

TIMEMASTER II H.O.

USER MANUAL

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NOTICE:

THE TIMEMASTER II H.O. DESIGN, PCB LAYOUT AND ROM FIRMWARE WERE COPYRIGHTED IN 1984 BY APPLIED ENGINEERING. THIS MANUAL IS ALSO COPYRIGHTED. A PATENT IS PENDING ON THE TIMEMASTER II H.O.

REV 1.2

Thank you very much for selecting the H.O. for use in your computer. We feel confident that you will enjoy owning it and using it as much as we've enjoyed designing it and constructing it.

Because of the fact that all different kinds of people buy Apple computers and clock cards for them, for literally thousands of different types of applications, we have tried to categorize the sections in this manual with regard to computing skill. In this way, if you're just beginning at computing, you can avoid the more technical and programming related sections of the manual. On the other hand, if you possess more computer skills, you can quickly skim over the beginning sections and move right into the necessary information for programming. Each section will fall into one of four skill levels. The skill level is indicated with the numbers 1 through 4 in parentheses just to the right of each section heading. Please do not be intimidated by reading skill levels that you may think are beyond you because chances are you're a lot smarter about computers than you think. Of course, no programming skill is required to use the Timemaster II H.O. because hundreds of commercially prepared software programs are designed to use it automatically and nearly all serious software under development today is designed to read your clock card. In general, the manual begins in the easier skill levels and moves to the more advanced. However, this order is not strictly adhered to. A description of these four skill levels follows below:

(1) You should know how to get inside your Apple, make a copy of a disk, be able to CATALOG a disk, and RUN a program. If you do not know how to do this, please see pages 57 through 69 in the Apple IIe owners manual or pages 15 and 16 in the Apple II+ Applesoft Tutorial.

(2) Simple BASIC Programming Skills - If you do not currently possess these skills, a few hours spent with the Applesoft Tutorial will give them to you.

(3) Advanced BASIC Programming Skills and small knowledge of electronics. You should know what is meant by "when this line is pulled low and be able to convert numbers from hex to decimal and back again. This skill level is rarely shown because the TimeMaster II H.O. is so easy to use in BASIC.

(4) Machine Language Programmer As the title would indicate, you need to know how to program in machine language. You'll find many source listings in this manual as well as on disk. All machine language programs on disk were written with the S-C Macro Assembler. We have experimented with many assemblers and we agree with the software reviewers that the S-C assembler is the best. We regret that we cannot provide source code for other assemblers. We remind our customers that competitive clock cards come with little or no source code at all. The S-C Macro assembler may be purchased at low cost from S-C Software, telephone number 214-324-2050.

Welcome to the world of real time!

Your Applied Engineering TIMEMASTER II H.O. will greatly expand the use of your Apple computer by adding the dimension of real time and date in intervals of 1 millisecond to 99 years.

Applications of the H.O. are limited only to the imagination. Anywhere you need to know the time or date you can use the H.O. Applications include time and date stamping of reports, checks, letters, file updates, calculating time intervals, and recording measurements (data logging).

As you read this manual, you will soon learn why the TIMEMASTER series is the favorite among professional programmers.

```
.....
*
*                               IMPORTANT! (1)
*           Make a backup copy of your H.O. disk
*
*           before installing the clock or doing
*
*           anything else.
*
*
*.....
```

The H.O. has many options. These options can sometimes confuse a computer novice. The ONLY way we could have made the H.O. easier to use would be to have limited its performance. Some of the programs on the H.O. disk were written for just one of the modes (the TIMEMASTER II H.O. is really 8 clocks in one) so be sure you are in the right mode for the sample program you are experimenting with.

Your new clock uses the latest in CMOS and NMOS large scale integration ([.51) technology to bring to you a unique peripheral which retains the day, date, and time even when your Apple computer is turned off. The on-board ROM allows the highest degree of programming simplicity as well as a very high degree of compatibility with existing software. The TIMEMASTER was designed to meet or exceed all of Apple's high quality standards.

Your new TIMEMASTER II H.O. is a fourth generation of clock cards designed by Applied Engineering. Our first clock card was designed in 1980. It was called the Time II. Our second clock card was the Timemaster and it had many improvements over the old Time II. In the Timemaster II, we added PRODOS compatibility. With the Timemaster II H.O., we've added BSR control and other features and yet maintained software compatibility with both the older Timemaster and Timemaster II. We consider the TIMEMASTER II H.O. (just H.O. for short) to represent the zenith in computer clock technology. It has received rave reviews from both professional programmers, beginning programmers, as well as the average computer user. Again, welcome to the world of real time!

INSTALLING THE H.O. IN YOUR APPLE (1)

- 1) TURN OFF THE APPLE'S POWER SWITCH. This is very important to prevent damaging the Apple as well as your H.O.
- 2) Remove the cover from the Apple.
- 3) Plug your H.O. into any slot except 0. (The Apple //e has no slot 0.) Slot 4 is the preferred slot (because some commercial software expects a clock to be in slot 4) but any slot is fine. Insert the fingers of the circuit board into the slot you have chosen. The fingers will enter the slot with some friction, and will then seat firmly.
- 4) Make certain switch #1 on the H.O. is in the ON (closed) position.
- 5) Replace the Apple's cover.

H.O. SWITCHES (1)

There is a device in the upper left corner of the H.O. card containing 4 switches. These provide control over the display format, enable/disable interrupts, and more. Please never use pen or pencil to change switch settings. A bent out paper clip works best.

O	1	SET	Must be closed when setting the clock.
P	2	MODE	Selects display mode (see below)
E	3	NMI	Enables Non-Maskable Interrupt
N	4	IRQ	Enables Interrupt Request

Note: OPEN = OFF. Push down toward "OPEN" to turn switch off.

The normal settings are switches 1 and 4 closed and 2 and 3 open.

MODE SELECTION (1)

Your H.O. has two switch-selectable modes, controlled by switch 2 on the card. The most powerful of these modes is called the TIMEMASTER mode, which includes compatibility with both DOS 3.3 and PRO DOS. The other mode is included for compatibility with certain older commercial software products which were designed around older generation clocks and do not allow modification for direct usage with the 11.0.

<u>MODE</u>	<u>Sw 2</u>	<u>Format</u>
TIMEMASTER	open	various, see below
Apple Clock	closed	MO/DD HH:MM:SS.WYY

TIMEMASTER MODE (SW 2 open) (1)

This is the most powerful mode and can supply the time/date information formatted in seven different ways. The desired format is selected by PRINTING a single character to specify which format to use.

In the following table, the character between quotation marks is the format selection character. Each format is illustrated using Friday, December 14, 1984, 3:30 PM.

" "	MO/DD HH:MI:SS.WYY 12/14 15:30:23.384	APPLE CLOCK MODE
"`"	W MO/DD/YY HH:MI:SS 3 12/14/84 15:30:23	TIMEMASTER MODE
"%"	WWW MMM DD HH:MI:SS PM FRI DEC 14 03:30:23	THUNDER CLOCK APPLESOFT
"&"	WWW MMM DD HH:MI:SS FRI DEC 14 15:30:23	THUNDER CLOCK APPLESOFT
"#"	MO,OW,DD,HH,MI,SS 12,03,14,15,30,23	THUNDER CLOCK APPLESOFT
">"	WWW MMM DD HH:MI:SS PM FRI DEC 14 03:30:23 PM	THUNDER CLOCK INTEGER
"<"	WWW MMM DD HH:MI:SS FRI DEC 14 15:30:23	THUNDER CLOCK INTEGER

So that the colons can be accepted by an Applesoft INPUT statement, formats which contain colons are preceded by a quotation mark. The quotation mark tells Applesoft to allow colons in the input string. The first four formats above are designed for use with Applesoft and include the leading quotation

mark. The last two formats are designed for use with Integer BASIC, and begin with a space rather than a quotation mark.

Even though there are two formats which display the time in AM/PM format using a 12-hour clock, the internal hardware is still keeping time in 24-hour format.

APPLE CLOCK MODE (SW 2 closed) (1)

The Apple Clock mode emulates the format of the Mountain Hardware Apple Clock, for compatibility with commercial software which specifies the Mountain Hardware card and does not allow other brands. Certain "signature" bytes in the firmware for this mode should be recognized by such software, allowing you to use it with your H.O.

The Mountain Hardware card delivers the time/date in this format:

MO/DD HH;MI;SS.MMM

Note the semicolons separating hours, minutes, and seconds. The last three digits are milliseconds. Hours are given for a 24-hour clock (00-23). Note also that day-of-week and year values are not present. The Mountain Hardware clock does not provide any day-of-week or year values.

The H.O. card substitutes day-of-week and year values for the millisecond values. (If you need time to the nearest millisecond, the H.O. can deliver it in a much more accurate way. Please see page 10 for more information.) So, the H.O. substitutes colons for semicolons, giving the standard display of time:

MO/DD HH:MI:SS.WYY
12/14 15:30:23.384 (Fri, Dec 14, 1984, 3:30 PM)

So that the colons can be accepted by an Applesoft INPUT statement, the format is preceded by a quotation mark. The quotation mark tells Applesoft to allow colons in the input string.

SETTING THE CLOCK (1)

To set the clock, the switch marked "SET" (switch 1) must be closed (ON). Once the time and date have been properly set, you may wish to protect the clock by placing switch 1 in the open (off) position. However, as of yet, no accidental time change has ever occurred.

The program called SET CLOCK conveniently reads the current clock setting, allows you to enter new date and time values, and then sets the clock to these new values at your signal. RUN the program and follow the directions on your screen. The program automatically finds your TIMEMASTER II H.O. card by searching slots 1 through 7 for certain "signature" bytes. The program also determines which mode you have selected with switch 2.

READING THE CLOCK (2)

It is very easy to read the date and time from the H.O. The H.O. contains 2048 bytes of on-board ROM. The ROM contains the software that makes it easy to obtain the date and time.

