BY RUSSELL J. BIK

BUILD

DYNADIM II

DELUXE HOME-LIGHTING CONTROL

Featuring an automatic dim-to-off mode from a few seconds to a slow 40 minutes, as well as conventional preset-level dimming.

THE INTRODUCTION of SCR's and triacs into light-dimmer design advanced the state of the art from the dark ages of the giant rheostat to the compact home devices of today. The Dynadim II project described in this article represents the next logical step in dimmer development. It performs all the functions of standard light dimmers and also provides automatic dimming of room lighting at adjustable rates.

As a mood setter at parties, the Dynadim II can dim lighting from full on down to any preset holding level or all the way off at dim rates ranging from a few seconds to an imperceptibly slow 40 minutes. The same slow dimming can serve as a sleep inducer by helping you to relax. It's especially handy to have around when the kids insist that the lights be left on after they are put to bed.

Shorter timing cycles can be applied to applications like providing a professional touch to the presentation of home movies and slides by bringing down the "house" lights while you attend to the projector.

How It Works. The Dynadim II circuit shown in Fig. 1 is designed to work in series with the ac power source and the load via the ac input terminals. The power to the load is regulated by triac *Q3* that acts as an ac switch that closes at some point during each alternation of the input power and opens automatically each time the voltage passes through the zero point. The point in the alternation where *Q3* is triggered into conduction determines how much power is supplied to the load. If triggering occurs early in the cycle, the controlled light glows at a higher average intensity than if triggering occurs later.

Fig. 1. Unlike a conventional light dimmer, the triac (Q3) is gated later and later in the power-line cycle as C1 discharges. Dimming time is controlled by varying discharge time to C1

PARTS LIST

C1—100-μF, 15-volt electrolytic capacitor
C2—0.01-μF, 50-volt capacitor
C3—0.01-μF, 200-volt capacitor
D1 through D4—1-ampere, 200-PIV rectifier diode
D5—12-volt zener diode (1N4742 or similar)
D6,D7—1N914 diode
L1—Line filter inductor approximately 100 μH at 4-amperes)
Q1—2N4860 field-effect transistor
Q2—2N4871 unijunction transistor
Q3—200-volt, 6-ampere triac ECC Q2006L4
R1—6800-ohm, ½-watt, 10% resistor
R2,R11—470-ohm, ½-watt, 10% resistor

R3—5-megohm slide potentiometer
R4,R6,R8—10,000-ohm, ½-watt, 10% resistor
R5,R12,R13—15-megohm, ½-watt, 10% resistor
R7—50,000-ohm slide potentiometer
R9—470,000-ohm, ½-watt, 10% resistor (see text)
R10—1-megohm, ½-watt, 10% resistor
S1,S2—Spst slide switch
T1—Pulse transformer with 1:1 ratio (Sprague No. 11Z12)
Misc.—Printed circuit board; suitable chassis box with cover; insulator (goes between pc board and box); felt strips;

knobs for slide pots; bus wire; machine hardware; solder; etc.
(The following items required only for portable table version of dimmer: 12' "remote-control" extension cord; right-angle strain relief; four rubber feet.)
Note: The following items are available from Celltronix, 1239 Old Bayshore Hwy., San Jose, CA 95112: Etched and drilled pc board for $5.50; complete kit of parts, including chassis box, in wall-mount version for $24.95 and in table version for $26.95. California residents, please add sales tax.

To send Q3 into conduction, a trigger pulse is applied to the gate of the triac by the discharge of C2 through Q2 and the primary of T1. The time constant of C2 and its resistors is rather long compared to the period of a single ac alternation. The values given in Fig. 1 were selected so that the potential across C2 just barely attains an amplitude sufficient to drive Q2 into conduction when the voltage across C1 is zero and R7 is set for minimum bias on Q1.

Closing S1 causes C1 to charge through R2 and D6, thereby increasing the bias on Q1 and allowing C2 to charge more quickly with each alternation of the ac power cycle. As a result, the Q2 oscillator circuit produces the triggering pulses for the triac earlier in the cycles, and the controlled lights brighten.

