WP 34S

OWNER’S MANUAL

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WELCOME

Dear user, you hold in your hands the result of careful customizing. Mechanics and hardware of your WP 34S are of the new *HP-30b Business Professional* as is: so you get its unexcelled processor speed and also the famous rotate-and-click keys with tactile feedback as known and appreciated in vintage Hewlett-Packard calculators for decades. On the other hand, firmware and user interface of the WP 34S are newly designed and written from scratch to give you a **fast and compact <u>scientific</u> calculator like you have never had before**.

Its function set is based on the one of the renowned *HP-42S RPN Scientific*, the most powerful RPN calculator built so far [1]. We extended this set, incorporating completely the functionality of the famous programmer's calculator *HP-16C*, the fraction mode of the *HP-32SII*, probability distributions as featured by the *HP-21S*, and even **more functions for mathematics, statistics, physics, engineering, programming etc.** like

- Euler's Beta function, Fibonacci number calculation, Lambert's W (all these in real and complex domain), incomplete regularized Beta and Gamma, testing for prime numbers,
- the error function as well as many statistical distributions and their inverses like Poisson, binomial, geometric as well as exponential, Weibull for reliability analysis, and Gaussian with arbitrary mean and standard deviation,
- programmable sums and products,
- extended date and time calculations based on a real time clock,
- financial operations like mean rate of return or margin calculations,
- nearly 50 fundamental physical constants as precise as known today by standards institutes like NIST,
- over 70 conversions, mainly between universal SI and old Imperial units,
- complete Greek and extended Latin letter fonts covering many languages (upper and lower case in two font sizes each).

The WP 34S is the first RPN calculator overcoming the limits of a 4-level stack – forget worries about stack overflow in calculations. It features a choice of two stack sizes expanded by a complex LASTx register: traditional 4 stack levels for HP compatibility, 8 levels for convenient calculations in complex domain, for more advanced real formulas, or for whatever application you have in your mind. You get a full command set for navigation in either size. Furthermore, the WP 34S features over 100 general purpose registers, 100 user flags, 476 program steps, 3 programmable hotkeys for your favourite programs, and a 31 byte alpha register for message generation.

If you know how to deal with a good old HP RPN calculator, you can start with your WP 34S right away. To show you its features completely, however, we wrote this little

[1] Though the *HP-42S* was sold in 1988 already, this statement holds still. – Due to display restrictions, matrix math cannot be supported by the WP 34S. Sorry for this.

manual. It starts with a survey of the active keyboard in various modes, so you know where to find what you are looking for. It continues with tables about addressing, browsing the catalogs, and a paragraph about the display and indicators used to tell you what's going on. The major part of this booklet is taken by the index of operations, catalog contents, constants and conversions featured. It closes with a list of messages the WP 34S will display if special input conditions prevent it from executing your command as expected.

Your WP 34S is the result of an intercontinental collaboration of two individuals, an Australian and a German, though we did this in our free time, so you may call it our hobby to some extent. We baptized it 34S in honour of one of the most powerful LED pocket calculators, the *HP-34C*, and since it is our humble approach – with the hardware given – to a future 43S we can only dream of so far becoming the successor of the *HP-42S*.

We have checked everything we could think of carefully to our best knowledge, so our hope may be justified the WP 34S is bug-free. We cannot guarantee this, however, nor can we bear any liability for errors in calculations nor their possible consequences. Nevertheless, we promise we will improve the WP 34S whenever it will turn out being necessary – so if you ever discover any strange result, please report it to us, and if it is unveiled being an internal error we will provide you with an update as soon as we have one.

Enjoy!

Paul Dale and Walter Bonin

PRINT CONVENTIONS

Throughout this manual, commands are generally called by their names, usually written in CAPITALS.

This **CPX** font is taken for explicit references to keys.

Register addresses are printed using Times New Roman. Lower case italic letters of this font are taken for register contents (e.g. ***y*** or ***r45*** or ***alpha*** for contents of stack level **Y** or general purpose register **R45** or the alpha register, respectively). Lower case bold italic Arial letters like ***n*** are used for variables.

All this holds unless stated otherwise explicitly.

KEYBOARD

Generally, white labels execute the *default primary function* of the respective key. To access a golden, blue, or green label, use *prefix* f, g, or h, respectively. Any label underlined opens a *catalog*. For example, RCL preceded by

- **f** will set calculator mode to floating point <u>d</u>ecimal numbers via **.d**,
- **g** will set angular mode to <u>rad</u>ians via **RAD**,
- **h** will recall the time of day via **TIME**.
- The dark red letter **H** will become relevant in *alpha mode* (see below).

Further remarks:

- The *hotkeys* **B**, **C**, and **D** in top row directly call the user programs carrying these labels if defined, else they act as **1/x**, **y^x**, or **√x**, respectively.
- Prefix **→** combined with **H.MS**, **H.d**, **DEG**, **RAD**, **GRAD**, **2**, **8**, **10**, and **16** converts x, while **R◀▶P** converts polar and rectangular coordinates in both x and y. So the latter switches representations of complex numbers, too.
- Prefix **CPX** may be used for calling functions in complex domain. Then names will be merged, e.g. **CPX** **f** **COS** will be displayed as ^{C}COS. Generally, if an arbitrary real function **f** works with x only, its complex sibling ^{C}**f** will work with $x_c = x + i\,y$. If **f** operates on one register, e.g. **R12**, then ^{C}**f** will operate on **R12** and **R13**. If **f** uses x and y then ^{C}**f** will use x, y, z and t. Please note all complex functions work with rectangular coordinates exclusively.
- Most one-number real functions replace x by the result $\mathbf{f}(x)$ stored in **X** again. In analogy, respective complex functions replace x by the real part and y by the imaginary part of the complex result $^{C}\mathbf{f}(x_c)$. Higher stack levels remain unchanged. Such functions are ^{C}1/x, ^{C}ABS, ^{C}FIB, ^{C}FP, ^{C}IP, ^{C}ROUND, ^{C}SIGN, ^{C}W, ^{C}W^{-1}, ^{C}x!, ^{C}x^{2}, ^{C}√‾, ^{C}**+/−**, ^{C}Γ(x), logarithmic and exponential with bases 10, 2 and e, as well as hyperbolic, trigonometric, and their inverses.

  Some real functions, e.g. DECOMP, operate on one number but return two. Other operations do not consume any stack input at all but return one or two numbers, like RCL or SUM. Then the extra number(s) will be pushed on the stack, taking one level per real or two per complex number, respectively.
- Two-number real functions replace x by the result $\mathbf{f}(x, y)$. Level **Y** is filled with the content of the next higher level, i.e. z. This goes on for higher levels, only the number on top is repeated as shown *below*.

  In analogy, respective complex functions replace x by the real part and y by the imaginary part of the complex result $^{C}\mathbf{f}(x_c, y_c)$. The next stack levels are filled with the contents of higher levels, and the complex number in the top two levels is repeated as shown *below*. Such complex functions are ^{C}LOGy, ^{C}y^{x}, ^{C}β(x,y), ^{C}//, and the basic arithmetic operations.
- There are two three-number real functions included – Iβ and %MRR – replacing x by the result $\mathbf{f}(x, y, z)$. Then **Y** is filled with t and so on, and the content of the top level is repeated twice. No such complex functions are featured.
- If **.** is used twice in input, the WP 34S enters fraction mode. Calculator modes in general are as described in the *separate paragraph* below.

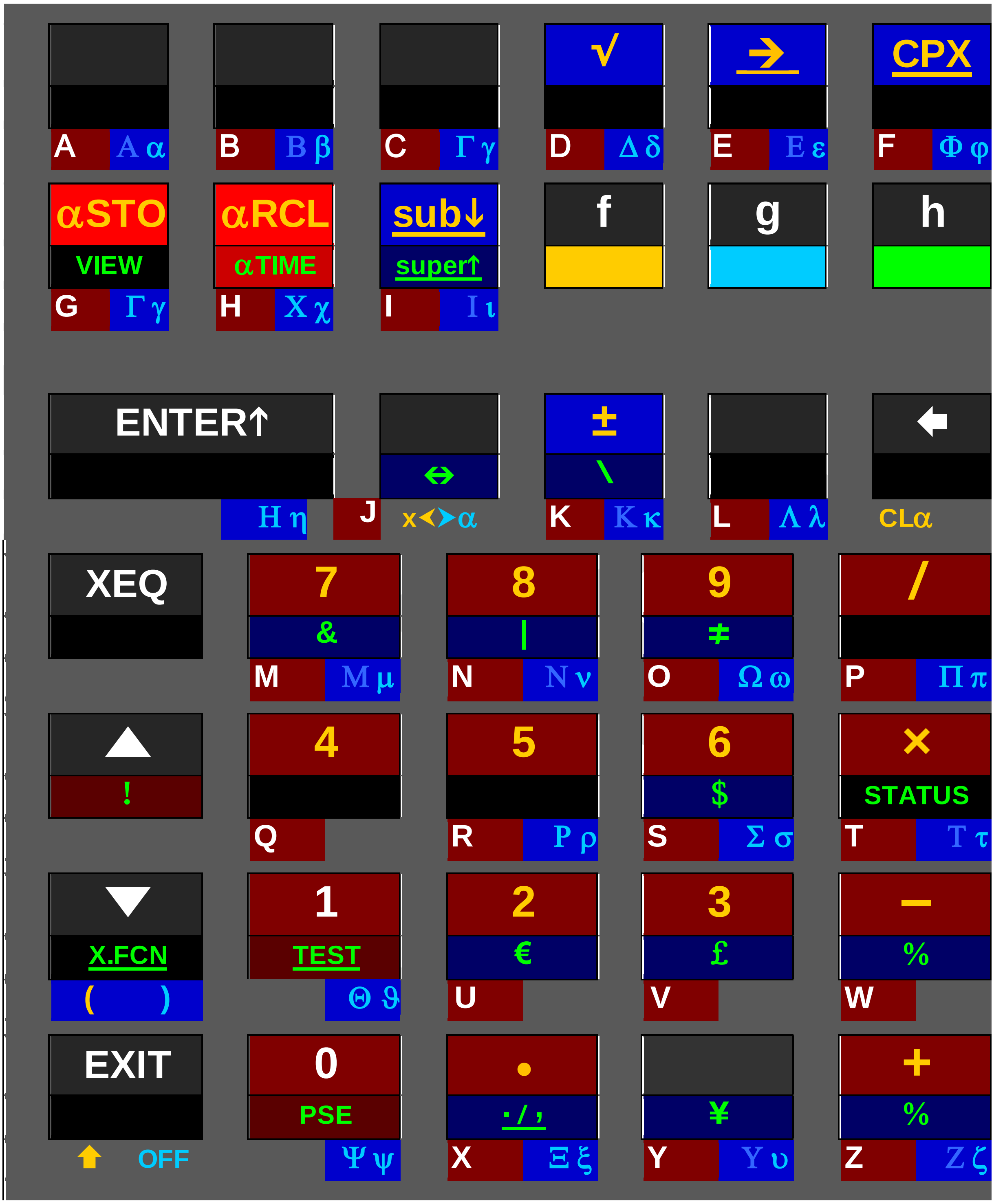
Please see the *index of operations* for a complete list of all the operations provided.

Virtual active keyboard in **hexadecimal mode**:

Primary functions of the top six keys will be numeric input, so their default primary functions are accessed using f . The key ➔ is exclusively for addressing and temporary display in other bases (see *addressing tables* and *index of operations* below).

For smaller integer bases, the active keyboard will look alike, but those top keys not needed for numeric input there will keep their default primary functions, except Σ+ and CPX . Attempts to enter an illegal digit will throw an *error*.

Virtual active keyboard in **alpha mode:**



In this mode, ***alpha*** is displayed in the dot matrix, and the numeric line is accessible by commands only. All labels printed on dark red or blue background in this picture append characters to ***alpha*** immediately or via alpha catalogs; those on blue deviate from the prints on the WP 34S at these locations.

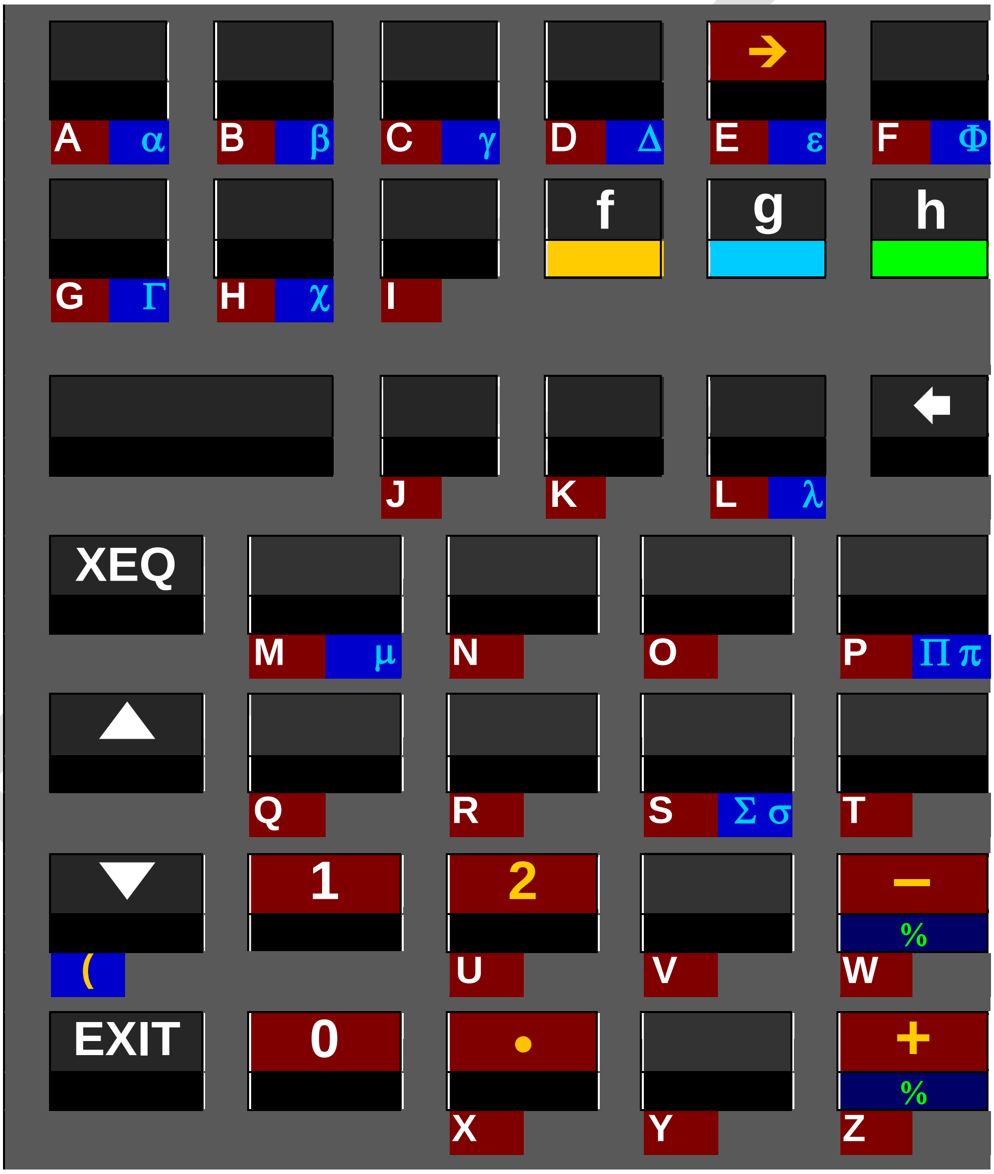
Alpha mode starts with upper case, then ↑ toggles upper and lower case. PSE appends a space. Primary function of most keys is appending the letter printed bottom left of this key – dark red on the key plate. Then f is used for reaching the key tops in alpha mode there, and g leads to homonymic Greek letters where applicable [2].

