

Section 1
Getting Started

What C71 Does

The C71 module contains a program called C71 that allows your HP-71 to act like a Hewlett-Packard Series 10 calculator. C71 simulates many of the functions found on the HP-11C (Scientific Calculator), the HP-12C (Financial Calculator), the HP-16C (Computer Scientist), and the HP-15C (Advanced Scientific Calculator). With just a few key strokes you can switch from Basic into the calculator and easily enter your calculations.

Installing and Removing the C71 Calculator Module

The C71 Calculator module can be plugged into any of the four ports on the front of the computer.

***** CAUTION *****

- * Do not place fingers, tools, or other foreign objects into any of the ports. Damage to plug-in module contacts and computer's internal circuitry may result. Such actions could result in minor electrical shock hazard and interference with pacemaker devices worn by some people.
- * Be sure to turn off the HP-71 (press **[f][OFF]**) before installing or removing a plug-in module.
- * If a module jams when inserted into a port, it may be upside down. Attempting to force it further may result in damage to the computer or the module.
- * Handle the plug-in modules very carefully while they are out of the computer. Do not insert any objects in the module connector socket. Always keep a blank module in the computer port when a module is not installed. Failure to observe these cautions may result in damage to the module or the computer.

To insert the module, orient it so that the label is right-side up, hold the computer with the keyboard facing up and push in the module until it snaps into place. Be sure to observe the precautions described above.

To remove the module, grasp the lip on the bottom of the front edge of the module and pull the module straight out of the port. Install a blank module in the port to protect the contacts.

Starting C71

To enter the calculator type:

C71 [END LINE]

the display will clear and then a number and the mode will be displayed. The number will be the value that was displayed the last time you used C71 or 0 if this is the first time you have used C71.

Leaving C71

There are two methods for leaving C71: **[f][OFF]** and **[g][EXIT]**

Turning the HP-71 Off

Pressing **[f][OFF]** will turn the HP-71 off, but will leave the calculator active. The next time ON is pressed, C71 will be reactivated and you will be working in the calculator again. The calculator's status is saved prior to turning off and restored upon turning back on. However, if something should happen so the calculator does not come back on, because the status was saved, typing C71 [END LINE] will restart the calculator just where you left it. For more information on the interaction between the calculator and the HP-71 BASIC refer to Appendix D: HP-71 System Usage.

Returning to BASIC

Pressing **[g][EXIT]** will store the current status of C71 and return control of the HP-71 to the BASIC operating system. Pressing C71 [END LINE] will restart the calculator just where you left it.

Display

Mode

C71 has two basic modes of operation which coincide with the two overlays provided for the keyboard. The first mode is *Engineering/ Business* mode. When C71 is in this mode an :F will be displayed on the right side of the display. This mode uses floating point numbers. Most operations such as financial, trigonometric, and engineering calculations are done in this mode. In this mode many of the functions found on the HP-11C, HP-12C and HP-15C calculators are simulated.

The second mode of operation is the *Computer Scientist* mode which simulates many of the functions found on the HP-16C. C71 signifies this mode by displaying a :H, :O, :D, or :B on the right hand side of the display. These letters signify the various number base formats (hexadecimal, octal, decimal, and binary respectively) available in the Computer Scientist mode. Computer Scientist mode operates only on integers. Refer to the "Number Base Modes" in section 10 for further information.

To switch between modes press **[f][RUN]**. The display will switch between the :F and :H, :O, :D, or :B to signify which mode the software is in.

While in Engineering/Business mode, you can choose a format in which to display the numbers. They are standard, fixed, scientific and engineering formats. Refer to section 3, Display Control, for further information.

Flags and Annunciators

Your HP-71B display contains five flags (0 through 4) on the right hand side and several annunciators on both the right and the left hand side. These flags and annunciators tell you the

status of the computer during certain operations. They are described, with the operations they refer to, in the appropriate sections of this manual.

