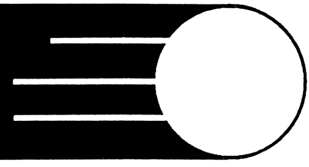
SUN FINDER



The Manual

Software for the HP 48SX

First Edition

First Printing, December, 1991.

The Sun Finder Manual

Scott Ferry

To Julie Kay and Esther A.

Acknowledgments

Special thanks to James Donnelly, Dr. William Wickes, Craig A. Finseth, and Hewlett Packard for their programs and/or encouragement, and to Greg Davies (who started me on this project 3 years ago with an in innocent question), Peter Thomas, and Steve Condiotti, of Davies, Thomas, Condiotti—gaffers and equipment—for their support.

CONTENTS

INTRODUCTION

The Sun Finder is a compilation of programs written on and to be used by the Hewlett Packard HP 48SX Scientific Expandable Calculator. The programs are imbedded in a card which is slid into the calculator. They allow the user to find the apparent location of the sun from anywhere in the world, any time between 1950 and 2050. It is menu-driven in that the user picks from a number of choices offered on the screen, only occasionally having to enter specific data by hand.

Included at startup is a short list of world cities from which to choose. You may add places to this list, up to the limit of your calculator's memory - hundreds if you like. After choosing the place, you choose the day, month, and year in a simple way. Then the main program is run and the results either appear on the screen or get sent to the HP 82240B Infrared Printer, as you choose. These results include:

- The place and day for which the program was done.
- The time and direction from North of the sunrise and sunset.
- The time of Local Apparent Noon and the altitude of the sun (in degrees) at that time.

- The length of Civil Twilight.

- The location of the sun in the sky, in degrees of altitude from the horizon and compass degrees from North for every hour-on-the-hour between sunrise and sunset.

Once the main program has been run, given one of the following: altitude, azimuth (direction from North), time, or length-of-shadow, you may solve for the other three.

You may review the results of the latest run at any time, recalling the results to the screen, or sending them to an infrared printer or a computer.

You may use the calculator as a compass, pointing it in the direction of the sun and running a program which draws a small compass on the screen.

If there is enough free memory in your calculator, you may call up a large map of the lower 48 United States, find a place on it, and by pressing a button dump the longitude and latitude into the system. You can then give this place a name and use it as the basis for calculations.

You may run a program which draws a picture of the moon on the screen, and gives its age and the percent of illumination.

These programs were originally written for use in the motion picture industry, for directors of photography and gaffers who need to know ahead of time where the sun will be. It has

been found useful, however, by architects, city planners, hikers, backpackers, and amateur astronomers.

Please read the manual carefully to take full advantage of the Sun Finder Library. The chapters are written in order—beginning with those concepts most necessary to get you started. The best way to learn Sun Finder is to read the manual from start to finish. If you've read the entire manual and still have questions, please call me at 510-845-1088. It would also be helpful, but not necessary, to read at least the first three chapters of the HP 48SX Owner's Manual.

Chapter 1

STARTUP

Installing the Card

1. If the calculator is on (that is, if the display is not completely blank) TURN IT OFF. To do this press the blue-colored right-arrow key (hereafter referred to as the [↱] key) and then press [ON]. *Do not press [ON] again until installation of the card is complete.*

2. Turn the calculator over and remove the port cover, which is the upper cover on the back of the machine.

3. Unless you already have a card in the machine, you will see two slots. Position the Sun Finder card over one of the empty slots with the *gold terminals on the bottom* and facing the *front of the calculator.* The heavy ridge on the top of the card should be facing you.

4. Firmly slide the card into the slot. After the first resistance is felt push the card about ¼" further, until it fully seats.

5. Replace the port cover.

Removing the Card

1. Turn the calculator off. *Do not press [ON] until you've completed step 4.*

2. Remove the port cover.

3. Press against the grip at the top of the card and slide the card out of the port.

4. Replace the port cover.

Conventions Used In This Manual

1. Commands or other things which are printed directly on the HP 48SX keyboard will be printed in this manual in [BOLDFACE], all capital letters, enclosed in brackets. For example, [CST] is the key in the second row from the top, third from the left. This may also be referred to as key 23, where the 2 is the row from the top and the 3 is position from the left. As noted above, the blue-right-shift key (81) will be written [↱]. The orange-left-shift key (71) will be written [↰]. The small words written in blue or orange above the keys of the HP 48SX are the shifted actions of these keys. In other words, to get into the Graph Environment you would press [↰] [GRAPH], key 71 followed by key 34. The four keys with white triangles on them, in positions 25, 34, 35, and 36, will be written [▲], [◀], [▼], and [▶]. They are called the scroll keys. The alpha key, 61, is written [α]. The backspace key, 55, is written [←].

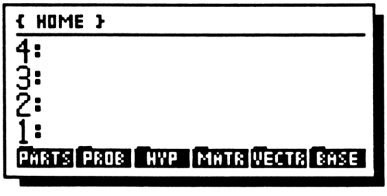
2. Throughout the Sun Finder program, on the bottom line of the calculator's display screen, you will see labels indicating different actions you may wish to take. These are called Menu labels. Each label corresponds to the WHITE key, also called a softkey, below it. Menu label keys will be in BOLDFACE, all capital letters, with no brackets.

3. When you will be required to enter input, such as the latitude of a city, it will be written as {**latitude**}, **bold** lower-case and in braces.

4. Titles on the screen (discussed in the next chapter) will be underlined.

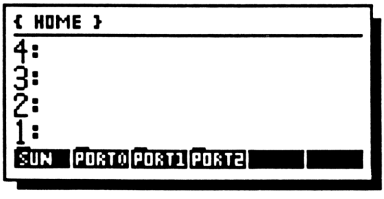
Entering the Sun Finder[1]

Now turn the calculator on by pressing [ON]. You will see the following screen:

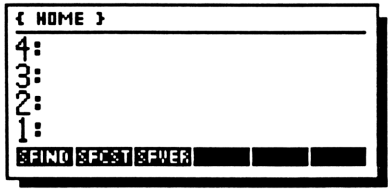


At this point you should set the correct date and time in the calculator's system, if you have not already done so. Refer to pages 440 - 442 of the HP 48SX Manual. The current time is required by the Sun Finder.

Next press [↰] [LIBRARY], keys 71 & 25. The screen should look like this if you have no other libraries installed:

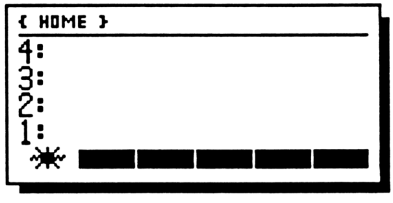


Hit the white menu key with SUN over it. You'll see:



Now you have a choice to make. If you do not have a Custom Menu or do not know what it is, choose (1). If you already have a custom menu, read Technical Note 2 in Appendix A and decide for yourself between (1) and (2).

(1) You may hit the SFCST key to put a little picture of the sun in your custom menu, and from now on all you will have to do to get into the program is press [CST] (key 23) and then the white key under the picture of the sun. This is recommended. If you have pressed SFCST and then [CST] the screen will look something like this:



Press the ✳ menu key.

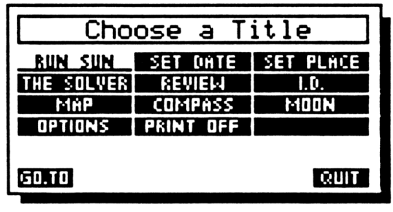
(2) If you don't want to use the custom menu option, press the menu key marked SFIND. Then, whenever you want to start Sun Finder you will have to follow the same routine.

That is, turn the calculator on, press [←] [LIBRARY], then SUN, then SFIND.

There exists a third option, that of typing the word SFIND on the calculator keyboard. You may start from any directory or menu, not just the Library menu. Do this by pressing [α] twice and then the keys with the white letters S-F-I-N-D at their lower-right corners. Then press [ENTER].

The word SFIND may also be included in a program. To learn about programming, read the HP 48 manual. A simple example would be to store the program « OFF SFIND » in a variable called 'Off' (minding the upper- and lower-case of the letters). Then, if you were to use the variable Off to turn the calculator off, when it was turned back on it would immediately start the Sun Finder application.

However you start the Sun Finder, the next screen looks like:



This is the main screen of the Sun Finder. Your screen may read NO MAP where this one reads MAP. To find out why, read Chapter 13, THE MAP.

Exiting the Sun Finder

Quitting the program is both simple and safe. Just press [ON]. This will get you out of the entire Sun Finder application no matter where you are in it. In a few cases, you might have to press [ON] two or three times in a row, but you'll always get back to the regular calculator screen, looking just the way you left it. Although it is never necessary to go back to the main screen in order to exit, if you want to quit the program from the main screen, you may also press the softkey QUIT. See Technical Note 3.

Environmental Limits

Operating temperature: 32 to 113° F (0 to 45° C).

Storage temperature: -4 to 140° F (-20 to 60° C).

Maximum humidity: 90% relative humidity at 104° F (40° C).

The Version

To view the copyright notice and version number of your copy of the Sun Finder, press [↰] [LIBRARY] SUN SFVER. This notice also appears, briefly, when you enter the program.

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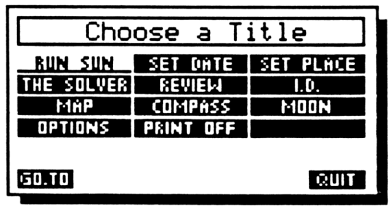
[1] You need about 6300 bytes of free memory in order for Sun Finder to operate. An empty machine has about 30,000 bytes of memory.
Also, a note of caution. Sun Finder creates a directory, called SUND, in the home directory, in which all the variables are held. *Do not access this directory unless you know what you are doing!*

Chapter 2

THE MAIN MENU

This again is what the main screen looks like:



Each of the eleven titles, from RUN SUN to PRINT OFF, has its own chapter. This section talks briefly about each and shows how to navigate within Sun Finder.

As you see, one of the titles is highlighted. To choose something else, use the four arrow keys: ◀ ▲ ▼ ▶. They move the highlight in the obvious directions. They also "wrap around", i.e., if RUN SUN is highlighted and you press [▲] the OPTIONS title will be highlighted. If you press [↰] [▼] a highlight moves to the bottom of the page and [↰] [▲] moves to the top of the page. If there are more than 15 items in the display, making more than one page necessary as in the SET PLACE menu, those combinations of keys will also move to the next and previous pages respectively. The [↱] [▼] and [↱] [▲] key combinations move the highlight to the bottom and top of the entire list, respectively.

Now that you can move around the screen, here is a description of each title:

1. RUN SUN is the main program. It calculates the times of sun rise and set and direction from North at those times, the length of the day, the time, altitude, and bearing of local apparent noon, the length of the twilights, and the altitude and bearing of the sun for each hour-on-the-hour between sun rise and set, and either prints it or puts it on the screen. The terms "bearing" and "azimuth" are used interchangeably in this manual, and refer to the apparent direction of the sun as measured in degrees from North.

2. SET DATE accesses another menu screen which allows you to easily set the date.

3. SET PLACE accesses a menu allowing you to set the place to be used by RUN SUN, as well as add new places to the list, delete ones no longer useful, edit the data stored with the places you already have, and view the data stored under a place name.

4. THE SOLVER accesses a menu that, given one of the following: altitude, azimuth, time, or length-of-shadow, solves for the other three.

5. REVIEW shows the results of the latest running of RUN SUN, and allows you to print them without running the program again, or to send them to a computer.

6. I.D. shows the last place and date stored in the main program's running system, whether you entered Standard or

Daylight Saving time, and the time shown on the calculator's system clock.

7. MAP accesses a map of the conterminous 48 states and allows you to enter places into the system without using an atlas, provided your calculator has enough free memory. If you don't have enough memory, this will read NO MAP.

8. COMPASS allows you to use the calculator as a compass, pointing it in the direction of the sun and reading directions off the display.

