

Reworking video games, EPROMs and EPROM burning, more laser printer info, technical literature

By Don Lancaster

We'll start with our usual reminder that this is your column, and you can pick up technical help by using the phone number shown in the "Need Help?" box. Best calling times are 8 AM to 5 PM—*Mountain Standard Time*.

I also have lots of free stuff available for you, including book and product lists, a *Laserwriter* demo pack, printer glossaries, some shaft encoder software, and bunches of other neat stuff. Just call or write to get in on the fun.

Onward and upward . . .

Can Surplus Video Game Boards be Adapted for Home Use?

Well, yes and no. I get an astounding number of helpline calls from people who found some old commercial video game boards and would I please show them a simple way to convert the RGB (red-green-blue) game video output to NTSC (*Never The Same Color*) broadcast television format, preferably via vhf channel 3 or 4. To which I reply: "Uh, why do you suppose the video-game people went to all that RGB trouble in the first place?" The answer, of course, is that they needed images that were much better than the usual broadcast quality. The bottom line is that most video games output far too much information far too fast to do anything but produce a hopeless smear on a stock TV set. Things get even worse if you try vhf entry via the tuner.

For the best possible image, the video-game people use three separate channels for the red, blue, and green color information. Any other color is produced by suitably blending these three colors in various combinations. The red, blue, and green channels are kept separate all the way from the computer memory through to the individual guns on the CRT display.

Some video games will further complicate things by using more dots per scan line and more lines per field than does

broadcast TV. Others may scan the display *sideways* to give a picture that is taller than it is wide. Unusual scanning and formats will cause all sorts of problems on a stock color TV set.

We saw how to get from split sync to composite video and back again in the September 1985 *Hardware Hacker*. Simple circuits like these work well for most personal computer video needs. Something much more elaborate may be required for video-game use. *Motorola* makes a special RGB-to-NTSC converter chip called the *TDA1133*. You might like to check this device out. Sample circuits appear on their data sheet and in their companion ap notes.

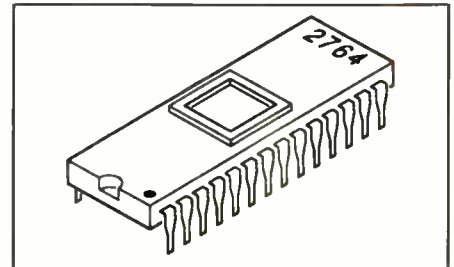


Fig. 1. A typical EPROM.

The best solution for home use of a commercial video game is to actually use an RGB monitor and make direct connections. This method will bypass the response limits of NTSC encoding and de-