Some logic symbols are accessible via the Boolean operations. Four currency symbols are located next to the %-sign as follows: **$** at the letter S, **€** at U for Euro, **£** at π, and **¥** at Y for Yen or Yuan. The catalogs h STAT, f →, f CPX, h TEST, and h ./. feature even more characters (see *below*).

If ***alpha*** is going to exceed 31 characters, the leftmost character(s) will be discarded.

See the *index of operations* for αSTO and αRCL and many more alpha operations.

A subset of these characters is sufficient for **catalog browsing:**



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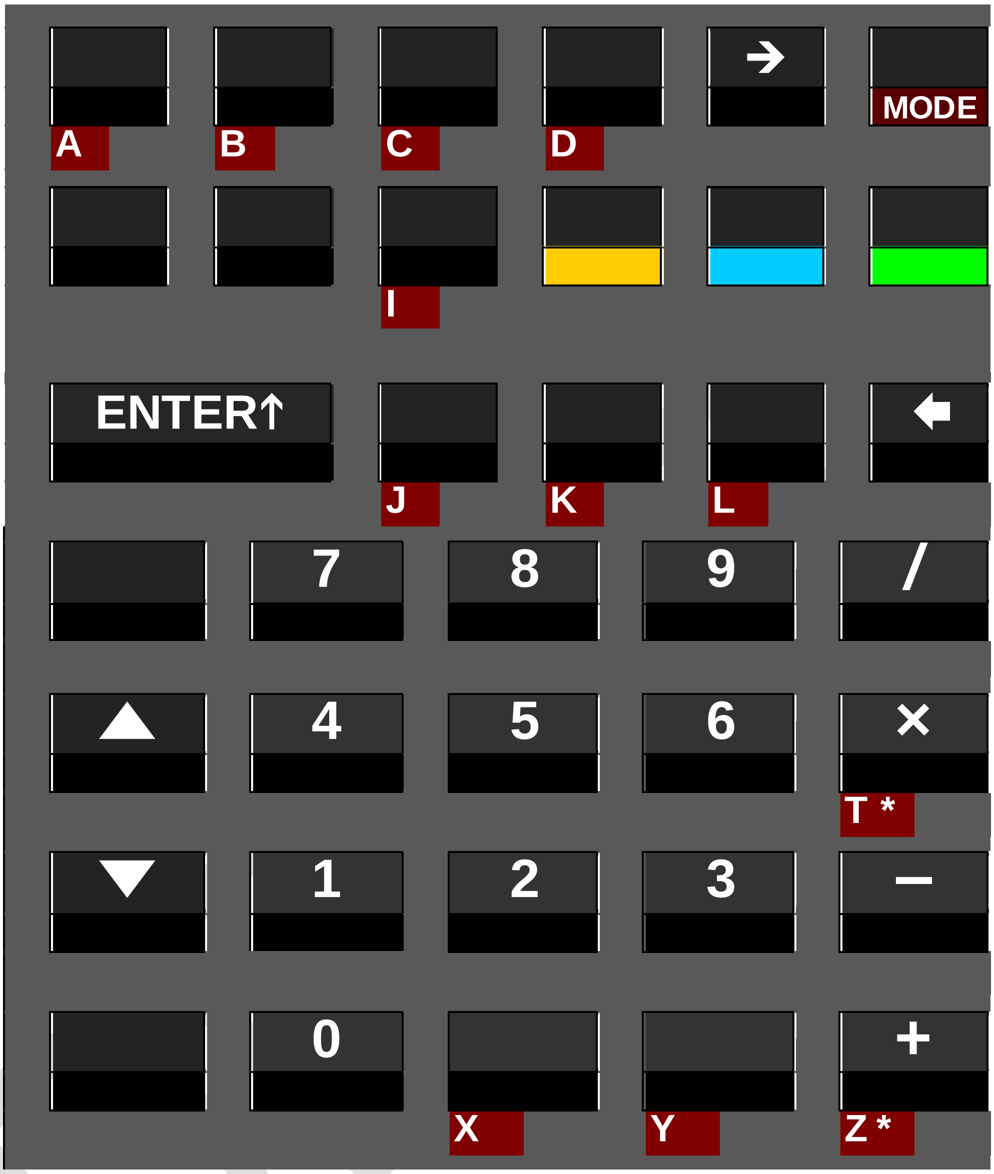
[2] "Homonymic" according to ancient Greek pronunciation. Three letters require special handling: **Psi** is accessed via g 0 (below PSE), **Theta** via g 1 (below TEST), and **Eta** via g ENTER↑. **Omicron** is not featured since looking exactly like **O** in either case. And we assigned **Gamma** also to **C** due to the alphabet, and **Chi** to **H** since this letter is next in pronunciation. Where we printed Greek capitals with lower contrast on page 7, they look like the respective Latin letters in our fonts. Greek professors, we hope for your understanding.

A **__temporary alpha__ mode** is entered during input processing in comparisons and addressing. See the respective virtual active keyboard here:



This mode is left automatically when sufficient characters are put in for the respective command. Find more about it *below*.

MEMORY

Stack registers

D *
C *
B *
A *
T
Z
Y
X

L	I **

Alpha (31 bytes)
Display

General purpose registers

R00
R01
R02
…
…
R85
R86
R87 Σ *x*
R88 Σ x^2
R89 Σ *y*
R90 Σ y^2
R91 Σ (*x y*)
R92 *n*
R93 Σ (ln *x*)
R94 Σ ($\ln^2 x$)
R95 Σ (ln *y*)
R96 Σ ($\ln^2 y$)
R97 Σ(lnx lny)
R98 Σ (*x* ln *y*)
R99 Σ (*y* ln *x*)

J ***
K ***

User flags

00
01
02
…
…
97
98
99

User readable system flags

B *Big, overflow*
C *Carry*
D *Danger*

Program steps

000
001
002
…
…
473
474
475

X = R100
Y = R101
Z = R102
T = R103
A = R104
B = R105
C = R106
D = R107
L = R108
I = R109
J = R110
K = R111

As the first calculator ever, the WP 34S offers a choice of 4 or 8 stack levels. So either **T** or **D** will be the top level. Registers **A - D** will be allocated as stack registers if required.

Please see *below* for top level repetition and stack contents in complex calculations. While register **L** takes the real part of the last argument, **I** takes the imaginary part when a complex function was executed (see LASTx).

After using [Σ+], general purpose registers **R87 - R99** will contain statistical sums as indicated. **J** and **K** may be taken for parameters of statistical distributions.

Unless required for the purposes mentioned above, the registers **A - D, I, J,** and **K** are available as additional general purpose registers.

System flags **B** and **C** are handled like in the *HP-16C*. Flag **D** is set if legal results include “NaN” and “infinite”.

STACK MECHANICS

What happens with the contents of particular stack levels depends on the function executed, its domain (integer/real or complex) and the stack size chosen.

Real functions in a 4-level stack work as known for decades. Everything works alike in a larger stack on the WP 34S – just with more levels for intermediate results. Calculating formulas from inside out stays a wise strategy in either stack. With more levels, however, stack overflow will hardly ever happen, even with the most advanced formulas you compute in your life as a scientist or engineer.

Calculating with complex numbers uses 2 registers or levels for each such number as explained above and shown here:

<table>
<tr><th rowspan="3"></th><th rowspan="3">Level</th><th rowspan="3">Assumed contents at the beginning:</th><th colspan="4">Stack contents after executing … … the complex stack register operations</th><th colspan="2">… complex functions of</th><th colspan="2">… integer/real</th></tr>
<tr><th rowspan="2">^{C}ENTER, ^{C}FILL</th><th rowspan="2">^{C}DROP</th><th rowspan="2">^{C}x↔y, ^{C}R↓, ^{C}R↑</th><th rowspan="2">^{C}LASTx</th><th rowspan="2">… 1 number like $^Cx^2$</th><th rowspan="2">… 2 numbers like ^{C}/</th><th colspan="2">functions of 2 numbers like /</th></tr>
<tr><th>Before</th><th>After</th></tr>
<tr><td rowspan="4">With SSIZE4:</td><td>T</td><td>t = Im(y_c) = Im(t_c)</td><td>Im(x_c)</td><td>Im(y_c)</td><td rowspan="2">x_c</td><td rowspan="2">x_c</td><td rowspan="2">$y_c = t_c$</td><td rowspan="2">$y_c = t_c$</td><td>t</td><td>t</td></tr>
<tr><td>Z</td><td>z = Re(y_c) = Re(t_c)</td><td>Re(x_c)</td><td>Re(y_c)</td><td>z</td><td>t</td></tr>
<tr><td>Y</td><td>y = Im(x_c)</td><td>Im(x_c)</td><td>Im(y_c)</td><td rowspan="2">y_c</td><td rowspan="2">$lastx_c$</td><td>Im($(x_c)^2$)</td><td>Im(y_c / x_c)</td><td>y</td><td>z</td></tr>
<tr><td>X</td><td>x = Re(x_c)</td><td>Re(x_c)</td><td>Re(y_c)</td><td>Re($(x_c)^2$)</td><td>Re(y_c / x_c)</td><td>x</td><td>y / x</td></tr>
</table>

<table>
<tr><th></th><th>Level</th><th>Assumed contents at the beginning:</th><th colspan="2">^{C}ENTER, ^{C}FILL</th><th>^{C}DROP</th><th colspan="3">^{C}x↔y, ^{C}R↓, ^{C}R↑</th><th>^{C}LASTx</th><th>… 1 number like $^Cx^2$</th><th>… 2 numbers like ^{C}/</th><th>Before</th><th>After</th></tr>
<tr><td rowspan="8">With SSIZE8:</td><td>D</td><td>d = Im(t_c)</td><td rowspan="2">z_c</td><td rowspan="2">x_c</td><td rowspan="2">t_c</td><td rowspan="2">t_c</td><td rowspan="2">x_c</td><td rowspan="2">z_c</td><td rowspan="2">z_c</td><td rowspan="2">t_c</td><td rowspan="2">t_c</td><td>d</td><td>d</td></tr>
<tr><td>C</td><td>c = Re(t_c)</td><td>c</td><td>d</td></tr>
<tr><td>B</td><td>b = Im(z_c)</td><td rowspan="2">y_c</td><td rowspan="2">x_c</td><td rowspan="2">t_c</td><td rowspan="2">z_c</td><td rowspan="2">t_c</td><td rowspan="2">y_c</td><td rowspan="2">y_c</td><td rowspan="2">z_c</td><td rowspan="2">t_c</td><td>b</td><td>c</td></tr>
<tr><td>A</td><td>a = Re(z_c)</td><td>a</td><td>b</td></tr>
<tr><td>T</td><td>t = Im(y_c)</td><td rowspan="2">x_c</td><td rowspan="2">x_c</td><td rowspan="2">z_c</td><td rowspan="2">x_c</td><td rowspan="2">z_c</td><td rowspan="2">x_c</td><td rowspan="2">x_c</td><td rowspan="2">y_c</td><td rowspan="2">z_c</td><td>t</td><td>a</td></tr>
<tr><td>Z</td><td>z = Re(y_c)</td><td>z</td><td>t</td></tr>
<tr><td>Y</td><td>y = Im(x_c)</td><td rowspan="2">x_c</td><td rowspan="2">x_c</td><td rowspan="2">y_c</td><td rowspan="2">y_c</td><td rowspan="2">y_c</td><td rowspan="2">t_c</td><td rowspan="2">$lastx_c$</td><td rowspan="2">$(x_c)^2$</td><td rowspan="2">y_c / x_c</td><td>y</td><td>z</td></tr>
<tr><td>X</td><td>x = Re(x_c)</td><td>x</td><td>y / x</td></tr>
</table>

So, an 8-level stack gives you the same flexibility in complex domain you are used to with a 4-level stack in real domain.

ADDRESSING AND COMPARING REAL NUMBERS

Step								
1	User input	x= ?, x≠ ?, x< ?, x≤ ?, x≈ ?, x≥ ?, or x> ?				RCL, STO, RCLS, STOS, αRCL, αSTO, VIEW, x≷, DSE, ISG, DSZ, ISZ, FIX, SCI, ENG, DISP, BASE, CB and many more bit commands, or CF and the other flag commands		
	Dot matrix display	OP _ (with temporary alpha mode set) e.g. ▫x > _				OP _ (with temporary alpha mode set) e.g. RCL _ [3]		
2	User input	0 or 1	*Stack level or named reg.* X, Y, ...	ENTER↑ [4] leaves temp. alpha mode.	→ opens indirect addressing.	*Stack level or named register* X, Y, Z,... , K [5]	***Number** of register or flag or bit(s) or decimals* [6]	→ opens indirect addressing.
	Dot matrix display	OP *n* e.g. x ≤ 0 ?	OP *x* e.g. x ≥ y ?	OP r_	OP →_	OP *x* e.g. SCI Z	OP *nn* e.g. SF 15	OP →_
3	User input	Compares ***x*** with the number **0**.	Compares ***x*** with the number on stack level **Y**.	*Register no.* 00 … 99	Look right for more about indirect addressing.	Sets scientific display with the number of decimals specified in stack level **Z**.	*Stack level etc.* X, Y, Z,... , K	*Register number* 00 … 99
	Dot matrix display			OP r *nn* e.g. x ≠ r23?			OP → *x* e.g. VIEW →L	OP → *nn* e.g. STO →45
				Compares ***x*** with the number stored in **R23**.			Shows the content of the register where **L** is pointing to.	Stores ***x*** into the location where **R45** is pointing to.

[3] For RCL and STO, any of +, −, ×, /, ▲, or ▼ may precede step 2, except in RCLM and STOM. See the index of operations.

[4] You may skip this for register numbers >19.

[5] Exceptions: RCL T, RCL× T, RCL Z, RCL+ Z require an ENTER↑ previous to T or Z, e.g. RCL + ENTER↑ Z for the latter. This holds for STO as well.

[6] Register and flag numbers may be 00 … 99, number of decimals 0 … 11, integer bases 2 … 16, bit numbers 0 to 63, and integer word size up to 64 bits. For numbers <10, you may key in e.g. 5 ENTER↑ instead of 0 5. There are three additional flags addressed via B, C, and D. – Take into account some registers may be allocated to special applications.

ADDRESSING AND COMPARING COMPLEX NUMBERS

1	User input	CPX x= ? or x≠ ?				CPX RCL, STO, or x⇄		
	Dot matrix display	**OP _** (with temporary alpha mode set) e.g. ▪x = _				**OP _** (with temporary alpha mode set) e.g. ▪RCL _ [7]		
2	User input	0 or 1	*Stack level or named register* X, Z, A, C, L, or J	ENTER↑ [8] leaves temp. alpha mode	→ opens indirect addressing.	*Stack level or named register* Z [9], A, C, L, or J	*Register number* 0 0 .. 9 8 [10]	→ opens indirect addressing.
	Dot matrix display	**OP *n*** e.g. ▪x = 0 ?	**OP *x*** e.g. ▪x ≠ z ?	**OP r_**	**OP →_**	**OP *x*** e.g. ▪RCL L	**OP *nn*** e.g. ▪STO 18	**OP →_**
3	User input	Compares $x + i\,y$ with the real number **0**.	Compares $x + i\,y$ with $z + i\,t$.	*Register number* 0 0 … 9 8	Look right for more about indirect addressing.	This is ^{C}LASTx.	*Stack level or named register* X, Y, … , K	*Register number* 0 0 … 9 9
	Dot matrix display			**OP r *nn*** e.g. ▪x ≠ r26?			**OP → *x*** e.g. ▪x<> →Z	**OP → *nn*** e.g. ▪STO →45
				Compares $x + i\,y$ with $r26 + i\,r27$.			Swaps ***x*** with the contents of the register where **Z** is pointing to, and ***y*** with the contents of the next one.	Stores $x + i\,y$ into 2 consecutive registers, starting with the one where **R45** is pointing to.