The simplest way to read the date and time involves three steps:

- 1) set input and output to the H.O.
- 2) INPUT the date/time info
- 3) restore input and output to keyboard and screen

Here is a simple example:

```
100  SLOT = 4
110  PRINT CHR$(4) "IN#"SLOT
120  PRINT CHR$(4) "PR#"SLOT
130  INPUT A$
140  PRINT CHR$(4) "IN#0"
150  PRINT CHR$(4) "PR#0"
```

The program will receive the formatted date/time information in the string A\$, in the format determined by the MODE switch on the H.O. The easiest way to tell what mode you have is to add one more line to the program:

```
160  PRINT A$
```

Type in the program above and run it. Remember to put in line 100 the slot number that your H.O. is in.

If you have switch-selected the TIMEMASTER mode, you can specify which of the formats to use. Change line 130 to one of the following, and try running the program again:

```
130  INPUT ":";A$
130  INPUT " ";A$
130  INPUT "%";A$
130  INPUT "&";A$
```

The TIMEMASTER mode also includes a format which returns numeric values rather than a string, and happens to be the mode used internally by Apple PRO DOS. Change line 130 and 160 like this, and RUN again:

```
130  INPUT "it ";Mnth,week,day,hr,min,sec
160  PRINT Mnth,week, day,hr,min,sec
```

It is a good programming technique to put CHR\$(4) in a string variable D\$, rather than including it "spelled-out" in each DOS command line. Another useful change to our demonstration program would be to keep reading the display the time in a loop, until you press any key on the keyboard. Combining these changes produces the program on the next page. TRY IT!!!


```

100  SLOT = 4                clock slot
110  D$ = CHR$(4) : HOME    D$ = "control D"
120  PRINT D$"IN#"SLOT     set input to clock
130  PRINT D$"PR#"SLOT     set output to clock
140  INPUT ":";A$          get the time
150  PRINT D$"IN#0"        restore keyboard in
160  PRINT D$"PR#0"        restore keyboard out
170  VTAB 12 : HTAB 10     center the display
180  PRINT A$              print the time
190  IF PEEK (-16384) < 128 THEN 120  key pressed?
200  POKE -16368,0        reset key test

```

If you want to rearrange the time/date to a different format, you can use the MID\$ function to pick any part out of the formatted string. The following examples show how to access various portions of the TIMEMASTER and APPLECLOCK formats. please see your APPLESOFT TUTORIAL if you are unfamiliar with string manipulation. (It's really quite easy.) TRY IT!!!

```

TIMEMASTER format:  W MO/DD/YY HH.MI.SS
WK$ = LEFT$(A$,1)   day of week ("0" — "6")
MO$ = MID$(A$,3,2)  month ("01" — "12")
DA$ = MID$(A$,6,2)  day of month ("01" — "31")
YR$ = MID$(A$,9,2)  year ("00" — "99")
HR$ = MID$(A$,12,2) hour ("00" — "23")
MI$ = MID$(A$,15,2) minute ("00" — "59")
SE$ = RIGHT$(A$,2) second ("00" — "59")

```

```

APPLECLOCK format:  MO/DD HH:MI:SS.WYY
WK$ = MID$(A$,16,1) day of week ("0" — "6")
MO$ = LEFT$(A$,2)   month ("01" — "12")
DA$ = MID$(A$,4,2)  day of month ("01" — "31")
YR$ = RIGHT$(A$,2)  year ("00" — "99")
HR$ = MID$(A$,7,2)  hour, ("00" — "23")
MI$ = MID$(A$,10,2) minute ("00" — "59")
SE$ = MID$(A$,13,2) second ("00" — "59")

```

So if you are only interested in seconds, we need only add or change these lines to the last program.

```

180  SE$ = RIGHT$(A$,2)
185  PRINT SE$

```

If you want the values as numbers, simply use the VAL function. For example, the day of week as a number would be WK = VAL (WK\$). Using the day of week as a number allows you to look up the full spelling of the day name. One easy way to program it would be like this:

```

WK = VAL(WK$)
IF WK=0 THEN WK$ = "SUNDAY"
IF WK=1 THEN WK$ = "MONDAY"
IF WK=2 THEN WK$ = "TUESDAY"
IF WK=3 THEN WK$ = "WEDNESDAY"
IF WK=4 THEN WK$ = "THURSDAY"
IF WK=5 THEN WK$ = "FRIDAY"
IF WK=6 THEN WK$ = "SATURDAY"

```

You can obviously do a similar thing to the spelling of the month names. You can prefix the year with a "19" or a "20" using any method you like.

If you have the clock set in one of the 24-hour modes and still want to read AM/PM times, you can use the following program segment to convert the hour and append "AM" or "PM" as appropriate:

```
HR VAL(HR$)
IF HR>11 THEN AP$ = "PM"
IF HR<12 THEN AP$ = "AM"
IF HR=0 THEN HR = 12
IF HR>12 THEN HR = HR-12
```

There are a number of programs included on disk with your H.O. which read and display the clock. Try them and then analyze how they are programmed.

FINDING THE CLOCK SLOT BY SOFTWARE (2)

Each switch-selected mode of the TIMEMASTER II has a unique firmware "signature" in ROM. Some of the signature bytes are embedded in certain locations for compatibility with commercial software written for different clock cards. For example, special effort was made to make the APPLE CLOCK mode appear to software as though you have the Mountain Hardware card.

As well, a simple to use signature was added to distinguish the Applied Engineering card from other brands, and to distinguish the various switch-selected modes.

The following subroutine will search slots 1 through 7 for a TIMEMASTER II H.O. card. If no H.O. is found, the subroutine will return with SLOT 0. If found, SLOT will equal the slot number, and AP will equal a 1 or 3 indicating which switch-selected mode is set.

```
1000 REM FIND TIMEMASTER II H.O. SLOT
1010 SLOT = 0
1020 FOR I = 1 TO 7
1030 ADDR = 12*4096 + 1*256: REM $CS00
1040 IF PEEK(ADDR) = 8 AND PEEK (ADDR + 1) = 120 AND PEEK
      (ADDR + 254) = 178 THEN SLOT I : I = 7
1050 NEXT
1060 IF SLOT = 0 THEN RETURN
1070 AP = PEEK(ADDP+255)
1080 PRINT "SLOT = ";SLOT;" AP = ";AP
```

The values of AP can be interpreted easily:

<u>AP</u>	<u>MODE</u>	<u>AP</u>	<u>MODE</u>
1	APPLECLOCK	3	TIMEMASTER

READING THE TIME WITH MILLISECONDS (2)

Before we begin our discussion of millisecond time, we remind the user not to go through the extra steps required for millisecond accuracy if the events being measured or program lengths will not allow you to realize this accuracy in a true sense. To quote an old and wise lab technician, "Don't measure it with a micrometer, mark it with chalk, then cut it with an ax." But if it's milliseconds you want, a few additional commands will enable milliseconds on the H.O. If you want to know the time to the nearest millisecond, please read on; however, most people are really trying to measure the elapsed time in milliseconds between two events. If this is what you're trying to do, please see the program on the Timemaster II H.O. disk called Millisecond Timer.

Any use of the H.O. involving milliseconds requires the use of interrupts. DOS 3.3 has an inconsistency in that it can sometimes cause interrupt software to crash. This particular bug has been discussed in several Apple magazines. Applied Engineering has written a program called PATCH DOS 3.3 FOR INTERRUPTS (found on Timemaster II H.O. disk). This program will fix DOS 3.3 to work with interrupts. After running this program, you can INITIALize as many disks as you'd like. Always run the PATCH DOS 3.3 FOR INTERRUPTS before using any millisecond or interrupt capabilities or use a boot disk that has the modification already made to it. Your Timemaster II H.O. disk is such a disk so after booting up on the Timemaster II H.O. disk, you can simply INITIALize new disks. Commercial programs that use interrupts make this patch automatically. The use of interrupts with PRODOS are extremely complex and therefore we recommend the use of DOS 3.3 until the many bugs in PRODOS are worked out.

The millisecond feature is enabled by printing a "." (period) to the clock card after selecting the format. (Format selection clears the interrupt selection.) The firmware sets up the IRQ vector at \$3FE and \$3FF to point to an interrupt handler in ROM, and sets a flag that will cause interrupts on the clock card to be set up. One additional step has to be done from your program, which is to enable the IRQ interrupt with a CLI instruction. In Applesoft, you can issue a CLI instruction by POKEing a CLI and RTS, and then calling them, as in line 100 below. The following program shows how; it assumes your clock card is in slot 4:

100	POKE 768,88: POKE 769,96: CALL 768	set up interrupts
110	TEXT: HOME	good programing
120	PRINT "PRESS A KEY TO END"	ref to line 200
130	SLOT = 4	or any slot
140	PRINT CHR\$(4) "IN#";SLOT	set clock input
150	PRINT CHR\$(4) "PR#";SLOT	set clock output
160	INPUT " :. ";A\$	get the time
170	PRINT CHR\$(4) "IN#0"	restore keyboard
		restore output
180	PRINT CHR\$(4) "PR#0"	print the time
190	VTAB 4: PRINT A\$	
200	IF PEEK (-16384) < 128 THEN 120	key pressed??
		reset key ck.
210	POKE -16368,0	

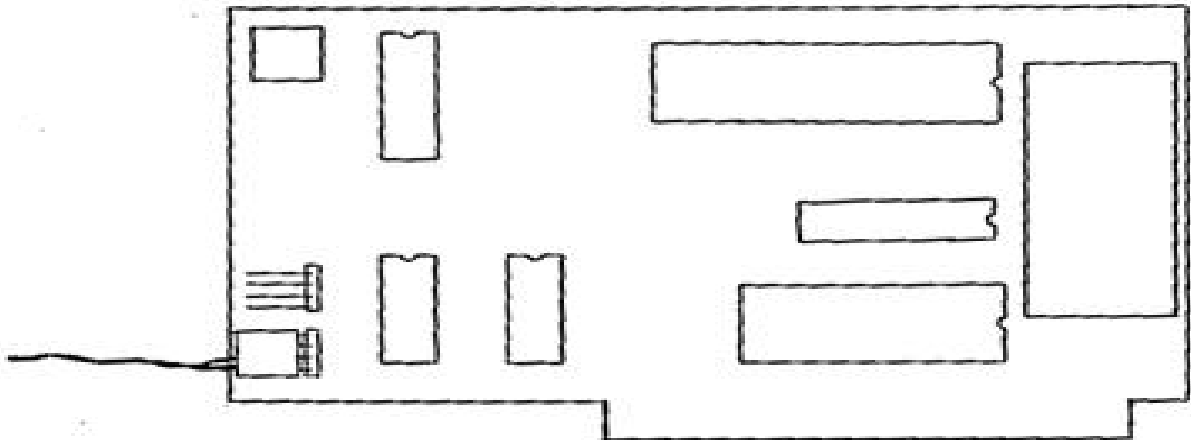
THE BSR REMOTE CONTROL OPTION (1)

The Applied Engineering BSR Remote Control option allows your Apple to send control signals to your BSR ultrasonic command console. The command console then sends these signals along your existing 120 volt AC wiring. To remotely control appliances or lights, or almost any electrical device, you plug into a BSR remote module. The BSR interface is designed to operate with the BSR/x-10 ultrasonic command console, model UC301 or model GDP-1510 from Heathkit (NOT a kit) This is the same command console that operates with the BSR/x-10 cordless controller. Be sure you have the right model of command console or it will not be able to hear the signals from your Timemaster II H.O. BSR interface. The command console sold by Radio Shack is not compatible with the BSR option because it has no ultrasonic receiver.

