Texas Instruments

TI-nspire™

Reference Guide

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TI-Nspire™ Reference Guide

This guide lists the templates, functions, commands, and operators available for evaluating math expressions.

Expression templates

Expression templates give you an easy way to enter math expressions in standard mathematical notation. When you insert a template, it appears on the entry line with small blocks at positions where you can enter elements. A cursor shows which element you can enter.

Use the arrow keys or press (tab) to move the cursor to each element's position, and type a value or expression for the element. Press (enter) or (ctrl) (enter) to evaluate the expression.

Fraction template — (ctrl) (÷) keys

Note: See also **/ (divide)**, page 95.

Example:

$\frac{12}{8 \cdot 2}$ → $\frac{3}{4}$

Exponent template — (^) key

Example:

2^3 → 8

Note: Type the first value, press (^), and then type the exponent. To return the cursor to the baseline, press right arrow (▶).

Note: See also **^ (power)**, page 96.

Square root template — (ctrl) (√) keys

Note: See also **√() (square root)**, page 101.

Example:

$\sqrt{4}$ → 2

$\sqrt{\{9,16,4\}}$ → $\{3,4,2\}$

Nth root template — (ctrl) (^) keys

Note: See also **root()**, page 67.

Example:

$\sqrt[3]{8}$ → 2

$\sqrt[3]{\{8,27,15\}}$ → $\{2,3,2.46621\}$

***e* exponent template** — (e^x) keys

Natural exponential *e* raised to a power

Note: See also **e^()**, page 25.

Example:

e^1 → 2.71828182846

Log template

ctrl log 10^x key

$\log_{\square}(\square)$

Calculates log to a specified base. For a default of base 10, omit the base.

Note: See also **log()**, page 44.

Example:

$\log_4(2.0)$ .5

Piecewise template (2-piece)

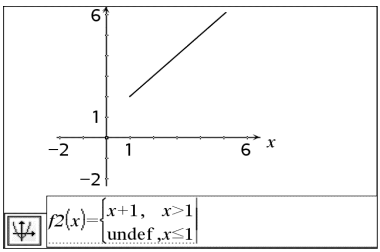
Catalog >

$\begin{cases} \square, & \square \\ \square, & \square \end{cases}$

Lets you create expressions and conditions for a two-piece piecewise function. To add a piece, click in the template and repeat the template.

Note: See also **piecewise()**, page 58.

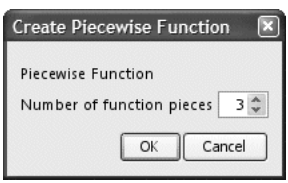
Example:



Piecewise template (N-piece)

Catalog >

Lets you create expressions and conditions for an N-piece piecewise function. Prompts for N.



Note: See also **piecewise()**, page 58.

Example:
See the example for Piecewise template (2-piece).

Absolute value template

Catalog >

$|\square|$ **Note:** See also **abs()**, page 5.

Example:

$\left|\left\{2,-3,4,-4^3\right\}\right|$ $\{2,3,4,64\}$

dd°mm'ss.ss'' template

Catalog >

$\square°\square'\square''$

Lets you enter angles in **dd°mm'ss.ss''** format, where **dd** is the number of decimal degrees, **mm** is the number of minutes, and **ss.ss** is the number of seconds.

Example:

30°15'10" .528011

Matrix template (2 x 2)

Catalog >

$\begin{bmatrix}\square & \square \\ \square & \square\end{bmatrix}$

Creates a 2 x 2 matrix.

Example:

$\begin{bmatrix}1 & 2 \\ 3 & 4\end{bmatrix}\cdot 5 \qquad \begin{bmatrix}5 & 10 \\ 15 & 20\end{bmatrix}$

Matrix template (1 x 2)

Catalog >

$\begin{bmatrix}\square & \square\end{bmatrix}$

Example:

$\text{crossP}\left(\begin{bmatrix}1 & 2\end{bmatrix},\begin{bmatrix}3 & 4\end{bmatrix}\right) \qquad \begin{bmatrix}0 & 0 & -2\end{bmatrix}$

Matrix template (2 x 1)

Catalog >

$\begin{bmatrix}\square \\ \square\end{bmatrix}$

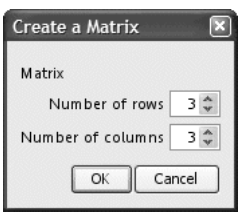
Example:

$\begin{bmatrix}5 \\ 8\end{bmatrix}\cdot .01 \qquad \begin{bmatrix}.05 \\ .08\end{bmatrix}$

Matrix template (m x n)

Catalog >

The template appears after you are prompted to specify the number of rows and columns.



Note: If you create a matrix with a large number of rows and columns, it may take a few moments to appear.

Example:

$\text{diag}\left(\begin{bmatrix}4 & 2 & 6 \\ 1 & 2 & 3 \\ 5 & 7 & 9\end{bmatrix}\right) \qquad \begin{bmatrix}4 & 2 & 9\end{bmatrix}$

Sum template (Σ)

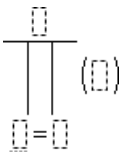
Catalog >

$\sum_{\square=\square}^{\square}(\square)$

Example:

$\sum_{n=3}^{7}(n) \qquad 25$

Product template (Π) **Catalog >**



Example:

$$\prod_{n=1}^{5}\left(\frac{1}{n}\right) \qquad \frac{1}{120}$$

Note: See also **Π() (product)**, page 101.

Alphabetical listing

Items whose names are not alphabetic (such as +, !, and >) are listed at the end of this section, starting on page 94. Unless otherwise specified, all examples in this section were performed in the default reset mode, and all variables are assumed to be undefined.

A

abs()

Catalog >

abs(*Value1***)** ⇒ *value*
abs(*List1***)** ⇒ *list*
abs(*Matrix1***)** ⇒ *matrix*

Returns the absolute value of the argument.

Note: See also **Absolute value template**, page 2.

If the argument is a complex number, returns the number's modulus.

$$\left|\left\{\frac{\pi}{2},\frac{-\pi}{3}\right\}\right| \qquad \{1.5708, 1.0472\}$$

$$|2-3\cdot i| \qquad 3.60555$$

amortTbl()

Catalog >

amortTbl(*NPmt***,***N***,***I***,***PV***, [***Pmt***], [***FV***], [***PpY***], [***CpY***], [***PmtAt***], [***roundValue***])** ⇒ *matrix*

Amortization function that returns a matrix as an amortization table for a set of TVM arguments.

NPmt is the number of payments to be included in the table. The table starts with the first payment.

N, *I*, *PV*, *Pmt*, *FV*, *PpY*, *CpY*, and *PmtAt* are described in the table of TVM arguments, page 86.

- If you omit *Pmt*, it defaults to *Pmt*=**tvmPmt(***N,I,PV,FV,PpY,CpY,PmtAt***)**.
- If you omit *FV*, it defaults to *FV*=0.
- The defaults for *PpY*, *CpY*, and *PmtAt* are the same as for the TVM functions.

roundValue specifies the number of decimal places for rounding. Default=2.

The columns in the result matrix are in this order: Payment number, amount paid to interest, amount paid to principal, and balance.

The balance displayed in row *n* is the balance after payment *n*.

You can use the output matrix as input for the other amortization functions **Σint()** and **Σprn()**, page 102, and **bal()**, page 10.

amortTbl(12,60,10,5000,,,12,12)

0	0.	0.	5000.
1	-41.67	-64.57	4935.43
2	-41.13	-65.11	4870.32
3	-40.59	-65.65	4804.67
4	-40.04	-66.2	4738.47
5	-39.49	-66.75	4671.72
6	-38.93	-67.31	4604.41
7	-38.37	-67.87	4536.54
8	-37.8	-68.44	4468.1
9	-37.23	-69.01	4399.09
10	-36.66	-69.58	4329.51
11	-36.08	-70.16	4259.35
12	-35.49	-70.75	4188.6

and

Catalog >

BooleanExpr1 **and** *BooleanExpr2* ⇒ *Boolean expression*
BooleanList1 **and** *BooleanList2* ⇒ *Boolean list*
BooleanMatrix1 **and** *BooleanMatrix2* ⇒ *Boolean matrix*

Returns true or false or a simplified form of the original entry.

and

Catalog >

Integer1 **and** *Integer2* ⇒ *integer*

Compares two real integers bit-by-bit using an **and** operation. Internally, both integers are converted to signed, 64-bit binary numbers. When corresponding bits are compared, the result is 1 if both bits are 1; otherwise, the result is 0. The returned value represents the bit results, and is displayed according to the Base mode.

You can enter the integers in any number base. For a binary or hexadecimal entry, you must use the 0b or 0h prefix, respectively. Without a prefix, integers are treated as decimal (base 10).

If you enter a decimal integer that is too large for a signed, 64-bit binary form, a symmetric modulo operation is used to bring the value into the appropriate range.

In Hex base mode:

0h7AC36 and 0h3D5F	0h2C16

Important: Zero, not the letter O.

In Bin base mode:

0b100101 and 0b100	0b100

In Dec base mode:

37 and 0b100	4

Note: A binary entry can have up to 64 digits (not counting the 0b prefix). A hexadecimal entry can have up to 16 digits.

angle()

Catalog >

angle(*Value1***)** ⇒ *value*

Returns the angle of the argument, interpreting the argument as a complex number.

In Degree angle mode:

$\text{angle}(0+2\cdot i)$	90

In Gradian angle mode:

$\text{angle}(0+3\cdot i)$	100

In Radian angle mode:

$\text{angle}(1+i)$	.785398
$\text{angle}(\{1+2\cdot i, 3+0\cdot i, 0-4\cdot i\})$	$\{1.10715, 0, -1.5708\}$

angle(*List1***)** ⇒ *list*
angle(*Matrix1***)** ⇒ *matrix*

Returns a list or matrix of angles of the elements in *List1* or *Matrix1*, interpreting each element as a complex number that represents a two-dimensional rectangular coordinate point.

$\text{angle}(\{1+2\cdot i, 3+0\cdot i, 0-4\cdot i\})$	$\left\{\frac{\pi}{2}-\tan^{-1}\left(\frac{1}{2}\right), 0, -\frac{\pi}{2}\right\}$

ANOVA

Catalog >

ANOVA *List1*,*List2*[,*List3*,...,*List20*][,*Flag*]

Performs a one-way analysis of variance for comparing the means of two to 20 populations. A summary of results is stored in the *stat.results* variable. (See page 76.)

Flag=0 for Data, *Flag*=1 for Stats

Output variable	Description
stat.F	Value of the F statistic.
stat.PVal	Least probability at which the null hypothesis can be rejected.
stat.df	Degrees of freedom of the groups.
stat.SS	Sum of squares of the groups.
stat.MS	Mean squares for the groups.
stat.dfError	Degrees of freedom of the errors.

Output variable	Description
stat.SSError	Sum of squares of the errors.
stat.MSError	Mean square for the errors.
stat.sp	Pooled standard deviation.
stat.xbarlist	Mean of the input of the lists.
stat.CLowerList	95% confidence intervals for the mean of each input list.
stat.CUpperList	95% confidence intervals for the mean of each input list.

ANOVA2way

Catalog >

ANOVA2way *List1*,*List2*[,*List3*,…,*List20*][,*LevRow*]

Computes a two-way analysis of variance for comparing the means of two to 20 populations. A summary of results is stored in the *stat.results* variable. (See page 76.)

LevRow=0 for Block

LevRow=2,3,…,*Len*-1, for Two Factor, where *Len*=length(*List1*)=length(*List2*) = … = length(*List10*) and *Len* / *LevRow* ∈ {2,3,…}

Outputs: Block Design

Output variable	Description
stat.F	F statistic of the column factor.
stat.PVal	Least probability at which the null hypothesis can be rejected.
stat.df	Degrees of freedom of the column factor.
stat.SS	Sum of squares of the column factor.
stat.MS	Mean squares for column factor.
stat.FBlock	F statistic for factor.
stat.PValBlock	Least probability at which the null hypothesis can be rejected.
stat.dfBlock	Degrees of freedom for factor.
stat.SSBlock	Sum of squares for factor.
stat.MSBlock	Mean squares for factor.
stat.dfError	Degrees of freedom of the errors.
stat.SSError	Sum of squares of the errors.
stat.MSError	Mean squares for the errors.
stat.s	Standard deviation of the error.

COLUMN FACTOR Outputs

Output variable	Description
stat.Fcol	F statistic of the column factor.

Output variable	Description
stat.PValCol	Probability value of the column factor.
stat.dfCol	Degrees of freedom of the column factor.
stat.SSCol	Sum of squares of the column factor.
stat.MSCol	Mean squares for column factor.

ROW FACTOR Outputs

Output variable	Description
stat.FRow	F statistic of the row factor.
stat.PValRow	Probability value of the row factor.
stat.dfRow	Degrees of freedom of the row factor.
stat.SSRow	Sum of squares of the row factor.
stat.MSRow	Mean squares for row factor.

INTERACTION Outputs

Output variable	Description
stat.FInteract	F statistic of the interaction.
stat.PValInteract	Probability value of the interaction.
stat.dfInteract	Degrees of freedom of the interaction.
stat.SSInteract	Sum of squares of the interaction.
stat.MSInteract	Mean squares for interaction.

ERROR Outputs

Output variable	Description
stat.dfError	Degrees of freedom of the errors.
stat.SSError	Sum of squares of the errors.
stat.MSError	Mean squares for the errors.
s	Standard deviation of the error.

ans ctrl ans (–) keys

ans ⇒ *value*

Returns the result of the most recently evaluated expression.

56	56
56+4	60
60+4	64

approx()

Catalog >

approx(*Value1***)** ⇒ *number*

Returns the evaluation of the argument as an expression containing decimal values, when possible, regardless of the current **Auto or Approximate** mode.

This is equivalent to entering the argument and pressing ctrl enter.

$\text{approx}\left(\frac{1}{3}\right)$ .333333

$\text{approx}\left(\left\{\frac{1}{3},\frac{1}{9}\right\}\right)$ {.333333,.111111}

$\text{approx}(\{\sin(\pi),\cos(\pi)\})$ {0.,-1.}

$\text{approx}([\sqrt{2}\quad\sqrt{3}])$ [1.41421 1.73205]

$\text{approx}\left(\begin{bmatrix}\frac{1}{3} & \frac{1}{9}\end{bmatrix}\right)$ [.333333 .111111]

approx(*List1***)** ⇒ *list*
approx(*Matrix1***)** ⇒ *matrix*

Returns a list or *matrix* where each element has been evaluated to a decimal value, when possible.

$\text{approx}(\{\sin(\pi),\cos(\pi)\})$ {0.,-1.}

$\text{approx}([\sqrt{2}\quad\sqrt{3}])$ [1.41421 1.73205]

approxRational()

Catalog >

approxRational(*Expr*[**,** *tol*]**)** ⇒ *expression*
approxRational(*List*[**,** *tol*]**)** ⇒ *list*
approxRational(*Matrix*[**,** *tol*]**)** ⇒ *matrix*

Returns the argument as a fraction using a tolerance of *tol*. If *tol* is omitted, a tolerance of 5.E-14 is used.

$\text{approxRational}(.333,5\cdot10^{-5})$ $\frac{333}{1000}$

$\text{approxRational}(\{.2,.33,4.125\})$ $\left\{\frac{1}{5},\frac{33}{100},\frac{33}{8}\right\}$

augment()

Catalog >

augment(*List1, List2***)** ⇒ *list*

Returns a new list that is *List2* appended to the end of *List1*.

augment(*Matrix1***,** *Matrix2***)** ⇒ *matrix*

Returns a new matrix that is *Matrix2* appended to *Matrix1*. When the "," character is used, the matrices must have equal row dimensions, and *Matrix2* is appended to *Matrix1* as new columns. Does not alter *Matrix1* or *Matrix2*.

$\text{augment}(\{1,-3,2\},\{5,4\})$ {1,-3,2,5,4}

$\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}\rightarrow m1$ $\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}$

$\begin{bmatrix}5\\ 6\end{bmatrix}\rightarrow m2$ $\begin{bmatrix}5\\ 6\end{bmatrix}$

$\text{augment}(m1,m2)$ $\begin{bmatrix}1 & 2 & 5\\ 3 & 4 & 6\end{bmatrix}$

avgRC()

Catalog >

avgRC(*Expr1***,** *Var* [=*value*] [**,** *H*]**)** ⇒ *expression*

Returns the forward-difference quotient (average rate of change).

Expr1 can be a user-defined function name (see **Func**).

When *value* is specified, it overrides any prior variable assignment or any current "such that" substitution for the variable.

H is the step value. If *H* is omitted, it defaults to 0.001.

Note that the similar function **nDeriv()** uses the central-difference quotient.

$x:=2$ 2

$\text{avgRC}(x^2-x+2,x)$ 3.001

$\text{avgRC}(x^2-x+2,x,.1)$ 3.1

$\text{avgRC}(x^2-x+2,x,3)$ 6

B

bal()

Catalog >

bal(*NPmt***,***N***,***I***,***PV* **,[***Pmt***], [***FV***], [***PpY***], [***CpY***], [***PmtAt***], [***roundValue***])** ⇒ *value*

bal(*NPmt***,***amortTable***)** ⇒ *value*

Amortization function that calculates schedule balance after a specified payment.

N, *I*, *PV*, *Pmt*, *FV*, *PpY*, *CpY*, and *PmtAt* are described in the table of TVM arguments, page 86.

NPmt specifies the payment number after which you want the data calculated.

N, *I*, *PV*, *Pmt*, *FV*, *PpY*, *CpY*, and *PmtAt* are described in the table of TVM arguments, page 86.

- If you omit *Pmt*, it defaults to *Pmt*=**tvmPmt(***N,I,PV,FV,PpY,CpY,PmtAt***)**.
- If you omit *FV*, it defaults to *FV*=0.
- The defaults for *PpY*, *CpY*, and *PmtAt* are the same as for the TVM functions.

roundValue specifies the number of decimal places for rounding. Default=2.

bal(*NPmt,amortTable***)** calculates the balance after payment number *NPmt*, based on amortization table *amortTable*. The *amortTable* argument must be a matrix in the form described under **amortTbl()**, page 5.

Note: See also **ΣInt()** and **ΣPrn()**, page 102.

bal(5,6,5.75,5000,,12,12) 833.11

tbl:=amortTbl(6,6,5.75,5000,,12,12)

0	0.	0.	5000.
1	−23.35	−825.63	4174.37
2	−19.49	−829.49	3344.88
3	−15.62	−833.36	2511.52
4	−11.73	−837.25	1674.27
5	−7.82	−841.16	833.11
6	−3.89	−845.09	−11.98

bal(4,*tbl*) 1674.27

▶Base2

Catalog >

Integer1 **▶Base2** ⇒ *integer*

Converts *Integer1* to a binary number. Binary or hexadecimal numbers always have a 0b or 0h prefix, respectively.

0b *binaryNumber*
0h *hexadecimalNumber*

Zero, not the letter O, followed by b or h.

A binary number can have up to 64 digits. A hexadecimal number can have up to 16.

Without a prefix, *Integer1* is treated as decimal (base 10). The result is displayed in binary, regardless of the Base mode.

If you enter a decimal integer that is too large for a signed, 64-bit binary form, a symmetric modulo operation is used to bring the value into the appropriate range.

256▶Base2 0b100000000

0h1F▶Base2 0b11111

▸Base10

Catalog >

Integer1 **▸Base10** ⇒ *integer*

Converts *Integer1* to a decimal (base 10) number. A binary or hexadecimal entry must always have a 0b or 0h prefix, respectively.

0b *binaryNumber*
0h *hexadecimalNumber*

Zero, not the letter O, followed by b or h.

A binary number can have up to 64 digits. A hexadecimal number can have up to 16.

Without a prefix, *Integer1* is treated as decimal. The result is displayed in decimal, regardless of the Base mode.

0b10011▸Base10	19
0h1F▸Base10	31

▸Base16

Catalog >

Integer1 **▸Base16** ⇒ *integer*

Converts *Integer1* to a hexadecimal number. Binary or hexadecimal numbers always have a 0b or 0h prefix, respectively.

0b *binaryNumber*
0h *hexadecimalNumber*

Zero, not the letter O, followed by b or h.

A binary number can have up to 64 digits. A hexadecimal number can have up to 16.

Without a prefix, *Integer1* is treated as decimal (base 10). The result is displayed in hexadecimal, regardless of the Base mode.

If you enter a decimal integer that is too large for a signed, 64-bit binary form, a symmetric modulo operation is used to bring the value into the appropriate range.

256▸Base16	0h100
0b111100001111▸Base16	0hF0F

binomCdf()

Catalog >

binomCdf(*n*,*p***)** ⇒ *number*

binomCdf(*n*,*p*,*lowBound***)** ⇒ *number* if *lowBound* is a number, *list* if *lowBound* is a list

binomCdf(*n*,*p*,*lowBound*,*upBound***)** ⇒ *number* if *lowBound* and *upBound* are numbers, *list* if *lowBound* and *upBound* are lists

Computes a cumulative probability for the discrete binomial distribution with *n* number of trials and probability *p* of success on each trial.

binomPdf()

Catalog >

binomPdf(*n*,*p***)** ⇒ *number*

binomPdf(*n*,*p*,*XVal***)** ⇒ *number* if *XVal* is a number, *list* if *XVal* is a list

Computes a probability for the discrete binomial distribution with *n* number of trials and probability *p* of success on each trial.

C

ceiling()

Catalog >

ceiling(*Value1***)** ⇒ *value*

Returns the nearest integer that is ≥ the argument.

The argument can be a real or a complex number.

Note: See also **floor()**.

ceiling(*List1***)** ⇒ *list*
ceiling(*Matrix1***)** ⇒ *matrix*

Returns a list or matrix of the ceiling of each element.

$\text{ceiling}(.456)$ → $1.$

$\text{ceiling}(\{-3.1,1,2.5\})$ → $\{-3.,1,3.\}$

$\text{ceiling}\begin{bmatrix} 0 & -3.2\cdot i \\ 1.3 & 4 \end{bmatrix}$ → $\begin{bmatrix} 0 & -3.\cdot i \\ 2. & 4 \end{bmatrix}$

char()

Catalog >

char(*Integer***)** ⇒ *character*

Returns a character string containing the character numbered *Integer* from the handheld character set. The valid range for *Integer* is 0–65535.

$\text{char}(38)$ → "&"

$\text{char}(65)$ → "A"

$\chi^2$2way

Catalog >

$\chi^2$2way *ObsMatrix*
chi22way *ObsMatrix*

Computes a χ^2 test for association on the two-way table of counts in the observed matrix *ObsMatrix*. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.χ^2	Chi square stat: sum (observed - expected)^2/expected
stat.PVal	Least probability at which the null hypothesis can be rejected.
stat.df	Degrees of freedom for the chi square statistics.
stat.ExpMat	Matrix of expected elemental count table, assuming null hypothesis.
stat.CompMat	Matrix of elemental chi square statistic contributions.

χ^2Cdf()

Catalog >

χ^2Cdf(*lowBound***,***upBound***,***df***)** ⇒ *number* if *lowBound* and *upBound* are numbers, *list* if *lowBound* and *upBound* are lists
chi2Cdf(*lowBound***,***upBound***,***df***)** ⇒ *number* if *lowBound* and *upBound* are numbers, *list* if *lowBound* and *upBound* are lists

Computes the χ^2 distribution probability between *lowBound* and *upBound* for the specified degrees of freedom *df*.

χ^2GOF

Catalog >

χ^2**GOF** *obsList*,*expList*,*df*
chi2GOF *obsList*,*expList*,*df*

Performs a test to confirm that sample data is from a population that conforms to a specified distribution. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.χ^2	Chi square stat: sum((observed - expected)^2/expected
stat.PVal	Least probability at which the null hypothesis can be rejected.
stat.df	Degrees of freedom for the chi square statistics.
stat.CompList	Elemental chi square statistic contributions.

χ^2Pdf()

Catalog >

χ^2**Pdf(***XVal*,*df***)** ⇒ *number* if *XVal* is a number, *list* if *XVal* is a list
chi2Pdf(*XVal*,*df***)** ⇒ *number* if *XVal* is a number, *list* if *XVal* is a list

Computes the probability density function (pdf) for the χ^2 distribution at a specified *XVal* value for the specified degrees of freedom *df*.

clearAZ

Catalog >

clearAZ

Clears all single-character variables in the current problem space.

$5 \rightarrow b$	5
b	5
ClearAZ	*Done*
b	"Error: Variable is not defined"

ClrErr

Catalog >

ClrErr

Clears the error status and sets system variable *errCode* to zero.

The **Else** clause of the **Try...Else...EndTry** block should use **ClrErr** or **PassErr**. If the error is to be processed or ignored, use **ClrErr**. If what to do with the error is not known, use **PassErr** to send it to the next error handler. If there are no more pending **Try...Else...EndTry** error handlers, the error dialog box will be displayed as normal.

Note: See also **PassErr**, page 58, and **Try**, page 84.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing ↵ instead of enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

For an example of **ClrErr**, See Example 2 under the **Try** command, page 84.

colAugment()

Catalog >

colAugment(*Matrix1***,** *Matrix2***)** ⇒ *matrix*

Returns a new matrix that is *Matrix2* appended to *Matrix1*. The matrices must have equal column dimensions, and *Matrix2* is appended to *Matrix1* as new rows. Does not alter *Matrix1* or *Matrix2*.

$\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix} \rightarrow m1$ $\quad \begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}$

$\begin{bmatrix}5 & 6\end{bmatrix} \rightarrow m2$ $\quad \begin{bmatrix}5 & 6\end{bmatrix}$

$\text{colAugment}(m1,m2)$ $\quad \begin{bmatrix}1 & 2\\ 3 & 4\\ 5 & 6\end{bmatrix}$

colDim()

Catalog >

colDim(*Matrix***)** ⇒ *expression*

Returns the number of columns contained in *Matrix*.

Note: See also **rowDim()**.

$\text{colDim}\left(\begin{bmatrix}0 & 1 & 2\\ 3 & 4 & 5\end{bmatrix}\right)$ $\quad 3$

colNorm()

Catalog >

colNorm(*Matrix***)** ⇒ *expression*

Returns the maximum of the sums of the absolute values of the elements in the columns in *Matrix*.

Note: Undefined matrix elements are not allowed. See also **rowNorm()**.

$\begin{bmatrix}1 & -2 & 3\\ 4 & 5 & -6\end{bmatrix} \rightarrow mat$ $\quad \begin{bmatrix}1 & -2 & 3\\ 4 & 5 & -6\end{bmatrix}$

$\text{colNorm}(mat)$ $\quad 9$

conj()

Catalog >

conj(*Value1***)** ⇒ *value*
conj(*List1***)** ⇒ *list*
conj(*Matrix1***)** ⇒ *matrix*

Returns the complex conjugate of the argument.