[7] For RCL and STO, any of +, −, ×, or / may precede step 2. See the index of operations.

[8] You may skip this keystroke for register numbers >19.

[9] Exceptions: ^{C}RCL Z, ^{C}RCL + Z, ^{C}STO Z, and ^{C}STO + Z require an ENTER↑ previous to Z, e.g. CPX STO + ENTER↑ Z for the latter.

[10] You may key in e.g. 8 ENTER↑ instead of 0 8. Take care of pairs, since a complex operation will always affect two registers: the one specified and the one following this. We recommend storing complex numbers with their real parts at even register numbers. – Take into account some registers may be allocated to special applications.

ADDRESSING LABELS

1	User input	B, C, or D	XEQ, GTO, LBL, SLV, ∫, π or Σ				
	Dot matrix display	**XEQ '*label*'** e.g. `XEQ 'A'`	**OP _** e.g. `GTO _`				
2	User input	Calls the function labeled **A**.	B, C, or D	ENTER↑ sets alpha mode.	→ [11] opens indirect addressing and sets temporary alpha mode.		*2-digit numeric label* 0 0 … 9 9
	Dot matrix display		**OP '*label*'** **e.g.** `Σ 'B'`	**OP '_**	**OP →_**		**OP *nn*** e.g. `LBL 07`
3	User input		Sums up the function labeled **B**.	***Alphanumeric label*** (≤ 3 characters [12])	*Stack level or named register* X, Y, Z, ... , K	*Register number* 0 0 … 9 9 [13]	
	Dot matrix display			**OP '*label*'** e.g. `SLV'F1µ'`	**OP → *x*** e.g. `∫ →T`	**OP → *nn*** e.g. `XEQ →44`	
				Solves the function **F1µ** (with **F1µ** keyed in as explained in footer).	Integrates the function which's label is on stack level **T**.	Executes the routine which's label is in **R44**.	

[11] Works with all these operations except LBL.

[12] The 3rd character terminates entry and closes alpha mode – shorter labels need a closing ENTER↑. For the example given here you just key in f 2 ENTER↑ CPX 1 f EXIT g 7 and you are done.

[13] Some registers may be allocated to special applications. Please check the memory table above.

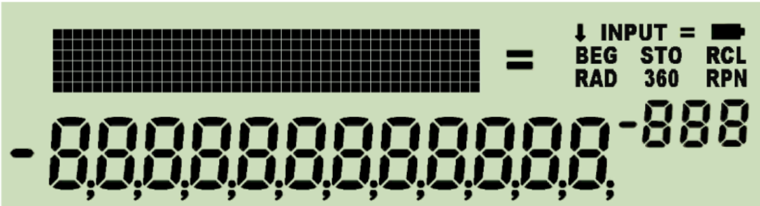
ADDRESSING CATALOG ITEMS

1	User input	CONST, CONV, MODE, PROB, P.FCN, STAT, TEST, X.FCN	CPX, sub⬇, or super⬆ in alpha mode	➡, TEST, or ./. in alpha mode
	Dot matrix display	**Shows 1st item in selected catalog.** (e.g. BC? in P.FCN) Alpha mode is set.	(e.g. Á in CPX)	(e.g. , in ./.)
2	User input	XEQ, ▼, ▲, EXIT, or 1st character (e.g. F)	XEQ, ▼, ▲, EXIT, or character (e.g. O)	
	Dot matrix display	**Shows 1st item starting with this character *)** (e.g. FB)	**Shows 1st item starting with this letter *)** (e.g. Ó)	
3	User input	XEQ, ▼, ▲, EXIT, or 2nd character (e.g. S)		
	Dot matrix display	**Shows 1st item starting with this sequence *)** (e.g. FS?)		
4	User input	XEQ, ▼, ▲, or EXIT (e.g. ▼)		
	Dot matrix display	**Shows next item in this catalog** (e.g. FS?C)	(e.g. Ò)	(e.g. ?)
…		Continue browsing this way until reaching the item desired (e.g. FS?F).	(e.g. Ö).	(e.g. :).
n	User input	XEQ Calculator leaves the catalog returning to the mode set before		
	Dot matrix display	… and executes or inserts the command chosen, or recalls the constant selected. **Result**	… and appends the selected character to ***alpha***. **Contents of alpha register** (e.g. Östl. Seite:)	

*) If a character or sequence specified is not found in this catalog then the first item following alphabetically will be shown.

DISPLAY

The display features three sections: numeric, dot matrix and fixed symbols. The numeric section features a minus sign and 12 digits for the mantissa, as well as a minus sign and 3 digits for the exponent. The dot matrix is 6 dots high and 43 dots wide, allowing for some 7 to 12 characters, depending on their widths. The fixed symbols (except the big "=") are called *annunciators*, and are for indicating modes.



The dot matrix section above is used for

1. indicating some more modes than the annunciators allow, adjusted to the right,
2. passing additional information to the user, adjusted to the left.

The numeric section in the lower part of the LCD is used for displaying numbers in different formats, status, or messages.

If two or more requests concur for display space, the items will be shown according to their priorities as follows:

1. error messages as described in a paragraph further below,
2. special information as explained below,
3. information about the modes the calculator is running in.

The *annunciators* or specific characters in the display signal the modes:

Signal	***INPUT***	**b**	**d**	**h**	**o**		***STO***
Mode name if different	**α**	**2**			**8**	**FLOAT**	**PRG**
Set by …	αON	BASE2	BASE10	BASE16	BASE8	BASE0	PRGON
Cleared by …	αOFF	any other BASE setting, FRACT, IMPFRC, PROFRC, H.MS, TIME, →H.MS					PRGOFF

Signal	***360***	***RAD***	**G**		
Mode name if different				**H.MS**	**FRC**
Set by …	DEG	RAD	GRAD	H.MS, TIME →H.MS	BASE1, FRACT IMPFRC, PROFRC 2^{nd} . in input
Cleared by …	GRAD RAD	DEG GRAD	DEG RAD	BASE, →H COS, SIN, TAN IMPFRC, PROFRC	BASE ≠1 H.MS, TIME →H.MS

A running program is signaled by a flashing ***RCL*** annunciator. ***RPN*** may be lit permanently. Time modes (12h / 24h) are seen in the time string directly. The numeric formats of H.MS and fraction modes are unambiguous as well. Further settings are signaled in the dot matrix section, like the different date modes being indicated there by **D.MY** or **M.DY**. Defaults Y.MD and FLOAT are not indicated. Please check the examples below.

Some mode and display settings may be stored and recalled collectively by STOM and RCLM. The command RCLM recalls a 18-bit word containing mode data packed as follows, starting with the least significant bit:

Bits	Meaning	Values and corresponding settings
0, 1	Display format for real numbers	0 = ALL 1 = FIX 2 = SCI 3 = ENG
2 … 5	Number of decimals	0 … 12
6, 7	Angular mode	0 = DEG 1 = RAD 2 = GRAD
8, 9	Date display format	0 = Y.MD 1 = D.MY 2 = M.DY
10	Time display format	0 = 24h 1 = 12h
11	Radix mark	0 = point 1 = comma
12 … 14	Curve fit model	0 = LinF 1 = ExpF 2 = PowerF 3 = LogF 4 = BestF
15, 16	Integer sign mode	0 = 2COMPL 1 = 1COMPL 2 = UNSIGN 3 = SIGNMT
17	Stack depth	0 = 4 levels 1 = 8 levels

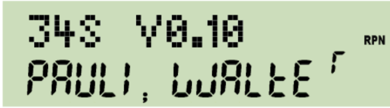
So the start-up default with 4 stack levels, ALL, DEG, Y.MD, 24h, decimal point, LinF, and 2COMPL is zero.

On the other hand, settings for e.g. 8 stack levels, SCI 2, RAD, D.MY, 12h, decimal comma, BestF, UNSIGN correspond to $110100110101001010_2 = 445770_{10}$.

STOM takes such a number and sets the calculator modes accordingly. Please see the [index of operations](#) for more information about changing modes.

Some commands and modes use the display in a special way. They are listed below in order of falling priority:

1. **VERS** generates a display like this:



   This tells you have a WP 34S with firmware version 0.10 – the display on your own WP 34S will deviate from this example. Pressing any key will delete this message and return to previous state.

2. **STATUS** displays the status of 30 flags very concisely, allowing an immediate status overview after some training. If e.g. flags 2, 3, 5, 7, 11, 13, 14, 17, 19, and 23 are set, and labels B, C, and D are defined in program memory, STATUS will display this:

   Within the numeric section, each row of horizontal bars in the mantissa shows the status of 10 flags. When a flag is set, the respective bar turns black. So here the top row of bars indicates flags 0 and 1 are clear, 2 and 3 set, and flag 4 clear. Then, the divider II separates the first group of five flags from the next. Top row bars on its right side indicate flags 5 and 7 are set. Next row of bars shows flags 11, 13, 14, 17, 19 are set, and in the lowest row only flag 23 is set. All other flags in the range from 10 to 29 are clear.

   Scrolling down by ▼ will display flags 10 - 39, then 20 - 49 etc. until 80 - D. Scrolling up by ▲ reverts this. Alternatively, pressing a digit, e.g. 5, will show 30 flags starting with 10 times this digit, e.g. flags 50 - 79. The numeric exponent always indicates the status of the 3 hotkeys top left on the keyboard.

   The status will be displayed until any key is pressed but ▼, ▲, or a digit < 9.

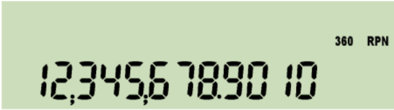
3. During **command input**, the dot matrix displays the command chosen until input is completed, i.e. until all required trailing parameters are entered. The prefixes f, g, and h are shown until they are resolved. In addressing, progress is recorded as explained in the *addressing tables above* in detail.

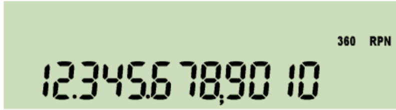
4. In **programming mode**, the numeric display indicates the program step (001 – 476) in the mantissa and the number of free steps in the exponent, while the dot matrix shows the command contained in the respective step, e.g.:

5. For **floating point numbers**, the mantissa will be displayed adjusted to the right, the exponent to the left. Within the mantissa, either points or commas may be selected as radix marks [14], and additional marks may be chosen to separate thousands. Assume the display set to FIX 4, then 12.345678901 millions may look like:

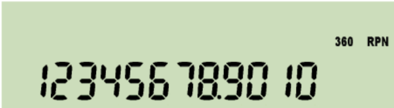
---

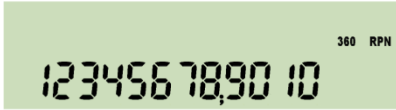
[14] Starting here, decimal input is written using a point as radix mark throughout this manual, although significantly less visible, unless specified otherwise explicitly. By experience, the „comma people" are more capable to read radix points and interpret them correctly than vice versa.



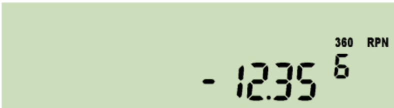
or


with thousands separators on, and without them like:



or


These separators may also be beneficial in integer or fraction modes described below. – With ENG 2 and after changing the sign, the same number will look like this:



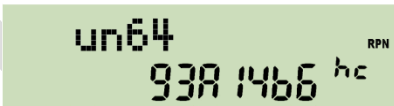
or


If the last operation executed was a complex one, a capital C is displayed top left in the dot matrix pointing to the fact that you find its result in **X** and **Y**.

6. In **integer modes**, numbers are displayed adjusted to the right as well. Word size and complement setting are indicated in the dot matrix using a format ***xx.ww***, with ***xx*** being **1c** or **2c** for 1's or 2's complement, respectively, **un** for unsigned, or **sm** for sign-and-mantissa mode. Sign and first digit of the exponent show the base, a "c" in the second digit signals a carry bit set, an "o" in the third an overflow. Integer bases are indicated as follows:

Base	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sign and 1st digit of exponent displayed	**b**	**3**	**4**	**5**	**6**	**7**	**o**	**9**	**d**	**-1**	**-2**	**-3**	**-4**	**-5**	**h**

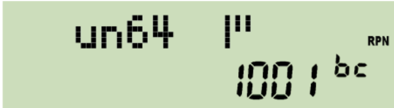
The example shows the WP 34S in unsigned hexadecimal mode with word size 64 and carry set:



After changing to binary, this number will need 28 digits, being 1001001110100001010010110110. Initially, the 12 least significant digits will be displayed together with an indication that there are three display windows in total with the rightmost shown:

Now press ◀ and you will get the next 12 digits in the middle window:

Press ◀ again to show the most significant digits:

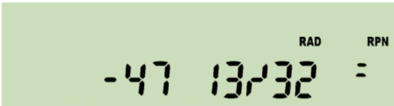


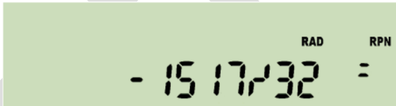
If leading zeros were turned on, there will be six display windows in this case, with the three "most significant" containing only zeros.

Please note the window will also change in numeric entry when more than 12 digits are keyed in. Leftmost digits will leave the display window then.

7. **Fraction mode** works similar to HP-35S. In particular, DENMAX sets the maximum allowable denominator (see the *index of operations*). Display will look like in the examples below. If the fraction is exactly equal, slightly less, or greater than the floating point number converted, "=", "Lt", or "Gt" is indicated in the exponent, respectively.

   Assume DENMAX ≥ 32. Then e.g. -47.40625 will be displayed as follows:

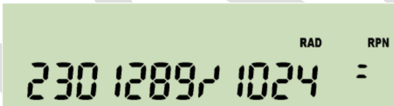
   

   or
   

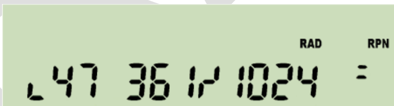
   depending on the output setting for proper or improper fractions. Please note integers like 123 will be displayed as "123 0/1" or "123/1" in fraction mode, respectively.

   Fraction mode can handle numbers with absolute values < 10,000 and > 0.0001. Maximum denominator is 9999.

   Using DENMAX = 9999, squaring the improper fraction shown above results in

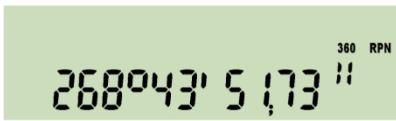
   Now, enter a b/c for converting this result into a proper fraction. Your 34S will display

   with a little hook left of the first digit shown. This indicates the first number being displayed incompletely – there are at least two digits preceding 47 but no more space. Press SHOW to unveil the integer part of this proper fraction is 2247.

8. In **H.MS mode**, format is `hhhh°mm'ss.dd"` with the number of hours or degrees limited to 9000. Output may look like this:

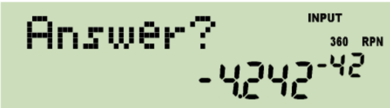
   or
   

   depending on the radix setting.

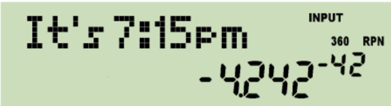
9. Output of the function **DAY** will look as follows for an input of 1.13201 in M.DY mode (equivalent to inputs of 13.01201 in D.MY or 2010.0113 in Y.MD):

The display may look similar for a result of DAYS+.

