

ZEPROM PROGRAMMER

USER'S MANUAL

Firmware Corp.

Corvallis Oregon

Table Of Contents

Section 1: General Information	1
Introduction	1
Setup	1
Section 2: General Operation	3
Copying a ZEPROM	3
How to Combine Multiple ROMs From Other Vendors	4
Section 3: Other Functions	7
How to Copy and Burn a ZEPROM	7
How to Burn Two ZEPROMS	7
How to Copy a Masked ROM	8
How to Combine Multiple Masked ROMS	9
How to Build a 16K User Program ROM	10
How to Build an 8K User Program ROM	10
How to Build a Private ROM	11
Verifying a ROM	12
Section 4: Using the ZP With a Personal Computer	13
Downloading from a PC	13
Uploading to a PC	14
Section 5: Advanced Topics	15
Specifications	15
Working With a Mass Storage Device	15
Working With an SDS System on a PC	15
Using the EDIT Command	16
In Case of Trouble	17
Bank Switching	18
Section 6: Command Summary	19
Appendix A: Care, Warranty, and Service Information . .	23
Appendix B: RS232 Information and Pinout	25
Appendix C: Error Messages	26
Appendix D: Quad Layout	27
Appendix E: Q-ROM Layout	29
Appendix F: References	31

Section 1: GENERAL INFORMATION

Introduction

The ZEPROM Programmer (ZP) is a self contained device that can handle every job from creating an Eprom image to actually programming a ZEPROM. It can be completely controlled from the HP-41C itself. There is no need for any additional hardware or software to have your own local ZEPROM programming capability. No additional equipment is required (other than an ultra violet light to erase the ZEPROMS).

The ZP not only can build a complete 16K ROM image, and burn one or two ZEPROMS at a time, but can also serve as a ROM emulator. Programs may be downloaded into the ZP's RAM and used to simulate the ROM image for testing. Once tested, ROM images can be saved to a mass storage device, uploaded to a personal computer in standard Intel Hex format, or burned into a ZEPROM to make an 8K or 16K ROM. ROM images developed with an SDS system can also be downloaded from a personal computer into the ZP.

Setup

- 1) Connect the supplied DC converter to the back of the ZP.

WARNING: DON'T SUPPLY POWER TO THE ZEPROM PROGRAMMER WITH ANY OTHER POWER ADAPTOR THEN THE ORIGINAL POWER ADAPTOR SUPPLIED WITH THE ZP, AS THIS MAY CAUSE SERIOUS DAMMAGE TO THE ZEPROM PROGRAMMER.

- 2) Turn of the HP-41C and remove all modules from ports 1 through 3 on the HP-41C. While the ZP is plugged into the HP-41C the only other modules that may be plugged into the HP-41C is a 4K or 8K module plugged into port 4.

NOTE: When plugging or unplugging the ZEPROM Programmer from the HP-41C, turn off the HP-41C. Also before plugging or unplugging a ZEPROM from the ports on the ZEPROM Programmer, turn off the HP-41C.

- 3) Connect the supplied HP-41C interface cable to the back of the ZP. Plug the HP-41C interface cable into one of the first three ports (port 1, 2, or 3) on the top of the HP-41C (refer to the back of the HP-41C case for the port numbers). The ZP will work if plugged into port 4, but you will not be able to plug any other ROMs into the HP-41C.

NOTE: The cable from the ZP to the HP-41C is not detachable from the ZP. The cable is permanently attached to the ZP.

5) Turn the ON/OFF switch, on the ZP, to the ON position. The POWER LED should now light up. Turn the HP-41C on.

Section 2: GENERAL OPERATION

There are two basic steps involved in creating a ROM with the ZP. The first step is to get a ROM image (a ROM image is a "blueprint" of a ROM that you are working with) into the ZP's internal memory. Once the ROM image is inside the ZP, the second step is to get the ROM image programmed onto a blank ZEPROM that you plug into one of the ZP's two ZEPROM ports.

There are several ways to get the ROM image into the ZP. One of these involves directly copying the ROM image from a previously created ZEPROM. Such a procedure is outlined below.

Copying a ZEPROM

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1) Follow the steps outlined in the setup procedure to connect the ZP to the HP-41C. Make certain the HP-41C is turned off and plug into PORT 1 on the front of the ZP, the ZEPROM that you want to copy. After you have plugged the ZEPROM into the port turn the HP-41C back on.

2) Execute the SELZP1 function. The PORT 1 LED should light up.

Note: When the manual says to execute a function, (such as execute the SELZP1 function) this means to press the XEQ key on the keyboard, then press the ALPHA mode key and type in the name of the given function (IE. in the case above type SELZP1 into the Alpha register). Finally press the Alpha mode key after you have finished keying in the function's name. This will cause the specified function to be run.

3) Execute the COPYZP function. This will transfer the contents of the ZEPROM plugged into the ZP into the internal RAM in the ZP.

Now that the ROM image is inside the ZP, the next step is to transfer the ROM image onto a blank ZEPROM, in such a way creating an exact copy of the original ZEPROM.

4) Turn off the HP-41C and unplug the ZEPROM in PORT 1. Plug into PORT 1 a blank ZEPROM (See the procedure below about a blank ZEPROM). Turn the HP-41C back on.

5) Execute the BLANKZ? function. The 41 will show "BLANK CHK 1" in the display. If the ZEPROM is blank the display will show "BLANK CHK OK". If the ZEPROM is not blank the display will show the address and the data that is at that address. The display will be in the form "AAAA=DDD" where AAAA is the address, and DDD

is the data

The step above is used to check that the ZEPROM actually is blank. If the ZEPROM is not blank then either get another ZEPROM and repeat steps 5 and 6, or erase the ZEPROM and then repeat steps 5 and 6.

The ZEPROM itself can be programmed, then erased and re-programmed many times. To erase a ZEPROM you need a UV (Ultra Violet) light source. UV light sources for such a purpose are usually sold as EPROM (not ZEPROM) erasers. Exposing the ZEPROM to the UV light causes it to be erased (losing all programs that it might have contained) and enables it to be programmed again.

6) Execute the PROGRAM function. The 41 will show "PROGRAM 1" in the display. The yellow LED on the ZP should light up. This will actually program and verify the ZEPROM. If all goes ok then the display will show "PROGRAM OK", this will take about 3 minutes.