An earlier triggering can also be obtained by adjusting the R6-R7 voltage divider. The effect on the bias of Q1 is the same as raising the potential across C1, except that a static control over lighting intensity is obtained to set threshold levels.

The automatic dimming feature is obtained by opening S1 and allowing C1 to slowly discharge through R3 and R4. This causes the lighting to diminish gradually as the triggering pulses to the triac are produced later and later in each cycle.

The high resistance required to prevent the voltage from being too rapidly shunted away from C1 is provided by using a field-effect transistor as Q1 and a very high resistance in its gate circuit.

The rectified power applied to the timing circuit by the diode bridge

made up of D1 through D4 is maintained at a constant 12 volts, regardless of load, by zener diode D5. The filtering network made up of C3 and L1 reduces interference to the AM broadcast band caused by triac switching transients.

Construction. To keep the dimmer as slim and compact as possible, it is recommended that you build it on a printed circuit board. An actual-size etching and drilling guide and component placement diagram are shown in Fig. 2. Note that the entire circuit, including controls and switches, mount directly on the pc board. To avoid lead breakage from vibration, it is best to epoxy T1 to the board. It is also advisable to mount R1 about ¼" (6.4 mm) above the surface of the board to assure good heat transfer.
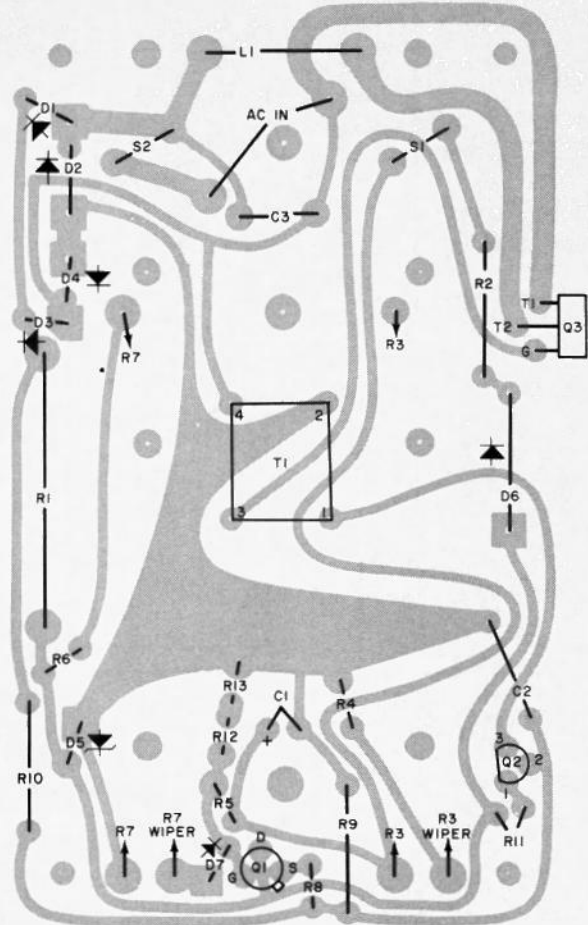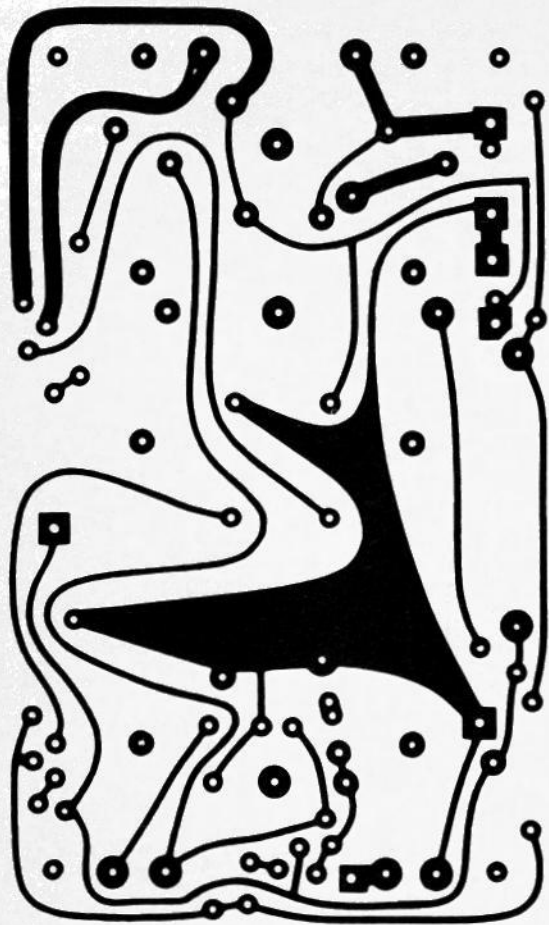
Fig. 2. Actual-size etching and
drilling guide is shown above
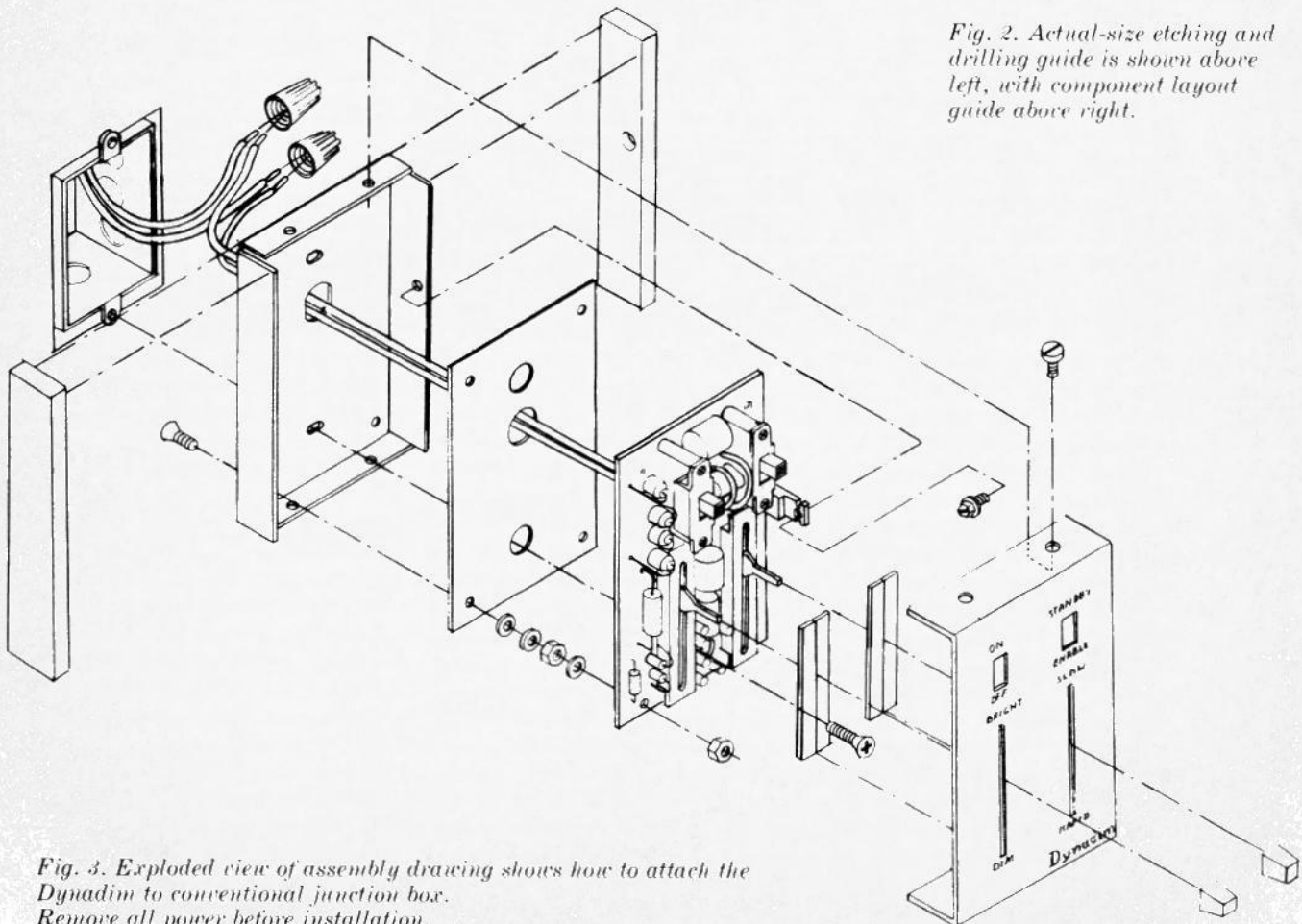left, with component layout
guide above right.