You will find that the command console has 22 command buttons. Sixteen for setting devices 1 through 16 and 6 function buttons. Your BSR interface can simulate the pushing of all 22 command buttons. Remote modules can be purchased in two types; an appliance module, which simply turns things on and off and can handle heavy loads. The second type is a lighting module, which comes in several styles, a plug in lamp type, wall mount single pole, and 3-way style that fit neatly where your old light switch was.

Please read the owners manual that comes with the BSR command console and remote modules before using the Timemaster II H.O. BSR interface. it is also a good idea to experiment a little bit with the command console and a few remote modules.

To connect the BSR interface to your H.O., slip the interface connector over the lower 4 pin plug, taking care that the two wires going into the connector go over the lowest two pins of this connector. Please refer to the drawing below.



The transducer itself should be placed near enough to the controller to operate. This can be as far away as 6 or 8 feet if the transducer is aimed directly at the pickup inside the controller box. After installing the H.O. with the BSR interface attached, you can type in the program below to test the positioning of the transducer. When the program is running, you should see the red light on the controller flashing on and off.

```

100 PR#4          (or whatever slot)
110 PRINT "U"
120 GOTO 110      (press CTRL RESET to stop)

```

The H.O. firmware includes the ability to send signals to the BSR system. After selecting the H.O. with PR~s C (s is the slot), you can print code letters to cause the various commands to be sent. The code letters correspond to the command console buttons as follows:

CODE LETTER	COMMAND BUTTON	CODE LETTER	COMMAND BUTTON
A	1	L	12
B	2	M	13
C	3	N	14
D	4	O	15
E	5	P	16
F	6	Q	ON
G	7	R	OFF
H	8	S	BRIGHT
I	9	T	DIM
J	10	U	ALL LIGHTS ON
K	11	V	ALL OFF

For example, to turn on light #1, do this: (2)

```

100 PRINT CHR$(4)"PR#4" (or whatever slot)
110 PRINT "AQ"
120 PRINT CHR$(4) "PR#0"

```

The "A" is button "1" and "Q" is "ON". Each command code is automatically transmitted 5 times to be certain it is correctly understood by the BSR controller. This is equivalent to holding down the button on the command console for about 1/2 second.

The BRIGHT and DIM commands are special. The range from fully OFF to fully ON is divided into many small steps. If you press and hold down the DIM button, it takes about 5 seconds to run through enough steps to fully dim the selected light; correspondingly, 5 seconds of BRIGHT will bring it back to fully on. The firmware simulates holding down the button, and you have the option of telling it how long to "hold it down". For the following sample program, you will need a light connected to button #1. Use the BSR controller manually and push (1) then

(ON). If the light does not come on, it may be necessary to hold down the BRIGHT button. Now type in the following program:

```
10 PRINT CHR$(4)"PR#4"  
20 PRINT "ATTTTTTTTTTTTTT"  
30 PRINT CHR$(4)"PR#0"
```

The "A" is for button "1" and the "T" means "DIM", the more "T",s the more dimming you'll get. Now change line 20 to:

```
20 PRINT "ASSSSSSSSSSSSSSS"
```

Now reRUN the program and notice that the light will brighten. A shorthand way of controlling the number of DIM or BRIGHT commands issued each time a "T" or "5" is printed is available. By printing a "i" followed by a letter "A" through "Z" to select the number of times the DIM or BRIGHT command will be transmitted for each "T" (DIM) or "5" (BRIGHT), "A" for a little, "Z" for a lot. So let's change line 20 in the program above to use the "*" command to dim the light on button "1". Now change line 20 to:

```
20 PRINT "A*NTIII"
```

Now reRUN the program, by changing the "N" to other letters you can vary how long the "BUTTON" is pressed. When the H.O. sees the "i" it knows that the next character, "N", is the duration code for the following DIM ("Tin') or BRIGHT ("S") commands. The letters "A" thru "Z" used here for duration control should not be confused with the letters "A" thru "V" used as button commands.

To use the next sample program, you will need a lamp on "1" with a lamp module and a appliance module on "2". Plug both remotes into wall outlets nearby. If you have small radio to plug into the appliance module, it would help you know when the module is turned on. Be sure your COMMAND CONSOLE is plugged in. To be sure everything is set up properly, press button "1" then press "ON" on the COMMAND CONSOLE. Then press "2", "ON" on the COMMAND CONSOLE. Now press "1", "OFF", "2", "OFF". The light and the radio should have turned on and then off. If not, check to see if you have things set up properly and try again.

Now enter the program below that will allow us to exercise the H.O.'s BSR capability.

```
90 INPUT "WHAT SLOT IS THE H.O. IN ";S  
100 INPUT "COMMAND ="  
110 IF B$ = "" THEN END  
120 PRINT CHR$(4)"PR#";S  
130 PRINT B$  
140 PRINT CHR$(4)"PR#0"  
150 GOTO 100
```

When we RUN this program using the commands shown, we get the following results:

RUN	
COMMAND = AQ	turns on the light
COMMAND = AR	turns the light off
COMMAND = BQ	turns on the radio
COMMAND = BR	turns off the radio
COMMAND = AQT	turns light on then dims it
COMMAND = ASSSSSSSSSSSS	brightens the light
COMMAND = AR	turns off the light
COMMAND = AQBQ	turns on the light and radio
COMMAND = ARBR	turns them both off

And now what you've all been waiting for, a program that will send commands to your REMOTE MODULES at specific times using the clock function of the H.O. This program will dim and brighten a light connected to REMOTE MODULE "1" every 30 seconds.

10 TEXT: HOME	just good programing
20 SLOT = 4	or any slot
30 PRINT CHR\$(4)"IN#";SLOT	set input to clock
40 PRINT CHR\$(4)"PR#";SLOT	set output to clock
50 INPUT ":";A\$	get time from clock
60 PRINT CHR\$(4)"IN#0"	restore keyboard
70 PRINT CHR\$(4)"PR#0"	restore output
80 SEC\$ = RIGHT\$(A\$,2)	throw away all but sec.
90 VTAB 4: PRINT "SEC. = ";SEC\$	display seconds
100 PRINT CHR\$(4)"PR#";SLOT	get ready to send code
110 IF SEC\$ = "00" THEN PRINT "A*RT"	dim if sec 00
120 IF SEC\$ = "15" THEN PRINT "A*RS"	brighten if sec = 15
130 IF SEC\$ = "30" THEN PRINT "A*RT"	dim if sec = 30
140 IF SEC\$ = "45" THEN PRINT "A*RS"	brighten if sec 45
150 PRINT CHR\$(4)"PR#0"	restore keyboard
160 GOTO 30	get new time

BSR set ups can vary from the simple to the complicated. For example, you could have two H.O.'s in your Apple that went to two different COMMAND CONSOLES, each with its own separate house code. This would give you control over 32 different devices. It is also possible to have one COMMAND CONSOLE in the study with your computer, and another COMMAND CONSOLE in the bedroom, set to the same house code. Each COMMAND CONSOLE would control the same devices.

TIME BASE CALIBRATION (1)

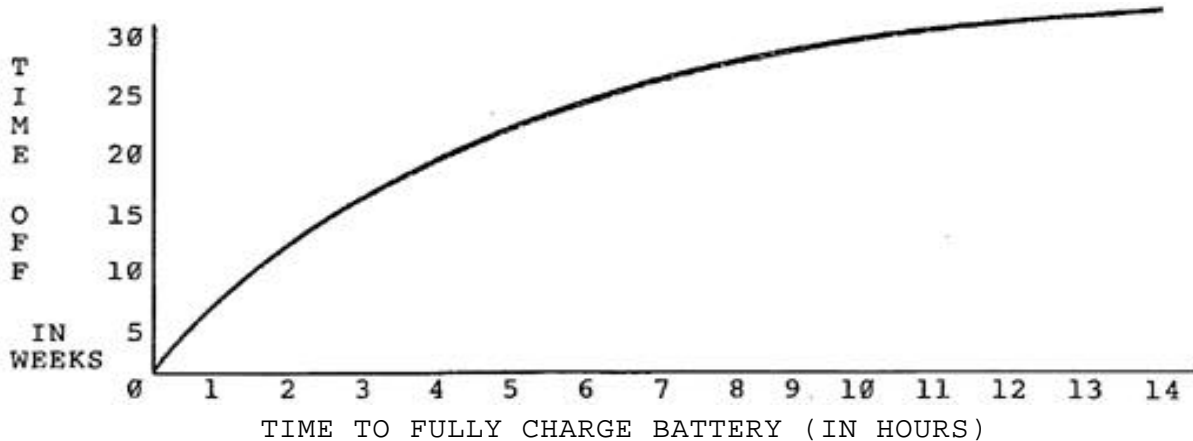
Your H.O. has a quartz crystal time base which oscillates at 32,768 HZ. This frequency can be adjusted up or down approximately 2 HZ by the trimmer capacitor which is next to the DIP switches at the rear of the board. Your H.O. was calibrated at the factory to 32,768.0 HZ. $\pm 0.002\%$. The manufacturer of the crystal specifies that the frequency may age up to 0.005% or 5 parts per million in one year. If the clock is consistently gaining or losing time, you may wish to adjust the trimmer. Using a small screwdriver, turn the trimmer SLIGHTLY clockwise to speed up the clock, or counter clockwise to slow it down.

