit monitors the length of time the power is off. If the off time exceeds a preset maximum, power is switched on to the air conditioner plugged into socket *SO1* immediately when available.

The timing circuit is powered by a transformer-input regulated 9-volt negative dc supply. In addition, the supply regulator protects *Q2* from excessive gate current. Because the triac is switched on at low-level points in the voltage cycle, no detectable rfi (radio-frequency interference) is generated. With power being fed to the circuit, *IC2* operates as a monostable multivibrator.

When the circuit is initially powered up, *Q1* provides a path through which *C3* charges. Gate current of *Q1* is limited to a safe value by *R3*. In addition, *C3* cannot discharge through the gate, since discharge current is in the reverse-bias direction.

When an interruption in line voltage occurs, power to *IC2* is lost. However, *C3* remains charged, due to the high-impedance discharge path established by *R2* and *R9*. Because *R9* is variable, the time for *C3* to discharge can be controlled from a few minutes up to 30 minutes. If *C3* is still charged when line voltage is restored to the circuit, a negative trigger pulse from *C4* and *R4* trigger a pulse from the timer. This causes the output at pin 3 to go high, effectively connecting pin 3 to the neutral leg of the power line, for a period of time determined by the time constant of *C6, R7* and *R8*.

While pin 3 of *IC2* is high, *Q2*'s gate voltage is equal to that at main terminal one (MT1). Thus, *Q1* does not switch on. When a monostable pulse ends, pin 3 returns to its low state of −8 volts with respect to the neutral leg and *Q2* switches on. Resistor *R10* sets *Q2*'s gate current, which must be high enough to ensure complete and rapid turn-on or the triac could overheat.

Closing *S1* provides a delay override, enabling you to defeat the delay and immediately restore power to an air conditioner. Switch *S2* provides a reset that enables you to initiate a new delay cycle.

Construction

Because the circuit operates from the ac power line, it is imperative that you

PARTS LIST

Semiconductors
IC1—7908 8-volt regulator
IC2—555 timer
Q1—MPF102 or similar JFET
Q2—400-volt (see text for current rating) stud-mount triac.
RECT1—Low-voltage, low-current pc-mount bridge-rectifier assembly

Capacitors
C1—470-μF, 16-volt axial-lead electrolytic
C2—10-μF, 16-volt radial-lead electrolytic
C3—220-μF, 16-volt radial-lead electrolytic
C4—1-μF, 50-volt radial-lead electrolytic
C5—0.01-μF ceramic disk
C6—1000-μF, 16-volt radial-lead electrolytic

Resistors (5% tolerance)
R1—6.2 ohms, ½ watt
R2,R7—100,000 ohms, ¼ watt
R3,R4—10,000 ohms, ¼ watt
R5,R6—51 ohms, ¼ watt
R10—50 to 220 ohms, 2 watts (depends on triac used)
R8,R9—2-megohm chassis-mount potiometer or pc-mount trimmer potentiometer (see text)

Miscellaneous
F1—0.5-ampere fuse
I1—Panel-mount neon lamp with built-in limiting resistor
P1—3-prong ac plug
SO1—3-contact chassis-mount ac receptacle
S1,S2—Normally-open, momentary-action spst pushbutton switch
T1—12-volt, 200-mA pc-mount transformer (Radio Shack Cat. No. 273-1385 or similar)
Suitable enclosure; heat sink for triac; terminal strip with three insulated lugs; pc clips for fuse; knobs for potentiometers (2); heavy-duty 3-conductor ac line cord; heavy-duty stranded hookup wire; machine hardware; solder; etc.

Note: An etched and drilled pc board is available for $11.50 ppd from: Dan Becker, 101 Highland Dr., Chapel Hill, NC 27514. NC residents please add sales tax.