Executing the PROGRAM function actually causes the ZP to transfer the ROM image that it has stored in it's internal RAM, out onto the blank ZEPROM. After this the ZEPROM should work exactly like the original ZEPROM.

7) Turn off the 41 before removing the ZEPROM.

The second way to get a ROM image into the ZP is by copying several 4K and 8K ROMs from other vendors, and combining them into one 16K ZEPROM.

How to Combine Multiple ROM's From Other Vendors

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1) Follow the steps outlined in the setup procedure for connecting the HP-41C and the ZP. Refer to the procedure above on copying ZEPROMs for terminology on executing a function and how to make a blank ZEPROM.

2) Turn off the HP-41C. Plug in the first 4K ROM to copy into port 4 of the HP-41C. Plug a blank ZEPROM into PORT 1 of the ZP. Turn the HP-41C back on.

3) Execute the CLRRAM function. This makes certain that all of the ZP's internal memory is blank and doesn't contain any old ROM images.

4) Put a 1 into the X-Reg of the 41. Execute the SELQUAD

function. This will select Quad 1 of the 16K memory of the ZP.

Each ZEPROM can actually appear to the HP-41C as 4 individual ROMs. The manual refers to these "sub ROMs" as quads. There are 4 quads inside the ZP's memory, each one of these quads can be loaded with an individual ROM image from a 4K ROM. When all 4 quads are loaded, the entire 16K ROM image (composed of the 4 smaller 4K ROMs) can be programmed onto a single 16K ZEPROM.

5) Put a one into the X-Reg of the 41. Execute the COPYROM function. The 41 will show "COPY L" in the display, this means that the 4K of the plug in ROM is being transferred into the 16K memory of the ZP.

Just as the ZEPROM can appear as 4 ROMs to the HP-41C, other manufacturer's ROMs can appear as 2 ROMs to the HP-41C. The number that you supply to the X-REG tells the ZP which of these 2 "sub ROMs" that you want to copy (1 for the first sub-ROM, 2 for the second sub-ROM). Generally a ROM appears as only 1 sub ROM, and you will then only need to put 1 into the X-REG when executing COPYROM.

6) Turn off the 41. Replace the ROM in port 4 on the HP-41C with the next 4K rom to be copied. Turn the HP-41C back on.

7) Select the next quad to put the ROM into by putting the quad number into the X-REG and executing the SELQUAD function. Put a 1 in the X-REG and execute the COPYROM function. The 41 will show "COPY L" in the display. This will transfer the 4K ROM to the 16K memory in the ZP. Repeat steps 5 and 6 until all the ROMs have been copied into the ZP (up to a maximum of four 4K ROMs).

Now the RAM in the ZP contains all the ROM images that you have loaded into it. The next step involves telling the ZP to program all of these onto your blank ZEPROM.

8) Execute the SELZP1 function. The PORT 1 LED on the ZP should light up.

9) Execute the PROGRAM function. The yellow LED on the ZP should light up. The 41 will show "PROGRAM 1" in the display. If all goes ok then the 41 should show "PROGRAM OK" in the display.

10) Turn off the 41 before removing the ROM in port 4 on the HP-41C, and the ZEPROM.

Section 3: OTHER FUNCTIONS

How to Copy and Burn a ZEPROM

This product supports copying of software only to the extent that you may improve the useability of legally acquired and operated software. You may not use this product to make illegal copies of copyrighted software.

- 1) Execute the CLRRAM function on the HP41, this will cause the ZP to clear all of internal RAM. This makes certain that you are working with a "clean slate".
- 2) Turn off the HP-41C and plug the ZEPROM that you want copied into PORT 1 on the ZP. Turn the HP-41C back on.
- 3) Execute the SELZP1 function. The PORT 1 LED should light up.
- 4) Execute the COPYZP function. This will transfer the contents of the ZEPROM plugged into the ZP into the internal 16K RAM in the ZP.
- 5) Turn off the HP-41C and unplug the ZEPROM in PORT 1. Plug into PORT 1 a blank ZEPROM. Turn the HP-41C back on.
- 6) Execute the BLANKZ? function. The 41 will show "BLANK CHK 1" in the display. If the ZEPROM is blank the display will show "BLANK CHK OK". If the ZEPROM is not blank the display will show "NO BLANK", in which case go back to step 5.
- 7) Execute the PROGRAM function. The 41 will show "PROGRAM 1" in the display. The yellow LED on the ZP should light up. This will actually program and verify the ZEPROM. If all goes ok then the display will show "PROGRAM OK", this will take about 3 minutes.
- 8) Turn off the 41 before removing the ZEPROM.

How to Burn Two ZEPROMs

This product supports copying of software only to the extent that you may improve the useability of legally acquired and operated software. You may not use this product to make illegal copies of copyrighted software.

- 1) Execute the CLRRAM function on the HP41, this will cause the ZP to clear all of internal RAM. This makes certain that you are working with a "clean slate".
- 2) Turn off the HP-41C and plug the ZEPROM that you want copied into PORT 1 on the ZP. Turn the HP-41C back on.

- 3) Execute the SELZP1 function. The PORT 1 LED should light up.
- 4) Execute the COPYZP function. This will transfer the contents of the ZEPROM plugged into the ZP into the internal 16K RAM in the ZP.
- 5) Turn off the HP-41C and unplug the ZEPROM in PORT 1. Plug into PORT 1 and PORT 2 a blank ZEPROM. Turn back on the HP-41C.
- 6) Execute the SELZP12 function. The PORT 1 and PORT 2 LEDs should both light up. This means that both the ZEPROM ports are selected.
- 7) Execute the BLANKZ? function. The 41 will show "BLANK CHK 1" in the display. If the ZEPROM is blank the display will show "BLANK CHK OK". Next the display will show "BLANK CHK 2". If either ZEPROM is not blank the display will show "NO BLANK", in which case go back to step 5.
- 8) Execute the PROGRAM function. The 41 will show "PROGRAM 1,2" in the display. The yellow LED on the ZP should light up. This will actually program and verify the ZEPROMs. If all goes ok then the display will show "PROGRAM OK", this will take about 3 minutes.
- 8) Turn off the 41 before removing the two ZEPROMs.

How to Copy a Masked ROM

This product supports copying of software only to the extent that you may improve the useability of legally acquired and operated software. You may not use this product to make illegal copies of copyrighted software.

