IC Bricklaying For Miniature Projects

Here's a method of stacking IC's that enables you to build IC-oriented projects into the smallest space possible

WALTER T. CARDWELL, JR.

THE PAST 10 YEARS HAVE SEEN A TREMENDOUS growth in both the number and complexity of large-scale integrated circuits. Yet, along with the increased complexity of IC's and thus the necessity for fewer circuits, the reduction in size of most electronic instruments has not used the full potential inherent in LSI circuitry. It is now technically feasible for an IC manufacturer to construct almost any test instrument—a VOM, signal generator, frequency meter, etc.—into a pen-sized device either by using LSI techniques alone or by a combination of methods. The obstacle facing such devices is economic and not technical. In the future, we shall be able to carry a complete test bench clipped to a shirt pocket. However, there will always be devices that do not justify designing a special IC. This article presents a construction method that can be used to make the smallest possible device using commercially available IC's.

When IC's were first designed, the standard approach was to transfer discrete circuits into integrated form. Now, IC's are designed to take advantage of the special features of IC technology. Nevertheless, once the IC's are out of the package, the same PC board techniques are used to mount them that were common in the age of vacuum tubes, resulting in large bulky instruments that in many respects look like, and must be used as, museum pieces of the forties and fifties.

Construction techniques

The bricklaying construction technique presented in this article uses the IC packages as the supporting structure of the device. Except for a few linear IC's, almost every IC made can be obtained in a dual in-line package; thus, this technique can be used almost everywhere.

First, cut the leads of the DIP's flush with the bottom of the package, as shown in Fig. 1-a. (Take care not to strain the leads at the case.) The IC's can be stacked one on top of the other to any height and glued together using a cyanoacrylate-type glue. Since the glue takes only seconds to harden, the IC block can be used immediately. (Note the caution on the label about gluing your fingers together because it takes about 30 minutes of soaking the fingers in nail polish remover or acetone to unglue them! Keep a bottle handy. A special solvent called *Cyano-solv*, manufactured by GC Electronics, also softens the glue.)

Once the ends of the block are stacked vertically, they can be filed smooth, using

