

The Hewlett-Packard Personal Calculator DIGEST

The HP Magazine and Product Catalog

Volume One, 1976

Printing Calculators that work almost anywhere.

BACKGROUND STORY ON PAGE 4.



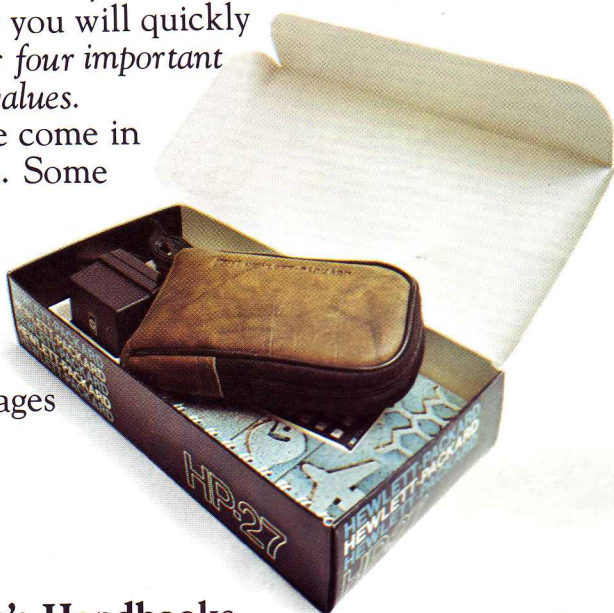
**HP CATALOG BEGINS ON PAGE 7!
5 NEW CALCULATORS LISTED!**

The hidden values They don't all c

When you buy a new calculator by Hewlett-Packard you will quickly discover *four important hidden values*.

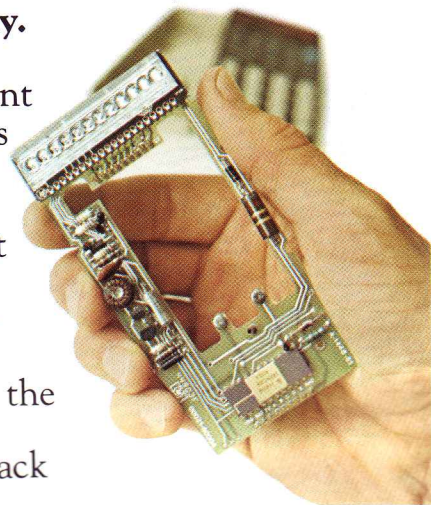
Some come in the box. Some do not.

All provide significant advantages to you.

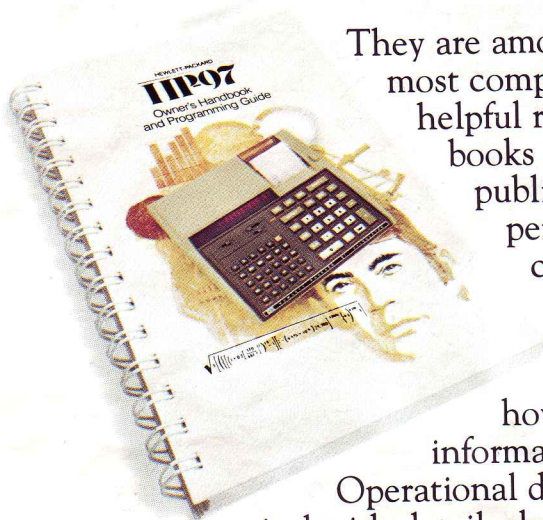


Super-fast service and a full, one-year warranty.

In the unlikely event your calculator fails to operate properly and your HP dealer can't correct it, send it to us. We'll repair it, normally, in only two working days from the time we receive it, and send it right back to you.



Owner's Handbooks that are far more than handbooks.

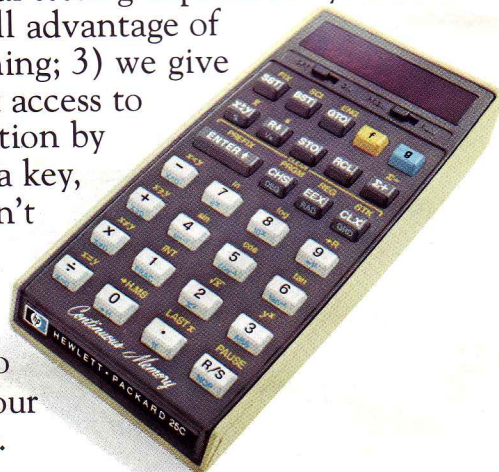


They are among the most complete and helpful reference books ever published for personal calculators, going far beyond the usual how-to-use-it information.

Operational data is given in lavish detail, along with many suggestions for maximum efficiency in use. And there's page after page of practical applications.

Design features that provide extra operational convenience.

Three cases in point: 1) We provide all the storage registers you usually need—for those problems that require them; 2) On HP programmable calculators we give you all the editing, branching and conditional testing capabilities you need to take full advantage of programming; 3) we give you direct access to each function by means of a key, so you don't have to memorize a secret formula to operate your calculator.



of HP Calculators. come in the box.

Uncompromising quality that top professionals rely on.

With an HP calculator, you're in good company. No less than five Nobel Prize winners own and use them. In fact, the first American to climb Mt. Everest packed one in his pocket.

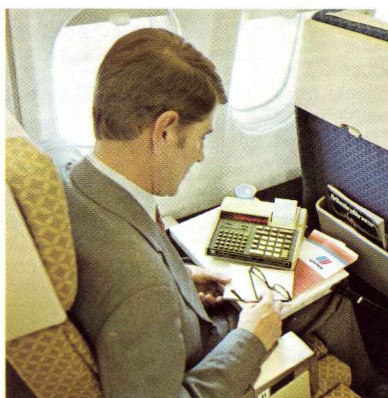
And HP calculators have been standard equipment on three manned space flights. During the USA-USSR link-up in space,



they were selected for critical in-flight calculations.

You'll also be glad to know that HP calculators are durable enough to have survived fires, plane crashes, immersion in salt water, falls from speeding cars, cruises through storm sewers, even trips through snow-blowing machines—and continued to work!

The sheer pleasure of owning an HP Calculator.



Ask the owner of an HP calculator how he likes it and you're apt to detect in his answer a quiet sense of pride.

For he has experienced the sheer pleasure of owning an instru-

ment that has been designed—in every detail—to be the finest of its kind in the world.

He has learned that the important values provided by an HP calculator can significantly extend his professional skills.

HEWLETT  **PACKARD**

Sales and service from 172 offices in 65 countries.
19310 Pruneridge Avenue, Cupertino, California 95014

Letters

Some of our customers have a flair for writing. It is with pleasure that we share with you a few of their letters to us.

I recently purchased an HP-25 calculator. I work for a small engineering design firm specializing in lightweight structures, generally for aircraft, I would like to tell you how delighted I am with the machine because it saves me time and also allows problems to be studied in greater depth than would have been possible without it, because it is possible to do quite complex mathematical analyses so easily that one does them where often one would have taken an informed guess before. I am writing to you partly because I am so pleased with the calculator, and partly because I saw the list of people who own your machines on the front page of the Owner's Handbook. You might like to know you also have a balloonist on the list.

—Julian Nott
London, England

Mr. Nott is the holder of the World Altitude Record for a hot air balloon, 45,800 feet, set in India in 1974. For the design and piloting of this special balloon and the organization of this project, Mr. Nott was awarded the Gold Medal of the Royal Aero Club, a unique distinction for a balloon pilot.

—Editor

I recently purchased an HP-21 and am writing to compliment you on both your calculator and your marvelously concise and well-written Owner's Handbook. They are a joy to own, and I am really impressed with the time and effort you have put into your Handbook. The logic used in the calculator really does make complex problem solving easy! I completed an intricate physics problem today that would normally take about twenty minutes manually in just about five minutes using my calculator. My previous calculator would have required about ten minutes to do the problem. The HP-21 is a real help! My most praise goes, however, to the Owner's Handbook. Besides teaching the owner to, step-by-step, work the calculator, it also does this in a manner that is fun and sometimes quite humorous. I actually enjoyed learning the new method of calculator operation. I am duly impressed and wish you success in the future.

—William J. Candee IV
Exeter, New Hampshire

We have run the HP-21 through a road test composed of basic electrical problems, through complex circuit analysis. These problems are similar to those the FCC poses in their federal license exams. The HP-21 proved to be the simplest mathematical aide of the scientific calculators we sampled. It is hard to boggle an equation using RPN, and the function keys which never operate more than two numbers at one time. Also the appearance and lift of the HP-21 makes it impossible to keep it out of everyone's hands who sees it.

—S.A. LeVasseur
San Francisco,
California

Questions and Answers

Here are five questions that often pop up in our mail, along with our answers.

If I order a calculator direct from the factory, when may I expect delivery?

The normal delivery period is two-three weeks but this may vary somewhat with newly introduced products. For fastest possible delivery, call us Toll Free at 800-538-7922 (in California: 800-662-9862), Extension 1000, and charge your purchase to your credit card.

Where do I send my calculator for service?

In an effort to provide faster and more economic service to all our customers, repairs for Hewlett-Packard pocket calculators were transferred to a central service center in Cupertino, California in mid 1975. As of September 1, 1976 this central service center will be moved to Corvallis, Oregon. Send your calculator for repair after this date to:

Hewlett-Packard Company
Corvallis Division Service Dept.
P.O. Box 999
1000 N.E. Circle Blvd.
Corvallis, Oregon 97330

Incidentally you might want to take a look at the *Service Plus* article on page 24 of this magazine to see what happens to your calculator after it comes to us for repair.

How long will my battery pack last before I need to replace it?

Battery life is measured by the number of times a pack can be recharged rather than by its age. Typically a pack will accept 500-1000 recharges. To help prolong its life, use the full charge/discharge cycle. In other words, use the calculator until the indicator lights come on and then put it on AC, instead of using it briefly and recharging for short periods.

Does the full one-year warranty include accessories?

Since repair cost often exceeds the value of an accessory, defective ones are replaced rather than serviced. The replacement can be made without charge if your calculator is still under warranty. (The warranty is for one year from the date of original purchase.) After a warranty has expired, replacement accessories can be ordered directly using the order form attached.

Can I order an HP calculator with a display in a color other than red?

Red is the only color used for the LED (light emitting diode) display on our calculators. Because the segments are magnified five times their actual size, it is necessary to use a material that emits a bright light. Other colors have been considered; however, the materials used to produce them do not give a light intense enough for a clear image.

Beyond the Call of Duty

Although the typical HP pocket calculator spends a normal life on a desktop, in a shirt pocket, or travelling in a briefcase, occasionally we hear of cases where extreme demands are made on them. It's satisfying to learn that our products can often withstand the severest of conditions and keep on working. Here are a few such cases, sent to us by HP owners.

"I am an owner of your HP-45 pocket calculator and I would like to relate to you an experience that I recently had. I attend summer school and go to and from school on my motorcycle with my HP-45 attached to my belt. Yesterday while driving to school at 40 miles per hour, my carrying case broke and my calculator went flying to the ground, and what I believed to be its inevitable destruction. After locating my HP-45 along the side of the road, I was amazed to see that the unit not only looked OK, but was in perfect operating condition. Although now without a carrying case, I am happy to have my calculator."

"I'd like to offer a little recent experience of my own which involved my HP-65. I just returned from a 2-month stay inside Alaska at Eielson Air Force Base (near Fairbanks) during January and February 1975. We were looking for cold weather to test one of the Air Force's newest fighter planes, and we found it! Temperatures reached 68°F below zero. I was required to read critical temperatures after over-night cold-soaking of the plane. It never went into the hangar. I found I could use my HP-65 outside at 20°, 30° and 35°F below zero for as long as 20 minutes at a time with no problems. However, when I tried to run my short program and get expected results at 40°F below zero, 'Old Faithful' balked and gave me erroneous information. But it revived with no loss of program after about 5 minutes inside at about 60°F above zero."

"I have this problem that weighs about 160 lbs. It's my Great Dane, Nimr, who seems to thrive on the taste of HP-65's. Ever since I got my calculator, I started spending more time playing with it than with my dog. Nimr took it rather personally and decided to adopt a new mission in life: destroy that mean machine and eliminate competition! We've had a few close shaves in the past, but thanks to my brilliant anti-canine strategy, I have so far managed to avoid any serious mishaps. Regrettably, however, my brilliant strategy was no match for Nimr's indefatigable determination, and, despite all efforts on my part to keep my HP-65 out of his reach, he, much to my dismay, succeeded in accomplishing his mission. Woe is me for I am now HP-less. Can you please help by replacing all the semi-digested parts?!"

Contribute to Digest: The Editors would be delighted to hear of any incident or experience you may have had with an HP calculator that would be of interest to our readers. Because of space limitations, not all letters received may be used and all letters are subject to editing. Please address your contributions to Editor, HP Digest, Hewlett-Packard Company, Advanced Products Division, 19310 Pruneridge Road, Cupertino, California, 95014, U.S.A.

The Hewlett-Packard Personal Calculator DIGEST

The HP Magazine and Product Catalog

Volume One, 1976

The Hewlett-Packard Full One Year Warranty*

Each Hewlett-Packard calculator and accessory is warranted against defects in materials and workmanship for one year from the date of delivery. During the warranty period, Hewlett-Packard will repair, or at its option, replace at no charge, components which prove to be defective, provided the calculator or accessory is returned, shipping prepaid, to Hewlett-Packard's Customer Service facility. (Refer to shipping instructions.)

This warranty does not apply if the calculator or accessory has been damaged by accident or misuse, or as a result of service or modification by other than an authorized Hewlett-Packard Customer Service facility. No other expressed warranty is given by Hewlett-Packard.

Hewlett-Packard shall not be liable for consequential damages.

*A copy of the complete warranty is available upon request.

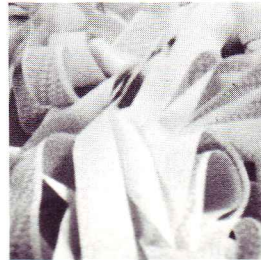
As of the date of this catalog, all prices, claims, materials and specifications are as shown. However, Hewlett-Packard reserves the right to make changes without notice.

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HEWLETT  PACKARD



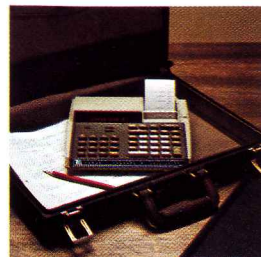
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Thermal Printing.

A new dimension in personal calculators.

When the Titan Prometheus brought fire from Mt. Olympus to earth (for which he paid dearly*), he certainly did not envision man using it to print on paper. But in thermal printing this is essentially what happens. A high-temperature source (resistor dot) is placed in contact with heat-sensitive paper to create images.

