

# **HP-41C**

## **A Calculator, A System, A Whole New Standard**

### **HP-41C Alphanumeric Programmable Scientific Calculator With Continuous Memory**

The new HP-41C represents a totally new concept in the design of Hewlett-Packard calculators. It incorporates the latest in calculator technology to give you a powerhouse of functions and features that will still slip right into your pocket. The HP-41C is fully-programmable with incredible power that can expand to over 2,000 lines of program memory. Or 319 registers for data storage. Or any mix of storage registers and program memory that you choose.

The HP-41C communicates with more than numbers. You can key in any combination of letters and numbers up to 24 characters wide. Twelve characters can be reviewed at one time. A complete system of status annunciators, which appear in a special area of display, also helps to keep you firmly in control of the HP-41C. You know whether the next key you press will be executed or "remembered" as a programming instruction; you see whether you're keying in numbers or alphabetic characters. You can tell at a glance the condition of program flags, trigonometric modes, battery life, even whether the shift key has been pressed. And error messages are displayed in plain, understandable English, too. For aural feedback, you can use the HP-41C "beeper." Ten different tones let you signal the end of a program or a data entry point without monitoring the display.

With a few keystrokes, you can actually create a "personalized" custom calculator for special applications of your own use. The HP-41C comes with some 58 popular functions right on the keyboard, ready to help you solve scientific and mathematic problems. But, in fact, over 130 separate operations comprise the total function library of the HP-41C. And you can assign any of these functions or any program you have written to any key. To help you use this customizing feature, each HP-41C comes with two keyboard overlays and a set of user labels. You simply mark on the overlay above each key the function you've assigned to it. And whether you've assigned it to your personalized keyboard or not, every operation in the HP-41C's vast function library is always accessible. You merely press the special "execute" key and key the function name into the alphabetic display.

The HP-41C is equipped with Continuous Memory that preserves stored data, program information, flag states, trigonometric modes, and your user-defined "personalized" keyboard assignments and memory configuration, even though the calculator is turned off. As a result, you need only program frequently-used programs once, then run them day after day, without reentering your programs.

You can maintain more programs and longer programs in the HP-41C than you ever thought possible. Each program is autonomous—you can call it up by name, edit it, even clear it without affecting other programs in the calculator. And each program can have up to 99 local labels for addresses, subroutines, or defining parts of a program. Yet these independent programs are also interactive. Using global labels, you can summon one program or branch to a subroutine (up to six levels) from another program.

## **The HP-41C System**

Standing alone, the HP-41C is a powerful programmable problem-solving calculator. But by adding optional plug-in peripherals and modules, you can expand the capabilities of the HP-41C to keep pace with your growing computational requirements. These options give the HP-41C increased flexibility, too. It can become a printing calculator, can save hundreds of programs on magnetic cards, or can even become a "specialized problem-solving machine."

Four input/output (I/O) ports are provided on the top of the HP-41C for interfacing with these devices. You can plug in any number of options, up to four, in any combination that you need. Each quick-connect peripheral and module is self-contained, with its own set of functions that is added to the calculator's existing functions library. And each is fully portable.

A detailed description of capabilities and operation is provided with each device. But to give you a feel of the remarkable power and flexibility you can achieve by adding to your basic HP-41C calculator, look briefly at some of the devices available.

### **HP 82106A Memory Module**

These handy memory modules can actually quintuple the HP-41C calculator's memory. Each module contains an additional 64 registers that can be allocated as program memory or storage registers, or any combination. You can add four memory modules to your HP-41C system, providing you with a whopping 319 registers. (That's 1000 to 2000 lines of program memory.) Like the calculator itself, the memory modules have Continuous Memory. As long as the memory module is plugged into the HP-41C, its contents are preserved for your later use, even while the HP-41C is turned off.

### **HP 82104A Card Reader**

The HP-41C is so easy to program—and the resulting programs so powerful and versatile—that you'll undoubtedly be inspired to write specialized programs for later use. When your programming output exceeds the sizeable capacity of the Continuous Memory in the HP-41C—or the even larger capacity with optional memory modules—you can permanently store your programs on magnetic cards using the HP 82104A Card Reader.

The HP-41C allows you to specify a single program you wish to record from its Continuous Memory onto a magnetic card. A program or group of registers need not be limited in length to the capacity of a single card (32 registers); it can be segmented among as many cards as necessary. You don't have to figure out whether more than one card is required for reading and writing; the HP-41C does that for you automatically, then *tells* you by displaying a message.

Adding over 30 more functions to your calculating system, the "extra smart" HP 82104A Card Reader will even record any key assignments that are made to run the recorded programs. If you wish, you can ensure "program security"—a secured program can only be executed, *not* viewed, altered or re-recorded. With an HP-41C and the HP-82104 Card Reader, you are not limited to reading programs or data on magnetic cards that you have recorded yourself. And, the HP-41C has been specifically designed to accept a program or data on a magnetic card recorded on an HP-67 or HP-97, thus, enabling you to utilize the vast number of specialized programs available from the HP-67/97 Users' Library.

### **HP 82143A Printer**

For a permanent record of calculation results, or for assistance in checking or editing long programs, you can connect an HP 82143 Printer to your HP-41C. Powered by its own set of batteries, it prints alphanumeric characters quietly and efficiently.

The printer can also be set to provide you automatically with valuable diagnostic information when creating or running a program. And when executing a program or series of manual keystrokes, the printer can provide a record of the numbers keyed in, functions performed, and answers calculated. The printer gives you numbers, upper and lower case letters, double-wide characters, character plotting, and an intensity control for optimum contrast and readability. It even allows you to define your own "special" characters.

### **HP 82153A Wand**

If you don't plan to program soon, you can still take advantage of the power and flexibility of the HP-41C system. The HP 82153A Wand permits you to load programs and data into the HP-41C quickly and easily. When plugged into one of the HP-41C ports, the Wand actually reads bar codes from a printed page, translating these codes into HP-41C program and data information as they are loaded into the calculator.

Drawing its power from the calculator, the Wand can load long programs into the HP-41C in a matter of seconds. And because HP-41C Solutions Books and Users' Library programs will be available with printed bar codes along with their step-by-step keystroke listings, the Wand makes it so fast and easy to load a wide variety of inexpensive software. HP-41C Solutions Book topics include business statistics, marketing, sales, geometry, test statistics, fluid dynamics and hydraulics, solar engineering, and many more. Even advanced programmers will want to experience the convenience of the HP 82153A Wand.

(Available Early, 1980)

## **HP-41C Application Modules**

Each preprogrammed Application Module turns the HP-41C into an answer machine for a particular discipline: a specific calculator for specific needs. Whether you're an engineer or technician, student or scientist, business person or professional, you'll find an Application Module to solve the most common and the toughest problems in your area of interest.

Every Application Module comes with a comprehensive manual, as well as a keyboard overlay. Up to four application modules can be plugged into the I/O ports on the HP-41C. You simply plug-in a module, put the keyboard overlay in place, and you're in business putting the combined problem-solving power of the HP-41C calculator and the module's functions and programs to work for you immediately. Choose from:

- Aviation
- Clinical Lab and Nuclear Medicine
- Circuit Analysis
- Financial Decisions
- Mathematics
- Games
- Home Management
- Real Estate
- Securities
- Statistics
- Stress Analysis—Mechanical Engineers
- Structural Analysis—Civil Engineers
- Surveying
- Machine Design
- Navigation
- Thermal and Transport Science

## **HP-41C Solution Books**

A wide range of Solution Books will give immediate access to software in most areas of interest. 41C Solution Books contain up to 10 programs each, programs written specifically to use the increased power and communications features of the HP-41C. Each program contains a keystroke listing that can be used to key the program directly into the HP-41C along with a description of how the program works and a sample problem. Topics include business, statistics, marketing, sales, geometry, test statistics, fluid dynamics and hydraulics, solar engineering, and many more.

There are presently 25 Solution Books written specifically for the HP-41C.



## HP-41C

### Technical Note: Program Lines vs. Bytes

"Program Lines" are exactly what their name implies, lines in a program. Each line has a line number and a complete 41C instruction. HP-41C instructions can be built up with several keystrokes, as an example,  $ST + 01$  is made by hitting [STO] [+] [0] [1]. In addition numeric constants, like 1.2467, and alphanumeric strings, like VALUE, appear on one program line even though they require several keystrokes.

