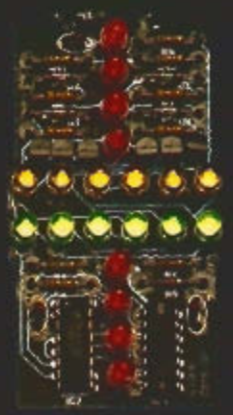
HIGH TECH XMAS ORNAMENTS



Add an electronics theme to your Christmas decorating with the Visible Components.

RON HOLZWARTH

CHRISTMAS WOULDN'T SEEM COMplete without at least one electronics project to add a little holiday spirit. This year, build the Visible Components, three light-up ornaments that take on the appearance of three common component symbols: a resistor, capacitor, and inductor. The Visible Components, and definitely worth adding to your Christmas ornament collection.

The Visible Components are surefire conversation pieces, and they are a great way to show off your Christmas spirit. After the holidays are over, the ornaments can decorate your workbench, office, or automobile, letting everyone know about your interest in electronics.

Flash patterns

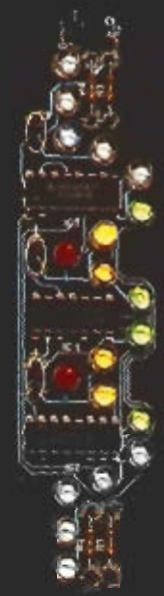
Each visible component has several LEDs that light up in the pattern of the actual component's schematic symbol. But rather than each visible component having a simple flashing, alternating, or light-chasing illumination pattern, each one lights up in a way that mimics that component's operation in an actual circuit. Let's see exactly what that means.

In an actual resistor, current moves at a constant rate through the component. In other words, the component has a linear I-V relationship. That is represented on the visible resistor by having light sweep through the LEDs at a continuous rate for three cycles and then turning off. The cycle then repeats again after a few seconds. The number of cycles during which light sweeps through the LEDs can be varied by changing certain component values.

Resistors do not store energy in an electric field, as do inductors and capacitors. To illustrate that, no LEDs are on during the off state.

A capacitor can store electrical energy while in a static state. This is illustrated on the visible capacitor by having the six LEDs that represent the lower plate of the capacitor remain lit during the off cycle. After a few seconds, the bottom plate dims completely and the top plate then lights. The following clock cycles successively turn off the outer LEDs of the top plate, and the bottom plate begins to light again indicate a buildup of charge.

The visible inductor has two display sections, the coil itself and the leads. An electromagnetic field striking the coils of the inductor is illustrated by sweeping the ten coil LEDs sequentially.



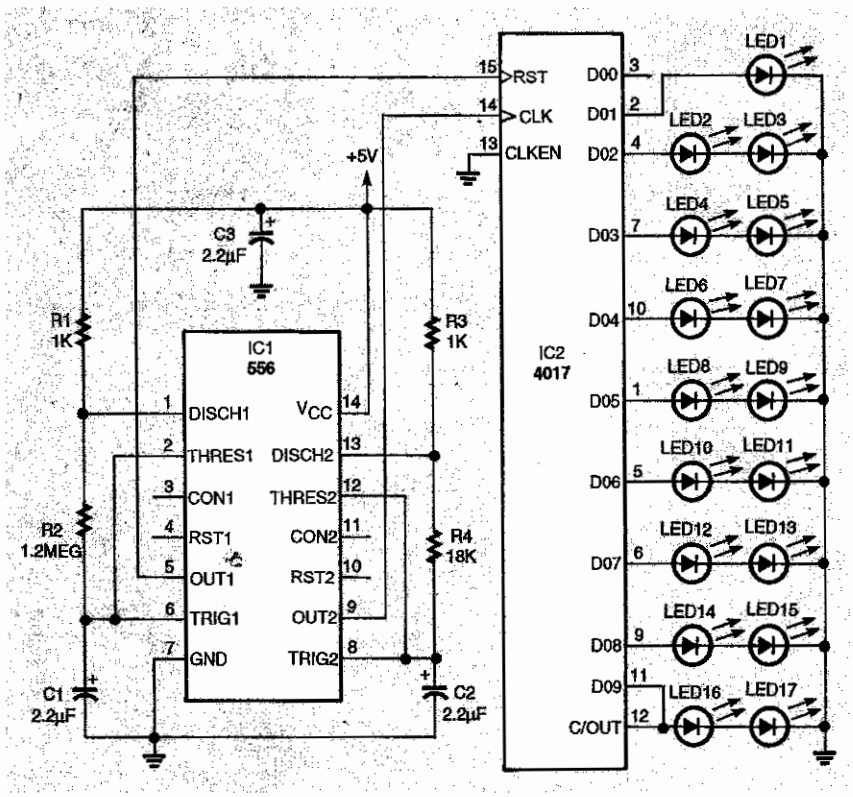


FIG. 1—VISIBLE RESISTOR SCHEMATIC. This circuit drives 17 LEDs in a pattern that represents current flow through a resistor.