Flag	Definition
0	Begin mode (Finance)
1	M.DY mode (Calendar)
2	Leading zeros (Computer Scientist)
3	Carry (Computer Scientist)
4	Out-of-Range (Computer Scientist)

Negative Numbers

To make a displayed number negative--either one that has just been keyed in or one that has resulted from a calculation--simply press **[CHS]** (*change sign*). When the display shows a negative number--that is, the number is preceded by a minus sign--pressing **[CHS]** removes the minus sign from the display, making the number positive.

Display Clearing: [CLR_x] and [←]

C71 has two types of display clearing operations, **[CLR_x]** (*clear X*) and **[←]** (*back arrow*). When **[CLR_x]** is pressed, any displayed number is cleared to zero.

Pressing **[←]** after executing almost any function clears all digits in the display to zero.

Keystrokes	Display		
12	12	:F	
[f][1/x]	.0833	:F	
[←]	.0000	:F	Pressing [←] after executing a function clears all digits in the display to zero.

After keying in a new number, if you press **[←]** before executing a function (that is, before terminating digit entry) the last digit you keyed in is deleted. After you delete one or more digits, you can, if you want, key in new digits to replace them.

Keystrokes	Display		
12345	12345	:F	
[←]	1234	:F	
[←]	123	:F	When digit entry has not been terminated, [←] acts on each digit separately.
9	1239	:F	

Scrolling

In Engineering/Business mode the display does not scroll. The display may be scrolled in Computer Scientist mode. For further information on scrolling in Computer Scientist mode refer to section 10.

Overflow and Underflow

C71 uses the HP-71's operating system and therefore has the same overflow and underflow conditions as the BASIC system does. The way C71 handles an overflow or underflow depends on the *DEFAULT* settings of the IEEE traps. On a **Memory Lost** or initial power on condition the HP-71 sets **DEFAULT ON**. With **DEFAULT ON** overflows are set to the maximum magnitude value of the machine: 9.999999999999E499. On underflow it defaults to 0. Whenever an overflow or underflow occurs the calculator will beep (unless the beep has been disabled while in the BASIC system). For more information on the behavior of the HP-71 with other **DEFAULT** settings, on the HP-71's IEEE math handling, and on the HP-71's numerical range, refer to section 2 of the HP-71 Owner's manual and to "The IEEE Proposal for Handling Math Exceptions" in the HP-71 Reference manual.

Working

When C71 is calculating a result that takes several seconds, the display will show or flash:

Working...

to let you know that it is working on your calculation. The functions that will display **Working...** are **[i]**, **[IRR]**, **[BFP]**, and **[BX]**.

Low Battery Indicator

A low power condition is indicated by the **BATT** annunciator in the upper left hand side of the display. When **BATT** is lit, new batteries should be installed. Refer to your HP-71 Owner's Manual for information on replacing the batteries.

Error Messages

If you attempt a calculation using an improper parameter, such as attempting to find the square root of a negative number, an error message will appear in the display.

Keystrokes	Display	
4[CHS]	-4	:F
[√x]	ERR:SQR(NEG)	:F
[<]	-4.0000	:F

For a complete listing of error messages and their cause, refer to Appendix A, Error Messages.

To clear any error message, press **[<]** (or any other key), then resume normal operation.

Memory

Continuous Memory

The Continuous Memory feature of your computer maintains the following even when the computer is turned off and when you exit C71:

- * All numeric data stored in C71.
- * The display mode and setting.

- * Flag settings.
- * Trig mode (Degree or Radians).
- * Calculator mode (Engineering/Business or Computer Scientist).

BASIC System Files

C71 creates two files in your HP-71 RAM:

- * FORTHSYS. C71 uses a special variation of the HP-71 FORTH/Assembler ROM for some of its software. FORTHSYS is required by the FORTH system for its storage. Also the X-, Y-, Z-, T-, and LAST X registers are maintained in this file. This file is used by all special ROMFORTH applications. This file requires about 1100 bytes.
- * C71RAM is also created by the FORTH system, however its use is exclusive to the C71 software. This is where all C71 related variables and storage registers are maintained. This file requires about 640 bytes.