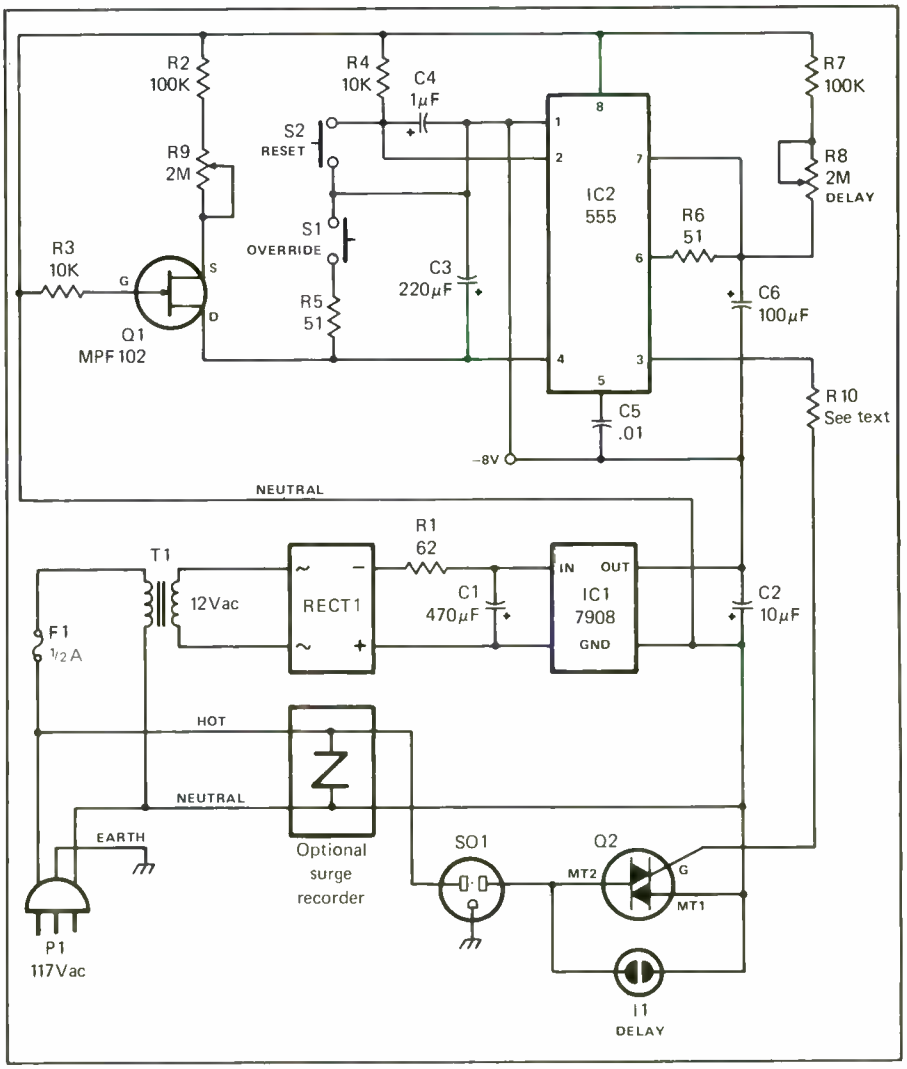


Fig. 1. Overall schematic diagram of the project.

observe standard electrical codes. This means using heavy duty three-prong power cord plug and socket. If the enclosure in which you plan to house the project is metal, it must be connected to the earth ground lead (center prong) of both the incoming and outgoing power cord. Secure each cord to the enclosure chassis with a cable lamp. Then connect both ground leads to the chassis with a crimp-on ring tongue.

Because a window air conditioner requires 12 to 20 amperes of current, a 30 ampere stud-mounted triac should be used for *Q2*. Because the triac must dissipate considerable heat, it must be mounted to a 30-to-50-watt heat sink. Also, if the triac does not have an electrically isolated stud, you must use appropriate hardware to insulate the heat sink from the chassis.

Connect the neutral lead from the incoming power cord to an insulated post of a terminal strip mounted to the enclosure, to which you also connect MT1 of the triac before soldering. In addition, connect the neutral lead to the primary of transformer *T1*. The neutral lead from the power cord that feeds the air conditioner connects to a second insulated post of the terminal strip, along with MT2 of the triac. Connect together the "hot" lead from both the incoming and outgoing power cords, using one of the remain-

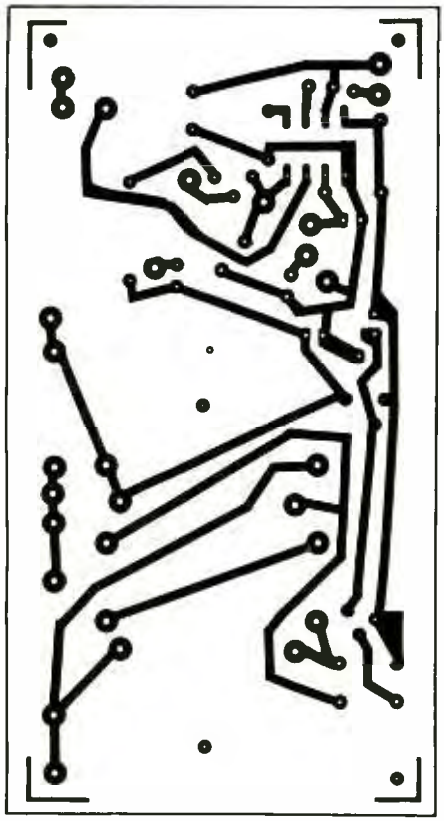


Fig. 2. Etching-and-drilling guide.

