*Once upon a time, in a magic kingdom far away, there lived a truly wondrous automobile. It was the first "no excuses, no apologies" automobile ever available, and was very popular among the princes and the populace alike. Alas, this otherwise stupendous machine had a single and very serious flaw. A flaw so insane that it could only have been placed there by a demented and wicked witch.*

*For, you see, this wondrous automobile had a large pedal on the floor that was plainly marked "BRAKE." Drivers of this automobile expected and assumed that, when this "BRAKE" pedal was pressed, the automobile would be brought to a swift and safe stop, without harm to the driver, or to any of the passengers, or to any cargo.*

*But this was nought to be. Forsooth, the "BRAKE" pedal was really a magical pedal under a horrible spell. If the "BRAKE" pedal was pressed by itself, the automobile, the driver, and all contents got magically and instantly whisked back to the carriage house from whence the trip began.*

*If a driver was foolish enough to press the "BRAKE" pedal at the same time he turned on the windshield wipers, the wondorous automobile did, in fact come to an immediate stop. But, alas and alack, the immediate stop was so sudden and so violent that it destroyed the driver, passengers, and all contents of the magical vehicle.*

*Well, not really destroyed. For, you see, all that really happened is that a pair of holes, five urflogs in diameter, got neatly punched completely through the driver, any passengers, and all else that happestance had placed inside the wondrous machine.*

*When the grand vizeers were asked why the "BRAKE" pedal was not really a "BRAKE" pedal, but instead an evil and demonic device, they offered two reasons.*

*Some vizeers said that the multitudinous makers of hood ornaments and glove compartment door hinges did not want the drivers bringing their vehicles to a quick and safe stop, since the hood ornaments and glove compartment door hinges could then—horror of unspeakable horrors—actually be inspected and possibly modified by the driver.*

*Others said that there must be some protection to keep the driver from inadvertently and unintentionally pressing the "BRAKE" pedal if he did not, in fact, really want to bring this wondrous automobile to a swift and safe stop. And indeed, a much older model of the same wondrous automobile, did have its "BRAKE" pedal situated where it could easily be mistaken for the horn ring.*

*Lo and behold, a certain driver of the wondrous automobile finally decided he had more than enough of this male bovine excreta.*

*He pulled out the old "BRAKE" pedal by its roots and threw it away. Then, he replaced the magical "BRAKE" pedal with a real one that was able to swiftly and controllably bring this wondrous automobile to a safe and sure stop. Having done so, the driver grabbed the nearest handy princess, drove off into the sunset, and lived happily ever after.*

# Upgrading Apple IIe's ROM Monitor

***Here are fixes to change this model's restrictive monitor to an absolute old reset one, giving users an opportunity to unleash the computer's real power.***

**By Don Lancaster**

A fable, you say? Only perhaps.

The wide-selling Apple IIe computer, likely the last Apple computer with reasonable expansion flexibility, including socketed ICs, is not as tractable as adventurous users would like it to be. Its ROM monitor, where the system's routines lie, has a fatal flaw of sorts. It's not in the code itself, but in what a resident monitor should allow a user to do beyond what its creators think you should do.

To got past the built-in restrictions imposed by the machine's system monitor, so that you can do all sorts of wonderful things—emulate a "snapshot" card, replace the entire operating system with your own custom code for dedicated data-acquisition purposes, perform certain CAD/CAM programs, run special turnkey applications, etc.—I'll show you how to design an improved monitor, like those in older Apples before the mass-market syndrome set in. With this ROM change, *you'll* be in control, custom-modifying "Applesloth" to your heart's desire.

Fortunately, the IIe monitor is resident in chips that can be swapped easily for 64K EPROMs. Along the way I'll show you how to burn in the new EPROMs (which cost only about $6 each), that will replace the original ones including putting in the necessary code. The improved monitor will do everything the original IIe monitor ROM does, as well as open new computing vistas for you. Moreover, there is no "hole blasting" done on a cold restart, which essentially destroyed pages of code on a reset, taking away marvelous tools such as stopping and inspecting. And if you keep your finger on the Open-Apple key for at least four seconds *after* a cold reboot, you will be dropped directly in the "old," more versatile monitor, awaiting your every machine-language command.

The code version covered here applies *only* to the "original" IIe ROMs, shipped in most IIe's up to late fall of 1984. Separate code is required for either the "new" IIe ROMs or for the IIc. (See box at end of article for details on getting code for versions.) You can tell you have an "original" IIe ROM if your scrolling appears disjointed and chunky.

I call this new monitor a KREBF monitor, named after the magic spell that "repairs willful damage" in Infocom's *Enchanter* adventure game. Actually, we won't repair any willful damage . . . we just won't do any in the first place. I'll show you a painless and fully automatic process for converting your own firmware into a form useful for EPROM programming. I will also give you the full *new* source code patch that will return absolute control of your IIe back where it rightly belonged in the first place. (This is also available ready-to-run on a companion diskette, as well.)

## *About The Firmware*

The stock Apple IIe has 16K of ROM-resident firmware that sits between $C000 and $FFFF. As Fig. 1 shows, this firmware is held in two 64K read-only memories. One of these is called the CD memory and sits in main board location E8, while the other is called the EF memory and sits in board location E10.