10. In **alpha mode**, the alpha register is displayed in the dot matrix, starting with the first character it is containing, while the numeric section keeps the result of the last numeric operation, e.g.:



Different information may be appended to ***alpha***. See the commands starting with "α" in the index of operations below. E.g. αTIME allows creating texts like



or


depending on time mode setting (12h / 24h).

All keyboard input will be interpreted according to the mode set at input time.

FONTS

The WP 34S features a big and a small font. Both are based on Luiz Viera's fonts as distributed in 2004. Some letters were added and some modified for better legibility, since the dot matrix is only 6 pixels high. The following tables show the characters directly accessible through the keyboard. Those contained in the alpha catalogs are found *below*.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
ABCDEFGHIJKLM NOPQRSTUVWXYZ
ABCDEFGHIJKLM NOPQRSTUVWXYZ

a b c d e f g h i j k l m n o p q r s t u v w x y z
abcdefghijklm nopqrstuvwxyz
abcdefghijklm nopqrstuvwxyz

A B Γ Δ E Z H Θ I K Λ M N Ξ O Π P Σ T Y Φ X Ψ Ω
ABΓΔEZHΘIKΛM NΞOΠPΣTYΦXΨΩ
ABΓΔEZHΘIKΛM NΞOΠPΣTYΦXΨΩ

α β γ δ ε ζ η ϑ ι κ λ μ ν ξ ο π ρ σ τ υ φ χ ψ ω
αβγδεζηϑικλμ νξοπρστυφχψω
αβγδεζηϑικλμ νξοπρστυφχψω

0 1 2 3 4 5 6 7 8 9	( ) + - × / ± . !	↔ % √ \ & | ≠ $ € £ ¥
0123456789	()+-×/±.!	↔%√\&|≠$€£¥
0123456789	()+-×/±.!	↔%√\&|≠$€£¥

INDEX OF OPERATIONS

All functions available are found below with their names and keystrokes necessary. Names printed in **bold** face therein belong to commands directly accessible on the keyboard, the others are accessible via catalogs. These names will show up in program listings as well. Sorting in index and catalogs is case insensitive and works as follows:

␣, 0…9, A…Z, !, α…ω, ( ) + – × / ± , . ? : ; " # ' * @ _ ~
→ ← ↑ ↓ ↔ < ≤ = ≠ ≥ > % $ € £ ¥ √ ∫ ∞ & \ ^ | G [ ] { }

Super- and subscripts are handled like normal characters in sorting.

Generally, functions and keystroke programming will work as on *HP-42S*, bit and integer functions as on *HP-16C*, unless stated otherwise under remarks. Especially, all **tests** will return "Yes" or "No" in the dot matrix if called from the keyboard; if called in a program, they will skip the next program line if the test is false. Please refer to the manuals of the vintage calculators mentioned, e.g. on the DVDs distributed by *www.hpmuseum.org*.

Functions available on the WP 34S for the first time on an RPN calculator are highlighted yellow under remarks, while operations carrying a familiar name but deviating in their functionality here are marked light red.

Parameters will be taken from the lowest stack levels unless being mentioned explicitly in the 2nd column. Then they must follow the command. If ***underlined***, they may also be specified using indirect addressing, as shown in the *tables* above. Some parameters of statistical distributions must be given in registers **J** and **K** if specified.

Each function is listed stating the mode(s) it will work in, abbreviated by their *indicators*. In this column an "&" stands for a Boolean AND, a comma for an OR, and a backslash for "not". So e.g. 2^X works in all modes but alpha. FLOAT^H stands for "FLOAT, H.MS". All operations will also work in mode PRG unless stated otherwise explicitly.

Name	Keys to press	in modes	Remarks
c...	CPX ...	FLOAT	Indicates an operation in complex domain (see above). CPX may be combined with the functions which's *names are printed in italics here* .
10^x	f 10^x	FLOAT	
12h	h MODE 12h	\α	Sets 12h time display mode meaning 1:23 becomes 1:23 a.m. and 13:45 becomes 1:45 p.m.
1COMPL	h MODE 1COMPL	\α	Sets 1's complement mode like in *HP-16C*.
1/x	f 1/x	FLOAT	
	B	FLOAT	Shortcut as long as label B is not defined yet.
24h	h MODE 24h	\α	Sets 24h time display mode meaning 1:23 a.m. becomes 1:23, and 1:45 p.m. becomes 13:45.
2COMPL	h MODE 2COMPL	\α	Sets 2's complement mode like in *HP-16C*.
2^x	f 2^x	\α	
ABS	f |x|	\α	CABS returns $r = \sqrt{x^2 + y^2}$ in **X** and clears **Y**.
ACOS	g COS^{-1}	FLOAT^H	
ACOSH	g HYP^{-1} COS	FLOAT	
ALL	h MODE ALL	\α	Selects the format displaying "all" digits.
AND	h AND	Integer	Works bitwise as in *HP-16C*.
		FLOAT	Works like AND in *HP-28S*, i.e. x and y are interpreted before executing this operation. 0 is "false", any other real number is "true".
ANGLE	h X.FCN ANGLE	FLOAT	Calculates the angle between positive x-axis and the straight line from the origin to the point (x, y) , returns this angle in **X** and clears **Y**.
ASIN	g SIN^{-1}	FLOAT^H	
ASINH	g HYP^{-1} SIN	FLOAT	
ASR	h X.FCN ASR ***n***	Integer	Works like ***n*** (up to 63) consecutive ASRs in *HP-16C*. ASR 0 executes as NOP.
ATAN	g TAN^{-1}	FLOAT^H	
ATANH	g HYP^{-1} TAN	FLOAT	

Name	Keys to press	in modes	Remarks
BASE	h MODE BASE ***n***	\α	Sets the base for integer calculations, with $2 \le n \le 16$. Popular bases are directly accessible on the keyboard. Current integer base setting is indicated in the exponent as explained *above*. Furthermore, BASE0 equals FLOAT, and BASE1 calls FRACT.
BASE10	f 10		
BASE16	g 16		
BASE2	f 2		
BASE8	g 8		
BC?	h TEST BC? ***n***	Integer	Tests the specified bit in x .
BestF	h STAT BestF	FLOAT	Selects the best curve fit model, maximizing the correlation like BEST does in *HP-42S*.
BS?	h TEST BS? ***n***	Integer	Tests the specified bit in x .
B(m)	h PROB B(m)	FLOAT	= BINOMDIST(x; j; k; **1**) in MS Excel, with the sample size j and the gross error probability k. B^{-1}(p) returns the number of successes g for a given probability p in **X**.
B^{-1}(p)	h PROB B^{-1}(p)		
CB	h X.FCN CB ***n***	Integer	Clears the specified bit in x .
CEIL	h X.FCN CEIL	FLOAT	Returns the smallest integer $\ge x$.
CF	h P.FCN CF ***n***	\α	Clears the flag specified.
CLFLAG	h P.FCN CLFLAG	\α	Clears all user flags.
CLREG	h X.FCN CLREG	All	Clears all general purpose registers.
CLSTK	0 g FILL h P.FCN CLSTK	\α	Clears all stack registers.
CLx	h CLx	\α	$^{\mathrm{C}}$CLx clears both **X** and **Y**.
CLα	f CLα	All	Clears the alpha register like CLA in *HP-42S*.
CLΣ	g CLΣ	FLOAT	Clears all statistical sums.
COMB	f Cy,x	FLOAT	Returns the number of possible <u>sets</u> of y items taken x at a time. No item occurs more than once in a set, and different orders of the same x items are <u>not</u> counted separately. Formula: $C_{y,x} = \binom{y}{x} = \frac{y!}{x! \cdot (y-x)!}$
CONJ	CPX X.FCN CONJ	FLOAT	Changes the sign of y .

Name	Keys to press	in modes	Remarks
CORR	g r	FLOAT	Returns the correlation coefficient for the current statistical data and curve fitting model.
COS	f COS	FLOAT^H	
COSH	f HYP COS	FLOAT	
DATE	h X.FCN DATE	FLOAT	Recalls the date from the real time clock and displays it in the numeric section in the format selected. See D.MY, M.DY, and Y.MD. The function DATE in *HP-12C* corresponds to DAYS+ here (see below).
DAY	h X.FCN DAY	FLOAT	Takes x as a date in the format selected and returns the name of the day in the dot matrix and a corresponding integer in the numeric display (Monday = 1, Sunday = 7).
DAYS+	h X.FCN DAYS+	FLOAT	Works like DATE in *HP-12C*, adding x days on a date in $\mathbf{Y}$ in the format selected and displaying the resulting date including the day of week in the same format as DAY does.
DBLR	h X.FCN DBLR	Integer	Double precision commands like in *HP-16C*.
DBL ×	h X.FCN DBL×		
DBL /	h X.FCN DBL/		
DECOMP	h X.FCN DECOMP	FRC	Decomposes x (after converting it into an improper fraction, if applicable), resulting in a stack [***numerator(x), denominator(x), y, z***] or [***num(x), den(x), y, z, t, a, b, c***] , respectively. Reversible by division.
DEG	g DEG	FLOAT	Sets angular mode to degrees.
DENANY	h MODE DENANY	\α	Sets default fraction format like in *HP-35S*, allowing maximum precision. Any denominator up to the value set by DENMAX may appear.
DENFAC	h MODE DENFAC	\α	Sets "factors of the maximum denominator". With e.g. DENMAX = 60, possible denominators are 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, and 60.
DENFIX	h MODE DENFIX	\α	Sets fixed denominator format, i.e. the denominator equaling DENMAX always.
DENMAX	h MODE DENMAX	\α	Works like /c in *HP-35S*, but maximum value settable is 9999. The maximum denominator will be set to 9999 if $x < 1$ or $x > 9999$ at execution time. For $x = 1$ the current setting is recalled.

Name	Keys to press	in modes	Remarks
DISP	h MODE DISP	FLOAT	Changes the number of decimals while keeping the display format (FIX, SCI, ENG) as is.
DROP	h P.FCN DROP	\α	Drops x, changing stack contents to $[y, z, t, t]$ or $[y, z, t, a, b, c, d, d]$, respectively. See above for ^{C}DROP.
DSE	f DSE ***r***	PRG	Given `cccccc.fffii` in r, this function decrements r by `ii`, skipping next program line if then `ccccccc` ≤ `fff` for DSE, or = 0 for DSZ
DSZ	h P.FCN DSZ ***r***		
D.MY	h MODE D.MY	\α	Sets the format for date display.
D→J	h X.FCN D→J	FLOAT	Takes x as a date in the format selected and converts it to a Julian day number.
D→R	h X.FCN D→R	FLOAT	Takes x as degrees and converts them to radians. Angular mode is kept.
E3OFF	h MODE E3OFF	\α	Toggle the thousands separator (either a point or a comma depending on the radix setting).
E3ON	h MODE E3ON		
ENG	h ENG ***n***	\α	Sets engineering display format.
ENTER↑	ENTER↑	\α	See above for ^{C}ENTER.
ERF	h STAT ERF	FLOAT	Calculates the error function $erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-\tau^2} d\tau$
EVEN?	h TEST EVEN?	\α	Checks if x is integer and even.
e ^{x}	f e^x	FLOAT	
ExpF	h STAT ExpF	FLOAT	Selects the exponential curve fit model.
Ex(t)	h PROB Ex(t)	FLOAT	= EXPONDIST($x; j$; **1**) in MS Excel, with J containing the rate λ.
e^x -1	h X.FCN e^x-1	FLOAT	Returns more accurate results for the fractional part of e^x with $x \approx 0$.
Ex^{-1}(p)	h PROB Ex^{-1}(p)	FLOAT	Ex^{-1}(p) returns the survival time t_s for a given probability p in X, with J containing the rate λ. See Ex(t) for more.
FB	h X.FCN FB ***n***	Integer	Inverts ("flips") the specified bit in x.

Name	Keys to press	in modes	Remarks
FC? FC?C FC?F FC?S	h TEST FC? ***n*** etc.	\α	Tests the flag specified. Clears, flips, or sets this flag after testing, if applicable.
FF	h P.FCN FF ***n***	\α	Flips the flag specified.
FIB	h X.FCN FIB	\α	Calculates the Fibonacci number F_x .
FILL	g FILL	\α	Copies x to all other stack levels. See above for ^{C}FILL.
FIX	h FIX ***n***	\α	Sets fixed point display format.
FLOAT	f H.d	\α	Works like DECM in *HP-42S*. Same as BASE0.
FLOOR	h X.FCN FLOOR	FLOAT	Returns the largest integer $\leq x$.
FP	g FP	FLOAT	Returns the fractional part of x .
FP?	h TEST FP?	\α	Tests x for having a nonzero fractional part.
FRACT	h P.FCN FRACT	FLOAT	Sets fraction mode like in HP-35S, but keeps display format as set by PROFRC and IMPFRC.
FS? FS?C FS?F FS?S	h TEST FS? ***n*** etc.	\α	Tests the flag specified. Clears, flips, or sets this flag after testing, if applicable.
F(x) F^{-1}(p)	h PROB F(x) h PROB F^{-1}(p)	FLOAT	F works like Q(F), F^{-1} like F_P in *HP-21S*. The degrees of freedom are given in **J** and **K**.
GCD	h X.FCN GCD	\α	Returns the Greatest Common Divisor of x and y .
Ge(m) Ge^{-1}(p)	h PROB Ge(m) h PROB Ge^{-1}(p)	FLOAT	Geometric distribution: $Ge(m)=1-(1-p_0)^m$ is the probability for a 1st success after $m = x$ Bernoulli experiments. The probability p_0 for a success in each such experiment must be given in **J**. Ge^{-1}(p) returns the number of failures ***f*** before the 1st success for a given probability ***p*** in **X**.
GRAD	g GRAD	FLOAT	Sets angular mode to gon or grads.

Name	Keys to press	in modes	Remarks
GTO	h GTO ***label***	PRG	Inserts an unconditional branch to ***label***.
		\PRG, \α	Positions the program pointer to ***label***.
	h GTO . ***nnn***	\α	Positions the program pointer to line ***nnn*** or to line 000, respectively (not programmable).
	h GTO . .		
H.MS	f H.MS	FLOAT	Sets H.MS mode for time or angular calculations. Display is formatted as shown above.
H.MS+	+	H.MS	Assumes **X** and **Y** containing times in the format `hhhh°mm'ss.dd"` , and adds or subtracts them, respectively. The shortcuts do not work in programming mode.
	h P.FCN H.MS+	FLOAT	
H.MS–	–	H.MS	
	h P.FCN H.MS–	FLOAT	
IMPFRC	g d/c	\α	Sets fraction mode allowing improper fractions in display (i.e. 5/3 instead of 1 2/3). Converts x according to the settings by DEN… Absolute decimal equivalents of x must be >1E-5 and <1E5. Compare PROFRC.
		FRC	Allows displaying improper fractions. Thus converts a proper fraction in **X** into the equivalent improper fraction, if applicable.
INT?	h TEST INT?	\α	Tests x for being an integer, i.e. having a fractional part equal to zero. Compare FP?.
IP	f IP	FLOAT	Returns the integer part of x .
ISG	g ISG ***r***	PRG	Given `cccccc.fffii` in ***r*** , this function increments ***r*** by `ii`, skipping next program line if then `ccccccc` > `fff` for ISG, or = 0 for ISZ.
ISZ	h P.FCN ISZ ***r***		
I β	h X.FCN Iβ	FLOAT	Returns the regularized incomplete beta function $\frac{\beta_x(x,y,z)}{\beta(y,z)} = \frac{1}{\beta(y,z)} \cdot \int_0^x t^{y-1}(1-t)^{z-1}dt$ with β_x being the incomplete beta function..
I Γ	h X.FCN IΓ	FLOAT	Returns the regularized incomplete gamma function $\frac{\gamma(x,y)}{\Gamma(x)}$ with $\gamma(x,y) = \int_0^y t^{x-1}e^{-t}dt$ being the lower incomplete gamma function.
J→D	h X.FCN J→D	FLOAT	Takes x as a Julian day number and converts it to a date in the format selected.
LASTx	RCL L	\α	See above for ^{C}LASTx .