$\text{conj}(1+2\cdot i)$ $\quad 1-2\cdot i$

$\text{conj}\left(\begin{bmatrix}2 & 1-3\cdot i\\ -i & -7\end{bmatrix}\right)$ $\quad \begin{bmatrix}2 & 1+3\cdot i\\ i & -7\end{bmatrix}$

CopyVar

Catalog >

CopyVar *Var1***,** *Var2*

If *Var1* is the name of an existing variable, copies the value of that variable to variable *Var2*. Variable *Var1* must have a value.

If *Var1* is the name of an existing user-defined function, copies the definition of that function to function *Var2*. Function *Var1* must be defined.

Var1 must meet the variable-naming requirements or must be an indirection expression that simplifies to a variable name meeting the requirements.

Define $a(x)=\frac{1}{x}$ $\quad$ *Done*

Define $b(x)=x^2$ $\quad$ *Done*

CopyVar $a,c: c(4)$ $\quad \frac{1}{4}$

CopyVar $b,c: c(4)$ $\quad 16$

corrMat()

Catalog >

corrMat(*List1***,***List2***[,…[,***List20***]])**

Computes the correlation matrix for the augmented matrix [*List1*, *List2*, ..., *List20*].

cos(*Value1***)** ⇒ *value*
cos(*List1***)** ⇒ *list*

cos(*Value1***)** returns the cosine of the argument as a value.

cos(*List1***)** returns a list of the cosines of all elements in *List1*.

Note: The argument is interpreted as a degree, gradian or radian angle, according to the current angle mode setting. You can use °, G, or r to override the angle mode temporarily.

In Degree angle mode:

$\cos\left(\frac{\pi}{4}_r\right)$ .707107

$\cos(45)$ .707107

$\cos(\{0,60,90\})$ $\{1.,.5,0.\}$

In Gradian angle mode:

$\cos(\{0,50,100\})$ $\{1.,.707107,0.\}$

In Radian angle mode:

$\cos\left(\frac{\pi}{4}\right)$ .707107

$\cos(45°)$ .707107

cos(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix cosine of *squareMatrix1*. This is not the same as calculating the cosine of each element.

When a scalar function f(A) operates on *squareMatrix1* (A), the result is calculated by the algorithm:

Compute the eigenvalues (λ_i) and eigenvectors (V_i) of A.

squareMatrix1 must be diagonalizable. Also, it cannot have symbolic variables that have not been assigned a value.

Form the matrices:

$$B = \begin{bmatrix} \lambda_1 & 0 & \dots & 0 \\ 0 & \lambda_2 & \dots & 0 \\ 0 & 0 & \dots & 0 \\ 0 & 0 & \dots & \lambda_n \end{bmatrix} \text{ and } X = [V_1, V_2, \dots, V_n]$$

Then $A = X\,B\,X^{-1}$ and $f(A) = X\,f(B)\,X^{-1}$. For example, cos(A) = X cos(B) X^{-1} where:

cos(B) =

$$\begin{bmatrix} \cos(\lambda_1) & 0 & \dots & 0 \\ 0 & \cos(\lambda_2) & \dots & 0 \\ 0 & 0 & \dots & 0 \\ 0 & 0 & \dots & \cos(\lambda_n) \end{bmatrix}$$

All computations are performed using floating-point arithmetic.

In Radian angle mode:

$$\cos\left(\begin{bmatrix} 1 & 5 & 3 \\ 4 & 2 & 1 \\ 6 & -2 & 1 \end{bmatrix}\right)$$

$$\begin{bmatrix} .212493 & .205064 & .121389 \\ .160871 & .259042 & .037126 \\ .248079 & -.090153 & .218972 \end{bmatrix}$$

$\cos^{-1}()$

ctrl cos⁻¹ keys

$\cos^{-1}$(*Value1*) ⇒ *value*
$\cos^{-1}$(*List1*) ⇒ *list*

$\cos^{-1}$(*Value1*) returns the angle whose cosine is *Value1*.

$\cos^{-1}$(*List1*) returns a list of the inverse cosines of each element of *List1*.

Note: The result is returned as a degree, gradian or radian angle, according to the current angle mode setting.

In Degree angle mode:

$\cos^{-1}(1)$ 0

In Gradian angle mode:

$\cos^{-1}(0)$ 100

In Radian angle mode:

$\cos^{-1}(\{0,.2,.5\})$ $\{1.5708,1.36944,1.0472\}$

$\cos^{-1}$(*squareMatrix1*) ⇒ *squareMatrix*

Returns the matrix inverse cosine of *squareMatrix1*. This is not the same as calculating the inverse cosine of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

In Radian angle mode and Rectangular Complex Format:

$$\cos^{-1}\left(\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}\right)$$

$$\begin{bmatrix}1.73485+.064606\cdot i & -1.49086+2.10514\cdot i\\ -.725533+1.51594\cdot i & .623491+.778369\cdot i\\ -2.08316+2.63205\cdot i & 1.79018-1.27182\cdot i\end{bmatrix}$$

To see the entire result, press ▲ and then use ◀ and ▶ to move the cursor.

cosh()

Catalog >

cosh(*Value1*) ⇒ *value*
cosh(*List1*) ⇒ *list*

cosh(*Value1*) returns the hyperbolic cosine of the argument.

cosh(*List1*) returns a list of the hyperbolic cosines of each element of *List1*.

$\cosh^{-1}(1)$ 0

$\cosh^{-1}(\{1,2.1,3\})$ $\{0,1.37286,1.76275\}$

cosh(*squareMatrix1*) ⇒ *squareMatrix*

Returns the matrix hyperbolic cosine of *squareMatrix1*. This is not the same as calculating the hyperbolic cosine of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

In Radian angle mode:

$$\cosh\left(\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}\right)$$

$$\begin{bmatrix}421.255 & 253.909 & 216.905\\ 327.635 & 255.301 & 202.958\\ 226.297 & 216.623 & 167.628\end{bmatrix}$$

$\cosh^{-1}()$

Catalog >

$\cosh^{-1}$(*Value1*) ⇒ *value*
$\cosh^{-1}$(*List1*) ⇒ *list*

$\cosh^{-1}$(*Value1*) returns the inverse hyperbolic cosine of the argument.

$\cosh^{-1}$(*List1*) returns a list of the inverse hyperbolic cosines of each element of *List1*.

$\cosh^{-1}(1)$ 0

$\cosh^{-1}(\{1,2.1,3\})$ $\{0,1.37286,\cosh^{-1}(3)\}$

cosh⁻¹()

Catalog >

cosh⁻¹(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix inverse hyperbolic cosine of *squareMatrix1*. This is not the same as calculating the inverse hyperbolic cosine of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

In Radian angle mode and In Rectangular Complex Format:

$$\cosh^{-1}\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}$$

$$\begin{bmatrix}2.52503+1.73485\cdot i & -.009241-1.49086\cdot i\\ .486969-.725533\cdot i & 1.66262+.623491\cdot i\\ -.322354-2.08316\cdot i & 1.26707+1.79018\cdot i\end{bmatrix}$$

To see the entire result, press ▲ and then use ◀ and ▶ to move the cursor.

cot()

Catalog >

cot(*Value1***)** ⇒ *value*
cot(*List1***)** ⇒ *list*

Returns the cotangent of *Value1* or returns a list of the cotangents of all elements in *List1*.

Note: The argument is interpreted as a degree, gradian or radian angle, according to the current angle mode setting. You can use °, ᴳ, or ʳ to override the angle mode temporarily.

In Degree angle mode:

$\cot(45)$ 1

In Gradian angle mode:

$\cot(50)$ 1

In Radian angle mode:

$\cot(\{1,2.1,3\})$
$\{.642093,-.584848,-7.01525\}$

cot⁻¹()

Catalog >

cot⁻¹(*Value1***)** ⇒ *value*
cot⁻¹(*List1***)** ⇒ *list*

Returns the angle whose cotangent is *Value1* or returns a list containing the inverse cotangents of each element of *List1*.

Note: The result is returned as a degree, gradian or radian angle, according to the current angle mode setting.

In Degree angle mode:

$\cot^{-1}(1)$ 45

In Gradian angle mode:

$\cot^{-1}(1)$ 50

In Radian angle mode:

$\cot^{-1}(1)$ .785398

coth()

Catalog >

coth(*Value1***)** ⇒ *value*
coth(*List1***)** ⇒ *list*

Returns the hyperbolic cotangent of *Value1* or returns a list of the hyperbolic cotangents of all elements of *List1*.

$\coth(1.2)$ 1.19954

$\coth(\{1,3.2\})$ $\{1.31304,1.00333\}$

coth⁻¹()

Catalog >

coth⁻¹(*Value1***)** ⇒ *value*
coth⁻¹(*List1***)** ⇒ *list*

Returns the inverse hyperbolic cotangent of *Value1* or returns a list containing the inverse hyperbolic cotangents of each element of *List1*.

$\coth^{-1}(3.5)$ .293893

$\coth^{-1}(\{-2,2.1,6\})$
$\{-.549306,.518046,.168236\}$

count()

Catalog >

count(*Value1orList1* [,*Value2orList2* [,...]]**)** ⇒ *value*

Returns the accumulated count of all elements in the arguments that evaluate to numeric values.

Each argument can be an expression, value, list, or matrix. You can mix data types and use arguments of various dimensions.

For a list, matrix, or range of cells, each element is evaluated to determine if it should be included in the count.

Within the Lists & Spreadsheet application, you can use a range of cells in place of any argument.

$\text{count}(2,4,6)$ → 3

$\text{count}(\{2,4,6\})$ → 3

$\text{count}\left(2,\{4,6\},\begin{bmatrix}8 & 10\\ 12 & 14\end{bmatrix}\right)$ → 7

countif()

Catalog >

countif(*List*,*Criteria***)** ⇒ *value*

Returns the accumulated count of all elements in *List* that meet the specified *Criteria*.

Criteria can be:

- A value, expression, or string. For example, **3** counts only those elements in *List* that simplify to the value 3.
- A Boolean expression containing the symbol **?** as a placeholder for each element. For example, **?<5** counts only those elements in *List* that are less than 5.

Within the Lists & Spreadsheet application, you can use a range of cells in place of *List*.

Note: See also **sumIf()**, page 80, and **frequency()**, page 30.

$\text{countIf}(\{1,3,\text{"abc"},\text{undef},3,1\},3)$ → 2

Counts the number of elements equal to 3.

$\text{countIf}(\{\text{"abc"},\text{"def"},\text{"abc"},3\},\text{"def"})$ → 1

Counts the number of elements equal to "def."

$\text{countIf}(\{1,3,5,7,9\},?<5)$ → 2

Counts 1 and 3.

$\text{countIf}(\{1,3,5,7,9\},2<?<8)$ → 3

Counts 3, 5, and 7.

$\text{countIf}(\{1,3,5,7,9\},?<4 \text{ or } ?>6)$ → 4

Counts 1, 3, 7, and 9.

crossP()

Catalog >

crossP(*List1***,** *List2***)** ⇒ *list*

Returns the cross product of *List1* and *List2* as a list.

List1 and *List2* must have equal dimension, and the dimension must be either 2 or 3.

crossP(*Vector1***,** *Vector2***)** ⇒ *vector*

Returns a row or column vector (depending on the arguments) that is the cross product of *Vector1* and *Vector2*.

Both *Vector1* and *Vector2* must be row vectors, or both must be column vectors. Both vectors must have equal dimension, and the dimension must be either 2 or 3.

$\text{crossP}(\{.1,2.2,-5\},\{1,-.5,0\})$ → $\{-2.5,-5.,-2.25\}$

$\text{crossP}([1\ \ 2\ \ 3],[4\ \ 5\ \ 6])$ → $[-3\ \ 6\ \ -3]$

$\text{crossP}([1\ \ 2],[3\ \ 4])$ → $[0\ \ 0\ \ -2]$

csc()

Catalog >

csc(*Value1***)** ⇒ *value*
csc(*List1***)** ⇒ *list*

Returns the cosecant of *Value1* or returns a list containing the cosecants of all elements in *List1*.

In Degree angle mode:

$\csc(45)$ 1.41421

In Gradian angle mode:

$\csc(50)$ 1.41421

In Radian angle mode:

$\csc\left(\left\{1,\frac{\pi}{2},\frac{\pi}{3}\right\}\right)$ $\{1.1884,1.,1.1547\}$

csc^{-1}()

Catalog >

csc^{-1}(*Value1***)** ⇒ *value*
csc^{-1}(*List1***)** ⇒ *list*

Returns the angle whose cosecant is *Value1* or returns a list containing the inverse cosecants of each element of *List1*.

Note: The result is returned as a degree, gradian or radian angle, according to the current angle mode setting.

In Degree angle mode:

$\csc^{-1}(1)$ 90

In Gradian angle mode:

$\csc^{-1}(1)$ 100

In Radian angle mode:

$\csc^{-1}(\{1,4,6\})$ $\{1.5708,.25268,.167448\}$

csch()

Catalog >

csch(*Value1***)** ⇒ *value*
csch(*List1***)** ⇒ *list*

Returns the hyperbolic cosecant of *Value1* or returns a list of the hyperbolic cosecants of all elements of *List1*.

$\operatorname{csch}(3)$ .099822

$\operatorname{csch}(\{1,2.1,4\})$ $\{.850918,.248641,.036644\}$

csch^{-1}()

Catalog >

csch^{-1}(*Value***)** ⇒ *value*
csch^{-1}(*List1***)** ⇒ *list*

Returns the inverse hyperbolic cosecant of *Value1* or returns a list containing the inverse hyperbolic cosecants of each element of *List1*.

$\operatorname{csch}^{-1}(1)$ .881374

$\operatorname{csch}^{-1}(\{1,2.1,3\})$ $\{.881374,.459815,.32745\}$

CubicReg

Catalog >

CubicReg *X*, *Y*[, [*Freq*] [, *Category*, *Include*]]

Calculates the cubic polynomial regression and updates all the statistics variables. A summary of results is stored in the *stat.results* variable. (See page 76.)

All the lists must have equal dimensions except for *Include*.

X represents xlist.
Y represents ylist.
Freq represents frequency list.
Category represents category codes.
Include represents category include list.

Output variable	Description
stat.RegEqn	Regression equation: a • x^3+b • x^2+c • x+d.
stat.a, stat.b, stat.c, stat.d	Regression coefficients.
stat.R^2	Coefficient of determination.
stat.Resid	Residuals of the curves fit = y - (a • x^3+b • x^2+c • x+d).
stat.XReg	List of data points in the modified *X List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.YReg	List of data points in the modified *Y List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.FreqReg	List of frequencies corresponding to *stat.XReg* and *stat.YReg*.

cumSum()

Catalog >

cumSum(*List1***)** ⇒ *list*

Returns a list of the cumulative sums of the elements in *List1*, starting at element 1.

cumSum(*Matrix1***)** ⇒ *matrix*

Returns a matrix of the cumulative sums of the elements in *Matrix1*. Each element is the cumulative sum of the column from top to bottom.

$\text{cumSum}(\{1,2,3,4\})$ → $\{1,3,6,10\}$

$\begin{bmatrix}1&2\\3&4\\5&6\end{bmatrix} \rightarrow m1$ → $\begin{bmatrix}1&2\\3&4\\5&6\end{bmatrix}$

$\text{cumSum}(m1)$ → $\begin{bmatrix}1&2\\4&6\\9&12\end{bmatrix}$

Cycle

Catalog >

Cycle

Transfers control immediately to the next iteration of the current loop (**For**, **While**, or **Loop**).

Cycle is not allowed outside the three looping structures (**For**, **While**, or **Loop**).

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing (↵) instead of (enter) at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

Function listing that sums the integers from 1 to 100 skipping 50.

```
Define g()=Func                    Done
    Local temp,i
    0→temp
    For i,1,100,1
    If i=50
    Cycle
    temp+i→temp
    EndFor
    Return temp
    EndFunc
```

$g()$ → 5000

▸Cylind

Catalog >

Vector **▸Cylind**

Displays the row or column vector in cylindrical form [r,∠θ, z].

Vector must have exactly three elements. It can be either a row or a column.

$[2\ \ 2\ \ 3]\blacktriangleright\text{Cylind}\ \ [2.82843\ \ \angle.785398\ \ 3]$

D

dbd()

Catalog >

dbd(*date1,date2***)** ⇒ *value*

Returns the number of days between *date1* and *date2* using the actual-day-count method.

date1 and *date2* can be numbers or lists of numbers within the range of the dates on the standard calendar. If both *date1* and *date2* are lists, they must be the same length.

date1 and *date2* must be between the years 1950 through 2049.

You can enter the dates in either of two formats. The decimal placement differentiates between the date formats.

MM.DDYY (format used commonly in the United States)
DDMM.YY (format use commonly in Europe)

dbd(12.3103,1.0104)	1
dbd(1.0107,6.0107)	151
dbd(3112.03,101.04)	1
dbd(101.07,106.07)	151

▸DD

Catalog >

Expr1 **▸DD** ⇒ *value*
List1 **▸DD** ⇒ *list*
Matrix1 **▸DD** ⇒ *matrix*

Returns the decimal equivalent of the argument expressed in degrees. The argument is a number, list, or matrix that is interpreted by the Angle mode setting in gradians, radians or degrees.

In Degree angle mode:

(1.5°)▸DD	1.5°
(45°22'14.3")▸DD	45.3706°
({45°22'14.3",60°0'0"})▸DD	{45.3706°,60°}

In Gradian angle mode:

1▸DD	$\frac{9}{10}°$

In Radian angle mode:

(1.5)▸DD	85.9437°

▸Decimal

Catalog >

Number1 **▸Decimal** ⇒ *value*
List1 **▸Decimal** ⇒ *value*
Matrix1 **▸Decimal** ⇒ *value*

Displays the argument in decimal form. This operator can be used only at the end of the entry line.

$\frac{1}{3}\blacktriangleright\text{Decimal}$ .333333

Define

Catalog >

Define *Var* = *Expression*

Define *Function*(*Param1*, *Param2*, ...) = *Expression*

Defines the variable *Var* or the user-defined function *Function*.

Parameters, such as *Param1*, provide placeholders for passing arguments to the function. When calling a user-defined function, you must supply arguments (for example, values or variables) that correspond to the parameters. When called, the function evaluates *Expression* using the supplied arguments.

Var and *Function* cannot be the name of a system variable or built-in function or command.

Note: This form of **Define** is equivalent to executing the expression: *expression* → *Function*(*Param1*,*Param2*).

Define *Function*(*Param1*, *Param2*, ...) = **Func**
Block
EndFunc

Define *Program*(*Param1*, *Param2*, ...) = **Prgm**
Block
EndPrgm

In this form, the user-defined function or program can execute a block of multiple statements.

Block can be either a single statement or a series of statements on separate lines. *Block* also can include expressions and instructions (such as **If**, **Then**, **Else**, and **For**).

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing enter instead of ≈ enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

Note: See also **Define LibPriv**, page 22, and **Define LibPub**, page 23.

```
Define g(x,y)=2·x−3·y                                   Done
g(1,2)                                                  −4
1→a: 2→b: g(a,b)                                        −4
Define h(x)=when(x<2,2·x−3,−2·x+3)                      Done
h(−3)                                                   −9
h(4)                                                    −5
```

```
Define g(x,y)=Func                                      Done
              If x>y Then
              Return x
              Else
              Return y
              EndIf
              EndFunc
g(3,−7)                                                 3
```

```
Define g(x,y)=Prgm
              If x>y Then
              Disp x," greater than ",y
              Else
              Disp x," not greater than ",y
              EndIf
              EndPrgm
                                                        Done
g(3,−7)
                                   3 greater than −7
                                                        Done
```

Define LibPriv

Catalog >

Define LibPriv *Var* = *Expression*

Define LibPriv *Function*(*Param1*, *Param2*, ...) = *Expression*

Define LibPriv *Function*(*Param1*, *Param2*, ...) = **Func**
Block
EndFunc

Define LibPriv *Program*(*Param1*, *Param2*, ...) = **Prgm**
Block
EndPrgm

Operates the same as **Define**, except defines a private library variable, function, or program. Private functions and programs do not appear in the Catalog.

Note: See also **Define**, page 22, and **Define LibPub**, page 23.

Define LibPub

Catalog >

Define LibPub *Var* **=** *Expression*

Define LibPub *Function*(*Param1*, *Param2*, ...) **=** *Expression*

Define LibPub *Function*(*Param1*, *Param2*, ...) **= Func**
Block
EndFunc

Define LibPub *Program*(*Param1*, *Param2*, ...) **= Prgm**
Block
EndPrgm

Operates the same as **Define**, except defines a public library variable, function, or program. Public functions and programs appear in the Catalog after the library has been saved and refreshed.

Note: See also **Define**, page 22, and **Define LibPriv**, page 22.

DelVar

Catalog >

DelVar *Var1*[, *Var2*] [, *Var3*] ...

Deletes the specified variables from memory.

$2 \rightarrow a$	2
$(a+2)^2$	16
DelVar a	*Done*
$(a+2)^2$	"Error: Variable is not defined"

det()

Catalog >

det(*squareMatrix*[, *Tol*]**)** ⇒ *expression*

Returns the determinant of *squareMatrix*.

Optionally, any matrix element is treated as zero if its absolute value is less than *Tol*. This tolerance is used only if the matrix has floating-point entries and does not contain any symbolic variables that have not been assigned a value. Otherwise, *Tol* is ignored.

- If you use ctrl enter or set the **Auto or Approximate** mode to Approximate, computations are done using floating-point arithmetic.
- If *Tol* is omitted or not used, the default tolerance is calculated as:

  5E-14 · **max(dim(***squareMatrix***))** · **rowNorm(***squareMatrix***)**

$\det\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}$	-2
$\begin{bmatrix}1.\text{E}20 & 1\\ 0 & 1\end{bmatrix} \rightarrow mat1$	$\begin{bmatrix}1.\text{E}20 & 1\\ 0 & 1\end{bmatrix}$
$\det(mat1)$	0
$\det(mat1,.1)$	1.E20

diag()

Catalog >

diag(*List***)** ⇒ *matrix*
diag(*rowMatrix***)** ⇒ *matrix*
diag(*columnMatrix***)** ⇒ *matrix*

Returns a matrix with the values in the argument list or matrix in its main diagonal.

diag(*squareMatrix***)** ⇒ *rowMatrix*

Returns a row matrix containing the elements from the main diagonal of *squareMatrix*.

squareMatrix must be square.

$\text{diag}\begin{bmatrix}2 & 4 & 6\end{bmatrix}$	$\begin{bmatrix}2 & 0 & 0\\ 0 & 4 & 0\\ 0 & 0 & 6\end{bmatrix}$
$\begin{bmatrix}4 & 6 & 8\\ 1 & 2 & 3\\ 5 & 7 & 9\end{bmatrix}$	$\begin{bmatrix}4 & 6 & 8\\ 1 & 2 & 3\\ 5 & 7 & 9\end{bmatrix}$
$\text{diag}(Ans)$	$\begin{bmatrix}4 & 2 & 9\end{bmatrix}$

dim()

Catalog >

dim(*List***)** ⇒ *integer*

Returns the dimension of *List*.

dim(*Matrix***)** ⇒ *list*

Returns the dimensions of matrix as a two-element list {rows, columns}.

dim(*String***)** ⇒ *integer*

Returns the number of characters contained in character string *String*.

$\dim(\{0,1,2\})$ → 3

$\dim\begin{bmatrix}1 & -1\\ 2 & -2\\ 3 & 5\end{bmatrix}$ → $\{3,2\}$

$\dim(\text{"Hello"})$ → 5

$\dim(\text{"Hello "\&"there"})$ → 11

Disp

Catalog >

Disp [*exprOrString1*] [**,** *exprOrString2*] ...

Displays the arguments in the Calculator history. The arguments are displayed in succession, with thin spaces as separators.

Useful mainly in programs and functions to ensure the display of intermediate calculations.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing (↵) instead of (≈ enter) at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

```
Define chars(start,end)=Prgm
  For i,start,end
  Disp i," ",char(i)
  EndFor
  EndPrgm
                                  Done
chars(240,243)
                                  240 ð
                                  241 ñ
                                  242 ò
                                  243 ó
                                  Done
```

▶DMS

Catalog >

Value **▶DMS**
List **▶DMS**
Matrix **▶DMS**

Interprets the argument as an angle and displays the equivalent DMS (DDDDDD°MM'SS.ss'') number. See °, ', '' on page 104 for DMS (degree, minutes, seconds) format.

Note: ▶DMS will convert from radians to degrees when used in radian mode. If the input is followed by a degree symbol °, no conversion will occur. You can use **▶DMS** only at the end of an entry line.

In Degree angle mode:

$(45.371)\blacktriangleright\text{DMS}$ → 45°22'15.6"

$(\{45.371,60\})\blacktriangleright\text{DMS}$ → $\{45°22'15.6",60°\}$

dotP()

Catalog >

dotP(*List1***,** *List2***)** ⇒ *expression*

Returns the "dot" product of two lists.

dotP(*Vector1***,** *Vector2***)** ⇒ *expression*

Returns the "dot" product of two vectors.

Both must be row vectors, or both must be column vectors.

$\text{dotP}(\{1,2\},\{5,6\})$ → 17

$\text{dotP}([1\ \ 2\ \ 3],[4\ \ 5\ \ 6])$ → 32

E

e^()

key

e^(*Value1***)** ⇒ *value*

Returns **e** raised to the *Value1* power.

Note: See also **e exponent template**, page 1.

Note: Pressing to display *e*^(is different from pressing the character E on the keyboard.

You can enter a complex number in $re^{i\theta}$ polar form. However, use this form in Radian angle mode only; it causes a Domain error in Degree or Gradian angle mode.

e^1 → 2.71828

e^{3^2} → 8103.08

e^(*List1***)** ⇒ *list*

Returns **e** raised to the power of each element in *List1*.

$e^{\{1,1.,.5\}}$ → $\{2.71828, 2.71828, 1.64872\}$

e^(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix exponential of *squareMatrix1*. This is not the same as calculating e raised to the power of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

$$e^{\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}} \rightarrow \begin{bmatrix}782.209 & 559.617 & 456.509\\ 680.546 & 488.795 & 396.521\\ 524.929 & 371.222 & 307.879\end{bmatrix}$$

eff()

Catalog >

eff(*nominalRate*,*CpY***)** ⇒ *value*

Financial function that converts the nominal interest rate *nominalRate* to an annual effective rate, given *CpY* as the number of compounding periods per year.

nominalRate must be a real number, and *CpY* must be a real number > 0.

Note: See also **nom()**, page 53.

eff(5.75,12) → 5.90398

eigVc()

Catalog >

eigVc(*squareMatrix***)** ⇒ *matrix*

Returns a matrix containing the eigenvectors for a real or complex *squareMatrix*, where each column in the result corresponds to an eigenvalue. Note that an eigenvector is not unique; it may be scaled by any constant factor. The eigenvectors are normalized, meaning that if $V = [x_1, x_2, \ldots, x_n]$, then:

$x_1^2 + x_2^2 + \ldots + x_n^2 = 1$

squareMatrix is first balanced with similarity transformations until the row and column norms are as close to the same value as possible. The *squareMatrix* is then reduced to upper Hessenberg form and the eigenvectors are computed via a Schur factorization.