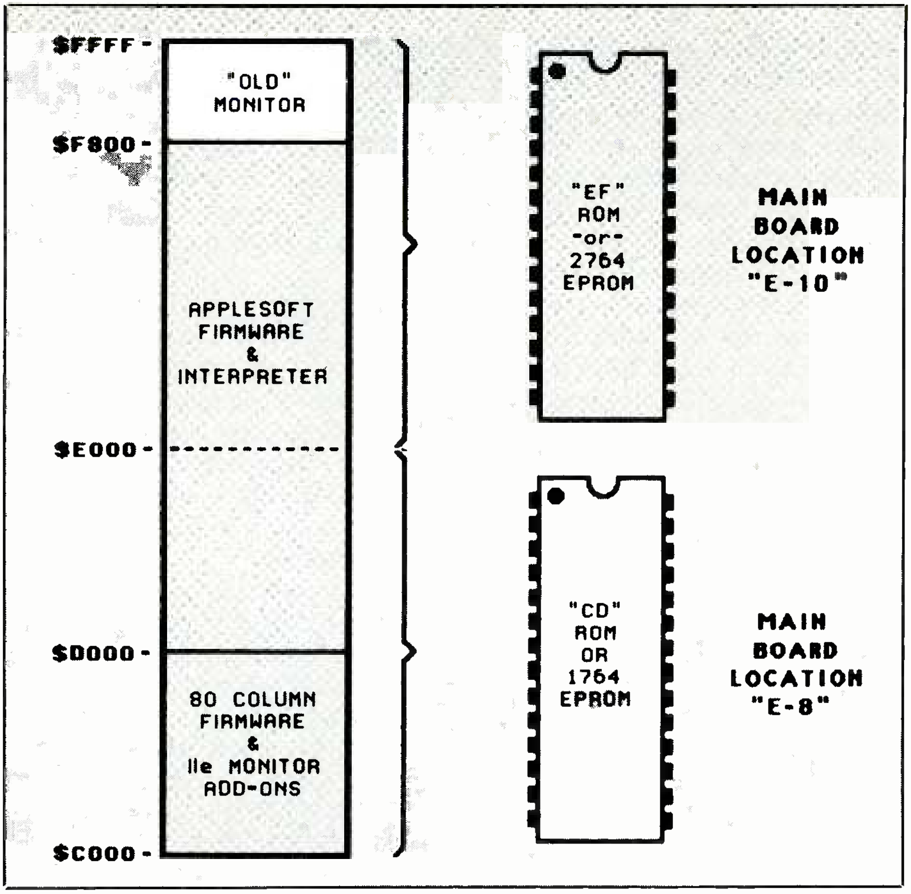

$FFFF
$F800
$E000
$D000
$C000
"OLD" MONITOR
APPLESOFT FIRMWARE & INTERPRETER
80 COLUMN FIRMWARE & IIe MONITOR ADD-ONS
"EF" ROM -or- 2764 EPROM
MAIN BOARD LOCATION "E-10"
"CD" ROM OR 1764 EPROM
MAIN BOARD LOCATION "E-8"

*Fig. 1. Apple IIe firmware is held in a pair of 8K × 8 ROMs. Standard 2764 EPROMs can be directly substituted for the supplied ROMs.*

The traditional monitor area to older Apple IIs needed only the 8K space from $F800 to $FFFF. This area is still used as a monitor for the IIe. To provide for the many new IIe features, expansion hooks have been added to also allow use of the $C000-CFFF memory area.

Since $C000 to $CFFF is in the I/O (input/output) area, special soft switches are used to pick either "normal" I/O or "monitor" use of this address space. Thus, anything that wants use of the "new" IIe monitor area must first turn off the I/O space and then turn on the CD firmware ROM. When you are finished using the new monitor area, the CD ROM must be turned back off and the I/O space must be reactivatcd.

There are four soft switches involved. One pair handles only the memory area from $C300 to $C3FF and is used to make the 80-column firmware look like it is sitting in slot 3 of the I/O space. The second pair of soft switches is used to switch everything else. These are called the $CX00 switches. The X here can be a 1, 2, 4, 5, 6 or 7.

The top half of the CD memory and the bottom three-quarters of the EF memory hold the Applesoft firmware. This code is apparently unchanged from earlier models, in the "original" IIe firmware. The "new" IIe and IIc firmware made some changes to Applesloth, such as allowing lower-case commands.

Older Apples used 16K ROMs that were not quite compatible with industry standard 2716 EPROMs. One enable pin was active-high on the

ROM, compared to an active-low state needed by a 2716 EPROM. While you could just change some jumpers around to do some short-sighted 2716 replacements, you really needed a small plug-in card to actually do the job right.

Without the inverter, certain plug-in cards could cause memory contention and hang up the machine. Quite a few articles on adding EPROMs to older Apples ignored this key point, leaving you with a potential time bomb on your hands. Thus, swapping for 2716 EPROMs did not get done much on older Apples because of the hassles involved.

Very fortunately, the 64K ROM firmware used in the IIe is directly and exactly compatible with the standard 2764 EPROM. So, to customize things any way you like, you simply swap chips.

The "CD" or "EF" chips in a IIe may be directly replaced by 2764 EPROMs. In case you've tuned into the microcomputer revolution late, a 2764 is a special "read-mostly" memory that you can custom program and reprogram yourself. You buy these for around six bucks. Erase any old memory contents by using a special ultra-violet lamp. You reprogram the memory to suit your application, using either a programming card for the Apple or a stand-alone EPROM programmer.

EPROM programmers are readily available at any hacker's club if you do not already own one. We will shortly see a sneaky way to program the 2764 on older burners that may not be directly able to handle such a large EPROM.

To customize your IIe, all you have to do is burn one or two 2764 EPROMs and then swap them for the CD or EF memory they are to replace. That quick and that simple.

There is one minor "gotcha" though: the 2764 EPROM used *must* be an Intel or Hitachi brand with 28 pins and an access time of 250 nanoseconds. Real 2764s always come in a 28-pin package, and are the *only* type of 2764 useable as a direct Apple monitor replacement. (Both Motorola and Texas Instruments have their own imitation versions of fake 2764's that come in 24-pin packages.)

## *About 64K Eproms*

Figure 2 shows the pinouts for a real 2764, along with some use details.

To analyze any memory chip, break the package leads down into four groups: supply, address, data, and control lines. Then analyze each group as follows:

- Only a single + 5-volt supply and ground are needed for normal reading of the 2764 EPROM. Supply current is typically around 150 milliamperes in the read mode.

- The 2764 is a 64K memory that is organized as 8K by 8. This means that there are 65,536 bit locations that are programmable to 1 or 0. These bit locations are arranged into word bytes of 8 bits each. Thus, there are 8192 different 8-bit words.

The address lines select which word is to be written to or read from. Thirteen address lines are needed, since $2^{13} = 8192$. To select a particular 8-bit word, the correct binary pattern of 1s and 0s is placed on the address lines. Internal address decoding inside the chip then selects the correct byte for reading or writing. Address lines always input *from* the microcomputer *to* the 2764.

There are eight data lines, used to route the contents of the addressed byte to the microcomputer during a read. The same lines are used to send the data to be written into the EPROM during a write. Thus, the data lines input to the EPROM during a write, and output from the EPROM during a read.

- There are five possible activities an EPROM can be up to:

1) Erase—clears the entire memory when exposed to strong UV light.

2) Program—writes a single byte into memory.

3) Verify—checks a byte just written during programming.

4) Read—outputs a previously programmed data value.

5) Standby—does nothing, allowing other data bus uses.

These activities are handled by four control lines, called VPP, $\overline{\text{PGM}}$, $\overline{\text{OE}}$, and $\overline{\text{CE}}$.

To use an EPROM, you first have to program it. Before you program it, you have to erase anything previously stored in it. Erasure forces all of the data bits to 1s, and all bytes to $FFs. This erasing is done with a special ultraviolet lamp.

