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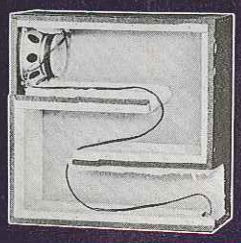

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A LOOK AT THE PC MARKET

KITS AND BASIC MATERIALS SIMPLIFY MAKING PRINTED CIRCUIT BOARDS AT HOME

BY ALEXANDER W. BURAWA

ANY HOBBYIST who has ever worked with integrated circuits and other miniature components knows that the printed circuit board offers the only realistic approach to assembling a project containing these devices. Traditional point-to-point wiring is clumsy, inefficient, unsightly, and potentially dangerous to the new breed of delicate components used by hobbyists.

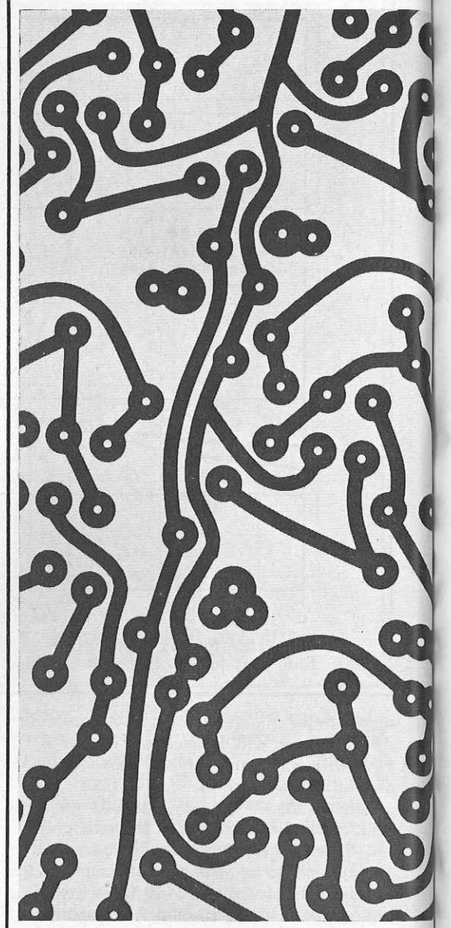
Yet, until a few years ago, materials for making printed circuit boards in the home workshop were difficult to come by. Often, materials had to be bought piecemeal; etchant here, board blank there, and resist another place. Some experimenters were very ingenious in their searches. Resist, usually the most difficult material to come by, took many forms, from nail enamel to China markers. Needless to say, results were crude.

In just three years, the situation in PC board materials has changed drastically. Now, every major mail-order house and most local electronic parts dealers are stocking a full line of PC materials, including kits. One need only order from a catalog or pick off a shelf anything he might need to fabricate any type of PC board in his home workshop.

The printed circuit kit offers the hobbyist his best dollar value. Here, the purchaser receives several items which, if bought separately, would undoubtedly cost him considerably more than the asking price of the kit. For the avid hobbyist who makes many projects a year, on the other hand, considerably greater savings can be effected if materials are bought in quantity—etchant in gallon and five-gallon bottles, large board blanks instead of several small ones, etc.

In the kit area, there are many offerings. The most basic PC kits contain at least one or more board blanks, one or more of several types of resist, etchant for removing from the board unwanted copper, and an etching tray which is usually the plastic tray in which the kit is packaged. In addition, some basic kits include one or more of the following items: resist remover, board cleaner, small drill, design paper, stencil cutter, etc.

In classifying a PC kit as "basic," we refer to the finished printed circuit board which it is capable of producing and not its price (although most maufacturers price their kits accordingly). Hence, our term "basic" refers to the fact that such a kit is primarily intended for the beginner and the hobbyist whose interests lean towards simple, non-critical projects.



A basic kit will yield varying results, according to the experience of the user. Working only with the materials provided in the kit, most non-IC projects should present no difficulties. The projects using IC's —especially the DIP's, or dual in-line packages—will require some talent in translating the original design into a usable printed circuit board on which the closely spaced conductors and solder pads nearly touch.