In Rectangular Complex Format:

$$\begin{bmatrix}-1 & 2 & 5\\ 3 & -6 & 9\\ 2 & -5 & 7\end{bmatrix} \rightarrow m1 \qquad \begin{bmatrix}-1 & 2 & 5\\ 3 & -6 & 9\\ 2 & -5 & 7\end{bmatrix}$$

eigVc(*m1*)

$$\begin{bmatrix}-.800906 & .767947 & .7679\\ .484029 & .573804+.052258\cdot i & .573804-.0\\ .352512 & .262687+.096286\cdot i & .262687-.0\end{bmatrix}$$

To see the entire result, press ▲ and then use ◀ and ▶ to move the cursor.

eigVl()

Catalog >

eigVl(*squareMatrix***)** ⇒ *list*

Returns a list of the eigenvalues of a real or complex *squareMatrix*.

squareMatrix is first balanced with similarity transformations until the row and column norms are as close to the same value as possible. The *squareMatrix* is then reduced to upper Hessenberg form and the eigenvalues are computed from the upper Hessenberg matrix.

In Rectangular complex format mode:

$$\begin{bmatrix} -1 & 2 & 5 \\ 3 & -6 & 9 \\ 2 & -5 & 7 \end{bmatrix} \rightarrow m1 \qquad \begin{bmatrix} -1 & 2 & 5 \\ 3 & -6 & 9 \\ 2 & -5 & 7 \end{bmatrix}$$

$$\text{eigVl}(m1)$$

$$\{-4.40941, 2.20471+.763006\cdot i, 2.20471-.76\blacktriangleright$$

To see the entire result, press ▲ and then use ◀ and ▶ to move the cursor.

Else

See If, page 35.

ElseIf

Catalog >

If *BooleanExpr1* **Then**
  Block1
ElseIf *BooleanExpr2* **Then**
  Block2
  ⋮
ElseIf *BooleanExprN* **Then**
  BlockN
EndIf
  ⋮

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing (↵) instead of (≈ enter) at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

```
Define g(x)=Func
              If x≤-5 Then
              Return 5
              ElseIf x>-5 and x<0 Then
              Return -x
              ElseIf x≥0 and x≠10 Then
              Return x
              ElseIf x=10 Then
              Return 3
              EndIf
              EndFunc
                                    Done
```

EndFor

See For, page 29.

EndFunc

See Func, page 31.

EndIf

See If, page 35.

EndLoop

See Loop, page 46.

EndPrgm

See Prgm, page 60.

EndTry

See Try, page 84.

Exit

Catalog >

Exit

Exits the current **For**, **While**, or **Loop** block.

Exit is not allowed outside the three looping structures (**For**, **While**, or **Loop**).

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing (enter) instead of (≈ enter) at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

Function listing:

```
Define g()=Func                    Done
             Local temp,i
             0→temp
             For i,1,100,1
             temp+i→temp
             If temp>20 Then
             Exit
             EndIf
             EndFor
             EndFunc
g()                                21
```

exp()

(ln / e^x) key

exp(*Value1***)** ⇒ *value*

Returns **e** raised to the *Value1* power.

Note: See also **e** exponent template, page 1.

You can enter a complex number in $re^{i\theta}$ polar form. However, use this form in Radian angle mode only; it causes a Domain error in Degree or Gradian angle mode.

e^{1} → 2.71828

e^{3^2} → 8103.08

exp(*List1***)** ⇒ *list*

Returns **e** raised to the power of each element in *List1*.

$e^{\{1,1.,.5\}}$ → $\{2.71828, 2.71828, 1.64872\}$

exp(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix exponential of *squareMatrix1*. This is not the same as calculating **e** raised to the power of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

$$e^{\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}} \rightarrow \begin{bmatrix}782.209 & 559.617 & 456.509\\ 680.546 & 488.795 & 396.521\\ 524.929 & 371.222 & 307.879\end{bmatrix}$$

expr()

Catalog >

expr(*String***)** ⇒ *expression*

Returns the character string contained in *String* as an expression and immediately executes it.

```
"Define cube(x)=x^3"→funcstr
                    "Define cube(x)=x^3"
expr(funcstr)                      Done
cube(2)                            8
```

ExpReg **Catalog >**

ExpReg *X, Y* [, [*Freq*] [, *Category, Include*]]

Calculates the exponential regression. A summary of results is stored in the *stat.results* variable. (See page 76.)

All the arguments must have equal dimensions except for *Include*.

X represents xlist.
Y represents ylist.
Freq represents frequency list.
Cetegory represents category codes.
Include represents category include list.

Output variable	Description
stat.RegEqn	Regression equation: a • $(b)^x$.
stat.a, stat.b	Regression coefficients: y = a • $(b)^x$.
stat.r^2	Coefficient of determination.
stat.r	Correlation coefficient for linear model.
stat.Resid	Residuals of the curves fit = y - a • $(b)^x$.
stat.ResidTrans	Residuals associated with linear fit of transformed data.
stat.XReg	List of data points in the modified *X List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.YReg	List of data points in the modified *Y List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.FreqReg	List of frequencies corresponding to *stat.XReg* and *stat.YReg*.

F

factor() **Catalog >**

factor(*rationalNumber***)** returns the rational number factored into primes. For composite numbers, the computing time grows exponentially with the number of digits in the second-largest factor. For example, factoring a 30-digit integer could take more than a day, and factoring a 100-digit number could take more than a century.

Note: To stop (break) a computation, press off on.

If you merely want to determine if a number is prime, use **isPrime()** instead. It is much faster, particularly if *rationalNumber* is not prime and if the second-largest factor has more than five digits.

factor(152417172689)	123457·1234577
isPrime(152417172689)	false

FCdf()

Catalog >

FCdf(*lowBound*,*upBound*,*dfNumer*,*dfDenom*) ⇒ *number* if *lowBound* and *upBound* are numbers, *list* if *lowBound* and *upBound* are lists

FCdf(*lowBound*,*upBound*,*dfNumer*,*dfDenom*) ⇒ *number* if *lowBound* and *upBound* are numbers, *list* if *lowBound* and *upBound* are lists

Computes the F distribution probability between *lowBound* and *upBound* for the specified *dfNumer* (degrees of freedom) and *dfDenom*.

Fill

Catalog >

Fill *Value, matrixVar* ⇒ *matrix*

Replaces each element in variable *matrixVar* with *Value*.

matrixVar must already exist.

$\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix} \rightarrow amatrix$ $\quad \begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}$

Fill 1.01,*amatrix* $\quad$ *Done*

amatrix $\quad \begin{bmatrix}1.01 & 1.01\\ 1.01 & 1.01\end{bmatrix}$

Fill *Value, listVar* ⇒ *list*

Replaces each element in variable *listVar* with *Value*.

listVar must already exist.

$\{1,2,3,4,5\} \rightarrow alist$ $\quad \{1,2,3,4,5\}$

Fill 1.01,*alist* $\quad$ *Done*

alist $\quad \{1.01,1.01,1.01,1.01,1.01\}$

floor()

Catalog >

floor(*Value1***)** ⇒ *integer*

Returns the greatest integer that is ≤ the argument. This function is identical to **int()**.

The argument can be a real or a complex number.

floor(−2.14) $\quad -3.$

floor(*List1***)** ⇒ *list*
floor(*Matrix1***)** ⇒ *matrix*

Returns a list or matrix of the floor of each element.

Note: See also **ceiling()** and **int()**.

$\text{floor}\left(\left\{\frac{3}{2}, 0, -5.3\right\}\right)$ $\quad \{1.,0.,-6.\}$

$\text{floor}\left(\begin{bmatrix}1.2 & 3.4\\ 2.5 & 4.8\end{bmatrix}\right)$ $\quad \begin{bmatrix}1. & 3.\\ 2. & 4.\end{bmatrix}$

For

Catalog >

For *Var*, *Low*, *High* [, *Step*]
  Block
EndFor

Executes the statements in *Block* iteratively for each value of *Var*, from *Low* to *High*, in increments of *Step*.

Var must not be a system variable.

Step can be positive or negative. The default value is 1.

Block can be either a single statement or a series of statements separated with the ":" character.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing ↵ instead of enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

```
Define g()=Func                                   Done
             Local tempsum,step,i
             0→tempsum
             1→step
             For i,1,100,step
             tempsum+i→tempsum
             EndFor
             EndFunc
g()                                               5050
```

format()

Catalog >

format(*Value*[, *formatString*]**)** ⇒ *string*

Returns *Value* as a character string based on the format template.

formatString is a string and must be in the form: "F[n]", "S[n]", "E[n]", "G[n][c]", where [ ] indicate optional portions.

F[n]: Fixed format. n is the number of digits to display after the decimal point.

S[n]: Scientific format. n is the number of digits to display after the decimal point.

E[n]: Engineering format. n is the number of digits after the first significant digit. The exponent is adjusted to a multiple of three, and the decimal point is moved to the right by zero, one, or two digits.

G[n][c]: Same as fixed format but also separates digits to the left of the radix into groups of three. c specifies the group separator character and defaults to a comma. If c is a period, the radix will be shown as a comma.

[Rc]: Any of the above specifiers may be suffixed with the Rc radix flag, where c is a single character that specifies what to substitute for the radix point.

format(1.234567,"f3")	"1.235"
format(1.234567,"s2")	"1.23E0"
format(1.234567,"e3")	"1.235E0"
format(1.234567,"g3")	"1.235"
format(1234.567,"g3")	"1,234.567"
format(1.234567,"g3,r:")	"1:235"

fPart()

Catalog >

fPart(*Expr1***)** ⇒ *expression*
fPart(*List1***)** ⇒ *list*
fPart(*Matrix1***)** ⇒ *matrix*

Returns the fractional part of the argument.

For a list or matrix, returns the fractional parts of the elements.

The argument can be a real or a complex number.

fPart(−1.234)	−.234
fPart({1,−2.3,7.003})	{0,−.3,.003}

FPdf()

Catalog >

FPdf(*XVal*,*dfNumer*,*dfDenom***)** ⇒ *number* if *XVal* is a number, *list* if *XVal* is a list

Computes the F distribution probability at *XVal* for the specified *dfNumer* (degrees of freedom) and *dfDenom*.

frequency()

Catalog >

frequency(*List1*,*binsList***)** ⇒ *list*

Returns a list containing counts of the elements in *List1*. The counts are based on ranges (bins) that you define in *binsList*.

If *binsList* is {b(1), b(2), …, b(n)}, the specified ranges are {**?**≤b(1), b(1)<**?**≤b(2),…,b(n-1)<**?**≤b(n), b(n)>**?**}. The resulting list is one element longer than *binsList*.

Each element of the result corresponds to the number of elements from *List1* that are in the range of that bin. Expressed in terms of the **countIf()** function, the result is { countIf(list, **?**≤b(1)), countIf(list, b(1)<**?**≤b(2)), …, countIf(list, b(n-1)<**?**≤b(n)), countIf(list, b(n)>**?**)}.

Elements of *List1* that cannot be "placed in a bin" are ignored.

Within the Lists & Spreadsheet application, you can use a range of cells in place of both arguments.

Note: See also **countIf()**, page 18.

datalist:={1,2,**e**,3,π,4,5,6,"hello",7}	{1,2,2.71828,3,3.14159,4,5,6,"hello",7}
frequency(*datalist*,{2.5,4.5})	{2,4,3}

Explanation of result:
2 elements from *Datalist* are ≤2.5
4 elements from *Datalist* are >2.5 and ≤4.5
3 elements from *Datalist* are >4.5
The element "hello" is a string and cannot be placed in any of the defined bins.

FTest_2Samp

Catalog >

FTest_2Samp *List1*,*List2*[,*Freq1*[,*Freq2*[,*Hypoth*]]]
FTest_2Samp *List1*,*List2*[,*Freq1*[,*Freq2*[,*Hypoth*]]]

(Data list input)

FTest_2Samp *sx1*,*n1*,*sx2*,*n2*[,*Hypoth*]
FTest_2Samp *sx1*,*n1*,*sx2*,*n2*[,*Hypoth*]

(Summary stats input)

Performs a two-sample F test. A summary of results is stored in the *stat.results* variable. (See page 76.)

Hypoth > 0 is Ha: $\sigma 1 > \sigma 2$
Hypoth = 0 is Ha: $\sigma 1 \neq \sigma 2$ (default)
Hypoth < 0 is Ha: $\sigma 1 < \sigma 2$

Output variable	Description
stat.F	Calculated [Y-VARS] statistic for the data sequence.
stat.PVal	Least probability at which the null hypothesis can be rejected.
stat.dfNumer	numerator degrees of freedom = n1-1.
stat.dfDenom	denominator degrees of freedom = n2-1.
stat.sx1, stat.sx2	Sample standard deviations of the data sequences in *List 1* and *List 2*.
stat.x1_bar stat.x2_bar	Sample means of the data sequences in *List 1* and *List 2*.
stat.n1, stat.n2	Size of the samples.

Func

Catalog >

Func
Block
EndFunc

Template for creating a user-defined function.

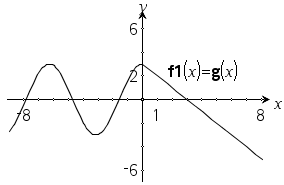
Block can be a single statement, a series of statements separated with the ":" character, or a series of statements on separate lines. The function can use the **Return** instruction to return a specific result.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing (enter) instead of (enter) at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

Define a piecewise function:

```
Define g(x)=Func                    Done
              If x<0 Then
              Return 3·cos(x)
              Else
              Return 3−x
              EndIf
              EndFunc
```

Result of graphing g(x)



G

gcd()

Catalog >

gcd(*Value1, Value2***)** ⇒ *expression*

Returns the greatest common divisor of the two arguments. The **gcd** of two fractions is the **gcd** of their numerators divided by the **lcm** of their denominators.

In Auto or Approximate mode, the **gcd** of fractional floating-point numbers is 1.0.

$\gcd(18,33)$ → 3

gcd(*List1, List2***)** ⇒ *list*

Returns the greatest common divisors of the corresponding elements in *List1* and *List2*.

$\gcd(\{12,14,16\},\{9,7,5\})$ → $\{3,7,1\}$

gcd(*Matrix1, Matrix2***)** ⇒ *matrix*

Returns the greatest common divisors of the corresponding elements in *Matrix1* and *Matrix2*.

$\gcd\left(\begin{bmatrix}2 & 4\\ 6 & 8\end{bmatrix},\begin{bmatrix}4 & 8\\ 12 & 16\end{bmatrix}\right)$ → $\begin{bmatrix}2 & 4\\ 6 & 8\end{bmatrix}$

geomCdf()

Catalog >

geomCdf(*p, lowBound, upBound***)** ⇒ *number* if *lowBound* and *upBound* are numbers, *list* if *lowBound* and *upBound* are lists

Computes a cumulative geometric probability from *lowBound* to *upBound* with the specified probability of success *p*.

For $p \le upBound$, set *lowBound* = 1.

geomPdf()

Catalog >

geomPdf(*p,XVal***)** ⇒ *number* if *XVal* is a number, *list* if *XVal* is a list

Computes a probability at *XVal*, the number of the trial on which the first success occurs, for the discrete geometric distribution with the specified probability of success p.

getDenom()

Catalog >

getDenom(*Fraction1***)** ⇒ *value*

Transforms the argument into an expression having a reduced common denominator, and then returns its denominator.

$x:=5:\ y:=6$ → 6

$\text{getDenom}\left(\frac{x+2}{y-3}\right)$ → 3

$\text{getDenom}\left(\frac{2}{7}\right)$ → 7

$\text{getDenom}\left(\frac{1}{x}+\frac{y^2+y}{y^2}\right)$ → 30

getMode()

Catalog >

getMode(*ModeNameInteger***)** ⇒ *value*
getMode(0) ⇒ *list*

getMode(*ModeNameInteger***)** returns a value representing the current setting of the *ModeNameInteger* mode.

getMode(0) returns a list containing number pairs. Each pair consists of a mode integer and a setting integer.

For a listing of the modes and their settings, refer to the table below.

If you save the settings with **getMode(0)** → *var*, you can use **setMode(***var***)** in a function or program to temporarily restore the settings within the execution of the function or program only. See **setMode()**, page 70.

getMode(0)	{1,1,2,1,3,1,4,1,5,1,6,1,7,1}
getMode(1)	1
getMode(7)	1

Mode Name	Mode Integer	Setting Integers
Display Digits	**1**	**1**=Float, **2**=Float1, **3**=Float2, **4**=Float3, **5**=Float4, **6**=Float5, **7**=Float6, **8**=Float7, **9**=Float8, **10**=Float9, **11**=Float10, **12**=Float11, **13**=Float12, **14**=Fix0, **15**=Fix1, **16**=Fix2, **17**=Fix3, **18**=Fix4, **19**=Fix5, **20**=Fix6, **21**=Fix7, **22**=Fix8, **23**=Fix9, **24**=Fix10, **25**=Fix11, **26**=Fix12
Angle	**2**	**1**=Radian, **2**=Degree, **3**=Gradian
Exponential Format	**3**	**1**=Normal, **2**=Scientific, **3**=Engineering
Real or Complex	**4**	**1**=Real, **2**=Rectangular, **3**=Polar
Auto or Approx.	**5**	**1**=Auto, **2**=Approximate
Vector Format	**6**	**1**=Rectangular, **2**=Cylindrical, **3**=Spherical
Base	**7**	**1**=Decimal, **2**=Hex, **3**=Binary

getNum()

Catalog >

getNum(*Fraction1***)** ⇒ *value*

Transforms the argument into an expression having a reduced common denominator, and then returns its numerator.

$x:=5: y:=6$	6
$\text{getNum}\left(\frac{x+2}{y-3}\right)$	7
$\text{getNum}\left(\frac{2}{7}\right)$	2
$\text{getNum}\left(\frac{1}{x}+\frac{1}{y}\right)$	11

getVarInfo()

Catalog >

getVarInfo() ⇒ *matrix* or *string*

getVarInfo(*LibraryNameString***)** ⇒ *matrix* or *string*

getVarInfo() returns a matrix of information (variable name, type, and library accessibility) for all variables and library objects defined in the current problem.

If no variables are defined, **getVarInfo()** returns the string "NONE".

getVarInfo(*LibraryNameString***)** returns a matrix of information for all library objects defined in library *LibraryName*. *LibraryNameString* must be a string (text enclosed in quotation marks) or a string variable.

If the library *LibraryName* does not exist, an error occurs.

```
getVarInfo()                                   "NONE"
Define x=5                                     Done
Define LibPriv y={1,2,3}                       Done
Define LibPub z(x)=3·x^2−x                     Done
getVarInfo()   [x  "NUM"   "□"
                y  "LIST"  "LibPriv "
                z  "FUNC"  "LibPub "]
getVarInfo(tmp3)
                "Error: Argument must be a string"
getVarInfo("tmp3")
                [volcyl2  "FUNC"  "LibPub "]
```

Goto

Catalog >

Goto *labelName*

Transfers control to the label *labelName*.

labelName must be defined in the same function using a **Lbl** instruction.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing ↵ instead of enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

```
Define g()=Func                                Done
             Local temp,i
             0→temp
             1→i
             Lbl top
             temp+i→temp
             If i<10 Then
             i+1→i
             Goto top
             EndIf
             Return temp
             EndFunc
g()                                            55
```

▸Grad

Catalog >

Expr1 ▸ **Grad** ⇒ *expression*

Converts *Expr1* to gradian angle measure.

In Degree angle mode:

```
(1.5)▸Grad                                     (1.66667)g
```

In Radian angle mode:

```
(1.5)▸Grad                                     (95.493)g
```

I

identity()

Catalog >

identity(*Integer***)** ⇒ *matrix*

Returns the identity matrix with a dimension of *Integer*.

Integer must be a positive integer.

identity(4)

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

If

Catalog >

If *BooleanExpr Statement*

If *BooleanExpr* **Then**
Block
EndIf

If *BooleanExpr* evaluates to true, executes the single statement *Statement* or the block of statements *Block* before continuing execution.

If *BooleanExpr* evaluates to false, continues execution without executing the statement or block of statements.

Block can be either a single statement or a sequence of statements separated with the ":" character.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing ↵ instead of enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

```
Define g(x)=Func                    Done
              If x<0 Then
              Return x^2
              EndIf
              EndFunc
g(-2)                               4
```

If *BooleanExpr* **Then**
Block1
Else
Block2
EndIf

If *BooleanExpr* evaluates to true, executes *Block1* and then skips *Block2*.

If *BooleanExpr* evaluates to false, skips *Block1* but executes *Block2*.

Block1 and *Block2* can be a single statement.

```
Define g(x)=Func                    Done
              If x<0 Then
              Return -x
              Else
              Return x
              EndIf
              EndFunc
g(12)                               12
g(-12)                              12
```

If

Catalog >

If *BooleanExpr1* **Then**
  Block1
ElseIf *BooleanExpr2* **Then**
  Block2
  ⋮
ElseIf *BooleanExprN* **Then**
  BlockN
EndIf

Allows for branching. If *BooleanExpr1* evaluates to true, executes *Block1*. If *BooleanExpr1* evaluates to false, evaluates *BooleanExpr2*, etc.

```
Define g(x)=Func
              If x<-5 Then
              Return 5
              ElseIf x>-5 and x<0 Then
              Return -x
              ElseIf x≥0 and x≠10 Then
              Return x
              ElseIf x=10 Then
              Return 3
              EndIf
              EndFunc
                                    Done
g(-4)                                 4
g(10)                                 3
```

ifFn()

Catalog >

ifFn(*BooleanExpr*, *Value_If_true* **[,***Value_If_false* **[,***Value_If_unknown***]])** ⇒ *expression, list, or matrix*

Evaluates the boolean expression *BooleanExpr* (or each element from *BooleanExpr*) and produces a result based on the following rules:

- *BooleanExpr* can test a single value, a list, or a matrix.
- If an element of *BooleanExpr* evaluates to true, returns the corresponding element from *Value_If_true*.
- If an element of *BooleanExpr* evaluates to false, returns the corresponding element from *Value_If_false*. If you omit *Value_If_false*, returns undef.
- If an element of *BooleanExpr* is neither true nor false, returns the corresponding element *Value_If_unknown*. If you omit *Value_If_unknown*, returns undef.
- If the second, third, or fourth argument of the **ifFn()** function is a single expression, the Boolean test is applied to every position in *BooleanExpr*.

Note: If the simplified *BooleanExpr* statement involves a list or matrix, all other list or matrix arguments must have the same dimension(s), and the result will have the same dimension(s).

```
ifFn({1,2,3}<2.5,{5,6,7},{8,9,10})
                                    {5,6,10}
```

Test value of **1** is less than 2.5, so its corresponding *Value_If_True* element of **5** is copied to the result list.

Test value of **2** is less than 2.5, so its corresponding *Value_If_True* element of **6** is copied to the result list.

Test value of **3** is not less than 2.5, so its corresponding *Value_If_False* element of **10** is copied to the result list.

```
ifFn({1,2,3}<2.5,4,{8,9,10})          {4,4,10}
```

Value_If_true is a single value and corresponds to any selected position.

```
ifFn({1,2,3}<2.5,{5,6,7})             {5,6,undef}
```

Value_If_false is not specified. Undef is used.

```
ifFn({2,"a"}<2.5,{6,7},{9,10},"err")
                                    {6,"err"}
```

One element selected from *Value_If_true*. One element selected from *Value_If_unknown*.

imag()

Catalog >

imag(*Value1***)** ⇒ *value*

Returns the imaginary part of the argument.

```
imag(1+2·i)                           2
```

imag(*List1***)** ⇒ *list*

Returns a list of the imaginary parts of the elements.

```
imag({-3,4-i,i})                    {0,-1,1}
```

imag()

Catalog >

imag(*Matrix1***)** ⇒ *matrix*

Returns a matrix of the imaginary parts of the elements.

$$\text{imag}\begin{bmatrix} 1 & 2 \\ i\cdot 3 & i\cdot 4 \end{bmatrix} \qquad \begin{bmatrix} 0 & 0 \\ 3 & 4 \end{bmatrix}$$

Indirection

See **#()**, page 103.

inString()

Catalog >

inString(*srcString***,** *subString***[,** *Start***])** ⇒ *integer*

Returns the character position in string *srcString* at which the first occurrence of string *subString* begins.

Start, if included, specifies the character position within *srcString* where the search begins. Default = 1 (the first character of *srcString*).

If *srcString* does not contain *subString* or *Start* is > the length of *srcString*, returns zero.

```
inString("Hello there","the")      7
inString("ABCEFG","D")             0
```

int()

Catalog >

int(*Value***)** ⇒ *integer*
int(*List1***)** ⇒ *list*
int(*Matrix1***)** ⇒ *matrix*

Returns the greatest integer that is less than or equal to the argument. This function is identical to **floor()**.

The argument can be a real or a complex number.

For a list or matrix, returns the greatest integer of each of the elements.

```
int(-2.5)                          -3.
int([-1.234  0  .37])              [-2.  0  0.]
```

intDiv()

Catalog >

intDiv(*Number1***,** *Number2***)** ⇒ *integer*
intDiv(*List1***,** *List2***)** ⇒ *list*
intDiv(*Matrix1***,** *Matrix2***)** ⇒ *matrix*

Returns the signed integer part of (*Number1* ÷ *Number2*).

For lists and matrices, returns the signed integer part of (argument 1 ÷ argument 2) for each element pair.

```
intDiv(-7,2)                       -3
intDiv(4,5)                        0
intDiv({12,-14,-16},{5,4,-3})      {2,-3,5}
```

invχ²()

Catalog >

invχ²(*Area***,***df***)**
invchi2(*Area***,***df***)**

Computes the Inverse cumulative χ^2 (chi-square) probability function specified by degree of freedom, *df* for a given *Area* under the curve.

invF()

Catalog >

invF(*Area***,***dfNumer***,***dfDenom***)**
invF(*Area***,***dfNumer***,***dfDenom***)**

computes the Inverse cumulative F distribution function specified by *dfNumer* and *dfDenom* for a given *Area* under the curve.

invNorm()

Catalog >

invNorm(*Area*[**,**μ**,**σ]**)**

Computes the inverse cumulative normal distribution function for a given *Area* under the normal distribution curve specified by μ and σ.

invt()

Catalog >

invt(*Area***,***df***)**

Computes the inverse cumulative student-t probability function specified by degree of freedom, *df* for a given *Area* under the curve.

iPart()

Catalog >

iPart(*Number***)** ⇒ *integer*
iPart(*List1***)** ⇒ *list*
iPart(*Matrix1***)** ⇒ *matrix*

Returns the integer part of the argument.

For lists and matrices, returns the integer part of each element.

The argument can be a real or a complex number.

iPart(−1.234)	−1.
$\text{iPart}\left(\left\{\frac{3}{2},-2.3,7.003\right\}\right)$	{1,−2.,7.}

irr()

Catalog >

irr(*CF0,CFList* [**,***CFFreq*]**)** ⇒ *value*

Financial function that calculates internal rate of return of an investment.