Unlike impact printers (found in most typewriters and adding machines) no messy ribbons and ink-clogged keys are involved. And thermal printers are smaller, lighter in weight, and less expensive—ideal for battery-operated calculators like the new HP-91 Scientific Printing Calculator and the HP-97 Fully-Programmable Printing Calculator.

The engineers in HP's labs had two types of thermal printers to choose from: fixed-head thermal printers, which use a large element array with five printhead resistors for each character, and moving-head thermal printers, which use a single seven-element printhead that moves across the paper to print characters. They chose the latter for the HP-91 and HP-97.

The thermal printer was developed by groups of engineers working concurrently on four major problems: the printhead, the mechanism to drive the printhead, the circuitry to drive the printhead, and the testing of both the printhead and the mechanism.

* Prometheus was chained to a rock by Zeus where an eagle continually gnawed his liver until he was later freed by Hercules.

The Printhead

The HP-91 and HP-97 use a thinfilm printhead with seven resistors that heat and cool very quickly. A piece of ceramic substrate is the basic building block for each 6.3mm by 20.3mm printhead. A two-layer film consisting of a resistive film plus an aluminum interconnect layer is deposited on the substrate by a process known as sputtering. In sputtering, argon ions are accelerated toward a target of the material to be deposited to effect a momentum transfer. Some of the material is ejected from the target surface and deposits on the ceramic surface. A mask is placed on this composite metal and resistor film and it is etched to make the seven-resistor pattern. Finally, a hard, wear-resistant layer is deposited to protect the resistor elements.

Thermal printing in these new calculators forms characters in a dot matrix that is seven dots high and five dots wide. (Refer to Figure 1.) Each dot is approximately .3mm on a side.

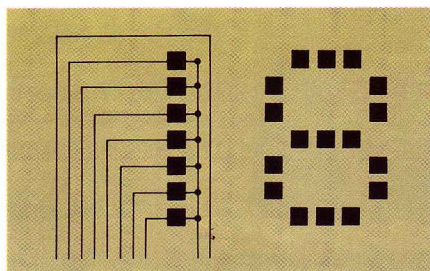
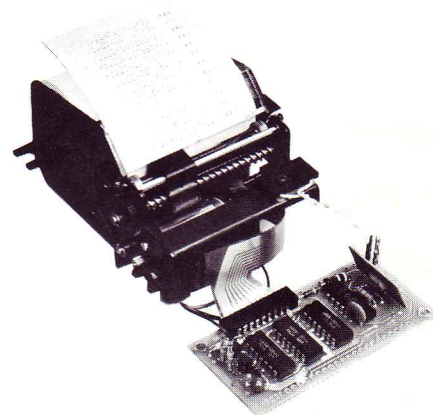


Figure 1. Printhead resistor pattern and dot matrix character.

Each dot is the result of a color reaction in the paper, which has been coated with two types of pulverized thermoreaction compounds and a binder. For example, many papers are coated with a colorless dyestuff (a triphenyl methane phthalide) such as crystal violet lactone and a phenol compound such as bisphenol A. The binder is composed of high-molecular compounds that have good film formation properties such as methyl cellulose, polyacrylic amide, or polyvinylbutyral. When heat is applied, a chemical reaction takes place (Refer to Figure 2.) which changes the color of the paper at the point of heat.

The Printer Mechanism

A fast-response ironless-armature DC motor is used to move the printhead across the paper. This type of motor is 70 to 80 percent efficient, a high rating compared to a conventional iron-core motor that averages 50 percent or less. The motor propels the printhead the required line length (a minimum of eight characters), then reverses to bring it back. This short line capability means faster printing for most applications. Characters are printed right-to-left and are right justified.



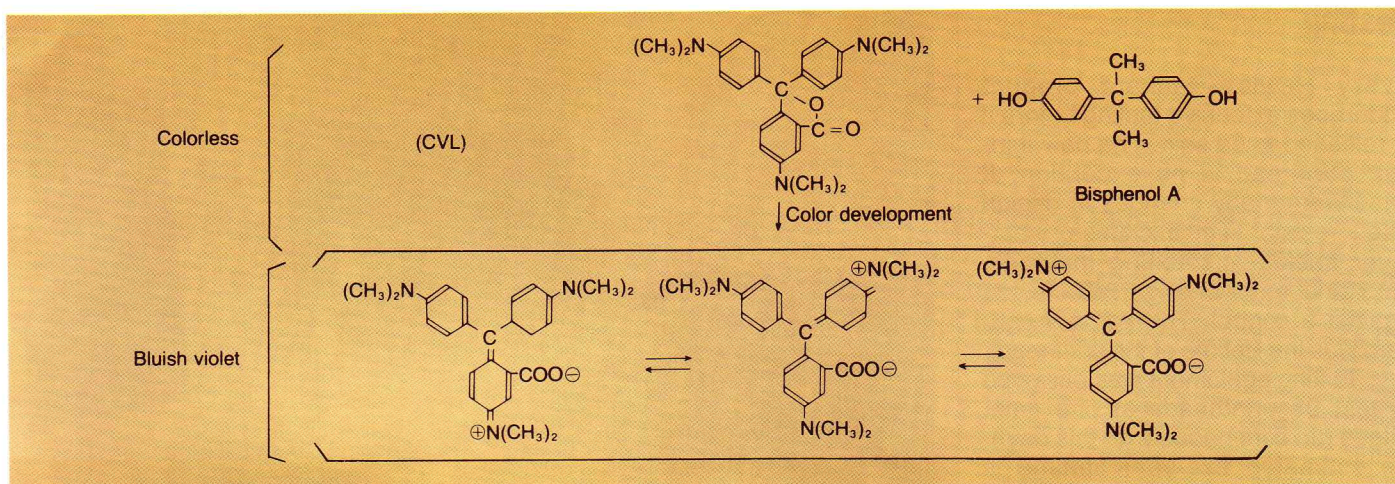


Figure 2. Typical thermal paper chemical reaction.

The printhead, which is always in contact with the paper, is guided by stainless steel shafts set in a plastic mainframe. A separate cam-shaft advances the paper on the return stroke.

Power to the printhead is supplied through a special flex-cable (that took almost 2 years to perfect) that bends as the printhead moves. Because the cable conductors are copper and the printhead interconnects are thin-film aluminum, conventional solder bonding was not possible. Ultrasonic wire or stitch bonding finally provided the answer.

The Printer Circuitry

Mounted on a printed-circuit board 38mm by 76mm, the printer circuitry is divided into four parts: the motor driver, the motor speed control, a thermal-head driver, and a power regulator and voltage reference.

The motor driver is a seven transistor circuit that drives the motor forward, reverses it, or brakes its rotation. The basic structure is that of a transistor bridge circuit as shown in Figure 3.

The motor speed control regulates the speed of the motor during the print time. The scheme is based on the sampled EMF principle. During a sample period, the back EMF of the motor, which is proportional to the speed of the motor, is measured and compared to a constant reference voltage. If the measured voltage is greater than the reference voltage, the motor is turning too fast. In this case the power to the motor is shut off until the EMF falls below the reference voltage. If the measured voltage is less than the reference voltage, the motor is turning too slowly. In this case the power to the motor is restored immediately after the sample period. Since the sample rate is fast (several hundred samples per second) and the motor mechanical response time is much longer than the sample period, the motor smooths out its pulsed power input. The result is a steady regular motor speed.

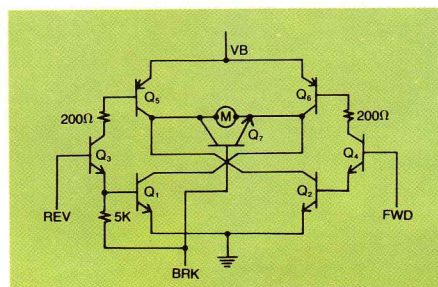


Figure 3. Transistor bridge circuit that forms the basic structure of the motor driver.

The head driver circuit selectively energizes the seven resistors when printing. Certain characters like a one, seven, "T", and "I" require all seven resistors to be on simultaneously. In order to minimize power loss in unwanted parasitic resistors, the character is electrically slanted by logic. (Refer to Figure 4.) This slanting method reduces the instantaneous current required to print, thereby increasing efficiency and prolonging battery life.

To maintain uniform print contrast, the head resistors must develop the same temperature profile each time they are energized. The power regulator circuit ensures that the head resistors are supplied with a constant energy independent of the battery voltage. Unlike most power regulators, this small, inexpensive circuit's efficiency is greater than 90 percent despite changes in battery voltage.

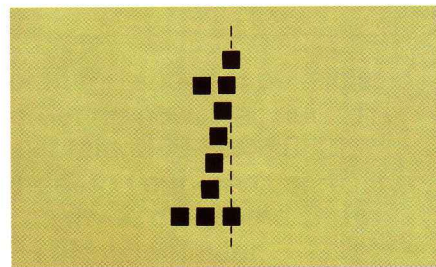


Figure 4. Some characters are electrically slanted by logic to increase efficiency.

(Continued on next page)

Thermal Printing—Continued

Testing

Every Hewlett-Packard product undergoes extensive testing before it is released to be sold. The new thin-film printhead is no exception. It underwent many changes in design (e.g., resistor film thickness, wear-layer thickness, etching methods, etc.) and each change was tested against a control. The primary concern was the lifetime of the printhead.

Testing equipment was designed to test 95 printheads at one time. These run continuously (to this day!). An estimated five-year lifetime is simulated every two weeks running 24 hours a day, printing over 17 million characters. During this time the seven resistors in each printhead are measured twice a day. If a single resistor value rises past 25 ohms (10 ohms is normal), that printhead has failed the test. To date we have tested over 1000 printheads and made over 70,000 resistor measurements. We are currently using paper at the rate of 360 miles per month. This is the amount of testing necessary to assure traditional Hewlett-Packard reliability.

Of course the thermal printer is only one feature of the new HP-91 and HP-97, fully described on pages 19 and 16, respectively. ■



Before paper take-up rollers were installed, thermal paper filled the testing room over weekends.

How to use the Hewlett-Packard Catalog and Buyer's Guide to Personal Calculators.

The Buyer's Guide Page 8-9

This guide lists every feature and function found in all HP Personal Calculators. You will find the list extremely useful in determining specific features and functions on any unit and for making fast direct comparisons of two or more units.

The Catalog Page 10-23

The catalog provides a description of each HP Personal Calculator with emphasis on its special capabilities and applications in meeting user requirements. Also given are physical specifications and accessories furnished with each unit.

How to order from this Catalog

You may order any HP Calculator from this catalog—using the enclosed Order Form, or by calling our toll-free number*—for a 15-day trial. If, after that time, you are not satisfied with the unit—for any reason—simply return it for a prompt refund in full (regardless of the payment method you choose) or for credit toward any other Hewlett-Packard calculator.

*You can get your new HP calculator in the shortest possible time by picking up the phone and ordering now. Call our Toll-Free number: 800-538-7922 (in California: 800-662-9862), Extension 1000, and charge your order to your credit card. You get the same return privileges as if you'd sent the Order Form—and you'll get your new HP calculator faster.

Buyer's Guide

Features/Functions	HP-21 PAGE 14	HP-27 PAGE 12	HP-25/25C PAGE 10	HP-22 PAGE 15	HP-80 PAGE 22	HP-91 PAGE 16	HP-67 PAGE 18	HP-97 PAGE 18
RPN Logic System								
Memory								
Automatic four-memory stack								
Addressable memory	1	10	8	10	1	16	26	26
Financial memory		5		5				
Last x memory								
Program memory			49				224	224
Continuous memory (program and data)			25C only					
Positioning Operations								
Stack roll down								
Stack roll up								
x, y memory exchange								
x, I memory exchange								
Display								
Fixed notation								
Scientific notation								
Engineering notation								
Automatic overflow into scientific								
Automatic underflow into scientific								
Enter exponent								
Change sign								
Improper operating and low battery indicators								
Special Features								
Digital Timer								
Calendar								
Programming Features								
Program review—back step								
Program review—single step								
Insert/delete								
Overwrite								
Direct branching								
Pause								
Conditional tests			8				8	8
Flags							4	4
DSZ, ISZ (looping)								
3 levels of subroutines								
Smart card reader:								
Stores programs and data								
Merges programs and data								
Automatic prompting								
20 labels								
10 user-defineable functions								
Indirect control of:								
Data storage and recall								
Storage arithmetic								
Unconditional branching								
Subroutine branching								
DSZ, ISZ								
Display								
Relative addressing								
Clearing Options								
Clear x								
Clear stack								
Clear all								
Clear addressable registers								
Clear statistical registers								
Clear prefix								
Clear program memory								
Reset financial registers								
Printing Features								
Print x								
List stack registers								
List addressable registers								
List statistical registers								
Paper advance								
Three print modes								
Print space								
List program								

This chart has been designed for your convenience in making direct comparisons of the features and functions on the HP calculators described in the following pages. For your convenience, page numbers of catalog listings are indicated alongside each calculator.

Features/Functions	HP-21 PAGE 14	HP-27 PAGE 12	HP-25/25C PAGE 10	HP-22 PAGE 15	HP-80 PAGE 22	HP-91 PAGE 16	HP-67 PAGE 18	HP-97 PAGE 18
Built-in Statistical Functions								
Mean and standard deviation (number of variables)		2	1	1	1	2	2	2
Trend line							•	•
Linear regression							•	•
Linear estimate							•	•
Factorial							•	•
Summations								
$(n, \Sigma x, \Sigma x^2)$								
$(n, \Sigma x, \Sigma x^2, \Sigma y, \Sigma xy)$								
$(n, \Sigma x, \Sigma x^2, \Sigma y, \Sigma y^2, \Sigma xy)$								
Correlation coefficient							•	•
Variance							•	•
Normal distribution							•	•
Built-in Financial Functions								
Number of periods							•	•
Interest rate/period							•	•
Payment/period							•	•
Present value							•	•
Future value							•	•
Simple interest							•	•
Accumulated interest							•	•
Remaining balance							•	•
Bond prices, yield							•	•
Rule of 78's interest rebate							•	•
Net present value							•	•
Internal rate of return							•	•
Beginning/ending period switch							•	•
Built-in Scientific Functions/Mathematics								
Trigonometric:								
Decimal degrees mode								
Radians mode								
Grads mode								
$\sin x, \sin^{-1}x, \cos x, \cos^{-1}x, \tan x, \tan^{-1}x$								
Rectangular coordinates \leftrightarrow Polar coordinates								
Decimal angle (time) \leftrightarrow Angle (time) in deg (hr.)/min/sec								
Angle in degrees \leftrightarrow Angle in radians								
Angle (time) arithmetic								
Logarithmic:								
$\log x, 10^x$								
$\ln x, e^x$								
Metric Conversions:								
Inch \leftrightarrow Millimeter							•	•
Btu \leftrightarrow Joule							•	•
Foot \leftrightarrow Meter							•	•
Gallon \leftrightarrow Liter							•	•
Pound \leftrightarrow Kilogram							•	•
Force in pounds \leftrightarrow Newton							•	•
Fahrenheit \leftrightarrow Celsius							•	•
Other:								
y^x								
\sqrt{x}								
$1/\sqrt{x}$								
x^2								
π								
%								
$\Delta\%$								
$\%\Sigma$								
$+, -, \times, \div$								
Absolute value								
Integer/fraction truncation								
Rounding								

• Not a built-in function, but available on pre-recorded magnetic program cards.