Fig. 3. Exploded view of assembly drawing shows how to attach the
Dynadim to conventional junction box.
Remove all power before installation.

The triac ($Q3$) specified in the Parts List has an electrically isolated heatsink tab that can be bolted to the metal cover to provide good heat sinking. If you use any other type of triac, an insulating mounting kit will be required.

After wiring the board, check it over for possible solder bridges between foil traces and to ascertain that all components are properly installed and polarized. To avoid leakage problems in the high-impedance circuit around the two transistors, remove all rosin and clean the board thoroughly with alcohol.

It is important that the leakage of $C1$ be minimized and that $Q1$ be properly biased to obtain the full 40-minute time delay. The leakage through an electrolytic capacitor is inversely proportional to the number of hours it is charged. This process is cumulative over the life of the capacitor. A dramatic reduction in leakage will occur during the first few hours of operation; improvement continues into the thousands of hours. (Note: The capacitors supplied with the kit listed in the Note under the Parts List come burned in. If you buy new capacitors locally, you can burn them in once they are mounted in the project simply by leaving the dimmer turned on in the standby mode.)

The value of $R9$ was selected to provide optimum bias for the nominal specifications of $Q1$. However, differences in individual transistors may have to be compensated for by changing $R9$'s value. Raising the resistance increases the apparent length of the timing cycle until a point is reached where the controlled light will not turn off even if $C1$ is discharged. The ideal value for $R9$ is just below the point at which this begins to occur.

You can mount the dimmer in a permanent wall mounting (at a lightswitch junction box) or in a separate box for portable table use. The assembly details for the junction-box approach is shown in Fig. 3. Note that the dimmer is connected in *series* with the load. Make sure that all electrical power is removed from the junction box before attempting to install the dimmer.

Mount the pc board assembly inside a form-fitting enclosure, with a thin insulator between the bottom of the board and the metal rear section of the box. The metal cover should have cutouts for the slide shafts of the potentiometers and switch toggles. Short lengths of felt fabric can be used be-

tween the inside of the front panel and the tops of the slide pots to keep out dust and other foreign material. Cement these strips in place so that they just touch each other in the two slider hole locations.

When you make the hookup to the ac line in the junction-box installation, be sure to use wire nuts for the connections.

Drill the rear wall of the dimmer's box so that it can be mounted directly on the junction box via the latter's switch mounting screws. (The original junction-box switch will no longer be needed.) In this manner, the complete dimmer can be affixed to the wall to eliminate the crowding that would exist if the entire circuit were to be "squeezed" into the junction box.

If you prefer to make your dimmer a table model, the same four screws that mount the circuit board to the box can be used to secure rubber feet to the bottom of the box in which the project is housed. In this configuration, a 12' (about 4-m) long "remote-control" extension line cord should be used to allow maximum flexibility. The lamp to be dimmed then plugs directly into the cord, which also plugs into the ac receptacle.

Using the Dimmer. For conventional control of lighting, it is recommended that the dimmer control be left in the full BRIGHT position and that the lights be controlled with the ON/OFF switch. When the dimmer is left on for long periods of time, a slight warming of the chassis will be noted. This is normal and should cause no apprehensions.

For dimming action, if you wish the lights to be full on and extinguish automatically to a very dim glow over a period of, say, 10 minutes, the procedure would be: First set the timing and dimming controls to DIM and RAPID and the STANDBY/ENABLE switch to ENABLE. The lights will extinguish quickly. Adjust the dimmer control to the position that gives the desired minimum illumination. Set the timing control to a position about four divisions above RAPID, $S1$ to STANDBY, and (when ready to initiate the dimming action) switch to ENABLE. The lights will begin slowly to dim to the preset level.

Although the Dynadim II itself draws very little power (about as much as an electric clock), it is advisable to turn it off when convenient. This will ensure maximum component life. ◈