- 1) Turn off the HP-41C. Plug in the 4K or 8K ROM to copy into port 4 of the HP-41C. Plug a blank ZEPROM into PORT 1 of the ZP. Turn the HP-41C back on.
- 2) Execute the CLRRAM function.
- 3) Put a 1 into the X-Reg of the 41. Execute the SELQUAD function. This will select Quad 1 of the 16K memory of the ZP.
- 4) Put a 1 into the X-Reg of the 41. Execute the COPYROM function. The 41 will show "COPY L" in the display, this means that the lower 4K of the plug in ROM is being transferred into the 16K memory of the ZP. If the ROM to be copied is 4K then skip to step 6, if the ROM is 8K then continue with step 5.
- 5) Put a 2 into the X-Reg of the 41. Execute the SELQUAD function. Put a two into the X-Reg of the 41 and execute the COPYROM function. The 41 will show "COPY U" in the display. This will transfer the upper 4K of the plug in ROM to

the 16K memory in the ZP.

- 6) Execute the MKBANK function. This will make it so that the Programmed ZEPROM acts as an 8K module instead of a 16K module.
- 7) Execute the SELZP1 function. The PORT 1 LED on the ZP should light up.
- 8) Execute the PROGRAM function. The yellow LED on the ZP should light up. The 41 will show "PROGRAM 1" in the display. If all goes ok then the 41 should show "PROGRAM OK" in the display.
- 9) Turn off the 41 before removing the masked ROM and the ZEPROM.

How to Combine Multiple Masked ROM's

This product supports copying of software only to the extent that you may improve the useability of legally acquired and operated software. You may not use this product to make illegal copies of copyrighted software.

- 1) Turn off the HP-41C. Plug in the first 4K ROM to copy into port 4 of the HP-41C. Plug a blank ZEPROM into PORT 1 of the ZP. Turn back on the HP-41C.
- 2) Execute the CLRRAM function.
- 3) Put a 1 into the X-Reg of the 41. Execute the SELQUAD function. This will select Quad 1 of the 16K memory of the ZP.
- 4) Put a 1 into the X-Reg of the 41. Execute the COPYROM function. The 41 will show "COPY L" in the display, this means that the 4K of the plug in ROM is being transferred into the 16K memory of the ZP.
- 5) Turn off the 41. Replace the ROM in port 4 on the HP-41C with the next 4K rom to be copied. Turn the HP-41C back on.
- 6) Select the next quad to put the ROM into by putting the quad number into the X-REG and executing the SELQUAD function. Put a one in the X-REG and execute the COPYROM function. The 41 will show "COPY L" in the display. This will transfer the 4K ROM to the 16K memory in the ZP. Repeat steps 5 and 6 until all the ROMs have been copied into the ZP (up to a maximum of 4 4K ROMs).
- 7) Execute the SELZP1 function. The PORT 1 LED on the ZP should light up.
- 8) Execute the PROGRAM function. The yellow LED on the ZP should light up. The 41 will show "PROGRAM 1" in the display.

If all goes ok then the 41 should show "PROGRAM OK" in the display.

9) Turn off the 41 before removing the masked ROM and the ZEPROM.

How to Build a 16K User Program ROM

1) Execute the CLRRAM function on the HP41. This will cause the ZP to clear all of internal RAM. This makes certain that you are working with a "clean slate".

2) Put a 1 into the X-Reg, and execute the SELQUAD function. This transfers the user programs into quad-1 in the 41.

3) Put the name of the user program into the Alpha register. Execute the LOADP function.

4) Repeat step three until all the user programs have been loaded in or until a "NO ROOM" error occurs. If all the user programs have been loaded in then go to step 6. If a "NO ROOM" error occurred then proceed with step 5.

5) Select the next quad to load programs into by putting the quad number into the X-REG and executing the SELQUAD function. Go back to step 3.

6) Select quad one using the SELQUAD function. Execute the ROMID function after putting the ROM ID that you have selected into the X-REG and the CAT 2 label of the ROM in the Alpha register. Do this for each quad you have loaded programs into.

7) Execute the BUILD function, this will compile all the user programs in all the quads into ROM images. When the HP-41C's display shows "BUILD COMP" then the ZP is done building the ROM images.

8) Turn off the HP-41C and insert a ZEPROM into PORT 1 of the ZP. Then turn the HP-41C back on.

9) Execute SELZP1 (the PORT 1 LED should light up) and then execute the PROGRAM function. After the ZP is done programming the ZEPROM, turn off the HP-41C and remove the ZEPROM.

How to Build an 8K User Program ROM

1) Execute the CLRRAM function on the HP41. This will cause the ZP to clear all of internal RAM. This makes certain that you are working with a "clean slate".

2) Execute the RAM8K function. This means that any ROMS built

will be 8K ROMS. It also selects quad 3 as the currently selected quad. In this mode you may only load programs into quads 3 and 4, if you try to load programs into quads 1 and 2 you will get a "N/A 8K MODE" error message.

3) Put the name of the user program into the Alpha register. Execute the LOADP function.

4) Repeat step three until all the user programs have been loaded in or until a "NO ROOM" error occurs. If all the user programs have been loaded in then go to step 6. If a "NO ROOM" error occurred then proceed with step 5.

5) Select the next quad to load programs into by putting 4 into the X-REG and executing the SELQUAD function. Go back to step 3.

6) Select quad three or four using the SELQUAD function. Execute the ROMID function after putting the ROM ID that you have selected into the X-REG and the CAT 2 label of the ROM in the Alpha register. Do this for each quad you have loaded programs into.

7) Execute the BUILD function, this will compile all the user programs in quads 3 and 4, and store ROM images in quads 1 and 2. This is special in 8K mode and is done so that you may later go back and add programs to quads 3 and 4 and then build them again.

8) Turn off the HP-41C and insert a ZEPROM into PORT 1 of the ZP. Then turn the HP-41C back on.

9) Execute SELZP1 (the PORT 1 LED should light up) and then execute the PROGRAM function. After the ZP is done programming the ZEPROM, turn off the HP-41C and remove the ZEPROM.

10) You can come back later to load more programs into quads 3 or 4, and then re-build the ROM image back into quads 1 and 2. This is a special feature of the 8K mode.

11) Note that you need to execute the ROM16K function to get back to the 16K mode. This will allow you to build a 16K module again.