HP-25C

Scientific Programmable Pocket Calculator with Continuous Memory.

Retains your programs and saves your data—even when you turn it off.

The continuous memory capability of the new HP-25C can provide tremendous values in time-saving and convenience to any scientist, engineer or student who uses a few long programs repeatedly—for example, if twenty percent of your programs will solve most of your problems.

The HP-25C retains a program—no matter how often you switch it on and off—by means of sophisticated complementary metal-oxide-semiconductor circuitry (C-MOS). The last program you store is saved, ready for use, until you clear it or enter a new program.

As a result, you can program a frequently-needed calculation once, and then perform it as often as necessary—hour after hour, day after day—without the bother or lost time caused by reentering your program.

Lets you add special functions not on the keyboard.

Continuous memory makes it possible to add specialized functions to those already preprogrammed into the HP-25C.

For example, if you anticipate extensive work with hyperbolics, you can program them into the

HP-25C where they will be retained by the continuous memory for repeated calculations at the touch of a key.

Many specialized functions can be programmed into the HP-25C for fast keystroke calculations, including conversions such as decimal degree/radian, octal/decimal; statistical functions; pricing analysis functions; real estate functions; business functions and many others.

Remembers data collected for later use.

The HP-25C with continuous memory not only retains all information in its 49-step program memory, it also retains all data in the 8 addressable registers and the LAST-X register.

This capability lets you use the HP-25C as a notebook to save data from previous problems for later use or to keep the sum of statistical data entries while taking samples in the field. For example, surveyors doing traverses in the field can keep intermediate results even while the calculator is turned off between readings.

Engineers will find the HP-25C convenient in storing conversion constants until needed later.

Power economy greatly extends battery operating time.

Since the HP-25C may be switched off between calculations without losing programs or data, battery operating time can be significantly extended.

Even when changing batteries, the HP-25C will retain your programs and data. When batteries are removed a capacitor temporarily furnishes power to the continuous memory circuits. Depending on the charge of the battery being replaced, time available for the exchange is between 5 seconds and 2 minutes.

The extended battery operating time made possible by C-MOS circuitry makes the HP-25C ideal for many uses in the field where time between data collections is prolonged; for example, navigation, surveying, and many other applications.

The HP-25C and the HP-25 solve repetitive problems quickly and easily.

Both the HP-25C and the HP-25 have all the advanced features described below.

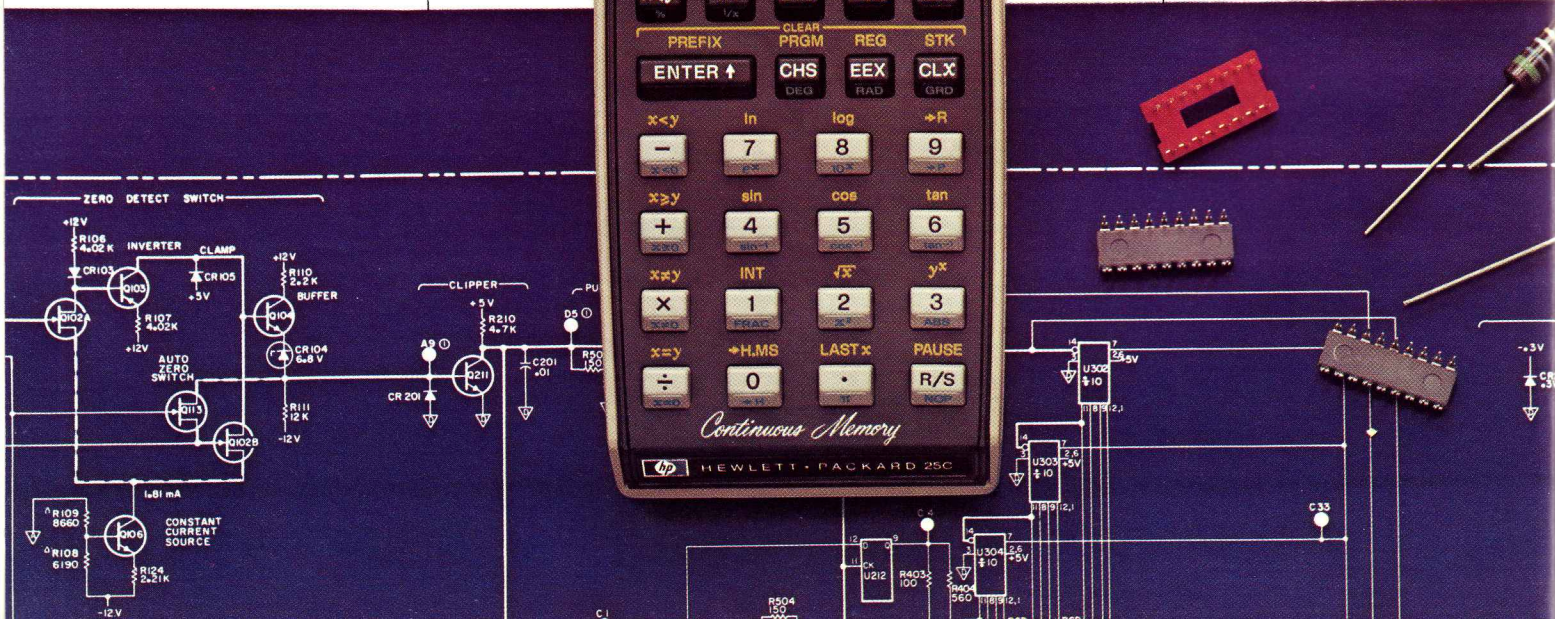
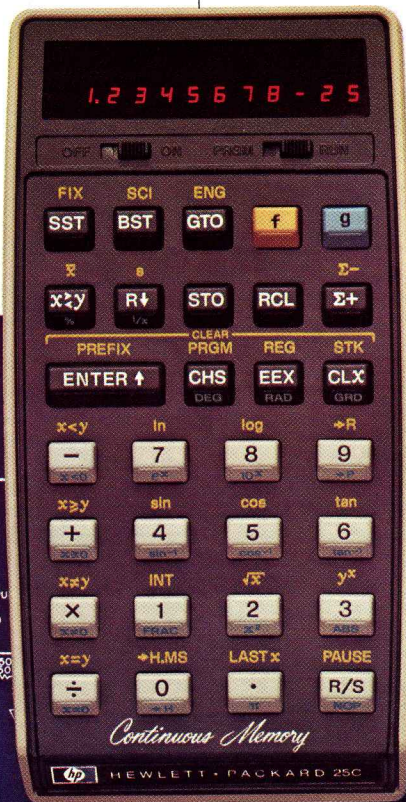
To write a program simply set the HP-25/25C to PRGM mode. Then press the keys you'd normally press to solve the problem. Your program is retained in the HP-25/25C's program memory.

To solve the problem, switch to RUN mode and enter the data. Then press the "Run/Stop" key. Your answer appears on the HP-25/25C display. To solve other problems using the same program, just enter the new data and press the "Run/Stop" key again.

Memory Review

The "BackStep" and "Single-Step" keys let you review the entire memory one step at a time, in either direction.

If you want to change your program, simply stop it at the appropriate step and key in a new entry, which will overwrite the previous one. To test your program a step at a time, switch to RUN and press "SST" repeatedly. You will see its numeric code when you press the key and the intermediate solution when you release the key.



HP-25

Decision branching.

Like a computer, the HP-25/25C can be programmed to make decisions, because it can do conditional branching.

You can program it to test the relationship between two values, by means of these tests:

$x < y$	$x \geq y$	$x \neq y$	$x = y$
$x < 0$	$x \geq 0$	$x \neq 0$	$x = 0$

Depending on the outcome of the tests, the HP-25/25C will automatically skip a step of the program ... or it will continue through the program in sequence.

Or, by means of the "GoTo" key, you can program the HP-25/25C to branch directly to a specified step, and then continue executing the program.

Pause feature.

Another feature of the HP-25/25C is the "PAUSE" key. You can use it to momentarily interrupt (about one second per PAUSE command) the program execution and display the contents of the X register. This gives you the opportunity to review or write down intermediate results.

Absolute and Truncation functions.

The ABSolute value function allows you to take the absolute value of a number within a programmed calculation.

The INTEger/FRACTION truncation function allows you to keep only the integer or fractional portion of a number. These functions are especially useful in base conversion, random number generation, or for storing two numbers in one memory.

Extra trigonometric capability.

Rectangular/polar coordinate conversions: you can convert rectangular coordinates to polar coordinates or vice versa, enabling you to do vector arithmetic quickly, easily and accurately.

Angle (time) conversions: You can convert angles (times) in decimal degrees (hours) to angles (times) in degrees (hours)/minutes/seconds ... or vice versa.

Of course the HP-25/25C also provides the six basic trig functions— $\sin x$, $\arcsin x$, $\cos x$, $\arccos x$, $\tan x$, $\arctan x$.

Logarithmic functions:

The HP-25/25C computes both natural and common logarithms as well as their inverse functions (antilogarithms).

Extra statistical capability:

Summations: The " $\Sigma +$ " key automatically calculates n , Σx , Σx^2 , Σxy for statistical and vector calculations. Data may be deleted via the " $\Sigma -$ " key.

Mean and standard deviations: The HP-25/25C also calculates the mean and standard deviation of a group of data.

You can display decimal, scientific or engineering notation.

The HP-25/25C will display in fixed decimal and scientific notation, common in many scientific calculators. It will also display values in engineering notation with exponents that are multiples of 3. This is useful in working with many units of measure, such as kilograms (10^3), nanoseconds (10^{-9}), etc.

Superior HP memory power.

In addition to the four operational stack memories and a last-x memory, the HP25/25C provides 8 addressable memories for data storage. The memories may also be used for register arithmetic.

A free applications book.

The Applications Programs Book contains 54 programs drawn from the varied areas of number theory, trigonometry and analytical geometry, statistics, finance, surveying, and navigation. Thus, whether your interest lies in solving a particular problem, or in learning more about the programming power of your calculator, this free book will help you get the most from your HP-25/25C.

HP-25/25C Physical Specifications

- Calculator length: 130.2 mm (5-1/8")
- Calculator width: 68.3 mm (2-11/16")
- Calculator height: 30.2 mm (1-3/16")
- Calculator weight: 170.1 g (6 oz.)
- Recharger weight: 141.8 g (5 oz.)
- Shipping weight: 680 g (1-1/2 lb.)
- Operating temperature range: 0°C to 45°C (32°F to 113°F)
- Charging temperature range: 15°C to 40°C (59°F to 104°F)
- Storage temperature range: -40°C to 55°C (-40°F to 131°F)
- Power requirements: AC:115V $\pm 10\%$, 50 to 60 Hz
- Battery: 2.75 Vdc nickel-cadmium rechargeable battery pack

For a complete list of features and functions, see the Buyer's Guide on Page 8.

The HP-25 Scientific Programmable Pocket Calculator

The HP-25 is identical in every respect to the HP-25C except for continuous memory. It is the logical choice for scientists, engineers or students who do not frequently use a few long programs in their work.

The HP-25 Scientific Programmable Pocket Calculator comes complete with:

- Rechargeable battery pack
- Recharger/AC adaptor
- Soft carrying case
- Illustrated Owner's Handbook
- Application Programs Book
- Quick Reference Guide

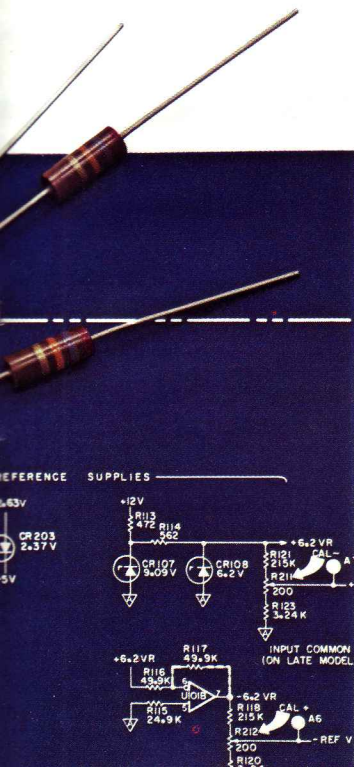
New Low Price: \$145

The HP-25C Scientific Programmable Pocket Calculator comes complete with:

- Rechargeable battery pack
- Recharger/ac adaptor
- Soft carrying case
- Illustrated Owner's Handbook
- Applications Programs Book
- Quick Reference Guide
- Continuous Memory Booklet

\$200

Use enclosed Order Form or our Toll-free phone. See page 7.



HP-27

Scientific/Plus Pocket Calculator.

Gives you every scientific function we've ever offered in a pre-programmed calculator—plus the added power of statistics and finance.

The new HP-27 Scientific/Plus is the most powerful preprogrammed pocket calculator Hewlett-Packard has ever built.

Its highly sophisticated design effectively integrates every significant scientific, statistical and financial function—and thus eliminates the need for separate calculators.

The extraordinary versatility of the HP-27 will be extremely valuable to any scientist, businessman or engineer whose responsibilities extend into targeting, budgets, cost analysis and other financial and forecasting considerations.

New statistical and financial functions greatly expand your calculating power.

The HP-27 gives you all the most-used statistical and financial

functions, including five new functions never before made available on an HP pocket calculator—variance, correlation coefficient, normal distribution, net present value and internal rate of return for uneven cash flows.

With the remarkable HP-27, you can handle not only scientific calculations but the statistical and financial calculations you need to arrive at intelligent financial decisions and recommendations.

All these functions are preprogrammed and permanently stored in the HP-27. All you have to do is key in your data, press the appropriate function keys and see your answer displayed in seconds.

And for added convenience, the HP-27 provides an exceptionally large memory capacity, flexible display controls and selective clearing options.

28 exponential, log and trig functions—all preprogrammed.

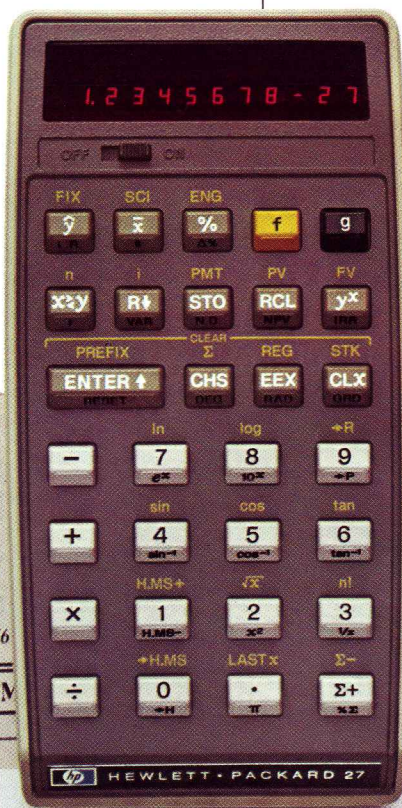
The HP-27 gives you all the most-used exponential, log and trig functions—including sines, cosines, tangents and their inverses in three angular modes; natural and common logs and anti-logs; pi; related arithmetic functions; coordinate conversions; angle conversion, addition and subtraction.

