# Summing up the HP 33S

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Upon reading the last issue some of you, I think, must have got the impression the new HP 33S scientific calculator is good only for those who are a) Chinese and b) all thumbs. Let me, then, give you more information about this neat machine. Except to a few collectors, details of my beta 33S are pretty irrelevant so it's better if I refer to my production unit, which is the latest version available to date (early May). Its serial number is CNA41101044. I've been told that the 'A' in the site code (not present in the first production units) is used for differentiating the multiple suppliers.

What's new?

It is in the current context of resorting to redesigns of discontinued models that we must view this calculator, but the result is quite good all the same. In essence, the 33S is a 32SII with much more memory (31KB), more keys (though somewhat *creased* as described by Craig Finseth in his HPDATABase), a 2-line by *14* character dot-matrix LCD, a few new functions and the inevitable algebraic entry mode, which is not so useless as in the 12C Platinum, but equally unnecessary since the 32SII could already handle algebraic expressions as well.
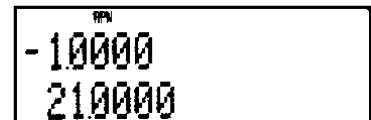
Some users will prefer the ALG mode, however, when operating with complex numbers as calculations are being displayed all the time, although the RPN sequence is shorter and ⎣↓⎦ is not required to view the imaginary part. Compare the following ways of evaluating $(5 + 3i) \times (3 - 2i)$ and the resulting displays:
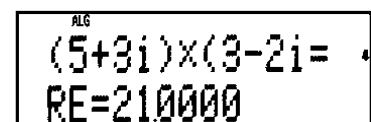
In RPN mode: 3 ⎣ENTER⎦ 5 ⎣ENTER⎦ 2 ⎣+/−⎦ ⎣ENTER⎦ 3 ⎣◧⎦ ⎣CMPLX⎦ ⎣×⎦ (all stack levels are used)

In ALG mode: 5 ⎣+⎦ 3 ⎣◧⎦ ⎣CMPLX⎦ ⎣ENTER⎦ ⎣×⎦ ⎣▸⎦ ⎣(⎦ 3 ⎣−⎦ 2 ⎣◧⎦ ⎣CMPLX⎦ ⎣ENTER⎦ (⎣↓⎦)

There is no provision for interchangeable overlays. Somehow they do not seem to be favoured in the slightest any more. (For instance, the five additional bezels for the 30S –F1908A– are only available in Australia).

Despite the 11 new keys, there are still 14 menus, whose names are no longer printed on darker backgrounds (actually lighter on the *black* 32SII). The functions in the 32SII PARTS and PROB menus are now on keys, while there are two new menus: the CONST menu (⎣▸⎦ ⎣CONST⎦), which displays an up-to-date list of 40 physics constants in metric units (nearly all the constants on the 48GX plus a few more, such as magnetic moments, muon mass, conductance quantum, etc.), and the menu displayed by ⎣R↓⎦ and ⎣▸⎦⎣R↓⎦ in ALG

mode to review the "stack" (four registers that keep the values returned by SOLVE and ⟦ʀ⟧⟦∫⟧).

Although the 33S is in general faster, it does not put the 32SII to shame. Simple loops with counters run about twice as fast on the 33S provided the ISG and DSE commands are *not* used: if 0.999 is stored in A, this program LBL A, ISG A, GTO A, RTN runs in 34 seconds on the 33S, whereas it takes only 16 seconds on the 32SII. With some exceptions such as the integral below, solving and integration calculations are 1.5-3 times faster on the 33S.

These are the new functions and operations:

- In addition to the engineering display format, the programmable functions ⟦ENG⟧ and ⟦ʀ⟧⟦←ENG⟧ cause the exponent of *x* (the contents of the X-register) to change in multiples of three.

- ⟦◄⟧⟦▼⟧ and ⟦◄⟧⟦▲⟧ move to the bottom/top of the equation or program list.

- ⟦ʀ⟧⟦ALG⟧ and ⟦◄⟧⟦RPN⟧: programmable logic switches.

- The real-number functions ⟦◄⟧⟦x³⟧, ⟦◄⟧⟦∛x⟧ and ⟦ʀ⟧⟦SGN⟧ (sign of *x*).

- ⟦ʀ⟧⟦INTG⟧ returns the greatest integer that is less than or equal to the argument. Same as FLOOR on the 48/49.

- ⟦◄⟧⟦INT÷⟧: same as INTG(y / x) (It returns IP(y / x) on early units!)