9. MOON draws a picture of the moon for a time you set.

10. OPTIONS accesses a menu which allows you to set parameters which affect system operations.

11. PRINT OFF (PRINT ON) is a toggle program allowing you to quickly choose to print, or not to print, the output of RUN SUN on an infrared printer.

To access these programs, commands, and menus, once you have highlighted the title you're interested in, all you need to do is press GO.TO or [ENTER].

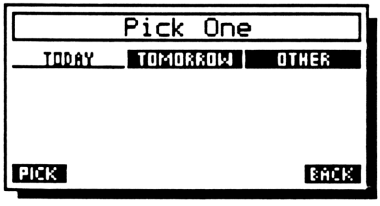
If you want to leave Sun Finder press either QUIT or [ON].

If you're reading this manual cover-to-cover, highlight SET DATE and press GO.TO or [ENTER].

Chapter 3

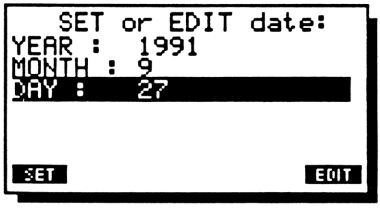
SET DATE

This is the SET DATE screen:

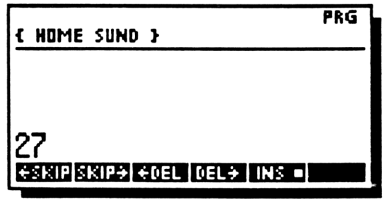


To set the Sun Finder's working date to be today's date (always presuming you have set the calculator's clock properly), highlight TODAY and press either **PICK** or [ENTER]. Set for TOMORROW similarly.

To set any other date highlight OTHER and pick it. The screen:



When you first enter this menu, the DAY will always be highlighted, as it is above, since you are more likely to want to change the day than the month or year. If you do want to change it, press EDIT. This is what the screen looks like:



The menu labels shown are part of the EDIT menu. The EDIT menu is used in several parts of Sun Finder. Please refer to Chapter 14 for an explanation. This menu is a standard tool of the calculator itself and a full explanation can also be found in the HP 48SX manual, P. 68. Using the commands **←SKIP**, etc., [DEL] (key 54), and [←] (backspace, key 55), you can skip or delete what's already on the screen. Use the calculator's number pad to input the date you want.

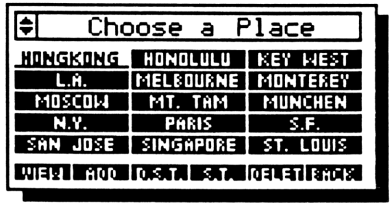
The mathematics used by the main programs are accurate for any date between 1950 and 2050, inclusive. The date setting schemes will not allow you to set dates which fall outside this realm, or to set impossible dates, such as September 31.

Once you have edited the date, if necessary, press SET on the set/edit menu or [ENTER] on the keyboard. The new date will be entered and the main screen will come up again.

Chapter 4

SET PLACE

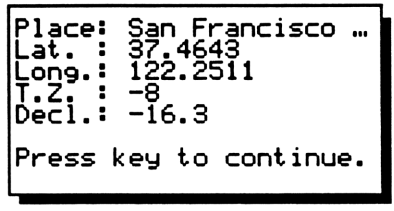
Highlight SET PLACE on the main screen and press GO.TO or [ENTER]. The screen you will see will look something like this:



with one of the cities highlighted, as HONGKONG is in this example. Also notice the two small arrows in the top-left corner of this picture. The one pointing up means there are more names above the top line displayed, and the one pointing down means there are more names below the bottom line. Using ◂▴▾▸ and the two shift keys, [↰] and [↱], you can quickly negotiate your way around the entire screen, as explained earlier. Remember, for example, that [↰] [▲] moves to the top of the page and [↱] [▲] moves to the very top of all the titles.

Section 1: VIEW

Having selected a city, try pressing VIEW. Here is an example of that screen:



Place is the place name which would be printed if you ran the main program, RUN SUN. Although up to 24 letters and spaces are allowed, not all can be shown on this screen. The fact that there is more after "San Francisco" is indicated by ellipses, "…".

Lat. is the latitude, 37°46′43″ (36 degrees, 46 minutes, 43 seconds). The fact that it's a positive number means that it is North Latitude. Displaying angles as decimals is standard on computers and calculators. If you are asked to enter something in "DD.MMSSss", it means enter the number of degrees "DD", followed by a decimal point, followed by the number of minutes "MM" (7 minutes is entered as 07, for instance), followed by the number of whole seconds "SS", followed by the fraction of a second "ss". Examples:

37°	=	37		
37°4′	=	37.04		
37°40′	=	37.40	=	37.4
37°54′30″	=	37.5430	=	37.543
37°54′31.258″	=	37.5431258		

Program output, however, will always be in easily readable form, i.e. 37°54′30″.

Long. is longitude. A positive number indicates West Longitude.

T.Z. is Standard Time zone. A negative number is the number of hours that the Standard Time of a place (mainly those West of Greenwich) is behind Coordinated Universal Time (UTC), nominally the time at Greenwich, U.K.. A positive number is for places (mainly those East of Greenwich) which are ahead of UTC.

Decl. is the magnetic declination of the place. To quote, "Declination, also called compass variation, is the angle between true north and the direction in which the magnetic compass points. It is considered east (E.) or west (W.) depending upon whether the compass points east or west of true north."[1] A negative sign indicates East declination, a positive sign West.

These things will be discussed further in Section 2. This is just to give you an idea of what you're looking at when you **VIEW** a place.

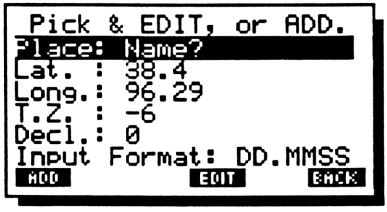
You'll notice, on the screen, the line "Press key to continue." This directive is seen in a number of different places within Sun Finder. "Key" means any key except:

[ON], which will, as usual, cause the whole program to terminate and put you back at the regular calculator screen, and
[α], [↰], or [↱], which will do nothing.

Press some other key now. You'll be back at the SET PLACE menu. The next section deals with the method of adding new places to this list. Press ADD.

Section 2: ADD

Your screen should look something like this:



The information on the screen is from the last time it was used, and each time you use it the data becomes the basis for building the screen the next time. Therefore, most of the time you will want to edit the data. Highlight Place: Name? and press EDIT. The screen will look like this:

Since you are editing a place name the machine presumes you want to enter letters of the alphabet. The small α at the top of the screen indicates that you are in *alpha mode*. In this mode the actions of the keys are indicated by the small white letters

beside them. If you press key 11 (first row, first column), an "A" will be typed; key 46 yields an "X", etc. The numbers on the keyboard are still active and you may use these as well. A comma may be entered by typing [↰][.]. Many special characters are available. For more information read "The Alpha Keyboard", P. 52 of the HP 48SX Owner's Manual.

If you accidentally hit the [α] (key 61) the machine will go out of *alpha mode*. To get back in just type [α] again and the α at the top of the board will reappear.

For an explanation of the menu commands, ◆SKIP etc., read Chapter 14 in this manual, or P. 68 of the HP 48SX Owner's Manual.

Do not delete the tag word ":place:" here. It will cause funny, but not serious, things to happen.

Follow along with this next example and you'll be taken through the whole ADD procedure. Type in {ISH KABIBBLE} for the name of a new place you are adding to the list. Remember, the braces around the name merely indicate that it is something you have to type in yourself. Do not include the braces themselves. Press [ENTER] as directed. The previous menu appears with the name "Ish Kabibble" entered as the place. The program has automatically lower-cased all but the first letters of each word.

Next highlight Input Format: DD.MMSS² and press [ENTER]. You're back at the same screen except you'll notice the last line has changed to Input Format: DD.MMmm. Repeat the process and it toggles back again. In the first case, any numbers you enter for latitude and

longitude in this menu will be interpreted as having the numbers to the left of the decimal point be degrees, the next two numbers minutes, the two after that seconds, and any after that fractions of a second (of arc). In the second case anything from the third decimal place on is interpreted as being a fraction of a minute of arc. (Many sources of airplane flight information give position in this form.) For example:

In DD.MMSS format, 58 degrees, 35 ½ minutes would be entered as

58.353

where the second 3 represents 30 seconds = ½ minute.

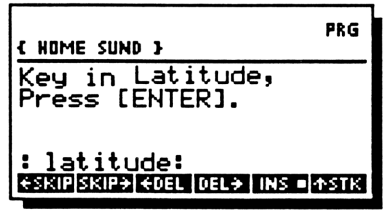
In DD.MMmm format, it would be entered as

58.355

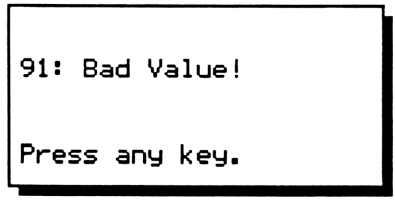
where the last 5 represents $^5/_{10}$ = ½ minute.

In either case, after entry the program converts the number to DD.MMSSss format for display.

Highlight the Lat. : and press EDIT. The screen will look like this:

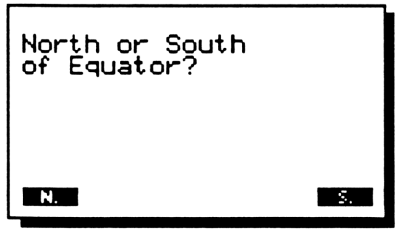


For an example of an error message, key in the number {91}. You will see this screen:

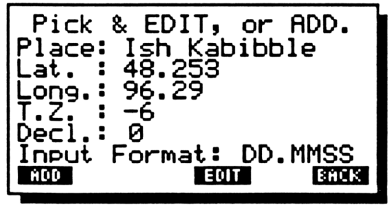


In this case, it's letting you know that 91° is an impossible entry for latitude. Latitude must be between 0° and 90°, inclusive. (If you plan on being precisely at the North Pole or South Pole, however, give me a call.)

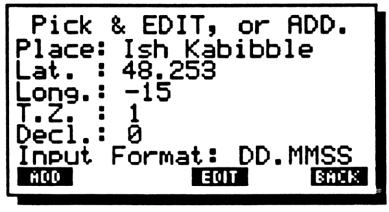
Key in the latitude, say 48°25′30″, paying attention to the format. Assuming you're in DD.MMSS format you would key in {48.253}. Press [ENTER]. You'll see this:



Press the white key under either N. or S. and you'll go back to the ADD menu. If you pressed N. you'll see this:



Edit the longitude in a similar way. Do not enter a number greater than 180°. For this example, enter {15} and when the screen comes up asking you if it is West or East of Greenwich, press E.



This program is Americo-centric in that North latitude and West longitude are stored as positive numbers. The latitude and longitude of selected world cities may be found in Appendix C.[3]

Notice that after you have set the longitude the time zone has also changed. This is a preliminary calculation and it is up to you to determine its accuracy. Time zone lines are determined by politics, not mathematics.

The time zone can be gotten from many maps, the telephone company, or Appendix D, World Time Zones. Remember that in the scheme of this program, places West of Greenwich have negative numbers for their time zones, and places East of Greenwich have positive numbers (the opposite sign of the longitude). If you think of a line of numbers, those to the left of zero (Greenwich) are negative, while those to the right of zero are positive.

Edit the time zone if necessary. For our example, let's edit it to 2. Key in EDIT {2} [ENTER]. A screen will come up

asking you if you're sure. If you press NO you will be given another chance to input the time zone. Press YES for our example.

Declination can be gotten from the maps mentioned in footnote 1, from the small scale maps in Appendix E, or from a local airport. It can also be determined on location by methods described in "Aspects of Compass Use" in Appendix B. Magnetic declination is constantly changing, up to 2° a year at the poles but more typically 10 or 15 minutes a year. This is not much, but to be completely accurate you may want to change it once every year or two. You'll find out how to do this in Section 3. For right now, try editing the declination, putting in any value between 0 and 180.

