

# ABC formula for the HP-41C family

A.J.M. Jacobs

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# 1 The ABC formula HP-41C code

| key strokes                                    | step | display code(s) | remark                                |
|--|------|-----------------|---------------------------------------|
| [ON]   |      |                 | Put the calculator [ON]               |
| [PRGM]   |      |                 | Enter program mode                    |
| <input type="checkbox"/> GTO . .               |      | 00 REG nnn      | Set program counter @ end of code     |
| <input type="checkbox"/> 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         |
| <input type="checkbox"/> X=0?                  | 10   | X=0?            | Check if 'a' is 0                     |
| <input type="checkbox"/> 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'                              |
| <input type="checkbox"/> $x^2$                 | 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 <input type="checkbox"/> I <input type="checkbox"/> 0 ?[ALPHA] | 20   | X<0?            | Check if 'd' is negative                  |
| <input type="checkbox"/> 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'                                  |
| $\div$  | 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'                                  |
| $\div$  | 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' |
| <input type="checkbox"/> BEEP   | 36   | BEEP            | Beep. Only ready and OK after beep signal |
| <input type="checkbox"/> RTN  | 37   | RTN             | Return                                    |
| <input type="checkbox"/> GTO . .  |      | 00 REG nnn      | END RPN coding                            |
| [PRGM]  |      |                 | Leave program mode                        |
| <input type="checkbox"/> 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     $X \leq Y$     1.0000

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