TIMEMASTER II H.O.

USER MANUAL

APPLIED ENGINEERING
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CONTENTS

REV 1.1

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 (LSI) 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 PRO-DOS compatibility. With the Timemaster II H.O., we've added BSR control and other features and yet maintained software compatiblity 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 Ø. (The Apple //e has no slot Ø.) 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 H.O.

MODE	Sw 2	Format
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 WED DEC 14 03:30:23	THUNDER CLOCK APPLESOFT
"&"	WWW MMM DD HH:MI:SS WED 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 WED DEC 14 03:30:23 PM	THUNDER CLOCK INTEGER
"<"	WWW MMM DD HH:MI:SS WED 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 (ØØ-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 1Ø 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 15:3Ø:23.384 (Fri, Dec 14, 1984, 3:3Ø 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 TIME 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 "#";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$(A$,10,1)      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 + I*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(ADDR+255)
1080 PRINT "SLOT = ";SLOT;"  AP = ";AP
```

The values of AP can be interpreted easily:

AP	MODE	AP	MODE
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 PRO-DOS are extremely complex and therefore we recommend the use of DOS 3.3 until the many bugs in PRO-DOS 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
180 PRINT CHR$ (4) "PR#0"                  restore output
190 VTAB 4: PRINT A$                       print the time
200 IF PEEK ( -16384) < 128 THEN 120       key pressed??
210 POKE  - 16368,0                        reset key ck.
```

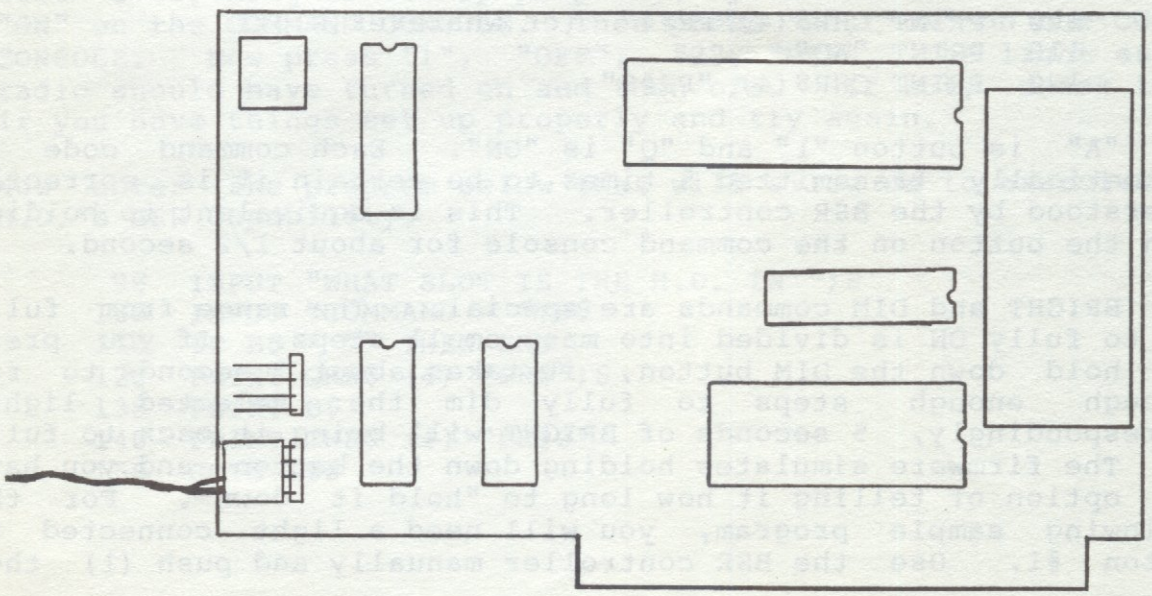
THE BSR REMOTE CONTROL OPTION (1)

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 X10-014301 (Sears part number). 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.

