HARDWARE HACKER

A new monthly column devoted to answering hardware questions posed by readers

By Don Lancaster

This new column is designed to be *your* column. That is, it will develop into an interactive column in which I'll try to answer most any hardware (and inescapable software) questions readers pose to me, look at some neat hacker-type stuff, and maybe explore a few off-the-wall things along the way.

To join in the fun, write or phone me directly (see "Need Help?" box). Frankly, I'm not so great at answering letters, so the telephone is your better choice. Best hours are 8 to 5 weekdays, Mountain Standard Time. (Someday, we'll even add a bulletin board on-line. To anyone who responds, I'll send a free book list and product list relating to my very special wares.

Now, for Column #1 . . .

How can I do a Hexadecimal LED Display?

There are lots of different integrated circuits available that will let you display the digits from 0 to 9 on a light-emitting diode (LED) display. Unfortunately, most of them treat codes decimal 10 through 15 or hexadecimal A through F as invalid codes, and will blank, or turn off, the display. This is fine for a digital instrument. But for a computer or trainer display, you need all 16 hex digits displayable and readable.

A circuit that will display all hex digits in response to all 16 possible $0 through $F code inputs is shown in Fig. 1. (Note: from here on, the $ prefix refers to hexadecimal notations.) As a bonus, it takes only a single integrated circuit, a *Motorola* MC14495, which even has the seven current-limiting resistors demanded by all seven-segment LED displays built right in.

Essentially, all you need for the circuit is the chip and an LED display. One gotcha: This takes a *common-cathode* 7-segment display. These are less common than the usual *common-anode* displays, but they are findable if you look around for them.

There are four data inputs, which I have labeled 8-4-2-1, and a clock input. You put the binary code for the letter you want to display on the 8-4-2-1 inputs. For instance, for a $6, you input a 0-1-1-0, or low-high-high-low, code. For a $B, you input a 1-0-1-1 combination. (By the way, you can tell the $6 from the $B since the six has a top bar, while the $B is shown in lower case.)

The MC14495 also has a memory feature. There is a hold-follow latch built into the chip. If you make the store input high, you will *hold* the old data. If you ground the store input, you will instead *follow* the new data as it arrives. Thus, for an "instant" display, ground the store input. For a

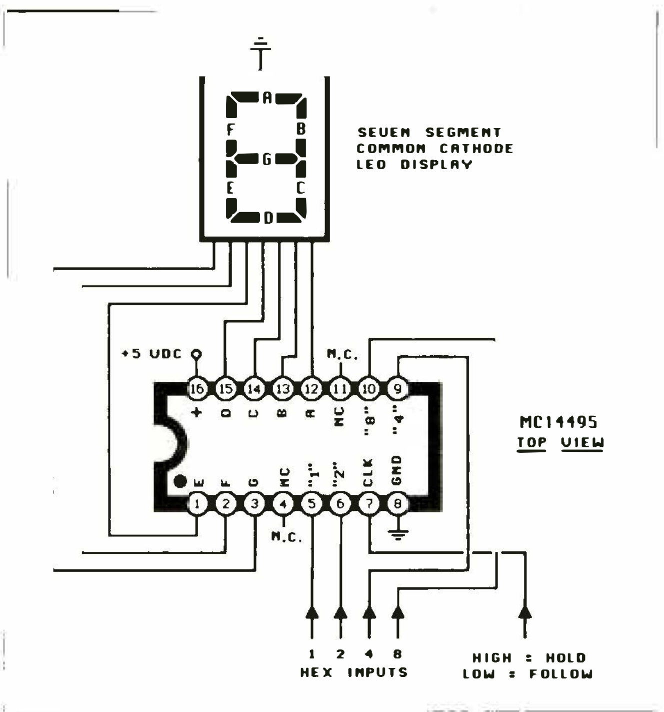


Fig. 1. A decoder/driver circuit for a 7-segment LED display that will show all 16 hex states.

