# HP-28S Review

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Refer to the article titled "HP's New Calculators" for more general comments and basic information about the new machines. This article concentrates specifically on analysis of the finer points of the HP-28S, its differences from the HP-28C, and an overall evaluation.

First time HP calculator users will have little trouble learning the basics of the 28's RPL (Reverse Polish Lisp) and stack operation. The RPL operating system is consistent in its postfix operation.

Users who have had earlier HP RPN calculators such as the 41 will immediately sense a difference. Gone is the CLX key, gone is the X< >Y key, gone is the Roll Down key. Even the ENTER key doesn't have the up arrow on it. RCL is a shifted key. There is a lot to get used to.

Having had a 28C and now a 28S for a while, my experience with earlier HP calculators (35, 25, 41C, 41CX) made adjusting to this new breed of Reverse Polish operating system uncomfortable. I must admit the 28C, with all of its innovation and symbolic processing, never really diverted my attention from the 41CX for long. It has no I/O, its user memory was miniscule for meaningful work, and it didn't operate the ways to which I had become accustomed. In short, it was somewhat of a toy.

The 28S addresses some of those concerns very well while ignoring others. The RAM upgrade from approximately 1.7K to 32K is overwhelming. Initial reaction: You've got to be kidding! Moreover, the machine is faster and has a number of new, fascinating functions. The clamshell (non-handheld, that is) design remains, and the menu system remains as well.

## What's New?

One by one, here is a list of the differences between the 28S and the 28C:

1. 32K bytes of RAM.
   Note also that the 28S is completely new electronics compared to the 28C. The CPU, one display driver, and 64K of ROM are integrated into a single IC (there are two of these). The 32K RAM is a commercial part, not a Saturn RAM. These points mean
   a) you can't make a 28C into a 28S, and
   b) you can't add RAM to a 28S--it's hard configured.
2. System clock speed increased from 640 KHz to 1 MHz (56% increase). Plotting (and cursor movement to digitize points) is very noticeably faster.
3. Directory system for USER menu (subdirectories). Associated MEMORY menu functions added include CRDIR (CReate DIRectory), HOME, PATH, and VARS. CLUSR now clears objects only in the current directory.
4. Display contrast is the same as the 28C. However, the 28S uses non-glare glass over the LCD, whereas the 28C did not. Custom menu in which you can combine user variables and built-in commands.
5. Keyboard menu markings on shifted keys are highlighted in light gray rectangles. Shifted key (red) characters are in slightly smaller letters yet are more legible due to better contrast with the light gray background. The red seems redder.
6. Some menus moved around, with STAT moved from right to left hand keyboard. Some spellings of menu names have changed also: CMPLX to COMPLX, ALGEBRA to ALGBRA, and CTRL to CONTRL.
7. ALPHA LOCK replaced by MENUS function on shifted ALPHA key. MENUS eliminates the need to press the red shift key to call up a menu such as BRANCH.
8. Mode toggles show the choice with a small square next to the name, rather than displaying in inverse video (e.g. FIX, etc.)
9. CUSTOM menus may now be created through the new MENU function. A custom menu can combine user variables and built-in commands. The input parameter for creating a custom user menu is a list. If the first item in the list is STO, the menu is used for inputs rather than outputs (evaluating user variables), and the menu appears in inverse video (black on white).
10. The new MENU function also can take an integer input which gives programmable selection of menus.
11. SOLVER soft key labels are now in 'inverse video'.