Each function within the HP-41C has a code number associated with it. These codes are called Bytes. Most functions only require one Byte (code), however, with the large number of functions in the HP-41C several of them require multiple Bytes (Appendix D, page 249 lists actual requirements).

Because of this, a Program Line may contain several Bytes. As examples:

<u>Program Line</u>	<u>Bytes</u>
001 ÷	1
002 STO 01	1
003 STO + 02	2
004 TABCD	5
005 1.2345	6

Each data register can be converted into seven Bytes of program memory. Therefore, the basic 41C can have up to 448 Bytes of program memory. The variable length of program lines makes it difficult to state the exact number of available Program Lines.

In conclusion, the distinction between Bytes and Program Lines is that Bytes are internal codes for functions and Program Lines are what the customer sees in their program.

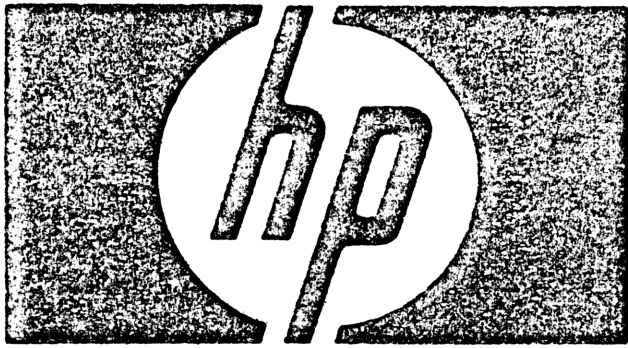


## HP-41C SYSTEM TRAINING MATERIALS

We have prepared a complete set of slides and accompanying text for your use when training dealers and/or end users on the HP-41C system. The material ranges from the most basic HP calculator operations (such as HP-RPN) to the most advanced operations of the HP-41C peripherals. This allows you the flexibility to tailor your presentations for any audience.

If you need additional training material, please contact your sales development representative.





HEWLETT-PACKARD 41C

. . . A CALCULATOR . . .

. . . A SYSTEM . . .

. . . A WHOLE NEW STANDARD . . .

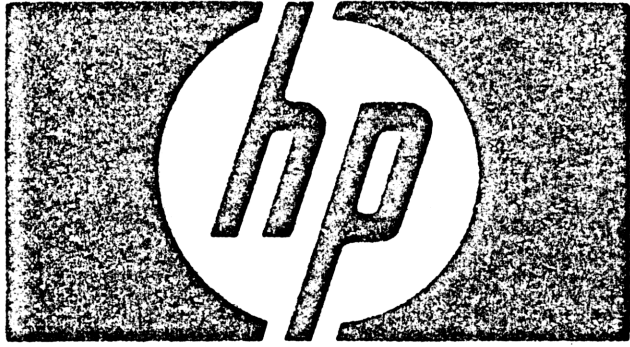


## INTRODUCING THE HEWLETT-PACKARD 41C

Many words can be used to describe the new HP-41C. A concise yet full description of the HP-41C is:

"A CALCULATOR, A SYSTEM, A WHOLE NEW STANDARD!"





HEWLETT-PACKARD 41C

. . . A CALCULATOR . . .

COMMUNICATES WITH THE USER  
CUSTOMIZES TO YOUR OWN DESIGN  
HP-RPN - PROGRAMMABLE  
CONTINUOUS MEMORY

. . . A SYSTEM . . .

UP TO FIVE TIMES MORE MEMORY  
EXTRA SMART CARD READER  
WHISPER QUIET PRINTER  
DIGITAL BAR CODE WAND  
EXTENSIVE SOFTWARE SUPPORT

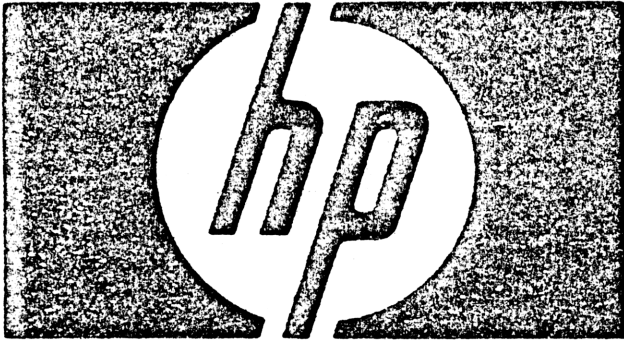
. . . A WHOLE NEW STANDARD . . .

POWER  
FLEXIBILITY  
EXPANDABILITY  
EASE OF USE



A CALCULATOR, A SYSTEM, A WHOLE NEW STANDARD

Several associated major benefits are highlighted below each segment of the summary description. (See Slide)

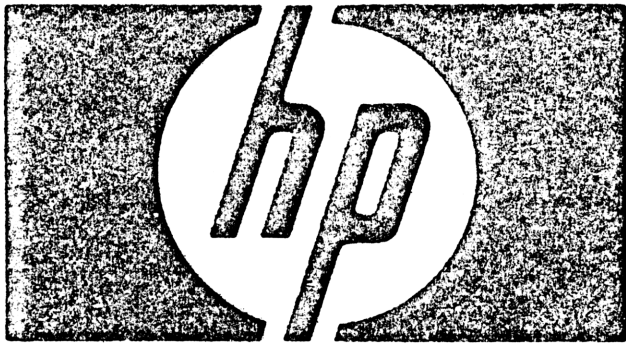


## HEWLETT-PACKARD 41C

- THE HP-41C IS A SIMPLE-TO-USE HANDHELD CALCULATOR . . . IT COMMUNICATES WITH THE USER.
- THE HP-41C HAS AN EXCITING NEW KEYBOARD DESIGN . . . YOU CAN CUSTOMIZE THE CALCULATOR TO YOUR OWN DESIGN.
- THE HP-41C HAS A UNIQUE COMBINATION OF PROGRAMMING EASE AND SOPHISTICATION . . . IT IS EASY TO PROGRAM.
- THE HP-41C HAS PROGRAMMING POWER . . . IT CAN SOLVE PROFESSIONAL PROBLEMS.
- THE HP-41C HAS CONTINUOUS MEMORY . . . IT SAVES DATA, PROGRAMS AND KEY ASSIGNMENTS EVEN WHEN TURNED OFF.
- THE HP-41C IS AN EXPANDABLE SYSTEM . . . IT MEETS YOUR NEEDS TODAY AND IN THE FUTURE.

## TRAINING OVERVIEW

As we learn about the HP-41C, we'll focus our attention on the following key HP-41C benefits, and the HP-41C features that provide them to the user. (See Slide)



HEWLETT-PACKARD 41C

- THE HP-41C IS A SIMPLE-TO-USE HANDHELD CALCULATOR . . . IT COMMUNICATES WITH THE USER

ON/OFF TOGGLE SWITCH  
LIQUID CRYSTAL DISPLAY (LCD)  
ANNUNCIATORS  
DIGIT ENTRY  
ALPHA CHARACTER ENTRY  
ERROR CORRECTION  
HP-RPN  
SIMPLE CALCULATIONS  
CHAIN CALCULATIONS  
ADVANCED FUNCTIONS  
AUTOMATIC MEMORY STACK  
DATA STORAGE AND RECALL  
DEFINING STORAGE REGISTER CONFIGURATIONS  
DISPLAY FORMAT CONTROL  
AUDIBLE BEEPER  
LONG BATTERY LIFE

### ON/OFF TOGGLE SWITCH

The HP-41C [ON] key is an easy to use On/Off toggle switch. Push it once and the calculator turns ON. Push it again, and the calculator turns OFF.

### LIQUID CRYSTAL DISPLAY

The HP-41C has an all new, easy to read Liquid Crystal Display (LCD). It offers better viewing in sunlight, and it helps to conserve battery power.

### ANNUNCIATORS

An exciting new feature offered by the HP-41C is a set of annunciators that let you know the status of your machine at all times. (Activate several annunciators, and then turn them all off.)

