

**AME DESIGN**

**PORT  
X  
TENDER**

**Model 4107**

**AME DESIGN  
BOX 373  
13450 MAXELLA  
MARINA DEL REY, CA. 90291**

213-306-1249

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## THE FIRST TIME

The modules for the HP-41 have spring contact which will spread apart after being in the calculator for awhile. Using these in the PORT-X-TENDER may cause soft crashes (a blank display).

Before using the PORT-X-TENDER for the first time, we suggest that you check all of your modules to be certain that they make good contact. The term "module" also refers to any device being connected to the PORT-X-TENDER. The procedure is as follows:

To check all of your modules, insert them one at a time into Slot 1 of your PORT-X-TENDER. Connect the PORT-X-Tender to your HP-41. Turn on Slot 1 (switch 1). If the calculator display is active, turn off and disconnect the PORT-X-TENDER. Remove the module from Slot 1 and repeat the procedure with the next module.

If you find a module that will cause the calculator display to blank, disconnect the PORT-X-TENDER from the HP-41. Clear the HP-41 and remove the module. Take a tooth-pick or other nonconductive probe and push each contact in the module toward the opposite side. Do this by placing the point of the pick under the half-moon bend of the contact and use a pushing and prying motion. Firm but not excessive force is used. When you have completed this procedure on all of the contacts, try the module in the PORT-X-TENDER again. New modules will have the proper contact tension.

Once all of your modules have been tested, configure the PORT-X-TENDER as you like by following the instructions in the manual.

Due to the state-of-the-art design of the HP-41, with it's low power consumption, it is susceptible to disruption (crashes). Should they occur, disconnect the PORT-X-TENDER and clear the crash as you would if you were not using a PORT-X-TENDER. Used properly, the PORT-X-TENDER should not cause any more crashes than you have experienced in the past.

## NOTES

1. Mark your name on the back label of the PORT-X-TENDER with a PILOT SC-UF, ultra fine point permanent pen.
2. The label is made of "LEXAN" (TM OF GE) material.
3. The PORT-X-TENDER is injection molded of ABS plastic.

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## INTRODUCTION

The AME Port-X-Tender is a device which functions as a companion to the Hewlett-Packard HP41C/CV advanced alphanumeric programmable calculator. It increases the HP41's capability to interface with ROM application and extension modules, RAM memory modules and peripheral devices. As the user continues to add to his system, the Port-X-Tender becomes increasingly useful for managing and channelling the flow of information between the calculator and external devices and modules. Table 1 presents an overview of the features of the Port-X-Tender.

1. Seven slots are provided to yield a total of 10 positions for plugging external devices and/or modules into the HP41.
2. A cable with an HP41 I/O port plug, designed to plug into the HP41's port #3 exits one end of the extender case.
3. The Port-X-Tender's slender shape allows it to ride under the HP41 with a card reader attached and still remain a compact enough system to be handheld. Four large rubber feet assure a non-slip surface when sitting on a desktop.
4. Six of the 7 slots may be switched on or off to select specific devices and/or modules in or out of the user's system.
5. Two of the slots may be selected to electronically function as a connection to any of the four HP41 I/O ports.
6. A 6-volt lithium battery in the extender preserves RAM memory (plugged into the extender slots) when disconnected from the calculator. (This applies to either main memory for the HP41C or extended memory for the HP41C or CV.)
7. A built-in battery tester checks both the battery in the extender and the cells in the calculator.

Table 1. Major features of the AME Port-X-Tender.

For the use of this manual, it is assumed that the reader is familiar with the HP41C or HP41CV through the Owner's Handbook. Any new terminology introduced is either defined in the text or appears in detail in the glossary of terms on page 30. No advanced programming knowledge is required to benefit from the Port-X-Tender. However, special advanced techniques and HP41-related products not manufactured by Hewlett-Packard are occasionally mentioned in the pages to follow. Most of these have been developed by members of PPC, an independent users group which supports advances in hardware and software related to the HP41. For more information, see "PPC" in the glossary of terms.

## I. GENERAL USE OF THE PORT-X-TENDER

Your Port-X-Tender comes with 2 circular pads and a set of Velcro strips. These are for the mechanical attachment of the HP41 to the extender; to add stability to the plug-connection between the extender cable and the I/O port on the calculator. Position the Velcro strips so the calculator attaches itself via the battery holder to the top surface of the extender. Secure one Velcro strip onto the extender in such a position so that the HP41 does not hang over any side of the extender's top surface when the card reader is attached (see figure 1). Since the thickness of the Velcro may cause instability when the keys are pressed, position the 2 circular pads onto the extender so the highest part of the HP41 underside will rest on them. This position should be approximately one inch away from the Velcro strip on the extender's top side. The pads should prevent any teetering when keys are pressed.

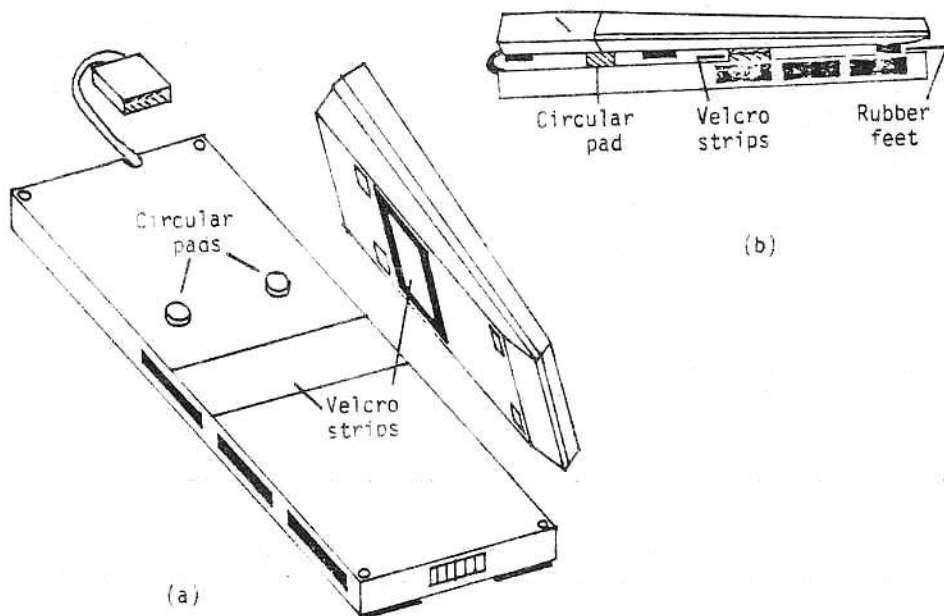


Figure 1a. Top surface of the Port-X-Tender showing position of the circular pads and velcro strips for attachment of the HP41.

Figure 1b. Left side view of the extender showing the HP41 with card reader attached. The calculator should contact the top surface of the extender by the circular pads, velcro strips and lower set of rubber feet.

### A. Connecting the Port-X-Tender:

Turn off the calculator and connect the Port-X-Tender plug to the calculator's port #3 (which is the port remaining uncovered when the card reader is attached). This will require a sharp 180-degree bend in the extender cable. Exercise the cable into bending tightly, if necessary. See figure 2.

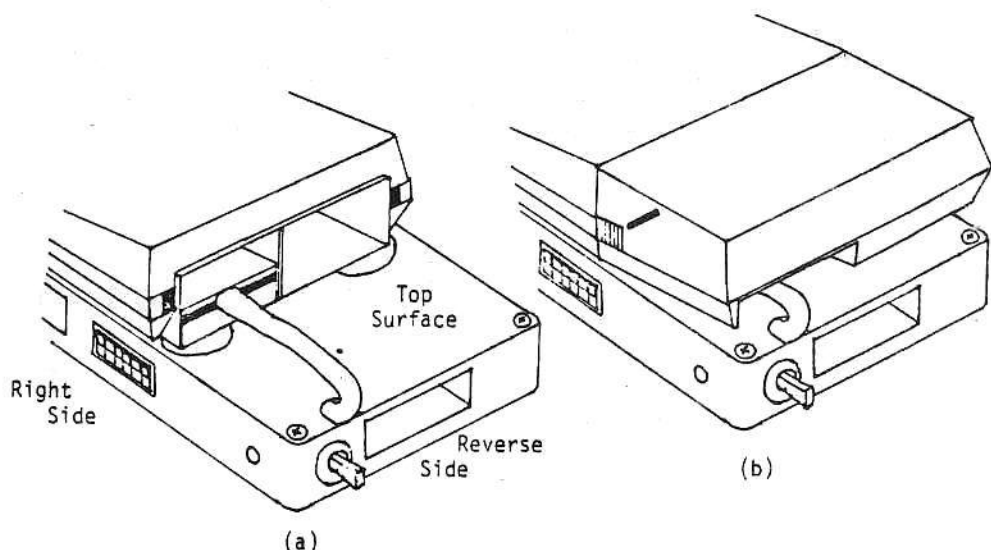


Figure 2a. Port-X-Tender with cable bent 180 degrees and plug inserted into HP41 port number 3.

Figure 2b. Port-X-Tender attached to HP41 with a card reader in port number 4.

### B. The Battery Test Switch:

Exercise the extender battery-test switch on the reverse side. Looking at this side, move the switch to the left to check the calculator batteries; then move it to the right to check the 6-volt battery in the Port-X-Tender. In each case, the red light emitting diode (LED) on the right side of the extender case near the battery-test switch should light brightly. The cell in the extender should last for 6 months to over one year. As battery power decreases in either the calculator or the Port-X-Tender, the brightness in the LED will decrease. When testing the extender cell, the LED will just be discernible in ambient light when the cell voltage has dropped to around 2.5 - 3 volts. At this time, it is advised that the battery be replaced. When the "BAT" annunciator in the HP41 display appears, the LED in the extender will appear dim when tested. Checking the calculator batteries with the test switch is also a quick way to insure the integrity of the plug connection between extender and calculator.

### C. Port-X-Tender Battery Power:

The battery in the Port-X-Tender powers RAM memory plugged into its slots only under certain conditions. If the calculator batteries' cell voltage is higher than that of the extender battery, then the extender (and calculator) RAM will be powered by the calculator when turned on. If the calculator voltage should drop below that of the extender's battery, then the extender RAM will be powered by the extender battery only. With the calculator off but connected to the extender, both power sources keep the RAM alive. Under no circumstances do ROM memory devices use power from the Port-X-Tender battery (with the exception of the HP82182A Time Module, which will keep time in a disconnected extender).