How to Build a Private ROM

1) Load user programs into ROMs by following the first six (6) steps outlined in either the 16K or 8K mode above. Then follow the steps below.

7) Select each quad that you want to be private by entering the quad number into the X-REG, and executing the SELQUAD function. After executing the SELQUAD function, execute the PRIVATE function (this will tell the ZP to make the ROM private when it builds it). The PRIVATE function adds a short piece of code to

the ROM, if there is not enough room for this code (you have to many user programs in the quad) then you will receive a "NO ROOM" error message and must remove some of the user programs in that quad. Do this for each quad that you want to make private.

8) Execute the BUILD function, this will compile all the user programs in all the quads into ROM images, and make private all the quads that you flagged by executing the PRIVATE function. All numeric GTO/XEQ will be compiled, all Alpha XEQ's will be compiled into XROM calls if the Alpha label is found in one of the four ROMs.

Verifying a ROM

There are two ways to verify a ROM's integrity. The first way is to use the VERIFY function to test if the ROM's checksum is good. The second way is to read in a master ROM that you know is good and use COMPARE to test the masters image against the test ROM.

To use the VERIFY function put an already programmed ZEPROM that you wished verified into PORT 1 on the ZP (remember to turn the HP-41C off while doing this), then use SELZP1 to select PORT 1. Execute the VERIFY command, the HP-41C's display should show "VERIFY 1", if the ROMs checksum is good the HP-41C's display will show "GOOD CHKSUM". If the checksum is bad then the HP-41C's display will show "BAD CHKSUM". This means that the ZEPROM has possibly been corrupted, and should be re-burned.

The COMPARE function is a much more thorough check than VERIFY is, but to do it you need a master ZEPROM that you know is reliable. To do the COMPARE function do the following steps:

1) Turn off the HP-41C and plug in the master ZEPROM into PORT 1 on the ZP. Turn the HP-41C back on and select PORT 1 by executing the SELZP1 function.

2) Read the master ROM into the ZP by executing COPYZP.

3) After the ZP is done reading in the master ZEPROM, turn off the HP-41C and replace the master ZEPROM in PORT 1 with the ZEPROM that you want verified. After you have switched the ZEPROMS turn the HP-41C back on.

4) Execute COMPARE. The COMPARE function will check each byte in the tested ZEPROM against the master ZEPROM. The HP-41C's display will show "COMPARE 1", if the ROM checks correctly against the master ZEPROM then the display will show "COMPARE OK". If there are any bytes that are not the same the HP-41C will halt execution and display "AAAA=RRR ZZZ" where AAAA is the address where the error occurred, RRR is the hexadecimal value that the master ROM image says should be there, and ZZZ is the hexadecimal value that is actually in the test ZEPROM.

Section 4: Using the ZP With a Personal Computer

Intel hex formatted ROM image files can be transferred between the ZP and a PC with a serial port. An example of such a session is given below. In this case we assume that the ZP is hooked up to an IBM PC ((tm) IBM Corp.), that is using Crosstalk ((tm) Microstuf) communication software. The ZP, however, can be used with almost any computer that is equipped with a serial port, and has some type of communication software that supports XON/XOFF protocol.

Downloading From a PC

1) Connect a serial cable between the PC and the ZP. Refer to appendix B for cable information.

2) Make certain that the PC is turned on and load the communication software. (For Crosstalk you would type XTALK at DOS prompt).

3) Configure the communication program to 9600 baud, 8 data bits, No parity, and 1 stop bit. (For Crosstalk the following key sequence will do this (Note : <CR> means press the carriage return key. All things on a line after a semicolon ";" are comments and should not be typed in)).

```
SP 96<CR>           ; set Crosstalk to 9600 baud
DA 8<CR>            ; 8 data bits
PA N<CR>           ; No parity
ST 1<CR>           ; 1 stop bit
BK 16<CR>          ; Block Size 16 x 256 = 4096
```

4) Now go to local mode in the communication software. This instructs the computer to watch the serial port for any incoming characters, and to send anything that you type at the keyboard, out the serial port. For Crosstalk type the following:

```
GO LO<CR>          ; tells Crosstalk Go to local mode
```

5) Turn OFF the ZP, then turn it back on. You should now see on the PC's screen the letters ZP. If you see these letters it means that the ZP and the PC are communicating correctly. If these letters do not appear then carefully check the connection between the PC and ZP, and go over the steps above to make certain that everything is set up the way it is supposed to be.

6) Execute the DNLOAD command on the HP-41C. This tells the ZP to get ready to receive and Intel hex file from the PC. The display on the HP-41C will show "DOWN LOADING"

7) Go to command mode on the PC. When in command mode what you type at the keyboard is interpreted by the communication software as commands, it won't send what you type out the serial port. In

Crosstalk you go to command mode by pressing the ESC (Escape) key.

8) Once in command mode on the PC tell the communications program to begin sending the intel hex file that you wish to transfer. In crosstalk type:

```
SE filename.HEX      ; SE tells crosstalk to send the file.  
                      filename is the name of the file that you  
                      wish to send, it will probably have the  
                      extension of .HEX.
```

9) When completed the HP-41C will return to the normal display. The ZP will now contain the ROM image from the PC. You can now plug in a ZEPROM to the ZP and program it with the ROM image.

Uploading to a PC

1) Follow steps 1-5 as above to connect the ZP and the PC together and make certain that they are communicating properly.

2) Get a ROM image into the ZP by one of the methods outlined previously. This is the ROM image that you will transfer.

3) Go to command mode on the PC. When in command mode what you type at the keyboard is interpreted by the communication software as commands, it won't send what you type out the serial port. In Crosstalk you go to command mode by pressing the ESC (Escape) key.

4) Once in command mode on the PC tell the communications program to begin receiving the intel hex file that you wish to transfer. In crosstalk type:

```
RE filename.HEX      ; RE tells crosstalk to receive the file.  
                      filename is the name of the file that you  
                      wish to receive. It is common practice to  
                      use the extension of .HEX for this type of  
                      file.
```

5) Select the quad that has the ROM image you wish to transfer by executing the SELQUAD function.

6) Execute the UPLOAD command on the HP-41C. This tells the ZP to begin sending the ROM image in the currently selected quad. The HP-41C's display will show "UP LOADING" while it is sending the file.

7) When completed the HP-41C's display will return to normal, and the ROM image should now be saved as a file on the PC.