The VPP (programming voltage) line provides normal + 5 volts dc for standby and reading. To program, this line must be brought to + 21 to + 24 volts. Earlier EPROMs did not not have this programming voltage on a separate pin, which complicated things. On some micro systems, it is a simple matter to in-socket program a 2764. Unfortunately, the stock Apple IIe does not have this capability. At any rate, leave VPP at + 5 volts to do anything but program. Raise it to + 24 volts to program.

Incidentally, most 2764s can use either a + 21- or a + 24-volt VPP programming voltage. Some older 2732As and a few 2764As demand a maximum of + 21 volts while being programmed and will self-destruct on the traditional + 24 volts. Check the data sheet for the exact brand you are using if there is any doubt.

The $\overline{\text{PGM}}$ (program) line is a normal logic control signal. This one is grounded to program and is set to + 5 for everything else.

The $\overline{\text{OE}}$ (output enable) line is brought low for a read or a write. A high $\overline{\text{OE}}$ line disconnects the outputs of the EPROM, but leaves the chip addressed and fully powered.

The $\overline{\text{CE}}$ (chip enable) is used to turn on or off the entire EPROM. During a read, $\overline{\text{CE}}$ must be brought

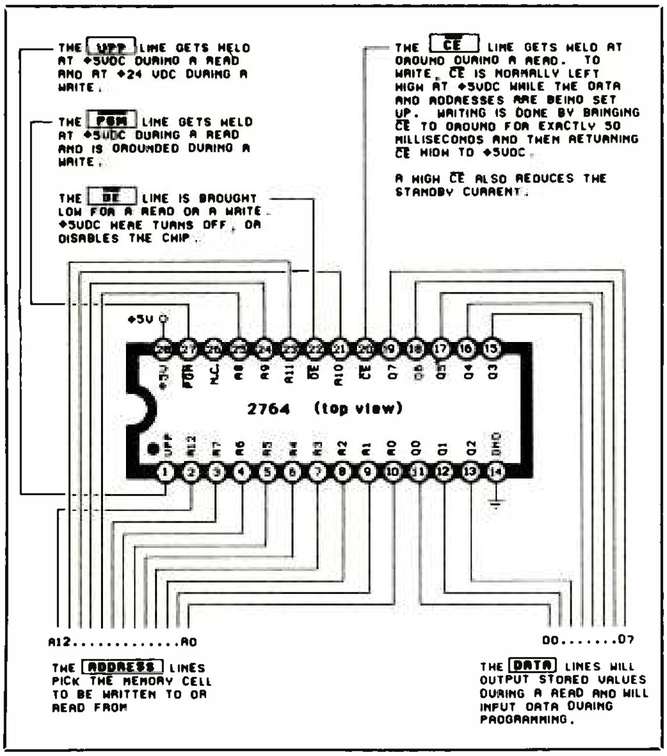

THE VPP LINE GETS HELD AT +5VDC DURING A READ AND AT +24 VDC DURING A WRITE.
THE PGM LINE GETS HELD AT +5VDC DURING A READ AND IS GROUNDED DURING A WRITE.
THE OE LINE IS BROUGHT LOW FOR A READ OR A WRITE. +5VDC HERE TURNS OFF, OR DISABLES THE CHIP.
THE CE LINE GETS HELD AT GROUND DURING A READ. TO WRITE, CE IS NORMALLY LEFT HIGH AT +5VDC WHILE THE DATA AND ADDRESSES ARE BEING SET UP. WRITING IS DONE BY BRINGING CE TO GROUND FOR EXACTLY 50 MILLISECONDS AND THEN RETURNING CE HIGH TO +5VDC.
A HIGH CE ALSO REDUCES THE STANDBY CURRENT.
+5V
28 27 26 25 24 23 22 21 20 19 18 17 16 15
+5V PGM N.C. A8 A9 A11 OE A10 CE O7 O6 O5 O4 O3
2764 (top view)
VPP A12 A7 A6 A5 A4 A3 A2 A1 A0 O0 O1 O2 GND
1 2 3 4 5 6 7 8 9 10 11 12 13 14
A12.............A0
O0.......O7
THE ADDRESS LINES PICK THE MEMORY CELL TO BE WRITTEN TO OR READ FROM
THE DATA LINES WILL OUTPUT STORED VALUES DURING A READ AND WILL INPUT DATA DURING PROGRAMMING.

Fig. 2. Drawing shows how a 2764 is used.

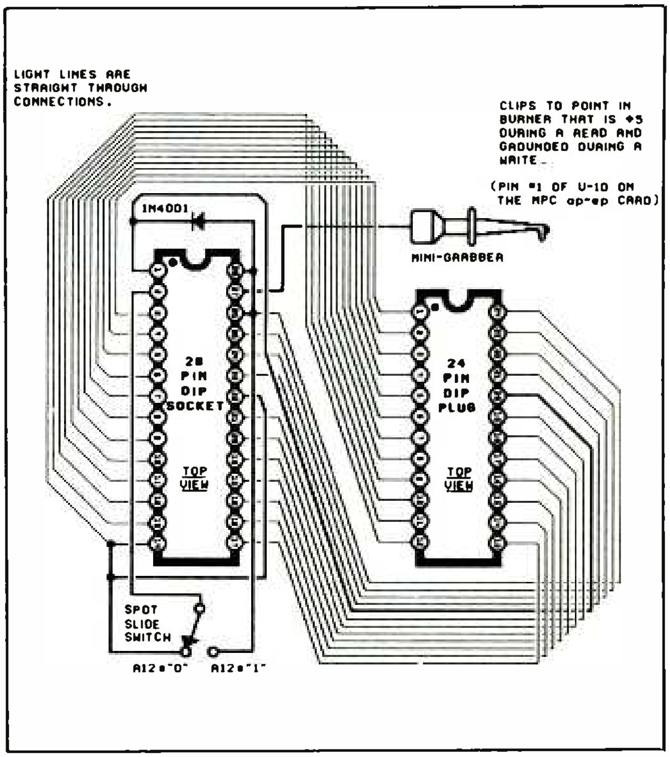

LIGHT LINES ARE STRAIGHT THROUGH CONNECTIONS.
CLIPS TO POINT IN BURNER THAT IS +5 DURING A READ AND GROUNDED DURING A WRITE.
(PIN #1 OF U-10 ON THE MPC ap-ep CARD)
1N4001
MINI-GRABBER
28 PIN DIP SOCKET
TOP VIEW
24 PIN DIP PLUG
TOP VIEW
SPDT SLIDE SWITCH
A12="0"
A12="1"

Fig. 3. Adapter for using 2764 in 2732 burner.

low. During a write, $\overline{CE}$ is held high until an address is selected and data is input. Then $\overline{CE}$ is brought low for exactly 50 milliseconds to blast the data value into the EPROM. $\overline{CE}$ is then returned high while the address changes for the next byte. A high $\overline{CE}$ also greatly reduces the standby supply power needed.