Name	Keys to press	in modes	Remarks
LBL	f LBL ***label***	PRG	Identifies programs and routines for execution and branching. See opportunities for specifying ***label*** in the table above.
LCM	h X.FCN LCM	α	Returns the Least Common Multiple of x and y.
LEAP?	h TEST LEAP?	FLOAT	Takes x as a date in the format selected, extracts the year, and tests for a leap year.
LinF	h STAT LinF	FLOAT	Selects the linear curve fit model.
LJ	h X.FCN LJ	Integer	
LN	g LN	FLOAT	
LN1+x	h X.FCN LN1+x	FLOAT	Natural logarithm for values close to zero. Returns $\ln(1+x)$, which provides a much higher accuracy in the fractional part of the result.
LN β	h STAT LNβ h X.FCN LNβ	FLOAT	Returns the natural logarithm of $\beta(x, y)$. See there.
LN Γ	h STAT LNΓ h X.FCN LNΓ	FLOAT	Returns the natural logarithm of $\Gamma(x)$. See there.
LOG₁₀	g LG	FLOAT	
LOG₂	g LB	α	Calculates the logarithm of x for base 2.
LogF	h STAT LogF	FLOAT	Selects the logarithmic curve fit model.
LOGy	g LOGy	FLOAT	Calculates the logarithm of x for base y.
	CPX g LOGy	FLOAT	Calculates the logarithm of $x + i\,y$ for the base $z + i\,t$.
LZOFF	h MODE LZOFF	Integer	Toggles leading zeros like flag 3 in HP-16C.
LZON	h MODE LZON		
L.R.	h L.R.	FLOAT	Calculates the parameters ***a1*** and ***a0*** of the fit curve through the data points accumulated, according to the model selected, and pushes them on the stack. For a straight regression line, ***a0*** is the y-intercept and ***a1*** the slope.
MASKL	h X.FCN MASKL ***n***	Integer	Work like MASKL and MASKR on *HP-16C*, but with the mask length following the command instead of taken from **X**.
MASKR	h X.FCN MASKR ***n***		
MAX	h X.FCN MAX	α	Returns the maximum of x and y.

Name	Keys to press	in modes	Remarks
MIN	h X.FCN MIN	\α	Returns the minimum of x and y .
MIRROR	h X.FCN MIRROR	Integer	Reflects the bit pattern in x (e.g. 000101 becomes 101000 for word size 6).
MOD	h MOD	\α	MOD of *HP-42S* equals RMD of *HP-16C*.
M.DY	h MODE M.DY	\α	Sets the format for date display.
NAND	h X.FCN NAND	\α	Works in analogy to AND.
NaN?	h TEST NaN?	\α	Tests x for “Not a Number”.
nBITS	h X.FCN nBITS	Integer	Counts bits set in x like #B does on *HP-16C*.
NOP	h P.FCN NOP	PRG	
NOR	h X.FCN NOR	\α	Works in analogy to AND.
NOT	h NOT	\α	Works in analogy to AND.
nΣ	h STAT nΣ	FLOAT	Recalls the number of accumulated data points. Necessary for basic statistics.
N(x)	h PROB N(x)	FLOAT	= NORMDIST(***x; j; k;* 1**) in MS Excel, with the mean ***j*** and the standard deviation ***k***.
N $^{-1}$(p)	h PROB N $^{-1}$(p)	FLOAT	= NORMINV(***x; j; k***) . See N(x) for more.
ODD?	h TEST ODD?	\α	Checks if x is integer and odd.
OR	h OR	\α	Works in analogy to AND.
PAUSE	h PSE	PRG	Pauses program execution for about 1 s.
PERM	g Py,x	FLOAT	Returns the number of possible arrangements of y items taken x at a time. No item occurs more than once in an arrangement, and different orders of the same x items are counted separately. Formula: $P_{y,x} = x! \cdot C_{y,x}$, see COMB and FACT.
PowerF	h STAT PowerF	FLOAT	Selects the power curve fit model.
PRIME?	h TEST PRIME?	\α	Checks if the absolute value of the integer part of x is a prime number. Exact for $x < 66049$, Miller-Rabin with 40 iterations otherwise, with the probability ***P*** for erroneously claiming a composite is prime being $P \approx 2^{-80} \approx 10^{-24}$.

Name	Keys to press	in modes	Remarks
PROFRC	f a b/c	FLOAT	Sets fraction mode like in *HP-35S*, allowing only proper fractions or mixed numbers in display. Converts x according to the settings by DEN… Absolute decimal equivalents of x must be >1E-5 and <1E5. Compare IMPFRC.
		FRC	Allows displaying only proper fractions. Thus converts an improper fraction in **X**, e.g. 5/3 into 1 2/3, if applicable.
PROMPT	h P.FCN PROMPT	PRG	Displays ***alpha*** and stops program execution (equaling αVIEW followed by STOP actually). If alpha input is requested, use the sequence αON PROMPT αOFF. With a program running, enter the value or text requested and press R/S to continue.
P(m)	h PROB P(m)	FLOAT	= POISSON(***x; j*k; 1***) in MS Excel, with the gross error probability ***j*** and the sample size ***k***. Alternatively, the Poisson parameter λ may be in **J** if ***k*** = 1.
$P^{-1}(p)$	h PROB $P^{-1}(p)$	FLOAT	P^{-1} returns the number of successes ***g*** for a given probability ***p*** in **X**. See P(x) for more.
Q(x)	f Q	FLOAT	Works like Q in *HP-32E* and Q(z) in *HP-21S*.
$Q^{-1}(p)$	g Q^{-1}	FLOAT	Works like Q^{-1} in *HP-32E* and z_P in *HP-21S*.
RAD	g RAD	FLOAT	Sets angular mode to radians.
RAN#	f RAN#	FLOAT	Returns a random number between 0 and 1 like RAN in *HP-42S*.
		Integer	Returns a random bit pattern for the word size set.
RCL	RCL ***s***	\α	See the *addressing table above* for ^{C}RCL.
RCLM	RCL MODE	\α	Recalls selected mode settings into **X**. See the paragraph about *indicators* above.
RCLS	h P.FCN RCLS ***s***	\α	Recalls 4 or 8 values from a set of registers starting at address ***s***, and pushes them on the stack. This is the converse command of STOS.

Name	Keys to press	in modes	Remarks
RCL+	RCL + ***s***	\α	Recalls the content of address ***s***, executes the specified operation on it and pushes the result on the stack. E.g. RCL–12 recalls ***r12***, subtracts ***x*** from it and displays the result. RCL↑ (↓) recalls the maximum (minimum) of the values in ***s*** and **X**. See the [addressing table above]() for ᶜRCL.
RCL–	RCL − ***s***		
RCL×	RCL × ***s***		
RCL/	RCL / ***s***		
RCL↑	RCL ▲ ***s***		
RCL↓	RCL ▼ ***s***		
RDX, **RDX.**	h ./,	FLOAT	Toggle the radix mark. Also available in P.FCN FWIW.
RJ	h X.FCN RJ	Integer	Works in analogy to LJ.
RL	h X.FCN RL ***n***	Integer	Works like ***n*** consecutive RLs / RLCs on *HP-16C*. For RL, 1 ≤ ***n*** ≤ 63. For RLC, 1 ≤ ***n*** ≤ 64. RL 0 and RLC 0 execute as NOP.
RLC	h X.FCN RLC ***n***		
ROUND	g RND	FLOAT	Rounds ***x*** using the current display format, like RND in *HP-42S*.
		FRC	Rounds ***x*** using the current denominator, like RND in *HP-35S*.
ROUNDI	h X.FCN ROUNDI	FLOAT	Rounds ***x*** to next integer. ½ rounds to 1.
RR	h X.FCN RR ***n***	Integer	Works like ***n*** consecutive RRs / RRCs on *HP-16C*. See RL / RLC for more.
RRC	h X.FCN RRC ***n***		
RTN	g RTN	\PRG	Entered from the keyboard: Moves the program pointer to the first line of the current routine. In program execution: Returns control to the calling routine, i.e. moves the program pointer one step behind the most recent XEQ instruction encountered. If there is none, program execution halts.
		PRG	Last command in a routine. See above.
R-CLR	h P.FCN R-CLR	FLOAT	Interprets ***x*** in the form `ss.nn`. Clears ***nn*** registers starting with number ***ss***. E.g. for ***x*** = 34.56, R-CLR will clear **R34** through **R89**.

Name	Keys to press	in modes	Remarks
R-COPY	h P.FCN R-COPY	FLOAT	Interprets ***x*** in the form `ss.nndd`. Takes ***nn*** registers starting with number ***ss*** and copies their contents to ***dd*** . E.g. for ***x*** = 7.0345678, ***r07, r08, r09*** will be moved into **R45, R46, R47**, respectively.
R-SORT	h P.FCN R-SORT	FLOAT	Interprets ***x*** in the form `ss.nn`. Sorts the contents of ***nn*** registers starting with number ***ss*** . Assume ***x*** = 49.026 , ***r49*** = 1.2 , ***r50*** = -3.4 ; then R-SORT returns ***r49*** = -3.4 , ***r50*** = 1.2.
R-SWAP	h P.FCN R-SWAP	FLOAT	Works like R-COPY but swaps the register contents of source and destination.
R→D	h X.FCN R→D	FLOAT	Takes ***x*** as radians and converts them to degrees. Angular mode is kept.
R↑	h R↑		Rotates the stack contents one level up or down, respectively. See *above* for complex rotations.
R↓	R↓		
s	g s	FLOAT	Calculates the standard deviations s_y and s_x and pushes them on the stack.
SB	h X.FCN SB ***n***	Integer	Sets the specified bit in ***x*** .
SCI	h SCI ***n***	\α	Sets scientific display format.
SEED	h STAT SEED	FLOAT	Stores a seed for random number generation.
SERR	h STAT SERR	FLOAT	Calculates the standard deviations and pushes the standard errors $s_y / \sqrt{n}$ and $s_x / \sqrt{n}$ on the stack.
SETDAT	h X.FCN SETDAT	FLOAT[H]	Sets the date or time, respectively, for the real time clock.
SETTIM	h X.FCN SETTIM		
SF	h P.FCN SF ***n***	\α	Sets the flag specified.
SIGN	h X.FCN SIGN	\α	Returns 1 for ***x*** > 0, –1 for ***x*** < 0, and 0 for ***x*** = 0 or non-numbers.
	CPX X.FCN SIGN	FLOAT	Returns the unit vector of ***x*** + *i* ***y*** in **X** and **Y**.
SIGNMT	h MODE SIGNMT	\α	Sets sign-and-mantissa mode for integers.
SIN	f SIN	FLOAT[H]	
SINC	h X.FCN SINC	FLOAT	Calculates $\frac{\sin(x)}{x}$.

Name	Keys to press	in modes	Remarks
SINH	f HYP SIN	FLOAT	
SL	h X.FCN SL ***n***	Integer	Works like ***n*** (up to 63) consecutive SLs on *HP-16C*. SL 0 executes as NOP.
SLV	f SLV ***label***	FLOAT	Solves the equation f(x) = 0, with f(x) calculated by the routine specified. Two initial estimates of the root must be supplied in **X** and **Y** when calling SLV. For the rest, the user interface is as in *HP-15C*.
SR	h X.FCN SR ***n***	Integer	Works like ***n*** consecutive SRs on *HP-16C*. SR 0 executes as NOP.
SSIZE4	h MODE SSIZE4	\α	Sets the stack size to 4 or 8 levels, respectively. If stack size grows, the top level contents will be copied into the new levels. If the stack shrinks, previous top levels will be lost. – The same will happen if stack size is changed via STOM.
SSIZE8	h MODE SSIZE8		
SSIZE?	h TEST SSIZE?	\α	Returns the number of stack levels accessible.
STO	STO ***d***	\α	See the *addressing table above* for ^{C}STO.
STOM	STO MODE	\α	Sets selected modes as encoded in x. See the paragraph about *indicators* above.
STOP	R/S	PRG	Stops program execution.
STOS	h P.FCN STOS ***d***	\α	Stores all stack levels in a set of 4 or 8 registers, starting at destination ***d***.
STO+	STO + ***d***	\α	Executes the specified operation on the content of address ***d*** and stores the result into said address. E.g. STO–12 subtracts x from $r12$, and stores the result in **R12** again. STO↑ (↓) takes the maximum (minimum) of the values in ***d*** and **X** and stores it. See the *addressing table above* for ^{C}STO.
STO–	STO − ***d***		
STO×	STO × ***d***		
STO/	STO / ***d***		
STO↑	STO ▲ ***d***		
STO↓	STO ▼ ***d***		
SUM	h STAT SUM	FLOAT	Recalls the linear sums Σy and Σx. Useful for basic vector algebra.
TAN	f TAN	FLOAT^H	
TANH	f HYP TAN	FLOAT	
TIME	h TIME	FLOAT^H	Recalls the time from the real time clock at execution and shows it according to the mode set.