There are 3 special classes of storage registers maintained in C71RAM:

1. User storage registers R0 through R9.
2. Financial registers n, i, PV, PMT, and FV.
3. Cash flow registers CF0 through CF20 and the cash flow group registers N0 through N20.

Additionally, C71 uses the HP-71's internal statistical functions and internally maintained statistical arrays. The HP-71's BASIC system allocates memory for these as required.

You must have about 1800 bytes of free memory as shown by the MEM function in order for C71 to run.

Resetting Memory

Initially, C71 has a set of default values which it saves in C71RAM. If you wish to reset these default values to their original state, type the following:

PURGE C71RAM

while in the BASIC system of the HP-71.

Keyboard Operation

Overlays

Two overlays are provided with the C71 Calculator pac. The first is the General Functions overlay and the second is the Computer Scientist overlay. These overlays tell you where the C71 functions are available for the C71 Calculator.

Primary and Alternative Functions

Most keys on your HP-71B perform one primary and two alternate functions. With C71 two overlays have been provided, because many of the keys have been reassigned to different functions other than the standard HP-71B keyboard functions. The primary function of any key is indicated by the character on the left of the key. It is written in a vertical fashion. If no characters appear to the left of the key, the primary key is what is on the face of the key (for example: 0 through 9 and /, *, -, +). The two alternate functions are indicated by characters above the face of the key.

To select the alternate function printed in gold above the key on the left, first press the gold prefix key **[f]**, then press the function key; for example **[f][BEG]**.

To select the alternate function printed in blue above the key on the right, first press the blue prefix key **[g]**, then press the function key; for example **[g][END]**.

To select the primary function on the face of the key, press only that key, for example: **[%]**.

Clearing Keys

Clear Stack. **[CLR STK]** clears automatic memory math registers: X, Y, Z, T, and LX.

Clear Registers. **[CLR REG]** clears the user storage registers R0 through R9.

Clear Financial Registers. **[CLR FIN]** clears the financial registers: n, i, PV, PMT, FV, CF0 through CF20, and N0 through N20.

Clear Statistics. **[CLR STAT]** clears the HP-71's internally maintained statistical array. C71 uses the HP-71's statistical functions and memory arrays.

Clear Prefix. If you make a mistake while keying in a prefix for a function, press the prefix key again to cancel the error.

Appendix D HP-71 System Usage

This section details the amount of memory required, file names used, variables used, and other technical aspects of C71's interaction with the HP-71.

File Names and Memory Usage

The following files are created and used by C71:

File	Type	Size	Used For:
FORTHSYS	FORTH	1102	Soft-FORTH system RAM file.
C71RAM	FORTH	640	C71 Calculator RAM file.
C71FILE	DATA	1292	Data file for register exchange with BASIC files from the function [BX] .

If any files exist in your HP-71 with those names prior to running C71, it will cause unexpected operations. If another file with the name of either of the FORTH files (FORTHSYS or C71RAM) exist, the calculator will give an **Invalid File Type** error message. If a file named C71FILE exists prior to pressing **[BX]**, a **File Exists** error message will be displayed.

The HP-71 must have enough memory to accommodate FORTHSYS and C71RAM before the calculator can be entered. C71 creates these two files when you first press **C71 [END LINE]**. If you never use the **[BX]** function, then you do not need memory for C71FILE. C71FILE is created when **[BX]** is pressed, and purged by the calculator when the function completes.

As there is some system overhead required to create files, your HP-71 will need a few bytes more than the actual size of the files.

Variables Used by C71

C71 uses several HP-71 BASIC variables in conjunction with the statistics functions and with **[BX]**. The following is a list of the variables and what they are used for.

Statistics:

R7(2)	The statistics array variable, declared using the BASIC STAT command.
R8	Used to get the slope from the BASIC LR function.
R9	Used to get the intercept from the BASIC LR function.