CF0 is the initial cash flow at time 0; it must be a real number.

CFList is a list of cash flow amounts after the initial cash flow CF0.

CFFreq is an optional list in which each element specifies the frequency of occurrence for a grouped (consecutive) cash flow amount, which is the corresponding element of *CFList*. The default is 1; if you enter values, they must be positive integers < 10,000.

Note: See also **mirr()**, page 49.

list1:={6000,−8000,2000,−3000}	{6000,−8000,2000,−3000}
list2:={2,2,2,1}	{2,2,2,1}
irr(5000,*list1*,*list2*)	−4.64484

isPrime()

Catalog >

isPrime(*Number***)** ⇒ *Boolean constant expression*

Returns true or false to indicate if *number* is a whole number ≥ 2 that is evenly divisible only by itself and 1.

If *Number* exceeds about 306 digits and has no factors ≤1021, **isPrime(***Number***)** displays an error message.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing ↵ instead of enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

isPrime(5)	true
isPrime(6)	false

Function to find the next prime after a specified number:

Define *nextprim*(*n*)=Func	*Done*
Loop	
n+1→*n*	
If isPrime(*n*)	
Return *n*	
EndLoop	
EndFunc	
nextprim(7)	11

L

Lbl

Catalog >

Lbl *labelName*

Defines a label with the name *labelName* within a function.

You can use a **Goto** *labelName* instruction to transfer control to the instruction immediately following the label.

labelName must meet the same naming requirements as a variable name.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing (↵) instead of (enter) at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

```
Define g()=Func                                   Done
             Local temp,i
             0→temp
             1→i
             Lbl top
             temp+i→temp
             If i<10 Then
             i+1→i
             Goto top
             EndIf
             Return temp
             EndFunc
g()                                                55
```

lcm()

Catalog >

lcm(*Number1***,** *Number2***)** ⇒ *expression*
lcm(*List1***,** *List2***)** ⇒ *list*
lcm(*Matrix1***,** *Matrix2***)** ⇒ *matrix*

Returns the least common multiple of the two arguments. The **lcm** of two fractions is the **lcm** of their numerators divided by the **gcd** of their denominators. The **lcm** of fractional floating-point numbers is their product.

For two lists or matrices, returns the least common multiples of the corresponding elements.

```
lcm(6,9)                                           18
lcm({1/3,-14,16},{2/15,7,5})                {2/3,14,80}
```

left()

Catalog >

left(*sourceString***[,** *Num***])** ⇒ *string*

Returns the leftmost *Num* characters contained in character string *sourceString*.

If you omit *Num*, returns all of *sourceString*.

left(*List1***[,** *Num***])** ⇒ *list*

Returns the leftmost *Num* elements contained in *List1*.

If you omit *Num*, returns all of *List1*.

left(*Comparison***)** ⇒ *expression*

Returns the left-hand side of an equation or inequality.

```
left("Hello",2)                                  "He"
left({1,3,-2,4},3)                          {1,3,-2}
```

LinRegBx

Catalog >

LinRegBx *X*,*Y*[,*Freq*[,*Category*,*Include*]]
Fits a y=a+bx linear regression model to *X* and *Y* with frequency *Freq*. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.RegEqn	Regression Equation: a+b • x.
stat.a, stat.b	Regression coefficients.
stat.r^2	Coefficient of determination.
stat.r	Correlation coefficient for linear model.
stat.Resid	Residuals of the curves fit: y - (a+b • x).
stat.XReg	List of data points in the modified *X List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.YReg	List of data points in the modified *Y List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.FreqReg	List of frequencies corresponding to *stat.FreqReg* and *stat.YReg*.

LinRegMx

Catalog >

LinRegMx *X*,*Y*[,*Freq*[,*Category*,*Include*]]

Fits a y=mx+b linear regression model to *X* and *Y* with frequency *Freq*. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.RegEqn	Regression Equation: m • x+b.
stat.m, stat.b	Regression coefficients: y = m • x+b.
stat.r^2	Coefficient of determination.
stat.r	Correlation coefficient for linear model.
stat.Resid	Residuals of the curves fit: y - (m • x+b).
stat.XReg	List of data points in the modified *X List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.YReg	List of data points in the modified *Y List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.FreqReg	List of frequencies corresponding to *stat.XReg* and *stat.YReg*.

LinRegtIntervals

Catalog >

LinRegtIntervals *X*,*Y*[,*Freq*[,**0**[,*CLevel*]]]

For Slope

LinRegtIntervals *X*,*Y*[,*Freq*[,**1**,*Xval*[,*CLevel*]]]

For Response

Computes the linear regression t interval for a line fit of the data point pairs, where y(k) = a + b • x(k). Two types of intervals are available: Slope and Response. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.RegEqn	Regression Equation: a+b • x.
stat.a,b	Regression line fit offset and slope parameter estimates.
stat.df	Degrees-of-freedom
stat.r^2	Coefficient of determination.
stat.r	Correlation coefficient for linear model.
stat.Resid	Residuals of the curves fit: y - (a+b • x).

For Slope type only

Output variable	Description
[stat.CLower, stat.CUpper]	Confidence interval on the slope containing CLevel of dist.
stat.ME	slope b confidence interval margin of error
stat.SESlope	SE Slope = s/sqrt(sum(x-bar)^2)
stat.s	Fit error standard deviation for y - (a + b • x)

For Predict type only

Output variable	Description
[stat.CLower, stat.CUpper]	Confidence interval on the prediction containing CLevel of dist.
stat.ME	Confidence interval margin of error
stat.SE	standard error for confidence interval
[stat.LowerPred, stat.UpperPred]	Predictive interval on the prediction containing CLevel of dist.
stat.MEPred	Predictive interval margin of error
stat.SEPred	standard error for predictive interval
stat.$\hat{y}$	a + b • XVal

LinRegtTest

Catalog >

LinRegtTest *X*,*Y*[,*Freq*[,*Hypoth*]]

Computes the linear regression line fit of the data point pairs, where y(k) = a + b • x(k) and tests the null hypotheses H0: b = 0 against one of the following three alternatives:

Hypoth > 0 is Ha: σ1 > σ2
Hypoth = 0 is Ha: σ1 ≠ σ2 (default)
Hypoth < 0 is Ha: σ1 < σ2

A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.RegEqn	regression equation: a + b • x
stat.a, stat.b	Regression line fit offset and slope parameter estimates
stat.df	Degrees-of-freedom
stat.s	Fit error standard deviation for y - (a + b • x)
stat.t	T-Statistic for slope significance
stat.PVal	Probability the alternate hypothesis is false
stat.r	Linear regression correlation coefficient
stat.r^2	Coefficient of determination
stat.SESlope	SE Slope = s/sqrt(sum(x-bar)^2)
stat.Resid	residuals of linear fit

ΔList()

Catalog >

ΔList(*List1***)** ⇒ *list*

Returns a list containing the differences between consecutive elements in *List1*. Each element of *List1* is subtracted from the next element of *List1*. The resulting list is always one element shorter than the original *List1*.

ΔList({20,30,45,70}) → {10,15,25}

list▸mat()

Catalog >

list▸mat(*List* [, *elementsPerRow*]**)** ⇒ *matrix*

Returns a matrix filled row-by-row with the elements from *List*.

elementsPerRow, if included, specifies the number of elements per row. Default is the number of elements in *List* (one row).

If *List* does not fill the resulting matrix, zeros are added.

list▸mat({1,2,3}) → [1 2 3]

list▸mat({1,2,3,4,5},2) →
$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 0 \end{bmatrix}$$

ln()

ctrl e^x keys

ln(*Value1***)** ⇒ *value*
ln(*List1***)** ⇒ *list*

Returns the natural logarithm of the argument.

For a list, returns the natural logarithms of the elements.

$\ln(2.)$ .693147

If complex format mode is Real:

$\ln(\{-3,1.2,5\})$ "Error: Non−real calculation"

If complex format mode is Rectangular:

$\ln(\{-3,1.2,5\})$ $\{1.09861+3.14159\cdot i,.182322,1.60944\}$

ln(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix natural logarithm of *squareMatrix1*. This is not the same as calculating the natural logarithm of each element. For information about the calculation method, refer to **cos()** on.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

In Radian angle mode and Rectangular complex format:

$$\ln\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}$$

$$\begin{bmatrix}1.83145+1.73485\cdot i & .009193-1.49086\cdot i\\ .448761-.725533\cdot i & 1.06491+.623491\cdot i\\ -.266891-2.08316\cdot i & 1.12436+1.79018\cdot i\end{bmatrix}$$

To see the entire result, press ▲ and then use ◀ and ▶ to move the cursor.

LnReg

Catalog >

LnReg *X*, *Y*[, [*Freq*] [, *Category*, *Include*]]

Calculates the logarithmic regression. A summary of results is stored in the *stat.results* variable. (See page 76.)

All the arguments must have equal dimensions except for *Include*.

X represents xlist.
Y represents ylist.
Freq represents frequency.
Category represents category codes.
Include represents category include list.

Output variable	Description
stat.RegEqn	Regression equation: a+b • ln(x).
stat.a, stat.b	Regression coefficients: y = a+b • ln(x).
stat.r^2	Coefficient of determination.
stat.r	Correlation coefficient for linear model.
stat.Resid	Residuals of the curves fit = y−(a+b • ln(x)).
stat.ResidTrans	Residuals associated with linear fit of transformed data.
stat.XReg	List of data points in the modified *X List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.YReg	List of data points in the modified *Y List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.

Output variable	Description
stat.FreqReg	List of frequencies corresponding to *stat.XReg* and *stat.YReg*.

Local

Catalog >

Local *Var1*[, *Var2*] [, *Var3*] ...

Declares the specified *vars* as local variables. Those variables exist only during evaluation of a function and are deleted when the function finishes execution.

Note: Local variables save memory because they only exist temporarily. Also, they do not disturb any existing global variable values. Local variables must be used for **For** loops and for temporarily saving values in a multi-line function since modifications on global variables are not allowed in a function.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing (enter) instead of (enter) at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

```
Define rollcount()=Func
                    Local i
                    1→i
                    Loop
                    If randInt(1,6)=randInt(1,6)
                    Goto end
                    i+1→i
                    EndLoop
                    Lbl end
                    Return i
                    EndFunc
                                                Done
rollcount()                                       16
rollcount()                                        3
```

log()

(ctrl) (log 10^x) keys

log(*Value1*[,*Value2*]**)** ⇒ *value*
log(*List1*[,*Value2*]**)** ⇒ *list*

Returns the base-*Value2* logarithm of the first argument.

Note: See also **Log template**, page 2.

For a list, returns the base-*Value2* logarithm of the elements.

If the second argument is omitted, 10 is used as the base.

$\log_{10}(2.)$ .30103

$\log_{4}(2.)$ .5

$\log_{3}(10)-\log_{3}(5)$ .63093

If complex format mode is Real:

$\log_{10}(\{-3,1.2,5\})$

"Error: Non−real calculation"

If complex format mode is Rectangular:

$\log_{10}(\{-3,1.2,5\})$

$\{.477121+1.36438\cdot i,.079181,.69897\}$

log(*squareMatrix1*[,*Value*]**)** ⇒ *squareMatrix*

Returns the matrix base-*Value* logarithm of *squareMatrix1*. This is not the same as calculating the base-*Value* logarithm of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

If the base argument is omitted, 10 is used as base.

In Radian angle mode and Rectangular complex format:

$$\log_{10}\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}$$

$$\begin{bmatrix}.795387+.753438\cdot i & .003993-.647471\cdot i\\ .194895-.315095\cdot i & .462485+.270779\cdot i\\ -.115909-.904706\cdot i & .488304+.777464\cdot i\end{bmatrix}$$

To see the entire result, press ▲ and then use ◀ and ▶ to move the cursor.

Logistic

Catalog >

Logistic *X*, *Y*[, [*Freq*] [, *Category*, *Include*]]

Fits a logistic regression model to *X* and *Y* with frequency *Freq*. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.RegEqn	Regression equation: $c/(1+a \cdot e^{-bx})$.
stat.a, stat.b, stat.c	Regression coefficients.
stat.Resid	Residuals of the curves fit = $y - (c/(1+a \cdot e^{-bx}))$.
stat.XReg	List of data points in the modified *X List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.YReg	List of data points in the modified *Y List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.FreqReg	List of frequencies corresponding to *stat.XReg* and *stat.YReg*.

LogisticD

Catalog >

LogisticD *X*, *Y* [, [*Iterations*] , [*Freq*] [, *Category*, *Include*]]

Calculates the logistic regression. A summary of results is stored in the *stat.results* variable. (See page 76.)

All the arguments must have equal dimensions except for *Include*.

X represents xlist.
Y represents ylist.
Freq represents frequency.
Category represents category codes.
Include represents category include list.

Iterations specifies the maximum number of times a solution will be attempted. If omitted, 64 is used. Typically, larger values result in better accuracy but longer execution times, and vice versa.

Output variable	Description
stat.RegEqn	Regression equation: $c/(1+a \cdot e^{-bx})+d)$.
stat.a, stat.b, stat.c, stat.d	Regression coefficients.
stat.Resid	Residuals of the curves fit = $y - (c/(1+a \cdot e^{-bx})+d)$.
stat.XReg	List of data points in the modified *X List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.YReg	List of data points in the modified *Y List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.FreqReg	List of frequencies corresponding to *stat.XReg* and *stat.YReg*.

Loop

Catalog >

Loop
Block
EndLoop

Repeatedly executes the statements in *Block*. Note that the loop will be executed endlessly, unless a **Goto** or **Exit** instruction is executed within *Block*.

Block is a sequence of statements separated with the ":" character.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing (enter) instead of (≈ enter) at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

```
Define rollcount()=Func
                    Local i
                    1→i
                    Loop
                    If randInt(1,6)=randInt(1,6)
                    Goto end
                    i+1→i
                    EndLoop
                    Lbl end
                    Return i
                    EndFunc
                                                Done
rollcount()                                     16
rollcount()                                     3
```

LU

Catalog >

LU *Matrix*, *lMatName*, *uMatName*, *pMatName*[, *Tol*]

Calculates the Doolittle LU (lower-upper) decomposition of a real or complex matrix. The lower triangular matrix is stored in *lMatName*, the upper triangular matrix in *uMatName*, and the permutation matrix (which describes the row swaps done during the calculation) in *pMatName*.

lMatName · *uMatName* = *pMatName* · *matrix*

Optionally, any matrix element is treated as zero if its absolute value is less than *Tol*. This tolerance is used only if the matrix has floating-point entries and does not contain any symbolic variables that have not been assigned a value. Otherwise, *Tol* is ignored.

- If you use (ctrl)(≈ enter) or set the **Auto or Approximate** mode to Approximate, computations are done using floating-point arithmetic.
- If *Tol* is omitted or not used, the default tolerance is calculated as:
  5E−14 · max(dim(*Matrix*)) · rowNorm(*Matrix*)

The **LU** factorization algorithm uses partial pivoting with row interchanges.

$$\begin{bmatrix}6 & 12 & 18\\ 5 & 14 & 31\\ 3 & 8 & 18\end{bmatrix}\rightarrow m1 \qquad \begin{bmatrix}6 & 12 & 18\\ 5 & 14 & 31\\ 3 & 8 & 18\end{bmatrix}$$

LU *m1*,*lower*,*upper*,*perm* — *Done*

lower
$$\begin{bmatrix}1 & 0 & 0\\ \frac{5}{6} & 1 & 0\\ \frac{1}{2} & \frac{1}{2} & 1\end{bmatrix}$$

upper
$$\begin{bmatrix}6 & 12 & 18\\ 0 & 4 & 16\\ 0 & 0 & 1\end{bmatrix}$$

perm
$$\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{bmatrix}$$

M

mat▸list()

Catalog >

mat▸list(*Matrix***)** ⇒ *list*

Returns a list filled with the elements in *Matrix*. The elements are copied from *Matrix* row by row.

$$\text{mat}\blacktriangleright\text{list}\left(\begin{bmatrix}1 & 2 & 3\end{bmatrix}\right) \qquad \{1,2,3\}$$

$$\begin{bmatrix}1 & 2 & 3\\ 4 & 5 & 6\end{bmatrix}\rightarrow m1 \qquad \begin{bmatrix}1 & 2 & 3\\ 4 & 5 & 6\end{bmatrix}$$

$$\text{mat}\blacktriangleright\text{list}(m1) \qquad \{1,2,3,4,5,6\}$$

max()

Catalog >

max(*Value1***, ***Value2***)** ⇒ *expression*
max(*List1***, ***List2***)** ⇒ *list*
max(*Matrix1***, ***Matrix2***)** ⇒ *matrix*

Returns the maximum of the two arguments. If the arguments are two lists or matrices, returns a list or matrix containing the maximum value of each pair of corresponding elements.

max(*List***)** ⇒ *expression*

Returns the maximum element in *list*.

max(*Matrix1***)** ⇒ *matrix*

Returns a row vector containing the maximum element of each column in *Matrix1*.

Note: See also **min()**.

$\max(2.3,1.4)$ → 2.3

$\max(\{1,2\},\{-4,3\})$ → $\{1,3\}$

$\max(\{0,1,-7,1.3,.5\})$ → 1.3

$\max\begin{bmatrix}1 & -3 & 7\\ -4 & 0 & .3\end{bmatrix}$ → $\begin{bmatrix}1 & 0 & 7\end{bmatrix}$

mean()

Catalog >

mean(*List***[, ***freqList***])** ⇒ *expression*

Returns the mean of the elements in *List*.

Each *freqList* element counts the number of consecutive occurrences of the corresponding element in *List*.

mean(*Matrix1***[, ***freqMatrix***])** ⇒ *matrix*

Returns a row vector of the means of all the columns in *Matrix1*.

Each *freqMatrix* element counts the number of consecutive occurrences of the corresponding element in *Matrix1*.

$\text{mean}(\{.2,0,1,-.3,.4\})$ → .26

$\text{mean}(\{1,2,3\},\{3,2,1\})$ → $\frac{5}{3}$

In Rectangular vector format:

$\text{mean}\begin{bmatrix}.2 & 0\\ -1 & 3\\ .4 & -.5\end{bmatrix}$ → $\begin{bmatrix}-.133333 & .833333\end{bmatrix}$

$\text{mean}\begin{bmatrix}\frac{1}{5} & 0\\ -1 & 3\\ \frac{2}{5} & \frac{-1}{2}\end{bmatrix}$ → $\begin{bmatrix}\frac{-2}{15} & \frac{5}{6}\end{bmatrix}$

$\text{mean}\left(\begin{bmatrix}1 & 2\\ 3 & 4\\ 5 & 6\end{bmatrix},\begin{bmatrix}5 & 3\\ 4 & 1\\ 6 & 2\end{bmatrix}\right)$ → $\begin{bmatrix}\frac{47}{15} & \frac{11}{3}\end{bmatrix}$

median()

Catalog >

median(*List***)** ⇒ *expression*

Returns the median of the elements in *List*.

median(*Matrix1***)** ⇒ *matrix*

Returns a row vector containing the medians of the columns in *Matrix1*.

Note: All entries in the list or matrix must simplify to numbers.

$\text{median}(\{.2,0,1,-.3,.4\})$ → .2

$\text{median}\begin{bmatrix}.2 & 0\\ 1 & -.3\\ .4 & -.5\end{bmatrix}$ → $\begin{bmatrix}.4 & -.3\end{bmatrix}$

MedMed

Catalog >

MedMed *X*,*Y* [, *Freq*] [, *Category*, *Include*]]

Calculates the median-median line. A summary of results is stored in the *stat.results* variable. (See page 76.)

All the arguments must have equal dimensions except for *Include*.

X represents xlist.
Y represents ylist.
Freq represents frequency list.
Category represents category codes.
Include represents category include list.

Output variable	Description
stat.RegEqn	Regression Equation: m • x+b.
stat.a, stat.b	Regression coefficients: y = m • x+b.
stat.Resid	Residuals of the curves fit = y - (m • x+b).
stat.XReg	List of data points in the modified *X List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.YReg	List of data points in the modified *Y List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.FreqReg	List of frequencies corresponding to *stat.XReg* and *stat.YReg*.

mid()

Catalog >

mid(*sourceString*, *Start*[, *Count*]**)** ⇒ *string*

Returns *Count* characters from character string *sourceString*, beginning with character number *Start*.

If *Count* is omitted or is greater than the dimension of *sourceString*, returns all characters from *sourceString*, beginning with character number *Start*.

Count must be ≥ 0. If *Count* = 0, returns an empty string.

```
mid("Hello there",2)          "ello there"
mid("Hello there",7,3)        "the"
mid("Hello there",1,5)        "Hello"
mid("Hello there",1,0)        ""
```

mid(*sourceList*, *Start* [, *Count*]**)** ⇒ *list*

Returns *Count* elements from *sourceList*, beginning with element number *Start*.

If *Count* is omitted or is greater than the dimension of *sourceList*, returns all elements from *sourceList*, beginning with element number *Start*.

Count must be ≥ 0. If Count = 0, returns an empty list.

```
mid({9,8,7,6},3)              {7,6}
mid({9,8,7,6},2,2)            {8,7}
mid({9,8,7,6},1,2)            {9,8}
mid({9,8,7,6},1,0)            {}
```

mid(*sourceStringList*, *Start*[, *Count*]**)** ⇒ *list*

Returns *Count* strings from the list of strings *sourceStringList*, beginning with element number *Start*.

```
mid({"A","B","C","D"},2,2)
                              {"B","C"}
```

min()

Catalog >

min(*Value1*, *Value2***)** ⇒ *expression*
min(*List1*, *List2***)** ⇒ *list*
min(*Matrix1*, *Matrix2***)** ⇒ *matrix*

Returns the minimum of the two arguments. If the arguments are two lists or matrices, returns a list or matrix containing the minimum value of each pair of corresponding elements.

min(*List***)** ⇒ *expression*

Returns the minimum element of *List*.

min(*Matrix1***)** ⇒ *matrix*

Returns a row vector containing the minimum element of each column in *Matrix1*.

Note: See also **max()**.

$\min(2.3,1.4)$ → 1.4

$\min(\{1,2\},\{-4,3\})$ → $\{-4,2\}$

$\min(\{0,1,-7,1.3,.5\})$ → -7

$\min\begin{pmatrix}1 & -3 & 7\\ -4 & 0 & .3\end{pmatrix}$ → $\begin{bmatrix}-4 & -3 & .3\end{bmatrix}$

mirr()

Catalog >

mirr(*financeRate***,***reinvestRate***,***CF0***,***CFList***[,***CFFreq***])**

Financial function that returns the modified internal rate of return of an investment.

financeRate is the interest rate that you pay on the cash flow amounts.

reinvestRate is the interest rate at which the cash flows are reinvested.

CF0 is the initial cash flow at time 0; it must be a real number.

CFList is a list of cash flow amounts after the initial cash flow CF0.

CFFreq is an optional list in which each element specifies the frequency of occurrence for a grouped (consecutive) cash flow amount, which is the corresponding element of *CFList*. The default is 1; if you enter values, they must be positive integers < 10,000.

Note: See also **irr()**, page 38.

$list1:=\{6000,-8000,2000,-3000\}$ → $\{6000,-8000,2000,-3000\}$

$list2:=\{2,2,2,1\}$ → $\{2,2,2,1\}$

$\text{mirr}(4.65,12,5000,list1,list2)$ → 13.41608607

mod()

Catalog >

mod(*Value1*, *Value2***)** ⇒ *expression*
mod(*List1*, *List2***)** ⇒ *list*
mod(*Matrix1*, *Matrix2***)** ⇒ *matrix*

Returns the first argument modulo the second argument as defined by the identities:

mod(x,0) = x
mod(x,y) = x − y floor(x/y)

When the second argument is non-zero, the result is periodic in that argument. The result is either zero or has the same sign as the second argument.

If the arguments are two lists or two matrices, returns a list or matrix containing the modulo of each pair of corresponding elements.

Note: See also **remain()**, page 66

$\text{mod}(7,0)$ → 7

$\text{mod}(7,3)$ → 1

$\text{mod}(-7,3)$ → 2

$\text{mod}(7,-3)$ → -2

$\text{mod}(-7,-3)$ → -1

$\text{mod}(\{12,-14,16\},\{9,7,-5\})$ → $\{3,0,-4\}$

mRow()

Catalog >

mRow(*Value***,** *Matrix1***,** *Index***)** ⇒ *matrix*

Returns a copy of *Matrix1* with each element in row *Index* of *Matrix1* multiplied by *Value*.

$\text{mRow}\left(\frac{-1}{3},\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix},2\right)$ → $\begin{bmatrix}1 & 2\\ -1 & \frac{-4}{3}\end{bmatrix}$

mRowAdd()

Catalog >

mRowAdd(*Value*, *Matrix1*, *Index1*, *Index2*) ⇒ *matrix*

Returns a copy of *Matrix1* with each element in row *Index2* of *Matrix1* replaced with:

Value • row *Index1* + row *Index2*

$$\text{mRowAdd}\left(-3,\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix},1,2\right) \qquad \begin{bmatrix}1 & 2\\ 0 & -2\end{bmatrix}$$

MultReg

Catalog >

MultReg *Y*, *X1*, *X2*, ..., *X10*

Calculates multiple linear regression of list *Y* on lists *X1*, *X2*, …, *X10*. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.RegEqn	Regression Equation: b0+b1 • x1+b2 • x2+ ...
stat.b0, stat.b1, ...	Coefficients of the regression equation
stat.R^2	Coefficient of multiple determination.
stat.$\hat{y}$List	$\hat{y}$List = b0+b1 • x1+ ...
stat.Resid	Residuals: Resid=y - $\hat{y}$list

MultRegIntervals

Catalog >

MultRegIntervals *Y*,*X1*,*X2*[,…[,*X10*]],*XValList*[,*CLevel*]

Computes multiple regression prediction confidence interval for the calculated $\hat{y}$ and a confidence for $\overline{y}$. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.RegEqn	Regression Equation: b0+b1 • x1+b2 • x2+ ...
stat.$\hat{y}$	A point estimate: $\hat{y}$ = b0 + b1 • xl + ... for *XValList*
stat.dfError	Error degrees of freedom.
stat.CLower, stat.CUpper	The confidence interval for a mean $\hat{y}$.
stat.ME	Confidence interval margin of error.
stat.se	Standard error for confidence interval.
stat.LowerPred, stat.UpperrPred	Prediction interval for $\hat{y}$.
stat.MEPred	Interval margin of error that you can predict.
stat.SEPred	Standard error for an interval that you can predict.

Output variable	Description
stat.bList	List of regression coefficients, {b0,b1,b3,...}.
stat.Resid	Residuals of the curves fit y = b0 + b1 • x1 + b2 • x2 + ...