<u>ANNUNCIATOR</u>	<u>IF DISPLAYED</u>	<u>KEYSTROKES TO ACTIVATE</u>
BATT	Low Batteries	AUTOMATIC
USER	User Mode	[USER]
RAD	Radians Mode	[XEQ] [ALPHA] RAD [ALPHA]
GRAD	Gradians Mode	[XEQ] [ALPHA] GRAD [ALPHA]
SHIFT	Shift Active	[GOLD]
0 - 4	Flag Set	[GOLD] SF 01-04
PRGM	PRGM Mode	[PRGM]
ALPHA	ALPHA Mode	[ALPHA]

## NUMBER ENTRY

KEYSTROKES	DISPLAY
[ON] [←]	MEMORY LOST
123	123_
4567890	1,234,567,890
[ENTER]	1,234,567,890.
[GOLD] [CLX]	0.0000

## NUMBER ENTRY

One of the most basic functions of calculator operation is NUMBER ENTRY. Before practicing simple Number Entry we'll first standardize our calculators by erasing all memory.

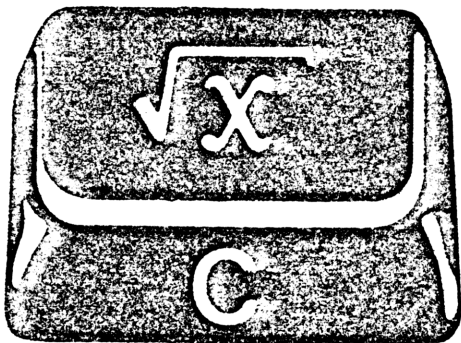
(Turn on calculator while holding down backarrow key.)

While practicing Number Entry, note two important HP-41C communication features, the PROMPT UNDERLINE and AUTOMATIC THOUSANDS SEPARATION.

While in Normal mode, the HP-41C can display up to 10 digits.

NORMAL KEYBOARD

$x^2$



FOR  $x^2$

PRESS [GOLD]  
THEN [√x]

FOR  $\sqrt{x}$

PRESS [√x]

ALPHA CHARACTER C  
CANNOT BE ACTIVATED  
WHILE IN NORMAL MODE

## NORMAL KEYBOARD

As with other advanced calculators, each key on the HP-41C serves multiple purposes.

In NORMAL MODE, the function on the face of the key is activated solely by pressing the key. The Gold function above the key is activated by first pressing the GOLD SHIFT KEY, and then the key below the Gold function. The character or function printed in Blue on the lower face of the key is not active when the calculator is in Normal Mode.

If you hold a function key down momentarily, you'll notice that the HP-41C prompts you by identifying the function about to be performed.

If you hold it down for over a second, it will say "NULL", and the function will not be executed. We'll learn more about the value of key prompting later.

## NORMAL KEYBOARD PRACTICE

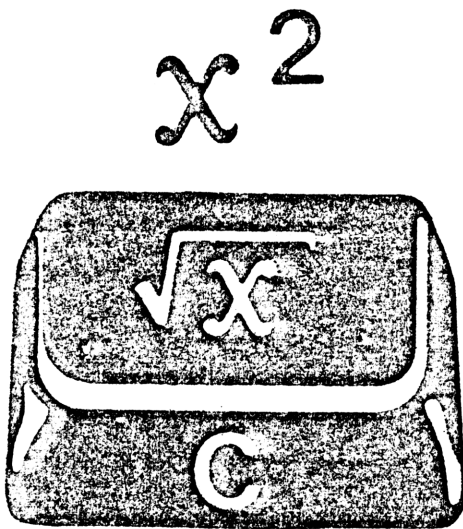
KEYSTROKES	DISPLAY
49	49_
[ $\sqrt{\text{X}}$ ]	7.0000
[GOLD] [ $\text{X}^2$ ]	49.0000
5	5_
[LOG]	0.6990
[GOLD] [ $10^{\text{X}}$ ]	5.0000
[GOLD] [CLX]	0.0000

### NORMAL KEYBOARD PRACTICE

To reinforce the previous two slides, practice using squares and square roots.

With HP-RPN, you do not have to ENTER the number before performing an operation.

## ALPHA KEYBOARD



$x^2$  FUNCTION IS NOT ACTIVE  
WHILE IN ALPHA MODE

$\sqrt{x}$  FUNCTION IS NO LONGER  
ACTIVE WHILE IN ALPHA MODE.  
FOR SPECIAL SHIFTED CHARACTER  
(LOWER CASE  $c$  IN THIS EXAMPLE)  
FIRST PRESS [GOLD]  
THEN [ $\sqrt{x}$ ]

FOR ALPHA CHARACTER  $c$   
PRESS [ $\sqrt{x}$ ]

## ALPHA KEYBOARD

An exciting new feature offered by the HP-41C is the ALPHA Keyboard. The Alpha keyboard is activated by first pressing the toggle switch designated "ALPHA".

The primary function of each key while the calculator is in Alpha mode is the Alpha character or special symbol printed in Blue on the lower face of each key. The Gold function above the key is no longer active. Instead, a special shifted Alpha character is now associated with the key. To activate this special shifted Alpha character, first press the [Gold] shift key, and then the function key. To identify the shifted Alpha character associated with each key, refer to the keyboard located on the back of your calculator.

## ALPHA KEYBOARD PRACTICE

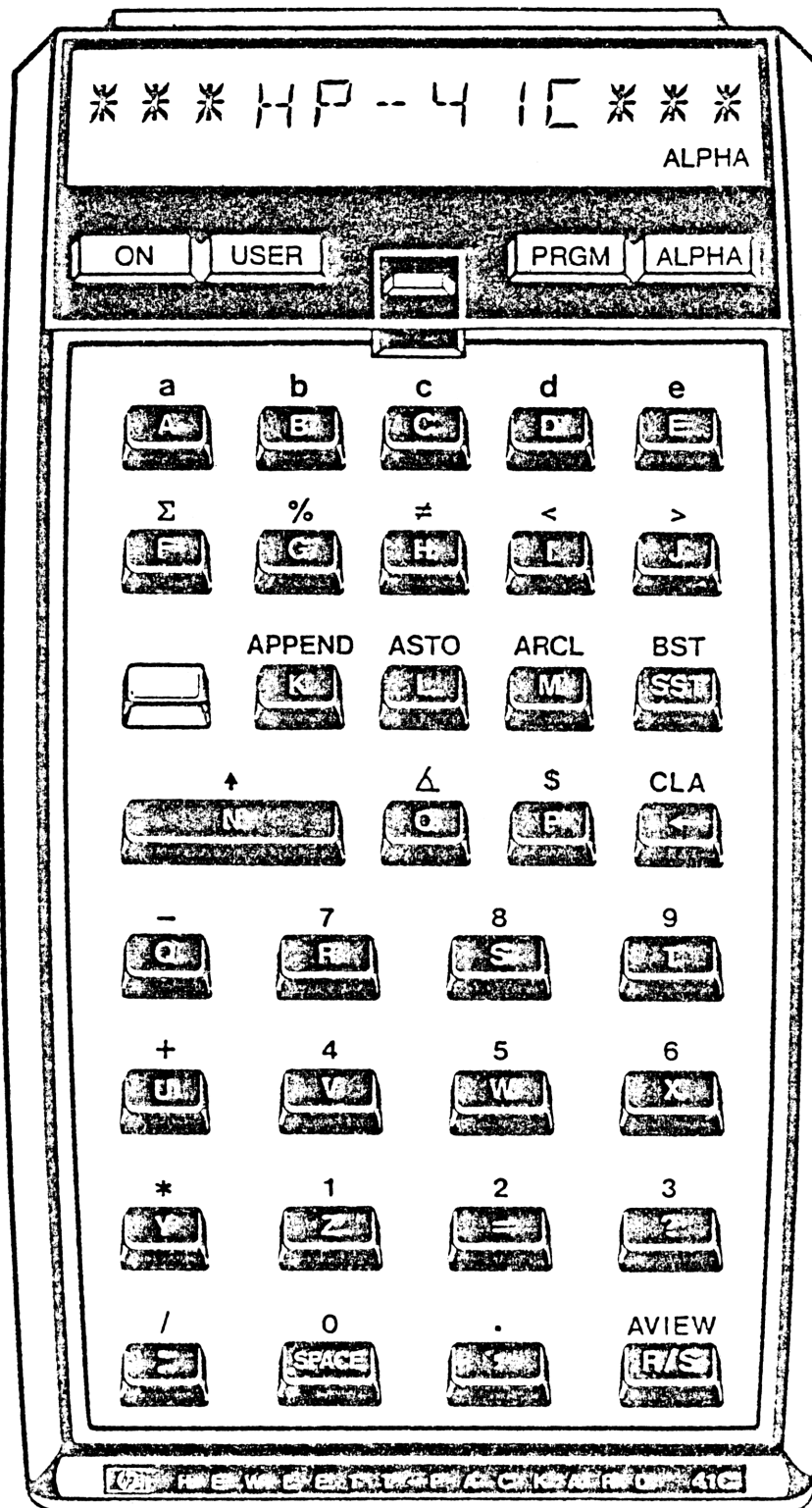
KEYSTROKES	DISPLAY
[ALPHA]	
C	C_
[GOLD] [CLA]	
ABC	ABC_
[GOLD] [CLA]	
NAME	NAME_
[GOLD] [CLA]	
ABCDEFGHIJK	ABCDEFGHIJK_
L	BCDEFGHIJKL_
M	CDEFGHIJKLM_
NOPQRSTUVWXYZ	NOPQRSTUVWXYZ_
[ALPHA]	0.0000
[ALPHA]	ABCDEFGHIJK SCROLLS MNOPQRSTUVWXYZ
[GOLD] [CLA]	