After you have set all the parameters individually, press ADD. A screen will come up asking you to key in the Title. This is what will appear on the SET PLACE menu screen. The place name appears by default, and you may just press [ENTER] to use this for the screen title, or you may enter another name, perhaps a shorter version which will be more readable in the limited space. If you do want to enter something else, use [DEL] (key 54), the backspace key , [←] (key 55), the arrow keys, and the edit menu keys, to move around and take out the parts you don't want. Then press [α] to get into *alpha mode* (notice the α at the top of the display) and type in what you *do* want. When you like it press [ENTER]. If you're following the example, let's shorten "Ish Kabibble" to "Ish". Press SKIP→ DEL→ [ENTER].

The last question you must answer is whether you want to add this place to the list "permanently" or just dump all the

parameters into the system to be used only once or twice. Choosing **PERM.** adds the place to the SET PLACE menu and takes up calculator memory until you **DELETE** it (discussed in Section 4 of this chapter). Choosing **TEMP.** puts the place name, latitude, longitude, time zone, and declination into variables that will be overwritten the next time you choose a different place. This saves you the trouble of having to remember to **DELETE** a place you are unlikely to use again. For the example, choose **PERM.** You'll be back at the SET PLACE screen.

Section 3: EDIT

Move the highlight around until it gets to the place you want to edit. If you're following the example, that will be ISH. Now press [NXT], (next menu page, key 26). This changes the little menu titles on the bottom of the screen. You'll see that now, there is only one label: **EDIT**. (If you pushed [NXT] again at this point, you would go back to the screen with **VIEW, ADD**, etc. at the bottom.) Press **EDIT**. The screen you see should cause no surprises. It is the normal EDIT menu, explained in Chapter 14. Highlight what you want to edit, press **EDIT**, change it, and press [ENTER]. Repeat the process with as many of the parameters as you want to edit. When you are satisfied with everything, press **SET**.

There are some differences between editing things here and editing them in the **ADD** menu.

1. If you change the place name, it will *not* automatically have all but the first letters of the words lower-cased. This

was done on purpose. You would want a printout to show "London, U.K." not "London, U.k.". Here is where you can make that happen. Remember that to enter letters, the α must be visible at the top of the screen. If it is not, press [α]. To enter lower-case letters, hold down the [↰], with the α visible at the top, and key in the letters. Read pages 52-54 of the HP 48SX manual for more information.

2. Numbers here are entered *only* in DD.MMSSss format, and are *signed* That is they are either positive (+) or negative (-). [±] , key 52, toggles a number between positive and negative if the insert pointer on the display is pointing to or actually over the number. If there is no sign in front of the number it is, of course, positive. Remember that North latitude and West longitude (the Western Hemisphere) are positive. Also be aware that East Declination is negative, West Declination positive. If you're still following the example, try highlighting **Longitude: -15** and pressing EDIT. Press DEL→ {20} [±] [ENTER] and you'll see the change.

3. Time zones in the **ADD** menu are always set to be of the opposite sign of the longitude, which is nearly always the case. If it is not (for instance, if the place is west of Greenwich but its Standard Time is *fast* on UTC), you can change the sign of the time zone in *this* edit menu.

The automatic choices made in the **ADD** menu should be the correct ones 99% of the time. N.B.: Normal out-of-range error checking *is* active in this edit menu.

When you're done editing all the things you want, press SET or [ENTER].

You'll be back at the SET PLACE menu. Now we'll delete this example entry.

Section 4: DELETE

To delete a place, press DELETE and then YES when the next screen asks if you are sure. NO, of course, aborts the action. For the example, make sure ISH is still highlighted and delete it.

Section 5: D.S.T. and S.T.

In order to run the main program you must make the highlighted place the current place by pressing D.S.T. *or* S.T., *or* [ENTER].

The two abbreviations stand for Daylight Saving Time and Standard Time. Pressing S.T. dumps the name, latitude, longitude, time zone, and magnetic declination of the highlighted place into the system, ready for the main program, RUN SUN, to crunch. D.S.T. adds one (1) to the time zone, but otherwise does the same thing.

You may also use the [ENTER] key to dump the parameters of a place into the system. After you press [ENTER], you'll see this:

```
Press [ENTER] if
Daylight Saving Time;

Press any other key if
Standard Time.
```

Follow the directions and the place you have chosen will become the "current" place, time zone entered according to your choice.

The only menu key in the SET PLACE menu we haven't talked about is BACK. The BACK key takes you back to the main menu. Pressing [ON] will, as usual, exit Sun Finder.

Now is a good time to add your home city to the list. Look up its coordinates in the index of a good atlas, or call the public library. Appendix C lists the coordinates of a few cities. The local airport may also give them to you, as well as the current magnetic declination. Once you have the information, press ADD and go through the routine. Then, back at the SET PLACE menu, press either D.S.T. or S.T. depending on what time of year it is. In a second you'll be back at the main screen.

---

[1] From the legend of the map " The Magnetic Field in the United States, 1985 - Declination Chart " by Norman W. Peddie and Audronis K. Zunde, 1988. Published by and available from the U.S. Geological Survey. Also available: "The Magnetic Field of the Earth ".

The maps include methods by which you may calculate how much the declination has changed since they were drawn. Note well that the signs of the numbers used on these charts are the opposite to those used in the Sun Finder.

[2] It really should be written DD.MMSSss but there was not enough room on the display.

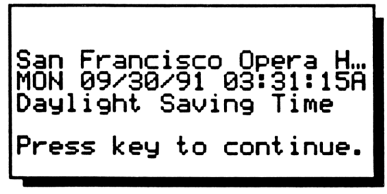
[3] For the truly serious, the U.S. Geological Survey publishes lists, by state, of the location of every place named on the largest scale topographic maps. The book for California contains about 63,000 place names and their latitude and longitude to the nearest second of arc ($34). Order Official State Gazetteers from:

U.S. Geological Survey
Books and Open-File Reports
Federal Center, Bldg. 41
Box 25425
Denver, Colorado 80225.

Chapter 5

THE I.D.

At the main menu, highlight I.D. The last place you stored in the running system, using S.T. or D.S.T. from the SET PLACE menu, will appear on the top line. (This is *not necessarily* the last place for which RUN SUN was done.) You'll see something like this:



except with your information entered.

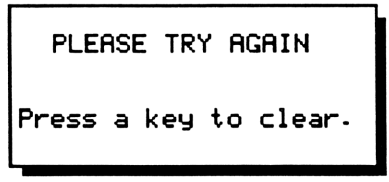
If you've set the system clock correctly, the time is the current time and is continually being updated. Notice the little hourglass at the top. That indicates that a program is active (the time updating mechanism). *The calculator will not automatically shut itself off* (as it normally will do after 10 minutes of inactivity) *as long as this icon is showing.* Press any key to go back to the main menu.

Chapter 6

RUN SUN

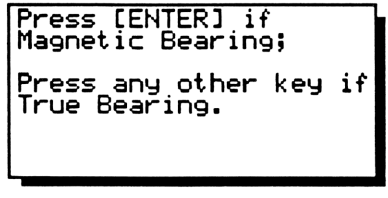
First, notice if the last title on the screen is PRINT ON or PRINT OFF. If it is PRINT OFF, make sure RUN SUN is highlighted and go on. If it is PRINT ON, highlight PRINT ON and press either **GO.TO** or **[ENTER]**. This will toggle this title to PRINT OFF. Using the PRINT ON/OFF function will be discussed in Chapter 10. Highlight RUN SUN and continue.

Next a word about how programs of this type work. They all need an assumed time for sunrise, at the very least, to use as a starting place for calculations. Every program that was researched uses 6 AM as that time. However, if the actual time of sunrise is, say, 9 AM, the calculations, when finally done, will be off by a fair amount. The Sun Finder attempts to minimize the error by using the time of the last sunrise calculated by the program as its point of beginning. Since this program is intended for professionals who will most likely use it at least once a week, this method works well to produce very accurate data. To do this, however, the program compares the last sunrise calculated with the one it's calculating now, and if there is more than a half hour difference between them, it aborts and displays the message:



You should only get this message if you're changing time zones, if you're going from Standard Time to Daylight Saving Time or *vice versa*, if the latitude of the last place is vastly different from the latitude of the current place, or if it's been a long time since the program was run. The results are a great deal more accurate with the cost of only a few seconds of time.

With that caveat, highlight RUN SUN and press GO.TO or [ENTER]. This screen appears:



You are being asked to decide whether you want the magnetic declination to be disregarded (True Bearing) or included (Magnetic Bearing) in the readouts of the sun's bearing (azimuth). For example:

Assume the declination, as it is stored with the place you are using, is 10° East, and that the sun rises at 7 AM due East. If you have selected "True Bearing" the output of RUN SUN

will read " Rise: 7:00 AM, 90°00'T ". If you have selected "Magnetic Bearing" it will read " Rise: 7:00 AM, 80°00'M ".

In the first case, you would set the magnetic declination on your compass, a capability most good compasses have. In the second case, if the declination cannot be set directly on your compass, or if you always prefer to leave it at zero, the calculator automatically adds the declination to each output of the sun's bearing. The first method is preferred, in that it gives you the opportunity to change the declination once you are actually at the location. You would then merely have to change it on your compass and continue to use the same Sun Finder output. If you had used "magnetic bearing" you would have to re-store the place with the new declination and RUN SUN again. This whole problem is discussed further in Appendix B.

For the moment, let's assume you want true bearing output. Press any other key but [ENTER] or [ON] (which, as usual, would abort the program). A notice comes on the screen letting you know that the Sun Finder is "Working on it!". If this is the first time you've run the program the screen will probably come up with the "PLEASE TRY AGAIN" message. This is because the initial settings of the Sun Finder are likely to be very different from the ones you are running now. Press a key to clear the message and RUN SUN again.

A note here about the "key buffer" on the HP 48SX. This is a part of the system that remembers the last keys pressed and, if you're pressing keys very fast, will go on executing the key actions in turn. Thus you don't have to wait for a message to come on the screen if you know what it says and what action

you want to take. For instance, if you habitually RUN SUN with a True Bearing output, just press the GO.TO key twice, as fast as you like. If you know you want Magnetic Bearing, press [ENTER] twice. If you're changing time zones, for instance, and know that you're going to get the "PLEASE TRY AGAIN" message, pressing GO.TO 5 times in quick succession will make the calculator fly past all the messages and give you a True Bearing readout. Play around with this. You cannot do any damage.

Once you have gotten through all the messages, you should have heard a European Siren as the run was coming to an end. This, along with any other beeps the calculator might produce, can be turned off. You can find out how by reading Chapter 9, "Options".

At the end of the run you should see:

except for your place and date. The small arrow on the right side indicates there is more information below. You use the scroll and shift keys in the usual way to see more of the output. Here's a line-by-line breakdown:

"San Francisco Opera Hse."	The place name.
"Thu., Sep. 12, 1991, DST"	Program run for 9/12/'91, Daylight Saving Time.
"Rise: 6:49 AM, 83°55′T"	The sun rises at 6:49 in the morning at 83°55′ from (T)rue North.[1]
"Set: 7:23 PM, 275°46′T"	Sunset is at 7:23 in the afternoon at 275°46′ from (T)rue north.
"Daylight: 12h. 34m."	Hours and minutes between rise and set.[2]
"Local Apparent Noon: 01:05:59 PM, 56°22′, 180°00′T"	The time, angle above the horizon, and direction from (T)rue north of the sun at it's highest point of the day. The bearing is always Due South in the Northern Hemisphere, Due North in the Southern Hemisphere.
"Length of TWILIGHTS: 31 min."	The length of the Civil Twilights, morning and evening.[3]
"7 AM: 1°46′, 86°00′T"	At 7 A.M., the center of the sun's disc is 1°46′ from the horizon and 86° from (T)rue north.

"8 AM: ..."	...Similarly for every hour-on-the-hour of the day between rise and set.
":Time: '31.609_s'"	This is the time it took for the main body of the program to run.[4]

You may want to know why you see only very small capital letters, while the above explanation shows both capital and lower-case letters. That is because you are in the "SMALL" font option. To learn how to view the screen in a larger font, read the Options chapter.

