Section 7

Programming Basics

The next three sections are dedicated to explaining aspects of programming the HP-16C. These programming sections will first discuss basic techniques (The Mechanics), then give example(s) for the implementation of these techniques, and lastly discuss any details of operation (Further Information). This allows you to read only as far as you need to support your use of the HP-16C.

The Mechanics

Creating a Program

Programming the HP-16C is an easy matter, based simply on recording the keystroke sequence used when calculating manually. (This is called "keystroke programming.") To create a program out of a series of calculation steps requires two extra manipulations: deciding where and how to enter your data; and loading and storing the program. In addition, programs can be designed to make decisions and perform iterations through conditional and unconditional branching.

Stepping through the fundamentals of programming, we'll work through a program designed to concatenate two 16-bit words in the X- and Y-registers into one 32-bit word in the X-register.

Loading a Program

Program Mode. Press g P/R (*program/run*) to set the calculator to *Program mode* (**PRGM** annunciator on). Most functions are stored and not executed when keys are pressed in Program mode.

Keystrokes	Display	
g P/R	000–	Switches to Program mode; **PRGM** annunciator and line number displayed.

Keystrokes in Program mode become program instructions occupying program lines. These numbered lines indicate the calculator's position in program memory. Line 000 marks the beginning of program memory and cannot be used to store an instruction; the first line that contains an instruction is line 001. No program lines except 000 exist until instructions are stored in them.

Programs are usually started at line 001, though you *can* start a program at any existent line. As you enter instructions, any existing programs will be preserved and "bumped" down in program memory, thereby incrementing their line numbers.

Beginning a Program. Clearing program memory will erase all programs in memory and position the calculator to line 000. To do so, press f CLEAR PRGM *in Program mode.*

If the calculator is not at line 000 and you do *not* want to clear program memory, you can position the calculator to line 000 by pressing f CLEAR PRGM or GTO · 000 in *Run mode,* or by pressing GTO · 000 in *Program mode.* (The GTO · instruction cannot be recorded.)

A LBL (*label*) instruction—g LBL followed by a digit or letter *label* {0 to 9, A to F}—is used to define the beginning of a program or routine. The use of labels allows you to quickly select and run a particular program or routine.

Keystrokes	Display	
f CLEAR PRGM	**000-**	Clears program memory and sets calculator to line 000 (start of program memory).
g LBL A	**001-43,22, A**	Keycode for label "A".

Recording a Program. A program consists of the same keystrokes you would use to solve a problem manually. Keys pressed in Program mode are recorded in memory as programmed instructions.* The display contains a line number and *keycode(s).* Keycodes are one- or two-digit numbers indicating the position of keys on the keyboard (described in more detail later).

* Except for the *nonprogrammable functions*, which are listed on page 81.

Example: The body of the concatenation program is listed below. Assuming that two separate numbers are given in the X- and Y-registers, program lines 002 to 008 below will concatenate those two 16-bit words into one 32-bit word. The word initially in the X-register will become the most significant bits of the result.

Keystrokes	Display	
HEX	002– 23	
2	003– 2	Doubles the word size from 16 to 32, providing 16 extra bits to the left of the numbers in X and Y.
0	004– 0	
f WSIZE	005– 42 44	
g LST*x*	006– 43 36	Brings back word size (32).
f SR	007– 42 b	Computes one-half of word size (16).
f RLn	008– 42 E	Shifts number left 16 bits.
f OR	009– 42 40	OR operation here concatenates the contents of X and Y.

Ending a Program.

- The instruction g RTN (*return*) will end a program, return to line 000, and halt.* This instruction can be omitted if the program is the last one in memory, since the end of the program memory contains an automatic RTN.
- The instruction R/S (*run/stop*) will stop a program *without* moving the line position to line 000.

Keystrokes	Display	
g RTN	010– 43 21	Optional if this is the last program in memory.

* Except when a subroutine return is pending, as discussed in section 9, page 94.

Running a Program

Run Mode. Switch back to Run mode (no **PRGM** annunciator displayed) when you are done programming by pressing [g] [P/R]. Program execution can take place only in Run mode.

Keystrokes	Display	
[g] [P/R]		Run mode; no **PRGM** annunciator displayed. Display will show previous result.

The position in program memory does not change when the calculator transfers between Run mode and Program mode. Whenever the calculator has been off, it "wakes up" in Run mode.

Executing a Program. In Run mode, press [GSB] *label.* This addresses a particular program and starts its execution. The display will flash **running**. (The [GSB] key is the same one used—under different circumstances—to "go to subroutine".)

Keystrokes	Display	([STATUS]: **2–16–0000**)
[HEX] FFFE [ENTER]	**FFFE h**	Enter the first number into the X- and Y-registers.
DDDC	**dddC h**	Key the second number into the X-register. These digits will become the most significant ones.
[GSB] A	**dddCFFFE h**	The concatenated hex number.
[f] [STATUS]	**2–32–0000**	The word size is now 32.

Alternatively, you can position the calculator to a particular line using [GTO] [·] *nnn* (three-digit line number) or [GTO] *label* and then start execution by pressing [R/S].

Intermediate Program Stops

Use [g] [PSE] (*pause*) as a program instruction to *momentarily* stop a program and display an intermediate result. Use ore than one [PSE] for a longer pause.