[BX]:

- | | |
|----------|--|
| R9\$[68] | Used to read the string representations of registers from the C71FILE. |
| R9 | Used to read certain HP-AF file format information from the C71FILE. |

Additional Technical Information

Overview

C71 is based on an interaction of three systems. First, it uses the HP-71 operating system to control all file handling, number control for floating point numbers, statistics, and many of the mathematical operations. Second, it uses an alternative operating system called Soft-FORTH, which is designed to co-exist with the HP-71 native BASIC operating system. Soft-FORTH is a special ROM version of the HP-71 FORTH/Assembler ROM. This version is designed to be put into application ROMs, and allows multiple Soft-FORTH applications to be present in the HP-71. Third, the actual calculator--C71--is written in a combination of FORTH and assembly code (FORTH primitives).

The Soft-FORTH uses the FORTHSYS file as its allocated, dedicated RAM area. While C71 uses C71RAM as its allocated, dedicated RAM area. If multiple Soft-FORTH applications are present in your HP-71, they will all use FORTHSYS while they are running. However, only C71 uses C71RAM. Your other Soft-FORTH applications will have their own dedicated RAM areas.

FORTHSYS maintains the FORTH stacks, pointers, and the X-, Y-, Z-, T-, and LAST X registers.

C71RAM maintains the storage registers, financial registers, internally-used working registers, and some special mainframe-save variables. In order to operate properly, C71 must over-write certain mainframe operating status information. This status information is saved in C71RAM upon entry into the calculator, and restored upon exit. Additional information on what is saved and potential problems are discussed below.

Display Delay

Upon entry, C71 stores the mainframe's delay setting and then sets the delay to **DELAY 0,0**. When a function is performed that goes into the basic interpreter, the machine's original delay setting is restored. If anything is displayed while in BASIC, the display delay and scrolling set in the BASIC system will be used. The two functions that provide an interface to BASIC are **[BX]** and **[BFP]**.

Statistics and BASIC Variables

While in the BASIC system's main environment, whether you're in **[BFP]**, **[BX]**, or exited from the calculator, if you do a **DESTROY ALL** or **DESTROY R7**, you will have destroyed your statistics array and will get an **Invalid stat array** error message next time you press a statistic function key, like **[Σ+]**. You solve this by pressing the **[CLR STAT]** key. The statistics will then work just fine. The only statistic function this does not apply to is the **[CLR STAT]** function.

R7 needs to be preserved to maintain a valid stat array entered with the **[Σ+]** and **[Σ-]** keys from within the calculator. R9\$, R9, and R8 are temporary variables that are a don't care on entry.

Any previous value will be lost upon using the above functions, so don't rely on them outside of the calculator.

Purging System Files

Purging the system files while exited from the calculator will cause no problem with the operation of the calculator. However, when the calculator is re-entered, the calculator will be set to its default values.

Purging C71RAM will cause the calculator to re-initialize the stat array the next time the $[\Sigma+]$ key is pressed. The other stat functions may work OK because the stat array is kept by the mainframe and not in C71RAM. $[\Sigma+]$ sets a flag in C71RAM when it has created a valid stat array in the mainframe. If C71RAM is purged, the calculator has no way of knowing if there is a valid array or not. So it creates a new array and sets the stat valid flag. CLRSTAT clears the stat valid flag.

A copy of the X-, Y-, Z-, T-, and LAST X register are kept in C71RAM when the calculator is exited. So there should be no change in the previous values or status of the calculator if FORTHSYS is purged. FORTHSYS is used only during the actual running of the calculator and not for value storage.

If C71RAM is purged while in **[BX]** or **[BFP]**, the HP-71 will perform a **Memory Lost**. The Soft-FORTH system is not able to recreate the file and begin running again. The flags that tell the Soft-FORTH system that it is active and in the middle of the **[BX]** or **[BFP]** routines (the FORTH pointers) are maintained in the FORTHSYS file. However, all of the calculator's status information is maintained in C71RAM, where it was saved prior to executing **[BX]** or **[BFP]**. So the Soft-FORTH system has no way of recovering the proper operation of the calculator as it tries to reestablish its pointers and begin running again. It gets pointed off into some unknown part of memory and ends up causing a **Memory Lost**.