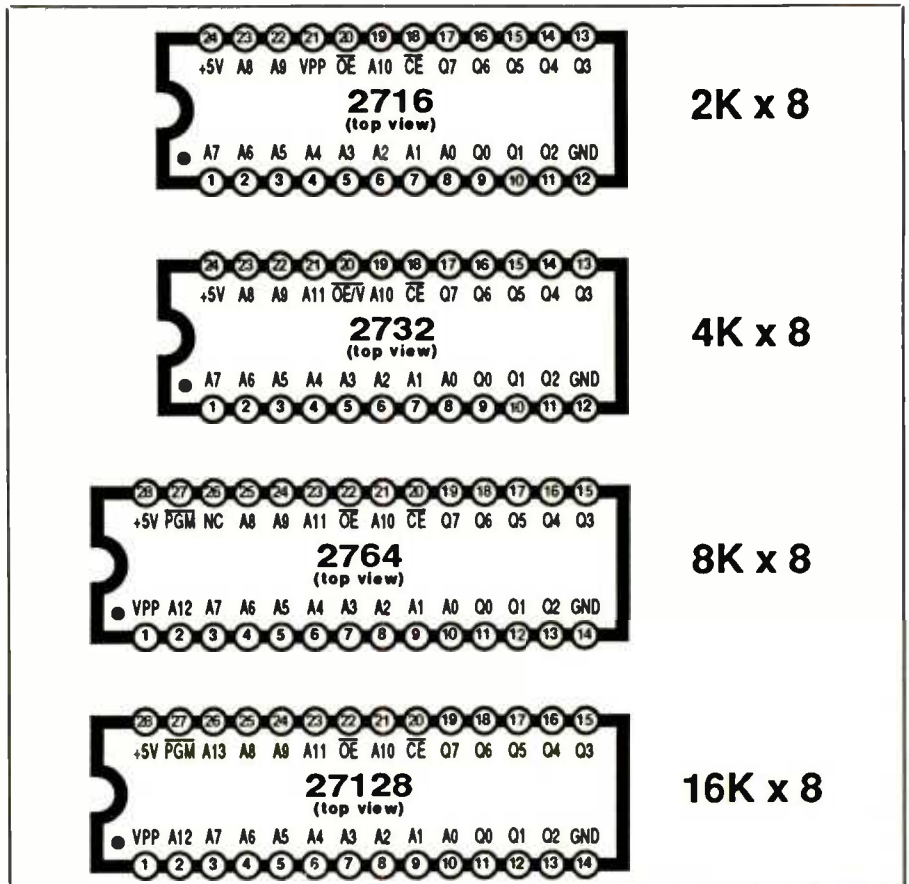


Fig. 2. Here are the pinouts for the four most popular EPROMs.

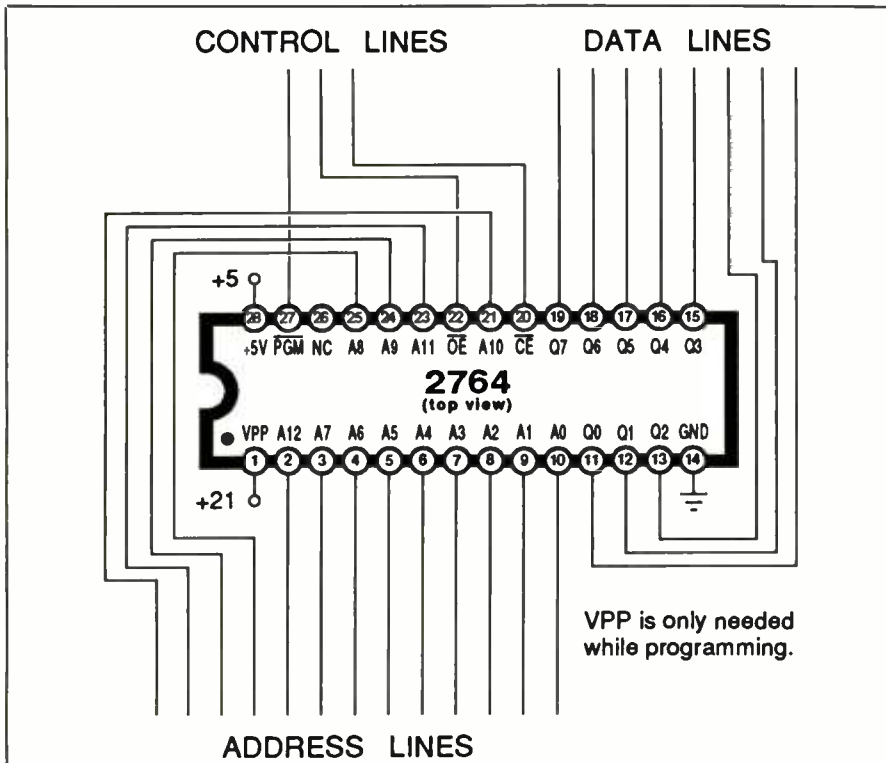


Fig. 3. How to connect a 2764 EPROM.

rial port commands that would not fit inside the original chip.