### D. Plugging, Unplugging and Calculator Crashes:

When plugging devices into Port-X-Tender slots, make sure that the metal prongs are directed downwards in the slot. Since the extender circuit board which accepts the devices, sits slightly lower than the center of the slot openings, and since peripheral plugs and modules have tapering sides, this precaution is necessary. See figure 3.

In order to insure that the HP41 operates properly, and to prevent keyboard lockup, make sure that the calculator is turned off when plugging and unplugging the Port-X-Tender to and from I/O port #3. Also, when inserting and removing devices from the extender slots, make sure that the HP41 is turned off. If keyboard lockups still occur, turn off the calculator and unplug the Port-X-Tender before plugging and unplugging from the extender's slots.

To prevent possible damage to the Port-X-Tender, never rotate or twist the extender when it is plugged into the calculator.

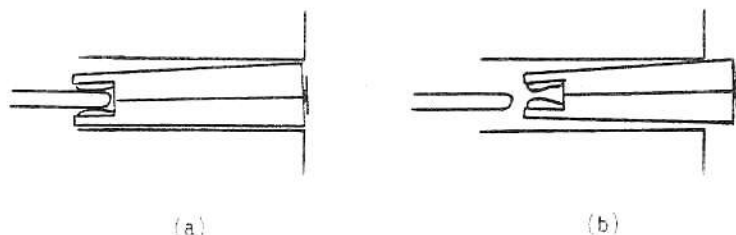


Figure 3a Side view of an HP41 module plugging into a Port-X-Tender slot. Note that since the circuit-board connector inside the extender sits slightly below the middle of the slot opening, the module must be directed downwards into the slot.

Figure 3b. A side view of an attempt to insert a module into a Port-X-Tender slot without regard to the position of the circuit board connector. The module will simply fail to travel all the way into the slot.



#### E. Identification of the 6 Sides of the Extender:

In order to accurately describe the various features of the extender, the following convention shall be adopted for identification of the six flat faces. The top side is the side on which the HP41 sits; the underside is the face with the rubber feet. The front surface is that which contains 6 small two-position switches; the reverse side contains the battery test switch; the left and right sides are referenced to the observer viewing the front side. Identify from the decal on the underside of the extender that the 7 slots are numbered 1 to 3 on the left side, 4 to 6 on the right side, and 7 on the reverse side.

## II. PORT-X-TENDER SLOTS' BASIC FUNCTIONS

This manual will consistently use the term 'slot' to denote a pluggable position in the Port-X-Tender, while 'port' will mean a position in the input-output bank in the calculator. Table 2 shows the seven extender slots along with their function as extensions of the HP41's I/O ports. Extender slots 1 through 4 are hard-wired to electronically behave as an additional set of calculator ports 1 through 4, respectively. Slot number 7 on the back side, is wired as an additional copy of calculator port number 3. Slots 5 and 6 are controlled by a set of small, two-position switches on the right side of the extender. These determine which calculator ports are to be extended by the slots. Table 3 (which also appears on the decal on the underside) lists the control scheme. (See section VII.D for port assignment control for slot number 7.)

EXTENDER SLOT:	WIRED TO HP41 PORT NO.:	
1	1	
2	2	
3	3	
4	4	
5	1 to 4	Selectable via 2-position
6	1 to 4	switches on right side
7	3*	

Table 2. Port-X-Tender slots and corresponding calculator ports. \* See chapter VII, section D on port assignment control for slot 7.

port assignment:	SLOT 5 CONTROL:			SLOT 6 CONTROL:		SLOT 7 CONTROL:	
	Switch 1	Switch 2		Switch 3	Switch 4	Switch 5	Switch 6
1	OFF	OFF	00	OFF	OFF	OFF	OFF
2	ON	OFF	10	ON	OFF	ON	OFF
3	OFF	ON	01	OFF	ON	OFF	ON
4	ON	ON	11	ON	ON	ON	ON

See Note

Table 3. Positions of small switches on the right side of the Port-X-Tender to control slots 5 and 6, wired as extensions of calculator ports 1 through 4. NOTE: Slot 7, although wired to port 3, may be made port-assignable through a wiring modification described in chapter VII, section D.

An additional bank of 6 two-position switches on the front side of the extender is used to turn slots 1 through 6 "on" or "off". A device in a slot which is "on" is perceived as being present by the calculator. If a slot is turned "off" by a front switch, the device in that slot is disconnected from the calculator. However, power from the Port-X-Tender battery is delivered to all 7 slots regardless of position of the front or side switches. Therefore, RAM memory module contents in the slots will remain intact as long as the extender battery is alive.

The front and side switches have holes into which a plastic locking rod may be inserted, in order to prevent accidental adjustment. Figure 4 shows these switches with the rod inserted.

Two types of devices may be plugged into the Port-X-Tender's slots: those containing ROM memory and those containing RAM memory. (Some may contain both ROM and RAM memory, such as the HP82180 Extended Function/Memory Module.) These will be discussed separately since they behave differently with respect to their positions in the extender.

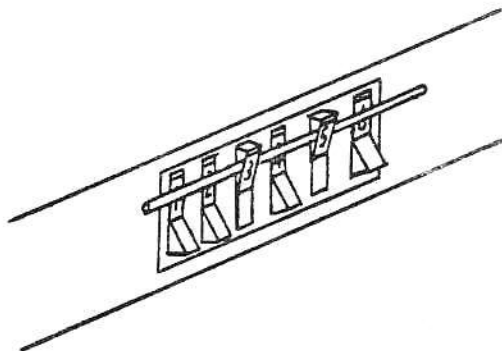


Figure 4. Port-X-Tender switches with the plastic locking rod inserted to prevent unwanted movement.

### III. HP41C/CV ROM MEMORY STRUCTURE

To explain how the HP41 accesses ROM memory, we should briefly consider the ROM addressing scheme as a whole. By ROM addressing, one means pointing to particular spots in read-only memory by numerical values corresponding to them; just like different houses on the same block have different address numbers.

The HP41 is really a very specialized handheld computer which has been programmed to behave like an advanced alphanumeric programmable calculator. The program which the HP41 executes in order to function this way is called the operating system. This program, which resides in internal ROM memory chips, controls the function of the keyboard, display, etc., including perceiving the presence of any devices plugged into the 4 I/O ports. One sixteenth of the total ROM memory capacity is equal in size to a single-density ROM application module, 4096 bytes long. These 16 sections are called "pages" of ROM, and are numbered 0 through 15. The HP41 operating system program occupies the first 3 pages of ROM memory; pages 0, 1 and 2, totalling over 12000 bytes.

Imagine the 16 pages of ROM to be a vertical stack of blocks, as shown in figure 5. A dividing line between the upper and lower 8 ROM pages represents the imaginary partition between the operating system plus plug-in extension ROMs (pages 0 - 7), and other plug-in peripherals and modules which are addressed as actually residing in the I/O port ROM area (pages 8 - 15). The ROM area for the I/O ports begins with pages 8 and 9 for port #1 and ends with pages 14 and 15 for port #4. This means that up to 8K bytes of ROM may be seen by the HP41 as being present in any I/O port. ROM memory plugged into an I/O port fills the available space beginning with the lower 4K byte page first. Thus, a single-density application or custom module in port #2 would be seen by the operating system as occupying ROM page #10. And, an 8k module in port #2 will occupy pages 10 and 11. This type of device is known as port-addressed, since its actual ROM address depends upon which port it occupies.

ROM PAGE (each 4096 bytes)	15	THIS SPACE	I/O
	14	FOR	Port 4
	13	PORT-ADDRESSED	I/O
	12	ROM	Port 3
	11	APPLICATION	I/O
	10	MODULES	Port 2
	9	AND	I/O
	8	DEVICES	Port 1
	7	THIS SPACE	82160A
	6	FOR	82142A Printer HPIL Module
	5	HARD-ADDRESSED	Time Module
	4	DEVICES,	
	3	ROM EXTENSION	
	2	MODULES	HP41
	1	AND	Operating
	0	OPERATING SYSTEM	System

Figure 5. HP41 ROM addressing scheme. Of the 64 Kbyte total ROM space, the upper half (32 Kbytes or 8 ROM pages) consists of the space for plug-in port-addressed devices in the four I/O ports. The lower half holds the ROM from the HPIL Module, Time Module, HP41 operating system (3 pages unto itself) etc.

Certain plug-in devices, however, such as the HP82143A Thermal Printer, will occupy a ROM address page that is below the I/O port area, regardless of the port to which they are connected. These devices are known as hard-addressed since their internal wiring dictates their position to the operating system of the calculator. The printer always occupies ROM page 6. Another example of a hard-addressed device is the HP82182A Time Module, which always occupies ROM page 5.

Table 4 lists all the current ROM memory devices associated with the HP41 system, along with size, address page and pertinent additional information. For plugging devices with ROM into the HP41's 4 I/O ports, the basic rule to follow is to avoid conflicts in ROM addressing; i.e. no 2 devices should be present which correspond to the same ROM page (such as having two HP82143A Printers). This safeguard is completely automatic for port-addressed devices since different ports mean different address pages. One should also avoid conflicts with devices present in the calculator with the same XROM numbers, such as two application modules marked with an "X" (XROM 19) or two wands (XROM 27). Hard-addressed devices will never conflict with port-addressed ones, except that without the use of the Port-X-Tender, the occupation of 2 ROM pages would physically be blocked by the presence of the hard-addressed device in that port.

#### A. ROM in the Port-X-Tender:

Now, with the Port-X-Tender yielding a total of ten positions for devices, an additional degree of care should be exercised in assuring a lack of conflicts. Considering all ten positions (7 extender slots plus HP41 ports 1, 2 and 4) and the selectable slots 5 and 6, at any one time we may have up to 4 positions simultaneously corresponding to any of the calculator's 4 ports. Two examples would be four port 1's: calculator port 1, extender slot 1 and slots 5 and 6 selected to 1 (all side switches OFF) and four port 3's: extender slots 3, 7 and slots 5 and 6 selected to 3 (side switches OFF, ON, OFF, ON).

If more than one port-addressed ROM device occupies plug-in positions corresponding to any single calculator port, a conflict will result, since the ROM pages for any single calculator port are also accessed in extender slots corresponding to that port. So, if a card reader (4K of port-addressed ROM) is in calculator port 4 (occupying page 14) with a statistics application module in extender slot 4 (also attempting to occupy page 14), a conflict will result, causing erratic behavior and possibly a system crash. The same is true if a 4K ROM and an 8K ROM are in the same port: the lower half of the 8K ROM will conflict with the 4K device.