12. Binary numbers now displayed with 'b', 'o', 'd' and 'h' to the right of the values. Also, a value may be entered in any base as long as it is identified with the proper letter.
13. CATALOG and UNITS menus scan by holding NEXT or PREV soft key down. Old SCAN soft key is gone.
14. ALPHA key now executes a three-way toggle between all three entry modes of the machine.
15. Programs decompile and print with automatic indentation to show control structures such as FOR/NEXT, IF/THEN/ELSE, etc.. This occurs when you EDIT, VISIT, or print programs. Hence the code is more readable.
16. A(I) returns the Ith element of a list or array, within an algebraic, allowing indexed variables. A(I,J) works, too. For example, 'L(3)' returns the 3rd element in ARRAY L or LIST L.
17. POS (position) finds an object in a list.
18. User defined functions may be defined with programs.
19. Single character operators (+,-,*,/ and ^) automatically add needed spaces in program entry.
20. Addition of COMB (combination) and PERM (permutation) functions to the STAT menu.
21. DGTIZ function allows interactive digitizing with INS key from a running program. This does exactly the same as the CURSOR routine in V1N3. (Note to 28C users: see OOPS column, this issue.)
22. Graphic plots may be saved as a string object in stack level 1, or restored from stack with LCD-> and ->LCD functions. Interactive storage of current plot with DEL key press. LCD-> captures the LCD image into a 548-byte string in level 1 of the stack, which can be stored as a user variable. LCD-> and ->LCD are fast. Boolean operators (AND, OR, XOR, NOT) may be applied to the strings to get inverse video. For example, the sequence CLLCD DRAW LCD-> NOT 'INVP' STO will save an inverse plot of the current EQuation to the object INVP. If you take two LCD image strings of different function plots and do a logical OR of them, this overlays them. To show the intersections of the plots you would AND them.
23. SYSEVAL entry points are changed. The clock entry point (#123E hex in the 28C) is #11CA hex in the 28S. Using #123E on the 28S results in memory lost.
24. Some of the unit conversion constants are changed to be more consistent with solid angles and the speed of light. For example, sr (steradian) now has a value of 7.95774715459E-2 instead of 1 as in the 28C. c, the speed of light, has been added even though it is just a constant.
25. Flag 46 set/clear controls wraparound on/off of GETI/PUTI index value back to 1.
26. Flag 47 set/clear controls double-space printing on/off.
27. Press ON-L together to dump LCD image to printer at any time.
28. Errors automatically identify the guilty command.
29. Plotting continues despite math errors/exceptions.
30. Command arguments requiring real numbers in lists permit use of programs or symbolics in place of the numbers.
31. RND (round) works on complex and array objects.
32. Singular matrix inversion is tied to the divide-by-zero exception flag.
33. Various 28C bugs fixed. The spurious } character bug described in V1N3 still exists.

### What's Wrong?

With all of the differences and enhancements, what is wrong with the 28S? That is subjective. I do not know of any feature which the 28S has changed which should be the way it was on the 28C, with the exception of hard-configured RAM, making memory upgrades of the 28S virtually impossible. The memory and speed improvements are major, and the additional functions are well thought out. There are also some functions which should have been included in the 28S--more on that later.

The most fundamental thing wrong with the HP-28S is lack of I/O. With 32K of RAM there is no way to back up the contents. Thus one is very reluctant to try any dangerous functions such as CLUSR and SYSEVAL. With about 13K of code in my 28S at the present moment, I shudder to think how long it would take to key it all back in! Without some sort of mass storage--card reader, HP-IL cassette or disc drive, anything--I am always greatly concerned about having a current listing of the machine's contents. My hunch is that sales of the infrared printer will go up dramatically for 28's because of this serious shortcoming of the mainframe. The other reason that lack of I/O is a problem is because what a wonderful contribution to the world of computing the 28S could be if it could link up with other computers to do symbolic processing, processing data sets, etc. While the Hookup interface and software allow the 28S et al. to transmit infrared data to a desktop machine, it is a one-way transfer, limited by that fact. Hewlett-Packard must admit that a machine with user memory of this magnitude simply must have offline storage, and that it makes sense to add more general I/O capabilities. Another important item is reliable memory. The user must be able to protect his data from temporary loss of power, system lockup, etc. HP is always trying to address this concern, and one can only hope for improvements in this area as well.

What else is wrong? Menus, menus, menus. Too many menus. This is a comment not necessarily directed at the 28S as opposed to the 28C, it is just a personal observation. Many times it has been confusing to remember where a function resides. The CATALOG function helps a lot in this area, but it is still not convenient to do things which would take minimal keystrokes on a 41, such as taking a log of a trig function. The number of functions present in the 28S, though, makes any scheme of execution difficult to be ideally efficient. The organization of menus in the 28S is better than in the 28C, more intuitive. On the whole, the 28S's use of menus is a mixed bag.

The clamshell case design is far from handheld, and the closed case does not fit into many pockets. More comments on this are in the "HP's New Calculators" article in this issue.

With all of the features the 28S has, why do people continue to use the 41? That is a complex question to answer, one which HP has been studying for some time. The 41 is very keystroke efficient for everyday calculations. I still find myself frustrated by not being able to press ENTER + to double a number on the 28. The percent function is another which is a problem on the 28. Try subtracting 15% from 85, and adding 6%. On the 41 it takes 12 keystrokes to get 76.585, and it is an operation you quickly become familiar with. RPN users often find it necessary to write their own percent function (OVER %) to emulate the 41's percent function!