Figure 1 shows a typical EPROM. The most popular and most used EPROMs are the 2716, 2732, 2764 and 27128. These are available from *Intersil* and *Hitachi*, among others. For sources, use the ads you'll find right here in *Modern Electronics*. The pinouts for these popular chips appear in Fig. 2.

As you can see, the EPROM package has a glass window on top. To erase the EPROM, you direct very strong *short wavelength* ultraviolet light through the window. You can do this with a commercial EPROM eraser or simply by leaving the EPROM out in the sun for a week.

How does an EPROM work?

To understand how *any* memory works, separate all the pins into four groups. These groups are the *power* lines, the *address* lines, the *data* lines, and the *control* lines. Figure 3 gives details for the 2764, which seems to be the most popular EPROM in use today.

The *organization* of an EPROM is decided by the total number of bits available and by how many bits are grabbable at one time when a word is accessed. In the case of the 2764, the "64" stands for 64K, which means that there are a total of 65,536 bits available. All of the storage bits are grouped into 8-bit words. So, the 2764 is organized as 8K × 8, meaning that there are 8192 separate words of 8 bits each. You read or write only one whole word at any instant.

There are only two supply lines needed to read the EPROM, namely +5 Vdc and ground. The +5 volts must be well regulated and thoroughly bypassed. The current drawn by an EPROM will depend on its size and its operating mode, but something around 100 milliamperes is more or less typical. EPROMs using CMOS technology draw much less current, particularly in their standby mode.

A second power supply voltage is needed only while the EPROM is being programmed. This voltage very much depends on both the EPROM manufacturer and the type number, although typical

coding. RGB monitors are readily available and are not all that expensive these days. Chances are you will be *very* disappointed if you try to use a stock color TV receiver instead.

What is an EPROM?

An EPROM is a very popular type of computer memory that you can program yourself. The name stands for *Erasable and Programmable Read-Only Memory*. Once programmed, the EPROM will remember what you taught it. An EPROM is a *nonvolatile* memory, which means that you do not have to keep the power applied to keep the memory alive.

EPROMs are now very large, very cheap, and extremely easy to use. Most personal computers, printers and peripherals use EPROMs for firmware.

Hardware hackers quickly learn to love

EPROMs, since they let you rearrange the scenery to suit yourself. More importantly, even the largest EPROMs are now so cheap that many hackers are now putting two or three times the features into their computers or peripherals than they originally had.

As an example, we saw in the November '85 *Hardware Hacker* how to put a double-size EPROM into the monitor of an Apple IIe. This lets you have both the "old" monitor that is essential to run most older Apple software, plus a "new" monitor that lets you pick up features that include the mini-assembler, interrupts, and such.

Apple just doubled the size of the EPROM in the IIc and now calls it the 3.5 ROM. This expanded memory interfaces with their new 3.5-inch diskettes, has an *Appletalk* interface and a few self-test routines, and also picks up some of the se-

To **STANDBY**, connect the *chip select* (20) to +5 vdc. This will disable and power down the chip.

To **READ**, connect *program* (27) and *VPP* (1) to +5 vdc. Connect the *chip select* (20) and the *output enable* (22) to ground.

To **PROGRAM**, connect the *output enable* (22) and *program* to +5vdc. Connect *chip select* (20) to ground. Next, apply +21 vdc to *VPP* (1). Select the address and input the data. Then bring the *program* (27) line to ground for exactly 50 milliseconds to burn the word you have selected.

Fig. 4. Using the control lines.

values will be +12.5, +21 or +24 volts dc. It is extremely important to use the right programming voltage for your particular EPROM! Fail to do so and you will either lose data or "fry" the chip. Note that an "A" suffix EPROM usually is a low-voltage, nonstandard device.

Data is put into the EPROM once during programming. Since we have 8 bits per word, we'll need eight *data lines*, or one data line for each bit. During actual use, data is *read*, or output, from these data lines to the microcomputer peripheral controlling the EPROM.