Circuitry

All three visible compo share some common circu Each is controlled by an LM556 dual timer IC and a CD14017 decade counter. Also, all three can be powered from a single 12-volt DC wall transformer. For the sake of discussion, we'll first examine the visible-resistor circuit shown in Fig. 1.

The reset time is controlled by one timer, IC1-a, whose timing components are C1, R1 and R2. The clock cycle time is set by the other timer, IC1-b, which uses timing components C2, R3, and R4.

The electrical differences between the visible components are the manners in which the decade counter is controlled by reset timer IC1-a.

In the visible resistor, the output at IC1-a pin 5 is connected to the RESET input (pin 15) of the decade counter (IC2). As long as the RESET line is held high, IC2 will not cycle and will keep pin 3 high. Since there is no LED connected to pin 3, no LEDs will be

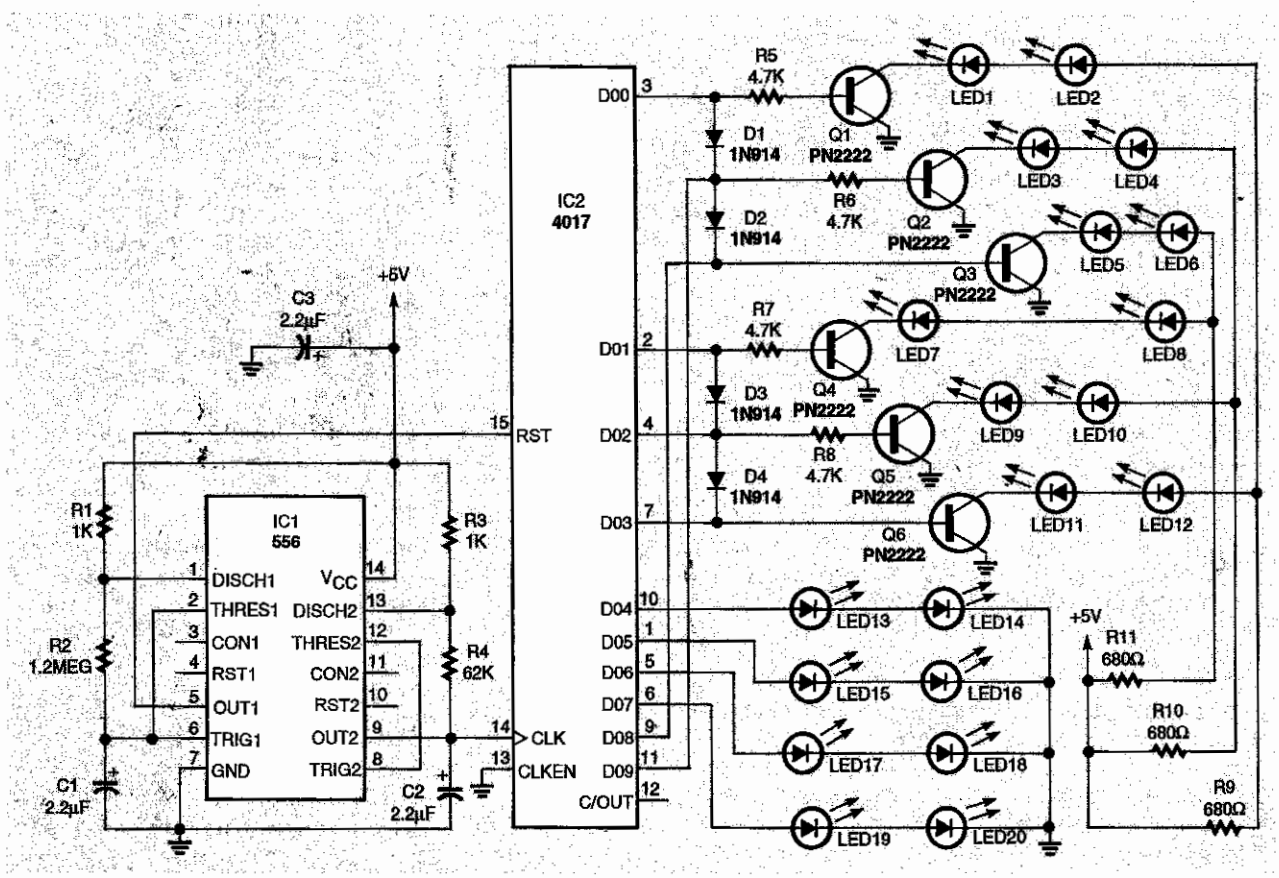


FIG. 2—VISIBLE CAPACITOR SCHEMATIC. This circuit drives 20 LEDs that are laid out in the pattern of a capacitor symbol.

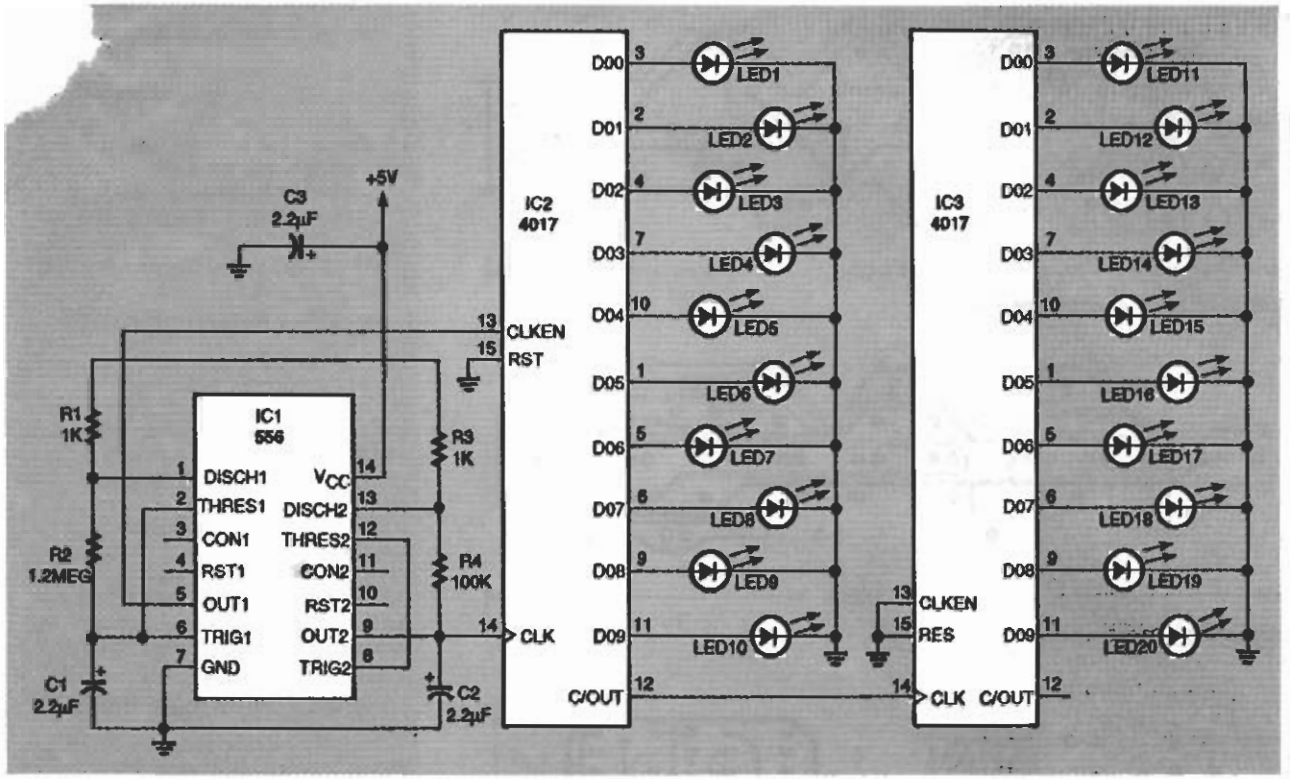


FIG. 3—VISIBLE INDUCTOR SCHEMATIC. The 20 LEDs in this circuit represent the coils of an inductor.