+1- 30 SECOND ADJUST (2)

Your H.O. has the ability to adjust the seconds ± 30 . By momentarily connecting the two top pins on the upper four pin connector marked "5V" and marked "ADJ" (for adjust) you can reset the seconds to 00, adding one minute if the seconds were greater than 30. It should be reminded that the set clock routine on the Timemaster II H.O. disk can set the clock as accurately as you can push the return key ; however , in some scientific applications, it may be necessary to trim the time more accurately using the ± 30 second adjust feature.

THE BATTERY (1)

The H.O. is supplied with a rechargeable Ni-Cad battery to keep the clock running when the computer is turned off, or when power fails. The H.O. will automatically detect power going off and switch to the on-board battery. The clock will continue keeping time while the on-board battery supplies power. The battery is charging whenever power is applied to the APPLE. The time to fully charge a discharged battery is approximately 10 hours. Your H.O. may be used while charging the battery. A fully charged battery can keep the clock running for 5 to 7 months. In order to keep the battery charged, your APPLE should be turned on at least 0.5% of the time or about 1 hour a week or 4 hours a month. The battery CANNOT be overcharged and under normal use it will not require attention.



AUTOMATIC TIME/DATE STAMPING OF FILES IN DOS 3.3 (2)

One nice application of the H.O. is to automatically record the current date and time on file names in the catalog when you SAVE, BSAVE, or RENAME files. This feature is found in many large computer systems, as well as Apple pascal, sos, and PRO DOS.

Some small but significant patches must be made to DOS 3.3 to allow automatic time/date stamping of your files. First, a routine to read the clock and overlay the time/date string on your file name must be called for every SAVE, BSAVE, or RENAME command. Second, the two places inside DOS 3.3 where file names are compared must be modified to ignore the right end of the names (where the time/date string may or may not be found).

A program on the TIMEMASTER II H.O. disk called INSTALL DOS DATER will automatically make these patches for you. This program allows you to specify what portion of the time/date string you want to use in stamping file names. The DOS DATER patches require that the H.O. be in the Timemaster mode (switch 2 open). The Timemaster format must be used because other clock cards contain no year information. INSTALL DOS DATER searches slots 1 through 7 to find your 1-1.0. and checks that you have the right mode selected.

You can select any contiguous portion of the formatted date and time:

```
W MO/DD/YY HH:MI:SS
```

The most commonly used stamp is the MO/DD/YY portion, with the leading space.

Using INSTALL DOS DATER, you can select the portion of the string you wish to use with the arrow keys and the "L" and "R" keys. When the string is as you like it, press RETURN and the patches will be recorded. Simply follow the directions in the program to modify as many DOS 3.3 disks as you'd like. Once the patches have been applied to the DOS booted, any disks you initialize with the INIT command will have the patched DOS on them.

After you become familiar with the various features of time/date stamping your files, you may wish to update the DOS on the older disks. The slot your H.O. was in at the time INSTALL DOS DATER was executed is frozen into the installed patches, so do not try to move the card to another slot! If you do move your H.O. to a different slot, you will have to reRUN INSTALL DOS DATER.

There is normally no problem with using the patched DOS with any existing programs on any disks as long as they are not copy protected. Any new files SAVED, BSAVED, or RENAMED will have the current date added. The INIT command will also cause the date to be added to the greeting program's name. Should you ever be running with an unpatched DOS and want to use files that have time/date stamps, you will probably want to temporarily patch the

DOS in memory so that it ignores the time/date stamp. (You don't have to; but if you don't, you will have to type all 30 characters of the file name, which includes the time/date stamp.)

There are two places that file names are compared inside DOS 3.3, and both of them must be patched to shorten the EFFECTIVE file name. The effective file name is 30 characters long, minus the length of your time stamp. If you are using the recommended stamp of " MO/DD/YY", your effective file name is 30-9, or 21 characters. You need the following POKES:

```
POKE -19965,21      in the catalog search routine
POKE -22653,20     in the OPEN command handler
```

(Note that the second POKE puts a value one less than the effective length into DOS.)

AUTOMATIC TIME/DATE STAMPING FILES IN PRODOS (1)

PRO-DOS will automatically time and date stamp files with the H.O. in the TIMEMASTER mode (switch 2 open). PRODOS goes one step further than the patches for DOS 3.3, in that the date and time of original creation of a file is kept along with the date and time of last modification.

A word of caution should be mentioned regarding date stamping of files in PRODOS. PRODOS was written for an older design clock made by another company. This clock does not have any year information so PRODOS calculates the year based on the date and day of week. In other words, if it's the 16th and it's Monday, it must be 1984? So the TIMEMASTER II H.O. had to take a small step backwards to be compatible with Apple's new PRODOS. The PRODOS look up table goes from 1981 to 1987. After 1987, it will restart again with 1981. Even though your H.O. will show the correct year of 1988, PRO-DOS will not read the year from the H.O. Apple Computer is expected to directly support the H.O. in future releases of PRODOS. Until then, you will have to live with the same limitations that the buyers of other clock cards will be stuck with forever.

READING TIMEMASTER II H.O. IN 6502 MACHINE CODE (4)

For those of you that wish to use the H.O. in a machine language program, keep reading. If this is not you, turn the page quickly!

The easiest way to read the H.O. from a machine language program is to call on the built-in firmware the same way a BASIC program does. The technique to use depends upon the switch-selected mode you have chosen.

If you have NOT chosen the TIMEMASTER mode (switch 2 open) then you can use the following short subroutine. There are four elementary steps involved:

- 1) save the current input hook (\$38,\$39)
- 2) set input hook to \$Cs00(where s=slot of TIMEMASTER II)
- 3) read the time, storing in a buffer
- 4) restore the original input hook

```

1040 *-----
1050 READ.TIME
0300- A5 38    1060      LDA $38      KSWL      PUT CURRENT
0312- 48      1070      PHA          KSWH      INPUT HOOK
0303- A5 39    1080      LDA $39      KSWH      ON THE STACK
0365- 48      1090      PHA
1100 *-----
0306- A9 C4    1110      LDA #$C4     $CN      (N=SLOT CLOCK IS IN)
0308- 85 39    1120      STA $39     KSWH
030A- A2 00    1130      LDX #0
030C- 86 38    1140      STX $38     KSWL
1150 *-----
030E- 20 18 FD 1160 .1     JSR $FD18  MONITOR KEY INPUT ROUTINE
0311- 9D 00 02 1170      STA $200,X  SAVE CHARACTER FROM CLOCK
0314- E8      1180      INX
0315- C9 8D    1190      CMP #$8D    END OF INPUT?
0317- D0 F5    1200      BNE .1
1210 *-----
0319- 68      1220      PLA          RESTORE INPUT HOOK
031A- 85 39    1230      STA $39     KSWH
031C- 68      1240      PLA
0310- 85 38    1250      STA $38     KSWL
031F- 60      1260      RTS

```

After the subroutine has executed, the time/date string is in the buffer at \$200, ending with a carriage return.

The above subroutine is on your TIMEMASTER II H.O. disk. The source code is in the S.ML (OLD MODES) in the format for the S-C Macro Assembler. The object code is in B.ML (OLD MODES). An Applesoft BASIC program which loads B.ML (OLD MODES) and CALLS it is called ML (OLD MODES).

If you have chosen to use the TIMEMASTER mode, your job is even easier. There are two direct entries in the TIMEMASTER mode firmware which you can use from machine language. Their use is illustrated in the following subroutine:

```

0300- A9 BA 1000 LDA #":" SELECT TIME MASTER MODE
0302- 20 OB C4 1010 JSR $C40B MODE SELECTION
0305- 20 08 C4 1020 JSR $C408 READ TIME TO $200
0305- 60 1030 RTS

```

If your H.O. is not in slot 4, modify lines 1010 and 1020 appropriately. The entry at \$CsOB receives the format selection character. The entry at \$Cs08 reads the clock and stores the correctly formatted string at \$200, terminated by a carriage return.

If you want to write a machine language program which can read the clock no matter how switch 2 is set, you can merely look at \$CsFF to see which mode the H.O. is in. The following program does just that, and proceeds to read the clock according to its mode:

```

1040 *-----
1050 READ.TIME
0300- A9 C4 1060 LDA #$C4 (FILLEDIN BY CALLER IF
DIFFERENT)
0302- 8D 10 03 1070 STA SLOT1
0305- 8D 19 03 1080 STA SLOT2
0309- 8D LC 03 1090 STA SLOT3
030B- 8D 25 03 1100 STA SLOT4
1101 *-----
030E- AD FF C4 1110 LDA $C4FF TIMEMASTERII WITH 5W3, 5W4
OFF?
0310- 1120 SLOT1 .EQ *-1 $CN BYTE
0311- C9 03 1130 CMP #$03
0313- DO 09 1140 BNE OLD.MODES NOT TIMEMASTER II MODE
0315- A9 BA 1150 LDA #":" SELECT TIME MASTER MODE
0317- 20 OB C4 1160 JSR $C40B MODE SELECTION
0319- 1170 SLOT2 .EQ *-1 $CN BYTE
031A- 20 08 C4 1180 JSR $C408 READ TIME TO $200
031C- 1190 SLOT3 .EQ *-1
031D- 60 1200
1210 *-----
1220 OLD.MODES
031E- A5 38 1230 LDA $38 KSWL PUT CURRENT
0320- 48 1240 PHA INPUT HOOK
0321- A5 39 1250 LDA $39 KSWH ON THE STACK
0323- 48 1260 PHA
1270 *-----
0324- A9 C4 1280 LDA #$C4 $CN (N~SLOT CLOCK IS IN)
0325- 1290 SLOT4 .EQ *-1
0326- 85 39 1300 STA $39 KSWH
0328- A2 00 1310 LDX #0
032A- 86 38 1320 STX $38 KSWL
1330 *-----

```

```

032C- 20 18 FD 1340 .1      JSR $FD18    MONITOR KEY INPUT ROUTINE
032F- 9D 00 02 1350      STA $200,x  SAVE CHARACTER FROM CLOCK
0332- E8              1360      INX
0333- C9 8D          1370      CMP #$8D    END OF INPUT?
0335- DO F5          1370      BNE .1
                        1390 *-----
0337- 68              1400      PLA          RESTORE INPUT HOOK
0338- 85 39          1410      STA $39      KSWH
033A- 68              1420      PLA
033B- 85 38          1430      STA $38      KSWL
0330- 60              1440      RTS

```

The above subroutine is on your TIMEMASTER II H.O. disk. The source code is in S.ML (ALL MODES) in the format for the S-C Macro Assembler. The object code is in B.ML (ALL MODES). An Applesoft BASIC program which loads B.ML (ALL MODES) and CALLS it is called ML (ALL MODES).

