dCAD Calculator

by Desktop CAD

a scientific and programmer's calculator
for the Apple Macintosh™

Before printing this manual...
This manual is formatted for MacWrite 4.5, with single spacing, full justification, using 9 point Geneva. Left margin was set at 1-3/4 inches, tab at 2-1/4 inches, decimal tab at 5-1/4 inches, and right margin at 6 inches. Two pages (sideways) per 8-1/2 by 11 sheet of paper.

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Desktop CAD
104 Helecho Court
Thousand Oaks, CA 91362-2712

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INTRODUCTION

Desktop CAD's dCAD Calculator provides advanced scientific and programmer functions, as well as a quick-reference ASCII table. To make it most useful to you, this program has been priced low and is distributed as shareware; if you decide to use it, **please remember to pay for it.** The price is $8.00. If you have any comments regarding its operation, we would appreciate hearing from you. Just write to us at:

Desktop CAD, 104 Helecho Court, Thousand Oaks, CA 91362-2712.

Two versions of the program are available: an application, used as any other standard program, and a desk accessory, which must be installed into your system file using Apple's Font/DA Mover. While the accessory is best suited for use on a Macintosh with at least 512K of RAM, it can be used on 128K systems with many application programs. Ideally, an accessory on a 128K machine would use no more than about 8K of the computer's memory, so as not to interfere with any application that may be running. However, in order to implement a useful calculator, our accessory version may exceed the 8K limit by as much as 10K of RAM. This is because we use the Mac's math packages, which total about 8.5K. This should not cause any problems on a 512K Macintosh, Mac Plus or a Mac XL. Of course, if you have a 512K Macintosh, you can also install the application version as one of the programs under Switcher.

1.0.0 GENERAL INFORMATION

1.1.0 Scientific/Programmer Modes

The calculator supports two basic modes of operation. In the Scientific (default) mode, trigonometric and logarithmic functions, as well as scientific notation, factorials, and several other standard functions are provided. In the Programmer mode, many of the calculator's keys are redefined to support logical operations, conversion between number bases, and shift and rotate operations. In addition, an ASCII table can be accessed from the programmer mode.

1.2.0 Registers & Operator Precedence

The calculator maintains intermediate results and operands in a set of registers (the x, y, z, and t registers). Each set of parentheses, as well as the basic expression entered, has its own set of registers. As operations involving multiple operands are being entered, operands are automatically moved between the registers by the calculator. Operands entered from the keyboard are first placed in the x register, which is usually displayed in the upper display box. The results of operations are also placed in the x register, unless a memory operation has been selected.

Unless modified by parentheses (see Section 2.5.1), expressions are evaluated with the following precedence of operators:

1. immediate functions (highest precedence),
2. powers and roots,
3. multiplication and division,
4. addition and subtraction (lowest precedence).

1.3.0 Displays

Two displays are provided. The upper display normally shows the contents of the x register ("**x:**" prompt). After some operations, the upper register may be used to show half of a two-part result. The lower display can be set to indicate either the contents of the memory register ("**M:**" prompt), or the contents of the y register ("**y:**" prompt). To change the lower display from y to M, or back, click the mouse in the lower display box. Please note: we have found that viewing the y register can be somewhat confusing to first-time users, particularly those who are familiar with RPN notation. Unless specifically using the y register (for example, in coordinate conversion or operand exchanges), we recommend that you display the memory register.

Three special cases exist with respect to the displays:

The first is in using the rectangular-to-polar coordinate conversion. Display prompts are changed to indicate that the upper display holds the angle value ("**ß:**" prompt) and the lower contains the radius value ("**r:**" prompt) after a rectangular-to-polar coordinate conversion. Use the **P > R** to get the "**x:**" and "**y:**" prompts back.

The second case is in the programmer mode of the Desk Accessory after multiplying two numbers. The result is a sixty-four bit number, the upper half of which is placed in the y register and the lower half in the x register.

The third case, also only with the Desk Accessory, is also in the programmer mode after dividing two numbers. Here the calculator uses the x register to hold the integer quotient and the y register to hold the remainder. Please keep this in mind when performing subsequent operations.

1.4.0 Accuracy

All real (scientific mode) numbers, including the constant pi, are stored using a twenty digit floating point internal representation, with three digit exponents. As a result of the increased accuracy provided, some results obtained on a pocket calculator with fewer digits of accuracy may differ slightly from the results of the same operations performed on the dCAD Calculator.