## ALPHA CHARACTER ENTRY PRACTICE

To familiarize ourselves with the Alpha capability of the HP-41C, let's first key in a simple example, and then our names.

The HP-41C can display up to 12 characters at one time, although it can retain up to 24 characters. When more than 11 characters are entered, the HP-41C will begin scrolling characters to the left. When 24 characters have been entered, the HP-41C will alert the user via a beep.

If a mistake is made, use [Gold] CLA. Soon, we'll learn how to overcome mistakes with a special error correction feature.



## SHIFTED ALPHA CHARACTERS

SHIFTED ALPHA CHARACTERS are accessed by first pressing the shift key while the HP-41C is in Alpha mode. The Shifted Alpha Characters assigned to each key are shown on this slide, as well as on a keyboard reference permanently attached to the back of your calculator.

## ALPHANUMERIC STRINGS

KEYSTROKES	DISPLAY
SPACE	_
[GOLD] Y (*)	*_
[GOLD] Y (*)	**_
H	**H_
P	**HP_
[GOLD] [-]	**HP-_
[GOLD] 4	**HP-4_
[GOLD] 1	**HP-41_
C	**HP-41C_
[GOLD] Y (*)	**HP-41C*_
[GOLD] Y (*)	**HP-41C**_
[GOLD] [CLA]	

## ALPHANUMERIC STRINGS

To this point, we have seen how numeric information is entered, and how Alpha characters are entered. Now, in order to truly appreciate the communicative ability of the HP-41C, let's examine its Alphanumeric capability, or the ability to integrate Alpha characters and numeric characters.

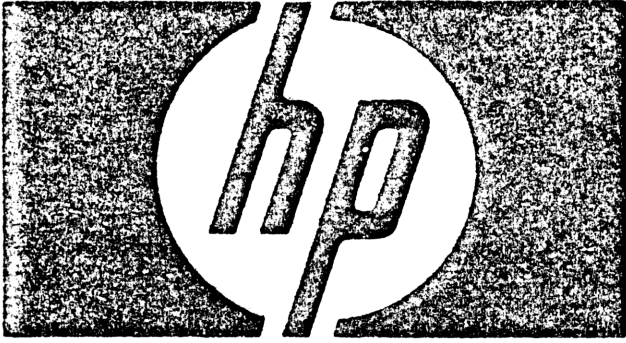
As explained earlier, each key has a special shifted character associated with it, while in Alpha mode. We will access some of these shifted characters as we create an ALPHANUMERIC STRING.

## ERROR CORRECTION

KEYSTROKES	DISPLAY
HYDVO	HYDVO_
[←]	HYDV_
[←]	HYD_
RO	HYDRO_
[GOLD] [CLA]	
[ALPHA]	0.0000
12355	12,355_
[←]	1,235_
[←]	123_
45	12,345_
[GOLD] [CLX]	0.0000

## ERROR CORRECTION

One of the exciting new features offered by the HP-41C is the ERROR CORRECTION key, [+]. No longer is it necessary to clear an entire entry when a mistake is made. In either Normal or Alpha mode, each press of the [+] key deletes one right-most character. Notice how the " \_ " (underscore) prompt moves back as you correct your mistake. Repeated pushes on the [+] will remove more characters.



HEWLETT-PACKARD RPN LOGIC



- \* CONSISTENT APPROACH TO NUMBER AND FUNCTION ENTRY
- \* MEANINGFUL INTERMEDIATE AND FINAL DISPLAY FEEDBACK
- \* KEYSTROKE EFFICIENCY - NO PARENTHESIS
- \* ERROR CORRECTION WITHOUT STARTING OVER

## HP - RPN

The HP-41C employs Hewlett-Packard's powerful yet easy to use RPN logic system. Simply stated, HP-RPN offers the following benefits:

1. **CONSISTENCY** - The operation ALWAYS follows the argument (or arguments) to be operated on. ALWAYS. This is similar to the way one works with pencil & paper.
2. **MEANINGFUL DISPLAY FEEDBACK** - With the HP-RPN system, the display ALWAYS shows the results of the function just performed. This allows a user to check for reasonableness all the way through a calculation. The HP-41C ALWAYS executes a function the instant it is pressed. It does not require storing operations for later execution (pending operations).
3. **KEYSTROKE EFFICIENCY** - The HP-RPN system does not require the entry of parenthesis into the calculator, thus resulting in fewer keystrokes. This feature of HP-RPN is also important for the way in which it conserves program memory space when programming the HP-41C.
4. **ERROR CORRECTION** - Using the LAST X feature, and the power to manipulate an automatic memory stack, HP-RPN gives the user the ability to "Back Up" or even reverse an operation performed by mistake. This eliminates the need to "Start Over" after making a mistake in the middle of a lengthy problem.

## SIMPLE CALCULATIONS

$$3 + 4$$

### WITH PAPER AND PENCIL

$$\begin{array}{r} 3 \\ 4 \\ + 4 \\ \hline 7 \end{array}$$

### WITH THE HP-41C USING HP-RPN

KEYSTROKE	DISPLAY
3	3_
[ENTER]	3.0000
4	4_
[+]	7.0000

## SIMPLE CALCULATIONS

Solving problems with HP-RPN is very similar to solving problems as you would with pencil and paper. We can note the similarity by working a simple problem.

With HP-RPN, the only new element is the [ENTER] key. The [ENTER] key is used simply to separate two numbers, or two intermediate calculations, as we'll see next.

## CHAIN CALCULATIONS

$$16 + 30 - 11 + 17 - 14$$

KEYSTROKE	DISPLAY	ANSWER EQUALS
[GOLD] [CLX]	0.0000	
16	16_	
[ENTER]	16.0000	
30	30	
[+]	46.0000	(16 + 30)
11	11_	
[-]	35.0000	(16 + 30 - 11)
17	17_	
[+]	52.0000	(16 + 30 - 11 + 17)
14	14_	
[-]	38.0000	(16 + 30 - 11 + 17 - 14)
[GOLD] [CLX]	0.0000	

### CHAIN CALCULATIONS

You only have to press [ENTER] when putting two numbers into the HP-41C, one after another. If an operation is to be performed after keying in a number, it is not necessary to "ENTER" the number.

## COMPLEX CALCULATIONS

$$5 \left[ \frac{(3 \div 4) + (4 \times 3)}{(3 \times .213)} \right]$$

KEYSTROKE	DISPLAY
3	3_
[ENTER]	3.0000
4	4_
[÷]	.7500
4	4_
[ENTER]	4.0000
3	3_
[X]	12.0000
[+]	12.7500
3	3_
[ENTER]	3.0000
.213	.213_
[X]	.6390
[÷]	19.9531
5	5_
[X]	99.7653 FINAL ANSWER
[GOLD] [CLX]	0.0000

## COMPLEX CALCULATIONS

Even complex calculations are easily solved using HP-RPN. As we work with more complex problems, you can begin to appreciate the benefits of HP-RPN.