Although conflicting ROMs in extender slots will present a problem, they may be switched off via the 6 switches in the front of the extender. Thus, the amount of plugging and unplugging can be significantly reduced by simply switching the undesirable ROM(s) out of the port(s). In addition, if the undesirable ROM is either slot 5 or 6, it may be switched (via the side switches) to a different port, and possibly an unoccupied ROM page.

The main advantage for ROM in the use of the Port-X-Tender is that hard-addressed devices may be plugged into slots corresponding to the same I/O port as a port-addressed device and no conflict will occur. Thus, while a wand may be plugged into extender slot #2 (occupying ROM page 10), we may still have a Time Module (hard-addressed to ROM page 5) in calculator port #2 and a printer (hard-addressed to ROM page 6) in extender slot #5 selected to port #2 with no conflicts.

The HPIL Module, while hard-addressed to ROM pages 6 and 7, may interfere with the HP82143A printer ROM which is also addressed to page 6. To alleviate this, a small switch on the underside of the HPIL Module, when set to the "disable" position, will allow only its ROM page 7 to be accessed by the calculator.

NAME	SIZE	DESCRIPTION	COMMENTS
A. Single-density Application Module	4 Kbytes *	Port-addressed to lower ROM page of occupied port	Up to 4 may be simultaneously used, 1 per port (ROM pages 8, 10, 12 and/or 14)
B. Dual-density Application Module	8 Kbytes	Port-addressed to both lower and upper ROM pages of occupied port	Up to 4 may be simultaneously used, 1 per port (ROM pages 8 through 15)
C. Custom ROM Application Module	4K or 8K bytes	Port-addressed: 4K: to lower ROM page 8K: lower & upper page	Up to 4 may be simultaneously used, 1 per port (including mixing 4K and 8K modules)
D. HP82182A Time Module	4 Kbytes	Hard-addressed to ROM page 5	Occupies no ROM port addresses, maximum one used
E. HP82143A Printer	4 Kbytes	Hard-addressed to ROM page 6	Occupies no ROM port addresses, maximum one used
F. HP82160A HPIL Module	8 Kbytes	Hard-addressed to ROM pages 6 & 7	Occupies no ROM port addresses, maximum one used. Disable switch eliminates pg 6 conflict with printer.
G. HP82104A Card Reader, HP82153A Wand	4 Kbytes each	Both port-addressed to lower 4K ROM page of occupied port	Card rdr. only fits mechanically to port 4 (ROM page 14); wand may go in any port (maximum one used)
H. HP82180A Extended Functions/Memory Module	4 Kbytes	Port-addressed to lower ROM page of occupied port	May be in any port (one max.), occupying ROM page 8, 10, 12 or 14
I. Peripheral EPROM Box **	4K to 16K bytes	Hard-addressed by box controls	May be in any port, occupies up to 4 consecutive ROM pages

Table 4. HP41 plug-in devices and modules which contain ROM memory. \* indicates that while the ROM size is referred to as being so many bytes in length, these ROM words are actually each 10 bits in length. For user language in ROM, however, they function the same as 8-bit bytes in RAM. \*\* indicates that EPROM boxes are not manufactured by Hewlett-Packard, but have been devised by individuals in PPC. See chapter VII section C for more details.

#### IV. HP41 RAM ADDRESSING SCHEME

The Random Access Memory (RAM) in the HP41 follows a scheme similar to that for Read Only Memory (ROM) discussed in the previous chapter. Also note that RAM and ROM memory do not interfere with each other in any way. Figure 6 presents HP41 RAM as a stack of blocks representing memory regions. This stack is divided into main memory (regions 0-4) and extended memory (regions 5-7).

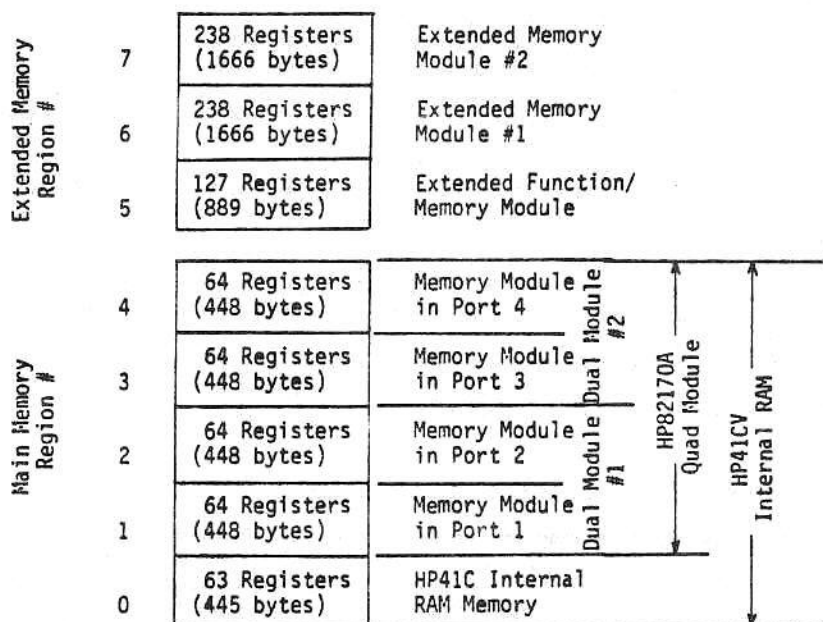


Figure 6. HP41C/CV RAM Memory space. Main memory is filled from the bottom up with no allowable gaps. External memory may be added to either a 41C or 41CV, and also is filled from the bottom up, beginning with the Extended Functions/Memory Module in region 5.

##### A. Main Memory:

HP41 main memory consists of 5 RAM regions, each 63 or 64 registers high. We may number these regions 0 through 4, with region 0 being internal to the HP41C and regions 1 to 4 representing plug-in RAM modules in the HP41C or internal memory (totalling 319 registers or 2237 bytes for all 5 regions) in the HP41CV. Since no plug-in RAM modules may be added to main memory in an HP41CV, further discussion shall be restricted to the HP41C.

The HP82106A memory module is a port-addressed device which contains 64 RAM registers and may be plugged into any I/O port, with a maximum of 4 used, 1 per calculator port, to fill RAM regions 1 to 4 (and also filling all I/O ports). However, there must not be any gaps in main memory, due to an open port between modules, or the HP41C will only perceive that main memory extends to the top of the highest RAM region that is contiguous with internal RAM region zero. Therefore, memory modules should be plugged into the calculator such that consecutive RAM regions are filled, beginning with region 1.

In 1979, shortly after the introduction of the HP41C, the PPC Club pioneered combining 2 memory modules into one plastic module case. There are 2 types of these "dual modules" - those which are hard-addressed to specific RAM memory regions regardless of the ports in which they reside; and those which fill unoccupied sets of memory regions in consecutive order (i.e., regions 1&2 for the first and 3&4 for the second). If the dual modules are hard-addressed, one is wired for RAM regions 1 and 2 and the other to regions 3 and 4. In order to prevent memory gaps, the "1-2" dual must be present (in any port) before the "3-4" dual can be utilized. If the dual modules are not hard-addressed, then the first will fill regions 1 and 2 and the second will fill 3 and 4. Be aware of which type dual modules are presently in the system, so a complete understanding of the memory layout will be known at all times.

The HP82170A Quad Module is hard-addressed to RAM regions 1 to 4 and may occupy any port in the 41C (or lost in the Port-X-Tender) without creating memory gaps. However, only one may be present at a time, since main memory stops at RAM region 4.

Some PPC experimenters have managed to fashion home-made triple- or quad-modules from combined memory modules. These have been made to fill RAM memory from region 1 upward, regardless of the occupied port.

#### A.1. Considerations for Main RAM Memory in the Port-X-Tender:

Port-addressed memory modules, either type of dual modules or quad modules all function in the Port-X-Tender as they do in the HP41C ports. Some additional care should be taken, however, when using RAM in multiple copies of the same calculator port. If more than one memory module is plugged to the same port through extender slot usage, the calculator will only perceive the existence of one module. The same goes for dual modules which are not hard-addressed. It is perfectly acceptable, however, to plug 2 hard-addressed dual modules into the same port, since they electronically point to completely different RAM regions.

Table 5 summarizes the behavior of all plug-in modules which contain RAM memory. In chapter VI, we will discuss switching multiple pages of main and extended RAM memory in the extender. Also, in chapter VII, the techniques for safely disconnecting and reconnecting the Port-X-Tender containing RAM (for the HP41C) will be covered.



<u>NAME</u>	<u>SIZE</u>	<u>DESCRIPTION</u>	<u>COMMENTS</u>
A. HP82106A Single Density Memory Module	64 Registers (448 bytes)	Port-addressed to occupied port's RAM region	Up to 4 may be simultaneously used, 1 per port (RAM regions 1-4)
B. Dual Density Module*	128 Registers (896 bytes)	Two types; either hard or port-addressed	Up to 2 may be simultaneously used
C. HP82170A Quad Module	256 Registers (1792 bytes)	Occupies all 4 RAM regions of main memory	Maximum of one may be used
D. HP82180A Extended Functions/Memory Module	127 Registers (889 bytes)	Hard-addressed to extended memory region 5	Maximum of one may be used
E. HP82181A Extended Memory Module	238 Registers (1666 bytes)	Port-addressed to RAM region 6 (if in port 1 or 3) or 7 (if in port 2 or 4)	Up to 2 may be simultaneously used, with one in port 1 or 3 first, & 2nd in port 2 or 4

Table 5. HP41 plug-in modules which contain RAM memory. \* indicates that dual modules are not manufactured by Hewlett-Packard, but have been devised by PPC. These modules may be wired as port- or hard-addressed devices, each occupying the equivalent main memory RAM regions as two HP82106A single density memory modules.

## B. Extended Memory:

HP41 Extended Memory consists of 3 RAM regions, which may be numbered 5, 6 and 7. Region 5 is 127 registers high and regions 6 and 7 are each 238 registers high, totalling 603 possible extended memory registers. The extended memory may be addressed with either an HP41C or CV. However, if full main memory in the HP41C is achieved through RAM modules of lower capacity than a quad module, some sort of extension of the calculator's ports will be necessary to provide enough positions to connect the full extended memory.