The particular word to be programmed or to be read is chosen by a set of *address lines*. Because there are 8192 words in an 8K x 8 EPROM such as the 2764, we need 13 address lines. This happens because the 13th power of two is 8192. These 13 address lines are usually numbered from A0 through A12.

To select a certain address, a binary pattern is put onto the address lines. For instance, to find word decimal 1659, a binary pattern of 0 0110 0111 1011 has to be placed on the EPROM address lines.

Because there are more address lines in a typical microcomputer than there are in a typical EPROM, the high-order address lines on the computer are separately de-

coded to decide when to activate the EPROM.

As an example, the 2764 used for the top half of the Apple IIe monitor sits at the top of the Apple address space from hex \$E000 to hex \$FFFF. Of the 16 Apple address lines, the top three go to an address decoder that activates the EPROM, while the bottom 13 lines go directly to the EPROM.

Finally, we have the three control lines—*chip-enable* (20), the *output-enable* (22) and the *program* (27) lines. These three lines decide what the EPROM will do at any time.

The various combinations of control lines are shown in Fig. 4. To read the EPROM, hold the *chip-enable* and the *output enable* at ground and connect *program* and *Vpp* (1) to +5 volts dc.

To put the EPROM in a standby mode, connect the *chip-enable* to +5 volts dc. This puts the EPROM in a power-down

mode that does not care in what state the other control pins are.

To program the EPROM, first connect the *output-enable* (22) and *program* (27) to +5 V dc. Ground the *chip-enable* (20). Apply the proper programming voltage to *Vpp* (1), which will typically be +21 V dc—*be sure and check*.

Continuing, select an address and input the desired bit pattern on the data lines. To blast the word into the EPROM, bring the *program* (27) pin to ground for exactly 50 milliseconds and then return this pin to +V dc.

Some newer EPROMs have a shorter programming time and some have "intelligent" programming algorithms that let you match the programming pulse width to what is needed. Be sure to consult the individual EPROM data sheets to determine exactly what is called for.

Today's EPROM's are so large that there is no way you could possibly pro-

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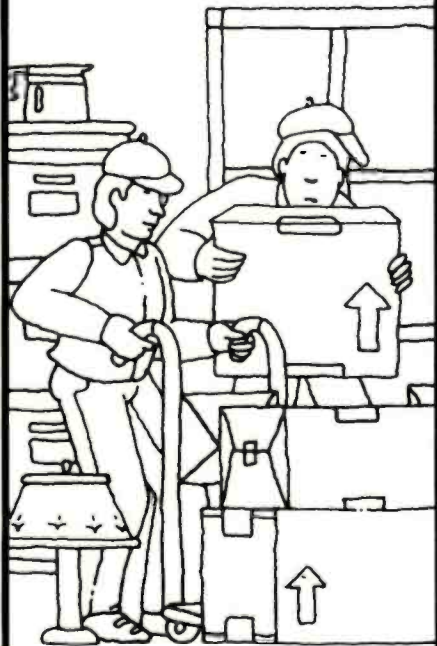
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gram one by hand, one byte at a time, without making a fatal error. So, our obvious next question is . . .

How do I Program an EPROM?

There are two reliable ways of programming an EPROM. You can use a service that does this for you, or else you buy your own EPROM programmer and eraser and do the chip burning yourself.

My favorite EPROM programming service is *E-Tech Services*, which charges something like \$14.50 to program a 2764. You usually submit your EPROM code ready to read on an Apple-compatible diskette. An east-coast source for EPROM programming is *Romulus Microcontrol*, but I have not personally checked these people out.

Most local computer clubs either own an EPROM programmer and eraser outright or will have a member who does custom programming for others.

For the many hackers who require only an occasional EPROM to be burned, these programming services are far and away the best way to go. Note that you would have to burn two dozen or more chips to pay for your own EPROM burner and eraser.

On the other hand, your own local EPROM burning service could be a very profitable venture.