Section 5: ADVANCED TOPICS

Specifications

The ZP addresses itself to the first three ports on the HP-HP-41C, no matter which port it is actually plugged into. Thus if you want to have another module plugged into the calculator at the same time as the ZP, the module must be plugged into port 4 on the HP-41C (see the back case of the 41C for port numbering).

NOTE : The ZP's 4K EPROM has a ROM ID of 22, thus when you are creating EPROMS with the ZP you cannot create or modify a ROM with a ROM ID of 22.

Working With a Mass Storage Device

The ZP allows you to store and recall ROM images from a mass storage device. The file format is compatible with those produced by some SDS systems and by some other ROMS that also allow you to store ROM images to mass storage. The two functions that facilitate this are STOROM, and RCLROM.

STOROM takes the data in the currently selected quad in the ZP's 16K memory and transfers it to a mass storage device. The file name that it is to be stored under is taken from the Alpha register. This file can be either a built ROM image, either built by the ZP itself or copied from another ROM, or it can be non-built user programs loaded into the quad with the LOADP function. ROM images saved this way can be loaded in and read by some SDS systems on a PC.

RCLROM does the reverse of STOROM in that it reads a ROM image, or pre-built user program ROM image, in from a mass storage device. The file name to be read in is taken from the Alpha register. This will read in files created with STOROM, ROM image files created by some other ROMS (like the GEMROM), and ROM image files created by SDS systems on PCs.

Note: Both of these functions assume that you have a mass storage device hooked up by the HP-41C/HP-IL adaptor, and it is plugged into port 4 on the HP-41C. If STOROM or RCLROM cannot find the HP-IL interface a "NO HPIL" error message will appear on the HP-41C's display.

Working With an SDS system on a PC

SDS stands for Software Development System, and allows HP-41C code to be developed on a personal computer (PC). They usually allow the user to mix both assembly code and user code in a single ROM, and converts the data into an Intel hex file which can then be downloaded into the ZP.

To transfer Intel hex files between the HP-41C and a PC you will need a telecommunication program for the PC. Set the parameters for the serial port at 9600 baud, 8 data bits, 1 stop bit, and no parity. The ZP will automatically convert incoming ROM images from Intel hex format, and will convert all outgoing ROM images into Intel hex format. The Pinout is given below, for a more complete pinout description see Appendix B.

Pin	Signal	Full Name
2	Txd	Transmitted Data
3	Rxd	Received Data
5	CTS	Clear to Send
6	DSR	Data Set Ready
7	Gnd	Signal Ground

Using the EDIT Command

EDIT allows you to view and change the contents of the ZPs memory. It is a very powerful utility but can also cause problems if the user doesn't exercise extreme care. A thorough understanding of how a HP-41C ROM is laid out is recommended before using the EDIT function to change any bytes in the ZP's memory (See Appendix D, and E for ROM layout specifications. Also see Appendix F: References, for a list of other sources of information on how the ROMs are layed out.)

When editing bytes of data at locations 8000-BFFF it is necessary to select either the RAM or the ZEPROM's memory when using EDIT. Execute the SELRAM function before using EDIT if you want to edit the memory in the ZP, execute one of the SELZP functions if you want to view the contents of a ZEPROM.

Changing any bytes in the 4K RAM located at address C000-CFFF can cause problems. The ZP and the HP-41C use this 4K area to hold information and pass data back and forth, tampering with this area may cause both the HP-41C and/or the ZP to lock up and therefore need to be reset. Refer to the appendices for information on how the memory is used.

When executed, EDIT returns with the prompt: "ADR: ____". It is now waiting for the hexadecimal address to be keyed in. At this point all of the number keys and the "A" - "F" keys are active. When all four hex digits have been entered, pressing the R/S key will cause the HP-41C to accept the entered address.

After you have entered the address, EDIT returns with the prompt: "AAAA DDD ____", where AAAA is the address that you entered, and DDD is the data at that address in hex. You can now either change the value at that memory location (provided that you are looking at RAM and not ROM), or view other locations by stepping through the memory with the SST, and BST keys.

To change the data at a memory location, key in the new hex

value that you want to appear at that location (note that the hex number represents the 10 bit word that the HP-41C's ROMs use. Therefore the first character can only be a 0-3 as it represents only two bits). When you have entered the entire three digit number press the R/S key to have the HP-41C actually change the memory location.

backarrow - If no characters have been entered on the prompt line then it exits back to normal HP-41C operation. If there are one or more characters entered on the prompt line then it deletes the last character entered.

[SHIFT] backarrow - Immediate exit back to normal HP-41C operation.

ENTER - Returns to the "ADR: ____" prompt so that you can enter a new address to view and change.

SST - advances the current location in memory to the next address. Can only be used at the "AAAA DDD ____" prompt.

BST - backs up one address in memory. Can only be used at the "AAAA DDD ____" prompt.

R/S - If all the characters have been entered on a prompt line then causes the HP-41C to accept the entered data, otherwise it is ignored.

In Case of Trouble

It is possible through using the EDIT function to change certain bytes in the HP-41C's, or ZP's memory that will either corrupt a ROM image that you have entered into the ZP, causing the HP-41C to act strangely, or completely lock up the HP-41C. If this happens then there are several remedies.

If you have simply corrupted the ROM image in the ZP then executing the CLRRAM function will cause the HP-41C to clear out all of the ZP's memory. Note that any programs you may have loaded into the ZP will be lost.

If the HP-41C is behaving strangely or is completely locked up then there are two things that should get it running again. First press the RESET switch on the back of the ZP, this is like executing the CLRRAM function on the HP-41C, except it can be used at any time. If the calculator still won't respond then you will have to do a memory reset on the HP-41C, refer to the owners manual for the procedure to do this.

Bank Switching

The ZEPROM is a 16K EPROM that can be set into a mode that makes it act as two 8K switching EPROMs. This is accomplished by setting a bit in the ZEPROM's memory (MKBANK will set this bit, NOBANK will clear it).

When the bank switching is enabled, the ZEPROM will appear as an 8K EPROM. When the HP-41C is turned on, you can only catalog the lower 8K of the ZEPROM. You need to execute a machine code instruction (select bank instruction) in the ZEPROM to cause it to switch to the upper 8K. Once in the upper 8K another select bank instruction must be executed to cause the ZEPROM to switch back to the lower 8K again.