In the Programmer mode, numbers are stored in a literal binary format. In the Binary mode, sixteen bits are used to store operands. In the Hexadecimal and Octal modes, 32 bits are used to store operands. Because each octal digit is assumed to be between 0 and 7 (three bits), it is not possible to enter the two most significant bits from the keyboard in this mode. Only ten octal digits can be entered. The full 32 bits are used for calculations in this mode, however. A carry bit is maintained for the x register in all three of the programmer bases. This bit can be included in shift and rotate operations if desired.

1.5.0 Edit menu

The **COPY** command can be used to transfer data from the upper display to the clipboard. The **CLEAR** command will perform the operation indicated by the **Clear** key legend, as explained in Section 2.3.3. The **CUT** command performs **COPY**, then **CLEAR**. **PASTE** is not supported.

1.6.0 Numeric Keypad

The calculator supports the Macintosh's optional numeric keypad.
While earlier versions of the calculator used a slightly different scheme,
the keys are now mapped identically to Apple's new (System File 3.2 or later) calculator. This means that the keycap legends on the numeric keypad do not always indicate the actual function of the key. Specifically, pressing the Enter key on a Mac XL keypad is identical to using the mouse to press the "=" key; likewise, the comma key on the Mac XL maps to "+", the Mac XL plus key maps to " ÷", the / key maps to "**-**", and the minus key is "**exp**". Our "exp" key is different from the new Apple calculator, which has two "=" keys instead. See illustration below.

Keypad Functions

2.0.0 KEYS

2.1.0 Key Usage

In order to simplify operations, we have avoided the use of "2nd function", or prefix, keys wherever possible. The only operations which depend on prefixes are special operations on the memory register, the "**arc**" and "**hyp**" trigonometric qualifiers, and logical operations involving the carry bit (see Sections 2.4.2, 2.5.6, and 2.6.7). Any key that can be used to perform different operations at different times is redrawn with a new legend indicating the new function which it will perform. Examples of this are changing the "**Clear**" key to "**Clear x**" or "**Clear M**" when these operations will occur, or changing between the scientific and programmer modes.

2.2.0 **Dec**, **Hex**, **Bin**, **Oct** Mode Key

The upper left key is used to select the base used by the calculator for numeric operations. When "**Dec**" is displayed, base 10 is used, which automatically places the calculator in the scientific mode. In the programmer mode, this key is used to select "**Hex**" (base 16), "**Bin**" (base 2), or "**Oct**" (base 8). If the key is pressed to reselect "**Dec**", which is the next base after octal, the calculator is returned to the scientific mode. (To display numbers in decimal form in the programmer mode without reverting to scientific mode, use the Display Conversion key. See Section 2.6.3.)

2.3.0 General Keys (Either Mode)

2.3.1 **0** to **9** Number Entry

These keys are used to enter numbers (operands) into the calculator.

2.3.2 +, —, **x**, ÷, = Basic Operators

These keys are used for addition, subtraction, multiplication, and division; the "=" key closes all open parentheses and completes the pending calculation.

2.3.3 **Clear** Clear

The operation of the Clear key is dependent upon the context. When the key indicates "**Clear**", pressing it will clear the pending calculation. If a number is being entered, the key will be labelled "**Clear x**" and, when pressed, the contents of the x register will be cleared, awaiting a corrected number. If the Memory Prefix has been selected (see Section 2.4.2), the key will read "**Clear M**", and permits the clearing of the memory register.

2.3.4 +/— Change Sign

With this key, you can change the sign of the displayed number from positive to negative, and back again. If pressed after an exponent has been entered, the sign of the exponent will change.

2.3.5  Exchange Registers

The contents of the x and y registers are swapped. This key is useful for entering values for coordinate conversion (see Section 2.5.5) or for swapping the numerator and denominator during division.

2.4.0 Memory Keys (Either Mode)

2.4.1 **STO RCL** Store to Memory & Recall from Memory

Store transfers the contents of the x register (source) to the memory register (destination). Recall transfers the contents of the memory register (source) to the x register (destination). The contents of source register remain unchanged, and the previous contents of the destination register are lost.

2.4.2 **M** Memory Prefix

The Memory Prefix key allows selected operations to occur between the x register and the memory register. When this key is pressed, the keys used to perform the available operations are highlighted. The operations available depend upon the mode in which the calculator is currently operating. In all cases, the result of the operations replaces the previous contents of the memory register. For example, press "**M**", then "**Clear M**" (the relabelled "**Clear**" key) to clear memory; press "**M**", then "+" to add the number in the x register to memory. To exchange the x register contents with memory contents, enter "**M**" followed by the Exchange Registers key (Section 2.3.5).