Name	Keys to press	in modes	Remarks
t(x)	h PROB t(x)	FLOAT	t works like Q(t) , t^{-1} like tp in *HP-21S*. The degree of freedom is stored in **J**.
t^{-1}(p)	h PROB t^{-1}(p)	FLOAT	
UNSIGN	h MODE UNSIGN	\α	Sets unsigned mode for integers.
VIEW	h VIEW ***s***	All	Views the contents of address ***s*** .
W	h X.FCN W	FLOAT	W returns Lambert's W for given ***x*** ≥ -1/e , while W^{-1} returns ***x*** for given W (≥ -1).
W $^{-1}$	h X.FCN W^{-1}	FLOAT	
Wb(t)	h PROB Wb(t)	FLOAT	= WEIBULL(***x; j; k;*** **1**) in Excel, with the *shape parameter* ***j*** and the *characteristic lifetime* ***k***.
Wb $^{-1}$(p)	h PROB Wb^{-1}(p)	FLOAT	Wb^{-1} returns the survival time t_s for given probability ***p*** . See Wb(t) for more.
WSIZE	h MODE WSIZE ***n***	\α	Works like WSIZE on *HP-16C*, but with the parameter following the command instead of taken from **X**. WSIZE 0 sets the word size to maximum, i.e. 64 bits.
WSIZE?	h TEST WSIZE?	\α	Recalls the word size set.
x ^{2}	g x^2	\α	
XEQ	XEQ ***label***	PRG	Calls the respective subroutine.
		\PRG, \α	Executes the respective program.
	B , C , or D (you may need f for accessing these hotkeys in integer bases >10.)	PRG	Calls the respective subroutine, so e.g. XEQ C will be inserted when C is pressed.
		\PRG, \α	Executes the respective program if defined.
XNOR	h X.FCN XNOR	\α	Works in analogy to AND.
XOR	h XOR	\α	Works in analogy to AND.
x̄	f x̄	FLOAT	Pushes $\frac{1}{n}\sum y$ and $\frac{1}{n}\sum x$ on the stack.
x̄w	h STAT x̄w	FLOAT	Returns the weighted mean $\sum xy \big/ \sum y$.
x̂	h STAT x̂	FLOAT	Returns a forecast ***x*** for a given ***y*** (in **X**) following the fit model chosen. See L.R. for more.
x !	h !	FLOAT	

Name	Keys to press	in modes	Remarks
x → α	g x◀▶α	All	Interprets ***x*** as a code of up to 6 characters. Appends these characters to ***alpha***, similar to XTOA in *HP-42S*.
***x*⇔**	h x⇄ ***r***	\α	Swaps the contents of **X** and ***r*** . See above for complex x⇔ .
x*⇔ *y	x⇄y	\α	Swaps ***x*** and ***y*** , performing Re⇔Im if a complex operation was executed immediately before. See above for ᶜx⇔y .
x < … ?	h TEST x < ? ***a***	\α	Compare ***x*** with ***a***. The three dots will be replaced in the listing by ***a*** according to the examples given in the addressing table above. x ≈ ? will be true if the rounded values of ***x*** and ***a*** are equal (see ROUND). CPX f x = ? ***a*** and CPX g x ≠ ? ***a*** compare the complex number ***x*** + *i* ***y*** as explained in the addressing table above.
x ≤ … ?	h TEST x ≤ ? ***a***		
***x* = … ?**	f x = ? ***a***		
x ≈ … ?	h TEST x ≈ ? ***a***		
***x* ≠ … ?**	g x ≠ ? ***a***		
x ≥ … ?	h TEST x ≥ ? ***a***		
x > … ?	h TEST x > ? ***a***		
y^x	f y^x	\α	In integer modes ***x*** must be ≥ 0.
	C	\(α, -3, -4, -5, h)	Shortcut working as long as label C is not defined yet.
ŷ	f ŷ	FLOAT	Returns a forecast ***y*** (in **X**) for a given ***x*** following the fit model chosen. See L.R. for more.
Y.MD	h MODE Y.MD	\α	Sets the format for date display.
αDATE	h X.FCN αDATE	\integer	Takes ***x*** as a date and appends it to ***alpha*** in the format set, preceded by a blank.
αDAY	h X.FCN αDAY	\integer	Takes ***x*** as a date, recalls the name of the respective day and appends its first 3 letters to ***alpha***, preceded by a blank.
αIP	h X.FCN αIP	All	Appends the integer part of ***x*** to ***alpha***, similar to AIP in *HP-42S*.
αLENG	h X.FCN αLENG	All	Returns the number of characters found in ***alpha***, like ALENG in *HP-42S*.
αMONTH	h X.FCN αMONTH	\integer	Works like αDAY, but processing the month.
αOFF	h P.FCN αOFF	PRG & α	Work like AOFF and AON in *HP-42S*, turning alpha mode off and on.
αON	h P.FCN αON	PRG & \α	

Name	Keys to press	in modes	Remarks
αRCL	f RCL ***s***	α	Interprets the content of the source ***s*** as characters and appends them to ***alpha***.
	h X.FCN αRCL ***s***	\α	
αRC#	h X.FCN αRC# ***s***	All	Takes the content of ***s*** as a number, converts it to a string in the format set, and appends this to ***alpha***. If e.g. ***s*** = 1234 and ENG 2 and RDX. are set, then ␣1.23E3 will be appended.
αRL	h X.FCN αRL ***n***	All	Rotates ***alpha*** by ***n*** characters like AROT in *HP-42S*, but with ***n*** ≥ *0* and the parameter trailing the command instead of taken from **X**. αRL 0 executes as NOP.
αRR	h X.FCN αRR ***n***	All	Works like αRL but rotates to the right.
αSL	h X.FCN αSL ***n***	All	Shifts the ***n*** leftmost characters out of ***alpha***, like ASHF in *HP-42S*. αSL 0 equals NOP.
αSR	h X.FCN αSR ***n***	All	Works like αSL but takes the ***n*** rightmost characters instead.
αSTO	f STO ***d***	α	Stores the first (i.e. leftmost) 6 characters in the alpha register into destination ***d*** .
	h X.FCN αSTO ***d***	\α	
αTIME	h X.FCN αTIME	FLOAT^H	Takes ***x*** as a time and appends it to ***alpha*** in the time format selected. Compare TIME.
	h TIME	α	Recalls the time from the real time clock at execution time and appends it to ***alpha*** in the format selected.
αVIEW	h X.FCN αVIEW	\α	Displays ***alpha***. In programs, use αVIEW followed by PAUSE for message output.
α → x	f x◀▶α	All	Returns the character code of the leftmost character in ***alpha*** and deletes this character, like ATOX in *HP-42S*.
β(x,y)	h STAT β(x,y)	FLOAT	Returns Euler's Beta $B(x,y)=\frac{\Gamma(x)\cdot\Gamma(y)}{\Gamma(x+y)}$ with $\mathrm{Re}(x)>0$, $\mathrm{Re}(y)>0$. Called β here for avoiding ambiguities.
	h X.FCN β(x,y)		
Γ(x)	h STAT Γ(x)	FLOAT	
	h X.FCN Γ(x)		
ΔDAYS	h X.FCN ΔDAYS	FLOAT	Assumes **X** and **Y** containing dates in the format chosen and calculates the number of days between them. Works like in *HP-12C*.

Name	Keys to press	in modes	Remarks
Δ%	f Δ%	FLOAT	Calculates $100 \cdot \frac{x-y}{y}$ like %CH in *HP-42S*.
π	h π	FLOAT	Complex version copies π in **X** and clears **Y**.
Π	f π ***label***	FLOAT	Computes a product with the routine specified by ***label***. Initially, **X** contains the loop control number in the format `cccccc.fffii` and the product is set to 1. Each run through the routine specified computes a factor. At its end, this factor is multiplied with said product; the operation then decrements `ccccccc` by `ii` and runs said routine again if `ccccccc` is then > `fff`, else returns the resulting product in **X**.
Σ	g Σ ***label***	FLOAT	Computes a sum with the routine specified by ***label***. Initially, **X** contains the loop control number in the format `cccccc.fffii` and the sum is set to 0. Each run through the routine specified computes a summand; at its end, this is added to said sum; the operation then decrements `ccccccc` by `ii` and runs said routine again if `ccccccc` is then > `fff`, else returns the resulting sum in **X**.
σ	h STAT σ	FLOAT	Works like s but calculates the standard deviation of the population instead.
$\Sigma \ln^2 x$	h STAT $\Sigma \ln^2 x$ etc.	FLOAT	Recall the respective statistical sums. These sums are necessary for curve fitting models beyond pure linear. Calling them by name enhances readability of programs significantly.
$\Sigma \ln^2 y$			
Σlnx			
Σlnxy			
Σlny			
Σxlny			
Σylnx			
Σx	h STAT Σx etc.	FLOAT	Recall the respective statistical sums. These sums are necessary for basic statistics and linear curve fitting. Calling them by name enhances readability of programs significantly.
Σx^2			
Σxy			
Σy			
Σy^2			

Name	Keys to press	in modes	Remarks
Σ+	Σ+	FLOAT	
Σ–	h Σ–		
χ^2INV	h PROB χ^2INV	FLOAT	χ^2 works like $Q(\chi^2)$, the inverse like χ^2_p in *HP-21S*. The degree of freedom is given in **J**.
χ^2(x)	h PROB χ^2(x)		
+	+	\α	
–	–		
×	×		
/	/		
//	g //	FLOAT	Calculates $\left(\frac{1}{x}+\frac{1}{y}\right)^{-1}$.
+/–	+/–		
→DEG	→ g DEG	FLOAT	Takes x as an angle in the angular mode set and converts it to degrees. Angular mode is kept.
→GRAD	→ g GRAD	FLOAT	Works like →DEG, but converts to grads.
→H	→ f H.d	H.MS	Takes x as hours or degrees in the format `hhhh°mm'ss.dd"` and converts them into decimal numbers.
→H.MS	→ f H.MS	FLOAT	Takes x as *decimal* hours or degrees and converts them into `hhhh°mm'ss.dd"`.
→POL	g R◀▶P	FLOAT	Assumes **X** and **Y** containing Cartesian coordinates (x, y) and converts them to the respective cylinder coordinates (r, ϑ).
→RAD	→ g RAD	FLOAT[H]	Works like →DEG, but converts to radians.
→REC	f R◀▶P	FLOAT	Assumes **X** and **Y** containing cylinder coordinates (r, ϑ) and converts them to the respective Cartesian coordinates (x, y).
%	g %	FLOAT	Calculates $\frac{x \cdot y}{100}$.
%MG	h X.FCN h % MG	FLOAT	Calculates the margin [15] $100 \cdot \frac{x-y}{x}$ in % for a price x and cost y, like %MU-Price in *HP-17B*.

Name	Keys to press	in modes	Remarks
%MRR	h X.FCN h % MRR	FLOAT	Calculates the mean rate of return in % per period, i.e. $100 \cdot \left[\left(\frac{x}{y} \right)^{1/z} - 1 \right]$ with $\boldsymbol{x}$ = FV = future value after $\boldsymbol{z}$ periods, $\boldsymbol{y}$ = PV = present value. For $\boldsymbol{z} = 1$, Δ% returns the same result easier.
%T	h X.FCN h % T	FLOAT	Calculates $100 \cdot \frac{x}{y}$, i.e. percent of total FWIW.
%Σ	h STAT h % Σ h X.FCN h % Σ	FLOAT	Calculates $100 \cdot \frac{x}{\sum x}$.
%+	h %+	FLOAT	Adds a markup of $\boldsymbol{x}$ % to a price $\boldsymbol{y}$, calculating $y \cdot \left(1 + \frac{x}{100} \right)$ like in %MU-Cost of *HP-17B*.
%+MG	h X.FCN h % +MG	FLOAT	Adds a margin [15] of $\boldsymbol{x}$ % to the cost $\boldsymbol{y}$, calculating a sales price $y \Big/ \left(1 - \frac{x}{100} \right)$, as %MU-Price does in *HP-17B*.
%–	h %–	FLOAT	Subtracts a discount of $\boldsymbol{x}$ % from the price $\boldsymbol{y}$, calculating $y \cdot \left(1 - \frac{x}{100} \right)$.
√‾	f √x	\α	
	D	\(α, -4, -5, h)	Shortcut working as long as label D is not defined yet.
∫	g ∫ ***label***	FLOAT	Integrates the function given in the routine specified. Lower and upper integration limits must be supplied in **Y** and **X**, respectively. Otherwise, the user interface is as in *HP-15C*.
∞?	h TEST ∞?	\α	Tests $\boldsymbol{x}$ for infinity.

[15] Margin corresponds to „Handelsspanne“ in German.

Alphanumeric input:

Letter or digit	Keys to press	in modes	Remarks
°	[.]	H.MS	Separates degrees (hours) from minutes and seconds, so input format is `hhhh.mmssdd`.
0 … 9	[0] … [9]	\α	Standard numeric input. For integer bases <10, input of illegal digits throws an *error message*.
		in addressing	Register input. See the *addressing tables* above for more.
	[0], [1], [f][2], … , [f][9]	α	Appends the respective digit to ***alpha***.
A … F	[A] … [F] (red print)	-1, -2, -3, -4, -5, h	Numeric input for digits >10. See page 6 for more information.
A … Z	[A] … [Z] (red print)	in addressing	Register input. See the *addressing tables* above for the letters applicable.
		α	Alphabetic input. See page 7 for more.
E	[E] (the key)	FLOAT	Like EEX in the older vintage calculators.
[/] or [ ]	[.]	FRC	First [.] is interpreted as a space, 2nd as a fraction mark. E.g. [2] [.] [3] [.] [4] results in 2 ¾ in the dot matrix display. Improper fractions are entered starting with a [.] .
[.]	[.]	D.MY, M.DY, Y.MD	Separates the leading unit in date modes. The user has to take care where a number represents a date.
[.] or [,]	[.]	FLOAT	Inserts the radix mark as selected.
		α	Inserts a point.
(or)	[f][◀(] / [g][)▶]	α	Appends a left / right parenthesis to ***alpha***.

Non-programmable control, clearing and information commands:

Name if existent	Keys to press	in modes	Remarks
	▲ / ▼ ↓	Status open	Goes to previous / next set of flags.
		Catalog open	Goes to previous / next item in this catalog.
		α	Shifts the display window to the left / right in ***alpha*** if possible. Useful for longer strings.
		Else	Acts like BST / SST in *HP-42S*.
	← ↓	Input pending	Deletes the last digit or character put in.
		α	Deletes the rightmost character in ***alpha***.
		PRG	Deletes current step.
		Else	Acts like CLx.
	f ◀ / g ▶	Integer	Shifts the display window to the left / right like in *HP-16C*. Helpful in working with small bases.
	f ⬆	α	Toggles upper and lower case.
	f α	\α	Toggle alpha mode for keyboard entry.
	ENTER↑	α	
	EXIT ↓	Catalog open	Leaves the catalog without executing anything.
		Input pending	Cancels the execution of pending operations.
		Else	Acts as NOP.
	g OFF	All	Turns calculator off.
	ON	Calculator off	Turns calculator on.
	h P/R	\PRG, \α	Toggle programming mode for keyboard entry.
		PRG	
	R/S	\PRG, \α	Entered from the keyboard: Runs the current program starting with the current step or stops the running program immediately. Compare the programmable command STOP.
	h SHOW	FLOAT & \PRG	Shows the full mantissa until EXIT is released.
		PRG	Displays a CRC-32 checksum of program memory contents (8 hex digits), allowing validation of program integrity.

Name if existent	Keys to press	in modes	Remarks
	XEQ	Catalog open	Selects the item displayed and exits, executing the respective command. See above.
CLALL	h X.FCN CLALL	\PRG	Clears all registers and programs if confirmed.
CLPR	h CLP	\α	Clears the current program (i.e. the one the program pointer is in) after confirmation.
RESET	h X.FCN RESET	All	Clears all registers and programs if confirmed, and resets all modes to start-up default, i.e. 24h, 2COMPL, ALL, DEG, DENANY, DENMAX 0, FLOAT, LinF, PROFRC, SSIZE4, WSIZE 64, Y.MD.
STATUS	h STATUS	\PRG	Shows the status of all user flags, similar to STATUS on *HP-16C*. See above.
VERS	h X.FCN VERS	\PRG	Shows the firmware version.
→BIN	→ f 2	\α	These commands show ***x*** in target integer representation until the key +/- or E is released, respectively. Base is kept as set. If used in integer bases 15 and 16, prefix f must precede the key →
→DEC	→ f 10		
→HEX	→ g 16		
→OCT	→ g 8		

Catalogs (not programmable):

Calling a catalog will set temporary alpha mode to allow for typing the first 1 or 2 characters of the item wanted. ▲ and ▼ browse the catalog, XEQ selects the item displayed and exits, while EXIT leaves the catalog without executing anything, returning to the mode as set before. See the *table above about addressing cataloged items*, and the *next paragraph* for detailed item lists.

Keys to press	in modes	Contents
h CONST	FLOAT	Constants like in HP35s. See them listed in a *table below*.
CPX CONST	FLOAT	This will clear **Y** in recalling the constant selected since they are all real.
h CONV	FLOAT	Conversions as listed in a *table below*.
f CPX	α	"Complex" letters mandatory for many languages. Upper or lower case will be displayed according to setting (see f ↑ above).
h MODE	\α	Mode setting functions.
h PROB	FLOAT	Extra probability distribution functions.
h P.FCN	\α	Extra programming functions.
f R↓	α	Subscripts.
h R↑	α	Superscripts.
h STAT	FLOAT	Extra statistical functions.
h TEST	\α	All tests except the two on the keyboard.
	α	Comparison symbols and brackets. Parentheses are called by f (and g), respectively.
h X.FCN	FLOAT	Extra real functions.
	Integer	Extra integer functions.
	α	Extra alpha functions.
CPX X.FCN	FLOAT	Extra complex functions.
h ./,	α	Punctuation marks and text symbols.
f →	α	Arrows and mathematical symbols.