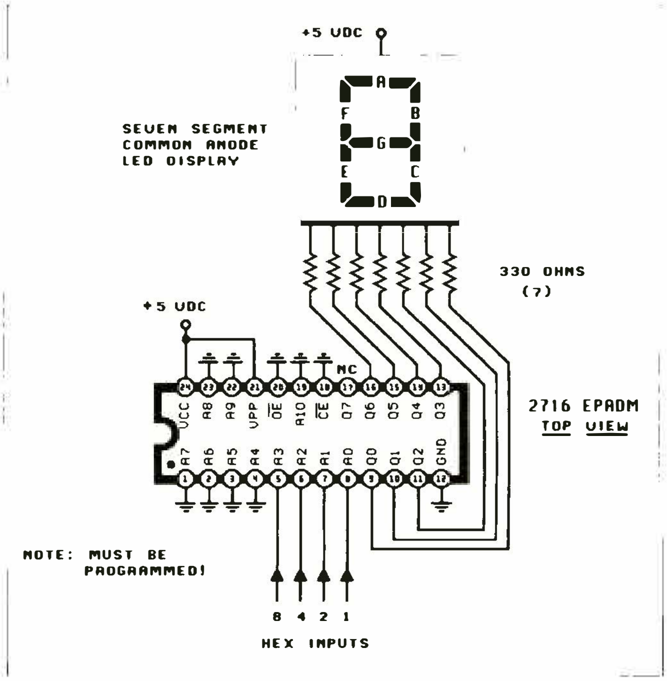


Fig. 2. When you can't find the circuit you need, a 2716 EPROM can often be used as a "sledgehammer" solution to your needs.

"memory" display, connect the store input to a signal that is normally high but goes low any time you want to update.

Since this is a CMOS device, be sure to connect all of the inputs at all times. The two pins I have marked "NC" are outputs intended for specialized and rare uses.

Though the chip works best off a +5-volt supply, you can use any supply from 4.5 to 16 volts. For LSTTL (low-power Schottky transistor-transistor logic) compatibility, use a +5-volt supply and add 4.7K pull-up resistors to all five inputs.

Besides this chip, there are apparently a Mitel MD4311B and a related Plessey MV4311 available. Either one will also drive a hex LED display. I haven't had a chance to look into these further, though.

There is also a sledgehammer solution to driving any code into any display. Just burn the pattern you need into a 2716 EPROM. A 2716 would normally use a +5-volt supply, a common-anode LED display, and seven 330-ohm current-limiting resistors. Use a truth table that pulls outputs *low* when you want to *light* the display. Figure 2 shows details.

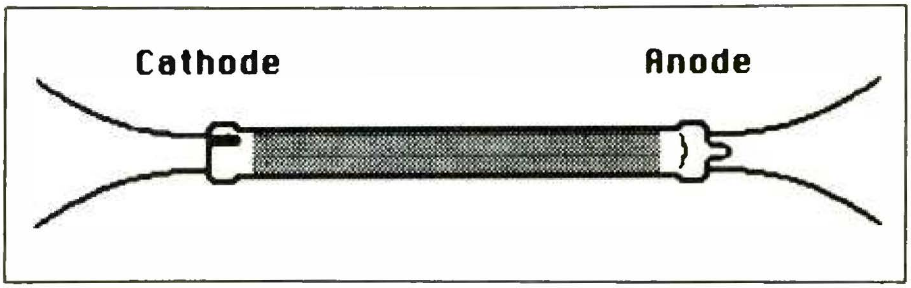


Fig. 3. The JKL BF659 lamp is only 2½" long and comes in several colors. It is very easy to power, from the ac line or transistor oscillator. Take careful note of polarity.

How can I do a cross references to a disk file?

An *intelligent disassembler* is a routine that lets you tear apart a machine-language computer program so that you can "capture" it to your own source code, including the usual features such as labels, comments, operands, and so on. A *cross reference* is a listing of who does what to whom. Cross references are particularly useful using the "avalanche effect" to tear into unknown code.

I'm an Apple person, so I use a program called "*DISASM IIE*" by RAK-WARE. This is the best one I have found, and it performs admirably, even though it is a tad on the user-vicious side. The normal cross reference listing on DISASM IIe is done to the screen or a printer. Many times, I have wanted to do a listing to a text file on disk. Once on disk, you can transfer the listing to a work processor and you'll be able to do all sorts of fancy things with it.

Bob Kovaks, the author of DISASM IIe, advises me that you can make a simple patch to capture a cross reference to disk. Locations $09A1 through $09A2 should be $20 -$E0 - $0C. Change this to $20 - $F1 -$0A, and your cross reference will be printed to disk. It works like a charm, except for a minor bug. Use this routine only once and then reboot, for a location or two gets clobbered in the X-REF disk access.