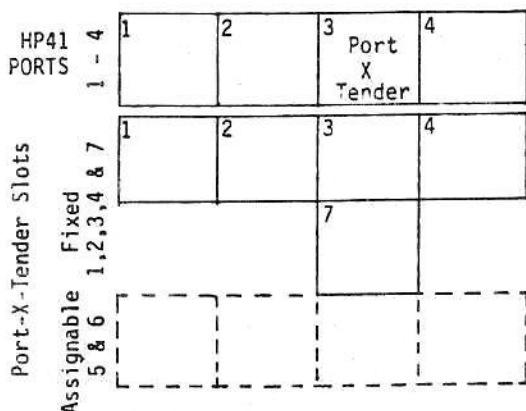
RAM region 5 is filled by the HP82180A Extended Function/Memory Module (in any port), which is hard-addressed to this region. Up to 2 HP82181A Extended Memory Modules are used to fill the remaining RAM regions 6 and 7. They may reside in any port with no memory gaps created, as long as the first one is in an odd-numbered port and the second is in an even-numbered port.

### B.1. Turning Extended Memory Off and On in the Port-X-Tender:

If files stored into extended memory (partially or completely) reside in the extended memory modules, extreme care should be taken in turning the modules on or off in the Port-X-Tender slots. If an extended memory module is turned off by one of the front switches, the information in it will be "lost" by the EMDIR (extended memory directory) and may be irrecoverable by conventional means. Upon turning the slot(s) back on, EMDIR will show all files absent from the module. Turning all 3 extended modules off and on together is acceptable, however, and disconnecting the extender containing all of the extended memory is fine, but individual modules in the group may not be switched off line without seriously altering the contents in those modules.

## V. Port-X-Tender Configurations

With many different devices and modules containing ROM and RAM, the options for plugging into ports and slots are many. Figure 7a shows an empty Port-X-Tender configuration chart, which may be used to design a system centered around the calculator. The top row of squares represents the calculator's four I/O ports (with port #3 occupied by the extender plug), and the lower 3 rows the extender slots. Slots 1 to 4 lie directly under their corresponding ports; slot 7 lies below port 3 and slot 3; and in a separate row, slots 5 and 6 are indicated under the ports to which they are assigned. Figure 7b shows a completed configuration chart for an HP41C with a quad module, full extended memory, Time Module, HP82143A printer, HPIL module, card reader, wand and statistics module. All lower-4K port-addressed ROM pages 8,10,12 and 14 are occupied, along with hard-addressed ROM pages 5,6 and 7. Full main and full extended memory (RAM regions 0 through 7) are also present.



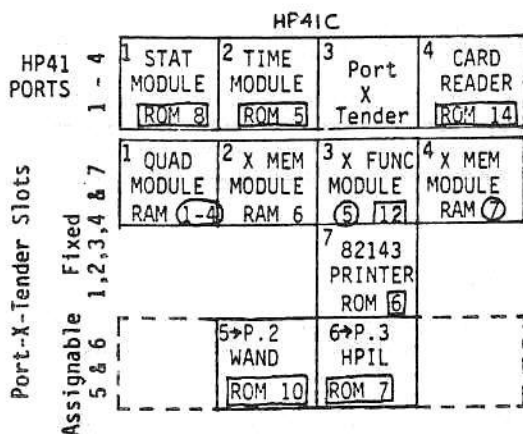
### ADDRESS CHECKLIST

ROM	RAM
14,15	7
12,13	6
10,11	5
8, 9	4
7	3
6	2
5	1

Ⓝ = RAM region #

Ⓝ = ROM page #

(a)



### ADDRESS CHECKLIST

ROM	RAM
14,15 Card Reader	7 X Memory
12,13 X Functions	6 X Memory
10,11 Wand	5 X Functions
8, 9 Statistics	4 ↑
7 HPIL Module	3 Quad
6 Printer	2 Module
5 Time Module	1 ↓

Ⓝ = RAM region #

Ⓝ = ROM page #

(b)

Figure 7a. An HP41/ Port-X-Tender configuration chart. Use the left side to indicate which devices are in which slots and ports. The right side is a ROM/RAM area checklist.

Figure 7b. A typical HP41/ Port-X-Tender configuration.

Use the extra blank configuration charts supplied at the end of this section to prepare HP41/Port-X-Tender systems. Figures 5 and 6 will aid in identifying the proper ROM pages and RAM regions occupied by devices in the ports and slots. In the configuration boxes along with the name of a device containing ROM, the occupied ROM page number should be placed in a small rectangle. For RAM modules, the RAM region number goes in a circle. This will obviate the possible conflicts of ROM and RAM when the system is being considered.

#### A. Some Guidelines for Positioning Peripherals and Modules:

Below is a brief set of rules to follow when building an HP41 configuration.

##### A.1. Devices Containing Hard-Addressed ROM:

**Time Module:** This is the only HP41 device which is both hard-addressed and is a small-sized plug-in module. As a result, this module can be connected anywhere in the calculator or Port-X-Tender without any addressing conflicts. However, in order to keep the extender slots open for other, less flexible devices, it is advised that the Time Module be kept in a calculator port. Since the module's crystal consumes power from whichever device's power source has the higher voltage, make sure the calculator's power source is adequate. If a card reader is used, the ports remaining for the module are #1 and #2. Nevertheless, with the Time Module in the Port-X-Tender, correct time is maintained even while the extender is disconnected from the HP41.

**ROM Page 6 Devices:** Both the HP82143A printer ROM and the lower 4K bytes of ROM in the HP82160A HPIL Module are hard-addressed to HP41 ROM page 6. When using both simultaneously, keep the HPIL Module's switch (on its underside) in the "DISABLE" position to avoid a ROM page 6 conflict. (The 82143A and 82162A printers may NOT be used at the same time.) Either page-6 device may be plugged into any port or slot without conflicts with other devices. But in the presence of a card reader (blocking access to ports 1 and 2), Port-X-Tender slots must be utilized. Slot number 7 on the reverse side is convenient to prevent the printer and HPIL module cables from physically interfering with the user.

**HPIL Module (ROM Page 7):** This is the only device which presently occupies this hard-addressed page. Plug it into any calculator port or, if a card reader is used, into any extender slot. No addressing conflicts are created; however to keep the HPIL cables out of the way, Port-X-Tender slot 7 is preferred for use over any other slots or ports.

##### A.2. Devices Containing Port-Addressed ROM:

**HP82104A Card Reader:** This can only mechanically fit onto calculator port #4, occupying the lower-4K HP41 ROM page 14. The Port-X-Tender has been designed so that the card reader will not fit in any of the slots.

**HP82153A Wand:** This can mechanically fit into any port or slot, however it must be in an extender slot if a card reader is present. With the card reader occupying port 4, the wand will conflict with extender slot 4 or slots 5 or 6 if assigned to

calculator port 4.

Application or Custom ROM Modules (4K or 8K Bytes): Use in ports or slots corresponding to ROM pages which are unoccupied. Remember that any device may reside in potentially conflicting Port-X-Tender slots 1 through 6 if the slots are switched off by the front switches.

HP82180A Extended Functions/ Memory Module: The ROM portion of this module is port-addressed, therefore requiring the same precautions in adding it to the system as a port-addressed peripheral or module. The extended-memory RAM portion does not add any additional constraints as to which port or slot this device may connect.

EPROM Box ROM Memory: Depending upon how much memory is in the box, a set of EPROM chips in a peripheral enclosure may occupy between 4K and 16K bytes of ROM memory. Conventional addressing in the box would have 4K and 8K chip sets port-addressed just like application modules of the same capacity; with 16K byte chip sets occupying two full 8K-ports (4 consecutive ROM pages). In addition, special addressing or wiring techniques may allow addressing of upper-4K ROM pages in the ports without the accompanying lower-4K pages. In these cases, it would still be safe to have conventional lower-4K byte port-addressed devices assigned to the same calculator ports as the EPROM chips without conflict.

#### A.3. Main-Memory RAM Modules (HP41C Only):

Single-Density Memory Modules, being port-addressed, must fill positions corresponding to HP41C ports 1, 2, 3, and 4 in that order with no gaps. Calculator ports or extender slots are both acceptable for this purpose. For example, full main memory is adequately maintained with 2 memory modules in calculator ports 1 and 3; and with 2 modules in extender slots 2 and 6 (assigned to port 4). The front switches must be turned on in the Port-X-Tender in order for the HP41 to recognize their presence.

Dual Modules also may reside in either calculator ports or Port-X-Tender slots, provided that they are in the correct positions. See section IV.A on page 12 for more on dual RAM considerations.

The Quad Module may go anywhere with no conflict problems. Remember that if other main-memory modules are also present in the system, however, they will not be recognized by the HP41C in the presence of the quad. See section VI on page-switching main memory in the HP41C for information on maintaining additional sets of main RAM memory in the extender.

#### A.4. Extended Memory RAM Devices (HP41C or HP41CV):

The Extended Functions/ Memory Module requires extra care in placement in the HP41 system due to the fact that it contains port-addressed ROM as well as hard-addressed extended-memory RAM. There is no constraint as to where the RAM must be placed, so the only restriction applies to avoidance of conflicts with other ROMs occupying lower-4K port addresses.

**Extended Memory Modules:** When using two of these, be sure one is in an odd-numbered port (or port-assigned slot) and the other is in an even-numbered port or slot. For example, it is acceptable to have one X Memory module in calculator port 1 and the other in Port-X-Tender slot 4. See section VI on page-switching extended memory in the HP41.

## B. Typical Configurations:

Figures 8(a) to 8(i) present 9 different configurations for various HP41/ Port-X-Tender/peripheral combinations. These are simply a guide since many more arrangements are possible.