READING THE CLOCK WITHOUT USING THE ON-BOARD FIRMWARE (3)

Sometimes you may want to read the H.O. without using the programs in the on-board ROM. This is not too difficult, and the job can be broken down into the following tasks:

1. Initialize the PIA chip.
2. "Hold" the clock.
3. Address a digit.
4. Read the digit.
5. Repeat steps 3 and 4 until all relevant digits have been read.
6. "Release" the clock, and allow interrupts.

The following Applesoft program shows how it can be done. (The program is on your H.O. disk.) The program is intended to be instructive in nature, as Applesoft does not quite run fast enough to update the time in precise one second intervals.

```

10  DIM FMT(30)
20  HOME : INPUT "SLOT:";SLOT: IF SLOT < 1 OR SLOT > 7
      THEN PRINT CHR$(7);: GOTO 20
40  GOSUB 2300: REM READ FORMAT DATA
50  GOSUB 2000: REM INITIALIZE PIA
60  GOSUB 2100: REM READ CLOCK
70  VTAB 10: HTAB 10: PRINT T$
80  IF PEEK (- 16384) < 128 THEN 60
90  POKE - 16368,0: END

2000  REM SETUP PIA
2010  PA = 49280 + SLOT * 16: REM $C080 + $NO
2020  CA = PA + 1:PB = PA + 2:CB PA + 3
2030  IF PEEK (CB) < > 0 THEN 2060
      :REM PIA ALREADY SET UP
2040  POKE CA,0: POKE CB,0: POKE PA,0: POKE PB,255
      :REM SET DIRECTION REGISTERS

```

```

2050     POKE CA,4: POKE CB,4: REM POINT AT DATA REGISTERS
2060     RETURN
2100     REM READ CLOCK USING FORMAT
2110     T$ = " ": FOR I = 1 TO NC
2120     POKE PB,16: REM     HOLD CLOCK
2130     D = FMT(I): IF D > 127 THEN 2170
2140     M = 16: IF D = 56 OR D = 53 THEN M = 4
2150     POKE PB,D:T     PEEK (PA): REM READ THE DIGIT
2160     D = T - INT (T / M) * M + 176
2170     T$= T$ + CHR$ (D)
2180     NEXT
2190     POKE PB,47: RETURN
2300     REM "W MM/DD/YY HH:MM:SS" FORMAT
2310     DATA 54,160,58,57,175,56,55,175,60,59,160,
           53,52,186,51,50,186,49,48,0
2320     NC = 0
2330     READ D: IF D = 0 THEN RETURN
2340     NC = NC + 1:FMT(NC) = D: GOTO 2330

```

In the program above, the PIA chip is initialized by the subroutine at line 2000. The subroutine at line 2300 reads a format definition into the array ENT. The numbers in the list are either clock digit addresses (values from 48 through 60) or ACSII characters (values) 127):

	Clock Registers		ASCII Character
	Tens Digit	Units Digit	
Year	60	59	160 space
Month	58	57	175 = slash
Day	56	55	186 = colon
Day of week	none	54	0 = end of format
Hour	53	52	
Minute	51	50	
Second	49	48	

The subroutine at line 2100 reads the clock by stepping through the format array. Line 2120 "holds" the clock, and line 2190 "releases" it.

The Applesoft program above is very similar in concept to the programs in the on-board ROMs. By varying the format definition, many different arrangements of the clock data can be displayed.

An assembly language program which reads the clock without using on-board firmware is on the TIMEMASTER II H.O. disk. The source code is in the file named S.TIME BY INTERRUPT, in the format of the S-C Macro Assembler. The object code, which can be BRUN, is in the file named B.TIME BY INTERRUPT.

INTERRUPTS (3)

One of the main features of the H.O. is the ability to generate interrupts at set intervals. Interrupts can add new dimensions to your Apple. For instance, background and foreground programming is possible by letting the interrupt handler routine initiate the background program. Also, data can be sampled at precise intervals.

The following interrupt intervals are available: 1/1024 second, 1 second, 1 minute, or 1 hour. The interval is selected by storing values from the table below in the control registers on the clock card.

Time	Control	Register
	CRA	CRB
none	\$04	\$04
1024 Hz	\$05	\$04
1 Sec	\$0C	\$04
1 Min	\$04	\$05
1 Hour	\$04	\$0C

SAMPLE INTERRUPT PROGRAMS (3)

This and other details of interrupt handling are best done with machine language routines. The source listing of a program that uses interrupts is on the last page of this manual. The name of this program is MILLISECONDS. Both source and object files are on your H.O. disk, in S.MILLISECONDS and B.MILLISECONDS respectively. The source file is in the format for the S-C Macro Assembler.

There are several programs on your H.O. disk which load B.MILLISECONDS and use the subroutines to illustrate the use of interrupts. MILLISECONDS will display a running count of milliseconds, using the 1024 Hertz interrupt. MILLISECOND STOPWATCH will allow you to precisely time the interval between two presses of the space bar, using your Apple as a stopwatch with accuracy to the nearest millisecond. TIME LIMIT QUIZ illustrates using interrupts to provide a time limit to some activity by the user (in this case an interesting multiple choice quiz)

It is interesting to listen to the Apple 'bell" while millisecond interrupts are being processed. Try it, and you will hear what happens when you slow down timed loops to process interrupts.

Note that the interrupt interval generated on the card is 1/1024th of a second, which is not a millisecond (it is about 0.977 milliseconds) Programs such as those above which need real milliseconds must multiply the 1024 Hz counter value by 1000/1024.

The two files S.TIME BY INTERRUPT and B.TIME BY INTERRUPT are the source and object files for another program which uses interrupts. Again, the source file is in the format of the S-C Macro Assembler. If you BRUN B.TIME BY INTERRUPT, the top two lines of the screen display will be used to display the current date and time. The time will be updated every second.

H.O. INTERRUPT UTILITIES (3)

A binary file named B.CLOCK UTILITIES is on the H.O. User Disk. This file contains seven very useful programs which can be called from an Applesoft program to work when you want to use interrupts.

The file is designed to be BLOADED at \$300, and uses all of the space from \$300 through \$3CF. Five bytes from \$EB through \$EF, not used by Applesoft or DOS, are used for communication between the UTILITIES and your Applesoft program. Include the following statement at the beginning of your Applesoft program:

```
PRINT CHR$(4)"BLOAD B.CLOCK UTILITIES":CALL 785
```

The "CALL 785" searches from slot 7 down toward slot 1 looking for the H.O. Even if you know ahead of time which slot is being used, you still must CALL 785 to set up the utilities.

After "CALL 785", you can PEEK(235) for the slot number. If PEEK(235) is zero, no H.O. was found. PEEK(236) will be 3 if the H.O. is in the normal mode, or 1 in the Appleclock mode.

The other six subroutines deal with interrupts:

```
CALL 768 -- Initialize interrupts
CALL 771 -- Turn off interrupts
CALL 774 -- Clear interrupt counter
CALL 777 -- Read interrupt counter
CALL 780 -- Enable interrupts
CALL 783 -- Disable interrupts
```

CALL 768 -- Initialize interrupts: Four interrupt intervals are available. You select which one you want by POKE 237:

```
POKE 237,0:CALL 768 1024 times per second
POKE 237,1:CALL 768 once per second
POKE 237,2:CALL 768 once per minute
POKE 237,3:CALL 768 once per hour
```

CALL 768 puts the address of an interrupt handler into #3FE and 3FF, clears an interrupt counter, selects the interrupt interval you have specified, and enables interrupts with a CLI instruction.

CALL 771 -- Turn off interrupts: This CALL disables interrupts with an SEI instruction, and de-selects interrupts on the clock.

CALL 774 -- Clear interrupt counter: Zeroes the 32-bit counter.

CALL 777 — Read interrupt counter: Disables interrupts, copies the interrupt 32-bit counter into 236, 237, 238, and 239 and re-enables interrupts. You may follow CALL 777 with CNT = PEEK(239) + 256 * PEEK(238) + 65536 * PEEK(237) + 16777216 * PEEK(236)

CALL 780 — Enable interrupts: Enables interrupts with the CLI instruction, without changing the clock card setup.

CALL 783 — Disable interrupts: Disables interrupts with the SEI instruction, without de-selecting clock card interrupts. Interrupts may later be re-enabled with CALL 780.