Where can I obtain small cases with built-in battery compartments?

I've found several sources on these. *Global Specialties* has a CTH-1 "Handheld" light-grey case that includes a built-in 9-volt battery compartment, input jacks, and provision for a keyboard and LED display. *Jameco* stocks it.

The ones I really like, though, are made by *Vero*. Check into this company's Series II case boxes, Types I, II and III. Type I is cute as a bug, and includes a front panel and a 9-volt battery compartment. Types II and III are slightly larger and are provided with a molded-in compartment for four penlight cells. *Dyna Service* is one distributor. Cost is well under $10 for most sizes.

The Type I box requires some cramming to get things to fit. I've found that you can hang circuit boards *upside-down* from the plastic bosses, to use normally wasted space. Much as I hate to solder ICs into place, instead of socketing them, this is one package where socket bulk may be intolerable. Even thinner pc boards may be of help. (We are working on a whiz-bang project using one of these neat little guys.)

Vero also has just the snap-in 9-volt battery compartment that you can pop into a rectangular hole in the case of your choosing. Their part number is 75-2859, and cost is under $3 in onesies. A battery connector is included.

Where can I get some Hacker's microcomputer books?

Funny you should ask that. By the most astounding coincidence, I have written two of them that treat microcomputer fundamentals from the point of view of a hacker-type person with a mostly hardware background.

There are my *Micro Cookbooks*, Volumes I and II, and are available as SAMS #21828 and #21829. Volume I is on bare-beginning fundamentals, while Volume II is on machine-language programming. You can get these books through your local computer store or directly from the SAMS order hotline by dialing 1-800-428-SAMS.

Are there miniature flourescent lamps available?

There sure are, and they are as cheap as $1.62 each. *JKL Components* has bunches of sizes and colors of these. They range from 2" to 5" long, and are available in white, red, green, blue, orange, yellow and pink. Figure 3 shows a typical example. It is JKL's Model BF659.

An ac line-operated test circuit is shown in Figure 4. There are some very subtle things happening in this circuit, so be extra careful to observe polarity of everything and do not rearrange the parts.

The bulb itself has a cathode end and an anode end. There is no filament and, thus, no filament to burn out. At the cathode end is a cup-shaped cathode that is marked with a black line. The anode end has a bulb evacuation tip on it, which also may have a black mark on its extreme end. Centered at the cathode end is a starting electrode. At the anode end are two starting electrodes, one of which acts as an anode when the lamp is running.

There are three operating modes for the Fig. 4 circuit: power up, start, and run. On power up, there is no lamp current, so you simply have a half-wave rectifier where the power diode charges the capacitor to some −200 volts. Note that the capacitor must have a rating of 200 volts dc or higher. While an electrolytic is shown, I prefer to use a good-quality 1-microfarad, 400-volt mylar capacitor instead.

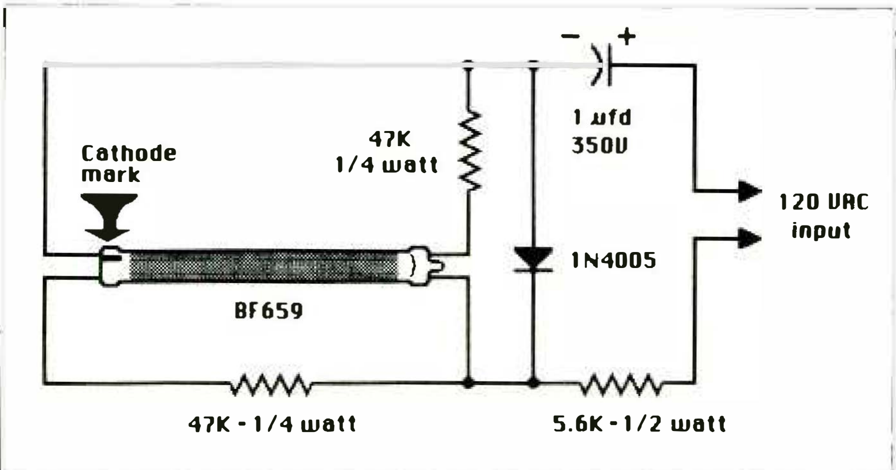
As with any ac line-operated circuit, this one has a stinger in its tail, so be careful! There's 400 volts here waiting to nail you.