- CONSISTENT APPROACH TO NUMBER ENTRY
- MEANINGFUL INTERMEDIATE AND FINAL DISPLAY  
FEEDBACK
- KEYSTROKE EFFICIENCY - NO PARENTHESIS
- ERROR CORRECTION WITHOUT STARTING OVER

## ADVANCED FUNCTION EXECUTION

PROBLEM	KEYSTROKES	DISPLAY
$\sqrt{5}$	5	5_
	[ $\sqrt{X}$ ]	2.2361
$1/20$	20	20_
	[1/X]	0.0500
$\sqrt{\pi}$	[GOLD] [ $\pi$ ]	3.1416
	[ $\sqrt{X}$ ]	1.7725
$2^2$	2	2_
	[GOLD] [ $X^2$ ]	4.0000
$\sin 35^\circ$	35	35_
	[SIN]	.5736
$6^3$	6	6_
	[ENTER]	6.0000
	3	3_
	[GOLD] [ $Y^X$ ]	216.0000
	[GOLD] [CLX]	0.0000

## ADVANCED FUNCTION EXECUTION

More ADVANCED FUNCTIONS are executed using the same consistent approach.

First key in the argument, then key in the operation. The function (operation) is performed immediately, and the answer appears in the display.

## AUTOMATIC MEMORY STACK

T	0.0000	
Z	0.0000	
Y	0.0000	
X	0.0000	DISPLAY

## AUTOMATIC MEMORY STACK

We have seen that the HP-41C provides an automatic mechanism for temporarily storing arguments and intermediate results, and then making them accessible at the appropriate point in a calculation sequence. This automatic mechanism is called the MEMORY STACK.

The Automatic Memory Stack consists of four storage registers logically arranged to provide a last in, first out storage and retrieval of arguments during calculations.

	T	0.0000	
Each storage register has a	Z	0.0000	
letter name. (See Example)	Y	0.0000	
	X	0.0000	Display

It is important to note that the X register is the display register. This means that the number you see in the calculator's display is always the number you see in the X register.

EXPLORING THE MEMORY STACK

3 + 4

T	0	0	0	0
Z	0	0	0	0
Y	0	3	3	0
X	3	3	4	7

KEYSTROKES     3       ENTER     4       +

## EXPLORING THE MEMORY STACK

We can follow the memory stack's automatic mechanisms by again working our simple addition problem. Note how numbers roll up the stack as we enter a new number and roll down the stack as we perform an operation.



ANOTHER EXAMPLE OF  
AUTOMATIC MEMORY STACK OPERATION

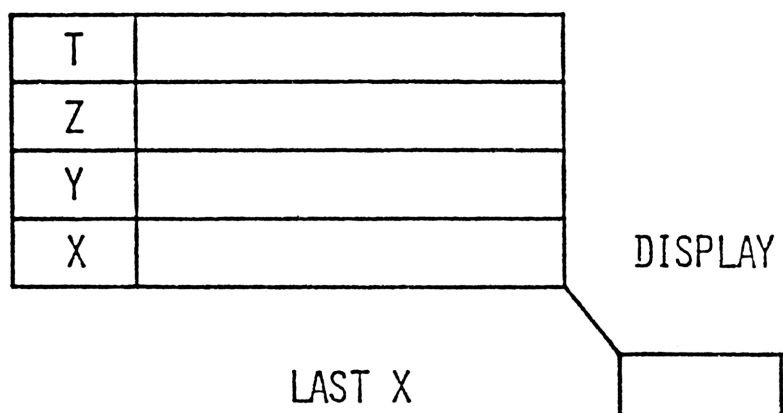
Again, using a problem encountered before, we can follow our intermediate and final calculations through the AUTOMATIC MEMORY STACK.



## STACK MANIPULATION SLIDE

Note to Trainer: This slide is provided for your use if you desire to develop additional stack manipulation examples.

## LAST X REGISTER



KEYSTROKES	DISPLAY
[GOLD] [CLX]	0.0000
3	3_
[ENTER]	3.0000
4	4_
[+]	7.0000
[GOLD] [LAST X]	4.0000
[GOLD] [CLX]	0.0000

## LAST X REGISTER

There are two added features associated with the automatic memory stack, the LAST X REGISTER and the stack manipulation functions. Both contribute to HP-RPN's problem solving flexibility and both are especially helpful in error recovery.

Think of the LAST X register as being separate from the automatic memory stack. The LAST X register preserves the value that was last in the display (X register) before the execution of a function. To place the contents of the the LAST X register into the display register (X register) press [Gold] LAST X.

## ERROR RECOVERY WITH LAST X

SOLVE  $3 + 4 - 6$

T	0	0	0	0	0	0	0	0	0	0
Z	0	0	0	0	0	0	0	0	0	0
Y	0	3	3	0	7	0	2	0	7	0
X	3	3	4	7	5	2	5	7	6	1

KEYSTROKE   3   ENTER   4   +   5   -   LAST X   +   6   -

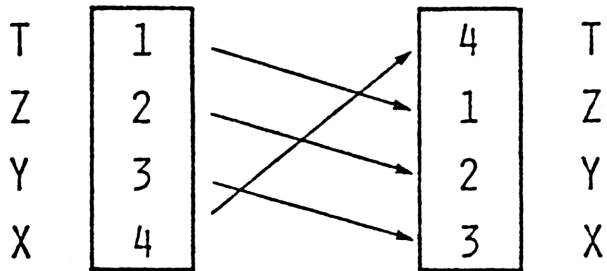
LAST X	0	0	0	4	4	5	5	5	5	6
--------	---	---	---	---	---	---	---	---	---	---

## ERROR RECOVERY WITH LAST X

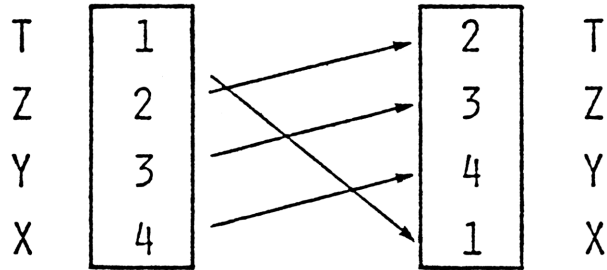
We've seen how one of the HP-41C's new features, the ERROR CORRECTION KEY [ + ], allows us to correct mistakes made while keying in digits. Using the LAST X feature, we can also recover from incorrect digit entry mistakes even after having performed an operation.

STACK MANIPULATION

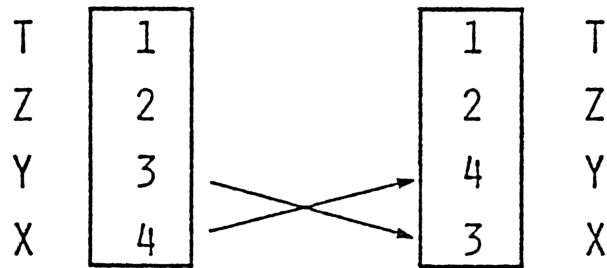
ROLL DOWN



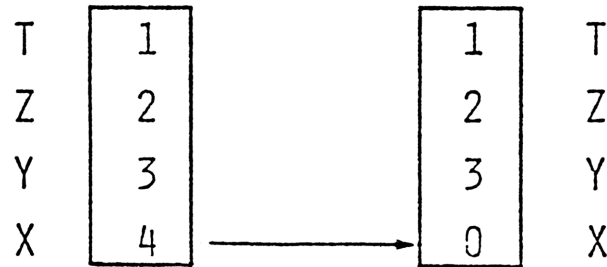
ROLL UP



$X \leq Y$  EXCHANGE



CLEAR X



## STACK MANIPULATION FUNCTIONS

The contents of the automatic memory stack can be manipulated between registers in several ways.