- ⟦ʀ⟧⟦Rmdr⟧: same as the 48/49 MOD command, i.e. $y - x \cdot \text{INTG}(y / x)$

- 0 ⟦ʀ⟧⟦SEED⟧ stores a random value as the seed for ⟦ʀ⟧⟦RAND⟧

The SCRL function has been replaced with cursor keys. The 🄱 (for busy) and HYP annunciators replace the blinking PRGM and EQN, and the HYP prefix operator respectively. Flag 4 now has its own annunciator. And there is now a RESET hole on the back; the second edition of the manual (page A-4) states that "stored data usually remain intact" when pressed, but it always wipes out the memory in my units.

Besides the changes derived from the two extra digits in the display, there are several differences between the 33S and the 32SII. The length of an equation is no longer limited only by the available memory, but *to 255 characters!* When entering equations, trailing parentheses ")" of two-argument functions are now required; on the other hand ⟦+∕–⟧ and ⟦–⟧ can be used interchangeably when entering the second argument of such functions. Also in equations, expressions like EXP(–X^2) now mean EXP(–(X^2)) fixing certain inconsistency of the 32SII, on which 25–5^2 evaluates to 0, while –5^2+25 evaluates to 50. A colon (⟦:⟧) and not a space is used for separating arguments of functions in equations; both the colon and the space can be used in messages. Calculations with "TOO BIG" numbers (out-of-range numbers displayed in non-decimal modes) are now possible provided the *result* is not outside the range: e.g. (RPN) 4⟦E⟧10 ⟦◄⟧⟦BASE⟧4 (i.e. binary mode) 1010 ⟦÷⟧ ⟦◄⟧⟦BASE⟧1 (restores decimal base) returns 4E9, while the 32SII returns 3,435,973,836 (the largest 36-bit positive integer divided by 10). On the 33S, if a

program is interrupted when calculating an integral, such calculation cannot be resumed. Lastly, certain calculations do not produce the same results on both machines (e.g. gamma of 9.29) which suggests that the CPU (a Sunplus SPLB31A, based on the 6502) is running native software rather than emulating the 32SII.

In fact, MEM and SHOW readings have changed, as well as the checksum for equations and programs. The following table shows the allocation of user memory. The 32SII values have been taken from pages 12-22 and B-2 of the 32SII owner's manual. The 33S user's manual omits such details. On the 33S, SHOW readings for equations (length) do not match differences between two consecutive MEM readings (amount of memory used). Notice that nibbles no longer come into play.

| Data | Amount of Memory Used | |
	32SII	33S
Variables	8 bytes per non-zero value. (No bytes for zero values).	No bytes. Variables (including *i* and the statistics registers) take up no *user* memory. Always allocated.
Statistics data	48 bytes maximum (8 bytes for each non-zero register).	
Numbers in program lines	Integers 0 through 254: 1.5 bytes. All other numbers: 9.5	15 bytes. No short form for frequently used values, but constants in program lines take 3 bytes, unless they are in an equation.
Instructions in program lines	1.5 bytes	3 bytes
Equations in program lines	1.5 bytes + 1.5 for each function + 9.5 or 1.5 for each number. Each "(" and each ")" uses 1.5 bytes, except the "(" for prefix functions.	3 bytes + 1 byte for each character (255 maximum).
Numbers in equations	Integers 0 through 254: 1.5 bytes. All other numbers: 9.5	Each entry in the equation list takes 6 bytes + 1 byte for each character. (255 maximum).
Operations in equations	1.5 bytes	

Still more telling is the fact that the algorithms for [SOLVE] and [▶][∫] have been rewritten. There is a detailed introduction to the new solver in the document *Advanced Use of the Formula Solver*, one of the numerous training guides for the 33S available at HP's website. SOLVE first tries to give a direct solution by rearranging the equation. The new message INVALID VAR is displayed when attempting to solve an equation for a variable not present. Incidentally, SOLVE now fails to find the pole in the example on page D-7 of the user's manual (C-8 in the 32SII owner's manual). VIEW and STOP instructions in programs that are being solved or integrated are executed only once, not each time the routine is

called by SOLVE or Integrate; to monitor their execution, intermediate steps can be displayed by the sequence VIEW *var* PSE (refer to pages 14-2 and 14-10 of the manual). ⌐∫⌐ returns exactly the *same* results as the 48GX integral function, including the uncertainty of the result (i.e. the 48GX IERR variable). The uncertainty (but no the actual error) tends to be a bit larger than the one returned by the 32SII. The following exception, taken from the August 1980 issue of the Hewlett-Packard Journal, shows that the integration algorithm is clearly different from the 32SII or the 15C, which return a wrong result in FIX 5:

$\int_0^1 \left(\dfrac{\sqrt{x}}{x-1} - \dfrac{1}{\ln x} \right) dx$	32SII		33S	
	FIX 5	FIX 7	FIX 5	FIX 7
Result	0.03662	0.0364900	0.03649	0.0364900
Uncertainty	0.00001	0.0000001	3.649E-7	3.649E-9
Actual error	1.282E-4	1.131E-8	5.373E-8	5.198E-10
Running time	3 sec	2 min 4 sec	39 sec	5 min 6 sec

Fig. 1 The battery compartment

The 33S is powered by two CR2032 batteries, which are held in place by the plates shown in Fig.1. Appendix A advises the user to "remove the batteries… and lightly press a coin against both battery contacts…" in case of malfunction. I've never seen a Chinese coin, but I rather suspect it's just a vestige of the manual for the 32SII… As Leif Harcke wrote in V22N6 "the manual is a one-to-one mapping from the 32SII manual." 388 pages printed in black and blue but in a sans serif typeface this time. There are indeed a few errors in the adaptation that need fixing, but that's what revisions are for. Although the ALG mode is wisely confined to Appendix C, some sample programs have been transcribed to ALG. This is not so bad as it sounds because programming in ALG has its own tricks (e.g. how to use LASTx or x↔y), which willing users can learn by studying the listings in the manual and in the learning modules – there's no other way, I'm afraid. In a posting to the comp.sys.hp48 Usenet newsgroup Bill Platt regrets that Horner's method is now written in ALG. Too bad they did not keep the RPN version so that users could compare $5x^4+2x^3$ in RPN (assuming x is on level one: ENTER ENTER ENTER 5 × 2 + × × ×) to the ALG routine supplied (5 × RCL X y^x 4 + 2 × RCL X y^x 3 ENTER, assumes x has been INPUT). Still, the ALG program for the general case $Ax^4+Bx^3+Cx^2+Dx+E$ on page 12-25 is *one line shorter* (but 25.5 bytes larger) than the 32SII version.

Fig. 2 The HP 33S RPN/ALG Scientific Calculator.
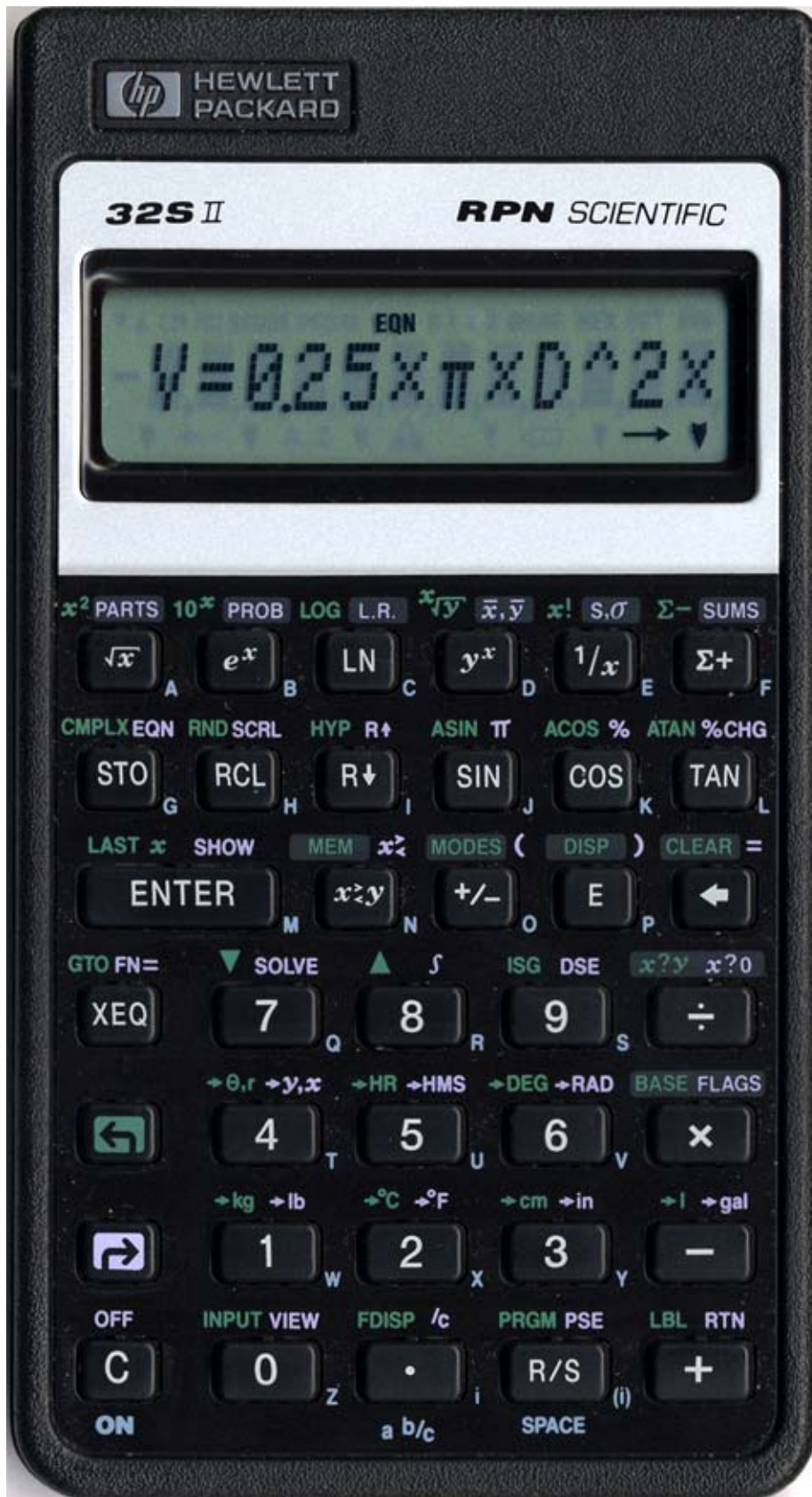Actual size: 15.8 x 8.3 x 1.61 cm.