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 (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 "ATTTTTTTTTTTTT"
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 "ASSSSSSSSSSSSS"
```

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 "S" is printed is available. By printing a "*" 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 "S" (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*NT"
```

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 "*" it knows that the next character, "N", is the duration code for the following DIM ("T") 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 = ";B$
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 = AQTTTTTTTTTTT         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)

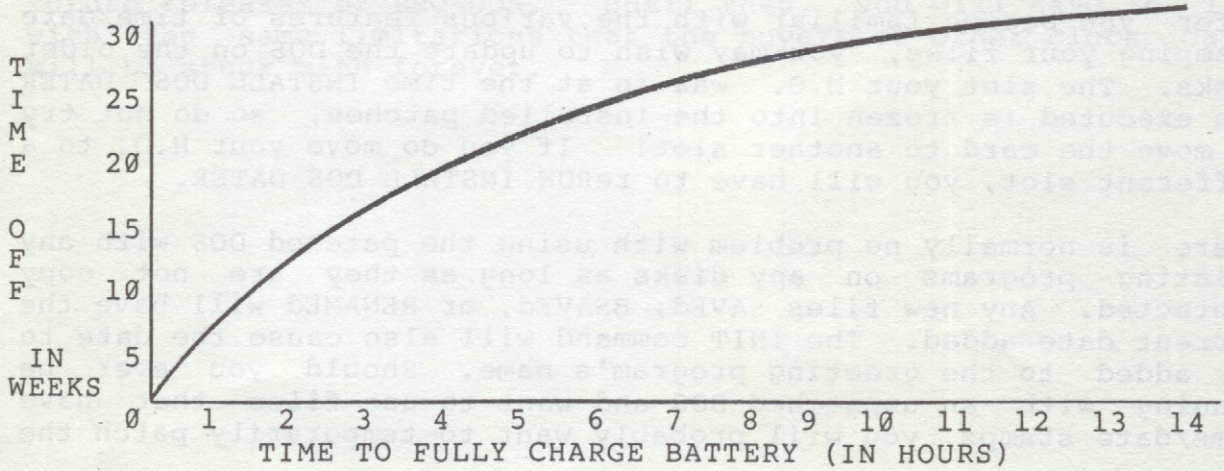
Your H.O. has a quartz crystal time base which oscillates at 32,768 HZ. This frequency can be adjusted up or down approximately 2 HZ by the trimmer capacitor which is next to the DIP switches at the rear of the board. Your H.O. was calibrated at the factory to 32,768.Ø HZ. +/- Ø.ØØ2%. The manufacturer of the crystal specifies that the frequency may age up to Ø.ØØ5% 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.

+/- 3Ø SECOND ADJUST (2)

Your H.O. has the ability to adjust the seconds +- 3Ø. 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 ØØ, adding one minute if the seconds were greater than 3Ø. 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 +- 3Ø 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 1Ø 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 Ø.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 H.O. 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 PRO-DOS (1)