15 important statistical functions—all preprogrammed.

Many statistical functions useful in both science and business are provided by the HP-27. These include three new functions: variance, correlation coefficient and normal distribution. Summations of data points are stored for easy access. What's more, you can adjust or correct input data without having to repeat an entire calculation. Once your data is keyed in, you can calculate the means, standard deviations and variances for two variables. You can also calculate linear regression, linear estimates and the correlation coefficient for two variables. In addition, you can calculate the density function and upper-tail area under a normal distribution curve.

10 valuable financial functions—all preprogrammed.

For convenience in solving both personal and job related business problems—such as mortgages, compound interests and sinking funds—all fundamental financial functions are preprogrammed into the HP-27 to eliminate the need for bulky books of equations and interest tables. Two new preprogrammed functions—net present value and internal rate of return with uneven cash flows—facilitate capital budgeting and resource allocation. In addition, the HP-27 provides three separate percentage functions for ease in calculating margins, markups, discounts, percents of totals, etc.



THE WALL

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VOL. XCIV NO. 2

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PACIFIC COAST EDITION

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Clown in Ink

Cartoonist MacNelly Is Stand-Up Comedian With Rightist Punch

Richmond, Va., Artist Mocks Both Sides, but Appeals To Conservative Editors

Meany as a Monkey Wrench

SCIENTIFIC AMERICAN

The American Statistician

20 memories help simplify your most difficult calculations.

In addition to the 5 financial memories, the 4 operational stack memories and a last-x memory, the HP-27 provides 10 addressable memories for data storage. This large memory capacity lets you make highly complex and lengthy calculations with ease and assurance. Displayed values may be stored in any addressable memory and later recalled to the display. In addition, register arithmetic can be performed on all ten addressable memories.

6 clearing options give you flexible use of memories.

With the CLX key, you can clear the display only. You can clear all four memories of the operational stack with the STK key. The last six addressable memories, which are used for statistics, are cleared with the Σ key. The REG key clears all ten addressable memories, all five financial memories and the last-x memory. Or you can clear the status of the financial memories with the RESET key. In addition, you can clear the prefix keys with the key labeled PREFIX.

You can display fixed decimal, scientific or engineering notation.

In fixed decimal, the most commonly used notation, you can display between 0-9 places to the right of the decimal point. Whenever the value is too large or too small to be displayed in fixed notation, the display automatically changes to scientific notation. In scientific notation, useful when working with very large or small numbers, values are displayed with a single digit to the left of the decimal point followed by up to seven digits to the right, and a two digit exponent. In engineering notation, values are displayed with exponents that are multiples of 3 (useful in working with many units of measure such as kilograms (10^3), nanoseconds (10^{-9}), etc.)

The 216-page Owner's Handbook.

The Owner's Handbook for the new HP-27 Scientific/Plus is one of the most extensive and detailed texts ever published for a pocket calculator. It covers every aspect of operation—including a clear description of the RPN Logic System—with valuable suggestions for maximum efficiency in use. Nearly half the book is devoted to practical applications of the HP-27 in mathematics, statistics, navigation, surveying and finance. Formulas for each of the preprogrammed functions in the HP-27 are provided for easy reference.

Physical Specifications:

- Calculator length: 130.2 mm (5-1/8")
- Calculator width: 68.3 mm (2-11/16")
- Calculator height: 30.2 mm (1-3/16")
- Calculator weight: 170.1 g (6 oz.)
- Recharger weight: 141.8 g (5 oz.)
- Shipping weight: 680 g (1-1/2 lb.)
- Operating temperature range: 0°C to 45°C (32°F to 113°F)
- Charging temperature range: 15°C to 40°C (59°F to 104°F)
- Storage temperature range: -40°C to 55°C (-40°F to 131°F)
- Power requirements:
AC: 115V
± 10%, 50 to 60 Hz
- Battery: 2.75 Vdc nickel-cadmium rechargeable battery pack

For a complete list of features and functions, see the Buyer's Guide on page 8.

The HP-27 Scientific/Plus Pocket Calculator comes complete with:

- Battery pack that under normal use provides 3 hours of operation and fully charges in under 6 hours.
- Recharger/AC adapter that lets you operate the calculator on AC while the battery pack is recharging.
- Soft carrying case with belt loop.
- Illustrated Owner's Handbook with instructions and sample problems.

New Low Price: \$175



Order your new HP calculator today. See page 7.

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RTIFIED?

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RIANCE OF A SYSTEMATIC SAMPLE MEAN
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NEAR REGRESSION

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INVOLVING LOGARITHMIC TRANSFORMATION OF
DEPENDENT VARIABLE

Ying Young

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HP-21

Scientific Pocket Calculator.

Extraordinary problem-solving power plus HP quality at an economical price.

The HP-21 is the lowest-priced scientific pocket calculator HP offers, yet it has all the functions and features you'd expect to find in a scientific pocket calculator.

More trigonometric capabilities.

Coordinate conversions—Convert polar coordinates to rectangular coordinates, or vice versa. This lets you do vector arithmetic quickly and easily.



Angular mode selection—Just flip a switch to perform trig operations in either of two angular modes: degrees or radians. You can also convert angles from one mode to the other, push-button fast.

Standard trig functions—The HP-21 gives you all of the standard trig functions: Sin x, Arc sin x, Cos x, Arc cos x, Tan x and Arc tan x.



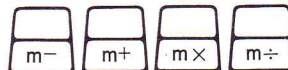
Logarithmic capabilities.

Standard log functions—The HP-21 also gives you all of the standard log and exponential functions: log x, ln x, e^x and 10^x.



Full register arithmetic.

Register arithmetic—The HP-21 has an addressable memory for storing constants or other data, for use later on in a calculation. Any of the four arithmetic operations may be performed directly upon this stored data.



The 120-page HP-21 Application Book.

Contains major sections on statistics, mathematics, finance, navigation, surveying, conversions. Provides 50 valuable applications to help you get the most from your HP-21 Scientific Calculator.

Physical Specifications:

- Calculator length: 130.2 mm (5-1/8")
- Calculator width: 68.3 mm (2-11/16")
- Calculator height: 30.2 mm (1-3/16")
- Calculator weight: 170. lg (6 oz.)
- Recharger weight: 141.8 g (5 oz.)
- Shipping weight: 680 g (1-1/2 lb.)
- Operating temperature range: 0°C to 45°C (32°F to 113°F)
- Charging temperature range: 15°C to 40°C (59°F to 104°F)
- Storage temperature range: -40°C to 55°C (-40°F to 131°F)
- Power requirements: AC: 115 ± 10% 50 to 60 Hz
- Battery: 2.75 Vdc nickel-cadmium rechargeable battery pack.

For a complete list of features and functions, see the Buyer's Guide on page 8.

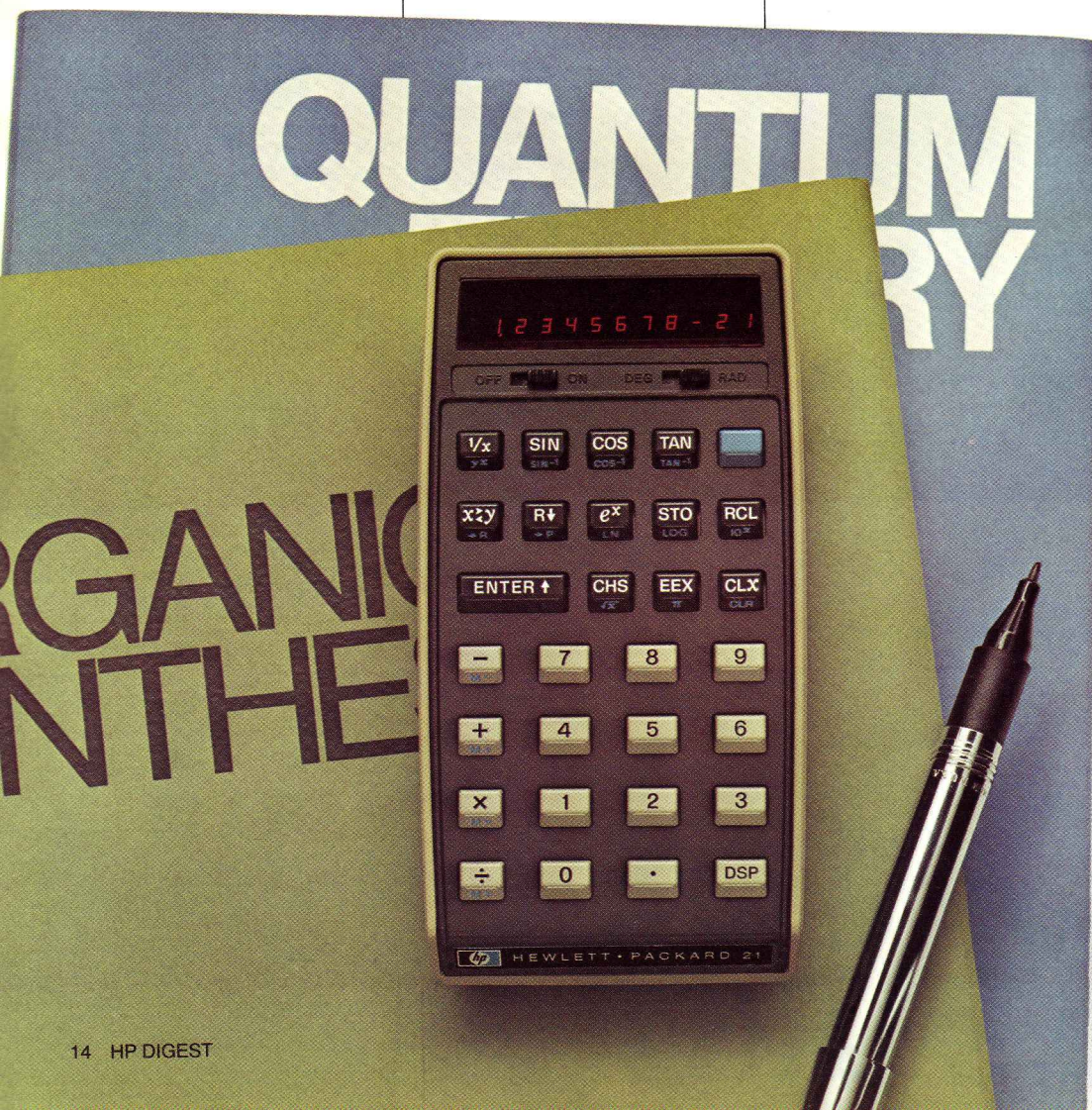
The HP-21 Scientific Pocket Calculator comes complete with:

- Rechargeable battery pack
- Recharger/ac adapter
- Soft carrying case
- Illustrated Owner's Handbook

New Low Price: \$80



You can order direct from this catalog. See page 7.



HP-22

Business Management Pocket Calculator.

Provides an ideal combination of the financial, mathematical and statistical capabilities you need in modern business.

With the HP-22 pocket calculator you can handle everything from simple arithmetic to complex time-value-of-money computations including interest rates; rates of return and discounted cash flows (net present value and internal rate of return) for investment analysis; extended percent calculations; accumulated interest/remaining balances, amortization and balloon payments. You can even handle planning, forecasting and decision analysis.

Built-in functions for ease of use.

Financial equations, statistical formulas and mathematical functions are built in the HP-22. All you have to do is key in your data, press the appropriate keys, and see your answers displayed—in seconds.

The financial capabilities.

The five keys in the top row of the HP-22 are the basic financial keys that replace equations and interest tables. To use any of the additional functions, press the gold key first. When you enter three known values with the financial keys, you can solve for another unknown value. For example: enter amount of present value [PV]; enter number of periods involved [n]; enter future value [FV]. Then, push [i] and get interest displayed automatically.

Expanded percentages capability.

Percentage is the common standard of measurement in the business and financial world. For this reason, the HP-22 provides three separate percentage function keys. The [%] key is used to calculate a percentage. The [Δ%] key is used to compute the percentage difference (ratio of increase or decrease) between two numbers. The [Σ%] key is used to find what percentage one number is of another number or of a total sum. The HP-22 saves

the base number for multiple percentage calculations of the same base number.

The statistical capabilities.

In addition to the financial capabilities, the HP-22 gives you advanced statistical capabilities for planning, forecasting and analysis. Using the [Σ+] key, you can enter statistical data into five of the ten addressable memories, where it remains unaffected by most other calculations. What's more, using the [Σ-] key you can adjust or correct input data without having to repeat the entire calculation. To project sales, key in past performance data with the [Σ+] key. Then key in the number of the forecast period and press the [ȳ] key to obtain sales at that future point in time. To obtain an average, key in all data, then press the [x̄] key. To find standard deviation (a measure of statistical validity), key in your data, then press the [s] key for the answer.

The mathematical capabilities.

The HP-22 gives you virtually all the math capabilities you need in business, such as logs, anti-logs, exponentiation and root extraction so you may work out your own solutions to unusual individual problems.

Expanded memory capacity.

In addition to the 5 financial memories and the 4 operational stack memories, the HP-22 provides 10 addressable memories you can use to store data. For example, to store a displayed value in the first addressable memory, press [STO] [0] and the value will be automatically stored in that memory. To recall the value, press the [RCL] recall key and the [0] key and the value will again be displayed. For added convenience, register arithmetic can be performed with all 10 memories.

The remarkable HP-22 Owner's Handbook.

Even if you lack special training in mathematics, statistics or advanced financial planning, the 148-page Owner's Handbook will make it easy for you to take full advantage of the capabilities of the HP-22. The book is a valuable survey course in modern

management problem-solving, analysis and planning. It provides formulas and procedures for solving more than 50 different financial, mathematical and statistical functions on the HP-22.

Physical Specifications:

- Length: 130.2 mm (5-1/8")
- Width: 68.3 mm (2-11/16")
- Height: 30.2 mm (1-3/16")
- Weight: 170.1 g (6 oz.)
- Recharger weight: 141.8 g (5 oz.)
- Shipping weight: 680 g (1-1/2 lb.)
- Operating temperature range: 0°C to 45°C (32°F to 113°F)
- Charging temperature range: 15°C to 40°C (59°F to 104°F)
- Storage temperature range: -40°C to 55°C (-40°F to 131°F)
- Power Requirements: AC: 115V ±10% 50 to 60 Hz
- Battery: 2.5 Vdc nickel-cadmium rechargeable battery pack.