Generally speaking, the basic printed circuit board kit (containing those items mentioned above) will provide excellent results every time if its limited materials are not taxed. The suggestion here is that if you plan to work with IC's and other components that demand more rigid control over the etching and drilling steps, it is better to move up to one of the so-called "lab" PC kits that are designed to cope with more precise demands.

As far as we have been able to determine, most printed circuit board kits fall into either the basic or the lab category with only one in the intemediate category. There is, however, no disadvantage to this step adopted by the industry since even intermediate hobbyist projects tend to take advantage of a potpourri of solid-state devices, including IC's.

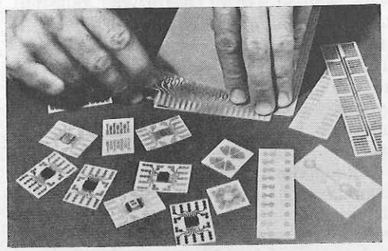
Although not all lab-type kits contain the same list of materials, there are certain items that are common to all of them. Among the standard items are various sizes and types of board blanks (clad on one or both sides, employing phenolic or epoxy-glass bases, photo-sensitized and unsensitized, and perforated and blank), etchant resists (usually a combination of the various types available), and etchant. While the list so far resembles that of the basic kit, the lab-type kit contains considerably more of each item. Then there are the other items in the kit which are designed to assure professional results.

Almost without exception, the lab-type PC kit features a dual-resist system. The primary system is based on a photographic technique in which a foil pattern "negative" is used to "expose" the photo-sensitized board. The negative itself is made from materials supplied, or it can be carefully drawn on a white background with India ink and submitted to a professional photographer to be make into a film negative. The latter approach, of course, will yield the best results and allow for finer detail.

In most cases, the exposing medium in an intense white light source or a medium-wave ultra-violet source (for the former, most kits also supply a photo-flood lamp). To prevent the negative from slipping around during exposure, and to keep it flat against the board blank, most kits also contain a plate glass sheet or jig that is used to clamp the two together.

Once the board has been exposed, it must be immersed in a developing solution (also supplied) to remove the resist over the areas of the board where you want to etch away the copper. Then the board, after rinsing in water, goes into the etching solution where it is converted from a blank to a PC card ready for drilling.

For unsensitized blanks and sensitized blanks which have accidentally been exposed (and thoroughly cleaned of photo-resist), conventional hand-apply resist can be used for making the PC board. Most kits supply more than enough of the hand-apply resist



Circuit-Stik's "Quik-Circuits" employ foil conductors on plastic laminates and perforated boards to take the mess out of designing PC boards.

materials to take care of just about any contingency.

The etched and cleaned PC card can be given a professional appearance by immersing it in a tin-plating bath. The tin covers only the exposed copper, facilitating easy soldering and sealing the copper against oxidation.

One more PC kit is worthy of mention here, although its appeal is mainly to the hobbyist who has to make multiple runs of a single type of board. This kit employs a silk-screen technique that can provide almost as fine a detail as is obtainable with the film-negative technique. All materials for making the silk screen master are supplied.

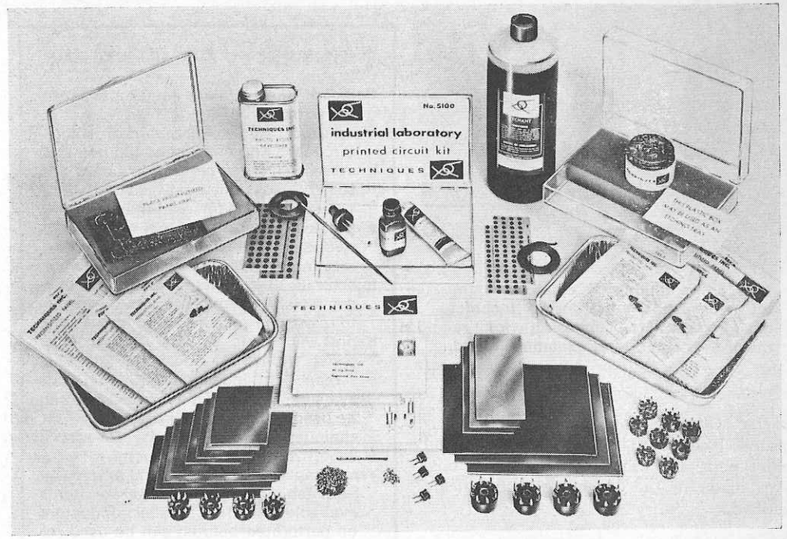
In the non-etch category, there are at present only two types of kits available. In one, a combination of different types of perforated boards are employed, one of which has a series of parallel strips of copper foil on one side. The foil can be easily cut to form the PC pattern. A special tool, supplied with the kit, is used for cutting the foil.

