EduCALC TECHNICAL NOTES

ADDING MORE MEMORY TO MY HP-41
Extended Memory, RAM Boxes, And EPROMs

There are three major categories of products that will provide more memory for HP-41 users. These are:

1. Extended memory. Offered by Hewlett-Packard only, this form of off-line storage requires that the program be copied into mainframe memory before it is run.[1] A total of two extended memory modules of 238 registers, 1,666 bytes, each may be used with the HP-41.

2. RAM boxes are advanced user products[2] that act as plug-in ROMs' on-line storage, as far as the HP-41   concerned. RAM boxes require special programs to laod program, data or ASCII files.

3. EPROMs[3] are a form of on-line memory that requires special programming equipment and are treated by the HP-41 as regular ROMs. Special equipment is also required to properly erase EPROMs.

Many prospective HP-41 users have difficulty understanding how these products work and which is best for their needs. Every machine can use more memory, so let's examine how memory is organized. When you switch to PRGM you see the program pointer location in mainframe memory. HP organizes memory into basic units called registers, which store seven bytes each. HP-41 functions are one, two, three, or variable length (up to 15) bytes each. The HP-41 microprocessor is able to address a total of 1024 registers, In general, the first 512 registers are used for mainframe RAM[4] The second 512 register address space is used for extended memory. Only 238 registers of the 256 register module is used due to addressing problems in the HP-41 system. Extended memory is considered as off-line memory because the program pointer is not allowed to execute programs above register 511. In this regard, programs stored in extended memory should be thought of as if they were stored on disc.

The HP-41 microprocessor has two separate addressing modes. One for RAM, as discussed above, and another for ROM. The RAM word is 8 bytes. The ROM words is 10 bytes. The longer addressing word allows for a larger addressing range. In terms of RAM registers there are over 9,360 ROM registers. ROM memory is best thought of as 16 pages of 4K words each. More precisely, there are 4,096 ROM words per page. The 16 pages are allocated as shown in Table 1.

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[1] Special techniques using synthetic programming allow the running of many programs in extended memory.
[2] Refer to TN #8 for more information on advanced user products.
[3] Refer to TN #10 for more information on using and burning HP-41 EPROMs.
[4] The 127 RAM registers in the Extended Functions Module are treated as part of extended memory, but are addressed below register 512.
[5] Refer to TN #14 for more information on system ESD crashes.

Table 1: HP-ROM Pages

Page	Used by	Page	Used by	Page	Used by	Page	Used by
0	Internal ROM	4	Diagnostic	8	Lower Port 1	12	Lower Port 3
1	Internal ROM	5	Timer (CX)	9	Upper Port 1	13	Upper Port 3
2	Internal ROM	6	Printer	10	Lower Port 2	14	Lower Port 4
3	Ex. Fcns (CX)	7	HP-IL	11	Upper Port 2	15	Upper Port 4

RAM boxes are designs that use commercial RAM memory, but the HP-41 cannot write to a RAM box unless special programs are used. As far as the HP-41 is concerned, the memory appears as ROM. Compared to an extended memory, RAM box memory is on-line storage because programs may be run in the RAM box itself.

Often the pages are numbered in HEX with 10 = A, 11 = B, . . . 15 = F. The lower eight pages (0-7) are described as hard addressed and the upper eight pages are port addressed. Page six is not used until a printer is plugged into a port. The HP-41 will recognize the printer ROM as hard addressed and the port is physically used but still able to address another ROM if connected in some way. The HP-41CX uses pages three and five. Page five is bank switched with two 4K pages in one place. Page four is reserved for the factory diagnostic ROM. A 32K RAM box will occupy all ports, which is 32K of ROM.

Special programs are used to write into a RAM box. In the ERAMCO RSU-2 RAM Expansion Box, an 8K collection of programs provides a complete capability to write data, program and ASCII files into a specified page. As of late 1987, ERAMCO offers 32K, 64K, and 128K sizes. An 8K operating system is in each 32K portion. This leaves 24K or six pages for the user. Earlier versions had DIP switches to select either one of the two 32K portions. The 128K RAM box switches the desired portion under software control and has no switches. Later versions (mid-1988 models) of the 32K or 64K size also eliminated the switches.

EPROMs are a form of memory similar to RAM memory except that a special EPROM burner is used to write the programs into the EPROM. The EPROM then acts as a regular ROM except that it is erased with an EPROM eraser. EPROMs have a glass window that is used to alow ultra violet light (short wave length) to enter from the EPROM eraser. The first use of EPROMS with the HP-41 required a separate EPROM box. Standard IC EPROMs were plugged into the box. Copies were easily made with most EPROM burners and EPROMs were the main form of exchange for MCODE programmers because MCODE instructions can only be in ROM. CMT designed an EPROM 'box' that fits into the regular ROM module package and HP-41 EPROMs today include the EPROM box as part of the EPROM. That is why EPROMs cost in the 100 dollar range whereas EPROMs used to cost in the 5 dollar range and the EPROM box cost several hundred dollars. Burning EPROMs require special programs to control the EPROM burner and the efficient assembly of ROM images to burn into EPROM requires enough skill that EPROM burning and RAM boxes are classified as advanced user products.

EPROM is especially attractive for situations that require the collection of data to be stored in mainframe RAM. All programs are placed in EPROM, leaving 319 registers of mainframe RAM free for data. EduCALC offers EPROM burning services to make use of this form of memory easy and convenient for every HP-41 user. EPROMs have one major advantage over all other forms of memory—reliability. Your programs will not be lost with dead batteries or system crashes.