The traditional RPN stack manipulations are ROLL DOWN, ROLL UP, X-Y EXCHANGE, and CLEAR X.

A new stack manipulation feature offered by the HP-41C is the ability to exchange data between the X register and any other register, including the LAST X register.

The ability to manipulate stack contents offers user flexibility in all calculator modes.

# STACK MANIPULATION

T	0	0	0	0	0	0	1	4	4	4	4	4	4	4	4
Z	0	0	0	1	1	2	1	1	1	4	4	4	4	4	4
Y	0	1	1	2	2	3	2	3	2	1	4	4	4	11	11
X	1	1	2	2	3	3	3	4	2	0	3	7	11	7	7

KEYSTROKE    1   ENTER   2   ENTER   3   ENTER   4   R↓   X≧Y   X≧Y   CLX   +   +   +   +   LAST X

LAST X	0	0	0	0	0	0	0	0	0	0	2	3	7	7	7
--------	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

## STACK MANIPULATION EXERCISES

Practice STACK MANIPULATION and watch the changes in the display (X) register.

Note also that, as the stack folds down after performing an operation, the number in the T register automatically "fills in" below.

ALPHA REGISTER

DISPLAY

ABC

ALPHA REGISTER

KEYSTROKES

DISPLAY

1

1\_

[ENTER]

1.0000

2

2\_

[ENTER]

2.0000

3

3\_

[ENTER]

3.0000

4

4\_

[ALPHA]

ABC

ABC\_

[ALPHA]

4.0000

[ALPHA]

ABC

[ALPHA]

4.0000

[R+]

3.0000

[R+]

2.0000

[R+]

1.0000

## ALPHA REGISTER

We have seen how you can execute a function and how the result is placed in the X register and appears in the display.

If you are in ALPHA mode, any characters you key in are placed into a special Alpha register as well as the display. The Alpha register, like the LAST X register, is separate from the automatic memory stack. The automatic memory stack is not disturbed when you key in Alpha characters.

To see what is in the Alpha register, simply place the HP-41C into ALPHA mode. In ALPHA mode, the Alpha register is always displayed.

## APPEND FUNCTION

KEYSTROKES	DISPLAY
[ALPHA]	ABC
[GOLD] [CLA]	
ADD	ADD_
[ALPHA]	1.0000
[ALPHA]	ADD
[GOLD] [K] (APPEND)	ADD_
ITION	ADDITION_
[ALPHA]	1.0000
[ALPHA]	ADDITION
RUN	RUN_
[GOLD] [CLA]	
[ALPHA]	1.0000
[GOLD] [CLX]	0.0000

## APPEND FUNCTION

The APPEND FUNCTION enables you to build on to a string in the Alpha register. You can add characters to a string already in the Alpha register by placing the HP-41C into Alpha Mode, executing the Append Function, and then keying in the desired additional characters.

If you don't execute the Append Function before adding new characters, the new characters will clear the previous string from the Alpha register.

## DATA STORAGE AND RECALL

STO 01 - STORES THE VALUE IN THE DISPLAY IN REGISTER 01  
RCL 01 - RECALLS THE VALUE IN REGISTER 01 INTO THE DISPLAY

KEYSTROKES	DISPLAY
.005	.005_
[STO] 02	0.0050
175	175_
[STO] 10	175.0000
[GOLD] [CLX]	0.0000
[RCL] 02	0.0050
[RCL] 10	175.0000

## DATA STORAGE AND RECALL

The HP-41C DATA STORAGE registers allow you to manually store and recall numbers and Alpha strings for use in later calculations. These registers are independent of the automatic memory stack and the LAST X register.

Note that the HP-41C prompts for a two digit Storage Register number.

## STORING AND RECALLING STACK REGISTER DATA

[STO] [.] Z - STORES THE VALUE IN THE DISPLAY IN THE Z STACK REGISTER

[RCL] [.] Z - RECALLS THE VALUE IN THE Z STACK REGISTER INTO THE DISPLAY

KEYSTROKES	DISPLAY
0	0_
[ENTER]	0.0000
[ENTER]	0.0000
[ENTER]	0.0000
100	100_
[STO] [.] Z	100.0000
[GOLD] [CLX]	0.0000
[RCL] [.] Z	100.0000
[GOLD] [CLX]	0.0000

## STORING AND RECALLING STACK REGISTER DATA

The HP-41C also allows you to STORE AND RECALL DATA in the automatic memory stack registers and the LAST X register.

This is a new feature, and it adds a new level of flexibility to programming.

## ALPHA STRING STORE AND RECALL

KEYSTROKES	DISPLAY
[ALPHA]	.
[GOLD] [CLA]	
ABC	ABC_
[GOLD] L (ASTO)	ASTO _ _
01	ABC
DEF	DEF_
[GOLD] L (ASTO) [.] Z	DEF
[GOLD] [CLA]	
[GOLD] M (ARCL) 01	ABC
[GOLD] M (ARCL) [.] Z	ABCDEF
[GOLD] L (ASTO) 02	ABCDEF
[GOLD] CLA	
[ALPHA]	0.0000
[RCL] 01	ABC
[GOLD] [CLX]	0.0000
[RCL] 02	ABCDEF
[GOLD] [CLX]	0.0000

## ALPHA STRING STORE AND RECALL

While in Alpha Mode, ALPHA STRINGS can be STORED AND RECALLED using the shifted Alpha functions of Alpha Store and Alpha Recall.

Alpha data can also be recalled from stack registers and storage registers while in normal mode, using the normal recall [RCL] function.

[ARCL] always adds the recalled strings to whatever is already in the Alpha register. Later, we'll see how this feature is very useful when labeling data output.

## STORAGE REGISTER ARITHMETIC

- [STO] + 01      NUMBER IN DISPLAY IS ADDED TO VALUE IN REGISTER 01  
AND SUM IS PLACED INTO REGISTER 01
- [STO] ÷ 03      NUMBER IN REGISTER 03 IS DIVIDED BY VALUE IN DISPLAY  
AND QUOTIENT IS PLACED INTO REGISTER 03

KEYSTROKES	DISPLAY
100	100
[STO] 01	100.0000
25	25_
[STO] 03	25.0000
25	25_
[STO]	STO _ _
[+]	STO +_ _
01	25.0000
10	10_
[STO]	STO_
[÷]	STO÷_
03	10.0000
[RCL] 01	125.0000
[RCL] 03	2.5000
[GOLD] [CLX]	0.0000

## STORAGE REGISTER ARITHMETIC

ARITHMETIC can be performed upon the contents of ALL storage registers by executing [STO] followed by the register address. Notice the user prompting during this process.

## DEFINING STORAGE REGISTER CONFIGURATIONS

- TURN-ON CONFIGURATION      17 DATA STORAGE REGISTERS  
                                    46 REGISTERS OF PROGRAM MEMORY  
                                    (322 LINES)  
                                    63 REGISTERS

- 1 DATA REGISTER = 7 PROGRAM LINES

- TO REALLOCATE MEMORY

KEYSTROKES

DISPLAY

[XEQ]

XEQ\_

[ALPHA] SIZE [ALPHA]

SIZE \_ \_ \_

080

PACKING

TRY AGAIN

[XEQ]

XEQ\_

[ALPHA] SIZE [ALPHA]

SIZE \_ \_ \_

010

0.0000



CONFIGURATION IS NOW

10 DATA STORAGE REGISTERS

53 REGISTERS OF PROGRAM  
MEMORY (371 LINES)

63 REGISTERS

## DEFINING STORAGE REGISTER CONFIGURATIONS

The HP-41C comes standard with 63 storage registers. Memory modules can be added to increase the number of registers to a total of 319.

In the HP-41C, program memory also uses storage registers for the storage of program instructions. One of the exciting features of the HP-41C is its ability to allocate registers between data storage and program memory. The [SIZE] function allows you to specify the number of data storage registers you wish to have allocated. Every register allocated to program memory provides the user with seven additional lines of program memory.

If you attempt to increase the allocation of storage registers and there is not enough unused space in program memory for this increase, the HP-41C will display PACKING and then TRY AGAIN. After you execute Size again, if the HP-41C again displays PACKING and TRY AGAIN, this means that the reallocation is not possible until program instructions are deleted from program memory.