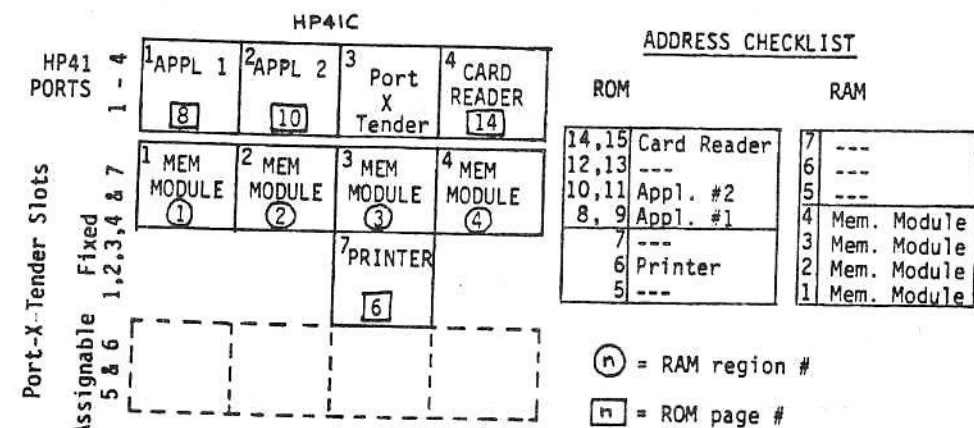


Fig. 8a

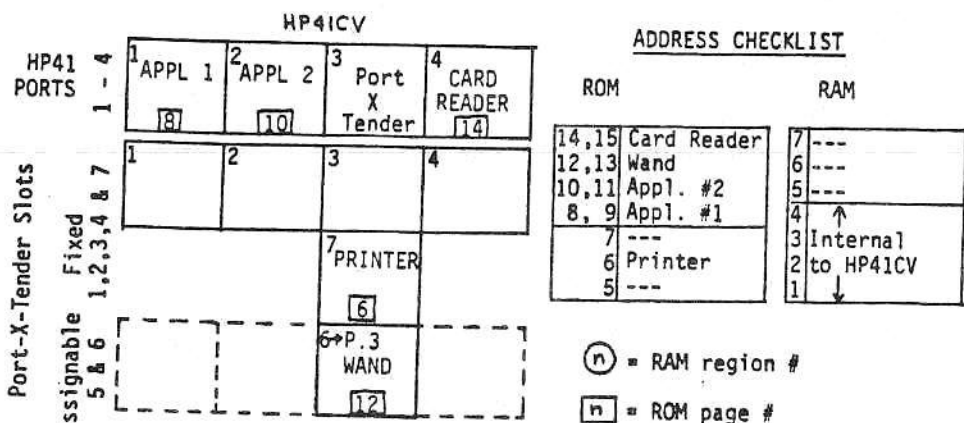
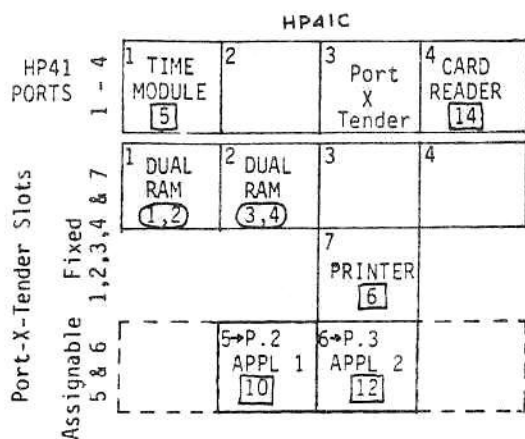


Fig. 8b

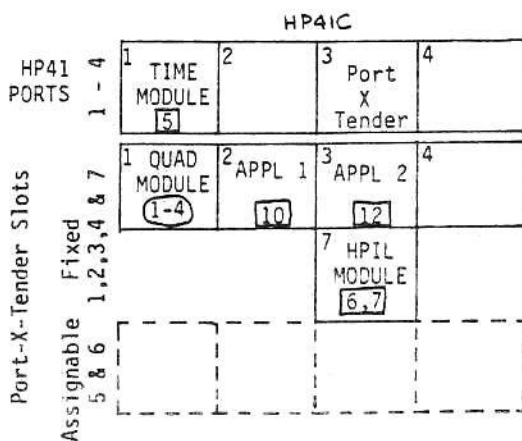


ADDRESS CHECKLIST

ROM	RAM
14,15 Card Reader	7 ---
12,13 App1 #2	6 ---
10,11 App1 #1	5 ---
8, 9 ---	4 Dual
7 ---	3 Ram #2
6 Printer	2 Dual
5 Time Module	1 Ram #1

(n) = RAM region #  
[n] = ROM page #

Fig. 8c

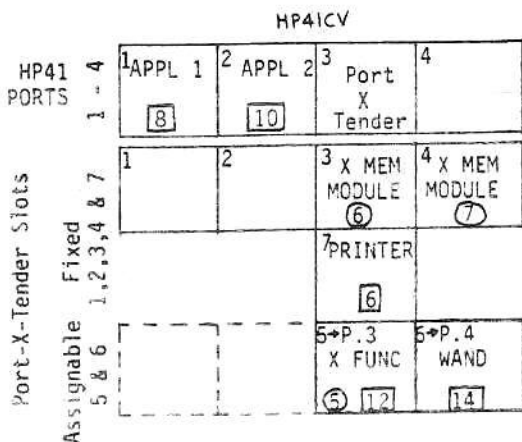


ADDRESS CHECKLIST

ROM	RAM
14,15 ---	7 ---
12,13 App1. #2	6 ---
10,11 App1. #1	5 ---
8, 9 ---	4 ↑
7 HPIL	3 Quad
6 Module	2 Module
5 Time Module	1 ↓

(n) = RAM region #  
[n] = ROM page #

Fig. 8d

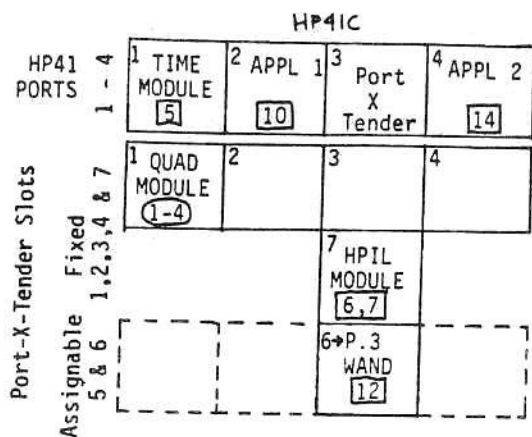


ADDRESS CHECKLIST

ROM	RAM
14,15 Wand	7 X Memory
12,13 X Functions	6 X Memory
10,11 Appl. #2	5 X Functions
8, 9 Appl. #1	4 ↑
7 ---	3 Internal
6 Printer	2 to HP41CV
5 ---	1 ↓

(n) = RAM region #  
[n] = ROM page #

Fig. 8e



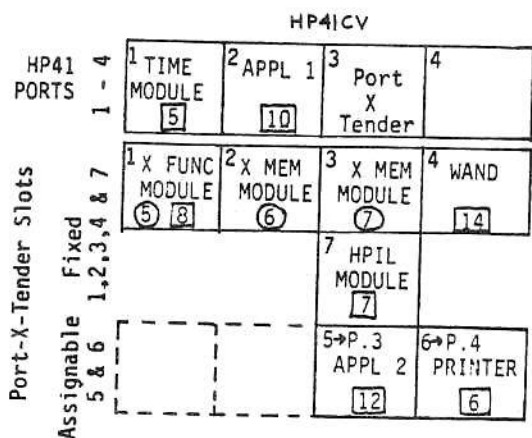
**ADDRESS CHECKLIST**

ROM	RAM
14,15 Appl. #2	7 ---
12,13 Wand	6 ---
10,11 Appl. #1	5 ---
8, 9 ---	4 ↑
7 HPIL	3 Quad
6 Module	2 Module
5 Time Module	1 ↓

(n) = RAM region #

[n] = ROM page #

Fig. 8f



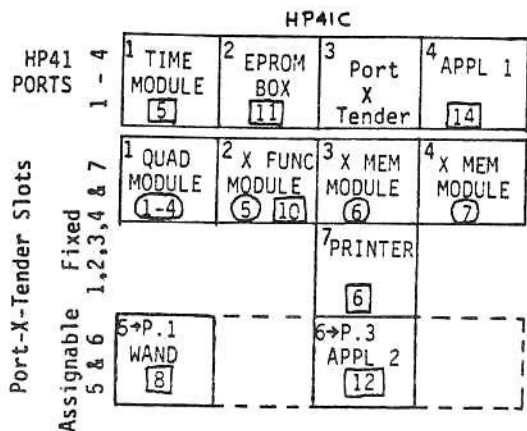
**ADDRESS CHECKLIST**

ROM	RAM
14,15 Wand	7 X Memory
12,13 Appl. #2	6 X Memory
10,11 Appl. #1	5 X Functions
8, 9 X Functions	4 ↑
7 HPIL Module	3 Internal
6 Printer	2 to HP41CV
5 Time Module	1 ↓

(n) = RAM region #

[n] = ROM page #

Fig. 8g



**ADDRESS CHECKLIST**

ROM	RAM
14,15 Appl. #1	7 X Memory
12,13 Appl. #2	6 X Memory
10,11 X Fun/EPROM	5 X Functions
8, 9 Wand	4 ↑
7 ---	3 Quad
6 Printer	2 Module
5 Time Module	1 ↓

(n) = RAM region #

[n] = ROM page #

Fig. 8h



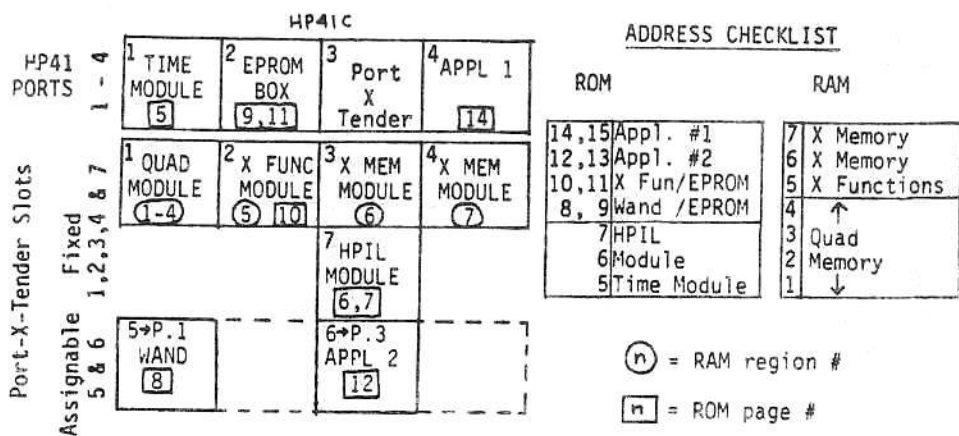


Fig. 8i

Figure 8. Nine different HP41/ Port-X-Tender configurations.