Printed circuit boards made with the parallel conductor pattern must be laid out to take full advantage of the hole matrix and foil strip orientation. And, although this type of kit was designed primarily for use in breadboarding and setting up original circuit prototypes to serve as models prior to industrial production runs, the carefully designed printed circuit board made at home can serve equally well as the finished product in a project.

The second type of kit also employs perforated boards (none with copper conductors on it). Different configurations of solder pads on heat-resistant laminates and copper foil, both adhesive-backed, are used in making up the printed circuit pattern. The adhesive is a special formulation that resists breakdown under normal soldering temperatures, and the laminate on which the soldering pads are deposited will resist even higher temperatures of operation.

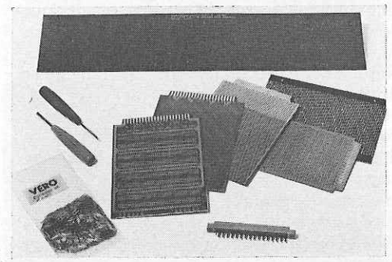
There is a considerable variety of paste-down solder pads available, including those for 6-, 8-, 10-, and 12-lead round IC's 14- and 16-pin dual in-line (DIP) IC's, flat packs, 3- and 4-lead signal and low-power transistors, tag-strip layouts, multiple-lead connection points, etc. To further simplify matters, the hole locations on the pads mate

Typical of Kepro kits are pyrex glass etching trays. Photosensitized board blanks are packaged in opaque plastic sleeves. Other materials in kit are etching and developing solutions, photo-flood and safe lights, design items.

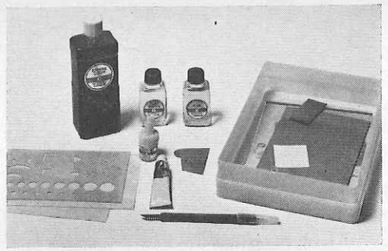


Called an "Industrial Laboratory," Techniques' kit includes everything needed for turning out first-rate printed circuit boards. Included in the well-rounded kit are a small drill, exposure jig (top left), and tube and transistor sockets. Both phenolic and epoxy-fiberglass base board blanks are supplied.

Vero's non-etch kits employ perforated boards with copper foil strips. Special foil cutter and push-in solder terminal insertion tools included.



Injectorall photo-resist kit contains usual materials plus test negative, stencil knife, cleaning pad. Clips and glass are exposure jig.



Eico kit is unique; it employs enamel resist (in tube), and includes design template, materials for removing enamel, and cleaning board.

exactly with the hole matrix on the perforated boards. And, since the foil and solder pads are adhesive-backed, any mistakes made in the layout can be quickly rectified.

Design and Layout Aids. When making up your shopping list, include a few items (available from most stationary or art supply stores) that will simplify the design and layout tasks. Include graph paper with ten divisions/inch, tracing paper (vellum is best), clear sheet acetate, soft-lead pencils, and india ink and pen for the design end. For actual layout work, add opaque flexible tape in several narrow widths, amberlith sheets, a dry-transfer lettering kit, and a hobby knife.

If you want really professional photographic-quality negatives for exposing sensitized board blanks, look into the drafting aids avaliable at art supply stores and from some of the mailorder electronics houses. These items are fairly expensive but well worth the investment if you are planning to make multiple runs or require precise control of the PC foil pattern.