CLOCK UTILITIES SOURCE CODE (4)

```

1010 *SAVE S.CLOCK UTILITIES
1020 *-----
1030         .OR $300
1040         .TF B.CLOCK UTILITIES
EB-      1050 *-----
1060 SLOT         .EQ $EB PEEK(235)
EC-      1070 MODE         .EQ $EC PEEK(236)
ED-      1080 INTERVAL     .EQ $ED POKE(237) 0=MS,1=SEC
                                           2=M1N,3=HR
EC-      1090 COUNT.SAFE .EQ $EC - $EF PEEK (239)
1100 *
1110 *
1120 *-----
0300-4C 49 03 1130 CALL.768 JMP INTERRUPT.INIT
0303-4C 9B 03 1140 CALL.771 JMP INTERRUPT.CLEAR
0306-4C 83 03 1150 CALL.774 JMP INTERRUPT.ZERO
0309-4C 8E 03 1160 CALL.777 JMP INTERROPT.READ
030c-4C 99 03 1170 CALL.780 JMP INTERRUPT.ENABLE
030F-78      1180 CALL.783 SEI             .DISABLE
0310- 60 1190 RTS
0311-      1200 CALL.785 .EQ * FIND SLOT
1210 *-----
1220 FIND.SLOT
0311-AO C7      1230         LDY #$C7 START WITH SLOT 7
0313-8C AA 03 1240         .1         STY GET.ROM.BYTE+2
0316-AD FF CF 1250         LDA $CFFF RELEASE $C800 SPACE
0319-A2 FE      1260         LDX #$FE LOOK FOR $B2 AT $CNFE
031B-20 A8 03 1270         JSR GET.ROM.BYTE
031E-C9 B2      1280         CMP ~t$B2
0320-DO 13      1290         BNE .2
0322-20 A8 03 1300         JSR GET.ROM.BYTE MODE BYTE
0325-85 EC      1310         STA MODE
0327-20 A8 03 1320         JSR GET.ROM.BYTE
032A-C9 08      1330         CMP #$08 "PHP" AT $CNOO
032C-DO 07      1340         BNE .2 NOT THIS SLOT
032E-20 A8 03 1350         JSR GET.ROM.BYTE
0331-C9 78      1360         CMP #$78 "SEI" AT $CNO1
0333-FO 07      1370         BEQ .3 THIS SLOT
0335-88      1380         .2         DEY             NEXT SLOT DOWN
0336-CO C1      1390         CPY #$C1
0338-B0 D9      1400         BCS .1

```

```

033A- A000          1410          LDY #0
1420 *---STUFF SLOT $NO VALUE-----
033C-  98          1430   .3      TYA          $CN
033D- 29 OF        1440          AND # $OF      $ON
033F- 85 EB        1450          STA SLOT
0341- OA           1460          ASL
0342- OA           1470          ASL
0343- OA           1480          ASL
0344- OA           1490          ASL
0345- 8D B0 03    1500          STA SLOT16   $NO
0348- 60           1510          RTS
1520 *-----
1530 INTERRUPT.INIT
0349- 78           1540
1550 *---LOAD INTERRUPT VECTOR-----
034A- A9 AD        1560          LDA #IRQ.HANDLER
034C- 8D FE 03    1570          STA $3FE
034F- A9 03        1580          LDA /IRQ.HANDLER
0351- 8D FF 03    1590          STA $3FF
1600 *---SET UP INTERRUPTIONS-----
0354- AE B0 03    1610          LDX SLOT16
0357- A9 00        1620          LDA #0          POINT AT DIRECTION REGS
0359- 9D 81 CO    1630          STA $C081,X
035C- 9D 83 CO    1640          STA $C083,X
035F- 9D 80 CO    1650          STA $C080,X    PORT A ALL INPUT
0362- A9 FF        1660          LDA #$FF
0364- 9D 82 CO    1670          STA $C082,X    PORT B ALL OUTPUT
0367- AS ED        1680          LDA INTERVAL 0... 3
0369- 29 03        1690          AND #$03
036B- A8           1700          TAY
036C- B9 CA 03    1710          LDA INTERVAL.CRA,Y
036F- 9D 81 CO    1720          STA $C081,X    5=MS 12~SEC 4M1N 4=HR
0372- B9 CC 03    1730          LDA INTERVAL.CRB,Y
0375- 9D 83 CO    1740          STA $C083,X    4=MS 4=SEC 5=MIN 12=HR
0378- A9 2F        1750          LDA #$2F ENABLE INTERRUPTS OUT PIA
037A- 9D 82 CO    1760          STA $C082,X
037D- BD 80 CO    1770          LDA $C080,X    CLEAR PREVIOUS INTERRUPT
0380- BD 82 CO    1780          LDA $C082,X
1790 *-----
1800 INTERRUPT.ZERO
0383- 78           1810          SEI          SET INTERRUPT DISABLE
0384- A9 00        1820          LDA #0          ZERO THE 4 BYTE COUNTER
0386- A2 03        1830          LDX #3
0388- 9D C6 03    1840   .1      STA COUNT,X
038B- CA           1850          DEX          DECREMENT X
038C- 10 FA        1860          BPL .1
1870 *-----
1880 INTERRUPT.READ
038E- 78           1890          SEI          DISABLE INTERRUPTS WHILE
038F- A2 03        1900          LDX #3
0391- BD C6 03    1910   .1      LDA COUNT,X
0394- 95 BC        1920          STA COUNT.SAFE,X
0396- CA           1930          DEX          DECREMENT X
0397- 10 F8        1940          BPL .1
1950 *-----

```

```

1960 INTERRUPT.ENABLE
0399- 58 1970 CLI ALLOW INTERRUPTS AGAIN
039A- 60 1980 RTS
1990 *-----
2000 INTERREJPT.CLEAR
039B- 78 2010 SEI DISABLE INTERRUPTS
039C- AE B0 03 2020 LDX SLOT16
039F- A9 04 2030 LDA #04
03A1- 9D 81 CO 2040 STA $C081,X
03A4- 9D 83 CO 2050 STA $C083,X
03A7- 60 2060 RTS
2070 *-----
2080 GET.ROM.BYTE
03A8- BD 00 C7 2090 LDA $C700,x
03AB- E8 2100 INX
03AC- 60 2110 RTS
2120 *-----
2130 IRQ.HANDLER
03AD- 8A 2140 TXA SAVE X-REG
03AE- 48 2150 PHA
03AF- A2 B0 2160 LDX #SLOT16 $NO
03B0- 2170 SLOT16 .EQ ~-1
03B1- BD 80 CO 2180 LDA $C080,X CLEAR INTERRUPT
03B4- BD 82 CO 2190 LDA $C082,X
03B7- A2 03 2200 LDX #3
03B9- FE C6 03 2210 .1 INC COUNT,X
03BC- DO 03 2220 BNE .2
03BE- CA 2230 DEX
03BF- 10 F8 2240 BPL .1
03C1- 68 2250 .2 PLA RESTORE X AND A REGS
03C2- AA 2260 TAX
03C3- AS 45 2270 LDA $45 GET SAVED A REG
03C5- 40 2280 RTI RETURN
2290 *-----
03C6- 2300 COUNT .BS 4
2310 *-----
03CA- 05 OC 2320 INTERVAL.CRA .DA #5,#12
03CC- 04 04 05
03CF- OC 2330 INTERVAL.CRB .DA #4,#4,#5,#12
2340 *-----
0300- CALL 768 0399- INTERRUPT.ENABLE
0303- CALL 771 0349- INTERRUPT.INIT
0306- CALL 774 038E- INTERRUPT.READ
0309- CALL 777 .01=0391
030C- CALL 780 0383- INTERREJPT.ZERO
030F- CALL 783 .01=0388
0311- CALL 785 ED- INTERVAL
03C6- COUNT 03CA- INTERVAL.CRA
EC- COUNT.SAVE 03CC- INTERVAL.CRB
0311- FIND.SLOT 03AD- IRQ.I-IANDLER
.01=0313 .02=0335 .03=033C SC- MODE
03A8- GET.ROM.BYTE SB- SLOT
039B- INTSRRUPT.CLSAR 03B0- SLOT16
.01=03139 .02=03C1

```

CONTROLLING INTERRUPTS WITHOUT MACHINE LANGUAGE (3)

In order to illustrate how to program interrupts using Applesoft, without separate machine language files, the following program was written by Bill Goodwill. Bill's program sets up the clock to interrupt once per second. Three tiny machine language programs are POKEd into memory: at \$300, a routine which the IRQ interrupt; and at CALL 782 a program to enable the IRQ interrupt. At each interrupt the program at \$300 stores a non-zero value at 779, so that the Applesoft program will know an interrupt occurred.

Bill's Applesoft program is in a tight loop waiting for a non-zero value (line 2400) . For grins, a period is printed every trip through this loop. When PEEK(77) is finally non-zero, Bill zeroes it and counts the event in C, and prints a slash, for grins again. When C finally reaches the limit T, the program reads the clock and displays it on the screen.

You could substitute your own list of activities to be performed after each interrupt, and after each time the counter C reaches the limit T.

PATCHES FOR DOS 3.3 WHEN USING INTERRUPTS (3)

The Apple and DOS designers must not have really expected users to take advantage of interrupts. The IRQ interrupt handler inside the Apple monitor ROM saves the A-register at location \$45 in RAM. This would be all right, except that DOS 3.3 uses location \$45 in 25 different places as a temporary variable. An interrupt at the wrong time could greatly confuse DOS, and has the potential of clobbering a disk or at least a running program.

The easiest way around the problem is to be certain that the IRQ interrupt is disabled before any/every DOS command, and enabled when the DOS commands are finished. Another approach (tried in a product called Doubletime Printer from Southwestern Data Systems) is to replace the monitor ROM chip with one which does not use location \$45. The best solution is to patch DOS 3.3 50 that it does not use location \$45.

The program called PATCH DOS 3.3 FOR INTERRUPTS on the H.O. disk installs patches which make DOS 3.3 completely compatible with the use of the IRQ interrupt.

If you are expecting to use the millisecond interrupt for precise interval counting or other purposes, you may still have a conflict with DOS. Because disk I/O operations are critically timed with software, DOS 3.3 disables the IRQ interrupt during the reading or writing of the disk data. The IRQ interrupt will be ignored during the time it takes to bring a drive up to speed, find the proper track and sector, and read or write the data.

HOW TO READ THE TIME/DATE UNDER AN INTERRUPT (3)

It is usually not a good idea to try to use the built-in firmware to read the time and date in an interrupt driven program. The H.O. firmware uses the system input buffer at \$200 to build the time/date string.