If FORTHSYS is purged while in **[BX]** or **[BFP]**, the Soft-FORTH system will have no way of knowing that it was active. When the mainframe polls to reenter Soft-FORTH, Soft-FORTH will just return leaving the system in BASIC, otherwise undamaged. The Radians setting may be different, however, all of the other BASIC system setting will be properly restored. Refer to the section on the BASIC interface for additional information on the Radians setting.

Display Contrast

The display contrast is constantly being altered. Upon entry into C71, your contrast setting is read and stored. As the calculator operates, you will notice the display being blanked at times. This is done by setting the contrast to 0 and then restoring it. If something really gets fouled up and you can no longer see the display, do an INIT1 to reset the system to get the display back, purge FORTHSYS and C71RAM, then re-set the display contrast to where you like it. INIT1 while in the calculator will reset the system back to BASIC. Some of your other system settings may no longer be as you like them as you were returned to BASIC before C71 could restore your BASIC system. Such things as your delay setting, your IEEE defaults, and your display mode may need to be reset.

C71 System Modes

The calculator maintains a separate display mode (fix, sci,...) and a separate radians-degrees mode from that of the BASIC system. If you are set to radians mode and fix 2 in the calculator, your BASIC system can be set to degrees and STD. The calculator will keep these separated by saving and restoring them at the proper times.

Appendix D: HP-71 System Usage

The one mode that is most likely to get mixed is the radians-degrees mode as the calculator's radians/degrees setting is maintained for **[BX]** and **[BFP]** calculations. This is done so you won't have to convert units. Every effort is used to maintain the separate status of these when entering and exiting the calculator. However, if an error occurs such that the calculator cannot recover and you're left in BASIC, then the calculator's mode will be in effect in your BASIC system.

Mainframe State Usage

The calculator tries to use your machine states as much as is reasonable. However some need to be altered for the proper running of the calculator, like the delay setting.

The following settings are modified and maintained separately by the calculator:

Function	Calculator's Setting
Display Delay	DELAY 0,0
Display Mode	User selectable from within C71
Display Width	WIDTH 80
Radians/Degrees	User selectable from within C71
ATTN key	Disabled

The remainder of the mainframe's states are used by C71. For example, if you have set beep off in BASIC, then it will be off in the calculator.

The state of IEEE math traps and defaults are used by the calculator with the following exception. C71 functions that are calculated using FORTH floating point functions force **DEFAULT ON** and **BEEP OFF**. Thus if overflows or underflows occur you will not be continuously beeped at as they are occurring. Overflows occurring during a calculation will not accurately reflect whether the final answer would be an overflow or an underflow. Likewise when these calculations are over no warning message will be given that an overflow or underflow occurred. Also if the final result is an overflow or an underflow, that result will not be displayed as INFs and EPS's but will be displayed as the largest or smallest number the HP-71 uses in **DEFAULT ON** mode. The beeper status will be restored as well as your default status when the calculation is finished.

The IEEE math trap settings are only applicable to Engineering/Business mode, Computer Scientist mode does not allow for this type of traps or exceptions.

The calculator makes use of the system and user flags. All of the flags are stored away before entering the calculator and restored when leaving (including BX, BFP). So your basic machine should always be in the state you had it before entering the calculator. However in the unlikely event that a really obscure error dumps you into the basic without restoring the basic state, you may have to do some clean-up before getting your system back where it should be.

BASIC system status' used by the calculator:

Warning suppress (flag -1)
 beep off (flag -2)
 continuous on (flag -3)
 beep loud (flag -25)
 IEEE traps
 round off setting (flags -11,-12)
 random number seed

If flag -1 is clear and the beep is set to ON (flag -2 is clear), a normal warning will not be displayed, but the HP-71 will beep. For example, with **DEFAULT ON**, if you do 2[**END LINE**][0][1], the calculator will beep and display the overflow result, but will not display the warning message. Whereas, in **BASIC 2/0** would display **WRN: /ZERO** for the delay setting, and then display the overflow result. If you key in a number too large for the calculator (1E+600) and press [**END LINE**], with **DEFAULT ON**, the calculator will beep and display the overflow number, 9.999999999999E499. If you key in a number too large for the calculator (1E+600) and then press a function key that will increase the number (like [**X!**]), the calculator will beep twice--once as it assigns the overflow number and a second time as [**X!**] overflows.