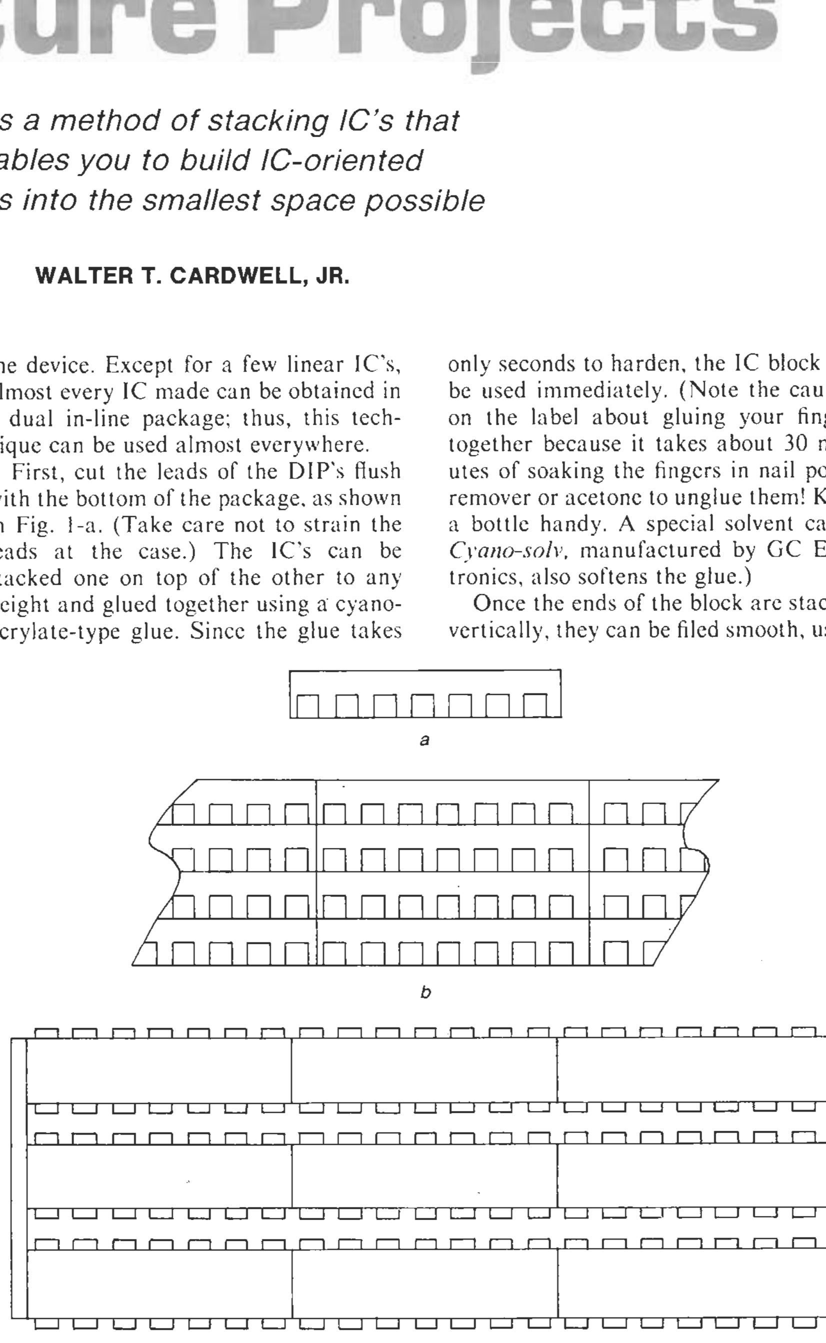

FIG. 1—HOW IC'S ARE STACKED. Drawing *a* represents a 14-pin DIP with leads cut flush with case. Diagram *b* shows how IC's can be stacked in tiers and end-to-end while drawing *c* is a top view of IC's stacked vertically, horizontally and laterally.

a regular metal file. Two blocks can then be joined end to end (Fig. 1-b) to make a flat sheet of bonded IC's. The IC leads prevent stacking side-by-side but this can be overcome by gluing spacers at the ends of the sheets and then gluing the sheets together, as shown in Fig. 1-c. The completed IC block is as strong as the plastic case material, and unless you use very thin plastic material, the block is fairly solid. It is impossible to break the IC's apart with your bare hands. The IC's will, however, crack if dropped.

How to wire

To wire the circuits, you have to go back to the Stone Age and use point-to-point wiring. This may make the technique unattractive to those in the industry, although automated point-to-point wiring is making a comeback. However, the experimenter and hobbyist will find it is much easier and takes less time than to lay out and etch a PC board.

Use the lead pads on the side of the IC package as bonding pads, and make the connections with AWG No. 30 solid wire-wrap wire. Remove 1/8-inch of insulation and solder the wire to the pads. The meter shown in Fig. 2 may look like a "rat's nest," but it is actually very easy and convenient to work on since there is no bulky chassis to move around. A pair of sharp-pointed tweezers and a small soldering iron are the only special tools required.

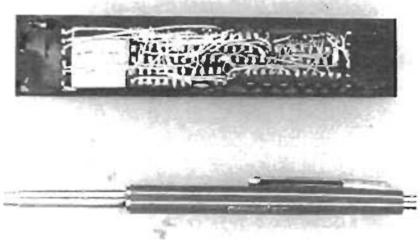

FIG. 2—INSIDE VIEW of a probe-type digital frequency meter. Compact construction is due to the "bricklaying" technique.

There are several areas that can cause problems. One is the damage that might be caused to the IC by clipping the leads so close to the case and soldering the wires with no heat sink. I thought CMOS units would be especially susceptible to damage. However, I have wired four different instruments and rewired several sections of each instrument without damaging any IC, including CMOS types. You should, however, take great care when soldering the wires to prevent the IC from being damaged by excessive heat.

Troubleshooting the IC's

Repair can be a problem. Actually these circuits are easier than most to troubleshoot since all the signal points are on the side of the IC. Locate the faulty IC before trying to remove it. Once it is located, remove the wires. If the IC is on the outside of the block, remove it simply by brushing the solvent along the joint. It generally takes about 30 minutes for the joint to soften enough so that a knife blade can be inserted into the joint to pry the IC apart. If the IC is on the inside of the block, you can use several alternatives. If there is enough space, just glue a new IC somewhere else and leave the defective one where it is. However, usually this will not be possible and the IC must be removed.

A second solution is to drill out the old IC. Use a drill that is smaller than the height of the case to remove as much of the defective IC as possible. Solvent may then be applied to remove any remaining loose chips. Slip the new IC into place. A final alternative is to remove the blocks of IC's until the defective IC is on the outside of a block; then follow the first method described above. Sometimes you can separate two IC's by using a pair of diagonal cutters between them after the joint has soaked for about 10 minutes. This method should only be used when both IC's are inexpensive units since it is always possible to damage them both.

The last problem is that of IC-generated heat. For CMOS units at low speeds there is no problem, but because higher-power devices have a large direct contact area, the heat that is generated conducts to adjacent IC's. Place heat-sensitive circuits away from high-power devices. In some cases, glue a strip of aluminum or copper between the IC's to remove the generated heat, as shown in Fig. 3. In fact, this method may be better than PC board methods, since each IC can be connected to a heat sink.