When you are done looking at the screen, press **BACK** to get back to the main screen.

---

[1] The sun is considered to rise or set when its top limb is at the horizon. Except for sunrise and sunset, calculations are done for the center of the sun's apparent disc.

[2] This is calculated from the times for sunrise and sunset as stored in the calculator as 12 digit numbers, and not from the rounded versions displayed.

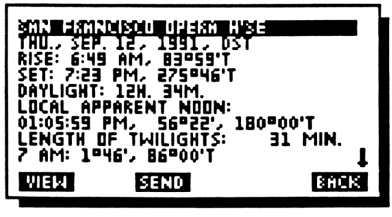
[3] The length of Morning Civil Twilight is the time elapsed from when the sun is 6° below the horizon and sunrise. The length of Evening Civil Twilight is the time elapsed from sunset to when the sun is 6° below the horizon again. For our purposes they are assumed to be equal on any given day. For perspective, the end of evening twilight is nominally "when the street lights go on".

[4] This was put in during development, and left in for purposes of comparison.

Chapter 7

REVIEW

Highlight REVIEW on the main screen and press GO.TO or [ENTER]. You'll see a screen which is similar to this:



In this chapter we'll discuss the action of the two softkeys VIEW and SEND.

VIEW only has an action if you have set the font to be LARGE. Changing the font size is discussed in Chapter 9. When the font is large, you will not be able to see the whole of a line. It will be cut off and end with "...". To see the whole thing, simply press VIEW. When you are done looking at the entry, press [ENTER], as directed by the screen.

SEND begets a screen that looks like this:

If you want to send REVIEW screen to a computer, you need to have a Serial Interface Cable between the computer and the calculator and the Kermit file transfer protocol in the computer.[1] Read Chapter 33 of the HP 48SX Owner's Manual. Once you have all the requisites, highlight Computer, set Kermit on the computer to receive TEXT files, and press **SEND**. The file will be transferred under the name RVW (ReVieW).

If you want to send the output to the HP 82240B Infrared Printer (a very small battery operated printer, and very nice to have). Position the printer such that its plastic window is an inch or so from the small black arrow on the top edge of the calculator, highlight IR Printer and press **SEND**.

BACK takes you back to the REVIEW screen.

Pressing **BACK** at the REVIEW screen takes you back to the main screen.

---

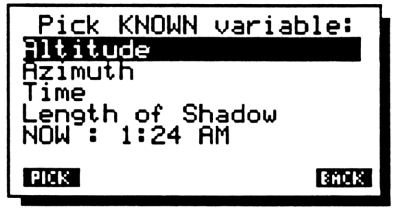
[1] These are available from EduCalc as the Serial Interface Kit. EduCalc is a mail order company specializing in calculator related items. They have absolutely *everything* having to do with the HP 48SX, and the best prices and service.

EduCalc
27953 Cabot Road
Laguna Niguel, CA 92677, U.S.A.
(800) 677-7001
8 A.M. to 5 P.M. West Coast time, Monday - Friday

Chapter 8

THE SOLVER

Highlight THE SOLVER on the main screen and press GO.TO or [ENTER]. The screen will change to:



with the current time after NOW :. In this part of the application, given one of the following:

altitude

azimuth

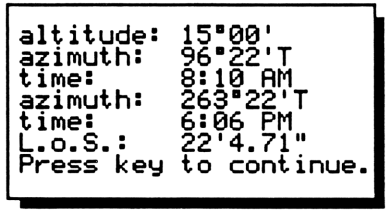
time

length of shadow

you may solve for the other three.

The prerequisite to using the solver is that you must have run the main program, RUN SUN, for the place and day you're interested in. Given that, highlight Altitude and press PICK or [ENTER]. The screen reads:

with the insert cursor blinking. For an explanation of "DD.MMSSss" see Chapter 4, Section 1. Punch in a number between zero and the sun's highest altitude for the day. (Nothing bad will happen if you put in numbers outside this realm; the answers just won't mean much.) If you key in {15} the resultant screen will look something like this:



Since the sun is at 15° at points during its rise and its set, two times and bearings are calculated. The last entry, L.o.S., is the length of the shadow of an object of a certain height when the sun is at this altitude. Setting the initial height, to whatever you want, is discussed in the Options chapter.

Picking Altitude, Time or Length of Shadow at the initial prompt produces screens that require appropriate input and produce similar results.

Picking NOW uses the calculator's system clock as the time input. This is extremely useful. If the calculator shows that

the sun is at 150° and your compass indicates it is at 140°, the declination (set on the compass or stored with the location name in the calculator, or both) is wrong. Reset your compass or the stored declination to correct the problem. If you use a compass with settable declination, and if you RUN SUN with True Bearing results, this problem becomes simple. Solve for NOW, point the compass in the direction of the sun[1], and adjust the compass declination until the compass says the sun is where it should be. The NOW function can also be useful in just finding one's bearings.

The **BACK** key sends you back to the main menu.

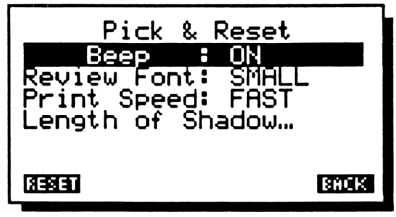
---

[1] Never look directly at the sun. Use an absolutely vertical stick to cast a shadow on flat ground and sight along that shadow.

Chapter 9

OPTIONS

At the main menu, highlight OPTIONS and press GO.TO or [ENTER]. The screen will become:

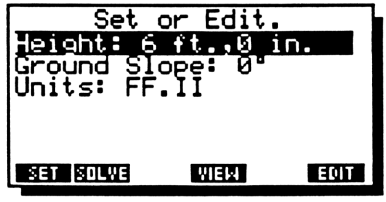


If Beep : ON is highlighted and you press **RESET** or [ENTER], the screen will be re–drawn, now reading Beep : OFF. This turns off the siren that indicates the end of RUN SUN and any error beeps that might occur. Pressing **RESET** or [ENTER] again toggles back to Beep : ON.

Review Font similarly toggles between SMALL and LARGE, and controls the size of the font on the REVIEW screen.

Print Speed toggles between FAST and SLOW. This is the speed at which the calculator sends information to the infrared printer when the PRINT ON option is selected in the main menu. Print Speed: FAST is usually the best, but when the day is long and there is much information to send, some of it might be lost. If you look at a printout and see black squares or blank spaces, switch to SLOW and RUN SUN again.

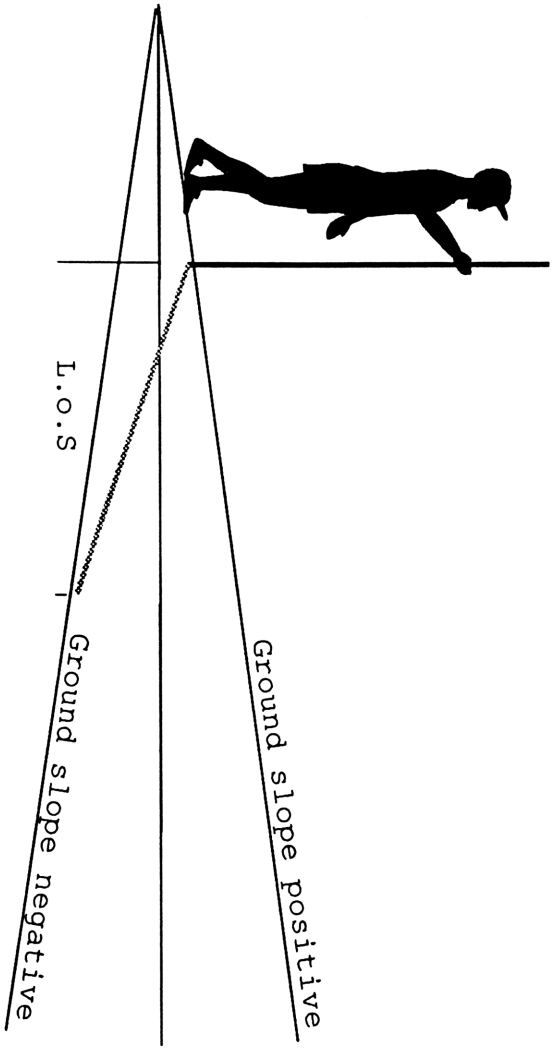
Highlight Length of Shadow... and press RESET or [ENTER]. You'll see this screen:



Highlight Units: FF.II and press EDIT and it toggles to Units: MM.mm, and 6 ft., 0 in. changes to 6 m.. Pressing EDIT again toggles it back. In the FF.II mode, input is of the form feet/decimal point/inches and output in the Solver will be in feet and inches. In MM.mm mode, input and output are in meters.

Highlight Height: and press EDIT. Here you can set the height of the object whose shadow you'll be dealing with in THE SOLVER. Paying attention to the units, key in the object height and press [ENTER].

Ground slope affects the length of a shadow. If you seriously want to calculate length-of-shadow you must include this parameter. It is entered in degrees. If the ground slopes up from the object in the direction of its shadow the slope is considered to be positive, and if the ground slopes down it is negative.


L.o.S
Ground slope negative
Ground slope positive

Highlight Ground Slope: and press EDIT. Key in the slope, using [±] to make it negative if necessary, and press [ENTER].

When you are satisfied with all the settings, pressing SET or [ENTER] takes you back one menu. Pressing SOLVE takes you directly into THE SOLVER. Pressing VIEW has an action if one of the parameters is too long to fit on the screen.

Chapter 10

PRINT ON/OFF

The most efficient way to use the Sun Finder is in conjunction with Hewlett Packard's HP 82240B Infrared Printer. The printer is very small, and runs on either batteries or AC.

Highlight the last title on the main screen, either PRINT ON or PRINT OFF, as it happens to be. Pressing either GO.TO or [ENTER] will toggle between one and the other. With PRINT ON lit, RUN SUN will send its output to the IR printer as it calculates, so you don't have to run it and then print it out using the SEND command in the REVIEW menu. (Whether PRINT ON or PRINT OFF is highlighted, the SEND functions will still work in their normal manner.)

Set up the printer such that the window on its face is approximately an inch from the small black arrow on the top edge of the calculator, and RUN SUN. This printout has somewhat more information than the output you get in REVIEW, however. It prints out the latitude, longitude, time zone, and magnetic declination of the place, as well as when the program was run.

You can also customize the printout, putting your name and phone number, or anything else, at the bottom. This information is held as a string in a variable called SFOWNER in the HOME directory. Follow these directions:

- Quit the Sun Finder application. You should see the normal calculator screen.

- Press [↱] [HOME], keys 81 and 31. This puts you in the HOME directory.

- Press [VAR], key 24. The Variable menu appears.

- Press [↱][-], keys 81 and 85. This puts open and close quotes on the screen.

- Press [α], key 61, twice and you'll see an α at the top of the screen. This is *alpha-lock* mode, and it will stay in this mode until you press [α] again.[1]

- Type in the letters you want. Lowercase letters are obtained by holding down the [↰] key as you type. Do not put more than 24 letters in before you create a new line. This is done by hitting [↱] [0], keys 81 and 92.

- When you are satisfied with the message, press [ENTER].

- Press ['], key 31, and hold down the

[α] key while you type S–F–O–W–N–E–R between the two 'tics'.

- Press [STO], key 32. You will see SFOW (the part of SFOWNER that will fit as a menu label) appear as a menu item.

Check your work by pressing SFOW.

To find out how to recall, edit, etc. this variable, read the HP owners manual.

```
------------------------
The Movement of the Sun
San Francisco Opera H'se
   Thu., Nov. 7, 1991
   37°46'43" N. lat.
  122°25'11" W. long.
Mag. Decl.: 16°30' E.
        -8 h.
    Standard Time
------------------------
SUNRISE
time, true bearing:

6:41 AM, 110°02'T

SUNSET
time, true bearing:

5:05 PM, 249°48'T

daylight: 10h. 24m.

Local Apparent NOON
time, altitude, bearing:

11:53:22 AM,
35°56', 180°00'T
------------------------

time, altitude, bearing:

7 AM: 2°55', 113°12'T
```

```
5 PM: 0°41', 248°32'T

length of TWILIGHTS:
   32 min.
------------------------

Time: 42.704_s

WED 11/06/91 01:04:25P

(Your name here)
```

That is what the printouts look like, on the strip paper that the IR printer uses. As mentioned in the Options chapter, two speeds are available for printing. Normally, you may use the Fast setting. However, if you notice data loss, indicated by small black squares in the printout, switch to the Slow setting.