It is possible that your use of the clock interrupt does not require all of the clock data. Perhaps only certain clock registers need to be read, so that a separate machine language program could be much faster than an attempt to read the whole clock using the on-board firmware. To keep interrupt overhead to a minimum your interrupt routine could read only selected registers.

The on-board firmware "forgets" your interrupt interval selection in most cases. If you don't want to reestablish the interrupt interval after each clock read, you may want to use a separate clock read program.

A program is on your H.O. disk which reads the clock and formats the date and time. The source code is in the file named S.TIME BY INTERRUPT, in the format of the S-C Macro Assembler. The object code, which can be BRUN, is in B.TIME BY INTERRUPT.

HOW TO DISABLE INTERRUPTS (4)

Once you begin using interrupts, it is important to know how to disable them. The IRQ interrupt can be disabled using the SEI instruction from machine language programs.

Pressing RESET (or Ctrl-RESET in newer Apples) will disable the IRQ interrupt. RESET will also clear the interrupt selections in the clock card, so that both IRO and NMI interrupts will cease.

Both IRQ and NMI interrupts from the clock can be cleared and disabled by storing a zero value in the control registers (\$C081+NO AND ~C083+NO).

Since the clock interrupts must be connected to the Apple bus by switches 3 or 4 on the clock card, flipping the switches off will obviously disconnect the interrupts.

```
1990 REM BASIC INTERRUPT ROUTINE BY WILLIAM P. GOODWILL
2000 TEXT : HOME : INPUT "WHAT SLOT IS THE TIMEMASTER IN?"
      ";SLOT: IF SLOT < 1 OR SLOT > 7 THEN 2000
2010 REM **LOAD 3 SMALL ASSY LANGUAGE ROUTINES**
2020 REM **;COME HERE UPON INTERRUPT
2030 REM **768 LDA #01 ;SET FLAG FOR BASIC
2040 REM **          STA 779
2050 REM **          LDA PIA ;CLEAR PIA
2060 REM **          LDA ~45 ;RESTORE ACCUMULATOR
2070 REM **          RTI      ;THEN RETURN
2080 REM **779 BYTE 00      ;BASIC FLAG
2090 REM **;USE "CALL 780" TO DISABLE INTERRUPTS
```

```

2100 REM **780 SET
2110 REM **RTS
2120 REM **;USE "CALL 782" TO ENABLE INTERRUPTS
2130 REM **782 CLI
2140 REM ** RTS
2150 DATA 169, 1,141,11,3,173,208,192,165,69,64,0,120,96,88,96
2160 FOR A = 768 TO 783: READ X: POKE A,X: NEXT A
2170 CALL 780: REM TURN OFF INTERRUPTS
2180 POKE 1022,0: POKE 1023,3: REM POINT TO INTERRUPT HANDLER
2190 A = -16256 + 16 * SLOT: REM PTA BASE ADDRESS = $C080+$NO
2210 POKE 774,128 + SLOT * 16
2220 POKE A + 1,0: POKE A + 3,0: REM DATA DIRECTION REGS
2240 POKE A,0: REM PORT A INPUT,8 BITS
2250 POKE A + 2,255: REM PORT B OUTPUT,8 BITS
2260 REM THE NEXT 2 POKES DETERMINE INTERRUPT RATE
2270 REM (THIS BASIC PROGRAM IS TOO SLOW FOR 1024 HZ INTERRUPTS)
2280 POKE A + 1,12: REM CONTROL REGISTER A (1 PER SECOND)
2290 POKE A + 3,4: REM CONTROL REGISTER B
2300 POKE A + 2,47: REM TELL PTA TO PASS INTERRUPTS
2310 X = PEEK (A): REM CLEAR PTA FLAGS
2320 F = 779: REM BASIC FLAG ADDRESS
2330 Z = 0: REM FLAG VALUE WHEN CLEAR
2340 CALL 782: REM      ENABLE INTERRUPTS
2350 T = 3: REM NUMBER OF INTERRUPTS PER CYCLE
2360 ONERR GOTO 2380
2370 GOTO 2460: REM TWIT
2380 CALL 780: STOP :REM DISABLE INTERRUPTS BEFORE HALTING
2400 IF PEEK (F) Z THEN PRINT ".":GOTO 2400:REM WAIT FOR TNT
2410 PRINT "/":REM DO THE FOLLOWING ON EVERY INTERRUPT
2420 POKE F,Z: REM      RESTORE FLAG AFTER INTERRUPT
2430 C = C + 1: IF C<T THEN GOTO 2400 REM TNCR CTR,COMPARE TO MAX
2450 REM PERFORM THIS OPERATION WHENEVER COUNT REACHES MAX
2460 C = 0: REM INIT COUNTER
2470 PRINT
2485 D$ = CHR~ (4): PRINT
2490 PRINT D$"IN#SLOT": PRINT D$"PR#"SLOT
2500 VTAB 5: INPUT ":";K$
2510 PRINT D$"IN#0": PRINT D$"PR#0"
2520 PRINT K$
2530 CALL -958
2540 POKE A + 1,12: REM CONTROL REGISTER A (1 PER SECOND)
2550 POKE A + 3,4: REM CONTROL REGISTER B
2560 GOTO 2400

```

CP/M AND YOUR TIMEMASTER II H.O. (2)

The TIMEMASTER II H.O. may be used under the CP/M operating system with the appropriate software. When using MBASIC or GEASIC your H.O. can be used most easily by POKEing a short interface routine. A sample program that shows how this is done may be found on the H.O. disk. The program is called T.CPMDE1 and is stored as a text file which can be converted to the CP/M system by using the APDOS utility on the CP/M master disk. This program was written for the TIMEMASTER mode.

To convert the APPLE DOS text file to a CP/M file, do the following:

- 1) Put a copy of your H.O. disk in drive 2 (B).
- 2) Put a CP/M disk with BASIC and APDOS on it in drive 1 (A)
- 3) Turn on computer or do a PR#6 (RETURN> SO YOU GET AN A>.
- 4) Type APDOS <RETURN> YOU SHOULD NOW HAVE AN *.
- 5) Type Tm1.BAS~T.CPMDE1 <RETURN> , this will convert T.CPMDE1.
- 6) Type <control> C , this will put you back in CP/M.

You should now have a program on your CP/M disk, called Tm1. This program can be run from MBASIC or GBASIC.

USING PASCAL WITH THE TIMEMASTER II H.O. (2)

In Pascal, an intrinsic unit has been supplied to enable the access of the H.O. from within a Pascal program. The unit is already linked into a standard Pascal library and can be accessed with the statement:

Uses TIMEMASTER

in a programs heading.

The unit supplies the following functions and procedures:

PROCEDURE GETCLOCK;

FUNCTION CLDAY;
FUNCTION CLMONTH;
FUNCTION CLDATE;
FUNCTION CLYEAR;
FUNCTION CLHOURS;
FUNCTION CLMINUTES;
FUNCTION CLSECONDS;

AND THE VARIABLES

TIME STRING 13
TODAY STRING 18

The functions listed return the integer value of the function name. Note that the CLDAY is the day of week and the CLHOURS is the hours 0 to 23 format. These return the same information that is returned when using the input statement in BASIC.

The procedure GETCLOCK sets the strings time and TODAY with the current time and date. The time string returns the time in the following format:

12:30:08 PM

while the TODAY string is in the format of

SUN MAR 20, 1983

and both have leading and trailing blanks.

To use these utilities, the system library on your boot disk will need to be replaced with the system library on the supplied disk.

The file system start up will also need to be included on your boot disk if the automatic dating feature is desired.

The three text files supplied are the programs that were used to make the TIMEMASTER II unit.

DISK CONTENTS (1)

Your TIMEMASTER II H.O. disk contains many useful and instructive example programs. Some of these have been mentioned in the preceding pages. The disk is not protected (however it is copyrighted) and you can and should make a backup copy using any standard Apple disk copy program (for example, COPYA on the DOS 3.3 System Master Diskette).

Side one of the diskette, which is labeled, contains DOS 3.3 (Copyright 1981 by Apple Computer, Inc.). A small patch has been made to this DOS, to speed up the LOAD, BLOAD, RUN, and BRUN commands.

The programs on this side include a file which can be moved to a CP/M environment. The others can be used either with DOS 3.3, and many of them with Apple PRO DOS. Side two of the diskette contains files intended to be used with Apple Pascal.

There are several files on side one of the H.O. diskette which are type thu. Normally file type I signifies Integer BASIC files, but in this case it signifies source assembly language files to be used with the S-C Macro Assembler. You may also have other programs on the H.O. disk.

S.MILLISECONDS	Source file (S-C Macro Assembler) of B.MILLISECONDS
B.MILLISECONDS	Object file used by next three programs which sets up and processes millisecond interrupts.
MILLISECONDS	Uses B.MILLISECONDS to give a running display of elapsed milliseconds.
MILLISECOND STOPWATCH	Uses B.MILLISECONDS to provide a very precise stopwatch.
THE LIMIT QUIZ	Uses B.MILLISECONDS to give a fun multiple choice quiz with time limits on your responses.
S.TIME BY INTERRUPT	Source file (S-C Macro Assembler) of B.TIME BY INTERRUPT
B.TIME BY INTERRUPT	BRUN this to put current date/time on top line of screen. It will stay there while you work, and be updated every second!
BASIC INTERRUPT ROUTINE	Bill Goodwill's program which sets up interrupts and demonstrates them entirely within Applesoft.

PATCH DOS 3.3 FOR INTERRUPTS
 Installs patches which make DOS 3.3 safe for interrupts. (See text)

SET CLOCK
 The program to use when you need to set a new time and/or date in your TIMEMASTER II.

EXAMPLE HOOKS
 Three different ways to hook in the TIMEMASTER II and read it.

DATE & TIME DISPLAY
 Nicely displays date and time, updating every second.

TIME II DEMO
 Reads the clock and displays date and time in all available formats according to selected mode.

ANALOG CLOCK
 Displays an old fashioned clock with moving hands and an audible "tick-tock".

FIND TIMEMASTER SLOT & MODE
 Program which finds the slot and mode of your TIMEMASTER II.