Apple chose to use the $\overline{OE}$ line as an alternate chip-enable, since it is faster. They were not in the least worried about saving any supply power, since they already had problems meeting the minimum power supply current drain during the IIe redesign. Apple also permanently grounded the $\overline{CE}$ line and permanently held the PGM line at +5 volts, forcing any 2764 plugged into the main board into a read-only mode.

Thus, unless you want to do some major board carving, "in situ" programming of a 2764 EPROM in an Apple IIe is not normally feasible. Instead, you have to use an EPROM programmer or programming card and then swap out the chips. For more information on this and other memory chips, check into *Don Lancaster's Micro Cookbooks,* SAMS #21828 and #21829.

## Programming A 2764 On An Older Burner

Many older EPROM burners cannot directly handle a 2764, and you won't find too many newer models available yet that do. Some of the nasties involved in physically upgrading an older burner include going from a 24-pin to a 28-pin socket, providing that thirteenth address line, getting a PGM signal to the socket, and figuring out how to stuff 8K worth of data into the 4K I/O space normally available on an Apple IIe.

We can bypass all these hassles by adding a fairly simple and easy-to-use adapter to an older EPROM burner. This adpater will make the 2764 to be programmed look like a sequential pair of older 2732s. If you can can program a 2732, as most older EPROM burners can, you can easily program a 2764 with this adaptor.

You will find a two-position slide switch on the adaptor. (*Caution:* Do not use a toggle switch here; it works "backward.") Put the switch in the LOW position to program the low 4K of your 2764 as if it is a 2732. Then flip the switch to the HIGH position so you can program the high 4K of your 2764 as if it is a separate 2732.

Our adapter is intended for use with the MPC "ap-ep" EPROM burner peripheral card for the Apple II or IIe. Certain details might change for other burners.

Listed in the table are the parts you will need to fabricate your adapter. These parts should be readily available anywhere, although you *must* be certain to use the type of premium *machine-contact* DIP socket that can safely be plugged into one another.

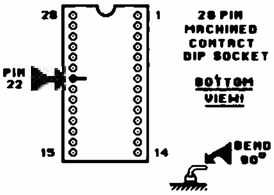
A schematic of the adapter is shown in Fig. 3. Note that this adaptor and the tools required to build it

NOTE This adaptor is needed ONLY if you must burn a 2764 EPROM on an older 2732 burner. You do NOT need this adaptor to replace a IIe ROM with a 2764 EPROM.

1.

[ ] Place the 28 pin machined contact DIP socket pins up and identify pin 22. Carefully bend pin 22 towards the center as shown.

Be sure you are using the long 28 pin socket and not the short 24 pin one. Pins are numbered "backwards" from usual when viewed from the bottom

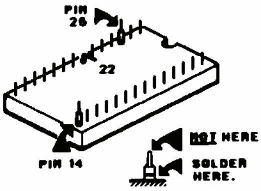


2.

[ ] Push a single bare machined contact socket pin onto pins 14 and 26 as shown.

[ ] NOTE: In any soldering steps, snap an extra DIP strip onto the cool end of the pins being soldered. This keeps the pins aligned should the plastic soften.

[ ] Solder pin to socket at pins 14 and 26. **DON'T GET SOLDER ON THE PIN TIPS!**

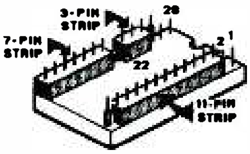


3.

[ ] Push an 11 pin machined contact DIP strip into pins 3-13 as shown.

[ ] Push a 7 pin machined contact DIP strip into pins 15-21 as shown.

[ ] Push a 3 pin machined contact DIP strip onto pins 23-25 as shown.

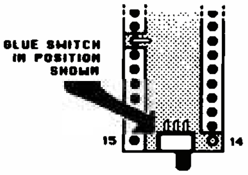


4.

[ ] Carefully roughen one side of the SPDT slide switch and the bottom of the 28 pin DIP socket between pins 14 and 15. Use very fine sandpaper or steel wool.

[ ] Glue the switch to the 28 pin DIP socket as shown using superglue or epoxy. Let sit overnight and then verify that the switch still works.

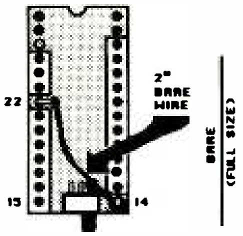
**DON'T GET ANY GLUE INSIDE THE SWITCH !**



5.

[ ] Prepare a two inch length of bare #24 wire. Connect this wire to pin 14 of the 28 pin socket, then to the nearest pin on the SPDT slide switch, and finally to bent pin 22.

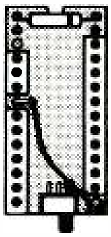
[ ] Solder all three connections, using a spare DIP strip as a safety backup heatsink. Cut off any remaining wire. Be careful not to get any solder on the tip of pin 14.



6.

[ ] Connect the 1N4001 silicon diode from pin 1 to pin 28 of the 28 pin DIP socket. Be certain that the cathode bar of the diode goes to pin 1.

[ ] Make mechnically secure connections, but do not solder them just yet.



7.

[ ] Take a two inch piece of red #24 solid insulated wire and strip 1/4 inch from one end and 3/4 inch from the other.

[ ] Solder the 1/4 inch end of this wire to the far unused pin on the SPDT slide switch. Loop the 3/4 inch end of this wire around pin #26 and then to the diode lead coming from pin #28.

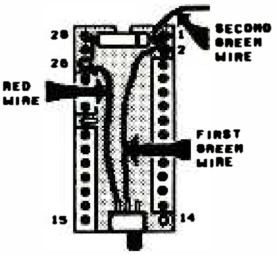
[ ] Use an extra DIP strip as a heatsink, and solder the red wire to pins 26, 28 and the diode lead. Make sure you do not contact pin 27.

RED
(FULL SIZE)

8.

[ ] Prepare two green insulated #24 wires two inches long by stripping 1/4 inch off each end. Solder one end of the first green wire to the center SPDT switch terminal.

[ ] Solder the other end of the first green wire to pin 2 as shown. Use a dip strip as a heatsink in all soldering steps.



are needed *only* if you are having trouble burning a 2764 EPROM on an older EPROM burner. All you need to do the actual upgrade on your IIe is a programmed 2716 and a simple chip swap.