It is possible through the duplication of certain quads to simulate 12K bank switching ROMs. To make a 12K bank switching ROM with the upper 8K switching, copy quad 1 into quad 3. To make a 12K bank switching ROM with the lower 8K switching, copy quad 2 into quad 4. Of course you don't have to duplicate any quads and can have a full 16K bank switching ROM.

Several functions have been provided to allow the creation of a user code bank switching ROM. These functions are MKBANK, NOBANK, and SWITCH.

MKBANK will set the bit in the ZEPROM that makes it into a bank switching ROM. NOBANK clears this bit and sets it back to a 16K ROM. SWITCH creates a command in the ZEPROM that will switch from one bank in the ROM to the other. SWITCH takes a program name that you supply from the Alpha register and makes this the name of the switching program in the ROM. The reason that the program name is taken from the Alpha register and not simply called "Switch", is that if you create two bank switching ROMs and have both plugged into the HP-41C at the same time, then the "Switch" programs in each of the two ROMs must have different names.

To create a bank switching ROM clear quads 1 and 3 first. Note that SWITCH will automatically execute the MKBANK instruction. Next put the name that you would like the switch program called in the Alpha register, and execute the SWITCH instruction. You must execute the SWITCH instruction before loading any programs into the ZP

At this point you can load user programs into the ZP and build it as you normally would. When the ZEPROM is burned a CAT function will only show those programs in the first two quads, executing the name of the program that you called the switch function will switch the ZEPROM to the other two quads and allow you to execute the programs in quads 3 and 4. Executing the switch program again will switch the ZEPROM back to quads 1 and 2.

Section 6: COMMAND SUMMARY

BLANKZ? - Checks to see if the currently selected ZEPROM(s) are blank. Will check the port(s) that are selected by the SELZP functions. Will return to the X-REG the port number (1=PORT 1, 2=PORT 2, 3=PORT 1 & 2) if the ZEPROMs are blank, and the negative of the port number (-1, or -2) if the ZEPROMs are not blank.

BUILD - convert user programs loaded into the 16K ram into a ROM image. BUILD will automatically convert all quads in which user programs have been loaded. Will compile all numeric GTO/XEQ's. All Alpha XEQ's will be compiled to XROM's if possible.

CHKSUM - calculate and stores the checksum of the currently selected quad. It stores the checksum in the checksum address of the quad, and also returns the checksum to the X-REG.

CLRQUAD - clears a quad in the ZP. The quad number (1-4) is taken from the X-REG.

CLRRAM - clears all 16K of the ZP's memory.

COMPARE - compares the currently selected ZEPROM against the image in the 16K ZP's RAM. If the compare fails the HP-41C will display the address at which the error occurred along with the two values at the address. The X-REG will also contain the port number, or negative of the port number if the compare failed, as outlined in BLANKZ?. Note that the programming voltage light will be turned on for the compare.

COPYQUAD - copies the contents of the quad specified in the X-REG (1-4) to the currently selected quad.

COPYROM - copies a ROM image from port 4 of the HP-41C into the currently selected quad in the ZP. If X-REG is 1 then the lower 4K of the ROM in port 4 is copied, if X-REG is 2 then the upper 4K of the ROM is copied.

COPYZP - copies a ROM image from the currently selected ZEPROM to the 16K ZP RAM. Note that the programming voltage light will be turned on for the copy operation.

DELPRG

DNLOAD - Downloads an Intel hex file from the serial port. This transfers a file from the PC to the ZP *into* QUAD 1.

EDIT - Allows the viewing and changing of memory locations. All values are hexadecimal. You must use SELRAM or SELZP function before doing the EDIT function to select whether you want to edit or view the memory in an actual ZEPROM or to edit the RAM in the ZP. All values are displayed, and entered in hexadecimal numbers.

ENTER - selects new starting address.

R/S - tells the HP-41C to accept the entered number.

SST - increments current address.
BST - decrements current address.
backarrow - deletes last entry.

GETMSG - Gets a message from the ZP's serial port and sends it to the HP-41C's display. If there is no data available from the serial port then the "NO MESSAGE" error is displayed.

LOADP - Loads the user program that's name is specified in the Alpha register into the currently selected quad. LOADP will return the number of bytes left in the quad to the X-REG. If there is not enough room left in the quad then the HP-41C will show the "NO ROOM" error message.

MEMLEFT - Displays in the X-Reg how much memory is available in the current quad.

MKBANK - Sets bits in the ZP's 16K RAM so that the next ZEPROM burned will have bank switching enabled and only appear as an 8K ROM.

NOBANK - Clears the bits in the ZP's 16K RAM so that the next ZEPROM burned will not have bank switching enabled and appear as a 16K ROM. Note: This is not the same as doing RAM16K. RAM16K also clears special flags that RAM8K sets.

PRIVATE - Adds a short poll handler to the ZP's 16K RAM, and sets bits in the FAT so that the next ZEPROM burned will be a PRIVATE ROM.

PROGRAM - Programs the currently selected ZEPROM(s) with the image stored in the ZP's 16K RAM.

RAM16K - Select so that all 16K of the ZP's memory is usable for uploading user programs. Any programmed ZEPROMS will be 16K ROMS. RAM16K will do a NOBANK instruction and clear special flags set by RAM8K.

RAM8K - Select so that only 8K of the ZP's memory is usable for uploading user programs. Any programmed ZEPROMS will be 8K ROMS. In 8K mode you may only upload into quads 3 and 4. At build time ROM images are built into quads 1 and 2. Additional programs can be loaded into quads 3 and 4 at a later time, and you can then rebuild the 8K ROM image in quads 1 and 2. RAM8K will do a MKBANK instruction, and set special flags telling the HP-41C where to load user programs, and where to put them when they are built, so that the original un-built user programs are saved.

RCLROM - Recalls the ROM image, who's name is stored in the Alpha register, from a mass storage device, into the current quad.

RDRAM - Read a byte from RAM from the address specified in the X-REG. Returns the value to the X-REG. Note that the address and returned value are decimal numbers, not hex numbers like EDIT uses.

RDZP - Read a byte from the currently selected ZEPROM from the address specified in the X-REG. Returns the value to the X-REG. Note the address and returned values are decimal numbers, not hex numbers like EDIT uses. Note that the programming voltage light will be turned on to read while reading the ZEPROM.