2.5.0 Scientific Mode Keys

2.5.1 **( )** Parentheses

To change the operator precedence order (see Section 1.2.0), enclose the part which must be evaluated first within parentheses. In a single expression, seven levels of parentheses can be pending.

2.5.2 **exp** Exponent

To enter a number in scientific notation, enter the mantissa, then press "**exp**", and enter the exponent (and sign, if required). You may add digits to the mantissa or change its sign after pressing "**exp**" by pressing the decimal point key, which then allows you to enter the desired changes to the mantissa. Pressing "**exp**" again returns you to the exponent.

2.5.3 **π** Pi

This key enters pi (3.1415926 . . .) into the x register.

2.5.4 **Deg** , **>Rad** Angle keys

The left key is the angle mode (**Deg**rees, **Rad**ians, and **Grad**ians) and indicates the units which will be used in evaluating trigonometric functions. The right key converts the displayed angle: degrees to **Rad**ians, radians to **Deg**rees, or gradians to **Rad**ians.

2.5.5 **R > P** Coordinate Conversion

To convert values in (x,y) coordinates to (r,ß), enter the y value, exchange the x and y registers, enter the x value (note that the display prompts correctly indicate the values), and press **R > P**. The resulting values of angle and radius (hypotenuse) will be displayed in the upper and lower displays; the angle will be shown in the units indicated by the **Deg**, **Rad**, **Grad** key.

For conversions from polar to rectangular coordinates, the displays must show "**ß:**" and "**r:**" (press the Conversion key if necessary). Enter the radius, exchange the x and y registers, enter the angle, and press **P > R**.

2.5.6 **ln x**, **e^x**, **log x**, **x!** Immediate Operators

hyp, **arc**, **sin**, **cos**, **tan**

Each of these operators (with the exception of the trigonometric prefixes **hyp** & **arc**) replaces the value of the x register with the computed result of the function. "**ln x**" is the natural logarithm; "**e^x**" raises the number **e** (2.718281828...) to the power shown in the x register; "**log x**" is the base 10 logarithm; and "**x!**" is x factorial. For x factorial, the value of x must be positive, less than 449, and an integer. Remember that numbers are internally represented in 20 digits, and that occasionally what looks to be an integer on the display may in fact have a very small fractional part. (To create an integer, cycle through the base conversion keys: Dec->Hex->Bin->Oct->Dec. The result is rounded.)

The standard trigonometric functions, and their inverses, are computed based on the units indicated by the angle mode key (see Section 2.5.4). Hyperbolic and inverse functions are obtained by pressing "**hyp**" or "**arc**" before pressing the function desired. Press both "**hyp**" and "**arc**" (the order of entry is unimportant) to obtain inverse hyperbolic functions. Note that the angle mode selected does not affect hyperbolic trigonometric function results.

2.5.7 **y^x**, **$\sqrt[x]{y}$** Power & Root Operators

These keys operate in a manner similar to other two-operand functions, such as multiplication. Enter the value for y, press one of these keys, then enter the value for x; you may include the expression as part of a chain calculation or press "=" to get the immediate result.

2.6.0 Programmer Keys

2.6.1 **A**, **B**, **C**, **D**, **E**, & **F** Numbers

These function as normal numbers in Hexadecimal mode, and are ignored in other modes. Keys "A" to "F" (base 16) represent the numbers 10 to 15 (base 10), respectively.

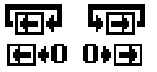
2.6.2 **Hex**, **Bin**, **Oct** Base

The upper left key (also described in Section 2.2) is used to select the number base for data entry and numerical operations in the programmer mode. The available bases are **Hex**adecimal, **Bin**ary, and **Oct**al. If a number key is pressed which does not make sense in the current base (pressing "5" in Binary mode, for example), it will be ignored.

When switching between bases, the contents of the registers are preserved, and will be displayed using the new base. This makes it possible to mix bases during calculations. For example, two numbers can be entered in binary, added together, and the result multiplied by a hexadecimal number. The result can then be displayed in octal.

2.6.3 **H > B** Display Conversion

The key just to the right of the mode key may be used to display an intermediate result in any of the available number bases. For instance, it is possible to perform a series of calculations on several hexadecimal numbers, and to display the results in binary, octal, or decimal format. This key is labelled to indicate a conversion between the current display base, and the next available base. To display a result obtained in the hexadecimal mode in octal, press the convert key twice (hex to binary first, then binary to octal). This key does not alter the contents of any of the registers, it just temporarily changes the way that they are displayed.