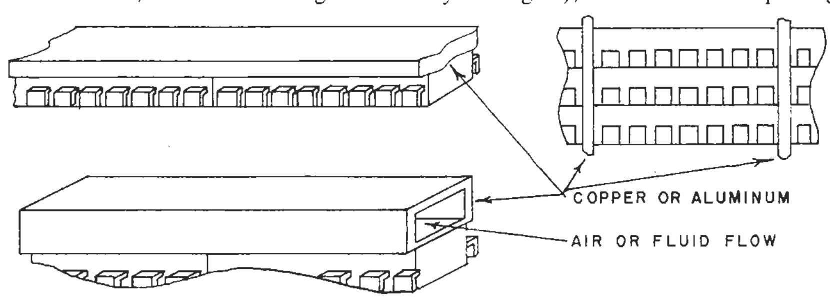

FIG. 3—HEAT SINKS atop and/or on the IC's can be metal slabs, strips or rectangular tubing.

This construction method is so convenient that in most cases it is not necessary to breadboard circuits anymore. You can build and test a small subsection before gluing it into the device. Wiring changes can easily be made at this point, and it is not too difficult to remove IC's. All leads are easy to locate and identify, especially if you use a standard alignment; that is, if all IC's face the same direction. It is a good idea to keep a location guide handy since IC type numbers are always hidden from view.

Other types of components

In addition to plastic DIP's, other components can also be used. You can use ceramic DIP's except that the cases can't be filed and you may have to add plastic shims to fill the gaps. Discrete components can be glued around the edge of the IC block. Four or five small TO-92 cases can be placed together in a slot that an IC would normally use. These cases are not as tall as the DIP's and a shim may be needed.

One-quarter-watt resistors are added to the bottom of the IC block. These resistors are almost as long as the width of the DIP's. Cut the resistor leads close to the body and solder the wire-wrap wire to the leads. Capacitors must be located wherever they will fit. (See Fig. 4.) Neither resistors nor capacitors should be used as structural support. The resistor bond is to the paint on the resistor body, and the resistor will come off if any great force is applied. Capacitors are usually not flat, so the surface area of the bond is quite small. If the device is really an odd-ball type, you can make a special plastic support structure for it.

Combining 14- and 16-lead packages may leave gaps at the ends of a block. When two blocks are joined end to end, a hole in the IC sheet may result. These holes can be used to pass leads from one side to the other and, since the end bond of even one IC is usually very strong, several holes can be left in the sheet.

The cyanoacrylate glues bond almost instantly, and once the IC's are joined, it is impossible to align them properly. Either line up the IC's first and apply a drop of glue at the joint (be careful of your fingers), or construct a simple alignment jig, as shown in Fig. 5. The guides may be coated with candle wax to prevent the IC's from sticking to them.

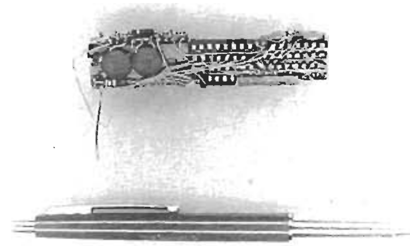

FIG. 4—RESISTORS, CAPACITORS and other components are glued wherever there is room.

Case materials

Anyone who has built an electronic device from scratch has faced the prob-

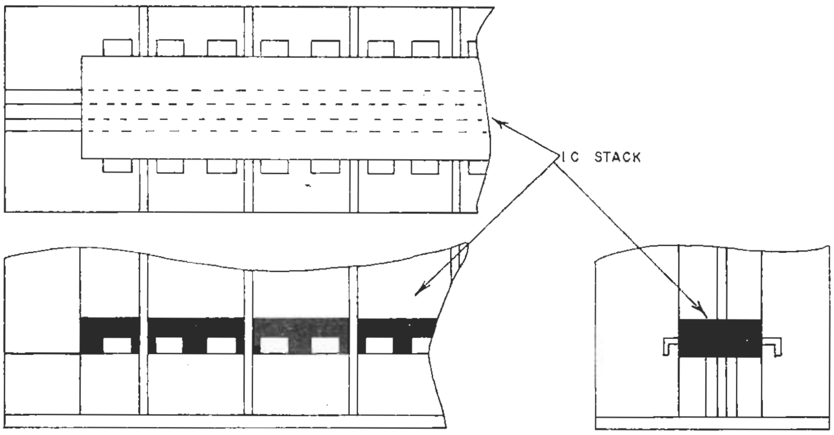

FIG. 5—A JIG IS USED to hold the IC's in perfect alignment so they can be glued. It is constructed from thin metal strips.