ROMID - Allows the user to specify the ROM ID for the currently selected quad. The ROM ID number is taken from the X-REG, and the ROM CAT 2 label is taken from the Alpha register.

SELQUAD - Selects the current quad, the quad number (1-4) is taken from the X-REG.

SELRAM - Selects the ZP's 16K RAM and de-selects the ZEPROM ports. You need to do this function first, before you execute the EDIT function, if you want to edit the ZP's RAM.

SELZP - Selects the current ZEPROM, the port number (1, 2 or 3 for both 1 and 2) is taken from the X-REG.

SELZP1 - Selects the ZEPROM in PORT 1 as the currently selected ZEPROM.

SELZP12 - Selects both ZEPROMs in PORT 1 and PORT 2 as the currently selected ZEPROMs.

SELZP2 - Selects the ZEPROM in PORT 2 as the currently selected ZEPROM.

SENDMSG - Sends a message to the ZP, and if a computer is hooked up via the RS232 interface then the message is sent out to the computer also. The message is taken from the Alpha register.

STOROM - Stores the current quad (raw program or ROM image) to a mass storage device. The file name is taken from the Alpha register.

SWITCH - Creates a "switching" function in a bank switching ROM. This must be run before any programs are loaded into quads 1 and 3. Put the name that you want to call the switch function in the Alpha register (max 7 characters).

UPLOAD - Sends the ZP's RAM to the RS232 port in Intel hex format.

VERIFYZ - Verifies the checksum in a ZEPROM in the currently selected port (1 or 2).

WRTRAMX - Writes the byte specified in the Y-REG out to the address specified in the X-REG in the ZP's 16K RAM. Note the address and written byte are decimal numbers, not hex like EDIT uses.

WRTZPX - Writes the byte specified in the Y-REG out to the

address specified in the X-REG in the currently selected ZEPROM port. Note the address and written byte are decimal numbers, not hex like edit uses. Must use the ZON instruction first to turn on the programming voltage to make the ZEPROM accept the data.

ZOFF - Turns off the programming voltage to the currently selected ZEPROM.

ZON - Turns on the programming voltage to the currently selected ZEPROM.

**Appendix A:
Care, Warranty, and Service Information**

Precautions

Only the normal precautions used for any electronic equipment need be observed:

- * The ZEPROM Programmer is NOT waterproof. Keep it out of the weather and away from water or other liquids.
- * It is a good practice to turn any electronic equipment off before connecting it to other equipment.
- * Static discharges can damage any electronic device. If your work area generates static easily, be sure you are discharged to ground before touching the ZEPROM Programmer. There are antistatic sprays which can easily be sprayed on carpet to reduce the problem.

Warranty

The ZEPROM Programmer is warranted by Firmware Corp. against defects in materials and workmanship for one (1) year from the date of original purchase. If you sell you unit or give it as a gift, the warranty is automatically transferred to the new owner and remains in effect for the original one (1) year period, Firmware Corp. will, at our option, repair or replace at no charge a product that proves to be defective, provided you return the product, shipping prepaid, to our company headquarters.

What is not covered

This warranty does not apply if the product has been damaged by accident or misuse, or as the result of service or modification by someone other than an authorized representative of Firmware Corp. Also not covered: equipment which has been altered, defaced or has had the serial number removed.

No other express or implied warranty is given. The repair and replacement of a ZEPROM Programmer is your exclusive remedy.

IN NO EVENT SHALL FIRMWARE CORP. BE LIABLE FOR CONSEQUENTIAL DAMAGES. And in any event, the company's liability shall not exceed the purchase price of the ZEPROM Programmer.

Obligation to make changes

Products are sold on the basis of specifications applicable at the time of manufacture. Firmware Corp. shall have no obligation to modify or update products sold.

Service Information

You must notify Firmware Corp. of any service requirements before returning a unit for service. If you have any questions concerning warranty or service arrangements, please contact us. After arrangements have been made, products requiring service shall be sent prepaid to the following address:

Firmware Corp.
605 NW 5th Street, Suite 2A
Corvallis, OR 97330
(503) 753-9314

**Appendix B:
RS232 Information and Pinout**

The serial port connector is a standard DB25 female connector. The ZEPROM Programmer is configured as a Data Communication Equipment or DCE. The pinout for the connector and communication protocols are given below.

Communication Parameters

9600 Baud
8 Data Bits
N No Parity
1 Stop Bit

RS232 Pinout

Pin	Signal	Full Name	Description
2	TxD	Transmitted Data	ZEPROM Programmer receives transmitted data over this line.
3	RxD	Received Data	ZEPROM Programmer sends data to be received by the PC.
5	CTS	Clear to Send	ZEPROM Programmer ready to receive data (Set high all the time).
6	DSR	Data Set Ready	ZEPROM Programmer ready to receive data (Set high all the time).
7	Gnd	Signal Ground	Reference for signal line.

Appendix C: Error Messages

ARGUMENT ERR - The value specified in the X-REG is not within the legal limits for the function being executed.

BAD CHKSUM - In response to the CHKSUM command. The Checksum verified incorrectly.

BUILT ROM - The ROM image in the currently selected quad has already been built.

FOREIGN ROM - This means that the ROM image is not one that was developed with the ZP, and thus some commands cannot be used.

GOOD CHKSUM - In response to CHKSUM command. The Checksum verified correctly.

NAME ERR - In response to the SWITCH command. This means that there is no name in the Alpha register.

NOT FOUND - The file name specified in the Alpha register was not found.

NO HPIL - In response to STOROM and RCLROM. This means that the HP-41C HP-IL interface is not plugged into the 41.

NO MESSAGE - In response to the GETMSG command. This means that there is no message available from the ZP.

NO ROMID - In response to the BUILD command. This means that no ROM ID has been specified for the current quad. Execute the ROMID function before doing BUILD.

NO ROOM - There is no room in the currently selected quad to load the specified program.

NO ZP RESP - The 41 detects no acknowledgement from the ZP. This could mean the ZP is turned off, not connected or not working properly.

NOT CLEARED - In response to the SWITCH command. This means that either quad-1 or quad-3 is not cleared.

N/A 8K MODE - you have selected 8K mode via the RAM8K command. The command or parameters to the command that you have specified are not allowed in 8K mode, (ex. trying to use the LOADP command when quad 1 or 2 is the current quad)

ROM - In response to LOADP command. Means that the program you are trying to load resides in a ROM and therefore cannot be loaded.