---

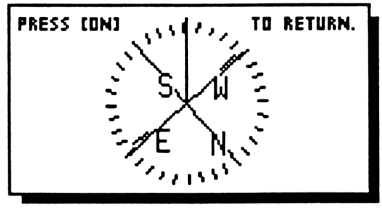
[1] This is assuming that System Flag -60 is clear.

Chapter 11

THE COMPASS

If you have set the place to be where you actually are, and have RUN SUN for today's date, you have a compass built right into the calculator. Just highlight COMPASS on the main screen and press GO.TO or [ENTER]. The first line you see drawn, straight up-and-down on the machine, indicates the direction of the sun. Point this line at the sun, leaving the calculator *flat*. You may put the calculator on the ground and use the shadow of a vertical stick, turning the HP 48 until the stick's shadow falls across this first line drawn. Or you may just hold the machine flat in your hand and turn towards the sun.

The program then starts drawing small ticks around the screen. Then, in quick succession, it draws two short lines inside these little ticks, and then draws and labels the cardinal directions, North, South, East, and West. The two short lines on the inside of the circle are sunrise (the easterly one), and sunset (the more westerly of the two). These may sometimes be overdrawn by other lines and difficult or impossible to see.



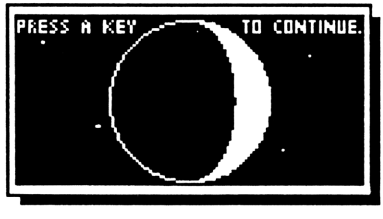
The small ticks can be seen to be drawn every 10°, from due North right around the compass. In this example, the sun is at about 221°, sunrise is at about 94°, and sunset is at about 266°. The directions are *always* True, not Magnetic. They are independent of whether you've RUN SUN with the True Bearing or Magnetic Bearing displayed. Press [ON] as directed, to clear the screen.

Chapter 12

THE MOON

This program draws a picture of the moon, showing its phase, on the date you load in with SET DATE and at a time which you will load in after highlighting MOON and pressing GO.TO or [ENTER]. The core of this program was developed by Craig A. Finseth of the University of Minnesota, to whom the author owes a great deal of thanks for allowing its inclusion. According to Craig, the algorithm is "intentionally inaccurate" in that, for reasons of speed, it uses only one of twenty-three sine terms for the calculations. It was included here for cinematographers, in order to give them a general idea of how much moonlight would be available on a given night, and has been found to be more than adequate for this purpose. It does not indicate, however, the times of moonrise and set, or indeed whether the moon rises at all.

Having started the MOON program, you will be asked to [ENTER] a time in "HH.MM, 24-hour format". That is, 9:15 A.M. is entered as 9.15 and 11:30 P.M. is entered as 23.30, or just 23.3. Press [ENTER] as directed and a picture of the moon will be drawn:



There are even a few random stars on the display.

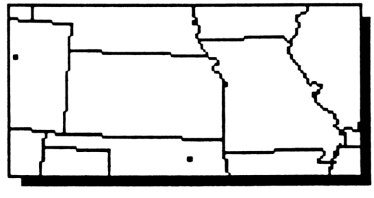
When you are done looking at it, press any key. The screen will display the moon's age (the number of days, hours, and minutes since the moon was new), and the percentage of the moon which is illuminated, such as "Age: 4d 17h 14m" and "Illuminated: 23%". Press any key and you'll be back at the main screen.

Chapter 13

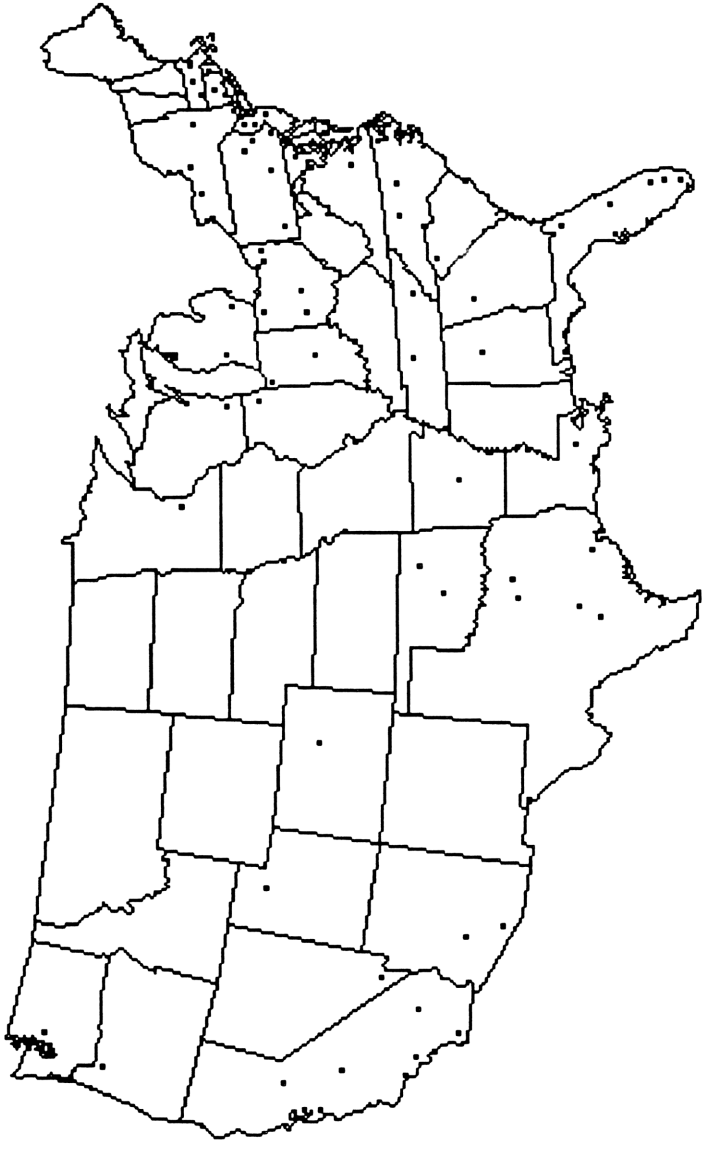
THE MAP

This program is one that, unfortunately, requires quite a bit of calculator merged memory to run. In fact, it will not run on a machine without an additional card, called a RAM card, in place and merged with system memory.[1] Read Chapter 34 of the HP 48SX Owner's Manual for more information on RAM cards. If you do have the required memory (about 28,000 bytes), the main screen will say MAP. Otherwise it will say NO MAP.

If the main display does read MAP, you have access to a program which substitutes for an atlas of the conterminous United States. Highlight MAP and press GO.TO or [ENTER]. A central portion of a map of the lower 48 United States will appear.



That is a small portion of the entire map:



which is much bigger than the screen. It is its sheer size that takes so much memory, but anything smaller was not deemed to be useful.

To show other parts of the map, use the arrow keys: [▲], [◀], [▼], and [▶]. This will scroll you around the whole thing. In conjunction with [↱] you can move to the edges of the map instantly. For example, [↱][◀], moves to the West Coast. Once you can see the part of the country you're interested in, press [↰][◀], the orange-left-shift key followed by the key which has GRAPH written in orange above it. Now you are in the Graphic Environment, a standard HP 48SX environment. In this case, however, ignore the menu labels, ZOOM, Z-BOX, etc.. You may press the [-] key in order to make them disappear. What we are interested in, that this environment provides, are the cross-hairs which appear in the center of the screen. Now when you scroll around the cross-hairs move and the map stays still. Use the same keys as before to scroll.

Center the cross-hairs over the exact spot you're interested in and press [ENTER], *and then* [ON][2]. After a second for calculations, the ADD menu will be displayed, with the latitude and longitude of the place you've selected entered with the appropriate tags. A preliminary time zone calculation has also been done, but it is up to you to check its accuracy. Refer to the ADD section of the SET PLACE chapter to find out how to proceed with naming, etc..

[1] RAM cards are available from EduCalc in two sizes, 32K and 128K. The first, with 32,768 bytes, is sufficient to allow MAP to run. I highly recommend the 128K card, however, which gives over 131,072 bytes of additional memory. This is enough to allow you to really customize the machine as you become more familiar with its amazing capabilities.

[2] I was unable to put the usual prompts to press these keys onto the map such that they always stayed visible. This is one of the few times you must remember how to continue the program.

Chapter 14

THE EDIT MENU

A *word*, as used in this explanation, is a series of characters between spaces or newlines.

The Operations

←SKIP : Moves the cursor to the beginning of the current word.

SKIP→ : Moves the cursor to the beginning of the next word.

←DEL : Deletes characters from the beginning of the word to the cursor.

DEL→ : Deletes characters from the cursor to the end of the word.

[↱] ←DEL : Deletes all characters from the beginning of the line to the cursor.

[↱] DEL→ : Deletes all characters from the cursor to the end of the line.

INS: Switches between the *Insert* cursor (▮) and the *Replace* cursor (■). A box in the menu label indicates Insert mode is active.

↑STK : Although this menu label appears in some occurrences of the Edit Menu in Sun Finder, it serves no purpose.

In normal calculator operation, it activates the Interactive Stack. Here, however, the stack is saved when you start the program and cannot be accessed.

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[1] The Edit Menu is used within various other menus of the Sun Finder. This explanation of the Edit Menu is basically Page 68 of the HP 48SX Owner's Manual.

APPENDICES

Appendix A

TECHNICAL NOTES

1. General

The Sun Finder application actually consists of four different libraries:

Library 765: CATLIB
Library 777: TBLIB: Title Browser
Library 910: Sun Finder
Library 1793: IF ERROR ver. B.

Libraries 765, 777, and 1793 were disassembled using Frederich Schroeder's Library 1791: TOOLS System Utilities, and reassembled with no names using the same library. These nameless forms are fully compatible with the named forms. If you have the normal libraries in your machine no conflict will arise when running Sun Finder.

The author owes a great debt to Hewlett Packard for making CATLIB available to programmers, and to Dr. William Wickes for the IF ERROR library.

The Title Browser is the wonderful work of James Donnelly and is used with his kind permission. I also extracted various of the programs from his Library 776: TLLIB: Tool Library and put them directly into Library 910. Jim has also been a great help in many other areas of this endeavor. Both TBLIB

and TLLIB are available from EduCalc as parts of Jim Donnelly's Programmer's Toolkit, highly recommended.

After 910 was built in directory form, it was made into a library using →LIB from 1791 and took about three hours for each of the first 70 times it was done. Now a personal computer and HP's RPL development system accomplish this in a few minutes.

Library 910 is written partially in RPN, for comfort, and partially in RPL, for speed. The RPL programs were written using Rick Grevelle's Library 1214: HACKIT and the Internals Address lists compiled by Jake Schwartz. Only much later did the new RPL tools help do the job.

2. Custom Menu

The SFCST library command puts `«Graphic 21 × 8 SFIND»` in the first position in your Custom Menu. If CST Is itself a list, the Sun grob is merely STO+ to the list. If CST is a variable name which is a list the grob is STO+ to *that* list, thereby keeping everything correct. The first position is a convenient one for Sun Finder, but not necessary at all, so you can move it to wherever you want it. Multiple calls to SFCST will not produce replications of the entry.

3. Error Trapping

The Sun Finder employs an extensive error trapping mechanism. It returns the stack, flags, menu, path, PRTPAR, and IOPAR to their former states. Much of the work is done at startup by Dr. Wickes' wonderful IFERR Library 1793,

which is included (unnamed) on the card. Key reassignment is also undone, but not by the startup program, in the interest of time. The key buffer is dumped when Sun Finder is quit.