MultRegTests **Catalog >**

MultRegTests *Y*,*X1*,*X2*[,*X3*[,...[,*X10*]]]

Multiple linear regression *t* test computes a linear regression on the given data, and provides the F test statistic for linearity. A summary of results is stored in the *stat.results* variable. (See page 76.)

Outputs

Output variable	Description
stat.RegEqn	Regression Equation: b0+b1 • x1+b2 • x2+ ...
stat.F	Global F test statistic.
stat.PVal	Least probability at which the null hypothesis can be rejected.
stat.R^2	Coefficient of multiple determination.
stat.AdjR^2	Adjusted coefficient of multiple determination.
stat.s	Standard deviation of the error.
stat.DW	Durbin-Watson statistic; used to determine whether first-order auto correlation is present in the model.
stat.dfReg	Regression degrees of freedom.
stat.SSReg	Regression sum of squares.
stat.MSReg	Regression mean square.
stat.dfError	error degrees of freedom
stat.SSError	error sum of squares
stat.MSError	error MEan square
stat.bList	{b0,b1,...} List of coefficients of the regression equation ? = b0+b1 • x1+...
stat.tList	list of t statistics for each coefficient in $\hat{y}$(B List)
stat.PList	list of probability values for each t statistic
stat.SEList	list of SE slopes of each coefficient in B
stat.$\hat{y}$List	$\hat{y}$List = b0+b1 • x1+ . . .
stat.Resid	y - $\hat{y}$list
stat.sResid	Residuals: Resid=y - $\hat{y}$list
stat.CookDist	Cook's distance; measure of the influence of an observation based on the residual and leverage
stat.Leverage	Measure of how far the values of the independent variable are from their mean values

nCr()

Catalog >

nCr(*Value1*, *Value2***)** ⇒ *expression*

For integer *Value1* and *Value2* with *Value1* ≥ *Value2* ≥ 0, **nCr()** is the number of combinations of *Value1* things taken *Value2* at a time. (This is also known as a binomial coefficient.)

$\mathrm{nCr}(z,3)|z=5$ → 10

$\mathrm{nCr}(z,3)|z=6$ → 20

nCr(*Value*, **0)** ⇒ **1**

nCr(*Value*, *negInteger***)** ⇒ **0**

nCr(*Value*, *posInteger***)** ⇒
Value · **(***Value*−1**)... (***Value*−*posInteger***+1)/**
*posInteger***!**

nCr(*Value*, *nonInteger***)** ⇒ *expression***!/**
((*Value*−*nonInteger***)!** · *nonInteger***!)**

nCr(*List1*, *List2***)** ⇒ *list*

Returns a list of combinations based on the corresponding element pairs in the two lists. The arguments must be the same size list.

$\mathrm{nCr}(\{5,4,3\},\{2,4,2\})$ → $\{10,1,3\}$

nCr(*Matrix1*, *Matrix2***)** ⇒ *matrix*

Returns a matrix of combinations based on the corresponding element pairs in the two matrices. The arguments must be the same size matrix.

$\mathrm{nCr}\left(\begin{bmatrix}6 & 5\\ 4 & 3\end{bmatrix},\begin{bmatrix}2 & 2\\ 2 & 2\end{bmatrix}\right)$ → $\begin{bmatrix}15 & 10\\ 6 & 3\end{bmatrix}$

nDeriv()

Catalog >

nDeriv(*Expr1*, *Var*[=*Value*] [, *H*]**)** ⇒ *expression*
nDeriv(*Expr1*, *Var*[, *H*] | *Var*=*Value***)** ⇒ *expression*
nDeriv(*Expr1*, *Var*[=*Value*]**,** *List***)** ⇒ *list*
nDeriv(*List1*, *Var*[=*Value*] [, *H*]**)** ⇒ *list*
nDeriv(*Matrix1*, *Var*[=*Value*] [, *H*]**)** ⇒ *matrix*

Returns the numerical derivative as an expression. Uses the central difference quotient formula.

When *Value* is specified, it overrides any prior variable assignment or any current "such that" substitution for the variable.

H is the step value. If *H* is omitted, it defaults to 0.001.

When using *List1* or *Matrix1*, the operation gets mapped across the values in the list or across the matrix elements.

Note: See also **avgRC()**.

$\mathrm{nDeriv}(\cos(x),x)|x=\frac{\pi}{2}$ → $-1.$

newList()

Catalog >

newList(*numElements***)** ⇒ *list*

Returns a list with a dimension of *numElements*. Each element is zero.

$\mathrm{newList}(4)$ → $\{0,0,0,0\}$

newMat()

Catalog >

newMat(*numRows*, *numColumns***)** ⇒ *matrix*

Returns a matrix of zeros with the dimension *numRows* by *numColumns*.

$\mathrm{newMat}(2,3)$ → $\begin{bmatrix}0 & 0 & 0\\ 0 & 0 & 0\end{bmatrix}$

nfMax()

Catalog >

nfMax(*Expr***,** *Var***)** ⇒ *value*
nfMax(*Expr***,** *Var, lowBound***)** ⇒ *value*
nfMax(*Expr***,** *Var, lowBound***,** *upBound***)** ⇒ *value*
nfMax(*Expr, Var***) | *lowBound*<*Var*<*upBound*** ⇒ *value*

Returns a candidate numerical value of variable *Var* where the local maximum of *Expr* occurs.

If you supply *lowBound* and *upBound*, the function looks between those values for the local maximum.

$\text{nfMax}(-x^2-2\cdot x-1,x)$ → $-1.$

$\text{nfMax}(.5\cdot x^3-x-2,x,-5,5)$ → $-.816497$

nfMin()

Catalog >

nfMin(*Expr***,** *Var***)** ⇒ *value*
nfMin(*Expr***,** *Var, lowBound***)** ⇒ *value*
nfMin(*Expr***,** *Var, lowBound***,** *upBound***)** ⇒ *value*
nfMin(*Expr, Var***) | *lowBound*<*Var*<*upBound*** ⇒ *value*

Returns a candidate numerical value of variable *Var* where the local minimum of *Expr* occurs.

If you supply *lowBound* and *upBound*, the function looks between those values for the local minimum.

$\text{nfMin}(x^2+2\cdot x+5,x)$ → $-1.$

$\text{nfMin}(.5\cdot x^3-x-2,x,-5,5)$ → $.816497$

nInt()

Catalog >

nInt(*Expr1, Var, Lower, Upper***)** ⇒ *expression*

If the integrand *Expr1* contains no variable other than *Var*, and if *Lower* and *Upper* are constants, positive ∞, or negative ∞, then **nInt()** returns an approximation of ∫**(***Expr1, Var, Lower, Upper***)**. This approximation is a weighted average of some sample values of the integrand in the interval *Lower*<*Var*<*Upper*.

The goal is six significant digits. The adaptive algorithm terminates when it seems likely that the goal has been achieved, or when it seems unlikely that additional samples will yield a worthwhile improvement.

A warning is displayed ("Questionable accuracy") when it seems that the goal has not been achieved.

Nest **nInt()** to do multiple numeric integration. Integration limits can depend on integration variables outside them.

$\text{nInt}(e^{-x^2},x,-1,1)$ → 1.49365

$\text{nInt}(\cos(x),x,-\pi,\pi+1.\text{E}-12)$ → $-1.04144\text{E}-12$

$\text{nInt}\left(\text{nInt}\left(\frac{e^{-x\cdot y}}{\sqrt{x^2-y^2}},y,-x,x\right),x,0,1\right)$ → 3.30423

nom()

Catalog >

nom(*effectiveRate,CpY***)** ⇒ *value*

Financial function that converts the annual effective interest rate *effectiveRate* to a nominal rate, given *CpY* as the number of compounding periods per year.

effectiveRate must be a real number, and *CpY* must be a real number > 0.

Note: See also **eff()**, page 25.

$\text{nom}(5.90398,12)$ → 5.75

norm()

Catalog >

norm(*Matrix***)** ⇒ *expression*

Returns the Frobenius norm.

$\text{norm}\left(\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}\right)$ 5.47723

normCdf()

Catalog >

normCdf(*lowBound***,***upBound***[,μ,σ])** ⇒ *number* if *lowBound* and *upBound* are numbers, *list* if *lowBound* and *upBound* are lists

Computes the normal distribution probability between *lowBound* and *upBound* for the specified μ and σ.

For $p(X \le upBound)$, set *lowBound* = **−9E999**.

normPdf()

Catalog >

normPdf(*XVal***[,μ,σ])** ⇒ *number* if *XVal* is a number, *list* if *XVal* is a list

Computes the probability density function for the normal distribution at a specified *XVal* value for the specified μ and σ.

not

Catalog >

not *BooleanExpr* ⇒ *Boolean expression*

Returns true, false, or a simplified form of the argument.

not (2≥3) true

not 0hB0▸Base16 0hFFFFFFFFFFFFFF4F

not not 2 2

not *Integer1* ⇒ *integer*

Returns the one's complement of a real integer. Internally, *Integer1* is converted to a signed, 64-bit binary number. The value of each bit is flipped (0 becomes 1, and vice versa) for the one's complement. Results are displayed according to the Base mode.

You can enter the integer in any number base. For a binary or hexadecimal entry, you must use the 0b or 0h prefix, respectively. Without a prefix, the integer is treated as decimal (base 10).

If you enter a decimal integer that is too large for a signed, 64-bit binary form, a symmetric modulo operation is used to bring the value into the appropriate range.

In Hex base mode:

Important: Zero, not the letter O.

not 0h7AC36 0hFFFFFFFFFFF853C9

In Bin base mode:

0b100101▸Base10 37

not 0b100101
0b1111111111111111111111111111111▸

not 0b100101▸Base10 −38

To see the entire result, press ▲ and then use ◀ and ▶ to move the cursor.

Note: A binary entry can have up to 64 digits (not counting the 0b prefix). A hexadecimal entry can have up to 16 digits.

nPr()

Catalog >

nPr(*Value1*, *Value2***)** ⇒ *expression*

For integer *Value1* and *Value2* with *Value1* ≥ *Value2* ≥ 0, **nPr()** is the number of permutations of *Value1* things taken *Value2* at a time.

nPr(*Value*, **0)** ⇒ **1**
nPr(*Value*, *negInteger***)**
⇒ **1/((***Value***+1)** · **(***Value***+2)**... **(***Value*−*negInteger***))**
nPr(*Value*, *posInteger***)**
⇒ *Value* · **(***Value*−**1)... (***Value*−*posInteger***+1)**
nPr(*Value*, *nonInteger***)**
⇒ *Value***! / (***Value*−*nonInteger***)!**

nPr(*List1*, *List2***)** ⇒ *list*

Returns a list of permutations based on the corresponding element pairs in the two lists. The arguments must be the same size list.

nPr(*Matrix1*, *Matrix2***)** ⇒ *matrix*

Returns a matrix of permutations based on the corresponding element pairs in the two matrices. The arguments must be the same size matrix.

$\text{nPr}(z,3)|z=5$ → 60

$\text{nPr}(z,3)|z=6$ → 120

$\text{nPr}(\{5,4,3\},\{2,4,2\})$ → $\{20,24,6\}$

$\text{nPr}\left(\begin{bmatrix}6&5\\4&3\end{bmatrix},\begin{bmatrix}2&2\\2&2\end{bmatrix}\right)$ → $\begin{bmatrix}30&20\\12&6\end{bmatrix}$

$\text{nPr}(\{5,4,3\},\{2,4,2\})$ → $\{20,24,6\}$

$\text{nPr}\left(\begin{bmatrix}6&5\\4&3\end{bmatrix},\begin{bmatrix}2&2\\2&2\end{bmatrix}\right)$ → $\begin{bmatrix}30&20\\12&6\end{bmatrix}$

npv()

Catalog >

npv(*InterestRate*,*CFO*,*CFList*[,*CFFreq*]**)**

Financial function that calculates net present value; the sum of the present values for the cash inflows and outflows. A positive result for npv indicates a profitable investment.

InterestRate is the rate by which to discount the cash flows (the cost of money) over one period.

CF0 is the initial cash flow at time 0; it must be a real number.

CFList is a list of cash flow amounts after the initial cash flow *CF0*.

CFFreq is a list in which each element specifies the frequency of occurrence for a grouped (consecutive) cash flow amount, which is the corresponding element of *CFList*. The default is 1; if you enter values, they must be positive integers < 10,000.

$list1:=\{6000,-8000,2000,-3000\}$ → $\{6000,-8000,2000,-3000\}$

$list2:=\{2,2,2,1\}$ → $\{2,2,2,1\}$

$\text{npv}(10,5000,list1,list2)$ → 4769.91

nSolve()

Catalog >

nSolve(*Equation*,*Var***[=***Guess***])** ⇒ *number or error_string*
nSolve(*Equation*,*Var***[=***Guess***]**,*lowBound***)**
⇒ *number or error_string*
nSolve(*Equation*,*Var***[=***Guess***]**,*lowBound*,*upBound***)**
⇒ *number or error_string*
nSolve(*Equation*,*Var***[=***Guess***]) |** *lowBound***<***Var***<***upBound*
⇒ *number or error_string*

Iteratively searches for one approximate real numeric solution to *Equation* for its one variable. Specify the variable as:

variable
– or –
variable = real number

For example, x is valid and so is x=3.

$\text{nSolve}(x^2+5\cdot x-25=9,x)$ → 3.84429

$\text{nSolve}(x^2=4,x=-1)$ → −2.

$\text{nSolve}(x^2=4,x=1)$ → 2.

Note: If there are multiple solutions, you can use a guess to help find a particular solution.

nSolve() Catalog >

nSolve() attempts to determine either one point where the residual is zero or two relatively close points where the residual has opposite signs and the magnitude of the residual is not excessive. If it cannot achieve this using a modest number of sample points, it returns the string "no solution found."

$\text{nSolve}(x^2+5\cdot x-25=9,x)|x<0$ -8.84429

$\text{nSolve}\left(\frac{(1+r)^{24}-1}{r}=26,r\right)|r>0 \text{ and } r<.25$ $.006886$

$\text{nSolve}(x^2=-1,x)$ "No solution found"

o

OneVar Catalog >

OneVar [**1**,]*X*[,[*Freq*][,*Category*,*Include*]]
OneVar [*n*,]*X1*,*X2*[*X3*[,…[,*X20*]]]

Calculates 1-variable statistics on up to 20 lists. A summary of results is stored in the *stat.results* variable. (See page 76.)

All the arguments must have equal dimensions except for *Include*.

X represents xlist.
Freq represents frequency list.
Category represents category codes.
Include represents category include list.

Output variable	Description
stat.$\bar{x}$	Mean of x values.
stat.Σx	Sum of x values.
stat.Σx^2	Sum of x^2 values.
stat.sx	Sample standard deviation of x.
stat.σx	Population standard deviation of x.
stat.n	Number of data points.
stat.MinX	Minimum of x values.
stat.Q_1X	1st Quartile of x.
stat.MedianX	Median of x.
stat.Q_3X	3rd Quartile of x.
stat.MaxX	Maximum of x values.
stat.SSX	Sum of squares of deviations from the mean of x.

or

Catalog >

BooleanExpr1 **or** *BooleanExpr2* ⇒ *Boolean expression*

Returns true or false or a simplified form of the original entry.

Returns true if either or both expressions simplify to true. Returns false only if both expressions evaluate to false.

Note: See **xor**.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing enter instead of ctrl enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

Integer1 **or** *Integer2* ⇒ *integer*

Compares two real integers bit-by-bit using an or operation. Internally, both integers are converted to signed, 64-bit binary numbers. When corresponding bits are compared, the result is 1 if either bit is 1; the result is 0 only if both bits are 0. The returned value represents the bit results, and is displayed according to the Base mode.

You can enter the integers in any number base. For a binary or hexadecimal entry, you must use the 0b or 0h prefix, respectively. Without a prefix, integers are treated as decimal (base 10).

If you enter a decimal integer that is too large for a signed, 64-bit binary form, a symmetric modulo operation is used to bring the value into the appropriate range.

Note: See **xor**.

```
Define g(x)=Func                    Done
              If x≤0 or x≥5
              Goto end
              Return x·3
              Lbl end
              EndFunc
g(3)                                  9
g(0)          A function did not return a value
```

In Hex base mode:

```
0h7AC36 or 0h3D5F                 0h7BD7F
```

Important: Zero, not the letter O.

In Bin base mode:

```
0b100101 or 0b100                 0b100101
```

Note: A binary entry can have up to 64 digits (not counting the 0b prefix). A hexadecimal entry can have up to 16 digits.

ord()

Catalog >

ord(*String***)** ⇒ *integer*
ord(*List1***)** ⇒ *list*

Returns the numeric code of the first character in character string *String*, or a list of the first characters of each list element.

```
ord("hello")                        104
char(104)                           "h"
ord(char(24))                       24
ord({"alpha","beta"})               {97,98}
```

P

P▶Rx()

Catalog >

P▶Rx(*rExpr***, θ***Expr***)** ⇒ *expression*
P▶Rx(*rList***, θ***List***)** ⇒ *list*
P▶Rx(*rMatrix***, θ***Matrix***)** ⇒ *matrix*

Returns the equivalent x-coordinate of the (r, θ) pair.

Note: The θ argument is interpreted as either a degree, gradian or radian angle, according to the current angle mode. If the argument is an expression, you can use °, G or r to override the angle mode setting temporarily.

In Radian angle mode:

```
P▶Rx(4,60°)                         2.
P▶Rx({-3,1.0,1.3},{π/3,-π/4,0})
                          {-1.5,7.07107,1.3}
```

P▶Ry()

Catalog >

P▶Ry(*rValue***, θ***Value***)** ⇒ *value*
P▶Ry(*rList***, θ***List***)** ⇒ *list*
P▶Ry(*rMatrix***, θ***Matrix***)** ⇒ *matrix*

Returns the equivalent y-coordinate of the (r, θ) pair.

Note: The θ argument is interpreted as either a degree, radian or gradian angle, according to the current angle mode.

In Radian angle mode:

$$\text{P▶Ry}(4,60°) \qquad 3.4641$$

$$\text{P▶Ry}\left(\{-3,10,1.3\},\left\{\frac{\pi}{3},\frac{-\pi}{4},0\right\}\right) \qquad \{-2.59808,-7.07107,0\}$$

PassErr

Catalog >

PassErr

Passes an error to the next level.

If system variable *errCode* is zero, **PassErr** does not do anything.

The **Else** clause of the **Try...Else...EndTry** block should use **ClrErr** or **PassErr**. If the error is to be processed or ignored, use **ClrErr**. If what to do with the error is not known, use **PassErr** to send it to the next error handler. If there are no more pending **Try...Else...EndTry** error handlers, the error dialog box will be displayed as normal.

Note: See also **ClrErr**, page 13, and **Try**, page 84.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing ↵ instead of enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

For an example of **PassErr**, See Example 2 under the **Try** command, page 84.

piecewise()

Catalog >

piecewise(*Expr1* [**,** *Condition1* [**,** *Expr2* [**,** *Condition2* [**,** *…*]]]]**)**

Returns definitions for a piecewise function in the form of a list. You can also create piecewise definitions by using a template.

Note: See also **Piecewise template**, page 2.

$$\text{Define } p(x)=\begin{cases}x, & x>0\\ \text{undef}, & x\le 0\end{cases} \qquad \textit{Done}$$

$$p(1) \qquad 1$$

$$p(-1) \qquad \text{undef}$$

poissCdf()

Catalog >

poissCdf(λ**,***lowBound*[**,***upBound*]**)** ⇒ *number* if *lowBound* and *upBound* are numbers, *list* if *lowBound* and *upBound* are lists

Computes a cumulative probability for the discrete Poisson distribution with specified mean λ.

For $P(X \le upBound)$, set *lowBound*=0

poissPdf()

Catalog >

poissPdf(λ**,***XVal***)** ⇒ *number* if *XVal* is a number, *list* if *XVal* is a list

Computes a probability for the discrete Poisson distribution with the specified mean λ.

▸Polar

Catalog >

Vector **▸Polar**

Displays *vector* in polar form [r ∠θ]. The vector must be of dimension 2 and can be a row or a column.

Note: ▸Polar is a display-format instruction, not a conversion function. You can use it only at the end of an entry line, and it does not update *ans*.

Note: See also **▸Rect**, page 65.

complexValue **▸Polar**

Displays *complexVector* in polar form.

- Degree angle mode returns (r∠θ).
- Radian angle mode returns $re^{i\theta}$.

complexValue can have any complex form. However, an $re^{i\theta}$ entry causes an error in Degree angle mode.

Note: You must use the parentheses for an (r∠θ) polar entry.

$[1 \quad 3.] \blacktriangleright \text{Polar} \qquad [3.16228 \quad \angle 71.5651]$

In Radian angle mode:

$(3+4\cdot i) \blacktriangleright \text{Polar} \qquad e^{.927295\cdot i}\cdot 5$

$\left(\left(4 \angle \frac{\pi}{3}\right)\right) \blacktriangleright \text{Polar} \qquad e^{1.0472\cdot i}\cdot 4.$

In Gradian angle mode:

$(4\cdot i) \blacktriangleright \text{Polar} \qquad (4 \angle 100)$

In Degree angle mode:

$(3+4\cdot i) \blacktriangleright \text{Polar} \qquad (5 \angle 53.1301)$

polyEval()

Catalog >

polyEval(*List1***,** *Expr1***)** ⇒ *expression*
polyEval(*List1***,** *List2***)** ⇒ *expression*

Interprets the first argument as the coefficient of a descending-degree polynomial, and returns the polynomial evaluated for the value of the second argument.

$\text{polyEval}(\{1,2,3,4\},2) \qquad 26$

$\text{polyEval}(\{1,2,3,4\},\{2,^{-}7\}) \qquad \{26,^{-}262\}$

PowerReg

Catalog >

PowerReg *X*,*Y* [**,** *Freq*] [**,** *Category***,** *Include*]]

Calculates the power regression. A summary of results is stored in the *stat.results* variable. (See page 76.)

All the arguments must have equal dimensions except for *Include*.

X represents xlist.
Y represents ylist.
Freq represents frequency list.
Category represents category codes.
Include represents category include list.

Output variable	Description
stat.RegEqn	Regression equation: a • $(x)^b$.
stat.a, stat.b	Regression coefficients: y = a • $(x)^b$.
stat.r^2	Coefficient of determination.
stat.r	Correlation coefficient for linear model.
stat.Resid	Residuals of the curves fit = y - a • $(x)^b$.
stat.ResidTrans	Residuals associated with linear fit of transformed data.

Output variable	Description
stat.XReg	List of data points in the modified *X List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.YReg	List of data points in the modified *Y List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.FreqReg	List of frequencies corresponding to *stat.XReg* and *stat.YReg*.

Prgm

Catalog >

Prgm
Block
EndPrgm

Template for creating a user-defined program. Must be used with the **Define**, **Define LibPub**, or **Define LibPriv** command.

Block can be a single statement, a series of statements separated with the ":" character, or a series of statements on separate lines.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing enter instead of enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

Calculate GCD and display intermediate results.

```
Define proggcd(a,b)=Prgm
                    Local d
                    While b≠0
                    d:=mod(a,b)
                    a:=b
                    b:=d
                    Disp a," ",b
                    EndWhile
                    Disp "GCD=",a
                    EndPrgm
                                        Done

proggcd(4560,450)
                                    450 60
                                    60 30
                                    30 0
                                    GCD=30
                                        Done
```

Product (PI)

See Π(), page 101.

product()

Catalog >

product(*List*[**,** *Start*[**,** *end*]]**)** ⇒ *expression*

Returns the product of the elements contained in *List*. *Start* and *end* are optional. They specify a range of elements.

```
product({1,2,3,4})                          24
product({4,5,8,9},2,3)                      40
```

product(*Matrix1*[**,** *Start*[**,** *end*]]**)** ⇒ *matrix*

Returns a row vector containing the products of the elements in the columns of *Matrix1*. *Start* and *end* are optional. They specify a range of rows.

$$\text{product}\begin{bmatrix}1&2&3\\4&5&6\\7&8&9\end{bmatrix} \qquad \begin{bmatrix}28&80&162\end{bmatrix}$$

$$\text{product}\begin{bmatrix}1&2&3\\4&5&6\\7&8&9\end{bmatrix},1,2 \qquad \begin{bmatrix}4&10&18\end{bmatrix}$$

propFrac() **Catalog >**

propFrac(*Value1*[**,** *Var*]**)** ⇒ *value*

propFrac(*rational_number***)** returns *rational_number* as the sum of an integer and a fraction having the same sign and a greater denominator magnitude than numerator magnitude.

$\text{propFrac}\left(\frac{4}{3}\right)$ $1+\frac{1}{3}$

$\text{propFrac}\left(\frac{-4}{3}\right)$ $-1-\frac{1}{3}$

propFrac(*rational_expression***,***Var***)** returns the sum of proper ratios and a polynomial with respect to *Var*. The degree of *Var* in the denominator exceeds the degree of *Var* in the numerator in each proper ratio. Similar powers of *Var* are collected. The terms and their factors are sorted with *Var* as the main variable.

If *Var* is omitted, a proper fraction expansion is done with respect to the most main variable. The coefficients of the polynomial part are then made proper with respect to their most main variable first and so on.

You can use the **propFrac()** function to represent mixed fractions and demonstrate addition and subtraction of mixed fractions.

$\text{propFrac}\left(\frac{11}{7}\right)$ $1+\frac{4}{7}$

$\text{propFrac}\left(3+\frac{1}{11}+5+\frac{3}{4}\right)$ $8+\frac{37}{44}$

$\text{propFrac}\left(3+\frac{1}{11}-\left(5+\frac{3}{4}\right)\right)$ $-2-\frac{29}{44}$

Q

QR **Catalog >**

QR *Matrix***,** *qMatName***,** *rMatName***[,** *Tol***]**

Calculates the Householder QR factorization of a real or complex matrix. The resulting Q and R matrices are stored to the specified *MatNames*. The Q matrix is unitary. The R matrix is upper triangular.

Optionally, any matrix element is treated as zero if its absolute value is less than *Tol*. This tolerance is used only if the matrix has floating-point entries and does not contain any symbolic variables that have not been assigned a value. Otherwise, *Tol* is ignored.

- If you use ctrl enter or set the **Auto or Approximate** mode to Approximate, computations are done using floating-point arithmetic.
- If *Tol* is omitted or not used, the default tolerance is calculated as:
  5E⁻14 · max(dim(*Matrix*)) · rowNorm(*Matrix*)

The QR factorization is computed numerically using Householder transformations. The symbolic solution is computed using Gram-Schmidt. The columns in *qMatName* are the orthonormal basis vectors that span the space defined by *matrix*.

The floating-point number (9.) in m1 causes results to be calculated in floating-point form.