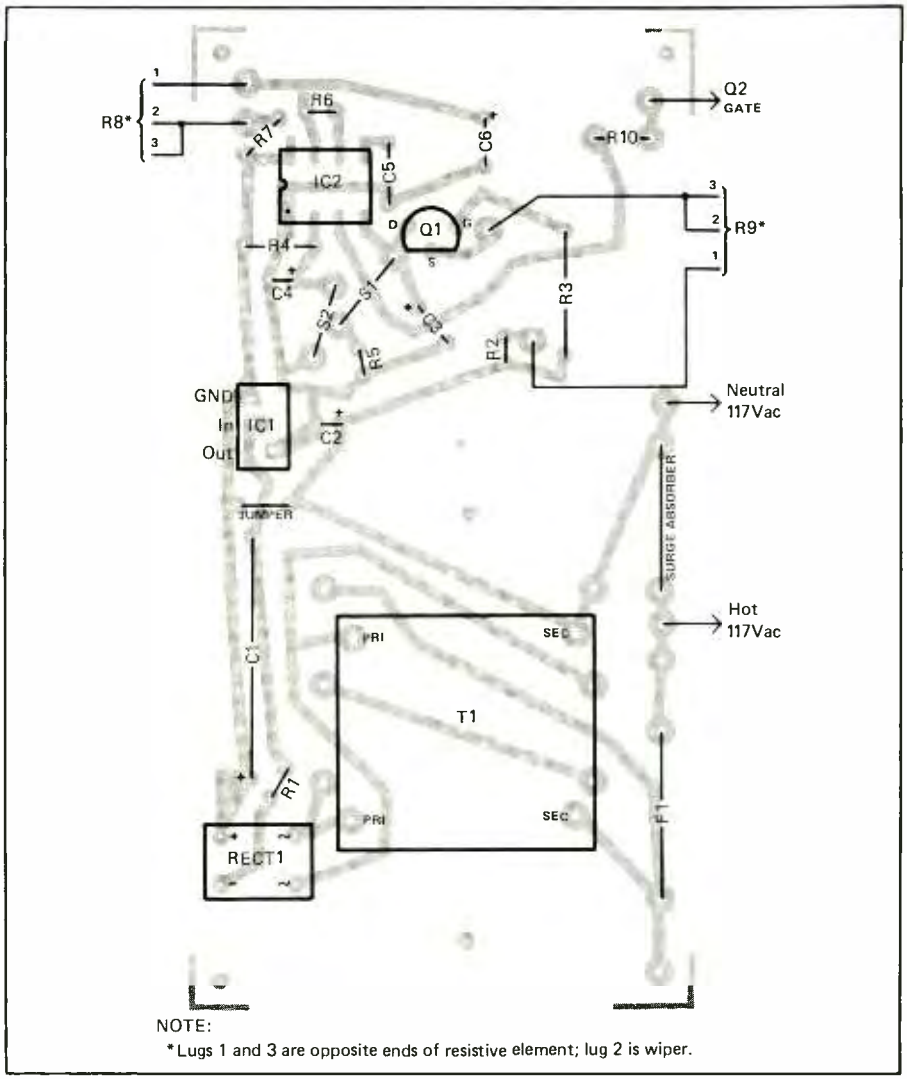


Fig. 3. Components-placement diagram.

ing insulated terminal-strip posts. Then run a heavy-duty stranded hookup wire from this connection to the fuse in series with the primary of the transformer.

Assembly of the timing circuit is best done on a printed-circuit board. You can fabricate your own pc board with the aid of the actual-size etching-and-drilling guide shown in Fig. 2. Alternatively, you can purchase a ready-to-wire pc board from the source given in the Parts List. Wire the board as shown in Fig. 3. Note that the potentiometers can be pc-mount trimmers or chassis-mount units. If the latter are used, connect a short length of hook-up wire between the wiper and left lugs (viewing the pots from the rear with the lugs pointing down). Run a pair of wires from the pc board to each control.

Checkout and Adjustment

Set *R8* and *R9* to their fully counter-clockwise (minimum-resistance positions). Plug a lamp, with its switch in the "on" position, into *SO1* and the project's plug into a 117-volt ac outlet. The lamp should immediately turn on.

Momentarly interrupt power to the project by pulling its plug from the ac outlet and then immediately replacing it. Neon DELAY indicator *I1* should light; after a 2-minute delay, it should extinguish. Repeat this test, but this time press the OVERRIDE button before the delay cycle times out.

Potentiometer *R8* controls the duration of the delay between the time power is restored to your home and to your air conditioner. Potentiometer *R9* sets the maximum time—during the power outage—that can elapse before a delay will no longer be provided. This is practical, because after several minutes, there is no need to delay starting your air conditioner. In other words, after a set time, an automatic override takes effect. The time delay can be preset for just a few minutes up to a maximum of about 30 minutes.

You are now ready to connect the protection circuit to your air conditioner. Make certain that the maximum current capacity of the triac exceeds the current rating of the air conditioner. **ME**