The 41 is comfortable to hold in the hand and can be operated with one hand. Surveyors need to do this, operating the surveying instrument with one hand while doing calculations with the other.

Software exists for the 41 in the forms of plug-in application ROMs, solution books with barcode, and Users' Library programs with magnetic cards and barcode. The 28S user must key in his own programs, some which are available in step-by-step books somewhat similar to solution books.

### What's Right?

The 28S has a lot of good features going for it. Memory and speed are the most obvious. The Saturn processor used in the 71B is used in the 28S, integrated with other components into one chip. The clock speed of the 28S is faster than the 71B. Memory is sufficient to deal with almost any problem, with much more capacity than the equivalent 41 system (without mass storage). The increase in RAM and functions from the 28C to the 28S is about equivalent to upgrading from a basic 41C with Extended Functions to a speeded-up 41CX with full Extended Memory.

The 28S deals with objects, not by going into various modes such as Program Mode. What this offers in flexibility of programming and usage is enormous. Strings can be converted into programs, lists can be interpreted and processed, etc. The FORTH/LISP-like RPL language, combined with the 28's symbolic processing processing features, pave the way for a completely new wave of software and intelligent programming.

The subdirectory memory structure of the 28S has two distinct advantages. One is that you can organize programs and other user objects into logical categories, avoiding long lists of user variables in any given directory. For example, you could put all your curve fitting programs into a subdirectory. The second advantage the subdirectories offer is the concept known in FORTH as having multiple vocabularies or dictionaries. The 28S allows you to have two entirely different user variables with the same name in different PATHs. Depending on where you are in the directory tree, you can evaluate one or the other.

The solver continues to be useful. The ability to store and recall graphs as well as combine them is a good feature added in the 28S. Animation is possible, as are multi-dimensional graphical rotations. The ON/L screen dump capability is a handy feature.

The indented display and printing of program structure is a welcome new feature on the 28S which aids debugging. The identification of the command causing an error can be helpful for program debugging, too. The single character operators automatically put spaces where needed, a feature which should have existed in the 28C.

The double-space printing control with flag 47 is a feature which should have been implemented in the 28C, and which is missing from the HP-41 Infrared Printer module.

Indexed variables for lists and arrays will be extremely useful for some users. This feature could enable development of some powerful matrix and database functions. Using lists, string arrays are possible.

## What's Missing?

Several other functions should have been included in the 28S. A few which come to mind are:

1. UP. With the subdirectory structure it is often desirable to jump up to the next higher level in the directory tree. MS-DOS has CD.., for example. The UP function is noticeably missing.
2. Rename subdirectories. You can rename user variables, but you can't rename a directory. A program to do so would be useful.
3. Execute or recall something in a different directory path and return to the present directory. A desired routine is not always available in the current path, and it wastes memory to have several copies of it in memory. Likewise, it is not always efficient to put it in the HOME directory.
4. EXCO (EXpand and COllect completely) or equivalent. This is one of the handiest routines (although limited when memory is tight) included in the HP-28C Programming Examples booklet and in the 28S manuals for handling algebraic expressions.
5. Be able to define other types of objects in terms of existing object types. This is a feature of some other languages, so why shouldn't the 28S be able to do so? The 28S is rich in powerful programming features; new object type definitions would be a natural extension. Gil Bachelor's article in this issue mentions fractions as being a missing object type; perhaps the LISP routine in the "HP-28 Routines" article will spur further development in this area.
6. Accurate system clock and time functions. Adding the equivalent of the 41CX time functions could prove to be very useful.

## Summary

The HP-28S is a considerable upgrade of the HP-28C. HP has smoothed out many of the rough edges and has added a number of very good functions. The machine is at once a *usable* HP-28, with enough room to handle realistic problems in algebra, calculus, and matrix math. The directory structure is an excellent, necessary addition. With persistence in learning the machine, it is possible to write some quite useful and powerful programs in very little time. Harry Bertuccelli may not care for it, but the HP-28S is a step forward for Hewlett-Packard in the field of handheld computation. Its lack of I/O and plug-in solutions will prevent it from becoming the kind of success the HP-41 has been, but the 28S makes strides in programming flexibility and consistency of operation.