Applying power charges the capacitor to −200 volts. On the positive line cycle, the potential across the "off" diode is some 400 volts, taking the difference between the positive peak line cycle and the negative capacitor voltage. So you have 400-volt pulses appearing across the diode.

Now for the startup. The object of the game is to get an ionized path from cathode to anode inside the bulb. This ionized gas will then whap the phosphor coating inside the tube and light the blub. The trouble is that it would normally take thousands of volts to ionize that long a path. So we get sneaky.

At the anode end of the bulb is a pair of pins spaced similarly to a common neon lamp. A pulse of 400 volts is more than enough to fire a localized ion path between these two pins. The localized current is limited by the 47K resistor.

Fig. 4. *Circuit to power a BF659 fluorescent lamp from the ac power line. The polarities of the lamp, capacitor and diode must be observed.*



Names & Numbers

Dyna Services
1020 S. Atlantic Blvd.
Los Angeles, CA 90022
(213) 268-8531

Global Specialties
70 Fulton Terrace
New Haven, CT 06509
(203) 624-3103

Jameco Electronics
1355 Shoreway Rd.
Belmont, CA 94002
(415) 592-8097

JKL Components
13343 Paxton St.
Pacoima, CA 91331
(800) 421-7244

3M Graphic Prep Systems
3M Center
St. Paul, MN 55144
(612) 733-3712

Mitel
360G Leggett Dr.
Kanata, Ontario K2K 1X5, Canada
(613) 592-5630

Motorola
Box 20912
Phoenix, AZ 85018
(602) 244-6900

Plessey
1674 McGraw Ave.
Santa Ana, CA 92705
(714) 540-9945

Rak-Ware
41 Ralph Rd.
West Orange, NJ 07052
(201) 325-1885

Howard W. Sams & Co.
4300 W. 65 St.
Indianapolis, IN 46206
(800)428-SAMS

Vero Electronics
171 Bridge Rd.
Hauppauge, NY 11788
(516) 227-8890

Webril/Kendall
One Federal Way
Boston, MA 02101
(617) 423-2000

At the cathode end is a cathode cup and a pin that is similarly spaced. It also will fire when 400 volts is placed across it. Eventually, some ions drift down the tube and a conduction path is established. At that time, the main lamp "fires," and the electron path is through the current-limiting input resistor, into the cathode, into the ionized path, out the anode and back to the supply via the large capacitor. The whole process takes only a few line cycles, so the bulb appears to "instantly" light.

Colors are produced by changing the phosphor chemistry. JKL also has an ultraviolet version. I have not tried this one for erasing EPROMs, but it is probably the usual "poster" low-energy UV, rather than the high-energy "rockhound" UV style needed to blast an EPROM.

Let me know if you have any luck on this, since most EPROM erasers are obscenely priced.

Brightness can be controlled over a reasonable range, from a lamp current of, say, 3 to 15 mA. You can also build a simple transistor oscillator to battery power the lamp. Efficiency can be quite high. Several cavers are even experimenting with these as underground light sources.

If you really want to get wild, JKL will custom-bend almost any shape or size lamp you want. But not on a hacker's budget.

Is there some simple way to handle 1:1 photographic reversals?

Getting from black-on-white artwork to clear-on-black film can be a real hassle. Yet it is often needed for printed circuits, silk screens, dialplates, overlays, and the like.

If you are able to work 1:1, you can eliminate both the camera and the darkroom, by using 3M's *Color Key* materials. These are intended for use by printers to do "prepress" color proofing, and are available in a wide variety of colors. Chances are the plain old black-over-transparent will work for you. 3M's #77-9801-6648-0 is typical in the 9″×12″ size. The packages tend to be expensive, but the cost per square-inch is fairly low.

The stuff is only moderately light sensitive, so you can work in subdued light if you are reasonably quick and make sure that all long-term storage is done in a light-tight package.

Here's all you do: Rig up a contact printing frame. Put whatever you want reversed in contact with the color-key sheet. Emulsion to emulsion is sharpest. To find the emulsion side, use the old darkroom stunt of touching the film to your lips. Whichever side sticks to your lips is the emulsion side.