Fig. 3 On the same scale, the HP32SII as last seen in 2002.
Actual size: 14.7 x 8.1 x 1.5 cm.

Fig. 4 Internal view of the HP 33S.

What's so wrong?

The early production batches that Włodek Mier-Jędrzejowicz referred to in his previous Chairman's Bytes have provided HP with a good many first-hand impressions from contributors to the forum at hpmuseum.org, Paul Brogger and sharp-witted Ben Salinas being the most active. Leaving aside the chevron keyboard, the most often repeated criticisms are that it is too big to fit comfortably in a shirt pocket, that the decimal point is too small, that there are too few new features and that users cannot take advantage of that much RAM.

As to the radix point size issue, there's only one thing for it – to upgrade the LCD, which, according to HP, will be implemented this July. They should not pass up the chance to get rid of the annoying shadows too. By inspecting the new functions, it becomes apparent that the designers did not have the slightest intention to undertake massive changes to the 32SII firmware. Writing a complete simulation

was challenging enough, I guess. Gene Wright says it all in this posting to the forum:

> My guess is HP said something like this: "We're really moving the 32SII to a new package and aren't going to be making many changes to it at all. We can't sell the old one because we can't make them any more. We face a choice guys...the cost of a 2K chip is the same (within pennies) as a 32K ram chip…which do we put in?" They went with the 32K ram. Will it be entirely useful? I don't know…I expect perhaps not. But, it is there to try to use.

With all the room for improvement, however, it is quite a good remake. What's wrong with more memory and an optional ALG mode? Nothing. Well, nothing much. Trouble is that there are up to ten thousand program lines at our disposal but only 26 program labels and 33 variables in total. Seen from the outside, giving the user more data registers even if only indirectly addressable does not *appear* to be too much of a hassle, but Kinpo must know best. A trick to create lists of constants with the ISG command and Paul's article on how to minimise label use (both posted to the forum) will help us get by with what we have. The algebraic mode is neither fish nor fowl. To quote Dave Johnson: "a prefix/postfix mix characteristic of low end TI calculators." Nevertheless, users can now choose from three different modes since the equation list has its own entry system.