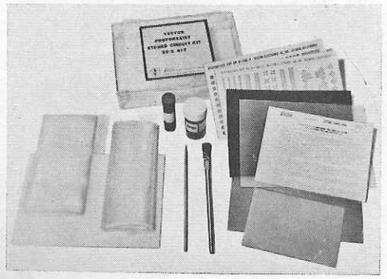
Directly from the electronics supply houses, you can get nibbling tools for cutting boards to size, PC board repair kits, board blanks, etchant, all types of resist, sockets, etc. And make a trip to your hardware store to pick up several small-diameter drills.

After working with PC boards for a while, you will realize that you no longer have to depend on commercial sources of boards to complete a project. With a little practice, you will be turning out boards every bit as good as those made by industrial techniques —and you will save a lot of money in the bargain. ◈

SUPPLIERS OF PC KITS AND MATERIALS

Calectro: Basic kits and materials; photoresist not used.
Circuit-Stik: Sold under name of "Quick-Circuits." Kits and materials; non-etch system employs perforated board and solder pads on heat-resistant laminates; suitable for all levels of work.
Eico: Basic kits; use enamel resist exclusively; include stencil knife, paint remover, design template, board cleaner.
Injectorall: Basic kits employ tape-and-dot resist; intermediate kits have photo-resist and include photo-flood lamp.
Kepro: All levels of kits, all types of resist. Nameplate and panel kits; silk-screen kit; individual PC materials available separately; advanced kits can be used in critical designs.
Techniques: All levels of kits; silk screen kit.
Vero: Industrial design PC kits employing non-etch system and separate items available; based on parallel conductors on perforated boards; can be used for all levels of work.
Dynachem Corp.: Aerosol photo-resist; developer; aerosol dye for photographic process in making PC boards; available in starter kit or separately.
Vector: All levels of kits; employ photo-resist; dry-transfer resist, and tape-and-dot resist; etchant comes as crystals to be mixed with water; suitable for all types of PC work.

Example of Vector photoresist kit shows etching crystals (lower left), rub-on resist patterns, burnisher, design materials, and board blanks.



Army Buys Tactical Landing System

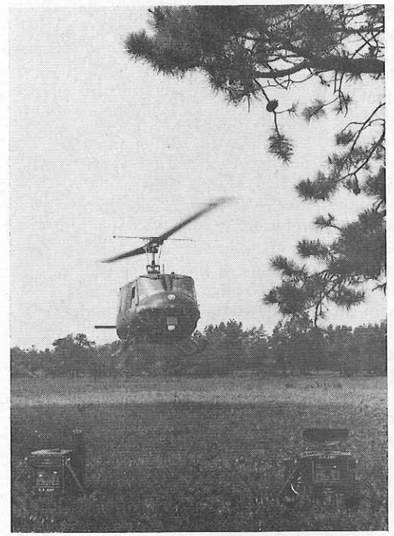
THE U.S. Army Electronics Command, Fort Monmouth, N.J., has awarded Cutler-Hammer's AIL Division a $4.8 million contract for the development and fabrication of a Tactical Landing System (TLS).

The small, easily transportable TLS system (shown here) can be set up in a matter of minutes at any landing site large enough to accommodate helicopters. The units transmit scanning flat microwave fan beams that sweep through a sector of 60° and provide proportional precision azimuth (steering) guidance information in the form of coded signals uniformly distributed over the coverage. During a separate time slot, but on the identical frequency, the glideslope beam sweeps vertically through an angular sector of 20° above the horizon. A third time slot is used for DME (distance measuring equipment) by the aircraft. This latter part is optional.

The overall system is to be used when the landing site is obscured by clouds or darkness.

The Army UH-1D helicopter is shown (below left) using the A-SCAN (prototype) during landing tests at Lakehurst Naval Air Station, N.J. The diagram and pictorialization at right show the functional concept of the TLC, which uses Ku-band frequencies. ◈

The helicopter landing system shown here is A-SCAN, predecessor of the new Tactical Landing System which is to be developed by Cutler-Hammer's AIL Division. A-SCAN was used as a laboratory tool in conducting live flight research into the steep, helicopter instrument approach problem.



The ground-based TLS system will use microwave scanning beams to provide approaching Army helicopters and/or fixed-wing aircraft with complete position coordinates by interpreting the coordinates in terms of approach path deviations, distance to go, distance rate and height of the aircraft.