ABC formula for the HP-41C family

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Contents

1 The ABC formula HP-41C code

key strokes	step	display code(s)	remark
[ON]			Put the calculator [ON]
[PRGM]			Enter program mode
☐ GTO . .		00 REG nnn	Set program counter @ end of code
☐ LBL [ALPHA]ABC[ALPHA]	01	LBL"ABC	Start position ABC formula
STO 23	02	STO 23	Store 'c' in register 23
R↓	03	RDN	Get next value from stack
CHS	04	CHS	Change sign
STO 22	05	STO 22	Store '-b' in register 22
R↓	06	RDN	Get next value from stack
2	07	2	
×	08	*	Multiply 'a' by 2
STO 21	09	STO 21	and store '2a' in register 21
☐ X=0?	10	X=0?	Check if 'a' is 0
☐ RTN	11	RTN	If YES then 'no' answer and return
2	12	2	
×	13	*	Calculate '4a'
RCL 23	14	RCL 23	Get 'c'
×	15	*	Calculate '4ac'
CHS	16	CHS	'-4ac'
RCL 22	17	RCL 22	Get '-b'
☐ x^2	18	X↗2	Calculate $('-b')^2$ which is 'b^2'
+	19	+	Calculate '$d = b^2 - 4ac$'

key strokes	step	display code(s)	remark
XEQ [ALPHA]X □ I □ 0 ?[ALPHA]	20	X<0?	Check if 'd' is negative
□ RTN	21	RTN	If YES then 'no' answer and return
$\sqrt{x}$	22	SQRT	Calculate square root of 'd'
STO 24	23	STO 24	Store square root of 'd' in register 24
RCL 22	24	RCL 22	Get '-b'
+	25	+	Calculate -b + square root of 'd'
RCL 21	26	RCL 21	Get '2a'
÷	27	/	Calculate the first X for Y=0
STO 25	28	STO 25	Store result in register 25
RCL 22	29	RCL 22	Get '-b'
RCL 24	30	RCL 24	Get square root of 'd'
-	31	-	Calculate -b - square root of 'd'
RCL 21	32	RCL 21	Get '2a'
÷	33	/	Calculate the second X for Y=0
STO 26	34	STO 26	Store result in register 26
RCL 25	35	RCL 25	Get first result, X1 in 'X' and X2 in 'Y'
□ BEEP	36	BEEP	Beep. Only ready and 0K after beep signal
□ RTN	37	RTN	Return
□ GTO . .		00 REG nnn	END RPN coding
[PRGM]			Leave program mode
□ ASN [ALPHA]ABC[ALPHA] TAN			Assign "ABC" to TAN
[USER]			Set USER mode

2 How to use the ABC formula

A quadratic equation with real or complex coefficients has two solutions, called roots. These two solutions may or may not be distinct, and they may or may not be real. With this program only real solutions are calculated.

Having:

$$ax^2 + bx + c = 0$$

The RPN coded ABC formula with Label "ABC" has been assigned to key TAN. The HP-41C calculator has been set in USER-mode. Enter the values a, b and c and execute the function by pressing key TAN.

Example with $a = 1$, $b = -5$ and $c = 4$:

Keystrokes:
1
ENTER↑
5
CHS
ENTER↑
4
TAN

Running...

Result: 4.0000 $X \lessgtr Y$ 1.0000

So the solution is: $x_1 = 1$ and $x_2 = 4$