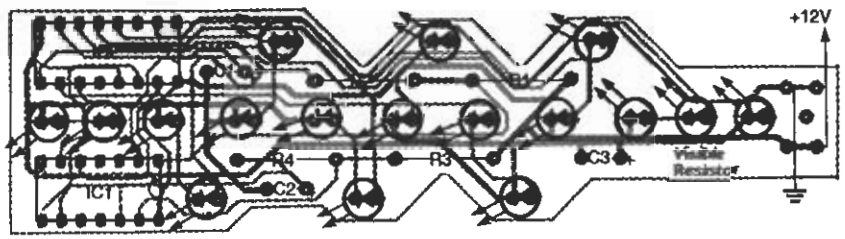


FIG. 4—VISIBLE RESISTOR PARTS PLACEMENT. The LEDs can be mounted on either side of the board as long as the cathode side points toward the power-supply leads.

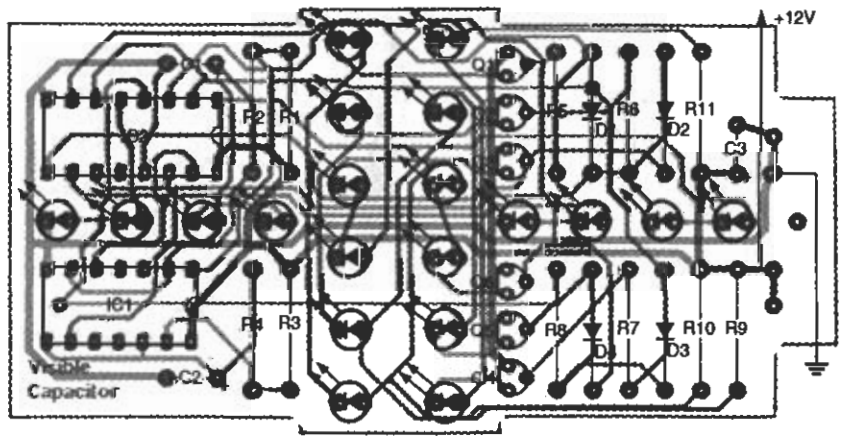


FIG. 5—VISIBLE CAPACITOR PARTS PLACEMENT. You can choose whatever colors you like for the LEDs.

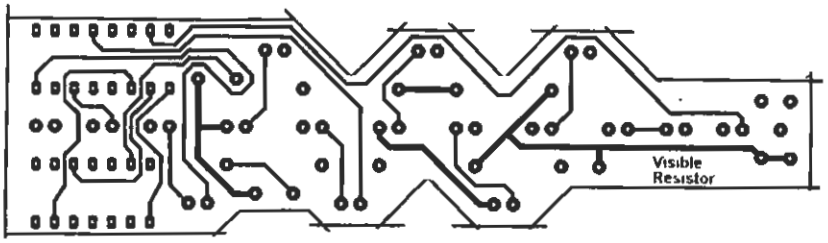
on at this point. When RESET goes low, IC2 will begin its count and repeat until it is again reset.

On the visible capacitor, shown in Fig. 2, pin 3 of IC2 is connected to the base of Q1 (through R5) and also the anode of D1. When pin 3 is high, Q1 will turn on, lighting LED1 and LED2. Each of the current-limiting resistors (R9–R11) are shared by two sets of two LEDs on different sides of the visible-capacitor plate. The ¼-watt resistors are sufficient because they have to supply current to only one set of LEDs at any time.

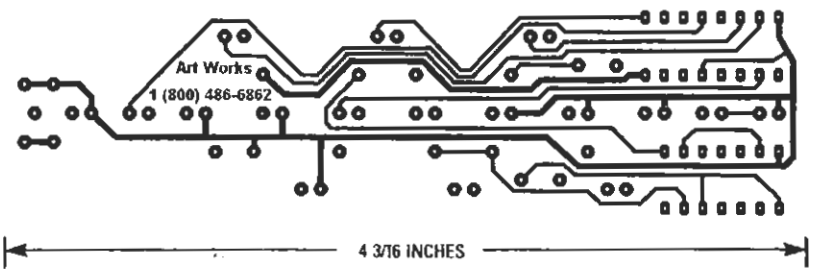
Steering diode D1 directs current to the base of Q2 and Q3, so that they also light their respective LEDs when one output is high. The diodes prevent illumination of adjacent LEDs, so that the outer LEDs are extinguished as the clock counts continue. The diodes are reversed for the other capacitor plate so that the LEDs illuminate from the center outward.