4. Accuracy

The output of the Sun Finder has been checked for years. Altitude readouts were checked using a sextant, and azimuth readouts using a very accurate compass. Both are routinely checked using the Voyager Desktop Planetarium, a computer program. To ensure precise declination figures, a sight was taken on a distant object and its direction compared with the true direction as taken from a large scale topographic map of the area. The declination was then set on the compass such that all directions were true.

The program calculates the semi-diameter of the sun's disc for several different times during the day. Refraction is calculated in a simplified manner, since it was deemed unlikely that the user would want to enter temperature and barometric pressure figures in order to get more accuracy. Horizontal parallax is assumed to be constant.

A decision was made early in development that this was to be a program for working professionals in the field, primarily motion picture lighting professionals, a group which includes the author. To this end, accuracy was deemed to be important only to the extent that normal compasses and inclinometers could measure it. Speed is at least as important, as well as ease of operation and a nicely formatted output. The author believes a well-rounded, accurate product is the result.

Appendix B

ASPECTS OF COMPASS USE

This is not an instructional on general compass use. For that information read the compass' instruction manual. The best reference on the subject is *Land Navigation Handbook, The Sierra Club Guide to Map and Compass*, by W.S. Kals. Here we talk briefly about specifics relating to the problems at hand.

The most accurate program in the world does little good if you do not have a good compass and inclinometer, or if you do not use them correctly. Many different compasses are available, by Silva, Suunto, and others, which are perfectly fine for our purposes. My personal choice is the Brunton Pocket Transit.[1] It is somewhat larger than a normal compass, allowing the face to be marked every degree, not every two as in most compasses. It has a built-in inclinometer which can be read to one-sixth of a degree. Its best feature is the bubble level. A compass is far less accurate if it is not held level for the sighting. Brunton also makes a ball-and-socket head and other accessories which combine to make this a very accurate instrument.

Other than lack of basic compass knowledge, the greatest impediment to getting proper results lies in not setting the declination properly, either on the compass (if it is of the type upon which declination can be set), or on the calculator.

When entering the parameters of a new place on the calculator, do your best to find out the current declination — the difference between true north and magnetic north. Once you have run the program RUN SUN and are out on the job, set up the compass in a flat and level manner at the exact place where the readings will be needed.

Now you need to get a bearing on the sun and compare it to the calculated values. The safest way to do this is to cause a perfectly vertical object to cast a shadow across the center of the compass. Experiment with this on your particular compass. On the Brunton various parts of the case flip up and are perfect for this purpose.

If you can set the declination directly on the compass and have run the program with True Bearing output, you need only go into The Solver and solve for NOW, and then change, if necessary, the declination on the compass until it reads exactly what the calculator is giving for the azimuth at that particular time.

If your compass does not have an adjustment for magnetic declination, or if you choose to always leave the declination set at zero, you should RUN SUN with Magnetic Bearing output. However, if the above test results in a discrepancy between the calculated azimuth and the observed azimuth, the only way to reconcile the two is to edit the declination as stored under the place name in the calculator and run the program again.

Before you despair of this being too complicated, go outside with a compass and play with it for a while. It's really quite simple.

For altitude readings I use either the Brunton Pocket Transit or the Suunto Optical Reading Clinometer PM-5/360 PC.[2] The Suunto is very quick and easy to use, and has a scale on it that, with a few calculations that can be done on the HP 48SX outside of the Sun Finder application, allows the user to calculate the height of a distant object. To take altitude readings on the Sun itself, I have attached a piece of #15 welding filter plate to my clinometer. Look directly at the sun, however, at your own risk.

---

[1] Brunton, U.S.A.
620 East Monroe Ave.
Riverton, WY 82501-4997
(307) 856-6559

[2] Both purchased from REI, Recreational Equipment Inc.

Appendix C

SELECTED WORLD CITIES

CITY	LAT. (DD.MM)	LONG. (DD.MM)
Adelaide, Australia	35.55 S	138.35 E
Albuquerque, NM	35.05 N	106.40 W
Alice Springs, Australia	23.42 S	133.53 E
Amsterdam, Netherlands	52.22 N	4.54 E
Anchorage, AK	61.13 N	149.53 W
Ankara, Turkey	39.56 N	32.52 E
Arecibo, Puerto Rico	18.28 N	66.43 W
Athens, Greece	37.58 N	23.43 E
Atlanta, GA	33.45 N	84.23 W
Auckland, New Zealand	36.53 S	174.45 E
Babylon, Iraq	32.33 N	44.24 E
Baltimore, MD	39.17 N	76.37 W
Bangkok, Thailand	13.45 N	100.31 E
Barcelona, Spain	41.23 N	2.11 E
Beijing, China	39.55 N	116.25 E
Belgrade, Yugoslavia	44.50 N	20.30 E
Berlin, Germany	52.31 N	13.24 E
Berne, Switzerland	46.57 N	7.26 E
Birmingham, AL	33.31 N	86.49 W
Bogota, Colombia	33.28 N	95.13 W
Boise, ID	43.37 N	116.13 W
Bombay, India	18.58 N	72.50 E
Bonn, Germany	50.44 N	7.05 E
Bordeaux, France	44.50 N	0.34 W
Boston, MA	42.21 N	71.04 W
Boulder, CO	40.01 N	105.17 W
Brisbane, Australia	27.28 S	153.02 E
Budapest, Hungary	47.30 N	19.05 E

CITY	LAT. (DD.MM)	LONG. (DD.MM)
Buenos Aires, Argentina	34.36 S	58.27 W
Burlington, VT	44.29 N	73.13 W
Butte, MT	46.00 N	112.32 W
Cairo, Egypt	30.03 N	31.15 E
Calcutta, India	22.32 N	88.22 E
Calgary, Canada	51.03 N	114.05 W
Caracas, Venezuela	10.30 N	66.56 W
Charleston, SC	32.48 N	79.57 W
Cheyenne, WY	41.08 N	104.49 W
Chicago, IL	41.53 N	87.38 W
Christchurch, New Zealand	43.42 S	172.38 E
Cincinnati, OH	39.06 N	84.31 W
Cleveland, OH	41.30 N	81.41 W
Copenhagen, Denmark	55.40 N	12.35 E
Dallas, TX	32.47 N	96.48 W
Damascus, Syria	33.30 N	36.18 E
Denver, CO	39.43 N	105.01 W
Des Moines, IA	41.35 N	93.37 W
Detroit, MI	42.20 N	83.03 W
Dublin, Ireland	53.20 N	6.15 W
Edinburgh, Scotland	55.57 N	3.13 W
Edmonton, Canada	53.33 N	113.28 W
El Paso, TX	31.45 N	106.29 W
Fairbanks, AK	64.51 N	147.43 W
Fargo, ND	46.52 N	96.48 W
Geneva, Switzerland	46.12 N	6.09 E
Genoa, Italy	44.25 N	8.57 E
Halifax, Canada	44.39 N	63.36 W
Hamburg, Germany	53.33 N	9.59 E
Hanoi, Vietnam	21.02 N	105.51 E
Havana, Cuba	23.08 N	82.22 W
Helsinki, Finland	60.10 N	24.58 E
Hiroshima, Japan	34.24 N	132.27 E
Hollywood, CA	34.06 N	118.20 W
Hong Kong	22.17 N	114.09 E

CITY	LAT. (DD.MM)	LONG. (DD.MM)
Honolulu, HI	21.19 N	157.52 W
Houston, TX	29.46 N	95.22 W
Istanbul, Turkey	41.01 N	28.58 E
Jackson, MS	32.18 N	90.12 W
Jakarta, Indonesia	6.10 S	106.48 E
Jerusalem, Israel	31.46 N	35.14 E
Johannesburg, S.Afr.	26.15 S	28.00 E
Kansas City, MO	39.05 N	94.35 W
Karachi, Pakistan	24.52 N	67.03 E
Kiev, USSR	50.26 N	30.31 E
Lahore, Pakistan	34.03 N	72.22 E
La Paz, Bolivia	16.30 S	68.09 W
Las Vegas, NV	36.11 N	115.08 W
Lisbon, Portugal	38.43 N	9.08 W
Little Rock, AK	34.44 N	92.15 W
London, England	51.30 N	0.10 W
Los Angeles, CA	34.03 N	118.15 W
Louisville, KY	38.16 N	85.45 W
Lyon, France	45.45 N	4.51 E
Madras, India	13.05 N	80.17 E
Madrid, Spain	40.24 N	3.41 W
Manila, Philippines	14.35 N	120.59 E
Melbourne, Australia	37.49 S	144.58 E
Mexico City, Mexico	19.24 N	99.09 W
Miami, FL	25.46 N	80.12 W
Milwaukee, WI	43.02 N	87.55 W
Minneapolis, MN	44.59 N	93.13 W
Montreal, Canada	45.31 N	73.34 W
Moskow, USSR	55.45 N	37.35 E
Munich, Germany	48.08 N	11.34 E
Nagoya, Japan	35.10 N	136.55 E
Nairobi, Kenya	1.17 S	36.49 E
Nanking, China	32.03 N	118.47 E
Naples, Italy	40.51 N	14.17 E
Nashville, TN	36.09 N	86.48 W

CITY	LAT. (DD.MM)	LONG. (DD.MM)
New Delhi, India	28.36 N	77.12 E
New Orleans, LA	29.58 N	90.07 W
New York, NY	40.43 N	74.01 W
Nice, France	43.42 N	7.15 E
Novosibirsk, USSR	55.02 N	82.55 E
Omaha, NE	41.16 N	95.57 W
Osaka, Japan	34.40 N	135.30 E
Oslo, Norway	59.55 N	10.45 E
Ottawa, Canada	45.25 N	75.42 W
Paris, France	48.52 N	2.20 E
Perth, Australia	31.56 S	115.50 E
Philadelphia, PA	39.57 N	75.07 W
Phoenix, AZ	33.27 N	112.05 W
Pittsburg, PA	40.26 N	80.00 W
Portland, OR	45.33 N	122.36 W
Prague, Czechoslavakia	50.05 N	14.26 E
Québec, Canada	46.49 N	71.14 W
Raleigh, NC	35.47 N	78.39 W
Richmond, VA	37.32 N	77.28 W
Rio de Janeiro,Brazil	22.54 S	43.15 W
Riyadh, Saudia Arabia	24.38 N	46.43 E
Rome, Italy	41.54 N	12.29 E
Sacramento, CA	38.35 N	121.30 W
St. Louis, MO	38.38 N	90.11 W
St. Petersburg, USSR	59.55 N	30.15 E
Salt Lake City, UT	40.46 N	111.53 W
San Diego, CA	32.46 N	117.13 W
San Francisco, CA	37.48 N	122.24 W
São Paulo, Brazil	23.32 S	46.37 W
Santiago, Chili	33.27 S	70.40 W
Seattle, WA	47.36 N	122.20 W
Seoul, Korea	37.33 N	126.58 E
Shanghai, China	31.14 N	121.28 E
Singapore, Sing.	1.17 N	103.51 E
Stockholm, Sweden	59.20 N	18.03 E

CITY	LAT. (DD.MM)	LONG. (DD.MM)
Sydney, Australia	33.52 S	151.13 E
T'aipei, Taiwan	25.03 N	121.30 E
Tashkent, USSR	41.20 N	69.18 E
Tehran, Iran	35.40 N	51.26 E
Tokyo, Japan	35.42 N	139.46 E
Toronto, Canada	43.39 N	79.23 W
Tripoli, Libya	32.54 N	13.11 E
Tucson, AZ	32.13 N	110.58 W
Tulsa, OK	36.09 N	95.58 W
Vancouver, Canada	49.16 N	123.07 W
Vienna, Austria	48.13 N	16.20 E
Warsaw, Poland	52.15 N	21.00 E
Washington, D.C.	38.54 N	77.01 W
Wellington, New Zealand	41.18 S	174.46 E
Winnipeg, Canada	49.53 N	97.09 W
Zürich, Switzerland	47.23 N	8.32 E

Appendix D

STANDARD TIMES

[Corrected to Sept. 1989]

LIST I—PLACES[1] FAST ON UTC [mainly those EAST OF GREENWICH]

The times given below should be *added* to UTC to give Standard Time.