Figure 4 gives complete construction details for the adapter. It is very easy to build, and should take all of half an hour. Be sure to use an extra machined-contact DIP socket or socket strip when soldering anything. This will keep the pins properly spaced and aligned should the plastic soften. Plug this extra socket into the cool ends of the pins soldered so it straddles any pins to be heated.

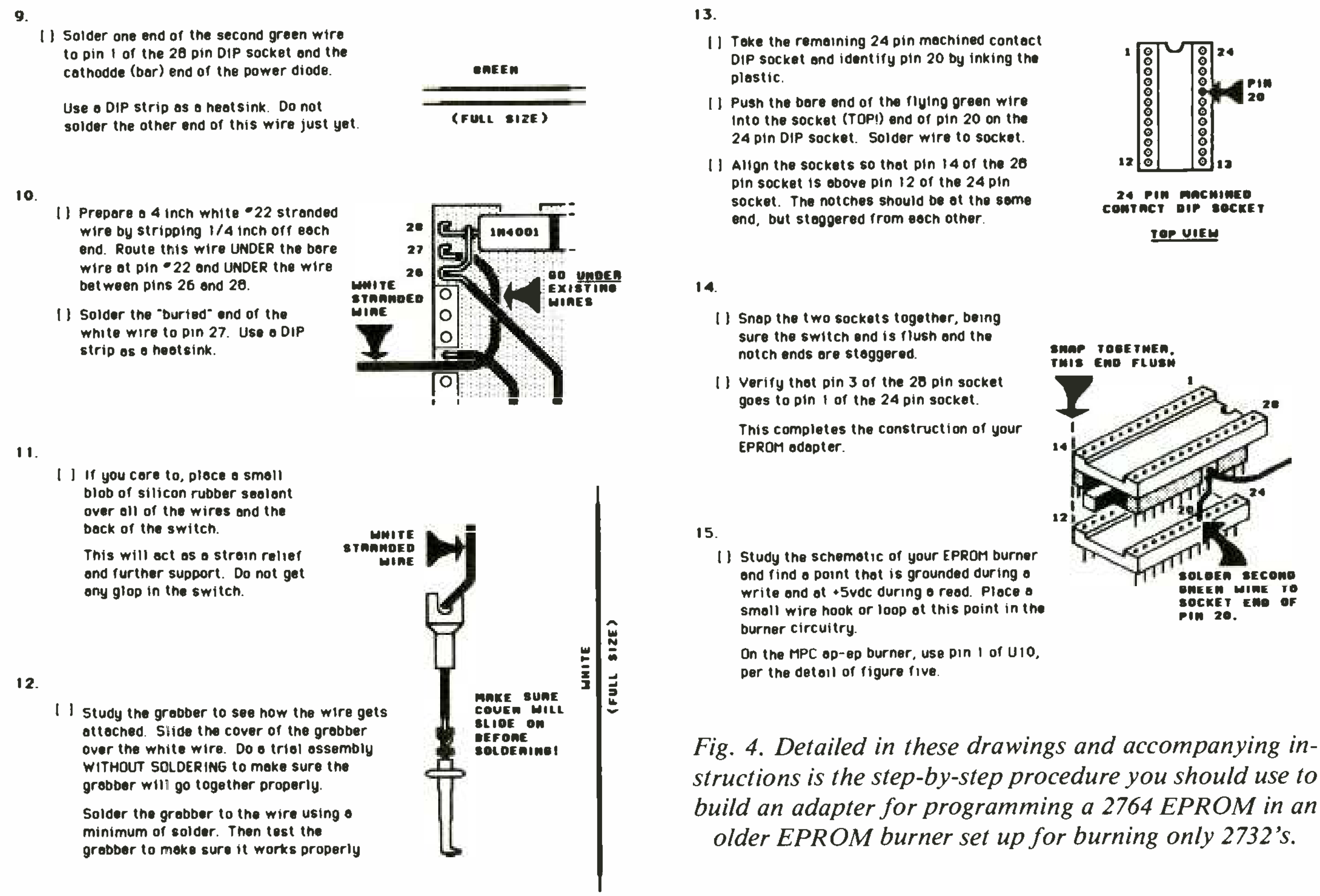
If you use the optional epoxy or super glue, be careful not to get any of it inside the slide switch. Carefully test the switch after the glue sets.

You might later want to add a 28-pin ZIF (zero-insertion-force) socket atop the regular socket. Depending on the pins on the ZIF, this may plug in or have to be soldered.

Figure 5 shows you how to use the adapter on the MPC "ap-ep" card. A very slight modification to the card itself is needed. You have to add a small wire hook to the top of pin one of integrated circuit U10. The easiest way to do this is to tin the top of the pin with a very small amount of solder. Then bend a hook in the end of a resistor lead. Reflow solder the resistor lead in place. Finally, cut away all of the resistor except enough lead to form a small loop.

If you are using a different card or a stand-alone burner, make sure you find a place that is at ground during writing and at +5 volts during reading. Add a small wire hook to this point so the grabber can access this signal. Also be sure that pin 1 will be at +5 volts during read and at +21 or +24 volts during programming.

One detail. Note that the 2732 requires a VPP signal of ground for a read and +21 or +24 volts for a write. The 2764 instead requires a VPP signal of +5 volts for a read and +21 or +24 volts for a write. This



9.

[ ] Solder one end of the second green wire to pin 1 of the 28 pin DIP socket and the cathodde (bar) end of the power diode.

Use a DIP strip as a heatsink. Do not solder the other end of this wire just yet.

10.

[ ] Prepare a 4 inch white #22 stranded wire by stripping 1/4 inch off each end. Route this wire UNDER the bare wire at pin #22 and UNDER the wire between pins 26 and 28.

[ ] Solder the "buried" end of the white wire to pin 27. Use a DIP strip as a heatsink.

11.

[ ] If you care to, place a small blob of silicon rubber sealant over all of the wires and the back of the switch.

This will act as a strain relief and further support. Do not get any glop in the switch.

12.

[ ] Study the grabber to see how the wire gets attached. Slide the cover of the grabber over the white wire. Do a trial assembly WITHOUT SOLDERING to make sure the grabber will go together properly.

Solder the grabber to the wire using a minimum of solder. Then test the grabber to make sure it works properly

13.

[ ] Take the remaining 24 pin machined contact DIP socket and identify pin 20 by inking the plastic.

[ ] Push the bare end of the flying green wire into the socket (TOP!) end of pin 20 on the 24 pin DIP socket. Solder wire to socket.