$\begin{bmatrix}1&2&3\\4&5&6\\7&8&9.\end{bmatrix}\rightarrow m1$ $\begin{bmatrix}1&2&3\\4&5&6\\7&8&9.\end{bmatrix}$

QR *m1*,*qm*,*rm* *Done*

qm $\begin{bmatrix}.123091&.904534&.408248\\.492366&.301511&-.816497\\.86164&-.301511&.408248\end{bmatrix}$

rm $\begin{bmatrix}8.12404&9.60114&11.0782\\0.&.904534&1.80907\\0.&0.&0.\end{bmatrix}$

ClearAZ *Done*

QuadReg

Catalog >

QuadReg *X*,*Y* [, *Freq*] [, *Category*, *Include*]]

Calculates the quadratic polynomial regression. A summary of results is stored in the *stat.results* variable. (See page 76.)

All the arguments must have equal dimensions except for *Include*.

X represents xlist.
Y represents ylist.
Freq represents frequency list.
Category represents category codes.
Include represents category include list.

Output variable	Description
stat.RegEqn	Regression equation: $a \cdot x^2+b \cdot x+c$.
stat.a, stat.b, stat.c	Regression coefficients.
stat.R^2	Coefficient of determination.
stat.Resid	Residuals of the curves fit = $y - (a \cdot x^2+b \cdot x+c)$.
stat.XReg	List of data points in the modified *X List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.YReg	List of data points in the modified *Y List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.FreqReg	List of frequencies corresponding to *stat.XReg* and *stat.YReg*.

QuartReg

Catalog >

QuartReg *X*,*Y* [, *Freq*] [, *Category*, *Include*]]

Calculates the quartic polynomial regression. A summary of results is stored in the *stat.results* variable. (See page 76.)

All the arguments must have equal dimensions except for *Include*.

X represents xlist.
Y represents ylist.
Freq represents frequency list.
Category represents category codes.
Include represents category include list.

Output variable	Description
stat.RegEqn	Regression equation: $a \cdot x^4+b \cdot x^3+c \cdot x^2+d \cdot x+e$.
stat.a, stat.b, stat.c, stat.d, stat.e	Regression coefficients.
stat.R^2	Coefficient of determination.
stat.Resid	Residuals of the curves fit = $y - (a \cdot x^4+b \cdot x^3+c \cdot x^2+d \cdot x+e)$.
stat.XReg	List of data points in the modified *X List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.YReg	List of data points in the modified *Y List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.

Output variable	Description
stat.FreqReg	List of frequencies corresponding to *stat.XReg* and *stat.YReg*.

R

R▸Pθ()

Catalog >

R▸Pθ (*xValue***,** *yValue***)** ⇒ *value*
R▸Pθ (*xList***,** *yList***)** ⇒ *list*
R▸Pθ (*xMatrix***,** *yMatrix***)** ⇒ *matrix*

Returns the equivalent θ-coordinate of the (*x*,*y*) pair arguments.

Note: The result is returned as a degree, gradian or radian angle, according to the current angle mode setting.

In Degree angle mode:

$R▸Pθ(2,2)$ → 45.

In Gradian angle mode:

$R▸Pθ(2,2)$ → 50.

In Radian angle mode:

$R▸Pθ(3,2)$ → .588003

$R▸Pθ\left(\begin{bmatrix}3 & -4 & 2\end{bmatrix},\begin{bmatrix}0 & \frac{\pi}{4} & 1.5\end{bmatrix}\right)$ → $\begin{bmatrix}0 & 2.94771 & .643501\end{bmatrix}$

R▸Pr()

Catalog >

R▸Pr (*xValue***,** *yValue***)** ⇒ *value*
R▸Pr (*xList***,** *yList***)** ⇒ *list*
R▸Pr (*xMatrix***,** *yMatrix***)** ⇒ *matrix*

Returns the equivalent r-coordinate of the (*x*,*y*) pair arguments.

In Radian angle mode:

$R▸Pr(3,2)$ → 3.60555

$R▸Pr\left(\begin{bmatrix}3 & -4 & 2\end{bmatrix},\begin{bmatrix}0 & \frac{\pi}{4} & 1.5\end{bmatrix}\right)$ → $\begin{bmatrix}3 & 4.07638 & \frac{5}{2}\end{bmatrix}$

▸Rad

Catalog >

Value1▸**Rad** ⇒ *value*

Converts the argument to radian angle measure.

In Degree angle mode:

$(1.5)▸Rad$ → $(.02618)^r$

In Gradian angle mode:

$(1.5)▸Rad$ → $(.023562)^r$

rand()

Catalog >

rand() ⇒ *expression*
rand(*#Trials***)** ⇒ *list*

rand() returns a random value between 0 and 1.

rand(*#Trials***)** returns a list containing *#Trials* random values between 0 and 1.

Sets the random-number seed.

RandSeed 1147 → *Done*

rand(2) → {.158206,.717917}

randBin()

Catalog >

randBin(*n***,** *p***)** ⇒ *expression*
randBin(*n***,** *p***,** *#Trials***)** ⇒ *list*

randBin(*n***,** *p***)** returns a random real number from a specified Binomial distribution.

randBin(*n***,** *p***,** *#Trials***)** returns a list containing *#Trials* random real numbers from a specified Binomial distribution.

randBin(80,.5)	34.
randBin(80,.5,3)	{47.,41.,46.}

randInt()

Catalog >

randInt(*lowBound***,***upBound***)** ⇒ *expression*
randInt(*lowBound***,***upBound* **,***#Trials***)** ⇒ *list*

randInt(*lowBound***,***upBound***)** returns a random integer within the range specified by *lowBound* and *upBound* integer bounds.

randInt(*lowBound***,***upBound* **,***#Trials***)** returns a list containing *#Trials* random integers within the specified range.

randInt(3,10)	7.
randInt(3,10,4)	{8.,9.,4.,4.}

randMat()

Catalog >

randMat(*numRows***,** *numColumns***)** ⇒ *matrix*

Returns a matrix of integers between -9 and 9 of the specified dimension.

Both arguments must simplify to integers.

RandSeed 1147	*Done*
randMat(3,3)	$\begin{bmatrix} 8 & -3 & 6 \\ -2 & 3 & -6 \\ 0 & 4 & -6 \end{bmatrix}$

Note: The values in this matrix will change each time you press enter.

randNorm()

Catalog >

randNorm(μ**,** σ**)** ⇒ *expression*
randNorm(μ**,** σ**,** *#Trials***)** ⇒ *list*

randNorm(μ**,** σ**)** returns a decimal number from the specified normal distribution. It could be any real number but will be heavily concentrated in the interval [μ−3 · σ, μ+3 · σ].

randNorm(μ**,** σ**,** *#Trials***)** returns a list containing *#Trials* decimal numbers from the specified normal distribution.

RandSeed 1147	*Done*
randNorm(0,1)	.492541
randNorm(3,4.5)	-3.54356

randPoly()

Catalog >

randPoly(*Var***,** *Order***)** ⇒ *expression*

Returns a polynomial in *Var* of the specified *Order*. The coefficients are random integers in the range −9 through 9. The leading coefficient will not be zero.

Order must be 0–99.

RandSeed 1147	*Done*
randPoly(x,5)	$-2\cdot x^5+3\cdot x^4-6\cdot x^3+4\cdot x-6$

randSamp()

Catalog >

randSamp(*List***,***#Trials***[,***noRepl***])** ⇒ *list*

Returns a list containing a random sample of *#Trials* trials from *List* with an option for sample replacement (*noRepl*=0), or no sample replacement (*noRepl*=1). The default is with sample replacement.

Define *list3*={1,2,3,4,5}	*Done*
Define *list4*=randSamp(*list3*,6)	*Done*
list4	{5.,1.,3.,3.,4.,4.}

RandSeed

Catalog >

RandSeed *Number*

If *Number* = 0, sets the seeds to the factory defaults for the random-number generator. If *Number* ≠ 0, it is used to generate two seeds, which are stored in system variables seed1 and seed2.

RandSeed 1147 → *Done*

rand() → .158206

real()

Catalog >

real(*Value1***)** ⇒ *value*

Returns the real part of the argument.

real(2+3·*i*) → 2

real(*List1***)** ⇒ *list*

Returns the real parts of all elements.

real({1+3·*i*,3,*i*}) → {1,3,0}

real(*Matrix1***)** ⇒ *matrix*

Returns the real parts of all elements.

$$\text{real}\begin{bmatrix} 1+3\cdot i & 3 \\ 2 & i \end{bmatrix} \rightarrow \begin{bmatrix} 1 & 3 \\ 2 & 0 \end{bmatrix}$$

▸Rect

Catalog >

Vector **▸Rect**

Displays *Vector* in rectangular form [x, y, z]. The vector must be of dimension 2 or 3 and can be a row or a column.

Note: ▸Rect is a display-format instruction, not a conversion function. You can use it only at the end of an entry line, and it does not update *ans*.

Note: See also **▸Polar**, page 59.

$$\begin{bmatrix} 3 & \angle\frac{\pi}{4} & \angle\frac{\pi}{6} \end{bmatrix} \blacktriangleright \text{Rect} \rightarrow \begin{bmatrix} 1.06066 & 1.06066 & 2.59808 \end{bmatrix}$$

complexValue **▸Rect**

Displays *complexValue* in rectangular form a+bi. The *complexValue* can have any complex form. However, an $re^{i\theta}$ entry causes an error in Degree angle mode.

Note: You must use parentheses for an (r∠θ) polar entry.

In Radian angle mode:

$$\left(4\cdot e^{\frac{\pi}{3}}\right) \blacktriangleright \text{Rect} \rightarrow 11.3986$$

$$\left(\left(4 \angle \frac{\pi}{3}\right)\right) \blacktriangleright \text{Rect} \rightarrow 2.+3.4641\cdot i$$

In Gradian angle mode:

$$\left((1 \angle 100)\right) \blacktriangleright \text{Rect} \rightarrow i$$

In Degree angle mode:

$$\left((4 \angle 60)\right) \blacktriangleright \text{Rect} \rightarrow 2.+3.4641\cdot i$$

Note: To type ∠, select it from the symbol list in the Catalog.

ref()

Catalog >

ref(*Matrix1***[, *Tol*]) ⇒ *matrix***

Returns the row echelon form of *Matrix1*.

Optionally, any matrix element is treated as zero if its absolute value is less than *Tol*. This tolerance is used only if the matrix has floating-point entries and does not contain any symbolic variables that have not been assigned a value. Otherwise, *Tol* is ignored.

- If you use ctrl ≈ enter or set the **Auto or Approximate** mode to Approximate, computations are done using floating-point arithmetic.
- If *Tol* is omitted or not used, the default tolerance is calculated as:
  5E⁻14 • max(dim(*Matrix1*)) • rowNorm(*Matrix1*)

Note: See also **rref()**, page 69.

$$\text{ref}\begin{bmatrix} -2 & -2 & 0 & -6 \\ 1 & -1 & 9 & -9 \\ -5 & 2 & 4 & -4 \end{bmatrix} \qquad \begin{bmatrix} 1 & \frac{-2}{5} & \frac{-4}{5} & \frac{4}{5} \\ 0 & 1 & \frac{4}{7} & \frac{11}{7} \\ 0 & 0 & 1 & \frac{-62}{71} \end{bmatrix}$$

remain()

Catalog >

remain(*Value1***, *Value2*) ⇒ *value***
remain(*List1***, *List2*) ⇒ *list***
remain(*Matrix1***, *Matrix2*) ⇒ *matrix***

Returns the remainder of the first argument with respect to the second argument as defined by the identities:

remain(x,0) ≡ x
remain(x,y) ≡ x−y • iPart(x/y)

As a consequence, note that **remain(**−x,y**)** ≡ −**remain(**x,y**)**. The result is either zero or it has the same sign as the first argument.

Note: See also **mod()**, page 49.

remain(7,0)	7
remain(7,3)	1
remain(−7,3)	−1
remain(7,−3)	1
remain(−7,−3)	−1
remain({12,−14,16},{9,7,−5})	{3,0,1}

$$\text{remain}\left(\begin{bmatrix} 9 & -7 \\ 6 & 4 \end{bmatrix},\begin{bmatrix} 4 & 3 \\ 4 & -3 \end{bmatrix}\right) \qquad \begin{bmatrix} 1 & -1 \\ 2 & 1 \end{bmatrix}$$

Return

Catalog >

Return [*Expr*]

Returns *Expr* as the result of the function. Use within a **Func**...**EndFunc** block.

Note: Use **Return** without an argument within a **Prgm**...**EndPrgm** block to exit a program.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing ↵ instead of ≈ enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

```
Define factoral(nn)=Func
                    Local answer,count
                    1→answer
                    For count,1,nn
                    answer·count→answer
                    EndFor
                    Return answer
                    EndFunc
                                    Done
factoral(3)                         6
```

right()

Catalog >

right(*List1***[, *Num*]) ⇒ *list***

Returns the rightmost *Num* elements contained in *List1*.

If you omit *Num*, returns all of *List1*.

right({1,3,−2,4},3)	{3,−2,4}

right()

Catalog >

right(*sourceString*[**,** *Num*]**)** ⇒ *string*

Returns the rightmost *Num* characters contained in character string *sourceString*.

If you omit *Num*, returns all of *sourceString*.

right(*Comparison***)** ⇒ *expression*

Returns the right side of an equation or inequality.

right("Hello",2) "lo"

root()

Catalog >

root(*Value***)** ⇒ *root*

root(*Value1***,** *Value2***)** ⇒ *root*

root(*Value***)** returns the square root of *Value*.

root(*Value1***,** *Value2***)** returns the *Value2* root of *Value1*. *Value1* can be a real or complex floating point constant or an integer or complex rational constant.

Note: See also **Nth root template**, page 1.

$\sqrt[3]{8}$ 2

$\sqrt[3]{3}$ 1.44225

rotate()

Catalog >

rotate(*Integer1*[**,***#ofRotations*]**)** ⇒ *integer*

Rotates the bits in a binary integer. You can enter *Integer1* in any number base; it is converted automatically to a signed, 64-bit binary form. If the magnitude of *Integer1* is too large for this form, a symmetric modulo operation brings it within the range.

If *#ofRotations* is positive, the rotation is to the left. If *#ofRotations* is negative, the rotation is to the right. The default is ⁻1 (rotate right one bit).

For example, in a right rotation:

Each bit rotates right.

0b00000000000001111010110000110101

Rightmost bit rotates to leftmost.

produces:

0b10000000000000111101011000011010

The result is displayed according to the Base mode.

In Bin base mode:

rotate(0b11111111111111111111111111111111) 0b10000000000000000000000000000001

rotate(256,1) 0b1000000000

To see the entire result, press ▲ and then use ◀ and ▶ to move the cursor.

In Hex base mode:

rotate(0h78E) 0h3C7

rotate(0h78E,⁻2) 0h80000000000001E3

rotate(0h78E,2) 0h1E38

Important: To enter a binary or hexadecimal number, always use the 0b or 0h prefix (zero, not the letter O).

rotate(*List1*[**,***#ofRotations*]**)** ⇒ *list*

Returns a copy of *List1* rotated right or left by *#of Rotations* elements. Does not alter *List1*.

If *#ofRotations* is positive, the rotation is to the left. If *#of Rotations* is negative, the rotation is to the right. The default is ⁻1 (rotate right one element).

In Dec base mode:

rotate({1,2,3,4}) {4,1,2,3}

rotate({1,2,3,4},⁻2) {3,4,1,2}

rotate({1,2,3,4},1) {2,3,4,1}

rotate(*String1*[**,***#ofRotations*]**)** ⇒ *string*

Returns a copy of *String1* rotated right or left by *#ofRotations* characters. Does not alter *String1*.

If *#ofRotations* is positive, the rotation is to the left. If *#ofRotations* is negative, the rotation is to the right. The default is ⁻1 (rotate right one character).

rotate("abcd") "dabc"

rotate("abcd",⁻2) "cdab"

rotate("abcd",1) "bcda"

round()

Catalog >

round(*Value1***[, *digits*]) ⇒ *value***

Returns the argument rounded to the specified number of digits after the decimal point.

digits must be an integer in the range 0–12. If *digits* is not included, returns the argument rounded to 12 significant digits.

Note: Display digits mode may affect how this is displayed.

$\text{round}(1.234567,3)$ → 1.235

round(*List1***[, *digits*]) ⇒ *list***

Returns a list of the elements rounded to the specified number of digits.

$\text{round}(\{\pi,\sqrt{2},\ln(2)\},4)$ → $\{3.1416,1.4142,.6931\}$

round(*Matrix1***[, *digits*]) ⇒ *matrix***

Returns a matrix of the elements rounded to the specified number of digits.

$\text{round}\left(\begin{bmatrix}\ln(5) & \ln(3)\\ \pi & e^1\end{bmatrix},1\right)$ → $\begin{bmatrix}1.6 & 1.1\\ 3.1 & 2.7\end{bmatrix}$

rowAdd()

Catalog >

rowAdd(*Matrix1***, *rIndex1*, *rIndex2*) ⇒ *matrix***

Returns a copy of *Matrix1* with row *rIndex2* replaced by the sum of rows *rIndex1* and *rIndex2*.

$\text{rowAdd}\left(\begin{bmatrix}3 & 4\\ -3 & -2\end{bmatrix},1,2\right)$ → $\begin{bmatrix}3 & 4\\ 0 & 2\end{bmatrix}$

rowDim()

Catalog >

rowDim(*Matrix***) ⇒ *expression***

Returns the number of rows in *Matrix*.

Note: See also **colDim()**, page 14.

$\begin{bmatrix}1 & 2\\ 3 & 4\\ 5 & 6\end{bmatrix} \rightarrow m1$ → $\begin{bmatrix}1 & 2\\ 3 & 4\\ 5 & 6\end{bmatrix}$

$\text{rowDim}(m1)$ → 3

rowNorm()

Catalog >

rowNorm(*Matrix***) ⇒ *expression***

Returns the maximum of the sums of the absolute values of the elements in the rows in *Matrix*.

Note: All matrix elements must simplify to numbers. See also **colNorm()**, page 14.

$\text{rowNorm}\left(\begin{bmatrix}-5 & 6 & -7\\ 3 & 4 & 9\\ 9 & -9 & -7\end{bmatrix}\right)$ → 25

rowSwap()

Catalog >

rowSwap(*Matrix1***, *rIndex1*, *rIndex2*) ⇒ *matrix***

Returns *Matrix1* with rows *rIndex1* and *rIndex2* exchanged.

$\begin{bmatrix}1 & 2\\ 3 & 4\\ 5 & 6\end{bmatrix} \rightarrow mat$ → $\begin{bmatrix}1 & 2\\ 3 & 4\\ 5 & 6\end{bmatrix}$

$\text{rowSwap}(mat,1,3)$ → $\begin{bmatrix}5 & 6\\ 3 & 4\\ 1 & 2\end{bmatrix}$

rref()

Catalog >

rref(*Matrix1***[, *Tol*]) ⇒ *matrix***

Returns the reduced row echelon form of *Matrix1*.

$$\text{rref}\begin{bmatrix} -2 & -2 & 0 & -6 \\ 1 & -1 & 9 & -9 \\ -5 & 2 & 4 & -4 \end{bmatrix} \qquad \begin{bmatrix} 1 & 0 & 0 & \frac{66}{71} \\ 0 & 1 & 0 & \frac{147}{71} \\ 0 & 0 & 1 & \frac{-62}{71} \end{bmatrix}$$

Optionally, any matrix element is treated as zero if its absolute value is less than *Tol*. This tolerance is used only if the matrix has floating-point entries and does not contain any symbolic variables that have not been assigned a value. Otherwise, *Tol* is ignored.

- If you use ctrl enter or set the **Auto or Approximate** mode to Approximate, computations are done using floating-point arithmetic.
- If *Tol* is omitted or not used, the default tolerance is calculated as:
  5E−14 · max(dim(*Matrix1*)) · rowNorm(*Matrix1*)

Note: See also **ref()**, page 66.

S

sec()

Catalog >

sec(*Value1***) ⇒ *value***
sec(*List1***) ⇒ *list***

Returns the secant of *Value1* or returns a list containing the secants of all elements in *List1*.

Note: The argument is interpreted as a degree, gradian or radian angle, according to the current angle mode setting. You can use °, G, or r to override the angle mode temporarily.

In Degree angle mode:

$\sec(45)$ 1.41421

$\sec(\{1,2.3,4\})$ $\{1.00015,1.00081,1.00244\}$

sec⁻¹()

Catalog >

sec⁻¹(*Value1***) ⇒ *value***
sec⁻¹(*List1***) ⇒ *list***

Returns the angle whose secant is *Value1* or returns a list containing the inverse secants of each element of *List1*.

Note: The result is returned as a degree, gradian or radian angle, according to the current angle mode setting.

In Degree angle mode:

$\sec^{-1}(1)$ 0

In Gradian angle mode:

$\sec^{-1}(\sqrt{2})$ 50

In Radian angle mode:

$\sec^{-1}(\{1,2,5\})$ $\{0,1.0472,1.36944\}$

sech()

Catalog >

sech(*Value1***) ⇒ *value***
sech(*List1***) ⇒ *list***

Returns the hyperbolic secant of *Value1* or returns a list containing the hyperbolic secants of the *List1* elements.

$\text{sech}(3)$ .099328

$\text{sech}(\{1,2.3,4\})$ $\{.648054,.198522,.036619\}$

sech⁻¹()

Catalog >

sech⁻¹(*Value1***)** ⇒ *value*

sech⁻¹ (*List1***)** ⇒ *list*

Returns the inverse hyperbolic secant of *Value1* or returns a list containing the inverse hyperbolic secants of each element of *List1*.

In Radian angle and Rectangular complex mode:

$\text{sech}^{-1}(1)$	0
$\text{sech}^{-1}(\{1,-2,2.1\})$	$\{0,2.0944\cdot i,8.\text{E}{-15}+1.07448\cdot i\}$

seq()

Catalog >

seq(*Expr***,** *Var***,** *Low***,** *High***[,** *Step***])** ⇒ *list*

Increments *Var* from *Low* through *High* by an increment of *Step*, evaluates *Expr*, and returns the results as a list. The original contents of *Var* are still there after **seq()** is completed.

Var cannot be a system variable.

The default value for *Step* = 1.

$\text{seq}(n^2,n,1,6)$	$\{1,4,9,16,25,36\}$
$\text{seq}\left(\frac{1}{n},n,1,10,2\right)$	$\left\{1,\frac{1}{3},\frac{1}{5},\frac{1}{7},\frac{1}{9}\right\}$
$\text{sum}\left(\text{seq}\left(\frac{1}{n^2},n,1,10,1\right)\right)$	$\frac{1968329}{1270080}$

Press **Ctrl Enter** (ctrl) (≈ enter) to evaluate:

$\text{sum}\left(\text{seq}\left(\frac{1}{n^2},n,1,10,1\right)\right)$	1.54977

setMode()

Catalog >

setMode(*modeNameInteger***,** *settingInteger***)** ⇒ *integer*
setMode(*list***)** ⇒ *integer list*

Valid only within a function or program.

setMode(*modeNameInteger***,** *settingInteger***)** temporarily sets mode *modeNameInteger* to the new setting *settingInteger*, and returns an integer corresponding to the original setting of that mode. The change is limited to the duration of the program/function's execution.

modeNameInteger specifies which mode you want to set. It must be one of the mode integers from the table below.

settingInteger specifies the new setting for the mode. It must be one of the setting integers listed below for the specific mode you are setting.

setMode(*list***)** lets you change multiple settings. *list* contains pairs of mode integers and setting integers. **setMode(***list***)** returns a similar list whose integer pairs represent the original modes and settings.

If you have saved all mode settings with **getMode(0)** → *var*, you can use **setMode(***var***)** to restore those settings until the function or program exits. See **getMode()**, page 33.

Note: The current mode settings are passed to called subroutines. If any subroutine changes a mode setting, the mode change will be lost when control returns to the calling routine.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing (↵) instead of (≈ enter) at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

Display approximate value of π using the default setting for Display Digits, and then display π with a setting of Fix2. Check to see that the default is restored after the program executes.

```
Define prog1()=Prgm                    Done
                Disp π
                setMode(1,16)
                Disp π
                EndPrgm
prog1()
                                     3.14159
                                        3.14
                                        Done
```

Mode Name	Mode Integer	Setting Integers
Display Digits	**1**	**1**=Float, **2**=Float1, **3**=Float2, **4**=Float3, **5**=Float4, **6**=Float5, **7**=Float6, **8**=Float7, **9**=Float8, **10**=Float9, **11**=Float10, **12**=Float11, **13**=Float12, **14**=Fix0, **15**=Fix1, **16**=Fix2, **17**=Fix3, **18**=Fix4, **19**=Fix5, **20**=Fix6, **21**=Fix7, **22**=Fix8, **23**=Fix9, **24**=Fix10, **25**=Fix11, **26**=Fix12
Angle	**2**	**1**=Radian, **2**=Degree, **3**=Gradian
Exponential Format	**3**	**1**=Normal, **2**=Scientific, **3**=Engineering
Real or Complex	**4**	**1**=Real, **2**=Rectangular, **3**=Polar
Auto or Approx.	**5**	**1**=Auto, **2**=Approximate
Vector Format	**6**	**1**=Rectangular, **2**=Cylindrical, **3**=Spherical
Base	**7**	**1**=Decimal, **2**=Hex, **3**=Binary

shift()

Catalog >

shift(*Integer1* **[,***#ofShifts***])** ⇒ *integer*

Shifts the bits in a binary integer. You can enter *Integer1* in any number base; it is converted automatically to a signed, 64-bit binary form. If the magnitude of *Integer1* is too large for this form, a symmetric modulo operation brings it within the range.

If *#ofShifts* is positive, the shift is to the left. If *#ofShifts* is negative, the shift is to the right. The default is ⁻1 (shift right one bit).

In a right shift, the rightmost bit is dropped and 0 or 1 is inserted to match the leftmost bit. In a left shift, the leftmost bit is dropped and 0 is inserted as the rightmost bit.

For example, in a right shift:

Each bit shifts right.

0b00000000000000111101011000011010

Inserts 0 if leftmost bit is 0,
or 1 if leftmost bit is 1.

produces:

0b00000000000000011110101100001101 0

The result is displayed according to the Base mode. Leading zeros are not shown.

In Bin base mode:

shift(0b1111010110000110101)	0b111101011000011010
shift(256,1)	0b1000000000

In Hex base mode:

shift(0h78E)	0h3C7
shift(0h78E,⁻2)	0h1E3
shift(0h78E,2)	0h1E38

Important: To enter a binary or hexadecimal number, always use the 0b or 0h prefix (zero, not the letter O).

shift(*List1* **[,***#ofShifts***])** ⇒ *list*

Returns a copy of *List1* shifted right or left by *#ofShifts* elements. Does not alter *List1*.

If *#ofShifts* is positive, the shift is to the left. If *#ofShifts* is negative, the shift is to the right. The default is ⁻1 (shift right one element).

Elements introduced at the beginning or end of *list* by the shift are set to the symbol "undef".

In Dec base mode:

shift({1,2,3,4})	{undef,1,2,3}
shift({1,2,3,4},⁻2)	{undef,undef,1,2}
shift({1,2,3,4},2)	{3,4,undef,undef}

shift(*String1* **[,***#ofShifts***])** ⇒ *string*

Returns a copy of *String1* shifted right or left by *#ofShifts* characters. Does not alter *String1*.