For a complete list of features and functions, see the Buyer's Guide on page 8.

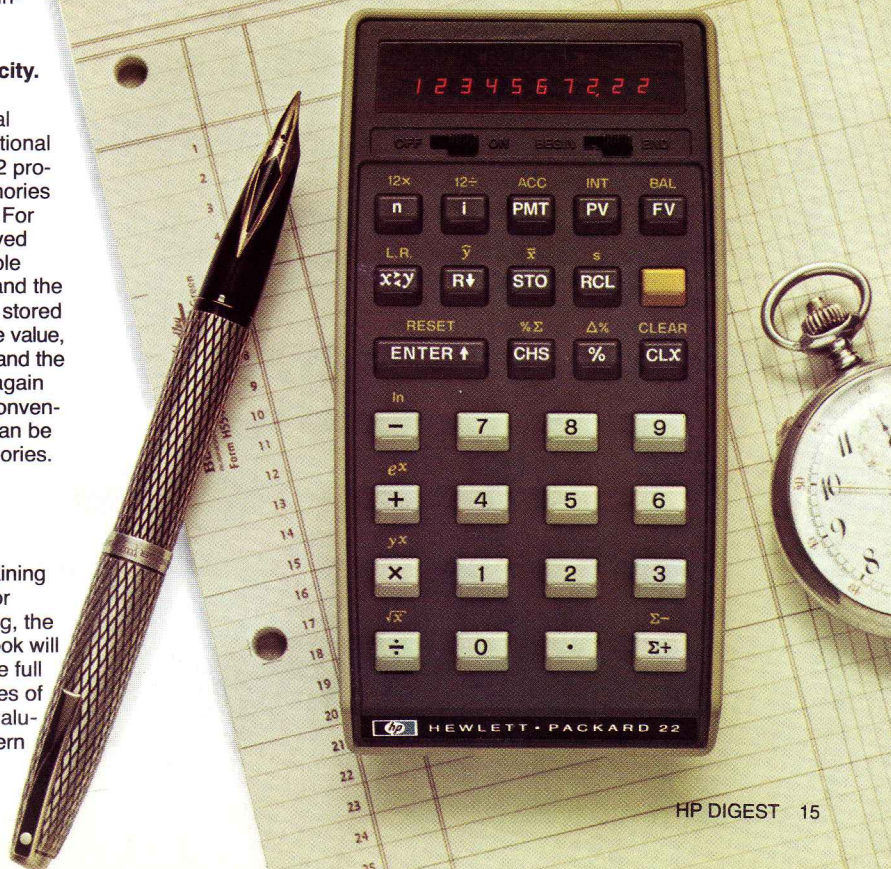
The HP-22 Business Management Pocket Calculator comes complete with:

- Rechargeable battery pack
- Recharger/ac adapter
- Soft carrying case
- Illustrated Owner's Handbook

New Low Price: \$125



Take advantage of our 15-day trial offer. See page 7.



HP-91

Scientific Printing Calculator.

The first battery-operated scientific calculator that delivers a printed record of all your calculations—wherever you go.

The new HP-91 Scientific Printing Calculator provides you with a full range of scientific and arithmetic functions—complete with a printed record—all in one compact calculator. And because the HP-91 prints and operates on AC or its own built-in batteries, you can use it anywhere—in the office or the remotest field locations.

Quiet thermal printer provides a complete record of your calculations.

The sophisticated new thermal printing system of the HP-91 employs a moving thin-film head to record and label your calculations on heat sensitive paper. Because the HP-91 can print all your calculations, you can print—with labels—statistical summations, contents of the operational stack, or the contents of all sixteen addressable memories. Your routine repetitive calculations can be performed by non-specialists and later checked for accuracy. Tape is available in 80-ft. rolls that accommodate 5,760 lines of printed data.

You select from three printing modes.

With switch set to ALL, the printer will show all entered data, functions, intermediate and final answers. With the switch set to NORMAL, the printer will record entered data and functions only. In this mode, intermediate and final answers may be printed by pressing the Print X key. With switch set to MANUAL, the printer will operate only when you press the Print X key or a list function. This mode is useful in conserving battery power or when the full printing capability of the HP-91 is not required.

You may operate on battery or AC.

The power requirement of the HP-91 thermal printing system is so low that it may be operated on batteries alone for between 3 and 7 hours, depending on extent of printer use. The AC adapter/recharger permits you to operate from electrical outlets while batteries are being recharged.

Extra large display is easy to read in office or field.

The brilliant lighted display of the HP-91 shows up to ten significant digits, plus two-digits exponent and appropriate signs. And the display is at a 45° angle that makes it easily read while seated at your desk or standing at your workbench or drafting board.

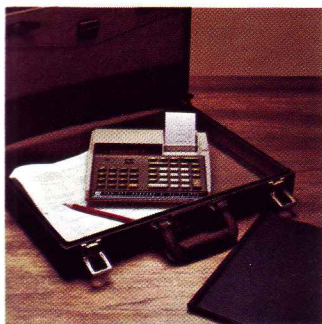


You can display and print in decimal, scientific or engineering notation.

The HP-91 will print and display in fixed decimal and scientific notation, common in many scientific calculators. It will also print and display in engineering notation, an exclusive HP feature that displays values with exponents that are multiples of 3. This is useful in working with many units of measure, such as kilograms (10^3), nanoseconds (10^{-9}), etc.

Compact design and light weight for easy portability.

Total weight of the HP-91 without AC adapter/recharger is only 2-1/2 pounds. It will fit into a standard briefcase so you can take it with you, and operate it while you travel in airplanes, taxis, anywhere. For security, it will easily fit into lockable desk drawers or the glove compartment of your car. A built-in metal tab lets you secure it to your desk easily with a cable or bolt. (A special cable and lock is available as an optional accessory.)



Easy for anyone to use as a fine desk-top office calculator.

Anyone now operating an office calculator can perform arithmetic on the HP-91 efficiently without special training. Large, conventionally-spaced keys are buffered, so data may be keyed in at high speed.

All the most-needed scientific functions—preprogrammed for speed and accuracy.

The HP-91 provides about the same preprogrammed functions found on the widely-used HP-45 pocket calculator—with the added advantage, of course, of a printed record of all your calculations. Its math capabilities include log and trig functions (the latter in degrees, radians or grads), rectangular/polar conversions and three separate percentage functions. Its statistical capabilities include summations, mean and standard deviation, linear regression, linear estimates (all for two variables) and factorial. All this, plus sixteen addressable registers, an automatic four-register stack, a Last-x register for easy error recovery and four clearing options.

220-page Owner's Handbook includes detailed applications.

The Owner's Handbook for the new HP-91 Scientific Printing Calculator is extensive and detailed. It covers all functions and operations—including a clear description of RPN. More than half the book is devoted to practical applications of the HP-91 in mathematics, statistics, finance, navigation, and surveying. Formulas for each of the preprogrammed functions in the HP-91 are provided for easy reference.

Physical Specifications:

- Calculator width: 228.6 mm (9")
- Calculator depth: 203.2 mm (8")
- Calculator height: 63.5 mm (2.5")
- Calculator weight: 1.13 kg (2.5 lb)
- Recharger weight: 268 g (9.5 oz)
- Shipping weight: 3.16 kg (7 lb)
- Operating temperature range: 0°C to 45°C (32°F to 113°F)
- Charging temperature range: 15°C to 40°C (60°F to 104°F)
- Storage temperature range: -40°C to 55°C (-40°F to 131°F)
- Paper temperature range (operating & storage): 10°C to 30°C (50°F to 86°F)
- Power Requirements: AC: 90-127V
50 to 60 Hz
- Battery: 5.0 Vdc nickel-cadmium rechargeable battery pack

For a complete list of features and functions, see the Buyer's Guide on page 8.

The HP-91 Scientific Printing Calculator comes complete with:

- Battery pack that under normal use provides 3 to 7 hours of continuous operation and fully charges in under 10 hours.
- Recharger/AC adapter that lets you operate the calculator on AC while the battery pack is recharging.
- Soft carrying case with handle.
- Illustrated Owner's Handbook with instructions and applications section.
- Thermal paper (2 rolls).

New Low Price: \$425

You can phone your order for fastest service. See page 7.



HP-97

The HP-97 Fully-Programmable Printing Calculator.

A major leap forward in fully-programmable personal calculators.

These are the most powerful personal calculators Hewlett-Packard has ever made. The HP-97 combines exceptional programming power—plus a battery-operated printer—all in one self-contained unit. The HP-67 provides the identical power of the HP-97 in the classic pocket size.

Exceptional power easily handles your lengthy, repetitive problems.

The HP-97/67 lets you write programs of up to 224 steps. Every function (one, two or three key-strokes) is merged to take only one step of program memory. And there are 26 data storage registers to provide the memory you need for your problems. You can record the contents of either program memory or the data storage registers on a magnetic card. Later, you can load all or part of them back into the calculator. The "smart" card reader of the HP-97/67 can handle either job. All this, plus these other powerful programming features:

- 3 Levels of Subroutines
- 10 User-Definable Keys
- 10 Conditional/Decision Functions
- 4 Flags
- 3 Types of Addressing:
 - Direct Addressing to labels
 - Relative Addressing
 - Indirect Addressing

You don't have to wait to get on a computer to handle those extremely difficult calculations you face daily.

The preprogrammed power of the HP-97/67 is equally versatile. Choose from trigonometric functions, exponentials, logs, statistical functions, angular conversions. Round your inputs and answers, display them in three different formats, truncate their fractional or integer parts.

So easy to use you'll write programs the first day.

Keystroke programming makes programming the HP-97/67 as simple as pressing the keys needed to calculate answers manually. Merged operations further simplify the task (and expand memory power) by letting you see the complete operation right in the display.

A "smart" card reader frees your mind by automatically recording the display mode setting, angular mode setting, and the status of the four flags when you record your program.

Because many programs require editing of some kind, we added useful features enabling you to easily review programs forward or backward, to easily jump to any step in the program, and to easily insert steps or delete them. RPN logic and the four-register automatic-memory-stack combine for more efficient problem solving. And RPN logic also helps when you program, because you don't use parentheses that waste valuable program memory. And there are no pending operations that make editing difficult. RPN lets you slide through the most complicated programs the same easy way it lets you slide through complex calculations—with complete confidence.

An unparalleled program of owner support.

The highly-detailed HP-97 and HP-67 Owner's Handbooks teach you how to write programs quickly and easily. They are incomparable instructional guides—with step-by-step explanations of every powerful feature and with a wealth of sample problems.

You can supplement your own programs with the extensive HP program library. The Standard Application Pac, with 15 programs in various disciplines, comes free with either calculator. The handbook for this Pac is full of additional programming tips and techniques.

Also available in many disciplines are HP Application Pacs, where a professionally programmed and documented solution may already exist to solve a problem. These pacs—which put the full power of the HP-97 or HP-67 at your disposal—quickly transform your calculator into a special-purpose machine designed to solve complex problems in your field at the touch of a few keys. As an HP-97 or HP-67 owner, you are also entitled to a one-year subscription to the Users' Library and a Newsletter to keep you abreast of current information. The library contains programs contributed by other owners as well as HP Application Pac programs.

The HP-97 provides battery-operation and thermal printing—in one self-contained unit.

The new HP-97 Fully-Programmable Printing Calculator combines exceptional programming power and the great usefulness of a quiet thermal printer. What's more, the HP-97 operates on batteries as well as AC—so you can have a printed record whenever and wherever you need it. In addition, there's an extra-large display for easy readability and a buffered keyboard so data may be keyed in at high speed. And to back it all up, there's one of the most comprehensive support programs ever developed for the owners of HP personal calculators.

Quiet thermal printer lists your programs on tape for checking and editing.

With the HP-97, you can list a program, (stepnumber, key mnemonic and, optionally, the keycode), contents of the automatic memory stack, or the contents of the data storage registers. And you have three printing modes to choose from. With the printer switch set to MANUAL, the printer will operate only when the Print X key or a list function is executed from the keyboard or from within a program. With the switch set to NORMAL, the printer will record all entered data and functions. With the switch set to TRACE, the printer will list the stepnumber, function and result of each step of an executing program or the operation and results of a manual calculation.

The printer is a valuable aid in editing programs or long calculations. You don't have to remember what you've done or what remains to be done. You see everything at once clearly, on tape.

HP-67

The HP-67 Fully-Programmable Pocket Calculator.

Compact in design and light in weight for easy portability.

Total weight of the HP-97 without AC adapter/recharger is only 1.13 kg. (2½ pounds). It's so small it will fit into a standard briefcase so you can take it with you, and operate it in airplanes, taxis, anywhere. For security, it will easily fit into lockable desk drawers or the glove compartment of your car. A built-in metal tab lets you secure it to your desk easily with a cable or bolt. (A special cable and lock is available as an optional accessory.)

Desktop keyboard and display adds extra convenience.

The HP-97 features large, conventionally-spaced keys that make it easy to key in data or programs. The keyboard also employs a seven-character buffer so skilled operators may use keys at high speed without danger of losing data.

The brilliant, large-size display of the HP-97 shows up to ten significant digits, plus two-digit exponent and appropriate signs. And the display is at a 45° angle that makes it easy to read while seated at your desk or standing at your workbench or drafting board.

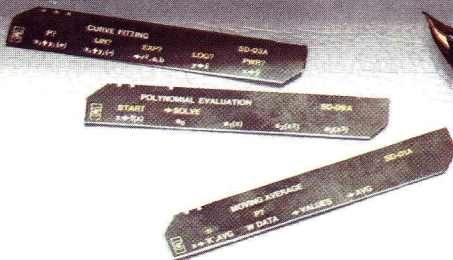
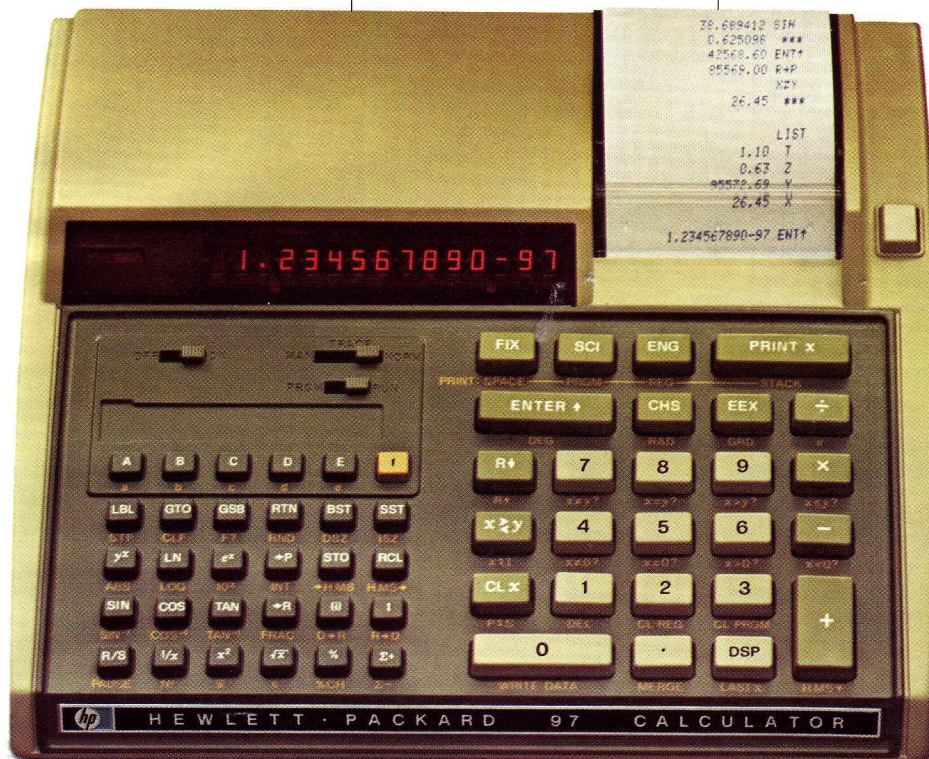
You can operate it on batteries or AC.