DETAILED CATALOG CONTENTS

The operations contained in the catalogs MODE, STAT, PROB, P.FCN, TEST, and X.FCN are listed in the following table. A single function, e.g. CB, may be contained in more than one catalog. The characters necessary to access a specific function in the respective catalog are printed bold in this table – ▼ has to be pressed once for each character printed red – if even the last letter of a function name is red, one may need more strokes of ▼ to access this function. See also the catalogs CONST and CONV in separate paragraphs below. The alpha catalogs are found two pages below.

MODE	STAT	PROB	P.FCN	TEST
12h	**B**estF	**B**(m)	**CF**	**BC**?
1COMPL	**E**RF	**B** $^{-1}$(p)	**CL**FLAG	**BS**?
24h	**E**xpF	**E**x(t)	**CLS**TK	**E**VEN?
2COMPL	**L**inF	**Ex** $^{-1}$(p)	**D**ROP	**F**C?
ALL	**LN**β	**F**(x)	**DS**Z	**FC**?C
BASE	**LNΓ**	**F** $^{-1}$(p)	**F**F	**FC?**F
DENANY	**L**ogF	**G**e(m)	**FR**ACT	**FC?S**
DENFAC	**n**Σ	**Ge** $^{-1}$(p)	**I**SZ	**FP**?
DENFIX	**P**owerF	**N**(x)	**H**.MS+	**FS**?
DENMAX	**SE**ED	**N** $^{-1}$(p)	**H.**MS-	**FS?**C
DISP	**SE**RR	**P**(m)	**N**OP	**FS?F**
D.MY	**SU**M	**P** $^{-1}$(p)	**P**ROMPT	**FS?S**
E3OFF	$\bar{x}$w	**t**(x)	**R**CLM	**I**NT?
E3ON	$\hat{x}$	**t** $^{-1}$(p)	**RC**LS	**L**EAP?
LZOFF	β(x,y)	**W**b(t)	**RD**X.	**N**aN?
LZON	Γ(x)	**Wb** $^{-1}$(p)	**RDX,**	**O**DD?
M.DY	**σ**	χ^{2}INV	**R-**CLR	**P**RIME?
SIGNMT	**Σl**n^{2}x	χ^{2}(x)	**R-C**OPY	**S**SIZE?
SSIZE4	**Σln**^{2}y		**R-SO**RT	**W**SIZE?
SSIZE8	**Σlnx**		**R-SWA**P	**x** < ?
UNSIGN	**Σlnxy**	**Σxy**	**S**F	**x ≤** ?
WSIZE	**Σlny**	**Σy**	**ST**OM	**x ≈ ?**
Y.MD	**Σx**	**Σy^{2}**	**STO**S	**x ≥ ?**
	Σx^{2}	**Σyln**x	**α**OFF	**x > ?**
	Σxlny	**%**Σ	**αO**N	**∞**?

X.FCN varies with the mode set; it contains in …

… alpha mode:	… FLOAT:		… integer modes:	
	ANGLE	SETTIM	ASR	RJ
CLALL	CEIL	SIGN	CB	RL
CLREG	CLALL	SINC	CLALL	RLC
RESET	CLREG	VERS	CLREG	RR
VERS	DATE	W	DBLR	RRC
αDATE	DAY	W^{-1}	DBL*	SB
αDAY	DAYS+	XNOR	DBL/	SIGN
αIP	DECOMP	αDATE	FB	SL
αLENG	D→J	αDAY	FIB	SR
αMONTH	D→R	αIP	GCD	VERS
αRC#	ERF	αLENG	LCM	XNOR
αRL	e^{x} -1	αMONTH	LJ	α IP
αRR	FIB	αRCL	MASKL	αLENG
αSL	FLOOR	αRC#	MASKR	αRCL
αSR	GCD	αRL	MAX	αRC#
αTIME	Iβ	αRR	MIN	αRL
	IΓ	αSL	MIRROR	αRR
	J→D	αSR	NAND	αSL
	LCM	αSTO	nBITS	αSR
	LN1+x	αTIME	NOR	αSTO
	LNβ	α VIEW	RESET	α VIEW
	LNΓ	β(x,y)		
	MAX	Γ(x)		
	MIN	ΔDAYS		
	NAND	%MG		
	NOR	%MRR		
	RESET	%T		
	ROUNDI	%Σ		
	R→D	%+MG		
	SETDAT			

CPX X.FCN
^{c}CONJ
$^{c}e^{x}$ -1
^{c}FIB
^{c}FP?
^{c}INT?
^{c}LN1+x
^{c}LNβ
^{c}LNΓ
^{c}SIGN
^{c}SINC
^{c}W
$^{c}W^{-1}$
^{c}β(x,y)
^{c}Γ(x)

CPX					
À			à		
Á			á		
Â Ã Ā Ă			â ã ā ă		
Ä			ä (ǎ)		
Å			å		
Ć			ć		
Č			č		
Ç			ç		
È			è		
É			é		
Ê Ē Ĕ Ě			ê ē ĕ ě		
Ë			ë (ě)		
			ℏ		
Ì			ì		
Í			í		
Î Ĩ Ī Ĭ			î ĩ ī ĭ		
Ï			ï (ǐ)		
Ñ Ň			ñ ň		
Ò			ò		
Ó			ó		
Ô Õ Ō Ŏ			ô õ ō ŏ		
Ö			ö (ǒ)		
Ø			ø		
Ř			ř		
Š			š		
			ß		
Ù			ù		
Ú			ú		
Û Ũ Ū Ŭ			û ũ ū ŭ		
Ü			ü (ǔ)		
Ů			ů		
Ý			ý		
Ÿ			ÿ		
Ž			ž		

Here are the contents of the alpha catalogs – big font in left column or upper row, small font right or lower – making the WP 34S the most versatile global calculator known.

./,
, ? : ; “ # ‘ * @ _ ~ `

TEST
< ≤ = ≈ ≥ > [ ] { }

→
→ ← ↑ ↓ ∫ ∞ ^

R↓ (subscripts)
0 1 2 A B c e k m n p u μ ∞

R↑ (superscripts)
° 2 x x̄ x̂ ȳ ŷ -1

The letters provided here allow for correct writing Afrikaans, Català, Cebuano, Česky, Cymraeg, Deutsch, Eesti, English, Español, Euskara, Français, Gaeilge, Galego, Bahasa Indonesia, Italiano, Basa Jawa, Kiswahili, Kreyòl ayisyen, Magyar, Bahasa Melayu, Nederlands, Português, Quechua, Shqip, Slovenčina, Slovenščina, Basa Sunda, Suomeksi, Svenska, Tagalog, Winaray, Zhōngwén (with a little trick explained below), and almost Hrvatski and Srpski (sorry, no đ) as well as Dansk and Norsk (no æ). If you know further living languages covered, please tell us.

Mandarin Chinese (Zhōngwén) features four tones, usually transcribed like e.g. mā, má, mǎ, and mà. So you need different letters for ā and ǎ here, and for e, i, o, and u, too. With 6 pixels total character height we found no way to display them in both fonts nicely, keeping letters and accents separated for easy reading. For an unambiguous solution, we suggest using a dieresis (else not employed in Hànyǔ pīnyīn) representing the third tone here.

CONSTANTS

This lists the contents of the catalog CONST. Values of physical constants (*incl. their relative standard deviations given in parentheses below*) are from CODATA 2006, copied in August 2010. Green background denotes exact or almost exact values. The more the background turns to red, the less precise the respective constant is known [16].

The characters necessary to get to a specific function in the catalog are printed bold in this index – [▼] has to be pressed once for each character printed red.

For the units, remember Tesla with $1T = 1\frac{Wb}{m^2} = 1\frac{V \cdot s}{m^2}$, Joule with $1J = 1N \cdot m = 1\frac{kg \cdot m^2}{s^2}$

and on the other hand $1J = 1W \cdot s = 1V \cdot A \cdot s = \frac{1}{e} eV \approx 6.24 \cdot 10^6 TeV$. Thus $1\frac{J}{T} = 1A \cdot m^2$.

	Numeric value	Unit	Remarks
a	365.2425	d	Gregorian year (per definition)
a_0	5.2917720859**E**-11 *(6.8**E**-10)*	m	Bohr radius $= \frac{\alpha}{4\pi \cdot R_\infty}$
c	2.99792458**E**8	m/s	Vacuum speed of light (per definition)
c_1	3.74177118**E**-16 *(5.0**E**-8)*	$m^2 \cdot W$	First radiation constant $= 2\pi \cdot h \cdot c^2$
c_2	0.014387752 *(1.7**E**-6)*	$m \cdot K$	Second radiation constant $= hc/k$
e	1.602176487**E**-19 *(2.5**E**-8)*	C	Electron charge $= \frac{2}{K_J R_K} = \Phi_0 G_0$
eE	2.718281828459045…	1	Euler's e. Please note the letter *e* is used for the electron charge elsewhere in this table.
F	96485.3399 *(2.5**E**-8)*	$\frac{C}{mol}$	Faraday's constant $= e\, N_A$
g	9.80665	m/s^2	Standard earth acceleration (per definition)
G	6.67428**E**-11 *(1.0**E**-4)*	$\frac{m^3}{kg \cdot s^2}$	Newton's gravitation constant
G_0	7.7480917004**E**-5 *(6.8**E**-10)*	$1/\Omega$	Conductance quantum $= 2e^2/h = 2/R_K$ with the von Klitzing constant R_K = 25812.807557 Ω

[16] The bracketed values printed here for your kind attention allow you to compute the precision of results you may obtain using these constants. The procedure to be employed is called error propagation. It is often ignored, though essential for trustworthy results – not only in science. Please turn to respective texts before you believe in 4 decimals of a calculation result based on yardstick measurements.

	Numeric value	Unit	Remarks
g_e	2.0023193043622 *(7.4E-13)*	1	Landé's g-factor
h	6.62606896E-34 *(5.0E-8)*	*J s*	Planck constant
$\hbar$	1.054571628E-34 *(5.0E-8)*		$= h/2\pi$
k	1.3806504E-23 *(1.7E-6)*	J/K	Boltzmann constant $= R/N_A$
m_e	9.10938215E-31 *(5.0E-8)*	*kg*	Electron mass
m_n	1.674927211E-27 *(5.0E-8)*		Neutron mass
m_p	1.672621637E-27 *(5.0E-8)*		Proton mass
m_u	1.660538782E-27 *(5.0E-8)*		Atomic unit mass $= 10^{-3}\, kg / N_A$
m_μ	1.88353103E-28 *(5.6E-8)*		Muon mass
N_A	6.02214179E23 *(5.0E-8)*	$1/mol$	Avogadro's number
p_0	101325	*Pa*	standard atmospheric pressure (per definition)
R	8.314472 *(1.7E-6)*	$\frac{J}{mol \cdot K}$	Molar gas constant
r_e	2.8179402894E-15 *(2.1E-9)*	*m*	Classical electron radius $= \alpha^2 \cdot a_0$
R_∞	1.0973731568527E7 *(6.6E-12)*	$1/m$	Rydberg constant $= \alpha^2 m_e c / 2h$
T_0	273.15	*K*	= 0°C, standard temperature (per definition)
t_p	5.39124E-44 *(5.0E-5)*	*s*	Planck time $= \sqrt{\hbar G / c^5}$
V_m	0.022413996 *(1.7E-6)*	m^3/mol	Molar volume of an ideal gas at standard conditions $= RT_0 / p_0$
Z_0	376.730313461…	Ω	Characteristic impedance of vacuum $= \sqrt{\frac{\mu_0}{\varepsilon_0}} = \mu_0 c$
α	7.2973525376E-3 *(6.8E-10)*	1	Fine-structure constant $= \frac{e^2}{4\pi\varepsilon_0 \hbar c} \approx \frac{1}{137}$
γEM	0.57721566490153286…	1	Euler-Mascheroni constant

	Numeric value	Unit	Remarks
γ_p	2.675222099**E**8 *(2.6**E**-8)*	$\frac{1}{s \cdot T}$	Proton gyromagnetic ratio $= 2\mu_P / \hbar$
ε_0	8.854187817…**E**-12	$\frac{A \cdot s}{V \cdot m}$ or F/m	Electric constant, vacuum permittivity $= \frac{1}{\mu_0 c^2}$
λ_c	2.4263102175**E**-12 *(1.4**E**-9)*	m	Compton wavelength of the electron $= h / m_e c$
λ_{cn}	1.3195908951**E**-15 *(1.5**E**-9)*		Compton wavelength of the neutron $= h / m_n c$
λ_{cp}	1.3214098446**E**-15 *(1.9**E**-9)*		Compton wavelength of the proton $= h / m_p c$
μ_0	1.2566370614…**E**-6	$\frac{V \cdot s}{A \cdot m}$	Magnetic constant, also known as vacuum permeability $= 4\pi \cdot 10^{-7} \frac{V \cdot s}{A \cdot m}$ (per definition)
μ_B	9.27400915**E**-24 *(2.5**E**-8)*	J/T or $A \cdot m^2$	Bohr's magneton $= e\hbar / 2m_e$
μ_e	-9.28476377**E**-24 *(2.5**E**-8)*		Electron magnetic moment
μ_n	-9.6623641**E**-27 *(2.4**E**-7)*		Neutron magnetic moment
μ_p	1.410606662**E**-26 *(2.6**E**-8)*		Proton magnetic moment
μ_u	5.05078324**E**-27 *(2.5**E**-8)*		Nuclear magneton $= e\hbar / 2m_p$
μ_μ	-4.49044786**E**-26 *(3.6**E**-8)*		Muon magnetic moment
π	3.141592653589793…	1	
σ_B	5.6704**E**-8 *(7.0**E**-6)*	$\frac{W}{m^2 K^4}$	Stefan-Boltzmann constant $= \frac{2\pi^5 k^4}{15 h^3 c^2}$
Φ	1.61803398874989485…	1	Golden ratio $= \frac{1+\sqrt{5}}{2}$
Φ_0	2.067833667**E**-15 *(2.5**E**-8)*	$V\,s$	Magnetic flux quantum $= h / 2e = 1 / K_J$ with the Josephson constant $K_J = 4.83597891 \cdot 10^{14}\, Hz / V$
∞		1	Infinity (may the Lord of Mathematics forgive us calling this a constant)

CONVERSIONS

These are the contents of the catalog CONV [17]. The characters necessary to access a specific conversion there are printed bold in this index – ▼ has to be pressed once for each character printed red. The constant $\mathbf{T_o}$ may be useful for conversions, too; it is found in the *catalog CONST*. The conversion factors or divisors listed in this table will not be seen when executing a conversion.

Conversion		Remarks	Class
°C→°F	* 1.8 + 32	Exactly	Temperature
°F→°C	- 32) / 1.8	Exactly	Temperature
acres→ha	* 0.4046873	1 ha = 10^4 m^2	Area
ar.→dB	10 * lg(R)	Amplitude ratio. Exactly	Ratio
atm→Pa	* 1.01325E5	Exactly	Pressure
AU→km	* 1.495979E8	Astronomic units	Length
bhp→W	* 745.6999	British horse power	Power
Btu→J	* 1055.056		Energy
cal→J	* 4.1868	Exactly	Energy
cft→*l*	* 28.31685	Cubic feet	Volume
cm→inches	/ 2.54	Exactly	Length
dB→ar.	$10^{R_{dB}/20}$	Amplitude ratio. Exactly	Ratio
dB→pr.	$10^{R_{dB}/10}$	Power ratio. Exactly	Ratio
fathom→m	* 1.8288		Length
feet→m	* 0.3048	Exactly	Length
flozUK→*ml*	* 28.41306	1 *ml* = 1 cm^3	Volume
flozUS→*ml*	* 29.57353		Volume
galUK→ *l*	* 4.54609		Volume
galUS→ *l*	* 3.785418		Volume
g→oz	/ 28.34952		Mass
g→tr.oz	/ 31.10348		Mass
ha→acres	/ 0.4046873		Area

[17] For most readers, many of the units appearing here may look obsolete at least. They die hard, however, in some corners of this world. For symmetry reasons, we may also add some traditional Indian and Chinese units. Anyway, this catalog provides the means to convert local to common units.