The times given below should be *subtracted* from Standard Time to give UTC.

For use in the Sun Finder, these numbers are entered as *positive decimals, HH.hh format,* e.g., the time zone for the Chatham Islands would be entered as 12.75.

	h	m
Admiralty Islands	10	
Afghanistan	04	30
Albania*	01	
Algeria	01	
Amirante Islands	04	
Andaman Islands	05	30
Angola	01	
Australia		
Australian Capital Territory *	10	
New South Wales[2] *	10	
Northern Territory	09	30
Queensland	10	
South Australia*	09	30
Tasmania*	10	
Victoria*	10	
Western Australia*	08	

	h	m
Austria*	01	
Bahrain	03	
Balearic Islands*	01	
Bangladesh	06	
Belgium*	01	
Benin (Dahomey)	01	
Bhutan	06	
Botswana, Republic of	02	
Brunei	08	
Bulgaria*	02	
Burma	06	30
Burundi	02	
Cameroon Republic	01	
Caroline Islands		
Pala Islands	09	
Yal Islands, Truk Islands	10	
Ponapel	11	
Pingelap Islands, Kusaie	12	
Central African Republic	01	
Chad	01	
Chagos Archepelago[3]	05	
Chatham Islands*	12	45
China*	08	
Christmas Island, Indian Ocean	07	
Cocos Keeling Islands	06	30
Comoro Islands (Comoros)	03	
Congo Republic	01	
Corsica*	01	
Crete*	02	
Cyprus		
Ercan*	02	
Larnaca*	02	
Czechoslovakia*	01	
Denmark*	01	

	h	m
Djibouti	03	
Egypt, Arab Republic of *	02	
Equatorial Guinea, Republic of	01	
Ethiopia	03	
Fiji	12	
Finland*	02	
France*	01	
Gabon	01	
Germany *	01	
Gibraltar*	01	
Greece*	02	
Guam	10	
Holland (The Netherlands)*	01	
Hong Kong	08	
Hungary *	01	
India	05	30
Indonesia, Republic of		
Bangka, Billiton, Java, West and Middle Kalimantan, Madura, Sumatra	07	
Bali, Flores, South and East Kalimantan, Lombok, Sulawesi, Sumba, Sumbawa, Timor	08	
Aru, Irian Jaya, Kai, Moluccas, Tanimbar	09	
Iran	03	30
Iraq*	03	
Israel*	02	
Italy *	01	
Japan	09	

	h	m
Jordan*	02	
Kampuchea, Democratic	07	
Kenya	03	
Kiribati Republic[4]	12	
Korea,		
North	09	
Republic of (South)	09	
Kuril Islands	11	
Kuwait	03	
Laccadive Islands (Lakshadweep)	05	30
Laos	07	
Lebanon*	02	
Lesotho	02	
Libya*	01	
Liechtenstein	01	
Lord Howe Island*	10	30
Luxembourg*	01	
Macao	08	
Macias Nguema Biyogo Island (Fernando Póo)	01	
Madagascar, Democratic Republic of	03	
Malawi	02	
Malaysia		
Malaya, Sabah, Sarawak	08	
Maldives, Republic of The	05	
Malta*	01	
Mariana Islands	10	
Marshall Islands[5]	12	
Mauritius	04	
Monaco*	01	
Mongolia*	08	
Mozambique	02	
Namibia (South West Africa)	02	

	h	m
Nauru	12	
Nepal	05	45
Netherlands, The*	01	
New Caledonia	11	
New Zealand*	12	
Nicobar Islands	05	30
Niger	01	
Nigeria, Republic of	01	
Norfolk Island	11	30
Norway *	01	
Novaya Zemlya	03	
Okinawa	09	
Oman	04	
Pagalu (Annobon Islands)	01	
Pakistan	05	
Papua New Guinea	10	
Pescadores Islands	08	
Philippine Republic	08	
Poland*	01	
Qatar	03	
Reunion	04	
Romania*	02	
Rwanda	02	
Ryukyu Islands	09	
Sakhalin	11	
Santa Cruz Islands	11	
Sardinia*	01	
Saudi Arabia	03	
Schouten Islands	09	
Seychelles	04	
Sicily *	01	
Singapore	08	

	h	m
Socotra	03	
Solomon Islands	11	
Somalia Republic	03	
South Africa, Republic of	02	
South West Africa (Namibia)	02	
Spain*	01	
Spanish Possessions in North Africa (Ceuta, Melilla)*	01	
Spitsbergen (Svalbard)	01	
Sri Lanka	05	30
Sudan, Republic of	02	
Swaziland	02	
Sweden*	01	
Switzerland*	01	
Syria (Syrian Arab Republic)*	02	
Taiwan*	08	
Tanzania	03	
Thailand	07	
Tonga	13	
Tunisia*	01	
Turkey *	02	
Tuvalu	12	
Uganda	03	
Union Of Soviet Socialist Republics[6] *		
Zone 1: Amderma, Arkhangelsk, Kiev, St. Petersburg, Moscow, Odessa	03	
Zone 2: Baku, Tbilisi, Volgograd	04	
Zone 3: Ashkhabad, Novyy Port, Sverdlovsk	05	
Zone 4: Alma-Ata, Omsk, Tashkent	06	
Zone 5: Krasnoyarsk, Novosibirsk	07	
Zone 6: Irkutsk	07	
Zone 7: Tiksi, Yakutsk	09	
Zone 8: Khabarovsk, Okhotsk		

	h	m
Vladivostok	10	
Zone 9: Magadan, Sakhalin I.	11	
Zone 10: Anadyr, Petropavlovsk	12	
United Arab Emirates	04	
Vanuatu, Republic of *	11	
Vietnam, Socialist Republic of	07	
Wrangel Island	12	
Yemen	03	
Yugoslavia*	01	
Zaire		
Kinshasa, Mbandaka	01	
Haut-Zaire, Kasai, Kivu, Shaba	02	
Zambia, Republic of	02	
Zimbabwe	02	

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* Summer time may be kept in these countries.

[1] Recent name changes are not reflected here.

[2] Except Broken Hill Area, which keeps $09^h 30^m$.

[3] Except Diego Garcia, which keeps 06^h.

[4] Except Kiritimati Island and the Phoenix Islands which keep 10^h and 11^h slow on UTC.

[5] Except the islands of Kwajalein and Eniwetok which keep time 24^h slow on that of the rest of the islands.

[6] The boundaries between the zones are irregular; listed are towns in each zone.

LIST II—PLACES NORMALLY KEEPING UTC

Ascension Island
Bourkina-Faso
Canary Islands*
Channel Islands[1]
Faeroes*, The
Gambia
Ghana
Great Britain[1]
Guinea Bissau
Guinea Republic
Iceland
Ireland, Northern[1]
Irish Republic*
Ivory Coast
Liberia
Madeira*
Mali
Mauritania
Morocco*
Portugal*
Principe
St. Helena
São Tomé
Senegal
Sierra Leone
Togo Republic
Tristan da Cunha

LIST III—PLACES SLOW ON UTC (mainly those WEST OF GREENWICH)

The times given below should be *subtracted* from UTC to give Standard Time.

The times given below should be *added* to Standard Time to give UTC.

For use in the Sun Finder, these numbers are entered as *negative decimals, HH.hh format*, e.g., the time zone for the Pitcairn Island would be entered as -8.5.

	h	m
Argentina	03	
Austral Islands[2]	10	
Azores*	01	
Bahamas*	05	
Barbados	04	
Belize	06	
Bermuda*	04	
Bolivia	04	
Brazil,		
eastern[3]*	03	
Territory of Acre*	05	

	h	m
western*	04	
British Antarctic Territory[4]	03	
Canada		
Alberta*	07	
British Columbia*	08	
Labrador*	04	
Manitoba*	06	
New Brunswick*	04	
Newfoundland*	03	30
Northwest Territories*		
east of long. W. 68°	04	
long. W. 68° to W. 85°	05	
long. W. 85° to W. 102°	06	
west of long. W. 102°	07	
Nova Scotia*	04	
Ontario*		
east of long. W. 90°	05	
west of long. W. 90°	06	
Prince Edward Island*	04	
Quebec*		
east of long. W. 63°	04	
west of long. W. 63°	05	
Saskatchewan*		
east of long. W. 106°	06	
west of long. W. 106°	07	
Yukon*	08	
Cape Verde Islands	01	
Cayman Islands	05	
Chile*	04	
Colombia	05	
Cook Islands*	10	
Costa Rica	06	
Cuba*	05	
Curaçao Island	04	
Dominican Republic	04	

	h	m
Easter Island (I. de Pascua)*	06	
Ecuador	05	
Falkland Islands*	04	
Fanning Island	10	
Fernando de Noronha Island*	02	
French Guiana	03	
Galápagos Islands	06	
Greenland[5]		
Scoresby Sound*	01	
Angmagssalik and west coast*	03	
Thule area	04	
Grenada	04	
Guadeloupe	04	
Guatemala	06	
Guyana, Republic of	03	
Haiti*	05	
Honduras	06	
Jamaica	05	
Jan Mayen Island	01	
Johnston Island	10	
Juan Fernandez Islands*	04	
Leeward Islands	04	
Marquesas Islands	09	30
Martinique	04	
Mexico[6]	06	
Midway Islands	11	
Nicaragua	06	
Niue	11	
Panama, Republic of	05	

	h	m
Paraguay *	04	
Peru*	05	
Pitcairn Island	08	30
Puerto Rico	04	
St. Pierre and Miquelon*	03	
Salvador, El*	06	
Samoa	11	
Society Islands	10	
South Georgia	02	
Sirinam	03	
Tobago	04	
Trindade Island, South Atlantic*	02	
Trinidad	04	
Tuamotu Archipelago	10	
Tubuai Islands	10	
Turks and Caicos Islands*	05	
United States of America		
Alabama[7]	06	
Alaska[7], east of W. 169° 30'	09	
Aleutian Islands, west of W. 169° 30'	10	
Arizona	07	
Arkansas[7]	06	
California[7]	08	
Colorado[7]	07	
Connecticut[7]	05	
Deleware[7]	05	
District of Columbia[7]	05	
Florida[7,8]	05	
Georgia[7]	05	
Hawaii[7]	10	
Idaho[7,8]	07	
Illinois[7]	06	
Indiana[8]	05	
Iowa[7]	06	

	h	m
West Virginia[7]	05	
Wisconsin[7]	06	
Wyoming[7]	07	
Uruguay *	03	
Venezuela	04	
Virgin Islands	04	
Windward Islands	04	

* Summer time may be kept in these countries.

[1] Summer time, one hour in advance of UTC, is kept from March $01^{d}\ 01^{h}$ to October $27^{d}\ 01^{h}$ UTC, subject to confirmation.

[2] This is the legal standard time, but local mean time is generally used.

[3] Including all the coast and Brasilia.

[4] Except South Georgia which keeps 02^{h}.

[5] Danmarkshavn and Mesters Vig keep UTC.

[6] Except the states of Sonora, Sinaloa, Nayarit, and the Southern District of Lower California which keep 07^{h}, and the Northern District of Lower California, which keeps 08^{h}.

[7] Summer (daylight saving) time, one hour fast on the time given, is kept in these states from the first Sunday in April to the last Sunday in October, changing at $02^{h}\ 00^{m}$ local mean time.

[8] This applies to the greater portion of the state. Boundaries within some states are county-by-county.

Appendix E

MAGNETIC DECLINATION CHARTS

Magnetic declination, called variation at sea, is the angle between true north and the direction in which a magnetic compass points. It is considered east or west depending upon whether the compass points east or west of true north.

In Sun Finder, east declination is negative, west declination positive.

The following charts are old, and as such are very approximate. To use them, first locate your position on one of the Declination charts. If it is on a line, write down the number (degrees) of the line. If it is between two lines, interpolate and write down the number in degrees and minutes. Then find your location on the corresponding Annual Rate of Change chart. These numbers are in *minutes* of arc. Multiply the number of minutes by the number of years since 1980.