Next, you expose. If you do not have an exposure box, try direct sunlight for three minutes. Then adjust for best results.

After exposure, pour some #77-9800-7992-3 developer over the sheet and gently rub the sheet with some non-woven fabric or soft paper. The same place that sells you the Color Key materials should stock *Webril* Proof Pads, which are ideal for this purpose. After a half a minute or so of gentle wiping, the part of the image that did not receive any light should literally fall off the sheet, leaving it clear where no light got through, and solid black where it did.

Unfortunately, this material is much too slow for use in any reduction or imaging camera, no matter how bright the lights or how long the exposure. It works only at 1:1 and then only when directly contact printed.

There are some related 3M products that let you do dialplates, either on aluminum or a polyester base material. These are available in several colors, and are ideal for dialplates and panels, particularly when you need only one or two of them but demand a professional result. The same developer is used.

3M, a huge corporation with many divisions, is monumentally hard to deal with as a company, so your best bet usually involves calling your local printer or lithography supply house.

These materials are easy and fun to use and have lots of hacker potential. Let us know what new uses you find for them. **ME**

Need Help?

Phone or write hardware hacker questions and comments directly to:

Don Lancaster
SYNERGETICS
Box 809
Thatcher, AZ 85552
(602) 428-4073

BOOK REVIEWS

The latest technical books and literature in the electronics and computer field.

Assembly Cookbook For The Apple II/IIe. By Don Lancaster. (Howard W. Sams & Co., Inc.; soft cover; 408 pages; $21.95.)

A lot of books on assembly-language programming are either so shallow or so advanced they turn off the reader for good. Making matters worse, their writing styles are frequently so dry that they can't maintain reader interest. None of these deficiencies are in the *Assembly Cookbook* For The Apple II/IIe. This book is a rare gem that's actually *fun* to read while being very informative and hilariously amusing. If you really want to learn assembly programming on the Apple, this is the book for you. It sets the stage by telling you why you should program in assembly language and then moves on to defining what an assembler is, how it works, and the ins and outs of using it. Throughout, the text is easy to read and so witty that it's almost guaranteed to hold your attention and make you come back for more and more. In terms of coverage, this book deserves high marks, but so do other books on assembly-language programming. What sets this one apart is its readability and the manner in which it holds reader interest right through to the last page.

DOS Primer For The IBM PC & XT. By M. Waite, J. Angermeyer and M. Noble. (New American Library; soft cover; 197 pages; $14.95.)

If you use the disk operating system in your IBM PC or XT for only routine everyday operations, you're taking advantage of only a small portion of PC-DOS's power. To really understand what you can do with PC-DOS, you must go beyond the supplied DOS manual. This is where the DOS Primer comes into play. Written to appeal to both the beginner and advanced user, this book uses an intensive interactive approach to teaching PC-DOS. To obtain maximum benefit from the learning experience, *DOS Primer* is designed to be used right at the computer's keyboard to hammer home what you're reading. The writing style is light and easy to absorb, though in no way lacking in very useful information. Each of the nine chapters into which the books is divided builds upon previously presented material, taking the reader logically from beginning concepts right on through advanced concepts. Along the way, there are extensive exercises to be performed at the keyboard, and each chapter closes with a series of review questions, answers for which immediately follow. The book covers versions of PC-DOS from 2.0 on backward. It covers both floppy and fixed-disk systems and details use of the EDLIN editor and CONFIG.SYS utilities.

Introducing Cellular Communications. By Stan Prentiss. (TAB Books; soft cover; 216 pages; $8.95.)

You've probably read or heard about "cellular communications," the hot new technology that expands the usefulness of mobile telephone communications. If you want to know a great deal more about it, this is the book for you. *Introducing Cellular Communications* is an authoritative one-stop source that offers both a general overview of cellular communications and all the technical details you'll ever want or need. It tells you what cellular communications is and why it's important to you. The author then gets into a technical, but by no means pedantic, discussion of the terrestrial and satellite carriers that make it all possible. For the technically inclined, there are 38 pages packed with technical specifications information, including dozens of tables and drawings that detail every part of the cellular-communications system. Current equipment, both at the user's and the base-station ends, also come in for thorough examination.