[ ] Align the sockets so that pin 14 of the 28 pin socket is above pin 12 of the 24 pin socket. The notches should be at the same end, but staggered from each other.

14.

[ ] Snap the two sockets together, being sure the switch end is flush and the notch ends are staggered.

[ ] Verify that pin 3 of the 28 pin socket goes to pin 1 of the 24 pin socket.

This completes the construction of your EPROM adapter.

15.

[ ] Study the schematic of your EPROM burner and find a point that is grounded during a write and at +5vdc during a read. Place a small wire hook or loop at this point in the burner circuitry.

On the MPC ap-ep burner, use pin 1 of U10, per the detail of figure five.

GREEN
(FULL SIZE)
28
27
26
1N4001
WHITE STRANDED WIRE
GO UNDER EXISTING WIRES
WHITE STRANDED WIRE
MAKE SURE COVER WILL SLIDE ON BEFORE SOLDERING!
WHITE
(FULL SIZE)
1
24
PIN 20
12
13
24 PIN MACHINED CONTACT DIP SOCKET
TOP VIEW
SNAP TOGETHER, THIS END FLUSH
1
28
14
24
12
20
SOLDER SECOND GREEN WIRE TO SOCKET END OF PIN 20.

*Fig. 4. Detailed in these drawings and accompanying instructions is the step-by-step procedure you should use to build an adapter for programming a 2764 EPROM in an older EPROM burner set up for burning only 2732's.*

read supply difference is the purpose of the diode between adaptor pins 1 and 28. If you are using an oddball EPROM burner, make sure that no "hard" ground shorts this diode or a supply line.

To install the adaptor, put it in the existing 24-pin ZIF socket so that the switch points *away* from the ZIF handle. You might have to jiggle the handle slightly, center the adapter, and then slide the locking handle home, as there is a very slight "negative clearance" between the open handle and the adapter. Then glomp the grabber onto the wire hook.

Be *certain* that the EPROM burner or card is configured for a 2732 burn! *Never* try connecting or disconnecting the grabber with a 2764 in place! As a special note to MPC "ap-ep" users, also be sure both *S2* and *S3* are in their OFF position, pointing towards the bottom of the card.

If your EPROM burner uses personality modules, be sure to use the 2732 module and *not* a 2732A module.

*Due to lack of space, we're unable to present the entire article at this time. Next month, we'll finish with programming on an older burner, tell you how to capture, modify and test the monitor, and give detailed instructions on how to install the "old" monitor in a IIe.* ME

## Parts Table

1—28-pin machined-contact DIP socket
1—24-pin machined-contact DIP socket
1—11-pin machined-contact DIP strip
1—7-pin machined-contact DIP strip
1—3-pin machined-contact DIP strip
2—bare machined-contact DIP pins
1—extra DIP socket for heat sink
1—miniature spdt slide switch
1—1N4001 silicon power diode
1—mini-grabber test clip
1—¼-watt resistor, any value (see text)
1—4" white #22 stranded wire
1—2" bare #24 solid wire
1—2" red #24 solid wire
2—2" green #24 solid wire
optional—super glue, epoxy, or silicone adhesive.

# Upgrading Apple IIe's ROM Monitor

## Part II

*Here are fixes to change this model's restrictive monitor to an absolute old reset one, giving users an opportunity to unleash the computer's real power.*

By Don Lancaster

*Last month in Part I of this article, we discussed Apple IIe firmware, cautioned you about using non-standard ROMs, and began to tell you how to program a 2764 on an old ROM burner. In this concluding part, we continue the burn instructions, tell you how to capture and modify the IIe monitor, and give you a checkout routine for testing your new custom ROM monitor.*

Here are the rules on the slide switch use:

The slide switch points to ground (pin 14) for a low address A12.

It points to +5 volts (pin 28) for a high address A12.

Use the LOW switch position for a C or E monitor burn.

Use the HIGH switch position for a D or F monitor burn.

You might like to mark a 0 on the left switch position and a 1 on the right switch position.

### *Capturing the IIe Monitor*

Catching the D, E, and F segments of the monitor ROM is rather trivial. In fact, some burner-card software will let you simply move their buffer directly to these locations. But the $C000 to $CFFF monitor capture is a bit tricky and non-obvious. So, Program 1 (not shown here due to lack of space, but available free of charge, along with the source code for KREBF SPELL patch by sending a self-addressed legal-size envelope to MODERN ELECTRONICS, Dept. PROG1, 76 N. Broadway, Hicksville, NY 11801) shows you an Applesloth program called SNATCHMON. What SNATCHMON does is grab four 4K segments of the monitor. It places these on disk under IIEMON.C, IIEMON.D, IIEMON.E, and IIEMON.F names.

You then modify these four segments as needed for your custom monitor. These are saved to disk to be BLOADed to a buffer at $8000 to $8FFF. You can relocate these as needed if your EPROM burner card needs a different buffer area. If you have a stand-alone burner, you can use a modem program to send these binary files out as serial text files, and then use them as needed.

SNATCHMON is surprisingly fast, since all of the actual moves are done using the monitor "M" command. Suitable POKEs'activate each move as needed. It is absolutely essential that the Y register be zeroed before a monitor move. To do this, any SNATCHMON move CALL first goes to a five-byte machine program at $7FFB that clears the Y register and then jumps to the actual move routine at $FE2C.

Locations $3C (low) and $3D (high) hold the move starting source address. Locations $3E (low) and $3F (high) hold the move ending address. Finally, locations $42 (low) and $43 (high) hold the starting destination address. After these six locations are POKEd with the correct values, the move can be made.

If you're having trouble converting Applesloth decimal into machine hex, check into the *Hexadecimal Chronicles* (SAMS #21802) for instant conversions.

To capture the $C100 to $CFFF monitor as IIEMON.C, you have to flip two pairs of soft switches just right. The magic switches involve $C006, $C007, $C00A, and $C00B. Soft switch $C007 turns on the monitor for the $CX00 access, while $C006 turns on the normal I/O. Soft switch $C00B turns on the monitor for $C300 access, while $C00A turns on the normal slot 3 usage. (Note that these switch flips are *backwards* from page 214 of the *Apple IIe Reference Manual.* Be sure you correct your reference manual. Very ungood things happen if you get these actions mixed up. Note that you must *write* to these locations to activate them, such as with a "C006:00 [cr]" or a

"POKE 49158,0 [cr]". Reads just won't hack it.)