If *#ofShifts* is positive, the shift is to the left. If *#ofShifts* is negative, the shift is to the right. The default is ⁻1 (shift right one character).

Characters introduced at the beginning or end of *string* by the shift are set to a space.

shift("abcd")	" abc"
shift("abcd",⁻2)	" ab"
shift("abcd",1)	"bcd "

sign()

Catalog >

sign(*Value1***)** ⇒ *value*
sign(*List1***)** ⇒ *list*
sign(*Matrix1***)** ⇒ *matrix*

For real and complex *Value1*, returns *Value1* / **abs(***Value1***)** when *Value1* ≠ 0.

Returns 1 if *Value1* is positive.

Returns −1 if *Value1* is negative.

sign(0) returns ±1 if the complex format mode is Real; otherwise, it returns itself.

sign(0) represents the unit circle in the complex domain.

For a list or matrix, returns the signs of all the elements.

$\text{sign}(-3.2)$ → -1

$\text{sign}(\{2,3,4,-5\})$ → $\{1,1,1,-1\}$

If complex format mode is Real:

$\text{sign}([-3 \quad 0 \quad 3])$ → $[-1 \quad \text{undef} \quad 1]$

simult()

Catalog >

simult(*coeffMatrix***,** *constVector***[,** *tol***])** ⇒ *matrix*

Returns a column vector that contains the solutions to a system of linear equations.

coeffMatrix must be a square matrix that contains the coefficients of the equations.

constVector must have the same number of rows (same dimension) as *coeffMatrix* and contain the constants.

Optionally, any matrix element is treated as zero if its absolute value is less than *tol*. This tolerance is used only if the matrix has floating-point entries and does not contain any symbolic variables that have not been assigned a value. Otherwise, *tol* is ignored.

- If you set the **Auto or Approximate** mode to Approximate, computations are done using floating-point arithmetic.
- If *tol* is omitted or not used, the default tolerance is calculated as:
  5E−14 • max(dim(*coeffMatrix*)) • rowNorm(*coeffMatrix*)

Solve for x and y:
x + 2y = 1
3x + 4y = −1

$\text{simult}\left(\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix},\begin{bmatrix}1\\ -1\end{bmatrix}\right)$ → $\begin{bmatrix}-3\\ 2\end{bmatrix}$

The solution is x= −3 and y=2.

Solve:
ax + by = 1
cx + dy = 2

$\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix} \rightarrow matx1$ → $\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}$

$\text{simult}\left(matx1,\begin{bmatrix}1\\ 2\end{bmatrix}\right)$ → $\begin{bmatrix}0\\ \frac{1}{2}\end{bmatrix}$

simult(*coeffMatrix***,** *constMatrix***[,** *tol***])** ⇒ *matrix*

Solves multiple systems of linear equations, where each system has the same equation coefficients but different constants.

Each column in *constMatrix* must contain the constants for a system of equations. Each column in the resulting matrix contains the solution for the corresponding system.

Solve:
x + 2y = 1
3x + 4y = −1

x + 2y = 2
3x + 4y = −3

$\text{simult}\left(\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix},\begin{bmatrix}1 & 2\\ -1 & -3\end{bmatrix}\right)$ → $\begin{bmatrix}-3 & -7\\ 2 & \frac{9}{2}\end{bmatrix}$

For the first system, x= −3 and y=2. For the second system, x= −7 and y=9/2.

sin()

sin⁻¹ sin key

sin(*Value1***)** ⇒ *value*
sin(*List1***)** ⇒ *list*

sin(*Value1***)** returns the sine of the argument.

sin(*List1***)** returns a list of the sines of all elements in *List1*.

Note: The argument is interpreted as a degree, gradian or radian angle, according to the current angle mode. You can use °, G, or r to override the angle mode setting temporarily.

In Degree angle mode:

$\sin\left(\frac{\pi}{4}_r\right)$ .707107

$\sin(45)$ .707107

$\sin(\{0,60,90\})$ $\{0.,.866025,1.\}$

In Gradian angle mode:

$\sin(50)$ .707107

In Radian angle mode:

$\sin\left(\frac{\pi}{4}\right)$ .707107

$\sin(45°)$ .707107

sin(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix sine of *squareMatrix1*. This is not the same as calculating the sine of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

In Radian angle mode:

$$\sin\left(\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}\right)$$

$$\begin{bmatrix}.9424 & -.04542 & -.031999\\ -.045492 & .949254 & -.020274\\ -.048739 & -.00523 & .961051\end{bmatrix}$$

sin⁻¹()

ctrl sin⁻¹ sin keys

sin⁻¹(*Value1***)** ⇒ *value*
sin⁻¹(*List1***)** ⇒ *list*

sin⁻¹(*Value1***)** returns the angle whose sine is *Value1*.

sin⁻¹(*List1***)** returns a list of the inverse sines of each element of *List1*.

Note: The result is returned as a degree, gradian or radian angle, according to the current angle mode setting.

In Degree angle mode:

$\sin^{-1}(1)$ 90

In Gradian angle mode:

$\sin^{-1}(1)$ 100

In Radian angle mode:

$\sin^{-1}(\{0,.2,.5\})$ $\{0,.201358,.523599\}$

sin⁻¹(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix inverse sine of *squareMatrix1*. This is not the same as calculating the inverse sine of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

In Radian angle mode and Rectangular complex format mode:

$$\sin^{-1}\left(\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}\right)$$

$$\begin{bmatrix}-.164058-.064606\cdot i & 1.49086-2.10514\cdot i\\ .725533-1.51594\cdot i & .947305-.778369\cdot i\\ 2.08316-2.63205\cdot i & -1.79018+1.27182\cdot i\end{bmatrix}$$

To see the entire result, press ▲ and then use ◀ and ▶ to move the cursor.

sinh()

Catalog >

sinh(*Numver1***)** ⇒ *value*
sinh(*List1***)** ⇒ *list*

sinh (*Value1***)** returns the hyperbolic sine of the argument.

sinh (*List1***)** returns a list of the hyperbolic sines of each element of *List1*.

sinh(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix hyperbolic sine of *squareMatrix1*. This is not the same as calculating the hyperbolic sine of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

$\sinh(1.2)$ → 1.50946

$\sinh(\{0,1.2,3.\})$ → $\{0,1.50946,10.0179\}$

In Radian angle mode:

$$\sinh\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix} \rightarrow \begin{bmatrix}360.954 & 305.708 & 239.604\\ 352.912 & 233.495 & 193.564\\ 298.632 & 154.599 & 140.251\end{bmatrix}$$

sinh⁻¹()

Catalog >

sinh⁻¹(*Value1***)** ⇒ *value*
sinh⁻¹(*List1***)** ⇒ *list*

sinh⁻¹(*Value1***)** returns the inverse hyperbolic sine of the argument.

sinh⁻¹(*List1***)** returns a list of the inverse hyperbolic sines of each element of *List1*.

sinh⁻¹(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix inverse hyperbolic sine of *squareMatrix1*. This is not the same as calculating the inverse hyperbolic sine of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

$\sinh^{-1}(0)$ → 0

$\sinh^{-1}(\{0,2.1,3\})$ → $\{0,1.48748,1.81845\}$

In Radian angle mode:

$$\sinh^{-1}\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix} \rightarrow \begin{bmatrix}.041751 & 2.15557 & 1.1582\\ 1.46382 & .926568 & .112557\\ 2.75079 & -1.5283 & .57268\end{bmatrix}$$

SinReg

Catalog >

SinReg *X*, *Y* [, [*Iterations*] ,[*Period*] [, *Category*, *Include*]]

Calculates the sinusoidal regression. A summary of results is stored in the *stat.results* variable. (See page 76.)

All the arguments must have equal dimensions except for *Include*.

X represents xlist.
Y represents ylist.
Category represents category codes.
Include represents category include list.

Iterations specifies the maximum number of times (1 through 16) a solution will be attempted. If omitted, 8 is used. Typically, larger values result in better accuracy but longer execution times, and vice versa.

Period specifies an estimated period. If omitted, the difference between values in *X* should be equal and in sequential order. If you specify *Period*, the differences between x values can be unequal.

The output of **SinReg** is always in radians, regardless of the angle mode setting.

Output variable	Description
stat.RegEqn	Regression Equation: a • sin(bx+c)+d.
stat.a, stat.b, stat.c, stat.d	Regression coefficients.
stat.Resid	Residuals of the curves fit = y N a • sin(bx+c)+d.
stat.XReg	List of data points in the modified *X List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.YReg	List of data points in the modified *Y List* actually used in the regression based on restrictions of *Freq*, *Category List*, and *Include Categories*.
stat.FreqReg	List of frequencies corresponding to *stat.XReg* and *stat.YReg*.

SortA

Catalog >

SortA *List1*[**,** *List2*] [**,** *List3*] ...
SortA *Vector1*[**,** *Vector2*] [**,** *Vector3*] ...

Sorts the elements of the first argument in ascending order.

If you include additional arguments, sorts the elements of each so that their new positions match the new positions of the elements in the first argument.

All arguments must be names of lists or vectors. All arguments must have equal dimensions.

$\{2,1,4,3\} \rightarrow list1$	$\{2,1,4,3\}$
SortA *list1*	*Done*
list1	$\{1,2,3,4\}$
$\{4,3,2,1\} \rightarrow list2$	$\{4,3,2,1\}$
SortA *list2*,*list1*	*Done*
list2	$\{1,2,3,4\}$
list1	$\{4,3,2,1\}$

SortD

Catalog >

SortD *List1*[**,** *List2*] [**,** *List3*] ...
SortD *Vector1*[**,***Vector2*] [**,***Vector3*] ...

Identical to **SortA**, except **SortD** sorts the elements in descending order.

$\{2,1,4,3\} \rightarrow list1$	$\{2,1,4,3\}$
$\{1,2,3,4\} \rightarrow list2$	$\{1,2,3,4\}$
SortD *list1*,*list2*	*Done*
list1	$\{4,3,2,1\}$
list2	$\{3,4,1,2\}$

▸Sphere

Catalog >

Vector **▸Sphere**

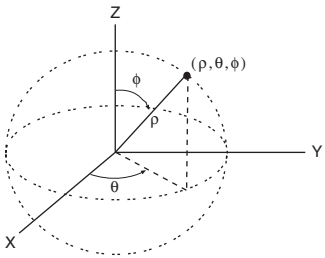
Displays the row or column vector in spherical form [ρ ∠θ ∠ϕ].

Vector must be of dimension 3 and can be either a row or a column vector.

Note: ▸Sphere is a display-format instruction, not a conversion function. You can use it only at the end of an entry line.

$[1 \quad 2 \quad 3]\blacktriangleright\text{Sphere}$
$[3.74166 \quad \angle 1.10715 \quad \angle .640522]$

$\left[\begin{bmatrix} 2 & \angle\frac{\pi}{4} & 3 \end{bmatrix}\right]\blacktriangleright\text{Sphere}$
$[3.60555 \quad \angle .785398 \quad \angle .588003]$



sqrt()

Catalog >

sqrt(*Value1***)** ⇒ *value*
sqrt(*List1***)** ⇒ *list*

Returns the square root of the argument.

For a list, returns the square roots of all the elements in *List1*.

Note: See also **Square root template**, page 1.

$\sqrt{4}$ → 2

$\sqrt{\{9,2,4\}}$ → $\{3,1.41421,2\}$

stat.results

Catalog >

stat.results

Displays a matrix of statistical analysis results.

The results are displayed as a set of name-value pairs. The specific names shown are dependent on the most recently evaluated statistics function or command.

You can copy a name or value and paste it into other locations.

Note: Avoid defining variables that use the same names as those used for statistical analysis. In some cases, an error condition could occur. Variable names used for statistical analysis are listed in the table below.

xlist:={1,2,3,4,5} → {1,2,3,4,5}

ylist:={4,8,11,14,17} → {4,8,11,14,17}

LinRegMx *xlist*,*ylist*,1: *stat.results*

"Title"	"Linear Regression (mx+b)"
"RegEqn"	"m*x+b"
"m"	3.2
"b"	1.2
"r²"	.996109
"r"	.998053
"Resid"	"{...}"

stat.values

"Linear Regression (mx+b)"
"m*x+b"
3.2
1.2
.996109
.998053
"{-.4,.4,.2,0.,-.2}"

stat.a
stat.AdjR²
stat.b
stat.b0
stat.b1
stat.b2
stat.b3
stat.b4
stat.b5
stat.b6
stat.b7
stat.b8
stat.b9
stat.b10
stat.bList
stat.χ^2
stat.c
stat.CLower
stat.CLowerList
stat.CompList
stat.CompMatrix
stat.CookDist
stat.CUpper
stat.CUpperList
stat.d
stat.dfDenom
stat.dfBlock
stat.dfCol
stat.dfError
stat.dfInteract
stat.dfReg
stat.dfNumer
stat.dfRow
stat.DW
stat.e
stat.ExpMatrix
stat.F
stat.FBlock
stat.Fcol
stat.FInteract
stat.FreqReg
stat.Frow
stat.Leverage
stat.LowerPred
stat.LowerVal
stat.m
stat.MaxX
stat.MaxY
stat.ME
stat.MedianX
stat.MedianY
stat.MEPred
stat.MinX
stat.MinY
stat.MS
stat.MSBlock
stat.MSCol
stat.MSError
stat.MSInteract
stat.MSReg
stat.MSRow
stat.n
stat.$\hat{p}$
stat.$\hat{p}$1
stat.$\hat{p}$2
stat.$\hat{p}$Diff
stat.PList
stat.PVal
stat.PValBlock
stat.PValCol
stat.PValInteract
stat.PValRow
stat.Q1X
stat.Q1Y
stat.Q3X
stat.Q3Y
stat.r
stat.r^2
stat.RegEqn
stat.Resid
stat.ResidTrans
stat.σx
stat.σy
stat.σx1
stat.σx2
stat.Σx
stat.Σx^2
stat.Σxy
stat.Σy
stat.Σy^2
stat.s
stat.SE
stat.SEList
stat.SEPred
stat.sResid
stat.SEslope
stat.sp
stat.SS
stat.SSBlock
stat.SSCol
stat.SSX
stat.SSY
stat.SSError
stat.SSInteract
stat.SSReg
stat.SSRow
stat.tList
stat.UpperPred
stat.UpperVal
stat.$\bar{x}$
stat.$\bar{x}$1
stat.$\bar{x}$2
stat.$\bar{x}$Diff
stat.$\bar{x}$List
stat.XReg
stat.XVal
stat.XValList
stat.$\bar{y}$
stat.$\hat{y}$
stat.$\hat{y}$List
stat.YReg

stat.values

Catalog >

stat.values

Displays a matrix of the values calculated for the most recently evaluated statistics function or command.

Unlike **stat.results**, **stat.values** omits the names associated with the values.

You can copy a value and paste it into other locations.

See the **stat.results** example.

stDevPop()

Catalog >

stDevPop(*List***[,** *freqList***])** ⇒ *expression*

Returns the population standard deviation of the elements in *List*.

Each *freqList* element counts the number of consecutive occurrences of the corresponding element in *List*.

Note: *List* must have at least two elements.

stDevPop(*Matrix1***[,** *freqMatrix***])** ⇒ *matrix*

Returns a row vector of the population standard deviations of the columns in *Matrix1*.

Each *freqMatrix* element counts the number of consecutive occurrences of the corresponding element in *Matrix1*.

Note: *Matrix1* must have at least two rows.

In Radian angle and auto modes:

$\text{stDevPop}(\{1,2,5,-6,3,-2\})$ 3.59398

$\text{stDevPop}(\{1.3,2.5,-6.4\},\{3,2,5\})$ 4.11107

$$\text{stDevPop}\begin{bmatrix} 1 & 2 & 5 \\ -3 & 0 & 1 \\ 5 & 7 & 3 \end{bmatrix}$$

$$\begin{bmatrix} 3.26599 & 2.94392 & 1.63299 \end{bmatrix}$$

$$\text{stDevPop}\left(\begin{bmatrix} -1.2 & 5.3 \\ 2.5 & 7.3 \\ 6 & -4 \end{bmatrix},\begin{bmatrix} 4 & 2 \\ 3 & 3 \\ 1 & 7 \end{bmatrix}\right)$$

$$\begin{bmatrix} 2.52608 & 5.21506 \end{bmatrix}$$

stDevSamp()

Catalog >

stDevSamp(*List*[**,** *freqList*]**)** ⇒ *expression*

Returns the sample standard deviation of the elements in *List*.

Each *freqList* element counts the number of consecutive occurrences of the corresponding element in *List*.

Note: *List* must have at least two elements.

stDevSamp(*Matrix1*[**,** *freqMatrix*]**)** ⇒ *matrix*

Returns a row vector of the sample standard deviations of the columns in *Matrix1*.

Each *freqMatrix* element counts the number of consecutive occurrences of the corresponding element in *Matrix1*.

Note: *Matrix1* must have at least two rows.

stDevSamp({{1,2,5,-6,3,-2}}) 3.937

stDevSamp({{1.3,2.5,-6.4},{3,2,5}})
4.33345

stDevPop([[1 2 5][-3 0 1][5 7 3]])
[3.26599 2.94392 1.63299]

stDevPop([[-1.2 5.3][2.5 7.3][6 -4]],[[4 2][3 3][1 7]])
[2.52608 5.21506]

Stop

Catalog >

Stop

Programming command: Terminates the program.

Stop is not allowed in functions.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing enter instead of ~enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

```
i:=0                                   0
Define prog1()=Prgm                    Done
  For i,1,10,1
  If i=5
  Stop
  EndFor
  EndPrgm
prog1()                                Done
i                                      5
```

Store

See → **(store)**, page 106.

string()

Catalog >

string(*Expr***)** ⇒ *string*

Simplifies *Expr* and returns the result as a character string.

string(1.2345) "1.2345"

string(1+2) "3"

subMat()

Catalog >

subMat(*Matrix1***[, *startRow*] [, *startCol*] [, *endRow*] [, *endCol*]) ⇒ *matrix***

Returns the specified submatrix of *Matrix1*.

Defaults: *startRow*=1, *startCol*=1, *endRow*=last row, *endCol*=last column.

$$\begin{bmatrix}1&2&3\\4&5&6\\7&8&9\end{bmatrix}\rightarrow m1 \qquad \begin{bmatrix}1&2&3\\4&5&6\\7&8&9\end{bmatrix}$$

$$\text{subMat}(m1,2,1,3,2) \qquad \begin{bmatrix}4&5\\7&8\end{bmatrix}$$

$$\text{subMat}(m1,2,2) \qquad \begin{bmatrix}5&6\\8&9\end{bmatrix}$$

Sum (Sigma)

See Σ(), page 101.

sum()

Catalog >

sum(*List*[, *Start*[, *End*]]) ⇒ *expression*

Returns the sum of the elements in *List*.

Start and *End* are optional. They specify a range of elements.

$$\text{sum}(\{1,2,3,4,5\}) \qquad 15$$

$$\text{sum}(\{a,2\cdot a,3\cdot a\}) \qquad \text{"Error: Variable is not defined"}$$

$$\text{sum}(\text{seq}(n,n,1,10)) \qquad 55$$

$$\text{sum}(\{1,3,5,7,9\},3) \qquad 21$$

sum(*Matrix1*[, *Start*[, *End*]]) ⇒ *matrix*

Returns a row vector containing the sums of the elements in the columns in *Matrix1*.

Start and *End* are optional. They specify a range of rows.

$$\text{sum}\left(\begin{bmatrix}1&2&3\\4&5&6\end{bmatrix}\right) \qquad \begin{bmatrix}5&7&9\end{bmatrix}$$

$$\text{sum}\left(\begin{bmatrix}1&2&3\\4&5&6\\7&8&9\end{bmatrix}\right) \qquad \begin{bmatrix}12&15&18\end{bmatrix}$$

$$\text{sum}\left(\begin{bmatrix}1&2&3\\4&5&6\\7&8&9\end{bmatrix},2,3\right) \qquad \begin{bmatrix}11&13&15\end{bmatrix}$$

sumIf()

Catalog >

sumIf(*List*,*Criteria*[, *SumList*]**)** ⇒ *value*

Returns the accumulated sum of all elements in *List* that meet the specified *Criteria*. Optionally, you can specify an alternate list, *sumList*, to supply the elements to accumulate.

List can be an expression, list, or matrix. *SumList*, if specified, must have the same dimension(s) as *List*.

Criteria can be:

- A value, expression, or string. For example, **34** accumulates only those elements in *List* that simplify to the value 34.
- A Boolean expression containing the symbol **?** as a placeholder for each element. For example, **?<10** accumulates only those elements in *List* that are less than 10.

When a *List* element meets the *Criteria*, the element is added to the accumulating sum. If you include *sumList*, the corresponding element from *sumList* is added to the sum instead.

Within the Lists & Spreadsheet application, you can use a range of cells in place of *List* and *sumList*.

Note: See also **countIf()**, page 18.

$\text{sumIf}(\{1,2,e,3,\pi,4,5,6\},2.5<?<4.5)$

12.859874482

$\text{sumIf}(\{1,2,3,4\},2<?<5,\{10,20,30,40\})$

70

system()

Catalog >

system(*Value1* [**,** *Value2* [**,** *Value3* [**,** ...]]]**)**

Returns a system of equations, formatted as a list. You can also create a system by using a template.

T

T (transpose)

Catalog >

Matrix1^T ⇒ *matrix*

Returns the complex conjugate transpose of *Matrix1*.

$$\begin{bmatrix}1&2&3\\4&5&6\\7&8&9\end{bmatrix}^T \qquad \begin{bmatrix}1&4&7\\2&5&8\\3&6&9\end{bmatrix}$$

tan()

tan⁻¹ tan key

tan(*Value1***)** ⇒ *value*
tan(*List1***)** ⇒ *list*

tan(*Value1***)** returns the tangent of the argument.

tan(*List1***)** returns a list of the tangents of all elements in *List1*.

Note: The argument is interpreted as a degree, gradian or radian angle, according to the current angle mode. You can use °, G or r to override the angle mode setting temporarily.

In Degree angle mode:

$\tan\left(\left\{\frac{\pi}{4}\right\}_r\right)$ → 1.

$\tan(45)$ → 1.

$\tan(\{0,60,90\})$ → $\{0.,1.73205,\text{undef}\}$

In Gradian angle mode:

$\tan\left(\left\{\frac{\pi}{4}\right\}_r\right)$ → 1.

$\tan(50)$ → 1.

$\tan(\{0,50,100\})$ → $\{0.,1.,\text{undef}\}$

In Radian angle mode:

$\tan\left(\frac{\pi}{4}\right)$ → 1.

$\tan(45°)$ → 1.

$\tan\left(\left\{\pi,\frac{\pi}{3},-\pi,\frac{\pi}{4}\right\}\right)$ → $\{0.,1.73205,0.,1.\}$

tan(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix tangent of *squareMatrix1*. This is not the same as calculating the tangent of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

In Radian angle mode:

$$\tan\left(\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}\right) \rightarrow \begin{bmatrix}-28.2912 & 26.0887 & 11.1142\\ 12.1171 & -7.83536 & -5.48138\\ 36.8181 & -32.8063 & -10.4594\end{bmatrix}$$

tan⁻¹()

ctrl tan⁻¹ tan keys

tan⁻¹(*Value1***)** ⇒ *value*
tan⁻¹(*List1***)** ⇒ *list*

tan⁻¹(*Value1***)** returns the angle whose tangent is *Value1*.

tan⁻¹(*List1***)** returns a list of the inverse tangents of each element of *List1*.

Note: The result is returned as a degree, gradian or radian angle, according to the current angle mode setting.

In Degree angle mode:

$\tan^{-1}(1)$ → 45

In Gradian angle mode:

$\tan^{-1}(1)$ → 50

In Radian angle mode:

$\tan^{-1}(\{0,.2,.5\})$ → $\{0,.197396,.463648\}$

tan^{-1}()

ctrl tan^{-1} tan keys

tan^{-1}(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix inverse tangent of *squareMatrix1*. This is not the same as calculating the inverse tangent of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

In Radian angle mode:

$$\tan^{-1}\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}$$

$$\begin{bmatrix}-.083658 & 1.26629 & .62263\\ .748539 & .630015 & -.070012\\ 1.68608 & -1.18244 & .455126\end{bmatrix}$$

tanh()

Catalog >

tanh(*Value1***)** ⇒ *value*
tanh(*List1***)** ⇒ *list*

tanh(*Value1***)** returns the hyperbolic tangent of the argument.

tanh(*List1***)** returns a list of the hyperbolic tangents of each element of *List1*.

$$\tanh(1.2) \qquad .833655$$

$$\tanh(\{0,1\}) \qquad \{0,.761594\}$$

tanh(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix hyperbolic tangent of *squareMatrix1*. This is not the same as calculating the hyperbolic tangent of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

In Radian angle mode:

$$\tanh\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}$$

$$\begin{bmatrix}-.097966 & .933436 & .425972\\ .488147 & .538881 & -.129382\\ 1.28295 & -1.03425 & .428817\end{bmatrix}$$

tanh^{-1}()

Catalog >

tanh^{-1}(*Value1***)** ⇒ *value*
tanh^{-1}(*List1***)** ⇒ *list*

tanh^{-1}(*Value1***)** returns the inverse hyperbolic tangent of the argument.

tanh^{-1}(*List1***)** returns a list of the inverse hyperbolic tangents of each element of *List1*.

In Rectangular complex format:

$$\tanh^{-1}(0) \qquad 0$$

$$\tanh^{-1}(\{1,2.1,3\})$$

$$\{\text{undef},.518046-1.5708\cdot i,.346574-1.5708\cdot$$

To see the entire result, press ▲ and then use ◀ and ▶ to move the cursor.

tanh^{-1}(*squareMatrix1***)** ⇒ *squareMatrix*

Returns the matrix inverse hyperbolic tangent of *squareMatrix1*. This is not the same as calculating the inverse hyperbolic tangent of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

In Radian angle mode and Rectangular complex format:

$$\tanh^{-1}\begin{bmatrix}1 & 5 & 3\\ 4 & 2 & 1\\ 6 & -2 & 1\end{bmatrix}$$

$$\begin{bmatrix}-.099353+.164058\cdot i & .267834-1.49086\cdot i\\ -.087596-.725533\cdot i & .479679-.947305\cdot i\\ .511463-2.08316\cdot i & -.878563+1.79018\cdot i\end{bmatrix}$$

To see the entire result, press ▲ and then use ◀ and ▶ to move the cursor.

tCdf()

Catalog >

tCdf(*lowBound*,*upBound*,*df***)** ⇒ *number* if *lowBound* and *upBound* are numbers, *list* if *lowBound* and *upBound* are lists

Computes the Student-*t* distribution probability between *lowBound* and *upBound* for the specified degrees of freedom *df*.

For $p(X \le upBound)$, set *lowBound* = **−9E999**.