HP41  
PORTS

1 - 4

1	2	3 Port X Tender	4
---	---	-----------------------	---

Port-X-Tender Slots

Fixed  
1,2,3,4 & 7

1	2	3	4
---	---	---	---

Assignable  
5 & 6

		7	
--	--	---	--

# ADDRESS CHECKLIST

ROM

RAM

14,15	
12,13	
10,11	
8, 9	
7	
6	
5	

7	
6	
5	
4	
3	
2	
1	

(n) = RAM region #

[n] = ROM page #

HP41  
PORTS

1 - 4

1	2	3 Port X Tender	4
---	---	-----------------------	---

Port-X-Tender Slots

Fixed  
1,2,3,4 & 7

1	2	3	4
---	---	---	---

Assignable  
5 & 6

		7	
--	--	---	--

# ADDRESS CHECKLIST

ROM

RAM

14,15	
12,13	
10,11	
8, 9	
7	
6	
5	

7	
6	
5	
4	
3	
2	
1	

(n) = RAM region #

[n] = ROM page #

HP41  
PORTS

1 - 4

1	2	3 Port X Tender	4
---	---	-----------------------	---

Port-X-Tender Slots

Fixed  
1,2,3,4 & 7

1	2	3	4
---	---	---	---

Assignable  
5 & 6

		7	
--	--	---	--

# ADDRESS CHECKLIST

ROM

RAM

14,15	
12,13	
10,11	
8, 9	
7	
6	
5	

7	
6	
5	
4	
3	
2	
1	

(n) = RAM region #

[n] = ROM page #

Use these configuration charts to help plan the correct positions for plug-in modules and devices.

## VI. PAGE-SWITCHING RAM MEMORY

Since the HP41 system cannot support more main memory than 319 registers, any additional RAM present in the HP41C ports (or any RAM at all in the HP41CV ports) cannot be utilized. However, RAM modules in the Port-X-Tender may be switched on or off by the front extender switches, allowing multiple sets or "pages" of main memory (for the HP41C only) to be maintained. In addition, multiple sets of extended memory are possible (in either the HP41C or HP41CV) as well.

### A. Switching Main Memory (HP41C Only):

Refer to the RAM memory map in figure 9 on page 24. Working downwards from the uppermost main-memory region #4, we find the highest current data register number moving down to R00. Just below the data is the program memory starting with line 1 of the first program, extending down towards RAM region zero. (which is internal to the calculator). Below the permanent .END. after the last program line lies unused registers, and in region zero the key assignments (if any) and finally, the 16 internal status registers containing ALPHA, the operational stack, user and system flags, etc. The status registers also keep track of the current SIZE along with the number of program registers utilized (by knowing the position of the .END.). Since region zero is inside the calculator, its contents remain the same while RAM regions 1 and up are switched in Port-X-Tender.

Both data and programs in main memory may be switched in and out of the system, depending upon the current SIZE designation. If full memory is present and the SIZE is currently 100, then 219 program (plus key assignment) registers are available. Subtracting 63 for region zero leaves 156 switchable program registers in addition to all of the 100 switchable data registers.

### A.1. Switching Data Registers:

If external RAM main memory in all memory pages is SIZE'd completely to data registers (meaning that only the 63 registers of permanent region zero remain for program memory), one may simply access data in any page and switch to any other page. Just turn off the front switches corresponding to the current page and turn on the destination-page switches. A program in region zero may access data registers and then prompt the user to page-switch. After the pages are switched, pressing R/S will continue the program with access to a new set of R00 and up.

### A.2. Switching Programs:

Two situations are possible if program registers are to be page-switched. First, if programs only reside in external main RAM (i.e. the .END. is not in region zero), programs may be run and then page-switched after execution stops. (The data registers are also switched, since they are also above region zero.) In order to prevent undesirable alteration of the status registers, however, all memory pages must have been previously SIZE'd to allow the same number of program registers in each page. (For different capacity pages such as quad modules versus 3-single-module pages, perform the following: clear key assignments, GTO ., and SIZE until ".END. REG nn" shows the same value "nn" in all pages. For pages of equal capacity, turn them all on simultaneously and SIZE the calculator - this will partition all pages at the same time.)

Secondly, if programs extend downward from external RAM into region zero, the page-switching process will alter the program which crosses the region 0/region

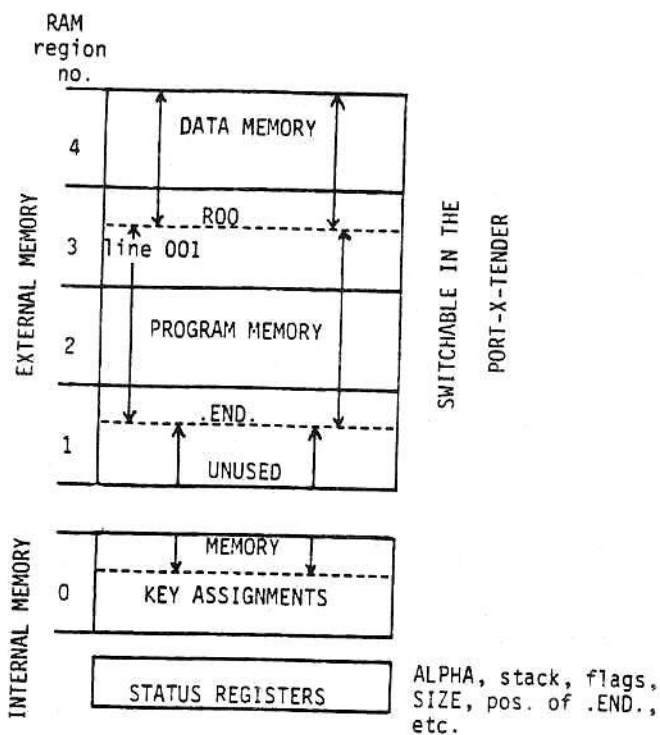


Figure 9. HP41C internal and full external main RAM memory. Multiple sets of RAM regions 1 to 4 may be maintained and switched off and on together in the Port-X-Tender using special page-switching techniques.

1 boundary. If this cross-over program is half in page A, switching to page B will cause attachment of any partial program in the new RAM region 1 to the original lower half of the page-A program in region zero. Execution of this program will undoubtedly cause undesirable results. If page B program area ends above the boundary, then two .END.'s will be created - one in page B and the original one pushed down into region zero by page A programs. Again, erratic behavior should be expected.

Many difficulties may arise with program page-switching involving upsetting the contents of the status registers. When the calculator gets "confused" into thinking that the SIZE is something which it is not, or if the position of the .END. in the current page is different from its actual position an unexpected "MEMORY LOST" may occur. Packing memory before switching is sometimes helpful. In any event, it is suggested that more advanced understanding of the HP41C memory be gained before manual page-switching of programs is attempted.

### A.3. Page-Switching Programs With the PPC ROM:

In 1981, the PPC generated a custom module containing many useful routines and programs for the HP41. Two of these routines, IP and PS were produced to aid in automatically taking care of the housekeeping involved in switching pages of RAM memory. The routine IP (Initialize Page) prepares a page of RAM for being switched off by first saving important information from status register c (position of the .END., position of the program/data curtain) into the lowest register in the page (namely the first register in the external memory). This memory page once initialized, may be switched off or on with the help of the PS (Page Switch) routine. PS prompts the user to switch the current page off and the destination page on. Then after the user switches and presses R/S, the routine returns the information from the lowest register in the new page back to status register c. It then attempts to continue execution in a routine in the new page whose global label was placed into ALPHA before PS was executed. Routine PS may be called as a subroutine by a running program in order to transfer execution to a program in another memory page. However, since all data registers are also changed as a result of page-switching, any information important to both source and destination pages must be transferred via special techniques, such as storing it below program memory in the unused portion of RAM region zero and then retrieving it again after page-switching. Both the PPC ROM and a fair knowledge of the HP41 memory structure is suggested before advanced techniques such as this are attempted. More information on the PPC ROM may be obtained directly from PPC (see "PPC" in the glossary of terms on page 25.)

### B. Page-Switching Extended Memory (HP41C or CV):

The extended memory RAM regions 5, 6 and 7 occupied by the Extended Functions/ Memory Module and up to two Extended Memory Modules, may be accessed by either the HP41C or CV. Extended memory may be switched off or on in the Port-X-Tender, and since the status registers are not affected by extended memory, region 5, 6 and 7 may be switched without worry about possible master clearing the calculator. However, the full extended memory pages must be switched together as a group or the extended memory directory will be permanently altered. With files stored in extended memory page A, turning the page off and turning extended memory page B on will yield full access to the new EMDIR. Note that since each page requires an Extended Functions/ Memory module which contains identical ROM, a conflict will arise if more than one is ever turned on at the same time.

## VII. OTHER ADVANCED APPLICATIONS

### A. Piggybacking Port-X-Tenders:

Should the seven slots in a single Port-X-Tender fall short in supporting all the devices in the user's system, it is possible to connect multiple extenders to an HP41. Plugging a second extender into slot 7 of the first extender will add 6 more slots, making a total of 16 positions for devices. Each additional extender provides 6 more slots. Stack the extenders on top of each other for the most compact approach. Piggybacked extenders may support multiple pages of main and/or extended RAM memory, as well as many application modules and peripheral devices.

### B. Preserving RAM in a Disconnected Port-X-Tender:

Occasionally, a user may wish to disconnect the Port-X-Tender from the calculator and preserve the RAM (main and/ or extended) memory there for use upon later reconnection. Disconnecting extended memory places no constraints on the HP41 system at all; simply disconnect and reconnect at any time and the memory is preserved. However, main memory preservation requires many special rules to be followed in order to prevent altering RAM contents.

First, when a memory module containing the permanent .END. is removed from the HP41 system (even by simply turning that module off in the Port-X-Tender) a MEMORY LOST condition will probably result. Thus, if any information was in internal main RAM region zero, it would have been lost had the extender (containing the RAM with the .END.) been disconnected. For this reason, it is necessary to not have any important programs or data below RAM memory regions 1 to 4 in the extender. Secondly, if the .END. was pushed down into region zero, disconnecting the extender would not cause MEMORY LOST, but would leave information in RAM region 0 of the calculator, unprotected. Thirdly, if the Port-X-Tender whose external memory had been SIZE'd to value A is reconnected to the calculator after it was sized to value B, it will be very difficult to restore complete control of program memory to the user.