2.6.4  Logical Rotate
Logical Shift

The Shift keys are used to shift the contents of the x register to the right or to the left one bit. A zero is shifted into the most significant bit if a shift right is performed, and into the least significant bit if a shift left is performed. The Rotate keys are used to rotate the contents of the x register to the right or left one bit.

The carry bit may also be included in these operations, if desired, by pressing the "**CY**" key before the operation key.

2.6.5 **neg** & **not** Negate & Not

The **neg** key is used to negate the contents of the x register. This operation is equivalent to pressing the +/- key, and either key may be used. The result is the two's complement of the original number. The **not** key is used to logically invert the contents of the x register. This is the one's complement operation.

2.6.6 **and**, **nand**, **or**, **nor**, **xor**, **nxor** Logical Operators

These keys are used to logically combine the x and y registers. The result of the operation is placed in the x register. Logical operations between the memory register and the x register, with the results placed in the memory register, may be performed by using the "**M**" key.

2.6.7 **CY** Carry Prefix & $\overline{\textbf{CY}}$ Complement Carry

The Carry Prefix is used to indicate that an operation is to be performed which either uses the carry bit (Shift and Rotate, above), or affects the carry bit as follows: to set or clear the carry bit, press "CY", followed by "1" or "0", respectively.

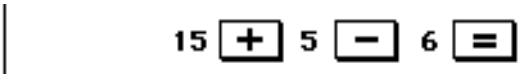
Complement Carry is used to complement the carry bit.

2.6.8 **ascii** ASCII table

This key is used to invoke the Apple-extended ASCII table. The characters listed after hexadecimal 7F are the extensions which Apple has made standard for its own use. There sometimes exist other, font-dependent, characters which do not appear in the table. With the Application version, it is necessary to **Put Away** the ASCII table before attempting to do anything else. With the Desk Accessory, however, you may either click within the window to put away the ASCII table, or click in the Go Away box to put away the entire Accessory.

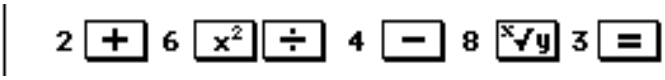
3.0.0 **Examples** (press the **Clear** key between examples)

Basic calculations are performed using standard algebraic entry. For instance, 15 + 5 - 6 = 14 is entered as



Expressions, no matter how complex, are always evaluated using correct operator precedence (see Section 1.2.0):

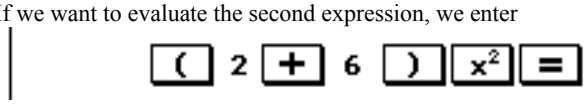
$2 + 6^2 \div 4 - \sqrt[3]{8} = 9$



However, parentheses may be used to change the operator precedence.

$2 + 6^2 = 38$ while $(2 + 6)^2 = 64$

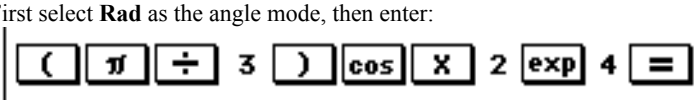
If we want to evaluate the second expression, we enter



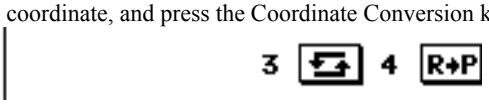
Suppose we want to use a trigonometric function and scientific notation:

$\cos(\pi / 3) \times 2 \times 10^4 = 10{,}000$

First select **Rad** as the angle mode, then enter:



To convert the rectangular coordinates (4, 3) to polar coordinates, with the angle in degrees: First select **Deg** as the angle mode, then enter the y coordinate, and swap it into the y register. Next enter the x coordinate, and press the Coordinate Conversion key (results are ß = 36.86989765 ; r = 5):

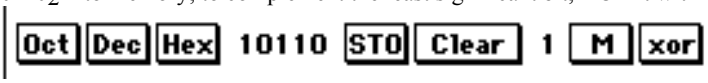


Pressing the Coordinate Conversion key again converts the polar coordinates back to rectangular (and restores the **x:** and **y:** prompts).

The Programmer's mode is invoked by pressing the **Dec** key. We can mix bases in an expression, as well as temporarily change the displayed base; for example

$12_{16} \times 11_8 = 10100010_2$

To perform operations with the memory register, preceed the operator with the **M** key. First store 10110_2 into memory; to complement the least significant bit, XOR it with 1:



The result, 10111, is in the memory register.