PRO-DOS will automatically time and date stamp files with the H.O. in the TIMEMASTER mode (switch 2 open). PRO-DOS 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 PRO-DOS. PRO-DOS was written for an older design clock made by another company. This clock does not have any year information so PRO-DOS 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 PRO-DOS. The PRO-DOS 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 PRO-DOS. 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
0302- 48        1070         PHA                    INPUT HOOK
0303- A5 39     1080         LDA $39     KSWH       ON THE STACK
0305- 48        1090         PHA
                1100 *--------------------------------
0306- A9 C4     1110         LDA #$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 0B 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 $Cs0B 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   (FILLED IN BY CALLER IF
DIFFERENT)
0302- 8D 10 03  1070      STA SLOT1
0305- 8D 19 03  1080      STA SLOT2
0309- 8D 1C 03  1090      STA SLOT3
030B- 8D 25 03  1100      STA SLOT4
                1101 *-----------------------------
030E- AD FF C4  1110        LDA $C4FF  TIMEMASTER II WITH SW3, SW4
OFF?
0310-           1120 SLOT1 .EQ *-1     $CN BYTE
0311- C9 03     1130       CMP #$03
0313- D0 09     1140       BNE OLD.MODES   NOT TIMEMASTER II MODE
0315- A9 BA     1150       LDA #":"    SELECT TIME MASTER MODE
0317- 20 0B 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- D0 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 + $N0
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 FMT. 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
                     1050 *--------------------------------
EB-                  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=MIN,3=HR
EC-                  1090 COUNT.SAFE .EQ $EC - $EF  PEEK (239)
                     1100 *
                     1110 *
                     1120 *--------------------------------
0300- 4C 49 03       1130 CALL.768 JMP INTERRUPT.INIT
0303- 4C 9B 03       1140 CALL.771 JMP INTERRUPT.CLEAR
0306- 4C 83 03       1150 CALL.774 JMP INTERRUPT.ZERO
0309- 4C 8E 03       1160 CALL.777 JMP INTERRUPT.READ
030C- 4C 99 03       1170 CALL.780 JMP INTERRUPT.ENABLE
030F- 78             1180 CALL.783 SEI          .DISABLE
0310- 60             1190          RTS
0311-                1200 CALL.785 .EQ *      FIND SLOT
                     1210 *--------------------------------
                     1220 FIND.SLOT
0311- A0 C7          1230          LDY #$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 $CNFE
031B- 20 A8 03       1270          JSR GET.ROM.BYTE
031E- C9 B2          1280          CMP #$B2
0320- D0 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 $CN00
032C- D0 07          1340          BNE .2       NOT THIS SLOT
032E- 20 A8 03       1350          JSR GET.ROM.BYTE
0331- C9 78          1360          CMP #$78     "SEI" AT $CN01
0333- F0 07          1370          BEQ .3       THIS SLOT
0335- 88             1380 .2       DEY          NEXT SLOT DOWN
0336- C0 C1          1390          CPY #$C1
0338- B0 D9          1400          BCS .1
```

```
033A- A0 00     1410        LDY #0
                1420 *---STUFF SLOT $NO VALUE-------
033C- 98        1430 .3     TYA          $CN
033D- 29 0F     1440        AND #$0F     $ON
033F- 85 EB     1450        STA SLOT
0341- 0A        1460        ASL
0342- 0A        1470        ASL
0343- 0A        1480        ASL
0344- 0A        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 C0  1630        STA $C081,X
035C- 9D 83 C0  1640        STA $C083,X
035F- 9D 80 C0  1650        STA $C080,X  PORT A ALL INPUT
0362- A9 FF     1660        LDA #$FF
0364- 9D 82 C0  1670        STA $C082,X  PORT B ALL OUTPUT
0367- A5 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 C0  1720        STA $C081,X 5=MS 12=SEC 4=MIN 4=HR
0372- B9 CC 03  1730        LDA INTERVAL.CRB,Y
0375- 9D 83 C0  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 C0  1760        STA $C082,X
037D- BD 80 C0  1770        LDA $C080,X CLEAR PREVIOUS INTERRUPT
0380- BD 82 C0  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 EC     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 INTERRUPT.CLEAR
039B- 78            2010         SEI          DISABLE INTERRUPTS
039C- AE B0 03      2020         LDX SLOT16
039F- A9 04         2030         LDA #04
03A1- 9D 81 C0      2040         STA $C081,X
03A4- 9D 83 C0      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 C0      2180         LDA $C080,X  CLEAR INTERRUPT
03B4- BD 82 C0      2190         LDA $C082,X
03B7- A2 03         2200         LDX #3
03B9- FE C6 03      2210 .1      INC COUNT,X
03BC- D0 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- A5 45         2270         LDA $45      GET SAVED A REG
03C5- 40            2280         RTI          RETURN
                    2290 *-------------------------------
03C6-               2300 COUNT       .BS 4
                    2310 *-------------------------------
03CA- 05 0C         2320 INTERVAL.CRA .DA #5,#12
03CC- 04 04 05
03CF- 0C            2330 INTERVAL.CRB .DA #4,#4,#5,#12
                    2340 *-------------------------------
```