On the visible inductor, shown in Fig. 3, the IC1-a output (pin 5) controls the CLOCK ENABLE input (pin 13) of IC2. Since IC1-a's RESET line is never pulsed high, the LEDs stay in the state they were in when the CLOCK ENABLE input went high. The CARRY output of IC2 (pin 12) provides the clock signal for IC3. Each complete cycle of IC2 results in the advancement of only one output of IC3, and so 99 steps are required for IC3 to make a complete cycle.

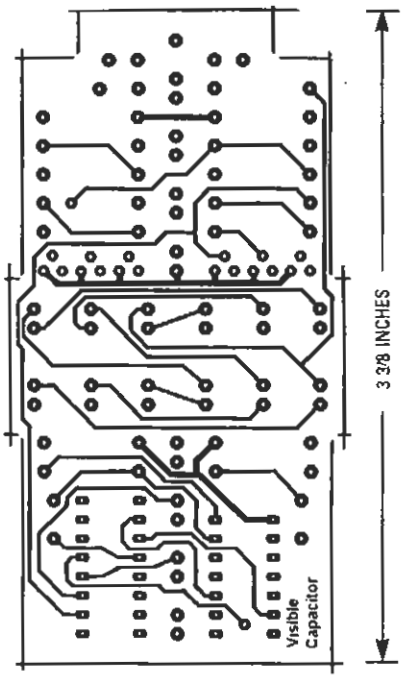
Timing resistors included in



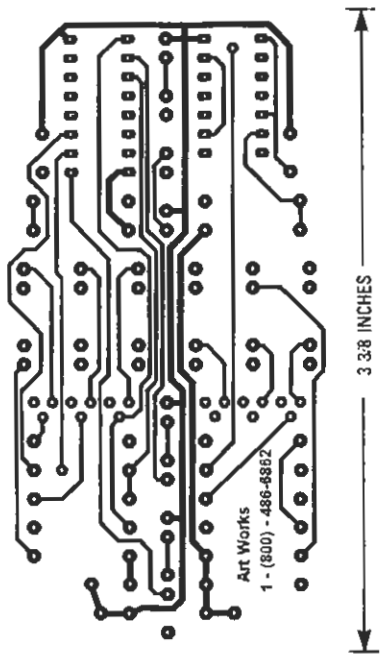
VISIBLE RESISTOR component side.



VISIBLE RESISTOR solder side.



VISIBLE CAPACITOR component side.



VISIBLE CAPACITOR solder side.

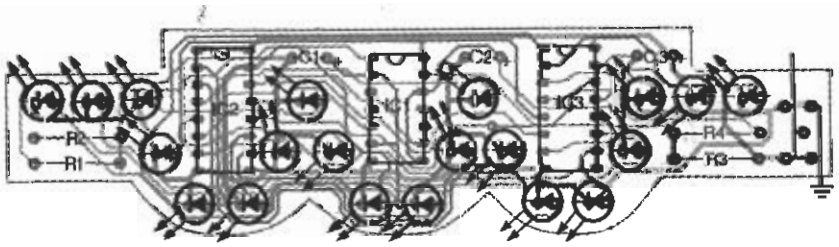


FIG. 6—VISIBLE INDUCTOR PARTS PLACEMENT. Mount the LEDs last, so they're not in your way when installing the other components.

VISIBLE RESISTOR PARTS

R1, R3—1000 ohms, ¼-watt, 5%
R2—1.2 megohms, ¼-watt, 5%
R4—18,000 ohms, ¼-watt, 5%
C1–C3—2.2 µF, 25 volts, tantalum
IC1—LM556 dual timer
IC2—CD14017 decade counter
17 LEDs (any color), 12-volt DC 300-mA wall transformer (one is sufficient to power all three visible components), PC board, wire, solder

VISIBLE CAPACITOR PARTS

R1, R3—1000 ohms, ¼-watt, 5%
R2—1.2 megohms, ¼-watt, 5%
R4—62,000 ohms, ¼-watt, 5%
R5–R8—4700 ohms, ¼-watt, 5%
R9–R11—680 ohms, ¼-watt, 5%
C1–C3—2.2 µF, 25 volts, tantalum
IC1—LM556 dual timer
IC2—CD14017 decade counter
D1–D4—1N914 diode
Q1–Q6—PN2222 NPN transistor
20 LEDs (any color), 12-volt DC 300-mA wall transformer (one is sufficient to power all three visible components), PC board, wire, solder

VISIBLE INDUCTOR PARTS

R1, R3, R4—1000 ohms, ¼-watt, 5%
R2—1.2 megohms, ¼-watt, 5%
C1–C3—2.2 µF, 25 volts, tantalum
IC1—LM556 dual timer
IC2, IC3—CD14017 decade counter
20 LEDs (any color), 12-volt DC 300-mA wall transformer (one is sufficient to power all three visible components), PC board, wire, solder