The power requirement of the HP-97 thermal printing system is so low that it may be operated solely on batteries for 3 to 5 hours, depending on how much you use the printer. The AC adapter/recharger permits you to operate from electrical outlets while batteries are being recharged. You can use it in the office or in the field.

The HP-67 Fully-Programmable Pocket Calculator provides the identical power of the HP-97.

The HP-67 is ideal for those who want the powerful features of the HP-97, but do not require a printing capability. The HP-67 is completely compatible with the HP-97. Programs recorded on one unit may be loaded and executed on the other—even the print commands (e.g., when the HP-67 executes a Print X command, it pauses, and displays the current results).

Used separately—or together—these compatible fully-programmable calculators do the job faster and with less chance for error.



HP-97 and HP-67 — Continued

The HP-97 and HP-67 give you exceptional programming power you won't outgrow.

As your needs increase, you can be confident of your capacity to handle them—because the HP-97 and the HP-67 give you the power you need to solve the most lengthy and repetitive problems you are ever likely to encounter.

New "Smart" magnetic card reader makes every problem easier.

The magnetic card reader in both the HP-97 and the HP-67 does much more than record programs from calculator to card or load programs from card to calculator.

You can load the entire program memory, or selected portions, either manually or under program control.

You can record data from all registers onto a magnetic card. You can also load every data storage register or selected registers.

When recording programs, the HP-97 and HP-67 automatically record the angular mode setting, the display setting and the status of the four flags.

10 User-definable Keys.

There are ten user-definable keys you can use for any special function you may require—such as defining portions of your program for subroutines or branches. They may be executed from the keyboard or from within a program. In addition, there are ten numerical labels (LBL 0 thru LBL 9). These user-definable keys and labels may be executed from the keyboard or from within a program.

Direct Branching

Though program steps are executed sequentially in many programs, you have the power to transfer (branch) program execution to any part of program memory you desire.

GTO Go To.

When followed by a label designator (A through E, f A through f E, or 0 through 9) GTO directly branches program execution to the specified label.

Subroutines

When a series of instructions is executed several times in a program, you can save program memory by executing that series as a subroutine.

GSB Go Subroutine.

A GSB instruction followed by a label designator (A through E, f A through f E, 0 through 9) branches program execution to the label specified just as a GTO instruction does. But, using the GSB instruction, program execution is then "returned" automatically to the step following the GSB instruction when the next RTN (Return) instruction is executed.

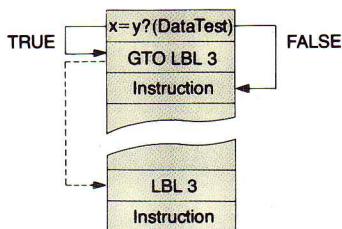
A GSB instruction can also be used within a subroutine to a depth of three levels.

Conditional Branching.

$x \neq y$, **$x = y$** , **$x \leq y$** , **$x > y$**

$x \neq 0$, **$x = 0$** , **$x < 0$** , **$x > 0$**

These keys allow your program to make decisions for you by testing the values in the X- and Y-registers or by testing the value in the X-register against zero as indicated. If the data test is true, the calculator will "do" the next instruction in program memory. (Remember "Do If True.") if the data test is false, program execution branches around the next instruction.



The next step is executed if $x=y$. Program execution branches around one step if x does not equal y .

Flags.

You can use the four flags in the calculator for tests in your programs. They can be set, cleared, or tested. When a flag is tested, the calculator executes the next step if the flag is set ("Do If True" again). The calculator branches around the next step if the flag is clear.

Indirect Control.

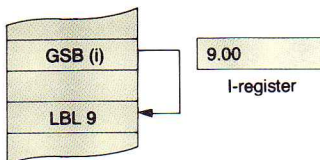
The (i) key combined with certain other functions uses the number stored in the specially-defined I-register to control those functions. This indirect control gives you the power and versatility you need to complement the extra large program capacity and data capacity.

Indirect Addressing.

You can perform a direct branch or subroutine to a label specified by the current number in the I-register.

GTO (i) **GSB (i)**

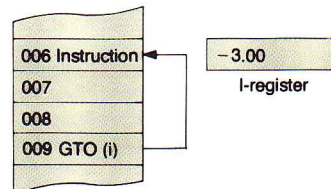
These operations depend on the number in the I-register. If it is positive they perform a direct branch (GTO (i)) or a subroutine (GSB (i)) to the label specified.



Relative Addressing.

GTO (i) **GSB (i)**

When the number in the I-register is a negative number these instructions perform a direct branch (GTO (i)) or a subroutine (GSB (i)) backward the number of steps specified by the current negative number in the I-register.



Indirect Control of Data Register Operations.

You can also use the I-register to specify the address of a storage register.

STO (i)

This instruction stores the displayed number in the storage register specified by the value in the I-register.

RCL (i)

This instruction recalls the contents of the storage register specified by the value in the I-register.

STO + (i), **STO - (i)**

STO x (i), **STO ÷ (i)**

These four instructions perform storage register arithmetic upon the contents of the storage register specified by the value in the I-register.

ISZ (i) **DSZ (i)**

You can also increment (ISZ (i)) or decrement (DSZ (i)) the contents of the storage register specified by the value in the I-register and then test against zero. If the contents equal zero, program execution branches around the next step in program memory.

HP-97 Specifications:

- Calculator width: 228.6 mm (9")
- Calculator depth: 203.2 mm (8")
- Calculator height: 63.5 mm (2.5")
- Calculator weight: 1.13 kg (2.5 lb)
- Recharger weight: 268 g (9.5 oz)
- Shipping weight: 3.16 kg (7 lb)
- Operating temperature range: 15°C to 40°C (59°F to 104°F)
- Charging temperature range: 10°C to 40°C (50°F to 104°F)
- Storage temperature range: -40°C to 55°C (-40°F to 131°F)
- Paper temperature range (operating & storage): 10°C to 40°C (50°F to 104°F)
- AC Power Requirement: 15°C to 40°C (59°F to 104°F)
- Battery Power Requirement: 5.0 Vdc nickel cadmium rechargeable battery pack

HP-67 Specifications:

- Calculator length: 152.4 mm (6")
- Calculator width: 81 mm (3.2")
- Calculator height: 18 to 34 mm (0.7 to 1.4")
- Calculator weight: 342 g (11 oz)
- Recharger weight: 142 g (5 oz)
- Shipping weight: 1.4 kg (3 lb)
- Operating temperature range: 10°C to 40°C (50°F to 104°F)
- Charging temperature range: 10°C to 50°C (50°F to 122°F)
- Storage temperature range: -40°C to 55°C (-40°F to 131°F)

- AC Power Requirement: 86-127V 50 to 60 Hz
- Battery Power Requirement: 3.75 Vdc nickel cadmium rechargeable battery pack.

For a complete list of features and functions, see the Buyer's Guide on Page 8.

The HP-67/97 Fully Programmable Calculators come complete with:

- Illustrated Owner's Handbook and Programming Guide.
- Quick Reference Card. (HP-67 only)
- Standard Pac complete with 40 cards, card holder, and manual.
- Battery pack that under normal use provides about 3 hours of continuous operation.
- Recharger/AC adapter that lets you operate the calculator on AC while the battery pack is recharging.
- Soft carrying case.
- Programming pad.
- Users' Library and newsletter subscription card.
- 2 rolls of thermal paper (HP-97 only).

HP-97:
\$750

HP-67:
\$450

Use enclosed Order Form or our Toll-free phone. See page 7.

158 pre-recorded programs already available for the HP-97 and HP-67.

With HP Application Pacs, the solutions you require may already exist. They let you put the full power of the HP-97 and HP-67 to work instantly. You save significant time because no researching, programming, debugging or documenting is needed.

A wide variety of programs—in science, engineering and business—is available on pre-recorded magnetic cards that program the calculator for you in less than 2 seconds. Each program is fully documented with helpful comments on each program listing. Using these valuable programming hints, you can adapt programming techniques you find useful in each application area.

Application Pacs contain 19 to 26 preprinted prerecorded program cards, a program card holder and a manual of complete documentation. The manual also provides operating instructions, equations, limits and warnings, and sample problems with solutions for each program in the Pac.

Here is a brief description of Application Pacs for the HP-97 and HP-67:

Math Pac

The 19 programs of Math Pac 1 have been drawn from the fields of number theory, algebra, trigonometry, analytical geometry, calculus, and special functions.

Stat Pac

Programs for your Stat Pac have been selected from the areas of general statistics, distribution functions, curve fitting, analysis of variance, test statistics, probability, quality control and queueing theory.

Business Decisions Pac

The 22 programs of the Business Decisions Pac have been selected from the areas of investment analysis, real estate, banking, leasing, securities, and statistics, areas which require rapid and accurate analysis of data.

EE Pac

The 18 programs of EE Pac 1 have been drawn from the fields of network analysis, network synthesis, transistor theory, and microwave engineering.

Surveying Pac

The 19 programs of Surveying Pac 1 are designed to solve problems such as reduction and adjustment of field traverse data, solution of curve and intersection problems, layout of curves, field data reduction, earthwork calculations and coordinate transformations.

Clinical Lab and Nuclear Medicine Pac

The 19 programs of Clinical Lab and Nuclear Medicine Pac have been drawn from the fields of clinical chemistry, nuclear medicine, radioimmunoassay, and statistics.

M.E. Pac

The 25 programs of M.E. Pac 1 have been drawn from the fields of statistics, dynamics, stress analysis, machine design, and thermodynamics.

Each Pac : \$35

The HP-67/HP-97 Users' Library

Administered by Hewlett-Packard as a customer service, the HP-67/HP-97 Users' Library is dedicated to making programs contributed by HP-67 and HP-97 users available to others. In addition, all programs in the HP-67/HP-97 Application Pacs are included in the Library and are available on an individual basis.

With the many programs available in a wide variety of application areas, the program solutions you require may have already been developed. You won't have to research the application, program the solution, debug the program, or complete the documentation. Programs from the Library can also serve as a source of programming techniques in your application area.

A one-year subscription to the Library costs \$9.00. You will receive the Catalog of Contributed Programs, updates to the Catalog, and coupons entitling you to three free programs of your choice (a \$9.00 value).



HP-80

Financial Pocket Calculator.

Specialized features, including bond prices & yields, depreciation, a 200-year calendar, and a comprehensive application book.

The HP-80 Financial Pocket Calculator lets you solve business math or time-and-money problems quickly and easily.

All the interest equations and tables have been built-in. So has a 200-year calendar, used in solving for bond price and yield, or short-term interest.

It's designed to handle general business math problems.

Percentages.

The “%” and “Δ%” keys allow you to easily handle problems concerned with: percentages; net amounts (markups, discounts, chained discounts, dealer discount ratios, anticipation discounts, etc.) and percent difference.

Just press the keys to solve time-and-money problems in seconds.

At the top of the HP-80's keyboard are five keys for solving all types of business problems.

These financial keys save you time and effort when calculating: Amortized (direct reduction) loans (ordinary annuity); Sinking funds (ordinary annuity); Consumer loans; Savings functions (annuity due); Lease and rent functions (annuity due).

Discounted cash flow analysis.

You can quickly and easily perform a discounted cash flow analysis, and calculate the net present value of even, uneven or deferred payment streams.

The HP-80 can also be used to calculate the discounted or internal rate of return.

Equity investment analysis for income property.

You can use the calculator to solve for: equity yield rate; equity investment value and present value; and future value and overall appreciation/depreciation rate.

Bond functions.

The HP-80 has built-in function keys for bond calculations: “Yield-To-Maturity,” “INTeRest” and “BOND”. You can calculate bond price, yield and after-tax yield, accrued interest (between coupons) and bond amortization. You can also calculate a callable bond price and yield-to-call.

Commercial loans (short term notes).

The HP-80's “INTeRest” key lets you calculate the accrued interest amount or the discount amount and annual yield for a discounted note (for either a 360- or 365-day year).

Calendar functions.

This key puts a 200-year calendar (1900 to 2099) at your fingertips. You can find: the number of calendar days between two dates; the day of the week a date falls on; a future date, or a past date, given the number of days from a known date.

Depreciation functions.

The HP-80 incorporates a unique key labeled “SOD” for calculating sum-of-the-years'-digits depreciation—amount and remaining balance—on a full-year or partial year basis.

You can also calculate the depreciation amount and remaining balance via the straight-line method, or via the declining-balance method (full year or partial year).

Statistical functions.

By using the “Trend Line” key, you can easily calculate: a trend line (time series linear regression) giving you the y-intercept (value at point 0); the number of time periods; the slope, and automatic projections.

The HP-80 can also calculate: the mean and the standard deviation, with the ability to change data points after a calculation and recalculate. The “Σ+” key provides running totals and computes the sum of the squares and the number of entries.

Memory power.

In addition to the four memory stack, the HP-80 has an addressable memory for storing constants or other numbers to be used later on in a calculation.

The financial application book.

With the HP-80 you get a 101-page book offering dozens of keystroke sequences—including Annual Percentage Rate calculations with balloon payments—that benefit brokers, investors, appraisers, assessors, mortgage bankers, analysts and other decision makers in investment analysis.

Specifications:

- Length: 147 mm (5.8 in)
- Width: 81 mm (3.2 in)
- Height: 18 to 33 mm (0.7 to 1.3 in)
- Weight: 255 g (9 oz.) with battery pack
- Recharger: 142 g (5 oz.)
- Shipping weight: 900 g (2 lb)
- AC: 86-127V 50-60 Hz
- Battery: 3.75 Vdc nickel-cadmium rechargeable battery pack
- Operating temperature range: 0°C to 50°C (32°F to 122°F)

For a complete list of features and functions, see the Buyer's Guide on page 8.