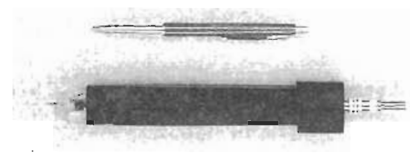

FIG. 6—THE COMPLETE FREQUENCY METER. Its case is just a little longer than a ball-point pen and about three times greater in cross-section.

lem of what kind of a case to use. The good old standby, the Minibox, leaves a great deal to be desired so far as appearance is concerned. You can use the construction technique described in this article to solve the problem of a suitable enclosure.

Figure 6 shows a frequency meter in a case made from 1/16-in. black acrylic plastic. The readouts are covered by transparent amber plastic. A 12-pin socket is glued at each end of the IC block to form the meter case foundation. If no sockets are needed, substitute a 1/8-inch or a 1/4-inch piece of plastic. The sides, top and bottom of the case can then be made from 1/16-inch plastic, which is very easy to work with. If you use cyanoacrylate glue, the joints can be opened with a razor blade. Do not use a solvent on the joint as it will dissolve the plastic. Do not use the normal *Plexiglas* cement because it melts the two surfaces so that the two pieces are fused together. This type of joint cannot be opened very easily.

There are a few tricks that are helpful when using acrylic plastics. Thin pieces can be scratched and broken like glass. Any wood saw will cut thick pieces, but the saw should have fairly fine teeth. In general, most metal- and wood-working tools can be used. Once the edges are cut, file them flat and at right angles to make an almost invisible seam. The paper masking the material should be left on as long as possible.

Acrylic plastics can be cut to any desired shape, and the gloss can then be restored. File the surface, if it is flat, and then wet-sand it with 240-grit, 400-grit and finally 600-grit wet-or-dry sandpaper. Buff the surface, using a cloth buffing wheel charged with jewelers' rouge. Figure 7 shows a transparent plastic probe tip made this way. Of all the special tools available, none are more useful than a bench grinder with a cloth buffing wheel and a hard-backed (not rubber) sanding disk.

An alternative to an acrylic plastic such as *Plexiglas* is ABS plastic. This material is much softer and easier to work with, but it does not have the deep gloss of *Plexiglas*. Most hobby stores carry it under the name of *Plastruct*. ABS plastic can be used to make shims and support pieces inside the device where looks are not important. It is also available in much thinner sheets than *Plexiglas*.

While the construction technique described here was used to make a probe, it can also be applied to almost any project. The method is easy, takes little time, can be changed easily and results in the smallest possible device. You can now build that beautiful stereo amplifier or preamplifier you have been discouraged from building because of all the mechanical work involved, since the bricklaying technique eliminates much of that work. **R-E**

New RCA color TV chassis uses less power

RCA recently announced that it has been converting all its color TV receivers to new low-level energy consumption models that it predicts will save the consumer approximately 2¢ a day. The sets will operate at about half the power requirements of the 1972 color sets.

RCA's "XTENDEDLIFE" CHASSIS uses only 89 watts to power the 19-inch models. This compares with the average solid-state color TV set that uses 145 watts.

Four years ago, the company took a series of steps to reduce the energy-consuming capacities of their products by introducing a line of solid-state receivers. They then switched their entire black-and-white line to solid-state operation, eliminating all power-drawing tubes. From this, it was a natural progression to the introduction of their new "XtendedLife" color TV chassis.

This chassis has four integrated circuits and uses about as much energy as a 100-watt light bulb, compared with the average solid-state color set that uses 145 watts. It is estimated that, with its projected cost of 2¢ per day, the "XtendedLife" would set the consumer back only about $7.70 a year, a sharp contrast to the $28.88 of older tube-type models. Since the average American family spends 6.3 hours a day watching its favorite entertainment, both energy and cost savings appreciable.

Two-part seminar program on microcomputers

The Virginia Polytechnic Institute and State University at Blacksburg, VA, will hold a two-part seminar program in December. The first session, entitled "Microcomputing Interfacing Workshop," held December 8–10, will offer participants a hands-on opportunity to work with the popular 8080 and 8085 microprocessors.

The second session, called "Digital Electronics for Automation Workshop," will take place December 6–7, and will concern small-scale and medium-scale TTL IC's. Many lab hours with breadboarding stations and in-depth lectures are planned.

Both the three-day and the two-day seminars will be under the direction of Dr. Peter Rony, Dr. Paul Field and David Larsen. For more information on these programs, write Dr. Norris Bell, Continuing Education Center, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, or call (703) 951-6328.

CB license applications up 10% in 1977

The Federal Trade Commission reports receiving 3,254,825 applications for CB licenses during the first six months of this year, a 10% increase in sales over the same period of time in 1976. Since 1958 more than 11 million CB licenses have been issued, over half of which were granted during the last year and a half.

John Sodolski, president of EIA (Electronic Industries Association), states: "It's obvious that personal two-way communication is fast becoming an integral part of mobile America." His projection for 1980: more than 50 million CB's and more than 20 million base stations will be sold. **R-E**