There are a few other soft switches used to control the monitor ROM area, but we need not worry too much about these here. Normally, a cold boot is done before you try running SNATCHMON, which flips the switches into their "normal" positions. You then flip soft switches $C007 and $C008 long enough to move the $C100 to $CFFF monitor image to $8100 to $8FFF, and then flip these switches back to their usual $C006 and $C00A positions.

SNATCHMON assumes you have a single disk drive. A "press the spacebar" prompt lets you change diskettes if you want the images of IIEMON.C, IIEMON.D, IIEMON.E, and IIEMON.F to end up on a different diskette.

## *Modifying the IIe Monitor*

The IIe monitor is crammed full and has very little in the way of free bytes. There are a few bizarre bugs, such as a programmer's ASCII first name that can get executed as op-codes by certain programs accessing <ctrl>-Y at the old location. The percentage of "compatible" II+ programs is far lower than Apple cares to admit, since just about any decent II+ program makes use of "illegal" monitor access. As a general rule, schlock II+ programs are IIe compatible, while creative and useful ones are not.

Areas available for rewriting are the cassette routines, the screen message, and the above-mentioned "Bryan" code. I urge you not to clobber the cassette routines, since cassettes can often salvage a disaster, even after all else has failed.

About the only monitor area that nobody wants to keep is the hole blaster from $C249 to C260. So, as an example of patching the monitor, we will overwrite this hole blaster with code that accesses the old monitor.

The source code appears as Program 2 (see above for availability). It is called KREBF SPELL.SOURCE, and assembles into a KREBF SPELL patch. This module is simple enough that we can forego a flowchart. We've used the "new" EDASM format for the source code here.

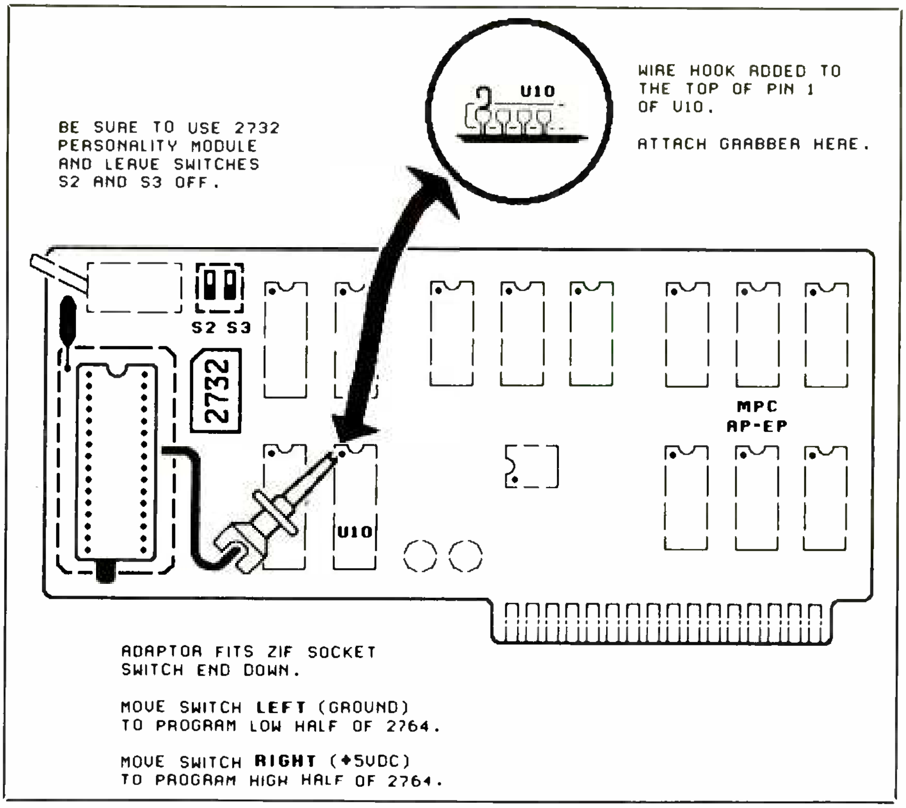
You can get to location $C249 on a [ctrl] <open-apple dingbat> [reset]. We first blast the warm start location at $03F4 by *incrementing* it. This tells the Apple that we are to do a cold reboot, rather than letting the applications program in use "capture" the reset back to itself.

Then we run through a timing loop 40 times. Each time through, we stall for a tenth of a second via the monitor WAIT routine at $FCA8. We then check to see if the open-apple key is released. If it is released, we continue with a stock cold reboot, sans the hole blasting. If the key is down, we keep on stalling.

If we timeout to a full four seconds, we instead jump directly to the "old" reset code which, thankfully, remains in the monitor at $FF59. The four seconds was selected to be long enough that a child or an unknowing user is unlikely to accidently trip the old monitor access.

There are some undocumented Apple IIe diagnostics stashed at $C400 to $CFFF that will fail the CD ROM if a checksum of all the bits in the entire ROM does not agree with a magic value.

To pass these diagnostics, the checksum of the KREBF SPELL must be the same as that of the hole blaster bytes it replaced. The magic checksum for these $18 bytes of code is $0BA8. The byte at $825E corrects this checksum to let your altered code pass the diagnostics. Note that any



BE SURE TO USE 2732 PERSONALITY MODULE AND LEAVE SWITCHES S2 AND S3 OFF.

WIRE HOOK ADDED TO THE TOP OF PIN 1 OF U10.

ATTACH GRABBER HERE.

ADAPTOR FITS ZIF SOCKET SWITCH END DOWN.

MOVE SWITCH **LEFT** (GROUND) TO PROGRAM LOW HALF OF 2764.

MOVE SWITCH **RIGHT** (+5VDC) TO PROGRAM HIGH HALF OF 2764.

*Fig. 5. This drawing shows how to use the 2764 adapter in the MPC "ap-ep" burner card.*

changes at all to this code will need a different value for the checksum adjustment byte.

To use your source code, you assemble it into the patch, and then overwrite the patch onto your monitor image. Alternatively, you can hand-load the patch over the monitor code. Details on this appear in the "How To Install Your 'Old' Monitor EPROM In An Apple IIe" box.

Basically, what you do is BLOAD IIEMON.C. Then you BLOAD KREBF SPELL. This patch overwrites the hole blaster with the "old" monitor access timer. Then you BSAVE KREBFMON.C, A$8000, L$1000. All of which casts the Krebf spell on your monitor image.

You then program your 2764, using KREBFMON.C for the low half (switch left) and IIEMON.D for the upper half (switch right). For this particular use, you need only replace the CD ROM with a 2764 EPROM. The EF ROM does not get changed.