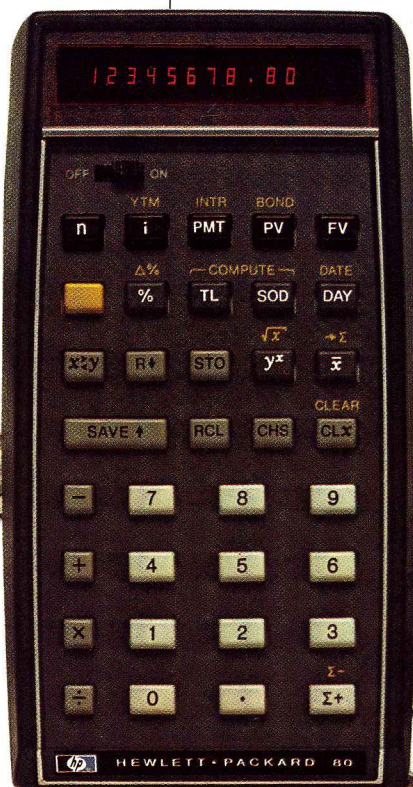
The HP-80 Financial Pocket Calculator comes complete with:

- Rechargeable battery pack
- Recharger/ac adapter
- Soft carrying case
- Illustrated Owner's Handbook
- Quick Reference Guide
- A Guide to Profitable Investment Analysis.

\$295



Order your new HP calculator today. See page 7.



Accessories

Designed to protect and increase the versatility of Hewlett-Packard Personal Calculators.

Reserve power pack.

You'll always have a fully-charged spare battery pack on hand when you use this reserve power pack, especially designed for Hewlett-Packard pocket calculators. It comes complete with a spare battery pack.

Simply slip the battery pack into the holder, then plug the holder into the recharger/ac adapter that comes with your calculator. A built-in light-emitting diode tells you that the battery pack is recharging. In six to eight hours, you'll have a full-charged battery pack to exchange for the one in your calculator.*

Temperature range: 0°C to 40°C (32°F to 104°F)

Dimensions: 8 x 8 x 3 cm (3 x 3 x 1")

Weight with battery pack: 110 g (4 oz.)

Battery pack and holder for models HP-80 and HP-67/82004A\$20.00
Battery pack and holder for models HP-21, HP-22, HP-25/25C (shown), and HP-27/82028A\$20.00
Battery pack and holder for models HP-91 and HP-97/82037A\$35.00

*For models HP-67 and HP-80 the recharging time is between 14 and 17 hours.

Security cradle helps reduce pilferage.

When leaving your HP calculator unattended in the office or lab, you can help guard it against "mysterious disappearance" by means of this ruggedly-constructed security cradle.

A key is used to lock and unlock the cradle holding your calculator. And while your calculator is in place you have complete access to the keyboard and display, with battery pack or ac operation.

The security cradle may be attached to your desk via: (1) four corner screws, (2) center screw attachment, allowing 360° rotation, (3) removable six-foot steel cable, or (4) extremely-hard-to-remove adhesive tape. (All are supplied.)

Security cradle for model HP-80/82007A\$30.00
Security cradle for model HP-67/82015A\$30.00
Security cradle for models HP-21, HP-22, HP-25/25C (shown), and HP-27 has built-in prism to provide better viewing angle when on flat surface/82029A ...\$30.00
Security cable for models HP-91 and HP-97/82044A\$10.00

Hard leather case helps protect your calculator outdoors.

Using your HP calculator outdoors? Help protect it by carrying it in this hard leather field case. It snaps onto your belt and guards your calculator against normal environmental conditions in the field—dust, dirt, rain, snow, bumps and jars. Calculator removal is easy with the snap-open flap and contoured front opening.

Field case for model HP-80/82006A\$30.00
Field case for model HP-67/82016A\$35.00

Accessories to replace or replenish those received with your pocket calculator.

Owner's Handbook.

HP-21/00021-90001\$ 2.00
HP-22/00022-90001\$ 5.00
HP-25/25C/00025-90001\$ 3.00
HP-27/00027-90001\$ 5.00
HP-80/00080-90001\$ 2.00
HP-91/00091-90001\$10.00
HP-97/00097-90001\$10.00
HP-67/00067-90001\$10.00

Quick Reference Guide.

HP-25/25C/00025-90021\$ 1.00
HP-80/00080-90003\$ 1.00
HP-67/00067-90001\$ 3.00

Application Books.

HP-25/25C Application Programs/00025-90011\$10.00
HP-80 Real Estate Applications/00880-6606\$10.00
HP-21 Applications Book/00021-90016\$10.00

Soft Case.

HP-21, HP-22, HP-25/25C, and HP-27/82027A\$ 6.00
HP-80/82021A\$ 6.00
HP-67/82053A\$ 7.00
HP-91 and HP-97/82035A\$10.00

Battery Pack.

HP-21, HP-22, HP-25/25C and HP-27/82019A\$ 7.00
HP-80 and HP-67/82001A\$10.00
HP-91 and HP-97/82033A\$18.00

Recharger/ac adapter.

HP-21, HP-22, HP-25/25C and HP-27/82041A\$15.00
HP-80 and HP-67/82002A\$20.00
HP-91 and HP-97/82040A\$10.00

Thermal Printing Paper for models HP-91 and HP-97/82045A (6 rolls)\$ 6.00

3 Program Card Holders for models HP-67 and HP-97/00097-13142\$ 10.00

Program Pad for models HP-25/25C, HP-67 and HP-97/00097-13154\$ 4.00

Blank Program Cards for models HP-67 and HP-97
40-card pac/00097-13141\$20.00
120-card pac/00097-13143\$45.00

You can order direct from this catalog. See page 7.

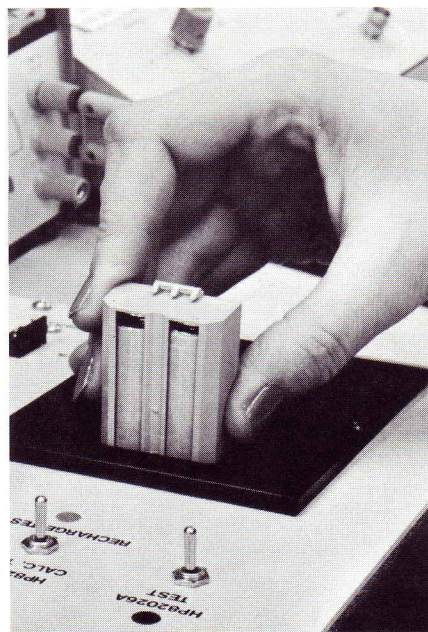


Service Plus!

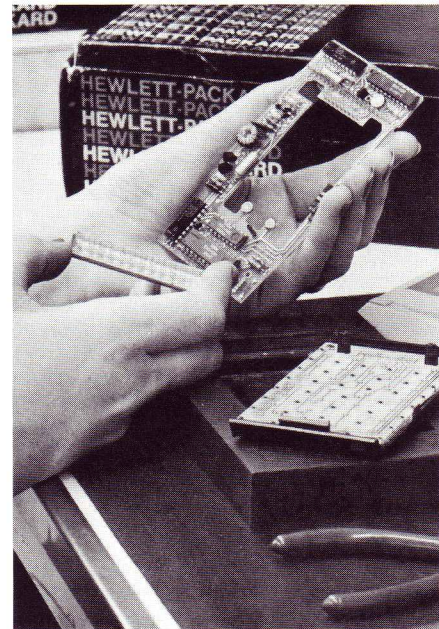
In the unlikely event your HP calculator should fail, our Service Department is set up to repair it in only two days.



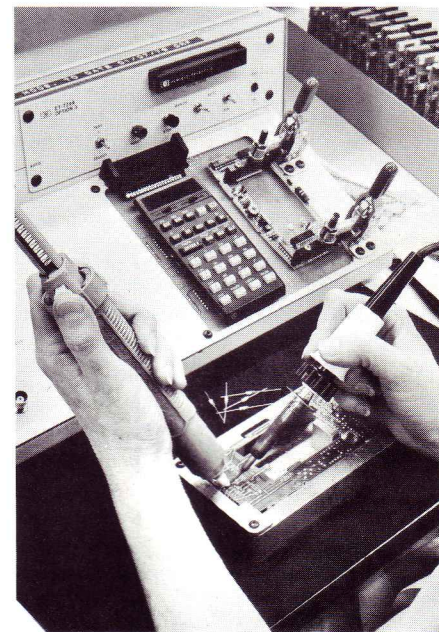
1. Reception and logging-in is the first step in the fast HP two-day repair procedure. Here the problem is noted and any additional customer requests for information are filled. A customer can speed the process by describing the problem as fully as possible.



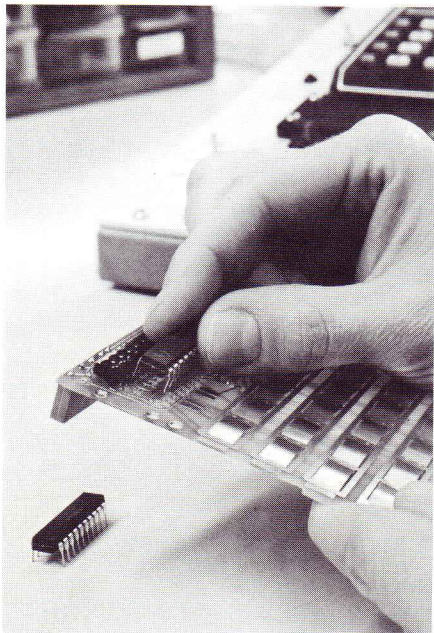
2. Both batteries and rechargers, sometimes neglected by owners, are checked electronically. It's important to include these, if you send your calculator in for repair.



3. Calculators receive individualized service. One operator takes the unit through each step of the service process. The "symptoms" are compared with the customer's written description of the problem. When the problem is isolated, the calculator is disassembled and the repair process begins.



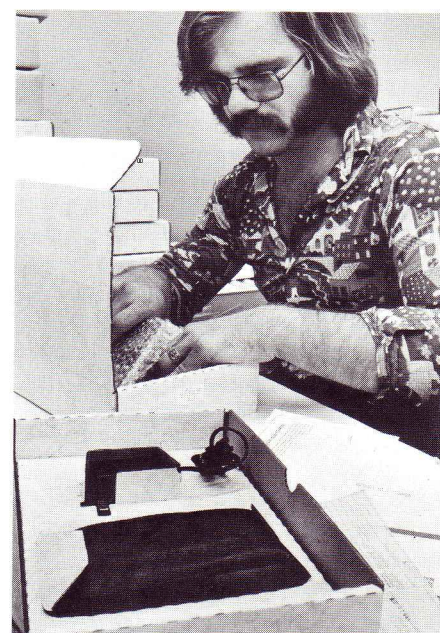
4. A handy tool, the "solder-sucker" (left-hand) is used in conjunction with a soldering iron to remove a faulty integrated circuit.



5. After repair, all parts are carefully reassembled and the unit begins a rigorous series of tests, both mechanized and personal.



7. When the calculator passes all electronic tests, it is sent to the Quality Assurance Station. Here, the operator inspects the overall appearance of the calculator, and runs a final set of test calculations.



9. Repaired calculators are packaged and shipped back to owners directly from the Service Department. A calculator is normally on an airplane to the customer within two working days from the time it was received.



6. An electronic "button-pusher" runs the logic board through a sequence of calculations to make sure the keyboard works perfectly.



8. Customers may call the Service Department to ask about the status of their calculators. Computerized records are kept on each unit throughout the process, and Service personnel can give you an up-to-date report.

Hewlett-Packard's Service Department will be relocated to Corvallis, Oregon on September 1, 1976. For fast repair service after that date, send your calculator or accessory to the following address:

**Hewlett-Packard Company
Corvallis Division Service Dept.
P.O. Box 999
1000 N.E. Circle Blvd.
Corvallis, Oregon 97330**

C-MOS Remember

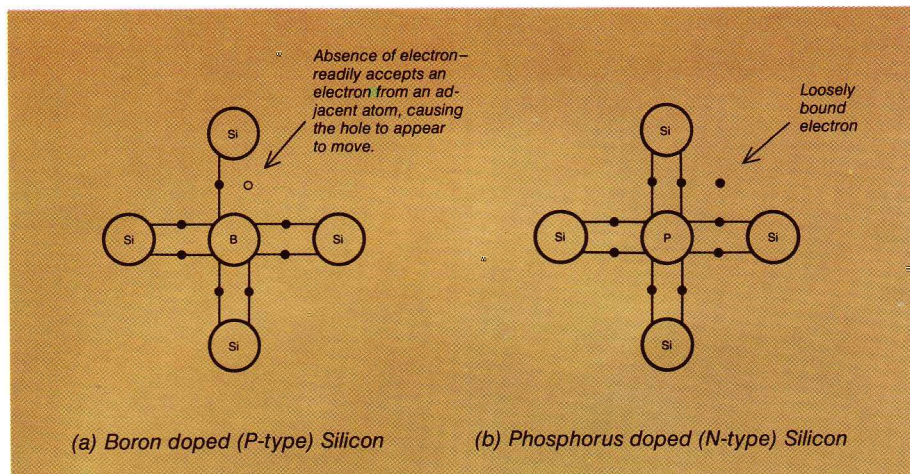
C-MOS stands for complementary metal-oxide-semiconductor and is the heart of the new HP-25C Scientific Programmable Calculator from Hewlett-Packard.

Requiring as little as 1/80,000th of the calculator's normal operating power, C-MOS enables the HP-25C to have Continuous Memory—so that it retains your programs and data even when switched off.

In order to understand how C-MOS works, it helps to understand MOS technology in general.

MOS technology was developed in the early 1960's. The first MOS integrated circuit contained 16 MOS transistors on one silicon chip, .005 inches square. Today over 10,000 MOS transistors can be packed onto a single chip, and, as technology improves, this figure will increase.

MOS transistors are formed by the sandwiching of metal and oxide over a semiconductor material. The metal referred to in MOS is aluminum, the oxide is silicon dioxide (SiO_2), and the semiconductor is silicon, either P-type or N-type.



P-type and N-type Silicon

The "P" in P-type silicon stands for the mobile *positive* charges (sometimes called "holes") scattered throughout the structure of the silicon. These charges are actually the absence of an electron in the outermost shell of the silicon atoms (see below). They are produced by adding minute amounts of boron to pure silicon during its crystal growth form. The boron impurity makes the silicon a semiconductor that conducts using these mobile positive charges.

As you may have already guessed, the "N" in N-type silicon stands for mobile negative charges. N-type silicon is produced by adding an element such as phosphorous in small quantities to pure silicon leaving an extra electron in the outermost shell of the silicon atoms (see above).