Without special techniques, the only safe way of preserving information in external memory pages in the Port-X-Tender is if all of external memory consists of data registers, with program memory residing exclusively in region 0 (limiting programs to 448 bytes). However, using page-switching techniques in conjunction with the PPC ROM, memory in the Port-X-Tender may be saved and restored with no trouble. Two different methods are presented below.

#### B.1. Saving External Memory via a "Sacrificial" Memory Page (With the PPC ROM):

By using a single main RAM module (single, dual or quad-density) as a sacrificial page of memory, the contents of important main-memory pages may be preserved in a disconnected extender. Making sure that the .END. resides somewhere in the external memory regions 1 to 4, initialize the current memory page using IP. Now, insert the sacrificial memory page into an unoccupied, switched off slot. Execute PS and when the prompt to page-switch occurs, turn off the current page and turn on the sacrificial page, then press R/S. The display will say "NONEXISTENT", probably followed by "MEMORY LOST". The calculator along with its new memory page will have been master-cleared, however the original memory page is intact. Disconnect the Port-X-Tender and use the

calculator freely.

The reconnection process is as follows: turn off the calculator, connect the extender and turn the calculator back on. Turn on the sacrificial memory page and SIZE to a value such that the .END. remains in the external page, above region zero. Now execute IP. (If the .END. is still in region zero, the IP routine will prompt "OVERSIZE". If SIZE is already zero, program memory will have to be "trimmed" until the .END. moves up into region one.) Press 1 ENTER 2 XEQ PS, and when the prompt "1 OFF 2 ON" appears, switch off the sacrificial module and turn the desired page on. Press R/S and "NONEXISTENT" will appear. The original memory page is now restored.

## B.2. Saving External Memory With the PPC ROM Only:

If an extra RAM module or a spare Port-X-Tender slot is not available for switching off the active page of memory, the procedure below may be performed in conjunction with the PPC ROM in order to safely disconnect and reconnect the calculator from the extender.

### To Disconnect:

1. With the current active memory page on, execute IP (making sure the .END. is above region zero).
2. Execute PS. When the page-switch prompt occurs, turn the active page off.
3. Press R/S. Display will eventually say "NONEXISTENT". Hit the back-arrow key to delete this prompt.
4. Turn off the calculator and disconnect the Port-X-Tender. You may now use the HP41C freely.

### To Reconnect:

1. Turn off the calculator, connect the extender, insert the PPC ROM and turn the calculator back on.
2. Execute PS. Display will prompt "OVERSIZE".
3. Press GTO PS, GTO . 121 R/S and display will prompt "NONEXISTENT".
4. Press PRGM SST PRGM R/S.
5. Press GTO . 082 R/S. When page-switch prompt occurs, turn desired page on and press R/S.
6. Display will prompt "NONEXISTENT". Press back-arrow key to delete this.
7. Your memory page has been successfully restored.

## C. EPROMs Addressed to Ports' Upper ROM Pages:

Earlier, it had been mentioned that EPROM chips containing an HP41 ROM image may be used in an external enclosure attached to a calculator port or Port-X-Tender slot. In addition, 4K byte EPROM chip sets may be programmed to behave as an upper (odd-numbered) ROM page of an I/O port as well as a lower ROM page like conventional 4K ROM devices. Likewise, 8K byte EPROM sets may be addressed to 2 consecutive upper-4K byte ROM pages, such as pages 9 and 11, corresponding to the upper half of calculator ports 1 and 2. When the number of ports and slots is critical, it is very useful to have an EPROM chip set which does not conflict with a conventional 4K ROM device addressed to the same I/O port.

When using a 4K upper-page EPROM set, make sure it is addressed to a port which contains no more than 4K bytes of port-addressed ROM already present.

Sharing a port with RAM modules or hard-addressed devices with ROM below page 8 is perfectly acceptable. Figure 8(h) shows an example configuration which contains a 4K EPROM chip set addressed to upper ROM page 11, sharing port 2 with the Extended Functions/ Memory Module (in ROM page 10).

An 8K EPROM set addressed to two consecutive ports' upper-4k ROM pages may coexist with up to two port-addressed ROM devices in the same 2 ports. Once again, RAM modules or hard-addressed devices below ROM page 8 create no conflicts. Figure 8(i) shows an example configuration which has an 8K EPROM chip set addressed to upper ROM pages 9 and 11, and sharing ports 1 and 2 with the wand (ROM page 8) and Extended Functions/ Memory Module (ROM page 10).

#### D. Port Assignment Control for Extender Slot 7:

With the following simple modification to the Port-X-Tender, slot number 7 may be made to be port-assignable via side-switches 5 and 6. This is similar to the function of extender slots 5 and 6 being assignable via side-switches 1 through 4. (See table 3 on page 6 for details on exact switch positioning for port control.).

#### Tools and Materials Required:

- Phillips screwdriver
- "Exacto" knife
- Small-tip medium-temperature soldering iron (Do not use a soldering gun)
- Small diameter rosin-core solder
- 2 inches of 22 AWG insulated solid wire or wire-wrap wire

1. Remove the cover of the Port-X-Tender by unscrewing the 6 Phillips-head screws on the top surface.
2. Locate the places on the extender circuit board corresponding to points a, b, c, d and e in the drawing in figure 10, below.

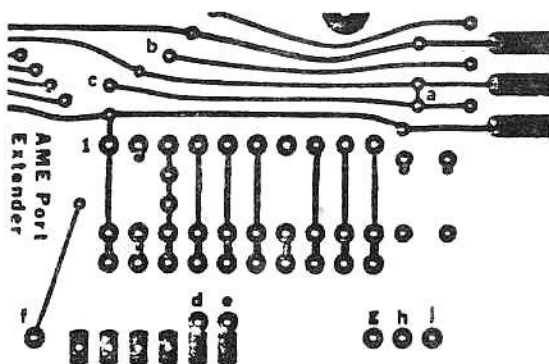


Figure 10. A section of the circuit board of the Port-X-Tender, showing points a, b, c, d, and e, where the simple modification described allows slot number 7 to be port-assignable like slots 5 and 6.



3. Use an Exacto knife and cut the conductive trace between the two long traces at point a. Be neat - you only need to sever this trace. Do not cut a deep hole in the board.
4. Cut two 1-inch pieces from the 22 AWG solid insulated wire. Strip 1/8-inch insulation from each end of the wires.
5. Bend the bare wire at a right angle to the insulated portion.
6. Insert the ends of one wire into the holes at points c and e. Solder points c and e with the soldering iron. Remember - use rosin core solder only!
7. Repeat this procedure with the other wire by placing it into the holes at points b and d. Solder these two points.
8. Check your work for any bare wire or stray solder touching other metal or components. Correct any errors.
9. Replace the cover and the screws. Make sure that the cable exits the extender at the cutout. Check the Port-X-Tender for proper operation.

## APPENDIX A

### GLOSSARY OF TERMS

Addressing: Locating a position in ROM or RAM memory of the HP41.

Crash (or lockout): A calculator state when the system becomes inoperative. The display may show illegal characters which cannot be cleared with back-arrow. The system may not be able to be shut off, requiring battery pack removal and replacement again. This usually does not cause MEMORY LOST, merely returning control to the keyboard. However, in some severe cases, a keyboard lockup may occur such that battery removal and replacement will not cure the situation. Leave the battery pack out for several minutes and replace. If this fails, leave the pack out overnight and replace.

Curtain: The imaginary partition between data registers (above) and program registers (below) in HP41 RAM memory.

Dual-density (or simply Dual) Memory Module: A RAM plug-in module for the HP41C consisting of single-density memory modules wired together in one plastic package. This procedure was pioneered by PPC.

Dual-Density ROM: A ROM module or ROM containing the instructions for a peripheral device which is 8K (8192) bytes long.

EPROM Memory (Erasable programmable read-only-memory): Memory which is electronically programmed by an external device, and then used as a conventional read-only-memory. Later, it may be erased by being exposed to ultraviolet light, and then reprogrammed electronically.

Extended Memory: RAM memory for the HP41C or CV which consists of the HP82180 Extended Functions/Memory Module and up to 2 HP82181A Extended Memory Modules. This memory, totalling 603 registers (4221 bytes), acts like a continuous-memory mass storage area, holding programs, data, and/or other information for later use when moved into HP41 main RAM memory.

External (Main RAM) Memory: Main RAM memory for the HP41C which is added to the basic internal RAM memory by way of plug-in modules, such as HP82106A Memory Modules or HP82170A Quad Module.

HPIL (Hewlett-Packard Interface Loop): The interface protocol for HP battery-powered instruments and controllers, introduced December, 1981. The first HPIL controller is the HP41C/CV calculator with its HP82160A HPIL Module; and some of the HPIL peripherals include the HP82161A Digital Cassette Drive, HP82162A Thermal Printer Plotter and HP3468A Digital Multimeter.

HPIL Module: The plug-in module containing 8K bytes of ROM instructions allowing the HP41 to interface to other devices using the HPIL interface protocol.

I/O Ports (or simply Ports): Any of the four plug-in positions in the HP41C/CV.

Main Memory: RAM memory in the HP41 system where programs, data, key assignments, etc. normally reside. This can be as much as 319 registers, or 2237

bytes long (internal to the HP41CV or utilizing the maximum allowable main-memory RAM plug-in modules in the HP41C).

Master Clear: The act of clearing the entire contents of HP41 RAM memory. Turn off, then press ON and back-arrow keys together. Release back-arrow key first. The display message "MEMORY LOST" should appear in the display and memory will be repartitioned to 46 program registers and the remainder data. If "MEMORY LOST" does not appear, try it again but tap the ON key while holding the back-arrow key down. Release together.

MEMORY LOST: The display message after a master-clear has been executed or after the HP41 cleared its own memory due to a system crash, lockup or power disruption.

Memory Module (single density): A RAM plug-in module for the HP41C, containing 64 RAM registers (448 bytes) of program and/or data memory.

Non-Normalized Number: A numeric value in a register (usually the stack) which may either appear legitimate or contain illegible characters, and behaves peculiarly when operated upon with arithmetic functions. In general, some of the binary bits in the register are set in irregular positions.

Operating System: A program which a computer continually runs which gives the device its personality as a calculator, a high level language operable computer, word processor, etc.

PPC (Personal Programming Center): A worldwide, nonprofit, loosely organized users' group which supports hardware and software applications for personal programmable devices, such as the HP41C/CV. For more information, send a 9 by 12 inch self-addressed, stamped envelope with 2 ounces of first class postage to PPC, 2545 W. Camden Place, Santa Ana, Calif. 92704.