The following system status' are preserved, but not used by the calculator:

user defined keys
 user flags

The following is a list of the functions that are performed using the **FORTH** floating point functions and thus, force a **DEFAULT ON** setting:

AMORT	NPV	->H
INT	IRR	->H.MS
n	%	H.MS+
i	Δ%	H.MS-
PV	%T	All the complex number functions
PMT	->P	All the Hyperbolic functions
FV	->R	

C71 Default Settings

When a new C71RAM file and FORTHSYS file are created, the following are the calculator's default status setting when the calculator first starts:

Delay 0,0 (cannot be changed)
 Display mode--STD
 Engineering/Business mode
 End mode (financial)
 Degrees mode
 Random number seed--same as mainframe's (uses mainframe's routines)
 X-, Y-, Z-, T-, LAST X registers are clear
 Finance registers are clear
 Storage registers are clear
 Statistics array -- presumed clear (see note above)
 IEEE Math traps--same as mainframe's

Appendix D: HP-71 System Usage

16 bit wordsize
HEX base
carry clear (flag 3)
out-of-range clear (flag 4)
Unsigned complement math
Leading zeros not displayed

ATTN Key

The **ATTN** key on the HP-71 is normally enabled to interrupt a running program. If the **ATTN** key were to be pressed while in Soft-FORTH, the Soft-FORTH system would terminate and return you to the BASIC system. The **ATTN** key, however, can be disabled from interrupting a running program. With all of the keystrokes available around the **ATTN** key it was felt that there would be too great of a chance of accidentally pressing it. If it were allowed to terminate the running of the calculator, the calculator would not have a chance to restore the BASIC system environment and to save its own. Thus, when the calculator is reentered, the status of the calculator would also be different.

For the above reasons, the **ATTN** key is disabled during the actual calculator and cannot be used to interrupt the program. If a run-away condition (infinite loop) should occur or the calculator gets into a bad state, an **INIT1** will need to be used to recover.

Any time the calculator is returned to the BASIC environment, the **ATTN** key is restored to its program interruption capability state. The functions that restore this state are: **[f][OFF]**, **[g][EXIT]**, **[f][BFP]**, and **[f][BX]**.

Program Deallocation

When the calculator times out or you press **[f][OFF]**, the calculator is turned off with a BASIC programmable **BYE** after restoring the BASIC environment and saving the calculator's environment. When the **[ON]** (**ATTN**) key is pressed to turn the HP-71 back on, the HP-71 will try to continue running the program that was being run prior to the **BYE**. However, if a plug-in module is put in or removed while the HP-71 is off from a programmable **BYE**, the HP-71 deallocates the program and will not try to continue running the program.

Thus, if you turn the calculator and the HP-71 off with a **[f][OFF]**, and then plug in a module or remove a module, the calculator will not come back on when you press the **ATTN** key. You will be left in BASIC. However, as the BASIC state was restored and the calculator state saved, pressing **C71** will restart the calculator.

If you turn off the HP-71 while at the basic prompt from **[BX]** or **[BFP]** by pressing **f OFF** or allowing the HP-71 to timeout, the program will also deallocate and you'll be left in the BASIC system. A programmable **bye** in a basic program or a user-defined function does not deallocate the program.

Cautions

Do not copy or purge LEX files from within a user-defined function executed from **[BFP]**. Soft-FORTH cannot recover properly and a **MEMORY LOST** is the final result. Usually, an **INIT1** will set things up for a **System Error** message. Once this message is given an **INIT3** is the only resolution. (Refer to section 12 on the BASIC interface for more detail.)

If your user-defined function is interrupted with the ATTN key and the user defined function was called from **[BFP]**, the Soft-FORTH will not recover and an eventual **MEMORY LOST** message will be displayed. (Refer to section 12 on the BASIC interface for more detail.)