Remaining bugs in my production 33S are the 0 SEED bug (described in V23N2, page 4); nCr returns bogus results for large arguments (e.g. 2000nCr1000); the bug reported by Ben: after exiting a self-test ($\boxed{C}$-$\boxed{y^x}$ or $\boxed{C}$-$\boxed{1/x}$), the RAD/GRAD, 0-4 and HEX/OCT/BIN *annunciators* are always cleared (as well as the stack level one) but the corresponding modes and flags are not actually altered (i.e. if radians mode was active before starting the self-test, it will keep operating in radians mode after the self-test *even though the RAD annunciator is not on*). Speaking of $\boxed{C}$-key combinations, $\boxed{LN}$ and not $\boxed{e^x}$, is now the still undocumented *Oops!* key, which cancels the $\boxed{C}$-$\boxed{y^x}$, $\boxed{C}$-$\boxed{1/x}$ and $\boxed{C}$-$\boxed{e^x}$-$\boxed{\Sigma+}$ operations so long as $\boxed{LN}$ is pressed before releasing $\boxed{C}$, like ON-B on the 48/49.

The forty-two learning modules and training guides for the 33S that Gene and Włodek have written are evidence less of the need for outsourcing than of HP's resolution to recover the good name they once had. The modules remind me of the instructional materials produced by the HP Educator Programme (see V20N2, pages 3 and 30). One of the activities for the 30S prepared by Colin Croft in *Investigating Mathematics through Patterns* (Volume 2) dealt with Dubois' formula for estimating body surface area given a person's height and weight. The same problem is tackled in the 33S module *Applications in Medicine*. It's fascinating to compare the two approaches, as both authors carry out a careful presentation for different audiences.

If I may digress for a moment… By bringing expert users in, HP take advantage of the vast knowledge and experience of the user community. We know only too well that the dissolution of the Corvallis group meant a lack of continuity in too many things: mastery, innovation, responsiveness, etc. "True continuity appears to be in

the hands of users who know how older products were designed, where function keys were placed, or the best angle to view the display at" wrote Bruce Horrocks in his first editorial (V19N6). Whether such users agree or not is another matter. While many enthusiasts swear by the 42S, others just don't understand why it is such a sought-after model on eBay. Quite telling is a posting to comp.sys.hp48 by Hydrix CEO Jean-Yves Avenard, software team leader as was, preserved at groups.google.com like a fly in amber: "In my opinion you'd have to be a nutcase to buy a 42S at that price [$320-$399]. I didn't want to buy it when it was still being sold, why would I pay so much for something that has so many problems and such a poor user interface?"

HP Lovecraft vs. Salvador Dali?

It's about time we talked about the keyboard… The following thought that Diana Byrne, R&D project manager for the 48GX and the 38G, wrote in her article for *RCL 20* will put us in the picture:

> It's hard not to think about design while waiting for a flight at the Copenhagen airport. Posters of Scandinavian-designed chairs and lamps hang overhead as compact, quiet luggage carts glide across beautiful teak floors. These elegant, yet practical items are not only nice to use, they are also delightful. Many people feel this way about the traditional keys on HP calculators: they provide just the right feedback with a satisfying click.

Despite a somewhat loud click, keys have a good if rigid tactile feel. There's no sign of double-shot injection moulding yet (or is that now a red herring?) All keys on my units register flawlessly, even when hit on a side. Whether $\boxed{ENG}$, $\boxed{x^2}$ and $\boxed{\%}$ deserve to be primary keys or not is certainly debatable, but the keyboard layout *is* a definite improvement on that of the first prototypes, where $\boxed{\sqrt[y]{x}}$, $\boxed{INT\div}$ and $\boxed{ALG}$ were all primary keys (see the cover picture on V22N5). If they were mistaken, it is well to remember that ACO enjoyed no better success: the ON key on the 10BII *does nothing* once the calculator has been turned on!

Thinking back, the first time I saw the keyboard I was reminded of the paintings of Salvador Dali. Not that it's a work of art, but it's hard for a Catalan not to think about Dali's designs this year, when we are celebrating the centenary of his birth. Still, some *functional* design might well lie behind it all: some suggest that the chevron keyboard makes the 33S look less cluttered and helps the user find functions more quickly; others find it easier to use it with two hands but had the designers have that in mind, they should have placed the $\boxed{ENTER}$ key in the middle or in the lower-right corner at least (as on the 30S or the 9S). Some believe the 33S will never fit in well in their workplace. I do find this calculator much slicker than the 32SII shown in Fig.3. Alas, there's no accounting for taste: "The HP 33S is the most threatening-looking calculator I've ever seen," wrote Eric Smith, "the awkward angles of the keys are very disconcerting, and somehow bring to mind the Cthulhu Mythos." A nightmare or surrealism? Oh well, I'd better stop trying to understand it!