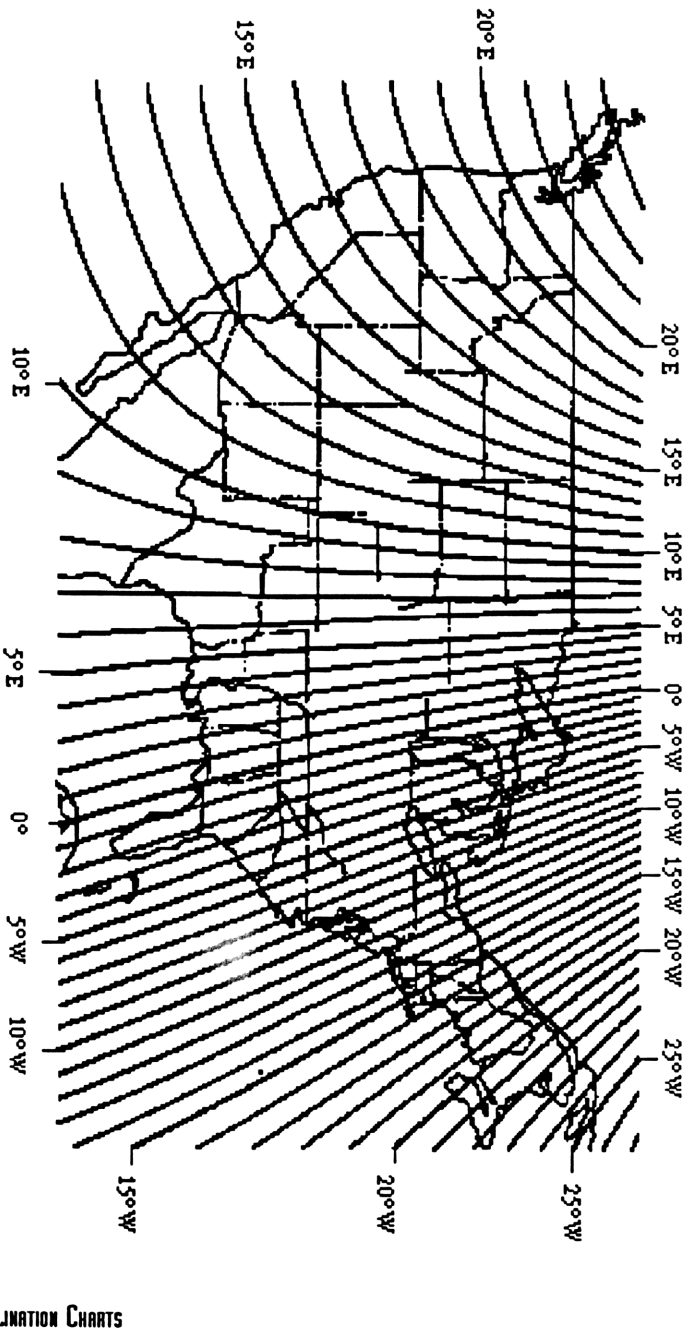
If the declination from the first chart is west, and the annual change is also west, add the two numbers. Remember, you're adding degrees to minutes, so you'll probably have to do some simple conversion.

If the declination is west and the annual change is east, subtract the annual change from the declination.

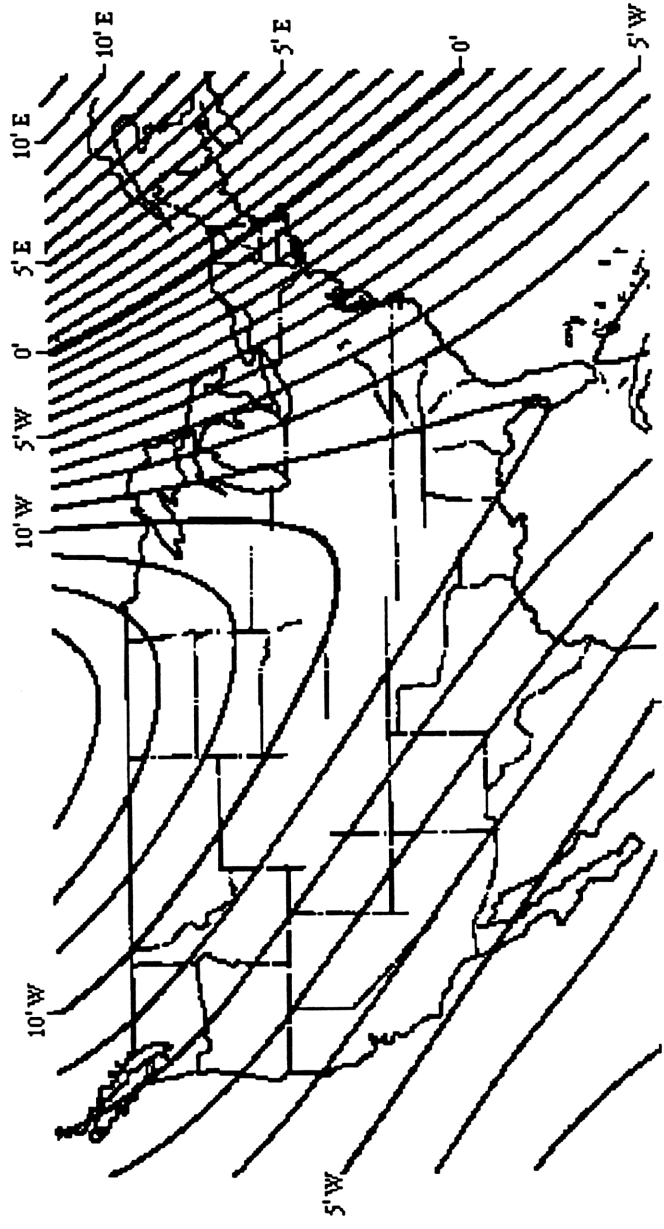
If both are east, add. If the declination is east and the annual change west, subtract the change from the declination.

For example, from the first chart we estimate that the declination of the north-east corner of California was 17°20' E in 1980. From the second chart, we get the annual rate of change at that location to be 7' W. By 1992 this change will be equal to 7 x 12 = 84' = 1°24'W. Subtracting 1°24' from 17°20' gives the declination in 1992 as 15°56' E.

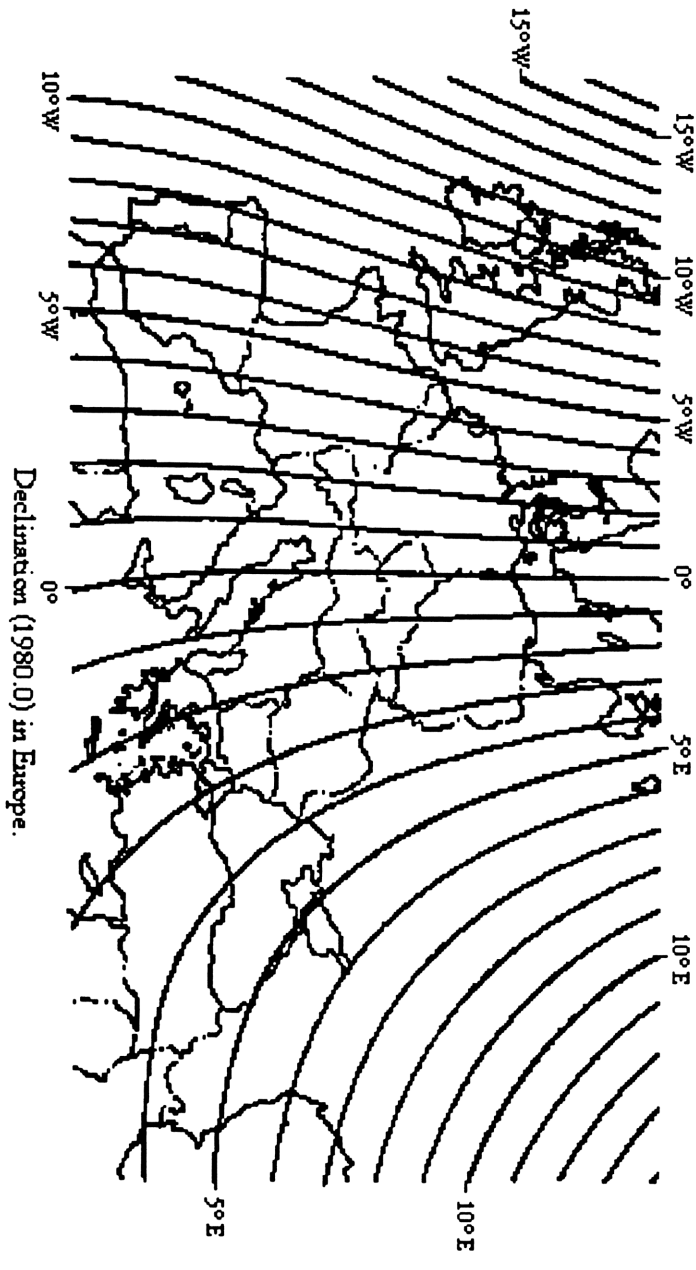
More current and accurate declination charts may be purchased from the U.S. Geological Survey. These charts are from *Land Navigation Handbook: The Sierra Club Guide to Map and Compass* by W.S. Kals, published by Sierra Club Books of San Francisco, 1983, and are used with permission.

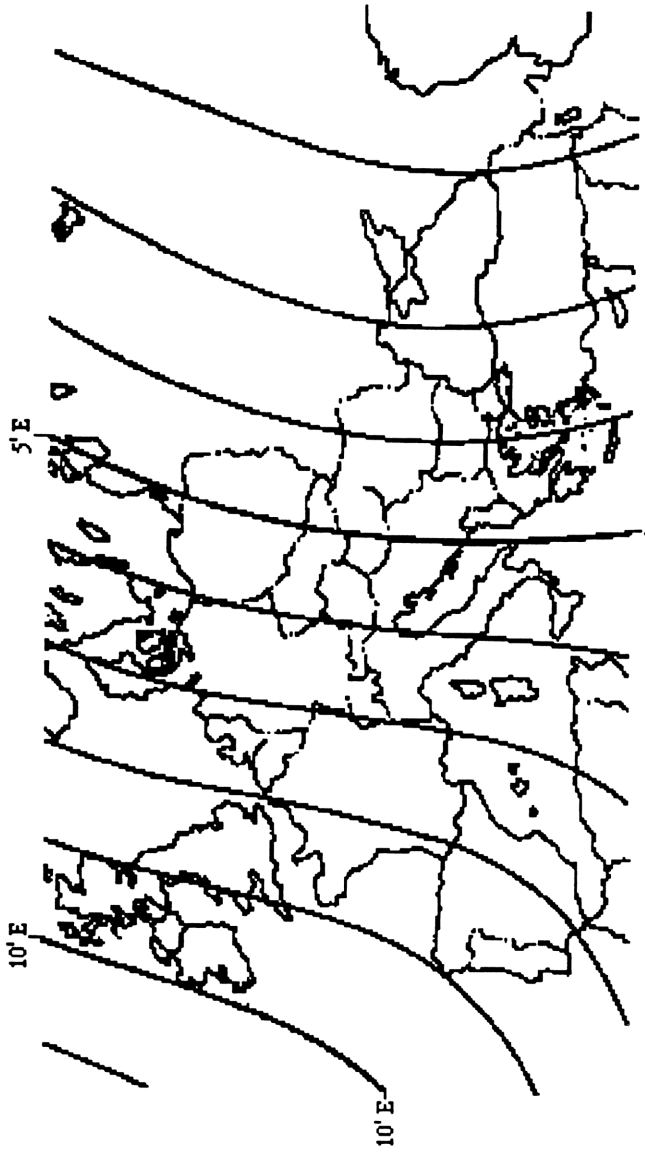


Declination (1980.0) in the United States.



Annual rate of change in declination (1980.0) in the United States.


15°W
10°W
5°W
0°
5°E
10°E
Declination (1980.0) in Europe.



Annual rate of change in declination (1980.0) in Europe.

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