If you decrease the allocation of data storage registers, any information in reallocated data storage registers will be lost.

The HP-41C turns on with a standard allocation of 17 storage registers and 46 registers of program memory. Each storage register can convert to 7 program lines.

Since we'll need more program memory than the standard allocation to complete our training, use [SIZE] to allocate an additional 7 storage registers to program memory. (Execute [SIZE] 010, leaving 53 registers of program memory.)

## DISPLAY FORMAT CONTROL

### FIXED POINT

KEYSTROKE	DISPLAY
[GOLD] FIX 2	0.00
[GOLD] FIX 9	0.0000000000
[GOLD] FIX 4	0.0000

### SCIENTIFIC NOTATION

KEYSTROKE	DISPLAY
150	150_
[ENTER]	150.0000
[GOLD] [SCI] 6	1.500000 02
[GOLD] [SCI] 4	1.5000 02
100	100_
[X]	1.5000 04

### ENGINEERING NOTATION

KEYSTROKE	DISPLAY
[GOLD] [ENG] 4	15.000 03
[GOLD] [ENG] 2	15.0 03
100	100_
[X]	1.50 06
[GOLD] [CLX]	0.00 00
[GOLD] [FIX] 4	0.0000

## DISPLAY FORMAT CONTROL

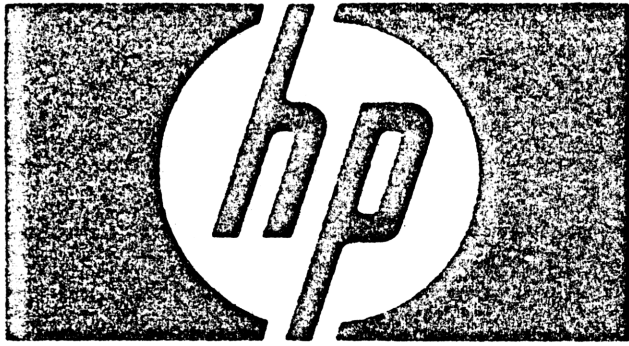
As seen earlier, the HP-41C can display up to 10 digits at one time. The user also has his choice of three display modes.

- FIXED            -        Using Fixed Point display, you can specify the number of places to be shown after the decimal point.
  
- SCIENTIFIC      -        With the HP-41C in Scientific Notation mode, each number is displayed with a single digit to the left of the decimal point. This number is followed by a user specified number of digits (up to 7) to the right of the decimal point and is followed by the appropriate exponent of 10.
  
- ENGINEERING     -        Engineering Notation is similar to scientific notation except that Engineering Notation shows all exponents in multiples of 3.  
                              (e.g.,  $10^3$ ,  $10^{-6}$ ,  $10^{12}$ ).

AUDIBLE BEEPER

KEYSTROKE	DISPLAY
[GOLD] [BEEP]	0.0000
[GOLD] [BEEP]	0.0000
[GOLD] [BEEP]	0.0000





## HEWLETT-PACKARD 41C

- THE HP-41C IS A SIMPLE-TO-USE HANDHELD CALCULATOR . . . IT COMMUNICATES WITH A USER
- THE HP-41C HAS AN EXCITING NEW KEYBOARD DESIGN . . . YOU CAN CUSTOMIZE THE CALCULATOR TO YOUR OWN DESIGN
- 130 STANDARD FUNCTIONS
- FUNCTION CATALOGS
- EXECUTE FUNCTION
- ASSIGN FUNCTION
- USER MODE KEYBOARD
- KEY PROMPTING
- KEYBOARD OVERLAYS

## CUSTOMIZES TO YOUR OWN DESIGN

We've seen how the HP-41C communicates with the user.

Now we'll see how you can CUSTOMIZE it to your own design.

## COMPLETE FUNCTION SET

- OVER 130 STANDARD FUNCTIONS, INCLUDING EXTENSIVE
  - GENERAL MATHEMATICS FUNCTIONS
  - TRIGONOMETRIC FUNCTIONS
  - LOGARITHMIC AND EXPONENTIAL FUNCTIONS
  - STATISTICAL FUNCTIONS
  - OPERATIONAL AND GENERAL FUNCTIONS

## COMPLETE FUNCTION SET

### 130 STANDARD FUNCTIONS

As you may have noticed by now, not all of the functions available in the HP-41C are printed on the keyboard.

The HP-41C has a very complete function set, including over 130 standard functions, 68 of which are immediately accessible by pressing keys on the keyboard.

## FUNCTIONS CATALOGS

CATALOG 1 - THE USER CATALOG

CATALOG 2 - THE EXTENSION CATALOG

CATALOG 3 - THE STANDARD FUNCTION CATALOG

KEYSTROKES	DISPLAY
[GOLD] [CLX]	0.0000
[GOLD] [CATALOG]	CAT_
3	CAT 3
	+
	-
	.
	.
	.
	X↗2
	Y↗X
	0.0000
[GOLD] [CATALOG]	CAT_
1	.END. REG 53
	0.0000
[GOLD] [CATALOG]	CAT_
2	0.0000

## FUNCTIONS CATALOGS

Most of the standard functions (117) are conveniently stored away for the user in what is called CATALOG 3. In order to review the standard functions contained in Catalog 3, press [Gold] Catalog 3. The HP-41C will then list the functions in alphabetical order. To slow down the listing press and hold [ + ], to stop the listing press [R/S]. After pressing [R/S] you can single step forward or backward through the catalog listing. To continue the listing, press [R/S] again.

Besides Catalog 3, which contains standard functions, the HP-41C has two other catalogs.

CATALOG 1, the user catalog, contains a listing of all user programs currently stored in the HP-41C. If no user programs are stored in the HP-41C, Catalog 1 remains empty.

CATALOG 2, the extension catalog, contains all functions that become active when you plug extensions into the HP-41C, such as the Card Reader, Printer, Application Modules, or other accessories. If no extensions are plugged into the HP-41C, Catalog 2 remains empty. (If an extension is available, review Catalog 2 while it is plugged into the HP-41C.)

## EXECUTE FUNCTION

KEYSTROKES	DISPLAY
6	6_
[XEQ]	XEQ _ _
[ALPHA]	XEQ_
FACT	XEQ FACT_
[ALPHA]	720.0000
[XEQ]	XEQ _ _
[ALPHA]	XEQ_
SQRT	XEQ SQRT
[ALPHA]	26.8328
[XEQ]	XEQ _ _
[ALPHA]	XEQ_
INT	XEQ INT_
[ALPHA]	26.0000

## EXECUTE FUNCTION

All 130 standard functions can be executed from the display using the EXECUTE FUNCTION.

Before using the Execute Function, you must first place the argument to be executed upon in the display. Then press the [XEQ] key. The HP-41C will then prompt you for a function to be executed. The HP-41C will execute the desired function immediately after receiving it, just as it does when executing a keyboard function.

## ASSIGN FUNCTION

KEYSTROKES	DISPLAY
[GOLD] [CLX]	0.0000
[GOLD] [ASN]	ASN_
[ALPHA]	ASN_
FACT	ASN FACT_
[ALPHA]	ASN FACT _ _
[Σ+]	0.0000
[GOLD] [ASN]	ASN_
[ALPHA]	ASN_
SQRT	ASN SQRT_
[ALPHA]	ASN SQRT _ _
[1/X]	0.0000
[GOLD] [ASN]	ASN_
[ALPHA]	ASN_
INT	ASN INT_
[ALPHA]	ASN INT _ _
[√X]	0.0000

## ASSIGN FUNCTION

You may find that you use functions not on the keyboard as often as those permanently on the keyboard. The HP-41C allows you the flexibility to correct for this by providing the capability to assign any function in any catalog to any key. This includes Standard Functions, Extension Programs, or User Programs. This flexibility to customize your calculator to your own design is made possible with the ASSIGN FUNCTION.

Once a function or a program is assigned to a key, merely press the key while in User Mode, and it is immediately executed.

If you attempt to assign a function whose name does not exist in the calculator, the HP-41C will display non-existent. Use Catalog 3 to help you with function names.