PPC Custom ROM (or PPC ROM): The first HP41 custom applications ROM module designed by PPC. It contains over 120 programs and routines in housekeeping, peripherals, mathematics and synthetic programming applications.

Permanent or global END (or ".END."): The final END step in HP41 program memory, which cannot be removed. The operating system always places it after the last step in the last program in RAM. Removal of RAM memory modules which contain the .END. will cause MEMORY LOST.

Quad Module: A RAM plug-in module for the HP41C containing 256 RAM registers (1792) bytes of program and/or data memory.

RAM (Random Access Memory): Program and/or data memory into which information may be stored, from which it may be recalled or copied. It may be accessed randomly, i.e., from any position in memory. When electrical power is removed, this memory is erased. Continuous memory is RAM memory which may be kept alive by a trickle of current far lower than the amount needed to power a computing device. Thus, turning it off preserves RAM.

ROM (Read Only Memory): Memory which contains permanently stored program instructions or data, such as an application module or the instruction ROM of a

peripheral device like the HP41 card reader. This memory is not erased when electrical power is removed.

Single-Density ROM: A ROM module or ROM containing the instructions for a peripheral device which is 4K (4096) bytes long.

Slots: Any of the seven plug-in positions in the Port-X-Tender.

Status Registers: The 16 lowest RAM registers in the HP41C/CV; which comprise the four-level operational stack registers X, Y, Z, and T, the last-X (L) register, the ALPHA register (which actually consists of registers M, N, O and P) and seven other internal registers.

Synthetic Programming: Software containing instructions or manipulating data which cannot normally be created by conventional means; accessing normally inaccessible data registers, display characters or other features not supported by the manufacturer. This activity has been promoted by PPC since the Hewlett-Packard HP65 calculator was prevalent in 1974.

XROM Number: An identification number contained in every HP41 peripheral device or module which contains ROM. This number, ranging from 01 to 31, identifies the devices so the calculator may search for and execute functions residing in the ports (or Port-X-Tender slots). This number also identifies functions which correspond to peripherals when those devices are not presently plugged into the HP41.

## APPENDIX B

### BATTERY REPLACEMENT

NOTE: Before any work is performed inside your Port-X-Tender, transfer any important information to another medium (mag cards, cassettes, etc.). Once the battery power is interrupted, all information in the extender will be lost. With care, the cable from the Port-X-Tender may remain connected to the HP41 while making adjustments, thus preserving memory.

When the battery-test LED becomes noticeably dim, the extender will soon require a replacement for its lithium battery. Follow the instructions below.

1. Remove the cover of the Port-X-Tender by unscrewing the 6 Phillips-head screws on the top surface.
2. Observe the position of the Mallory PX-28L lithium battery located between slots 1 and 7.
3. Remove the battery with a small screwdriver, or your fingernail.
4. Place a new Mallory PX-28L battery in the battery holder with the positive (+) terminal toward the RED wire connected to the battery spring clip.
5. Check the battery by using the battery test switch and observing the LED. If the lamp does not light in the MEMORY TEST position, make sure the battery polarity is correct. If not, reverse and try again.
6. Replace the top cover, making sure that the cable exits at the cutout.
7. Replace the Phillips-head screws and check the Port-X-Tender for proper operation.

#### Battery substitutes:

In emergency only, use models 4SR44, 4G13, or 544/PX28, all of which are silver-oxide batteries. Others are not recommended.

# Appendix C

## Port-X-Tender Parts List

ITEM	QTY	P/N	REF	DESCRIPTION
1.	1	410700		Reference, Port-X-Tender
2.	1	410710		* Case
3.	1	410711		* Cover, Top
4.	1	410712		*
5.	4	410713		* Foot
6.	1	410714		* Fastener, Hook 3-inch
7.	1	410715		* Fastener, Loop 3-inch
8.	2	410716		* Pad
9.	1	410717	S3	* Switch, SPDT
10.	1	410718	D3	* Diode, LED, T1-RED
11.	1	410720		* Cable Assembly, 7-inch
12.	0	410721		Cable Assembly
13.	1	410722		Shell, Top
14.	1	410723		Shell, Bottom
15.	0	410724		Grommet
16.	1	410725		Cable, 10 Cond. 7-inch
17.	0	410726		PCB, Adapter
18.	1	410730		* PCB, Assembly
19.	1	410731		P.C. Board
20.	1	410732	C1	Capacitor, 22uF, 10V, Tant
21.	2	410733	D1,2	Diode, Si, 1N4001
22.	6	410734	R1-6	Resistor, 4.7 Megohm, 1/8 W, Comp
23.	1	410735	R7	Resistor, 3.6 K ohm, 1/4 W, Film
24.	2	410736	R8,9	Resistor, 430 ohm, 1/8 W, Film
25.	1	410737	R10	Resistor, Selected, Film
26.	2	410738		* Switch Assembly
27.	2	410739	S1,2	Switch, 6-Position DIP
28.	2	410740		Wire, 28 AWG, Solid, Non-insulated
29.	1	410741		* Rod, Locking, 3-inch
30.	1	410742		* Clip, Assembly, Batt, Red
31.	1	410743		* Clip, Assembly, Batt, Green
32.	2	410744		Clip, Battery
33.	1	410745		Wire, 22 AWG, Solid, RED 1.50"
34.	1	410746		Wire, 22 AWG, Solid, GRN 2.00"
35.	1	410747		Wire, 22 AWG, Solid, BLU 1.25"
36.	1	410748	B1	* Battery, 6V, Lithium
37.	8	410749		* Screw, #2X3/8, Phil, Flat
38.	12	410750		Terminal
39.	1	410790		* Case, Carrying

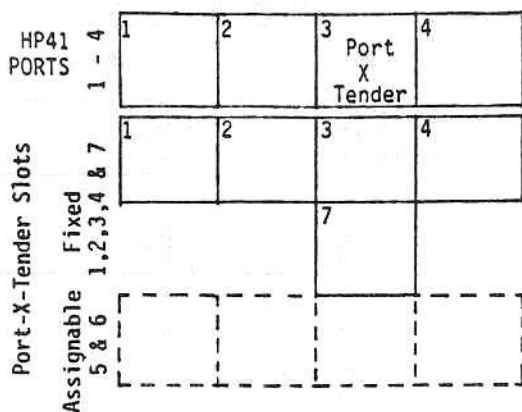
\* = Major Sub-Assemblies & Parts

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# ADDRESS CHECKLIST

ROM

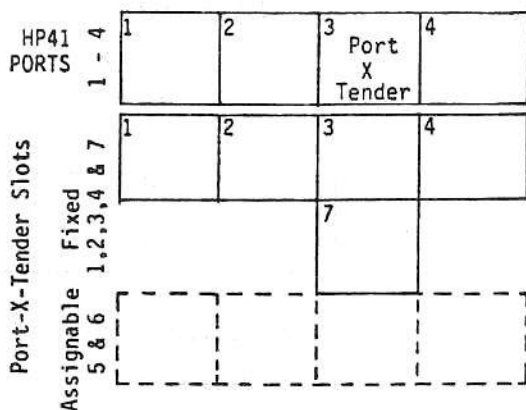
RAM

14,15	
12,13	
10,11	
8, 9	
7	
6	
5	

7	
6	
5	
4	
3	
2	
1	

(n) = RAM region #

[n] = ROM page #



# ADDRESS CHECKLIST

ROM

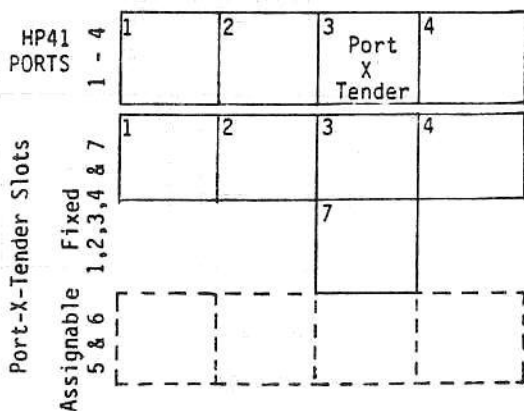
RAM

14,15	
12,13	
10,11	
8, 9	
7	
6	
5	

7	
6	
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# ADDRESS CHECKLIST

ROM

RAM

14,15	
12,13	
10,11	
8, 9	
7	
6	
5	

7	
6	
5	
4	
3	
2	
1	

(n) = RAM region #

[n] = ROM page #

Use these configuration charts to help plan the correct positions for plug-in modules and devices.

HP41  
PORTS

1 - 4

Port-X-Tender Slots

Fixed  
1,2,3,4 & 7

Assignable  
5 & 6

1	2	3 Port X Tender	4
1	2	3	4
		7	

# ADDRESS CHECKLIST

ROM

RAM

14,15		7	
12,13		6	
10,11		5	
8, 9		4	
7		3	
6		2	
5		1	

(n) = RAM region #

[n] = ROM page #

HP41  
PORTS

1 - 4

Port-X-Tender Slots

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1	2	3 Port X Tender	4
1	2	3	4
		7	

# ADDRESS CHECKLIST

ROM

RAM

14,15		7	
12,13		6	
10,11		5	
8, 9		4	
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1	2	3	4
		7	

# ADDRESS CHECKLIST

ROM

RAM

14,15		7	
12,13		6	
10,11		5	
8, 9		4	
7		3	
6		2	
5		1	

(n) = RAM region #

[n] = ROM page #

Use these configuration charts to help plan the correct positions for plug-in modules and devices.

### LIMITED 90 DAY WARRANTY

The AME DESIGN Model 4107 PORT-X-TENDER is warranted against defects in materials and workmanship for 90 days from the date of original purchase. During the warranty period, AME DESIGN will repair, or at it's option, replace at no charge a PORT-X-TENDER that proves to be defective, provided that you return the PORT-X-TENDER, shipping prepaid, to AME DESIGN at the following address:

AME DESIGN  
Box 373  
13450 Maxella, G185  
Marina del Rey, California 90291

This warranty does not apply if the PORT-X-Tender has been damaged by accident or misuse or as a result of modification or service by other than AME DESIGN. No other express warranty is given. Repair or replacement of the PORT-X-TENDER is your exclusive remedy. In no event shall AME DESIGN be liable for consequential damages.

The PORT-X-TENDER is sold on the basis of specifications applicable at the time of manufacture. AME DESIGN shall have no obligation to modify or update the PORT-X-TENDER once sold.

There is a charge for repairs after the 90 day warranty period.