ORDERING INFORMATION

Note: The following items are available from Art Works, 415 E. Emerson Street, St. Francis, Kansas 67756:

- **PC board for any single visible component (specify choice of resistor, capacitor, or inductor)—$12.00**
- **Set of three visible component PC boards (one of each)—$30.00, or $25 each when buying three or more sets**
- **Complete visible component kit including three PC boards, power supply, and 57 LEDs (specify choice of LED colors; red, green, yellow, or mixed)—$65.00, or $55.00 each when buying three or more kits**
- **Assembled string of three visible components (specify colors desired)—$75.00**

All prices include taxes, shipping, and handling. Visa/Mastercard orders call (800) 486-6862, 24 hours a day. For technical assistance call (913) 332-2726. Foreign orders require a bank check or postal money order in US funds and will be shipped air mail at no extra cost.

the kit available from the source mentioned in the parts list are supplied as fixed units with the values specified in the parts list.

If you would like to experiment with different timing-resistor values, the kit also includes an adapter board that lets you substitute multiturn potentiometers for fixed resistors. That will be useful if you are not sure what flash rates you want.

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:BLE COMPONENTS

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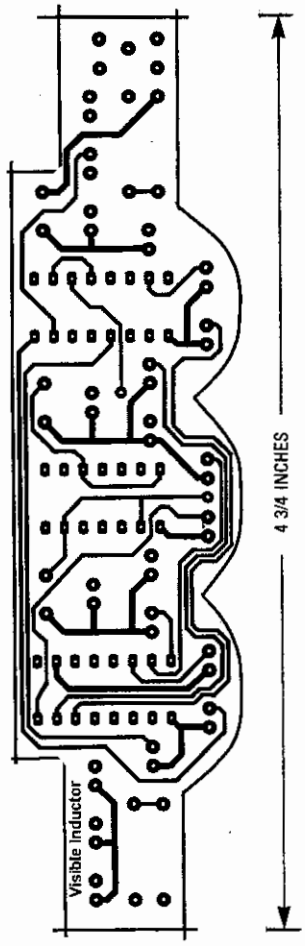
Construction

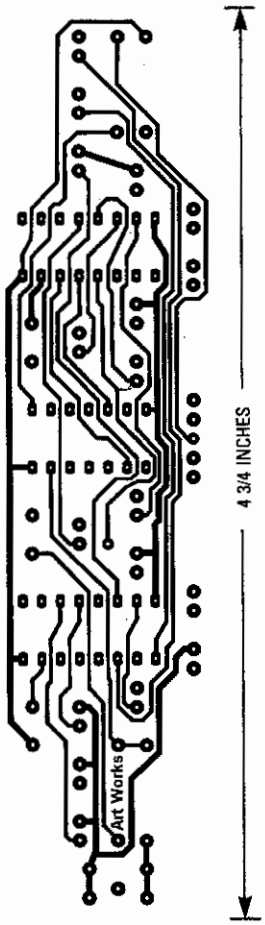
Assembly of the visible components is not difficult. Although you can build the circuits on perforated construction board, PC boards will provide a better appearance. Perfectly shaped component outlines are difficult to achieve when laying out the parts by hand. Parts-placement diagrams for the visible resistor, capacitor, and inductor are shown in Figs. 4–6.

A solder mask on the commercially available boards covers all runs and feedthroughs on both sides of the board, so that solder shorts are easily avoided. The solder mask gives the PC boards their color; the component sides of the boards are blue, and the solder sides are green.

Install the LEDs on each board last, as it will be more difficult to solder the other components in if you have to work around the LEDs. The LEDs are installed on all three boards with the cathode lead (the flat side) pointing away from the power-lead connections. The LEDs can be installed on either side of the board depending on whether you want your completed visible component to have a blue or green background. The LEDs can be any color available. You can specify LED colors when ordering.



VISIBLE INDUCTOR component side.



VISIBLE INDUCTOR solder side.

Once the LEDs are in place, solder the +12-volt and ground wires to the appropriate points as labeled on the PC board. Two sets of power pads are included on each board, and either set of holes can be used. The extra pair of holes are for stringing all three (or more or less) visible components together so that they can be draped around a tree or along a wall. After you're done soldering, check for correct component placement and good solder connections. Ω