Conversion		Remarks	Class
HP$_e$→W	* 746	Exactly	Power
inches→cm	* 2.54	Exactly	Length
in.Hg→Pa	* 3386.389		Pressure
J→Btu	/ 1055.056		Energy
J→cal	/ 4.1868	Exactly	Energy
J→kWh	/ 3.6E6	Exactly, since 1 h = 3600 s	Energy
kg→lbm	/ 0.4535924		Mass
km→AU	/ 1.495979E8	Astronomic units	Length
km→*l.y.*	/ 9.460730E12	Light years	Length
km→mi	/ 1.609344	Exactly	Length
km→nmi	/ 1.852	Nautical miles, exactly	Length
km→pc	/ 3.085678E16	Parsec	Length
kWh→J	* 3.6E6	Exactly	Energy
lbf→N	* 4.448222		Force
lbm→kg	* 0.4535924		Mass
l.y.→km	* 9.460730E12	Light years	Length
l →cft	/ 28.31685	Cubic feet	Volume
l →galUK	/ 4.54609		Volume
l →galUS	/ 3.785418		Volume
mbar→Pa	* 100	Exactly	Pressure
mi→km	* 1.609344	Exactly	Length
m*l*→flozUK	/ 28.41306		Volume
m*l*→flozUS	/ 29.57353		Volume
m→fathom	/ 1.8288		Length
m→feet	/ 0.3048	Exactly	Length
m→yards	/ 0.9144	Exactly	Length
nmi→km	* 1.852	Nautical miles, exactly	Length
N→lbf	/ 4.448222		Force
oz→g	* 28.34952		Mass

Conversion		Remarks	Class
Pa→atm	/ 1.01325**E**5	Exactly	Pressure
Pa→in.Hg	/ 3386.389		Pressure
Pa→mbar	/ 100	Exactly	Pressure
Pa→**p**si	/ 6894.757		Pressure
Pa→**to**rr	/ 133.3224		Pressure
pc→km	* 3.085678E16	Parsec	Length
pr.→dB	10 * lg(R)	Power ratio. Exactly	Ratio
psi→Pa	* 6894.757		Pressure
PS(hp)→W	* 735.4988		Power
s.tons→t	* 0.9071847	1 t = 10^3 kg	Mass
tons→t	* 1.016047		Mass
torr→Pa	* 133.3224	1 torr = 1 mm Hg	Pressure
tr.oz→g	* 31.10348		Mass
t→s.tons	/ 0.9071847		Mass
t→**t**ons	/ 1.016047		Mass
W→bhp	/ 745.6999		Power
W→HP$_e$	/ 746	Exactly	Power
W→**P**S(hp)	* 735.4988		Power
yards→m	* 0.9144	Exactly	Length

MESSAGES

There are some commands generating messages also in the dot matrix section of the display. Four of them, DAY, DAYS+, STATUS, and VERS, were introduced above in the paragraph about display already. Others are PROMPT, αVIEW and many more alpha commands, and the test commands as mentioned above.

Furthermore, there are a number of error messages. Depending on error conditions, the following messages will be displayed:

Message	Mode(s) allowing this message	Explanation and Examples
bad date Error	FLOAT	Invalid date format or incorrect date in input, e.g. month >12, day >31 etc.
bad digit Error	Integer	Invalid digit in integer input, e.g. 2 in binary, 9 in octal, or +/- in unsigned mode.
bad mode Error	All	Caused by calling an operation in a mode where it is not defined, e.g. SIN in hexadecimal.
domain Error	\α	An argument exceeds the domain of the mathematical function called. May be caused by roots or logs of negative numbers (if not preceded by CPX), by 0 / 0, LN(0), $\Gamma(0)$, TAN(90°) and equivalents, ATANH(x) for $\lvert\mathrm{Re}(x)\rvert \geq 1$, ACOSH(x) for $\mathrm{Re}(x) < 1$, etc.
no such LAbEL	All	Attempt to address an undefined label.
out of range Error	All	• A number exceeds the valid range. Caused e.g. by specifying decimals >11, word size >64, negative flag numbers, integers $\geq 2^{64}$, hours or degrees >9000, invalid times, denominators ≥9999 etc. • A register address exceeds the valid range. May also happen in indirect addressing. • An R-operation (e.g. R-COPY) attempts exceeding valid register numbers (0 … 99).
SLV ∫ Σ Π nESTEd	PRG	Nested use of solve, integrate, sum or product is not allowed.

Message	Mode(s) allowing this message	Explanation and Examples
undefined OP-CODE	All	An instruction with an undefined op-code occurred (should never happen, but who knows).
word size too SMALL	Integer, \PRG	Stack or register content is too big for the word size set.
+∞ Error −∞ Error	\α, \PRG	• Division of a number > 0 (or < 0) by zero. • Divergent sum or product or integral. • Positive (or negative) overflow in FLOAT.
>8 levels nESTEd	PRG	Subroutine nesting exceeds 8 levels.

Any key pressed will erase the error message displayed and execute with the stack contents present.

APPENDIX A: INTERNAL SUPPORT COMMANDS

Some commands are used in internal routines exclusively and are not accessible by the user. They are listed below for sake of a complete documentation:

Name	Purpose and remarks
BACK	Takes an argument 0 ≤ ***n*** ≤ 99 (may be specified indirectly) and jumps ***n*** program steps backwards. Reaching step 000 stops program execution.
iC	Internal constants, selected by the number specified: 0 0 1 1 2 5.01402 3 15.02903 4 0.149445554002916905664936468389821 5 0.995657163025808080735527280689003 6 0.011694638867371874278064396062192 7 0.930157491355708226001207180059508 8 0.054755896574351996031381300244580 9 0.780817726586416897063717578345042 10 0.093125454583697605535065465083366 11 0.562757134668604683339000099272694 12 0.123491976262065851077958109831074 13 0.294392862701460198131126603103866 14 0.142775938577060080797094273138717 15 0.973906528517171720077964012084452 16 0.066671344308688137593568809893332 17 0.032558162307964727478818972459390 18 0.865063366688984510732096688423493 19 0.149451349150580593145776339657697 20 0.075039674810919952767043140916190 21 0.679409568299024406234327365114874 22 0.219086362515982043995534934228163 23 0.109387158802297641899210590325805 24 0.433395394129247190799265943165784 25 0.269266719309996355091226921569469 26 0.134709217311473325928054001771707 27 0.148874338981631210884826001129720 28 0.295524224714752870173892994651338 29 0.147739104901338491374841515972068
INISLV	Initializes the solver. Its arguments come from some hidden registers and it updates these.
RTN+1	Returns control to the calling routine like RTN does, but moves the program pointer to the <u>second</u> line following the most recent XEQ instruction encountered. If there is no matching XEQ, program execution halts.
SKIP	Takes an argument 0 ≤ ***n*** ≤ 99 (may be specified indirectly) and skips ***n*** program steps forwards. If this skip would land beyond the end of <u>occupied</u> program memory, the effect will be the same as if a RTN had been encountered.

Name	Purpose and remarks
SPEC?	Tests if x is special (NaN or infinite).
STPSLV	Solver step. Updates the internal solver state based on the last function evaluation. Returns zero if finished and non-zero (i.e. 1) if solving should stop/has converged.
USR	Calls a user subroutine (used by SLV, ∫, Π and Σ). The subroutine is defined by the argument to the initial command (either numeric of alpha label)

APPENDIX B: CANDIDATES FOR FURTHER FUNCTIONS

If space allows, the following functions may be implemented easily since they are coded already. None of these are counting the catalog and function table overheads. Two bytes for a catalog entry (one for each catalog it is in) and 12-20 bytes for a function table entry (but only one of these), i.e. not terribly significant. These are all moderately useful functions.

Function name and remarks	Size	Domain
AGM = limit of arithmetic geometric mean.	528 B	$\mathbb{R}$
Bessel functions of first and second kinds: **J_n** & I_n: real and complex (argument and order); Y_n & K_n: real and complex (argument and order). Remember: $J_n(x)=\sum_{r=0}^{\infty}\frac{(-1)^r\cdot\left(x/2\right)^{2r+n}}{r!\cdot\Gamma(n+r+1)}$	4470 B	$\mathbb{R},\mathbb{C}$
Cube / cube root	576 B	$\mathbb{Z},\mathbb{R},\mathbb{C}$
Digamma function (ψ, needed for Bessel functions of second kind of integer order)	1384 B	$\mathbb{R},\mathbb{C}$
Fused multiply/add The real version can be replaced by complex multiply. x+y*z can be done via (y, x) * (z, -1) at a pinch.	96 B	$\mathbb{Z},\mathbb{R}$
Jacobi elliptic functions S_n, C_n & D_n	1780 B	$\mathbb{R},\mathbb{C}$
Riemann's Zeta function $\zeta(x)=\sum_{n=1}^{\infty}\frac{1}{n^x}$ with $\mathrm{Re}(x)>1$.	2012 B	$\mathbb{R},\mathbb{C}$
x!!	288 B	$\mathbb{R},\mathbb{C}$

PRIME? also includes overflow resistant code for (a * b) mod c and (a ^ b) mod c which could also be exposed if required.

Edit.	Date	Release notes
1	9.12.08	Start
1.1	15.12.08	Added the table of indicators; added NAND, NOR, XNOR, RCLWS, STOWS, //, N, SERR, SIGMA, < and >; deleted HR, INPUT, 2 flag commands, and 2 conversions; extended explanations for addressing and COMPLEX & …; put XOR on the keyboard; corrected errors.
1.2	4.1.09	Added ASRN, CBC?, CBS?, CCB, SCB, FLOAT, MIRROR, SLN, SRN, >BIN, >DEC, >HEX, >OCT, BETA, D>R, DATE, DDAYS, D.MY, M.DY, Y.MD, CEIL, FLOOR, DSZ, ISZ, D>R, R>D, EMGAM, GSB, LNBETA, LNGAMMA, MAX, MIN, NOP, REAL, RJ, W and WINV, ZETA, %+ and %-; renamed the top left keys B, C, and D, and bottom left EXIT.
1.3	17.1.09	Added AIP, ALENG, ARCL, AROT, ASHF, ASTO, ATOX, XTOA, AVIEW, CLA, PROMPT (all taken from 42S), CAPP, FC?C, FS?C, SGMNT, and the …# commands; renamed NBITS to BITS and STOWS to WSIZE; specified the bit commands closer; deleted the 4 carry bit operations.
1.4	10.2.09	Added CONST and a table of constants provided, D>J and J>D, LEAP?, %T, RCL and STO ▲ and ▼, and 2 forgotten statistics registers; deleted CHS, EMGAM, GSB, REAL and ZETA; purged and renamed the bit operations; renamed many commands.
1.5	5.3.09	Added RNDINT, CONV and its table, a memory table, the description of XEQ B, C, D to the operation index, and *a* and g_e to the table of constants; put CLSTK on a key, moved CLΣ and FILL, changed the % and log labels on the keyboard, put CLALL in X.FCN; checked and cleaned alpha mode keyboard and added a temporary alpha keyboard; rearranged the alphabet to put Greek after Latin, symbols after Greek consistently; separated the input and non-programmable commands; cleaned the addressing tables.
1.6	12.8.09	Added BASE, DAYS+, DROP, DROPY, E3OFF, E3ON, FC?F, FC?S, FIB, FS?F, FS?S, GCD, LCM, SETDAT, SETTIM, SET24, SINC, TIME, VERS, αDAY, αMONTH, αRC#; %Σ, as well as F-, t-, and χ^2-distributions and their inverses; reassigned DATE, modified DENMAX, FLOAT, αROT, and αSHIFT; deleted BASE arithmetic, BIN, DEC, HEX, and OCT; updated the alpha keyboards; added flags in the memory table; included indirect addressing for comparisons; added a paragraph about the display; updated the table of indicators; corrected errors.
1.7	9.9.09	Added P.FCN and STAT catalogs, 4 more conversions, 3 more flags, Greek character access, CLFLAG, DECOMP, DENANY, DENFAC, DENFIX, Iβ, IΓ, αDATE, αRL, αRR, αSL, αSR, αTIME, 12h, 24h, fraction mode limits, normal distribution and its inverse for arbitrary μ and σ, and Boolean operations working within FLOAT; deleted αROT, αSHIFT, the timer, and forced radians after inverse hyperbolics; renamed WINV to W^{-1}, and beta and gamma commands to Greek; added tables of catalog contents; modified label addressing; relabeled PRGM to P/R and PAUSE to PSE; swapped SHOW and PSE as well as Δ% and % on the keyboard; relabeled Q; corrected CEIL and FLOOR; updated X.FCN and alpha commands; updated the virtual alpha keyboard.
1.8	29.10.09	Added R-CLR, R-COPY, R-SORT, R-SWAP, RCLM, STOM, alpha catalogs, 1 more constant and some more conversions, a table of error messages, as well as the binomial, Poisson, geometric, Weibull and exponential distributions and their inverses; renamed some commands; put $\sqrt{\ }$ instead of π on hotkey D.
1.9	14.12.09	Added two complex comparisons; swapped and changed labels in the top three rows of keys, dropped CLST; completed function descriptions in the index.
1.10	19.1.10	Added IMPFRC, PROFRC, ^{C}ENTER, αBEG, αEND, and an addressing table for items in catalogs; updated temporary alpha mode, display and indicators, RCLM and STOM, alpha-commands and the message table; renamed the exponential distribution; wrote the introduction.
1.11	21.9.10	Changed keyboard layout to bring Π and Σ to the front, relabeled binary log, swapped the locations of π, CLPR, and STATUS, as well as SF and FS?; created a menu TEST for the comparisons removed and the other programmable tests from P.FCN; added %MG, %+MG, %MRR, RESET, SSIZE4, SSIZE8, SSIZE?, ^{C}DROP, ^{C}FILL, ^{C}R↓, ^{C}R↑, registers J and K, a table of contents and tables for stack mechanics and addressing in complex operations; updated memory and real number addressing tables, DECOMP, αOFF, αON, Π, and Σ; renamed ROUNDI, WSIZE?, β(x,y), Γ(x) and the constant p_0; deleted DROPY (use x⇔y, DROP instead), αAPP, αBEG, αEND, and the "too long error" message; deleted Josephson and von Klitzing constants (they are just the inverses of other constants included in CONST already); brought more symbols on the alpha keyboard.
1.12	22.12.10	Modified keyboard layout; added catalogs MODE and PROB; changed mode word, catalog contents and handling (XEQ instead of ENTER), as well as some non-programmable info commands; expanded IMPFRC and PROFRC; added a paragraph about the fonts provided and explained alpha catalogs in detail; added PRIME? and some conversions; deleted FRACT, OFF and ON.
1.13	3.2.11	Modified keyboard layout; modified αTIME, radix setting, H.MS+ and H.MS-; added EVEN?, FP?, INT?, LZOFF, LZON, ODD?, RCLS, STOS, returned FRACT; added and renamed some conversions; updated the paragraph about display; added appendices A and B; baptized the device WP 34S.