Applesloth program SNATCHMON, source code KREBF SPELL.SOURCE, and machine-language binary patch KREBF SPELL are available ready-to-run on a companion diskette. Also included are modules for the IIc and "new" IIe versions. See the box at the end of this article for full details.

Since I cannot legally sell you copies of the IIe monitor image if you do not personally own a IIe on which those images are to be uniquely used, these monitor images are not available from me. You will, instead, have to grab your own with SNATCHMON. The painless and automatic process takes all of half a minute.

It is very interesting to compare Programs 1 and 2. Assembly-language Program 2 was written and debugged much faster than was Applesloth Program 1. Program 2 does more. And its documentation is far more legible.

If you are weak on assembly language programming, check into *Don Lancaster's Assembly Cookbook for the Apple IIe,* (SAMS #22331), for some easy-to-understand text and ready-to-use support modules.

## *Testing and Extending*

Step 12 of the "How To Install" box gives a detailed checkout routine. Be very careful when you swap EPROM for ROM that you bend no pins and that the code dot and notch go towards the keyboard, or front, of your IIe. Save the old CD ROM in protective foam in case warranty repairs are ever needed.

### How to Install Your "Old" Monitor EPROM in an Apple IIe

1. Using the program SNATCHMON, place copies of IIe ROM images onto a work diskette under the filenames of IIEMON.C, IIEMON.D, IIEMON.E, and IIEMON.F.
2. Place a copy of KREBF SPELL onto the same work disk. Do this by copying the companion diskette, assembling from KREBF SPELL.SOURCE, or by simple hand loading.
3. Cast the KREBF spell this way:
   ```
   ] BLOAD IIEMON.C <cr>
   ] BLOAD KREBF SPELL <cr>
   ] BSAVE KREBFMON.C, A$8000,
     L$1000 <cr>
   ```
4. If it is needed, plug the 2764 adapter into your EPROM burner. Be sure the notch points to the handle and that the grabber contacts the correct point in the burner. In the MPC ep-ap, the grabber goes to pin #1 of U10.
   WARNING: BE SURE YOUR BURNER IS CONFIGURED FOR AN INTEL 2764 BURN (no adapter) OR A 2732 BURN (with adapter) BEFORE CONTINUING.
   The steps that follow assume you are using the adapter on an older burner, whose 2732 work buffer goes from $8000 to $8FFF.
5. Erase a 28 pin, 250-nanosecond Intel or Hitachi 2764 EPROM using a suitable ultraviolet source.
6. Insert the 2764 EPROM into the adapter socket. Be extra careful not to bend any pins. New 2764s will need all their pins "rocked" inwards to fit.
7. Flip the adapter switch to "0" (towards pin 14). Then arm the EPROM burner and boot the support code.
8. Verify the erasure. Then load, burn and verify KREBFMON.C as if it were intended for a 2732 EPROM.
9. Flip the adapter switch to "1" (towards pin 28). Then load, burn and verify IIEMON.D as if it were intended for a 2732 EPROM. Note that the Krebf spell does *not* get cast on the "D" side.
10. Turn the Apple supply power off and remove *both* ends of the line cord. Carefully remove the CD ROM at E8, using an IC puller, while keeping one wrist on the top of the Apple power supply. Store this ROM in protective foam for possible later warranty repairs.
11. Remove the newly programmed 2764 from the burner and insert it in the newly emptied socket on your IIe, being very careful that the notch goes *towards* the keyboard and no pins are bent or tucked under. Keep your wrist on the power supply as you do this.
12. Apply supply power and run the following checks:
    (a) Normal cold boot of *non-valuable* diskette in drive 1 when power is applied.
    (b) Normal reset to Applesloth or applications program on <ctrl>-<reset>.
    (c) Normal cold reboot on <ctrl>-<open-apple>-<reset>.
    (d) Drop into the monitor on <ctrl>-<open-apple>-<reset> with the <open-apple> key held down for four seconds after release of the reset key. Wait for the beep and the "*" symbol.
    (e) From the monitor, do a C006:00 <cr>, followed by a 6-<ctrl>-P. You should get a standard cold reboot.
    BE SURE TO USE THIS "C006:00 <cr> AT THE START OF EACH MONITOR ACCESS. OTHERWISE, THE I/O SPACE WILL NOT GET PROPERLY ACTIVATED.
    (f) Do a <ctrl>-<closed-apple>-<reset>. After some screen flashing, you should get the "KERNEL OK" message.
13. Put some opaque tape over the lid of your new "old" monitor. Add a bright dot to remind yourself of this change. Save the CD ROM should warranty repairs ever be needed. This completes installation.

Be sure to turn power off, and remove *both* ends of the Apple IIe line cord. Always lean on the top of the power supply with your wrist before inserting or removing any integrated circuit. Just to be darn sure, hold the Apple end of the line card in your hand as you do this.

It might be best to program your EPROMs on one II+ or IIe and test them on a second IIe. This separates programming bugs from strictly operational problems.

Your checkout procedure should include a cold boot, a cold reboot, a cold reboot into the monitor, a cold reboot from the monitor, and a diagnostics pass using the closed-apple key on the IIe's keyboard.

One very important "gotcha": When you drop into the "old" monitor, you do so with the I/O space disabled and the CD ROM enabled. *Always* do a C006:00 <cr> as your very first "old" monitor instruction!

This sounds slightly flakey, but I haven't found a really good way around it. Maybe you can. At any rate, this is no worse than good old CALL -151; in fact, it is one keystroke shorter. Besides, it *always* works—any time, any place, any program, any reason.

If you do not activate the I/O space, all of the usual monitor functions will work in the usual way. The only little problems are that you will have no DOS, printer, or other I/O slot access available. So, be sure to get in the habit of whapping $C006 on each monitor entry.

There are lots of possible things you can do with a custom monitor. For instance, you can rearrange "Applesloth" to suit yourself. You can also do much of what a "snapshot" card can for a tiny fraction of the price. To do this, grab the NMI vector and dump everything in sight to the stack, including all registers, all soft switches, hard-to-read locations such as $0200, and some identifying markers. Then exit to some code that uses none of the usual page-zero or screen-scrolling locations.

Let me know what other monitor mods you would like to see. Use the address or phone number in the box. I'll send a free book and product list to anyone who asks. **ME**

A companion diskette is available that includes the following ready-to-run programs:

SNATCHMON
KREBF SPELL OLD IIE.SOURCE
KREBF SPELL OLD IIE
KREBF SPELL NEW IIE.SOURCE
KREBF SPELL NEW IIE
KREBF SPELL IIC.SOURCE
KREBF SPELL IIC

plus a "must have" bonus book. Price is $19.50 from:

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