**Appendix D:
Quad Layout**

	ADDRESS (HEX)	ADDRESS (DECIMAL)	41C PORT NUMBER
16K Q-ROM	8000-BFFF	32768-49151 (16K)	1,2
4K Q-ROM	C000-CFFF	49152-53247 (4K)	3
4K 41C EPROM	D000-DFFF	53248-57343 (4K)	3
PORT 1	8000-BFFF	32768-49151 (16K)	1,2
PORT 2	8000-BFFF	32768-49151 (16K)	1,2

QUAD	ADDRESS (HEX)	ADDRESS (DECIMAL)
Quad 1	8000-8FFF	32768-36863
Quad 2	9000-9FFF	36864-40959
Quad 3	A000-AFFF	40960-45055
Quad 4	B000-BFFF	45056-49151

HP-41C HEX ADDRESS	DECIMAL	CONTENTS	# WORDS
0	0	XROM NUMBER	1
1	1	# OF CATALOG ENTRIES	1
2- 83	2- 131	FAT TABLE	130
84- 90	132- 144	ROM LABEL	13
91- FEC	145-4076	ROM FUNCTION CODE	3932
		PRIVATE ROM CODE	14
FED- FF3	4077-4083	TEMP STORAGE	7
FF4- FFA	4084-4090	POLL HANDLERS	7
FFB- FFE	4091-4094	ROM TRAILER	4
FFD		High bit enables bank switch	
FFF	4095	CHECKSUM	1

POLL HANDLERS

ADDRESS	INTERRUPT VECTOR
FF4	PAUSE LOOP
FF5	MAIN RUNNING LOOP
FF6	DEEP SLEEP WAKE UP, NO KEY DOWN
FF7	OFF
FF8	I/O SERVICE (Used for Private ROM)
FF9	DEEP SLEEP WAKE UP
FFA	COLD START

TEMP STORAGE

ADDRESS	CONTENTS
-----	-----
FED (4077) ---+	-- NEXT PROGRAM POINTER (Initialize to 145)
FEE (4078) ---+	
FEF (4079)	ROM ID
FF0 (4080)	NUMBER OF FUNCTIONS (HIGH BIT 0: Build as NON-PRIVATE ROM 1: Build as PRIVATE ROM)
FF1 (4081)	Reserved
FF2 (4082)	Reserved
FF3 (4083)	CONSTANT 'A5'

Appendix E: 4K Q-Rom Layout

The Q-ROM (or Quasi-ROM) is an area of memory that both the internal processor of the ZP and the 41C use.

ADDRESS	CONTENTS
-----	-----
C000-C001	RESERVED (ROM NUMBER & #FUNCTIONS) CAN'T USE
C002-CFAF	TEMP STORAGE USED DURING BUILD
CFB0-CFCF	MAIL BOX TO HP41 [32 WORDS]
CFD0-CFEF	MAIL BOX TO 6301 [32 WORDS]
CFF0-CFF2	RESERVED
CFF3	8K/16K ROM SELECT
CFF4-CFFA	RESERVED (INTERRUPT VECTORS) CAN'T USE
CFFB	QUAD SELECT
CFFC	ZEPROM SELECT
CFFD	ZEPROM/RAM SELECT
CFFE-CFFF	COLD START KEEPER BYTES

MAILBOX

ZP's	HP41	
MAILBOX	MAILBOX	
ADDRESS	ADDRESS	CONTENTS
-----	-----	-----
CFD0	CFB0	FUNCTION CODE
CFD1	CFB1	MESSAGE LENGTH
CFD2-CFEF	CFB2-CFCF	THE MESSAGE ITSELF

ZP MAILBOX FUNCTION CODES

FUNCTION CODE	MEANING
-----	-----
01	RECEIVE A MESSAGE FROM THE HP41 (Generally used for testing) - Also send the message out the serial port.
02	BUILD ROM IMAGES
03	UPLOAD AN INTEL HEX FILE
04	DOWNLOAD AN INTEL HEX FILE
05	SEND DATA RECEIVED FROM SERIAL PORT
06	DELETE A PROGRAM (Program name is in message bytes)

To use the ZP's mailbox put any message that you want to send (if using function code 1) in the message bytes (CFD2-CFEF), then the length in the length byte (CFD1). When you have written all of the message bytes, or if you are using one of the other function codes, write the function code to the first byte of the mailbox. The ZP will set the high bit of the first byte of the mailbox to acknowledge the command, and clear the first byte (the function code byte) when it is done processing the command.

While waiting for the completion of a command the HP-41C should monitor it's own mailbox for any messages the ZP might send back. If the ZP does send a message the HP-41C should set the high bit of the first byte of it's mailbox (CFAD), and clear the rest of the bytes in the mailbox.

Appendix F: References

If you are interested in making machine code ROMs, or want to learn more about the HP-41, there are many good books available. Some of these are listed below:

ZENROM

Firmware Corp.

605 NW 5th Street, Suite 2A

Corvallis, OR 97330

(This is a ROM and manual set that facilitates M Code programming)

HP-41 M Code For Beginners

By: Ken Emery

Synthetix

P.O. Box 1080

Berkeley, CA 94701-1080

Inside the HP-41

By: Jean-Daniel Dodin

Synthetix

P.O. Box 1080

Berkeley, CA 94701-1080

1may88 page 10: Older models do not respond to RAM8K as shown in the manual.

Instead of step 2 on page 10 perform the following steps:

- 2a. XEQ "RAM8K"
- 2b. XEQ "SELRAM"
- 2c. XEQ "EDIT"
- 2d. CFFC R/S (enter edit address)
- 2e. 003 R/S (enter new value for location CFFC)
- 2f. <-- (end edit)

This bug has been corrected in later models.

1may88 page 11: Older models will not install PRIVATE without SELRAM.

PRIVATE is ignored if the ZEPROM ports are selected.
Avoid this by using SELRAM before PRIVATE.
Later models will briefly select RAM while installing PRIVATE.

23may88 page 14: UPLOAD loses control of XON/XOFF.

While the micro-processor in the ZP is transferring data to the PC, the HP41 is asking for the micro-processor's status to know when the transfer is finished. If the HP41 requests status at the same time the PC is sending XOFF, the XOFF will be lost.

To avoid this situation turn off the HP41 right after the transfer begins in step 6 on page 14.