### USER MODE KEYBOARD

KEYSTROKES	DISPLAY
[USER]	0.0000
6	6_
[ $\Sigma$ +] (FACT)	720.0000
[1/X] (SQRT)	26.8328
[ $\sqrt{X}$ ] (INT)	26.0000
[USER]	26.0000
[ $\sqrt{X}$ ]	5.0990
[GOLD] [CLX]	0.0000

## USER MODE KEYBOARD

User assigned functions are active while the calculator is in USER MODE.

If you have assigned a function or a program to a key, that function or program will execute immediately when you press the key (while in User Mode). If you have not assigned anything to a key, its normal function continues to be active even in User Mode.

## KEY PROMPTING

KEYSTROKES	DISPLAY
[ $\Sigma$ +]	$\Sigma$ +
	NULL
[1/X]	1/X
	NULL
[ $\sqrt{X}$ ]	SQRT
	NULL
[USER]	
[ $\Sigma$ +]	FACT
	NULL
[1/X]	SQRT
	NULL
[ $\sqrt{X}$ ]	INT
	NULL
[USER]	0.0000

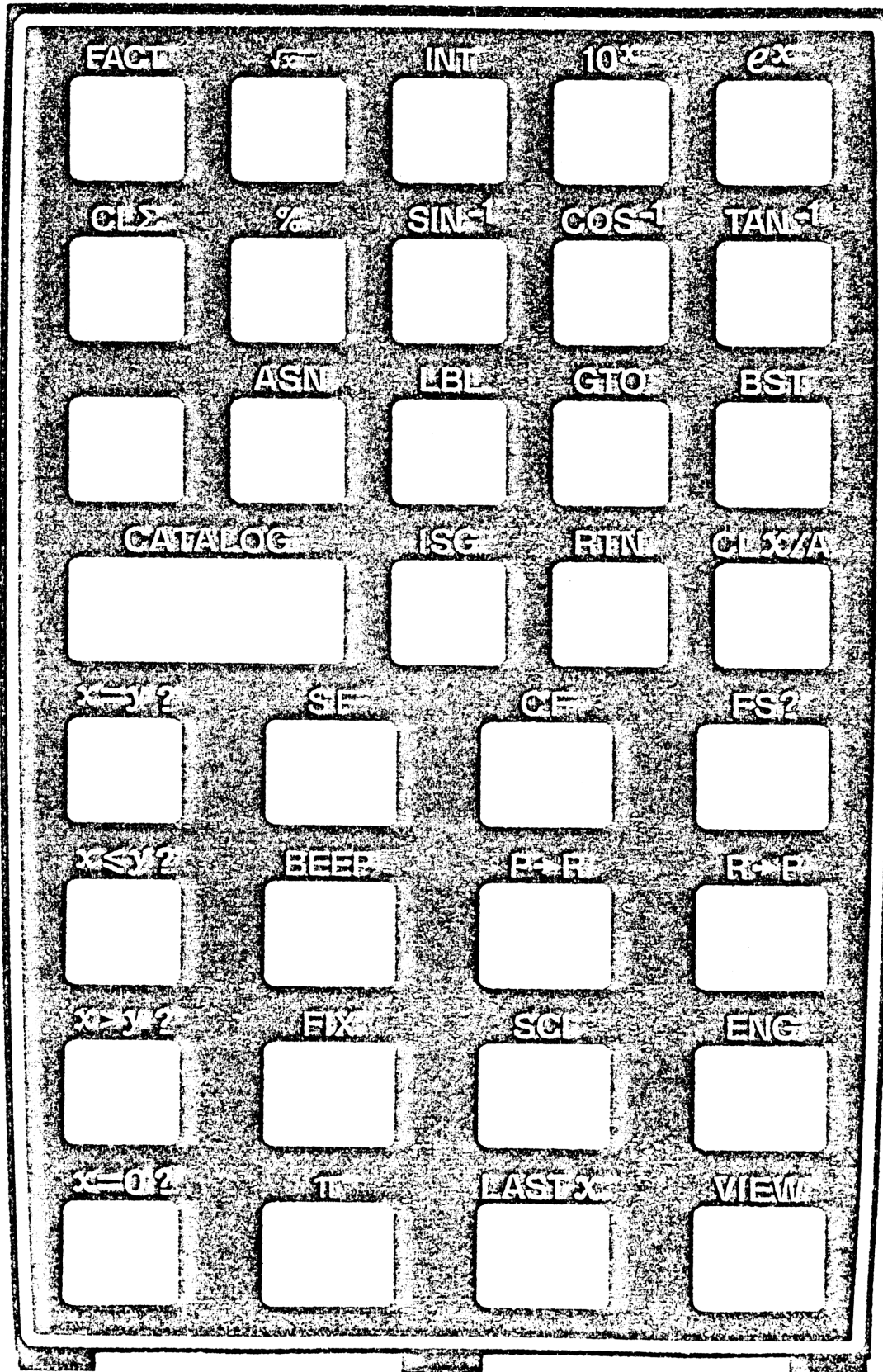
## KEY PROMPTING

The HP-41C will tell you which functions are active in both modes for each key through a special feature called KEY PROMPTING.

If you press down on a key and hold it down, it will prompt you with the function assigned to that key. The same is true while in User Mode. If you release the key, the function will execute. If you continue to hold the key down, the word NULL will appear, and the function will not execute.

# KEYBOARD OVERLAYS

USER DEFINED FUNCTIONS



## ALPHA PROMPTING

Some of the greatest benefits of the HP-41C ALPHA capabilities are realized during program execution. ALPHA Strings (a series of Alpha characters) in your programs can prompt you for information, inform you of the status of a program, and even label output.

Using the "Circle" program we wrote earlier, we'll see how to prompt for DATA Input using the Prompt function.

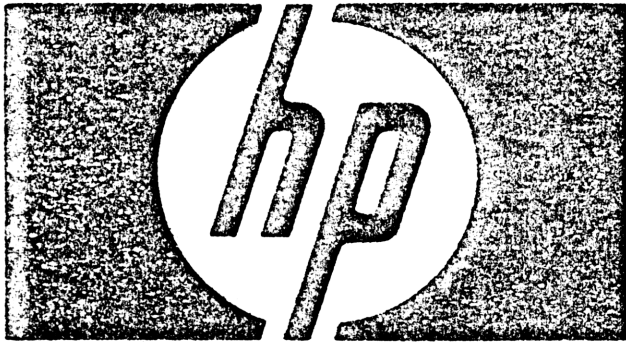
## DATA LABELING

KEYSTROKES	DISPLAY
[GOLD] [GTO]	GTO_
[ALPHA] CIRCLE [ALPHA]	78.5398
[PRGM]	1 LBL $\uparrow$ CIRCLE
[GOLD] [GTO].006	06 *
[ALPHA] AREA =	07 $\uparrow$ AREA =
[GOLD] M (ARCL) [.]X	08 ARCL X
[GOLD] [AVIEW]	09 AVIEW
[ALPHA]	09 AVIEW
[GOLD] [GTO] [.] [.]	00 REG NN
[PRGM]	78.5398
[X $\rightarrow$ Y] (CIRCLE)	RADIUS?
5	5_
[R/S]	AREA=78.5398
[X $\rightarrow$ Y] (CIRCLE)	RADIUS?
10	10_
[R/S]	AREA=314.1593
[USER]	AREA=314.1593

## DATA LABELING

DATA LABELING can make your program outputs much more meaningful. Labeled output leaves no doubt as to which result is displayed.

To label output, first key in the ALPHA line as a line in the program, then recall the result to be labeled into the display using [ARCL]. Remember that [ARCL] simply adds to whatever is already in the Alpha register. Then use the [AVIEW] function to place the contents of the Alpha register into the display.



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- THE HP-41C HAS A UNIQUE COMBINATION OF PROGRAMMING EASE AND SOPHISTICATION . . . IT IS EASY TO PROGRAM
- THE HP-41C HAS PROGRAMMING POWER . . . IT CAN SOLVE PROFESSIONAL PROBLEMS
  - CONDITIONAL BRANCHING
  - CONTROLLED LOOPING
  - SUBROUTINES
  - LOCAL LABELS
  - INDIRECT ADDRESSING
  - FLAGS