P-MOS

For the past ten years P-MOS has been the fundamental process for most of the industry. This is because it is relatively simple, reliable, well-proven and understood. Figure 1 shows a cross-section of a typical P-MOS transistor with its four functional parts: the source (S), the gate (G), the drain (D), and the substrate or body (B).

The body of the transistor is N-type silicon in which two P-type silicon regions are inserted. The gate is an electrode positioned between these two P regions and insulated from the body by a thin layer of silicon dioxide.

A voltage applied to the gate changes the conducting properties of the semiconductor surface.* As the gate voltage is raised past a critical point, called the threshold, a channel for current to flow is created between the source and drain regions.

* This phenomenon is called *surface field effect* and is fundamental to the operation of the MOS transistor.

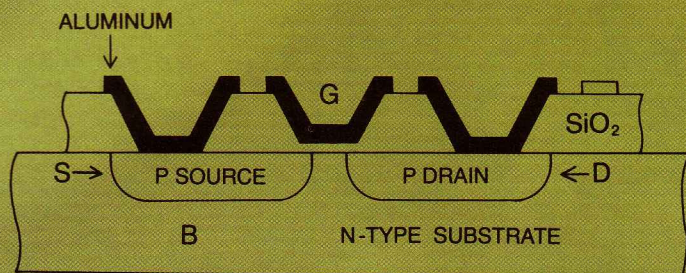


Figure 1

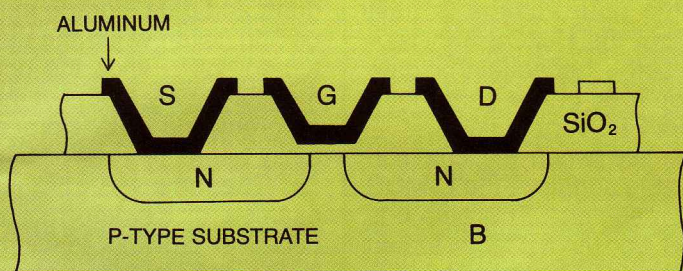


Figure 2

Normally the gate voltage is kept below the threshold of the transistor. In this state no current flows between the drain and the source and the transistor is "off". By raising the gate voltage slightly, however, the surface will begin accumulating mobile positive charges, attracted by the negative gate. Increasing the gate voltage further in a negative direction past the threshold essentially changes the substrate to P-type silicon with a continuous layer of mobile positive charges on the surface. In this state current flows freely through the newly created P-channel between the drain and the source and the transistor is "on".

N-MOS

N-MOS transistors are similar to P-MOS transistors. Figure 2 shows a cross-section of a typical N-MOS transistor.

As you can see, the N-MOS transistor consists of two N-type regions inserted into a P-type substrate, the opposite of the P-MOS transistor. The gate and thin layer of silicon dioxide remain the same in both.

The N-MOS transistor operates similarly to the P-MOS transistor except that the gate voltage is reversed in polarity. When the gate voltage is below the threshold of the transistor, no current flows between the drain and source and the transistor is "off". When the gate voltage is raised in a positive direction past the threshold, negative charges (electrons) accumulate and the surface essentially becomes N-type silicon. Current then flows freely through the newly-created N-channel between the source and drain and the transistor is "on".

These differences in operation result in dramatic differences in application. The mobility of the electrons in the N-MOS transistor is about three times that of the positive charges in the P-MOS transistor. Because of this mobility, N-MOS circuits have one-third the "on" resistance of equivalent P-MOS circuits. N-MOS circuits can therefore be smaller, faster, or require less power, though not all three at once. A limitation of N-MOS transistors is that they are difficult to make and consequently more expensive. However, N-MOS is becoming more and more popular as technology improves.

Up until now, all pocket calculators manufactured at Hewlett-Packard have used P-MOS circuits exclusively. Now, however, the new HP-27 Scientific/Plus Calculator uses all N-MOS circuits. What would have taken five P-MOS circuits and twice the power is accomplished with only three N-MOS circuits.

(Continued on next page)

C-MOS Remembers—Continued

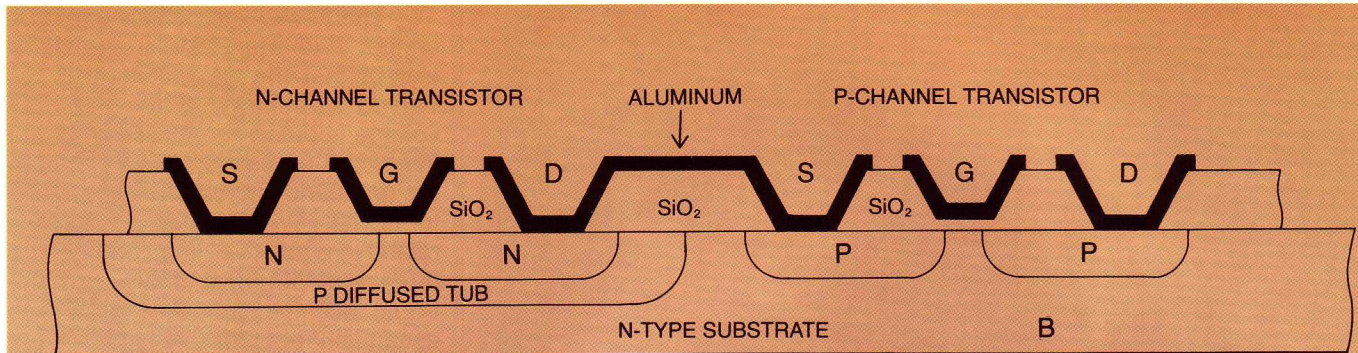


Figure 3

C-MOS

The basic C-MOS transistor consists of two adjacent transistors—one P-channel and one N-channel—on a single N-type substrate. This is accomplished by inserting a large P-type region into the substrate in addition to the P source and drain regions for the P-channel transistor. This large P-type region acts as the substrate for the N-channel transistor and the N source and drain regions are inserted in it subsequently. (Refer to Figure 3.)

As already mentioned, C-MOS requires very little power—only about $5\mu\text{W}$ of standby power as opposed to 400 mW of battery power consumed by the HP-25C when it is turned on and operating.

When the gate voltage (the same for both transistors) is positive, the C-MOS circuit is turned “on”. The N-MOS transistor is turned “on”, because the gate voltage is past threshold, but the P-MOS transistor is turned “off”, because the gate voltage for it is below threshold. Consequently no current flows.

Conversely, when the common gate voltage is negative, the C-MOS circuit is turned “off”. This time it is the N-MOS transistor that is turned “off” and the P-MOS transistor that is turned “on”. Again no current flows.

Separately, these P-MOS and N-MOS transistors consume power. But together in C-MOS, with only one transistor “on” at a time there is virtually no current flow or power consumption. The only power dissipated is during the switching from positive to negative or vice versa.

The tradeoffs with C-MOS are packing density and cost. In most C-MOS circuits two transistors are required where only one is needed using P-MOS or N-MOS. These extra transistors take up more space and result in higher costs. C-MOS circuits are also more complex to make due to the additional manufacturing steps required. These additional steps also add to the cost.

Hewlett-Packard uses this C-MOS technology in a new scientific calculator—the HP-25C. The C-MOS circuits in the HP-25C allow the program and data storage memories to be “on” even when the calculator is turned “off”. Since the power drain measures only tenths of microamps, program and data storage are virtually permanent.

The new HP-25C is another example of Hewlett-Packard’s technological prowess leading the way in the calculator industry. You can read all about this amazing new calculator, which has all the preprogrammed functions and programming power of our popular HP-25, in the catalog section of this magazine on page 10 and 11. ■

RPN

The last word in professional logic systems.

It's been a long time since we introduced our first pocket calculator (the HP-35) with the RPN logic system. It was then that the great debate began. ENTER vs EQUALS—which logic system is the best?

If you're already an HP calculator owner, you're convinced. But if you own an algebraic calculator, or if you haven't bought a calculator yet, you may not know.

The truth of the matter is that if you're adding, subtracting, multiplying, or dividing, an algebraic calculator will do the job. And you probably perform arithmetic calculations every day. Of course, a calculator with the RPN logic system can perform these arithmetic problems as easily, as quickly, and with the same number of keystrokes. So where is the advantage? It becomes readily apparent the minute you graduate to a more difficult problem.

With the RPN logic system you can begin calculating any problem without thinking it through ahead of time. Numbers are keyed in only

when you're going to use them in the problem. You don't have to remember what you've already put into the calculator. You also don't have to remember if the calculator multiplies before it adds, or performs logs before it divides. Operations happen as you key them in, making every step understandable. There are no surprises! And all problems are worked the same way.

Now you probably recognize that manufacturers of algebraic calculators make these same claims. Don't be confused by a careful selection of problems. The sum of products $((2 \times 3) + (4 \times 5))$ is the problem used most of the time to support the algebraic logic system. In truth, a sum of products calculation can be performed with one fewer keystroke on some algebraic calculators. But have you ever tried to work the product of sums $(2+3) \times (4+5)$ on the same calculator? This time it takes three more keystrokes.

The point is, it doesn't matter whether you do the sum of products or the product of sums when you're using RPN. It requires the same number of keystrokes either way because you do every problem the

same way. But don't take anybody's word on this. Select problems you face every day. Don't let the manufacturer select the problem for you.

Solving every problem the same way gives you confidence in your answers. How can you be confident with an algebraic calculator if you have to approach every problem differently? If you don't think each problem through ahead of time you'll probably get a wrong answer. Of course, you can get a wrong answer using RPN too. But it won't be because the calculator solves that particular problem differently.

If you are already conditioned to algebraic logic, relax. The transition to RPN is easy and the detailed HP Owner's Handbooks make it even easier with clear explanations of every powerful feature. The confidence you gain and the time you save make it well worth your while.

Why do we recommend RPN? It's because we think it's the most sensible logic system a calculator can have—for difficult problems, or for any problem. And HP owners feel the same way. We are very proud of the fact that they are our best salesmen.

HOW RPN WORKS

To use any one-number function key:

1. Key in the number.
2. Press the function key.

For example, to use the one-number function $1/x$ key, you first key in the number represented by x , then press the function key.

To calculate $1/4$:

Press	Display
4	4.
$1/x$	0.25

Two-number functions are functions that must have two numbers present in order for the operation to be performed. $+$, $-$, \times , and \div are examples of two-number function keys. You cannot add, subtract, multiply, or divide unless there are two numbers present in the calculator. Two-number functions work the same way as one-number functions—that is, the operation occurs when the function key is pressed. Therefore, both numbers must be in the calculator before the function key is pressed.

When more than one number must be keyed into the calculator before performing an operation, the ENTER \uparrow key is used to separate the two numbers. To place two numbers in the calculator and perform an operation:

1. Key in the first number.
2. Press ENTER \uparrow to separate the first number from the second.
3. Key in the second number.
4. Press the function key to perform the operation.

For example, to add 12 and 3:

Press	Display
12	12.
ENTER \uparrow	12.00
3	3.
$+$	15.00

The speed and simplicity of operation of the RPN logic system become most apparent during chain calculations. Even during the longest of calculations, you still perform only one operation at a time, and you see the results as you calculate. The Hewlett-Packard automatic memory stack stores up to four intermediate results inside the calculator until you need them, then inserts them into the calculation.

For example, solve $(12 + 3) \times 7$.

If you were working the problem with a pencil and paper, you would first calculate the intermediate result of $(12 + 3)$...

$$\begin{array}{r} (12 + 3) \times 7 = \\ 15 \end{array}$$

... and then you would multiply the intermediate result by 7.

$$\begin{array}{r} (12 + 3) \times 7 = 105 \\ 15 \end{array}$$

You work through the problem exactly the same way with the RPN logic system, one operation at a time. You solve for the intermediate result first ...

Press	Display
12	12.
ENTER \uparrow	12.00
3	3.
$+$	15.00

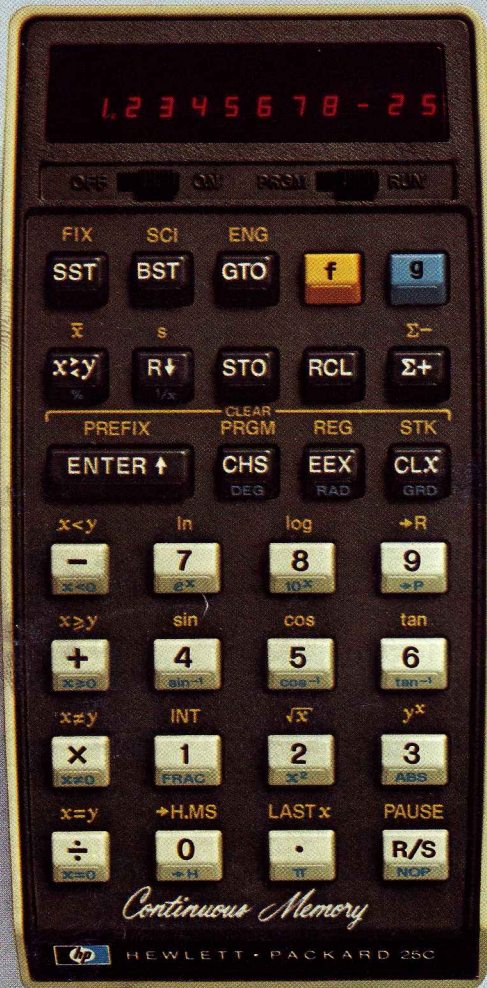
... and then solve for the final answer.

You don't need to press ENTER \uparrow to store the intermediate result. It is automatically stored when you key in the next number. To continue ...

Press	Display
7	7.
\times	105.00

No matter how complicated a problem may look, it can always be reduced to a series of one- and two-number operations. Simply work through the problem in the same logical order you would use if you were working it with a pencil and paper. ■

New Hewlett-Packard HP-25C Scientific Programmable Calculator with Continuous Memory. \$200.



**Retains your programs and saves your data—
even when you turn it off!**

The great new HP-25C is the first scientific calculator you can turn on and off as often as you like without losing your programs or stored data.

You can store and retain programmed solutions to any repetitive problem—from long, complex problems to hyperbolics, statistical functions, octal-decimal conversions, degrees-minutes-seconds addition and much more. Constants, statistical data, etc., may also be saved indefinitely in the eight addressable memories.

The new HP-25C is identical in every other respect to the popular HP-25. You get:

72 functions and operations. All trig functions in radians, degrees and grads; rectangular/polar conversions; logs; etc.

Keystroke programmability. Enter your keystrokes once. Then enter only the variables each time.

Full editing capability. You can easily review and quickly add or change steps.

Conditional branching. Eight logic tests let you program decisions.

8 addressable memories. And you can do full register arithmetic on all eight.

Fixed decimal and scientific notation—plus engineering notation which displays powers of ten in multiples of ± 3 for ease in working with many units of measure—e.g., kilograms (10^3), nanoseconds (10^{-9}), etc.

For more details, see page 10.

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