```
0300- CALL 768
0303- CALL 771
0306- CALL 774
0309- CALL 777
030C- CALL 780
030F- CALL 783
0311- CALL 785
03C6- COUNT
  EC- COUNT.SAVE
0311- FIND.SLOT
      .01=0313 .02=0335 .03=033C
03A8- GET.ROM.BYTE
039B- INTERRUPT.CLEAR
```

```
0399- INTERRUPT.ENABLE
0349- INTERRUPT.INIT
038E- INTERRUPT.READ
      .01=0391
0383- INTERRUPT.ZERO
      .01=0388
  ED- INTERVAL
03CA- INTERVAL.CRA
03CC- INTERVAL.CRB
03AD- IRQ.HANDLER
  EC- MODE
  EB- SLOT
03B0- SLOT16
      .01=03B9 .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 so 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 IRQ 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+N0 AND $C083+N0).

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  SEI
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  PIA BASE ADDRESS = $C080+$N0
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 PIA TO PASS INTERRUPTS
2310 X = PEEK (A): REM  CLEAR PIA 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 INIT
2380  CALL 780: STOP : REM DISABLE INTERRUPTS BEFORE HALTING
2400  IF PEEK (F) = Z THEN PRINT ".";:GOTO 2400:REM WAIT FOR INT
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 INCR 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 GBASIC 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 Ø 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 suppied 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 seveal files on side one of the H.O. diskette which are type "I". 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 TIMEMASTER II	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 SW3 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 language.
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.CPMDEl	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 TIMEMASTER II	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 interrrupts.

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  .BS4   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- D0 0F     1220        BNE .2
0320- E8        1230        INX            NEXT CHECK $CN00
0321- 20 88 03  1240        JSR GET.ROM.BYTE
0324- C9 08     1250        CMP #$08       "PHP" AT $CN00
0326- D0 07     1260        BNE .2         NOT THIS SLOT
0328- 20 88 03  1270        JSR GET.ROM.BYTE
032B- C9 78     1280        CMP #$78       "SEI" AT $CN01
032D- F0 06     1290        BEQ .3         THIS SLOT
032F- 88        1300 .2     DEY            NEXT SLOT DOWN
0330- C0 C1     1310        CPY #$C1
0332- B0 EQ     1320        BCS .1
0334- 60        1330        RTS
                1340 *---STUFF SLOT $NO VALUE---------
0335- 98        1350 .3     TYA            $CN
0336- 0A        1360        ASL
0337- 0A        1370        ASL
0338- 0A        1380        ASL
0339- 0A        1390        ASL
033A- 8D 10 03  1400        STA SLOT 16  $N0
033D- F0 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/IRQ.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 C0  1500        STA $C081,X
034F- 9D 83 C0  1510        STA $C083,X
0352- 9D 80 C0  1520        STA $C080,X  PORT A ALL INPUT
0355- A9 FF     1530        LDA #$FF
0357- 9D 82 C0  1540        STA #C082,X  PORT B ALL OUTPUT
035A- A9 05     1550        LDA #$05       SELECT INTERVAL (CRA)
035C- 9D 81 C0  1560        STA $C081,X
035F- A9 04     1570        LDA #$04       (CRB)
0361- 9D 83 C0  1580        STA $C083,X
0364- A9 2F     1590        LDA #$2F       ENABLE INT. OUT OF PIA
```

```
0366- 9D 82 C0  1600         STA $C082,X
0369- BD 80 C0  1610         LDA $C080,X  CLEAR LAST INT. USE
          $C080 FOR 1024 & 1SEC.  USE $C082 FOR 1MIN & 1 HOUR
                1620 *----------------------------
                1630 RESET.COUNT
036C- A9 00     1640         LDA #0       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
037B- A2 03     1720         LDX #3       WHILE COPYING THE 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
038B- E8        1820         INX
038C- 60        1830         RTS
                1840 *----------------------------
                1850 *----------------------------
                1860 IRQ.HANDLER
038D- A5 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 C0  1920         LDA $C080,X  CLEAR INTERRUPT
0398- A2 03     1930         LDX #3       INCREMENT COUNTER
039A- FE A8 03  1940 .1      INC MSCNT,X
039D- D0 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 *----------------------------
```