You'll find there are two styles of EPROM burners. There's the industrial "stand-alone" type that typically costs \$1000 or more, and the "plug-in" style that fits a slot on an Apple or other personal computer and is often priced anywhere from \$50 to \$250.

What should you look for in an EPROM burner? I would *always* choose the plug-in type because it costs much less and has all of the disk, printer, and communications resources of the controlling computer available to it. I would also make sure the burner could program at least a 27128, and preferably could handle a 27256 or even a 27512.

If the programmer can also handle

EPROM-like devices such as PALs, PLAs, FPLAs and so forth, so much the better. Prices of these new devices are dropping dramatically and have exciting hacker potential.

Should you be stuck with an older EPROM burner that can handle only a 2732, I have some plans available for simple adaptors that let you work up to a 2764 or even a 27128 on it. Write or call for your no-charge copies. And, if you want more info on microcomputer memory in general, check out volume one of my *Micro Cookbook* (SAMS #21828).

Where Can I Find out More About Laser Printers?

Laser printers are fast becoming *the* opportunity of the decade. And, if you think what is here now is rather impressive, the stuff just around the corner is downright scary—spooky even.

To show you where things sit right now, the original of this entire column was written, "drawn," and typeset using plain old *Applewriter* on an Apple IIe. That includes *all* of the text, *all* of the drawings in final form, *all* of the pictorial symbols, and all the detail work such as the initial cap, the end logo, and even that title "racing stripe." For examples of what I generated with a laser printer, see Fig. 1 through 4 (including captions) and the "Names and Addresses" and "Need Help?" boxes.

The big question is how can you tap this opportunity goldmine?

As with any other field, specialty magazines are your first and foremost way of getting current and useful technical information.

There are two brand-new laser printing specialty magazines. One is *Desktop Publishing*, the other is *Personal Publishing*.

As a reminder, I also have a free laser printer demo pack waiting for you if you call or write. Don't pass this one up.

Any New Tech Literature?

Great heaping mountains of it came in

this month. Let's start at the top of the big pile before it collapses . . .

From *Texas Instruments*, volume II of the *TTL Data Book*, along with a *MOS Memory Data Book*, and a separate *Supplement to the MOS Memory Data Book*. These are all first-rate data manuals from a major source. You'll find lots more on those EPROMs in these two MOS memory books.

From *Silconix*, a *Mospower Data Book*, and a hard bound book titled *Mospower Applications*. While this later jewel has a \$25 list price, it is a cut above usual application-note collections. There's lots of info here on power field-effect transistors, switching-mode power supplies, telephone circuits, and more.

From *Maxim* comes an exciting data book on lots of new linear integrated circuits. This one is called *CMOS Data Ac-*

quisition Products. Maxim is both a second source of *Intersil* products as well as the innovator of some really wild linear integrated circuits. One of these forms a complete line-operated power supply using nothing but a 4-pin mini-DIP package, two capacitors and two resistors.

From *Bishop Graphics*, comes *Circuit Drafting and Technical Manual*. Besides all your usual tape and dot stuff, this dude has lots of hints on printed-circuit layout, electronic schematics, mil standards, and so on.

And, somewhat near the bottom of the barrel, a host of "second tier" data books. These include the *Data Acquisition IC Handbook* from *Teledyne* and a full-line catalog from *Micro Power Systems*. There's a *CMOS Databook* from *Hughes*; a *Data Book Supplement* from *Burr Brown* on A/D converters and op

amps, and a pair of books from *Mitsubishi* on very large high-power semiconductors—*Power Module Data Book* and *Power Module Application Book*. All of these are usually free on written request or a phone call.

Finally, remember that the way to end up working hard is to also play hard. For \$3.00 from *NOAA*, get a copy of *Thermal Springs List for the United States*. **ME**

NEED HELP?

Phone or write your *Hardware Hacker* questions directly to:

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