READ TIME (NO ROM)
 Program which reads and displays the date and time without using the on-board ROM firmware.

ML (ALL MODES)
 Calls B.ML (ALL MODES) to read the date/time string regardless of the mode selected by 5W3 and SW4.

S.ML (ALL MODES)
 Source file (S-C Macro Assembler) of B.ML (ALL MODES), a program which reads the date/time string in assembly language.

B.ML (ALL MODES)
 Object file used by ML (ALL MODES).

ML (OLD MODES)
 Calls B.ML (OLD MODES) to read the date/time string, which works only when NOT in TIMEMASTER II mode.

S.ML (OLD MODES)
 Source file (S-C Macro Assembler) of B.ML (OLD MODES), a program which reads the date/ time string in assembly languages.

B.ML (OLD MODES)
 Object file used by ML (OLD MODES).

INSTALL DOS DATER
 Modifies DOS 3.3 in memory to stamp date and/or time on files with SAVE, BSAVE, RENAME, or INIT.

S.DOS DATER Source file (S-C Macro Assembler)

B.DOS DATER Object file used by INSTALL DOS DATER
TALKING CLOCK If you have an Echo II, this program
will speak the time once per minute.

TALK Used by TALKING CLOCK, do not BRUN

T.CPMDE1 CP/M demo

The files which can be moved to PRO DOS (using CONVERT on the PRO DOS Users Disk) are:

B.MILLISECONDS	ANALOG CLOCK
MILLISECONDS	FIND TIMEMASTER II SLOT & MODE
MILLISECOND STOPWATCH	READ TIME (NO ROM)
TIME LIMIT QUIZ	ML (ALL MODES)
BASIC INTERRUPT ROUTINE	B.ML (ALL MODES)
SET CLOCK	ML (OLD MODES)
EXAMPLE HOOKS	B.ML (OLD MODES)
DATE & TIME DISPLAY	TIME II DEMO

The file names will be changed by CONVERT so that non-letters become periods, and truncated to 15 characters. With two exceptions, these programs will function under PRO DOS without modification. The two programs ML (ALL MODES) and ML (OLD MODES) must be slightly modified, to correct the names of the binary files loaded in line 30 of both programs.

COMMON QUESTIONS ABOUT THE TIMEMASTER II H.O. (1)

- Q. Which slot should I plug the TIMEMASTER II H.O. into?
- A. Any empty slot from slot 1 through slot 7 will do, but we recommend slot 4 if it's available. Some commercial software expects a clock to be in slot 4 without looking anywhere else.
- Q. The program I have says it works with a clock card but I can't get it to work with the TIMEMASTER II H.O.
- A. You may have purchased a dud program. The H.O. has been tested with dozens of clock type programs. You may want to contact the software publishers for help. Applied Engineering is very cooperative with programming companies and most software houses will be eager to solve your problem because of the large volume of TIMEMASTER sales. By helping you, they will be helping their other customers as well.

- Q. What mode is recommended for my own programming?
- A. The TIMEMASTER mode (switch 2 open)
- Q. I'm thinking of buying a program that says it will work with a real-time clock. Does this automatically mean that it will work with the H.O.?
- A. usually, but not always. Try to check with the author of the program to make sure that he supports TIMEMASTER. Over 300 software developers have purchased the TIMEMASTER, so compatibility problems should be rare.
- Q. With some of the sample programs, I will see a cursor looking thing flashing on part of the screen. What causes this?
- A. The cursor is caused whenever control is restored to the screen. This is part of the Apple monitor ROM and cannot be avoided when using PR#'s. The cursor appears to flash because the clock is constantly being reread. However, most programs only read the clock periodically thereby preventing the cursor from reappearing. If you are going to write a program that must constantly read the clock, you might want to not use the on-board firmware or do it with interrupts.
- Q. I've written this really neat program that uses the H.O. Should I give it to Applied Engineering?
- A. Depending on the quality of the program, Applied Engineering may compensate you. If your program is really spectacular, you may want a software publisher to sell it for you.
- Q. The TIMEMASTER II H.O. seems to be way out in front of its competition, in both features and price. How did you do it?
- A. Apple peripherals are our only business that's why we're so good at it!

MILLISECONDS SOURCE CODE

```

1020      .OR $300
1030      .TF B.MILLISECONDS
1040 *-----

```

```

0300- 4C 11 03 1050          JMP INT.INTERRUPT          CALL 768
0303- 4C 6C 03 1060          JMP RESET.COUNT CALL 771
0306- 4C 7A 03 1070          JMP SAVE.COUNT CALL 774
0309- 4C A6 03 1080          JMP STOP.INTERRUPT CALL 777
1090 *-----
030C-          1100 MSCNT.SAFE .B54          780.. .783, MSB FIRST
1110 *-----
0310-          1120 SLOT 16 .BS 1          $NO (ZERO IF NOT FOUND)
1130 *-----
1140 INIT.INTERRUPT
0311- 78          1150          SEI          DISABLE IRQ
1160 * -FIND TIMEMASTER          II SLOT
0312- A0 C7          1170          LDY #$C7          START WITH SLOT 7
0314- 8C 8A 03 1180 .1          STY GET.ROM.BYTE+2
0317- A2 FE          1190          LDX #$FE          LOOK FOR $B2 AT $CNFE
0319- 20 88 03 1200          JSR GET.ROM.BYTE
031C- C9 B2          1210          CMP #$B2
031E- DO OF          1220          BNE .2
0320- E8          1230          INX          NEXT CHECK $CNOO
0321- 20 88 03 1240          JSR GET.ROM.BYTE
0324- C9 08          1250          CMP #$08          "PHP" AT $CNOO
0326- DO 07          1260          BNE .2          NOT THIS SLOT
0328- 20 88 03 1270          JSR GET.ROM.BYTE
032B- C9 78          1280          CMP #$78          "SEI" AT $CNO1
032D- FO 06          1290          BEQ .3          THIS SLOT
032F- 88          1300 .2          DEY          NEXT SLOT DOWN
0330- CO C1          1310          CPY 4b$C1
0332- BO EQ          1320          BCS .1
0334- 60          1330          RTS
1340 *---STUFF SLOT $NO VALUE-----
0335- 98          1350 .3          TYA          $CN
0336- OA          1360          ASL
0337- OA          1370          ASL
0338- OA          1380          ASL
0339- OA          1390          ASL
033A- 8D 10 03 1400          STA SLOT 16 $NO
033D- FO 48          1410          BEQ RETURN... NO TIMEMASTER II FOUND
033F- AA          1420          TAX
1430 *---LOAD INTERRUPT VECTOR -----
0340- A9 8D          1440          LDA #IRQ.HANDLER
0342- 8D FE 03 1450          STA $3FE
0345- A9 03 1460          LDA/I RQ HANDLER
0347- 8D FF 03 1470          STA $3FF
1480 *---SET UP INTERRUPTIONS-----
034A- A9 00          1490          LDA #0          POINT AT DIRECTION REGS
034C- 9D 81 CO 1500          STA $C081,X
034F- 9D 83 CO 1510          STA $C083,X
0352- 9D 80 CO 1520          STA $C080,X          PORT A ALL INPUT
0355- A9 FF          1530          LDA #$FF
0357- 9D 82 CO 1540          STA #C082,X          PORT B ALL OUTPUT
035A- A9 05          1550          LDA #~05          SELECT INTERVAL (CRA)
035C- 9D 81 CO 1560          STA $C081,X
035F- A9 04          1570          LDA #~04          (CRB)
0361- 9D 83 CO 1580          STA $C083,X
0364- A9 2F          1590          LDA #$2F          ENABLE INT. OUT OF PIA

```

```

0366- 9D 82 CO 1600          STA $C082,X
0369- BD 80 CO 1610          LDA $C080,X CLEAR LAST INT. USE
                                $C080 FOR 1024 & iSEC. USE $C082 FOR iMIN & 1 HOUR
                                1620 *-----
                                1630 RESET.COUNT
036C- A9 00          1640          LDA itO ZERO THE 4-BYTE COUNTER
036E- 8D A8 03      1650          STA MSCNT
0371- 8D A9 03      1660          STA MSCNT+1
0374- 8D AA 03      1670          STA MSCNT+2
0377- 8D AB 03      1680          STA MSCNT+3
                                1690 *-----
                                1700 SAVE.COUNT
037A- 78          1710          SEI DISABLE INTERRUPTS
0378- A2 03          1720          LDX #3 WHILE COPYING TUE COUNT
037D- BD A8 03      1730 .1      LDA MSCNT,X TO A SAFE LOCATION
0380- 9D 0C 03      1740          STA MSCNT.SAFE,X
0383- CA          1750          DEX
0384- 10 F7          1760          BPL .1
0386- 58          1770          CLI ALLOW INTERRUPTS AGAIN
0387- 60          1780          RETURN RTS
                                1790 *-----
                                1800 GET.ROM.BYTE
0388- BD 00 C7      1810          LDA $C700,X
0388- E8          1820          INX
038C- 60          1830          RTS
                                1840 *-----
                                1850 *-----
                                1860 IRQ.HANDLER
038D- AS 45          1870          LDA $45 SAVE A-REG
038F- 48          1880          PHA
0390- 8A          1890          TXA SAVE X-REG
0391- 48          1900          PHA
0392- AE 10 03      1910          LDX SLOT 16 $NO
0395- BD 80 CO      1920          LDA $C080,X CLEAR INTERRUPT
0398- A2 03          1930          LDX #3 INCREMENT COUNTER
039A- FE A8 03      1940 .1      INC MSCNT,X
039D- DO 03          1950          BNE .2
039F- CA          1960          DEX
03A0- 10 F8          1970          BPL .1
03A2- 68          1980 .2      PLA RESTORE X AND A REGS
03A3- AA          1990          TAX
03A4- 68          2000          PLA
03A5- 40          2010          RTI RETURN
                                2020 *-----
                                2030 STOP.INTERRUPT
03A6- 78          2040          SEI
03A7- 60          2050          RTS
                                2060 *-----
03A8-          2070          MSCNT .BS 4
                                2080 *-----

```