Then

See **If,** page 35.

TInterval

Catalog >

TInterval *List*[,*Freq*[,*CLevel*]]

(Data list input)

TInterval $\bar{x}$,*Sx*,*n*[,*CLevel*]

(Summary stats input)

Computes a *t* confidence interval. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.CLower, stat.CUpper	Confidence interval for an unknown population mean.
stat.$\bar{x}$	Sample mean of the data sequence from the normal random distribution.
stat.ME	Margin of error.
stat.df	Degrees of freedom.
stat.σx	Sample standard deviation.
stat.n	Length of the data sequence with sample mean.

TInterval_2Samp

Catalog >

TInterval_2Samp
List1,*List2*[,*Freq1*[,*Freq2*[,*CLevel*[,*Pooled*]]]]

(Data list input)

TInterval_2Samp $\bar{x}1$,*Sx1*,*n1*,$\bar{x}2$,*Sx2*,*n2*[,*CLevel*[,*Pooled*]]

(Summary stats input)

Computes a two-sample *t* confidence interval. A summary of results is stored in the *stat.results* variable. (See page 76.)

Pooled=**1** pools variances; *Pooled*=**0** does not pool variances.

Output variable	Description
stat.CLower, stat.CUpper	Confidence interval containing confidence level probability of distribution.
stat.$\bar{x}$1-$\bar{x}$2	Sample means of the data sequences from the normal random distribution.
stat.ME	Margin of error.

Output variable	Description
stat.df	Degrees of freedom.
stat.$\bar{x}$1, stat.$\bar{x}$2	Sample means of the data sequences from the normal random distribution.
stat.σx1, stat.σx2	Sample standard deviations for *List 1* and *List 2*.
stat.n1, stat.n2	Number of samples in data sequences.
stat.sp	The pooled standard deviation. Calculated when *Pooled* = YES.

tPdf()

Catalog >

tPdf(*XVal***,***df***)** ⇒ *number* if *XVal* is a number, *list* if *XVal* is a list

Computes the probability density function (pdf) for the Student-*t* distribution at a specified *x* value with specified degrees of freedom *df*.

Try

Catalog >

Try
  block1
Else
  block2
EndTry

Executes *block1* unless an error occurs. Program execution transfers to *block2* if an error occurs in *block1*. System variable *errCode* contains the error code to allow the program to perform error recovery. For a list of error codes, see "Error codes and messages," page 107.

block1 and *block2* can be either a single statement or a series of statements separated with the ":" character.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing ↵ instead of enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

Define *prog1*()=Prgm
  Try
  z:=*z*+1
  Disp "z incremented."
  Else
  Disp "Sorry, z undefined."
  EndTry
  EndPrgm

Done

z:=1:*prog1*()

z incremented.

Done

DelVar *z*:*prog1*()

Sorry, z undefined.

Done

Example 2

To see the commands **Try**, **ClrErr**, and **PassErr** in operation, enter the eigenvals() program shown at the right. Run the program by executing each of the following expressions.

$$eigenvals\left(\begin{bmatrix} -3 \\ -41 \\ 5 \end{bmatrix}, \begin{bmatrix} -1 & 2 & -3.1 \end{bmatrix}\right)$$

Note: See also **ClrErr**, page 13, and **PassErr**, page 58.

```
Define eigenvals(a,b)=Prgm
© Program eigenvals(A,B) displays eigenvalues of A·B
Try
  Disp "A= ",a
  Disp "B= ",b
  Disp " "
  Disp "Eigenvalues of A·B are:",eigVl(a*b)
Else
  If errCode=230 Then
    Disp "Error: Product of A·B must be a square matrix"
    ClrErr
  Else
    PassErr
  EndIf
EndTry
EndPrgm
```

tTest

Catalog >

tTest μ*0*,*List*[,*Freq*[,*Hypoth*]]

(Data list input)

tTest μ*0*,$\bar{x}$,*sx*,*n*,[*Hypoth*]

(Summary stats input)

Performs a hypothesis test for a single unknown population mean μ when the population standard deviation σ is unknown. A summary of results is stored in the *stat.results* variable. (See page 76.)

Test H0: μ = μ0, against one of the following:

Hypoth < 0 for Ha: μ < μ0
Hypoth = 0 for Ha: μ ≠ μ0 (default)
Hypoth > 0 for Ha: μ > μ0

Output variable	Description
stat.t	($\bar{x}$ − μ0) / (stdev / sqrt(n))
stat.PVal	Least probability at which the null hypothesis can be rejected.
stat.df	Degrees of freedom.
stat.$\bar{x}$	Sample mean of the data sequence in *List*.
stat.sx	Sample standard deviation of the data sequence.
stat.n	Size of the sample.

tTest_2Samp

Catalog >

tTest_2Samp *List1*,*List2*[,*Freq1*[,*Freq2*[,*Hypoth*[,*Pooled*]]]]

(Data list input)

tTest_2Samp $\bar{x}$*1*,*sx1*,*n1*,$\bar{x}$*2*,*sx2*,*n2*[,*Hypoth*[,*Pooled*]]

(Summary stats input)

Computes a two-sample *t* test. A summary of results is stored in the *stat.results* variable. (See page 76.)

Test H0: μ1 = μ2, against one of the following:

Hypoth < 0 for Ha: μ1 < μ2
Hypoth = 0 for Ha: μ1 ≠ μ2 (default)
Hypoth > 0 for Ha: μ1 > μ2

Pooled=**1** pools variances
Pooled=**0** does not pool variances

Output variable	Description
stat.t	Standard normal value computed for the difference of means.
stat.PVal	Least probability at which the null hypothesis can be rejected.
stat.df	Degrees of freedom for the t-statistic.
stat.$\bar{x}$1, stat.$\bar{x}$2	Sample means of the data sequences in *List 1* and *List 2*.

Output variable	Description
stat.sx1, stat.sx2	Sample standard deviations of the data sequences in *List 1* and *List 2*.
stat.n1, stat.n2	Size of the samples.
stat.sp	The pooled standard deviation. Calculated when *Pooled*=1.

tvmFV()

Catalog >

tvmFV(*N*,*I*,*PV*,*Pmt*,[*PpY*],[*CpY*],[*PmtAt*]**)** ⇒ *value*

Financial function that calculates the future value of money.

Note: Arguments used in the TVM functions are described in the table of TVM arguments, page 86. See also **amortTbl()**, page 5.

```
tvmFV(120,5,0,-500,12,12)                    77641.1
```

tvmI()

Catalog >

tvmI(*N*,*PV*,*Pmt*,*FV*,[*PpY*],[*CpY*],[*PmtAt*]**)** ⇒ *value*

Financial function that calculates the interest rate per year.

Note: Arguments used in the TVM functions are described in the table of TVM arguments, page 86. See also **amortTbl()**, page 5.

```
tvmI(240,100000,-1000,0,12,12)               10.5241
```

tvmN()

Catalog >

tvmN(*I*,*PV*,*Pmt*,*FV*,[*PpY*],[*CpY*],[*PmtAt*]**)** ⇒ *value*

Financial function that calculates the number of payment periods.

Note: Arguments used in the TVM functions are described in the table of TVM arguments, page 86. See also **amortTbl()**, page 5.

```
tvmN(5,0,-500,77641,12,12)                   120.
```

tvmPmt()

Catalog >

tvmPmt(*N*,*I*,*PV*,*FV*,[*PpY*],[*CpY*],[*PmtAt*]**)** ⇒ *value*

Financial function that calculates the amount of each payment.

Note: Arguments used in the TVM functions are described in the table of TVM arguments, page 86. See also **amortTbl()**, page 5.

```
tvmPmt(60,4,30000,0,12,12)                   -552.496
```

tvmPV()

Catalog >

tvmPV(*N*,*I*,*Pmt*,*FV*,[*PpY*],[*CpY*],[*PmtAt*]**)** ⇒ *value*

Financial function that calculates the present value.

Note: Arguments used in the TVM functions are described in the table of TVM arguments, page 86. See also **amortTbl()**, page 5.

```
tvmPV(48,4,-500,30000,12,12)                 -3426.7
```

TVM argument*	Description	Data type
N	Number of payment periods	real number
I	Annual interest rate	real number
PV	Present value	real number
Pmt	Payment amount	real number
FV	Future value	real number

TVM argument*	Description	Data type
PpY	Payments per year, default=1	integer > 0
CpY	Compounding periods per year, default=1	integer > 0
PmtAt	Payment due at the end or beginning of each period, default=end	integer (0=end, 1=beginning)

***** These time-value-of-money argument names are similar to the TVM variable names (such as **tvm.pv** and **tvm.pmt**) that are used by the Calculator application's finance solver. Financial functions, however, do not store their argument values or results to the TVM variables.

TwoVar

Catalog >

TwoVar *X*, *Y*[, [*Freq*] [, *Category*, *Include*]]

Calculates the TwoVar statistics. A summary of results is stored in the *stat.results* variable. (See page 76.)

All the arguments must have equal dimensions except for *Include*.

X represents xlist.
Y represents ylist.
Freq represents frequency list.
Category represents category codes.
Include represents category include list.

Output variable	Description
stat.$\bar{x}$	Mean of x values.
stat.Σx	Sum of x values.
stat.Σx2	Sum of x2 values.
stat.sx	Sample standard deviation of x.
stat.σx	Population standard deviation of x.
stat.n	Number of data points.
stat.$\bar{y}$	Mean of y values.
stat.Σy	Sum of y values.
stat.Σy^2	Sum of y2 values.
stat.sy	Sample standard deviation of y.
stat.σy	Population standard deviation of y.
stat.Σxy	Sum of x • y values.
stat.MinX	Minimum of x values.
stat.Q_1X	1st Quartile of x.
stat.MedianX	Median of x.
stat.Q_3X	3rd Quartile of x.
stat.MaxX	Maximum of x values.
stat.MinY	Minimum of y values.

Output variable	Description
stat.Q_1Y	1st Quartile of y.
stat.MedY	Median of y.
stat.Q_3Y	3rd Quartile of y.
stat.MaxY	Maximum of y values.
stat.$\Sigma(x-\bar{x})^2$	Sum of squares of deviations from the mean of x.
stat.$\Sigma(y-\bar{y})^2$	Sum of squares of deviations from the mean of y.

U

unitV()

Catalog >

unitV(*Vector1***)** ⇒ *vector*

Returns either a row- or column-unit vector, depending on the form of *Vector1*.

Vector1 must be either a single-row matrix or a single-column matrix.

```
unitV([1  2  1])
                [.408248  .816497  .408248]
unitV({1,2,3})
                {.267261,.534522,.801784}
```

V

varPop()

Catalog >

varPop(*List***[, *freqList*])** ⇒ *expression*

Returns the population variance of *List*.

Each *freqList* element counts the number of consecutive occurrences of the corresponding element in *List*.

Note: *List* must contain at least two elements.

```
varPop({5,10,15,20,25,30})      72.9167
```

varSamp()

Catalog >

varSamp(*List***[, *freqList*])** ⇒ *expression*

Returns the sample variance of *List*.

Each *freqList* element counts the number of consecutive occurrences of the corresponding element in *List*.

Note: *List* must contain at least two elements.

```
varSamp({1,2,5,-6,3,-2})        31/2
varSamp({1,3,5},{4,6,2})        68/33
```

varSamp(*Matrix1***[, *freqMatrix*])** ⇒ *matrix*

Returns a row vector containing the sample variance of each column in *Matrix1*.

Each *freqMatrix* element counts the number of consecutive occurrences of the corresponding element in *Matrix1*.

Note: *Matrix1* must contain at least two rows.

```
varSamp([1  2  5]
        [-3 0  1])      [4.75  1.03  4]
        [.5 .7  3]
varSamp([-1.1  2.2],[6  3])
        [3.4   5.1] [2  4]
        [-2.3  4.3] [5  1]
                [3.91731  2.08411]
```

W

when()

Catalog >

when(*Condition***,** *trueResult* [**,** *falseResult*][**,** *unknownResult*]**)**
⇒ *expression*

Returns *trueResult*, *falseResult*, or *unknownResult*, depending on whether *Condition* is true, false, or unknown. Returns the input if there are too few arguments to specify the appropriate result.

Omit both *falseResult* and *unknownResult* to make an expression defined only in the region where *Condition* is true.

Use an **undef** *falseResult* to define an expression that graphs only on an interval.

when() is helpful for defining recursive functions.

$\text{when}(x<0, x+3) \mid x=5$ undef

$\text{when}(n>0, n\cdot factoral(n-1), 1) \rightarrow factoral(n)$
Done

$factoral(3)$ 6

$3!$ 6

While

Catalog >

While *Condition*
Block
EndWhile

Executes the statements in *Block* as long as *Condition* is true.

Block can be either a single statement or a sequence of statements separated with the ":" character.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing enter instead of enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

```
Define sum_of_recip(n)=Func
                         Local i,tempsum
                         1→i
                         0→tempsum
                         While i≤n
                         tempsum+1/i→tempsum
                         i+1→i
                         EndWhile
                         Return tempsum
                         EndFunc
                                                Done
sum_of_recip(3)                                 11/6
```

"With"

See | ("with"), page 106.

X

xor **Catalog >**

BooleanExpr1 **xor** *BooleanExpr2* ⇒ *Boolean expression*

Returns true if *BooleanExpr1* is true and *BooleanExpr2* is false, or vice versa.

Returns false if both arguments are true or if both are false. Returns a simplified Boolean expression if either of the arguments cannot be resolved to true or false.

Note: See **or**, page 57.

Integer1 **xor** *Integer2* ⇒ *integer*

Compares two real integers bit-by-bit using an **xor** operation. Internally, both integers are converted to signed, 64-bit binary numbers. When corresponding bits are compared, the result is 1 if either bit (but not both) is 1; the result is 0 if both bits are 0 or both bits are 1. The returned value represents the bit results, and is displayed according to the Base mode.

You can enter the integers in any number base. For a binary or hexadecimal entry, you must use the 0b or 0h prefix, respectively. Without a prefix, integers are treated as decimal (base 10).

If you enter a decimal integer that is too large for a signed, 64-bit binary form, a symmetric modulo operation is used to bring the value into the appropriate range.

Note: See **or**, page 57.

true xor true	false
5>3 xor 3>5	true

In Hex base mode:
Important: Zero, not the letter O.

0h7AC36 xor 0h3D5F	0h79169

In Bin base mode:

0b100101 xor 0b100	0b100001

Note: A binary entry can have up to 64 digits (not counting the 0b prefix). A hexadecimal entry can have up to 16 digits.

Z

zInterval **Catalog >**

zInterval σ,*List*[,*Freq*[,*CLevel*]]

(Data list input)

zInterval σ,$\bar{x}$,*n* [,*CLevel*]

(Summary stats input)

Computes a *z* confidence interval. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.CLower, stat.CUpper	Confidence interval for an unknown population mean.
stat.$\bar{x}$	Sample mean of the data sequence from the normal random distribution.
stat.ME	Margin of error.
stat.sx	Sample standard deviation.
stat.n	Length of the data sequence with sample mean.
stat.σ	Known population standard deviation for data sequence *List*.

zInterval_1Prop

Catalog >

zInterval_1Prop *x*,*n* [,*CLevel*]

Computes a one-proportion *z* confidence interval. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.CLower, stat.CUpper	Confidence interval containing confidence level probability of distribution.
stat.$\hat{p}$	The calculated proportion of successes.
stat.ME	Margin of error.
stat.n	Number of samples in data sequence.

zInterval_2Prop

Catalog >

zInterval_2Prop *x1*,*n1*,*x2*,*n2*[,*CLevel*]

Computes a two-proportion *z* confidence interval. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.CLower, stat.CUpper	Confidence interval containing confidence level probability of distribution.
stat.$\hat{p}$Diff	The calculated difference between proportions.
stat.ME	Margin of error.
stat.$\hat{p}$1	First sample proportion estimate.
stat.$\hat{p}$2	Second sample proportion estimate.
stat.n1	Sample size in data sequence one.
stat.n2	Sample size in data sequence two.

zInterval_2Samp

Catalog >

zInterval_2Samp σ_1,σ_2 ,*List1*,*List2*[,*Freq1*[,*Freq2*,[*CLevel*]]]

(Data list input)

zInterval_2Samp σ_1,σ_2,$\bar{x}$*1*,*n1*,$\bar{x}$*2*,*n2*[,*CLevel*]

(Summary stats input)

Computes a two-sample *z* confidence interval. A summary of results is stored in the *stat.results* variable. (See page 76.)

Output variable	Description
stat.CLower, stat.CUpper	Confidence interval containing confidence level probability of distribution.
stat.$\bar{x}$1-$\bar{x}$2	Sample means of the data sequences from the normal random distribution.

Output variable	Description
stat.ME	Margin of error.
stat.$\bar{x}$1, stat.$\bar{x}$2	Sample means of the data sequences from the normal random distribution.
stat.σx1, stat.σx2	Sample standard deviations for *List 1* and *List 2*.
stat.n1, stat.n2	Number of samples in data sequences.
stat.r1, stat.r2	Known population standard deviations for data sequence *List 1* and *List 2*.

zTest

Catalog >

zTest $\mu 0$,σ,*List*,[*Freq*[,*Hypoth*]]

(Data list input)

zTest $\mu 0$,σ,$\bar{x}$,*n*[,*Hypoth*]

(Summary stats input)

Performs a *z* test with frequency *freqlist*. A summary of results is stored in the *stat.results* variable. (See page 76.)

Test H0: $\mu = \mu 0$, against one of the following:

Hypoth < 0 for Ha: $\mu < \mu 0$
Hypoth = 0 for Ha: $\mu \neq \mu 0$ (default)
Hypoth > 0 for Ha: $\mu > \mu 0$

Output variable	Description
stat.z	($\bar{x}$ − $\mu 0$) / (σ / sqrt(n))
stat.P Value	Least probability at which the null hypothesis can be rejected.
stat.$\bar{x}$	Sample mean of the data sequence in *List*.
stat.sx	Sample standard deviation of the data sequence. Only returned for *Data* input.
stat.n	Size of the sample.

zTest_1Prop

Catalog >

zTest_1Prop *p0*,*x*,*n*[,*Hypoth*]

Computes a one-proportion *z* test. A summary of results is stored in the *stat.results* variable. (See page 76.)

Test H0: $p = p0$ against one of the following:

Hypoth > 0 for Ha: $p > p0$
Hypoth = 0 for Ha: $p \neq p0$ *(default)*
Hypoth < 0 for Ha: $p < p0$

Output variable	Description
stat.p0	Hypothesized population proportion.
stat.z	Standard normal value computed for the proportion.
stat.PVal	Least probability at which the null hypothesis can be rejected.

Output variable	Description
stat.$\hat{p}$	Estimated sample proportion.
stat.n	Size of the sample.

zTest_2Prop

Catalog >

zTest_2Prop *x1*,*n1*,*x2*,*n2*[,*Hypoth*]

Computes a two-proportion *z* test. A summary of results is stored in the *stat.results* variable. (See page 76.)

Test H0: $p1 = p2$, against one of the following:

Hypoth > 0 for Ha: $p1 > p2$
Hypoth = 0 for Ha: $p1 \neq p2$ (default)
Hypoth < 0 for Ha: $p < p0$

Output variable	Description
stat.z	Standard normal value computed for the difference of proportions.
stat.PVal	Least probability at which the null hypothesis can be rejected.
stat.$\hat{p}$1	First sample proportion estimate.
stat.$\hat{p}$2	Second sample proportion estimate.
stat.$\hat{p}$	Pooled sample proportion estimate.
stat.n1, stat.n2	Number of samples taken in trials 1 and 2.

zTest_2Samp

Catalog >

zTest_2Samp σ_1,σ_2 ,*List1*,*List2*[,*Freq1*[,*Freq2*[,*Hypoth*]]]

(Data list input)

zTest_2Samp σ_1,σ_2,$\bar{x}1$,*n1*,$\bar{x}2$,*n2*[,*Hypoth*]

(Summary stats input)

Computes a two-sample *z* test. A summary of results is stored in the *stat.results* variable. (See page 76.)

Test H0: $\mu1 = \mu2$, against one of the following:

Hypoth < 0 for Ha: $\mu1 < \mu2$
Hypoth = 0 for Ha: $\mu1 \neq \mu2$ (default)
Hypoth > 0 for Ha: $\mu1 > \mu2$

Output variable	Description
stat.z	Standard normal value computed for the difference of means.
stat.PVal	Least probability at which the null hypothesis can be rejected.
stat.$\bar{x}$1, stat.$\bar{x}$2	Sample means of the data sequences in *List1* and *List2*.
stat.sx1, stat.sx2	Sample standard deviations of the data sequences in *List1* and *List2*.
stat.n1, stat.n2	Size of the samples.

Symbols

+ (add)

key

Value1 **+** *Value2* ⇒ *value*

Returns the sum of the two arguments.

56	56
56+4	60
60+4	64
64+4	68
68+4	72

List1 + *List2* ⇒ *list*
Matrix1 + *Matrix2* ⇒ *matrix*

Returns a list (or matrix) containing the sums of corresponding elements in *List1* and *List2* (or *Matrix1* and *Matrix2*).

Dimensions of the arguments must be equal.

$\left\{22,\pi,\frac{\pi}{2}\right\}\rightarrow l1$	$\{22,3.14159,1.5708\}$
$\left\{10,5,\frac{\pi}{2}\right\}\rightarrow l2$	$\{10,5,1.5708\}$
l1+*l2*	$\{32,8.14159,3.14159\}$

Value + *List1* ⇒ *list*
List1 + *Value* ⇒ *list*

Returns a list containing the sums of *Value* and each element in *List1*.

$15+\{10,15,20\}$	$\{25,30,35\}$
$\{10,15,20\}+15$	$\{25,30,35\}$

Value + *Matrix1* ⇒ *matrix*
Matrix1 + *Value* ⇒ *matrix*

Returns a matrix with *Value* added to each element on the diagonal of *Matrix1*. *Matrix1* must be square.

$20+\begin{bmatrix}1&2\\3&4\end{bmatrix}$	$\begin{bmatrix}21&2\\3&24\end{bmatrix}$

Note: Use **.+** (dot plus) to add an expression to each element.

− (subtract)

key

Value1 − *Value2* ⇒ *value*

Returns *Value1* minus *Value2*.

6−2	4
$\pi-\frac{\pi}{6}$	2.61799

List1 − *List2* ⇒ *list*
Matrix1 − *Matrix2* ⇒ *matrix*

Subtracts each element in *List2* (or *Matrix2*) from the corresponding element in *List1* (or *Matrix1*), and returns the results.

Dimensions of the arguments must be equal.

$\left\{22,\pi,\frac{\pi}{2}\right\}-\left\{10,5,\frac{\pi}{2}\right\}$	$\{12,-1.85841,0.\}$
$[3\ \ 4]-[1\ \ 2]$	$[2\ \ 2]$

Value − *List1* ⇒ *list*
List1 − *Value* ⇒ *list*

Subtracts each *List1* element from *Value* or subtracts *Value* from each *List1* element, and returns a list of the results.

$15-\{10,15,20\}$	$\{5,0,-5\}$
$\{10,15,20\}-15$	$\{-5,0,5\}$

− (subtract)

−key

Value − *Matrix1* ⇒ *matrix*

Matrix1 − *Value* ⇒ *matrix*

Value − *Matrix1* returns a matrix of *Value* times the identity matrix minus *Matrix1*. *Matrix1* must be square.

Matrix1 − *Value* returns a matrix of *Value* times the identity matrix subtracted from *Matrix1*. *Matrix1* must be square.

Note: Use **.−** (dot minus) to subtract an expression from each element.

$20-\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}$ $\quad\quad$ $\begin{bmatrix}19 & -2\\ -3 & 16\end{bmatrix}$

· (multiply)

·key

Value1 · *Value2* ⇒ *value*

Returns the product of the two arguments.

$2\cdot 3.45$ $\quad\quad$ 6.9

List1 · *List2* ⇒ *list*

Returns a list containing the products of the corresponding elements in *List1* and *List2*.

Dimensions of the lists must be equal.

$\{1.,2,3\}\cdot\{4,5,6\}$ $\quad\quad$ $\{4,10,18\}$

Matrix1 · *Matrix2* ⇒ *matrix*

Returns the matrix product of *Matrix1* and *Matrix2*.

The number of columns in *Matrix1* must equal the number of rows in *Matrix2*.

$\begin{bmatrix}1 & 2 & 3\\ 4 & 5 & 6\end{bmatrix}\cdot\begin{bmatrix}7 & 8\\ 7 & 8\\ 7 & 8\end{bmatrix}$ $\quad\quad$ $\begin{bmatrix}42 & 48\\ 105 & 120\end{bmatrix}$

Value · *List1* ⇒ *list*

List1 · *Value* ⇒ *list*

Returns a list containing the products of *Value* and each element in *List1*.

$\pi\cdot\{4,5,6\}$ $\quad\quad$ $\{12.5664,15.708,18.8496\}$

Value · *Matrix1* ⇒ *matrix*

Matrix1 · *Value* ⇒ *matrix*

Returns a matrix containing the products of *Value* and each element in *Matrix1*.

Note: Use **.·** (dot multiply) to multiply an expression by each element.

$\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}\cdot.01$ $\quad\quad$ $\begin{bmatrix}.01 & .02\\ .03 & .04\end{bmatrix}$

$6\cdot\text{identity}(3)$ $\quad\quad$ $\begin{bmatrix}6 & 0 & 0\\ 0 & 6 & 0\\ 0 & 0 & 6\end{bmatrix}$

/ (divide)

÷key

Value1 / *Value2* ⇒ *value*

Returns the quotient of *Value1* divided by *Value2*.

Note: See also **Fraction template**, page 1.

$\frac{2}{3.45}$ $\quad\quad$ $.57971$

List1 / *List2* ⇒ *list*

Returns a list containing the quotients of *List1* divided by *List2*.

Dimensions of the lists must be equal.

$\frac{\{1.,2,3\}}{\{4,5,6\}}$ $\quad\quad$ $\left\{.25,\frac{2}{5},\frac{1}{2}\right\}$

Value / *List1* ⇒ *list*

List1 / *Value* ⇒ *list*

Returns a list containing the quotients of *Value* divided by *List1* or *List1* divided by *Value*.

$\frac{6}{\{3,6,\sqrt{6}\}}$ $\quad\quad$ $\{2,1,2.44949\}$

$\frac{\{7,9,2\}}{7\cdot 9\cdot 2}$ $\quad\quad$ $\left\{\frac{1}{18},\frac{1}{14},\frac{1}{63}\right\}$

/ (divide)

Value / *Matrix1* ⇒ *matrix*

Matrix1 / *Value* ⇒ *matrix*

Returns a matrix containing the quotients of *Matrix1* / *Value*.

Note: Use **. /** (dot divide) to divide an expression by each element.

$$\frac{[7 \quad 9 \quad 2]}{7 \cdot 9 \cdot 2} \qquad \left[\frac{1}{18} \quad \frac{1}{14} \quad \frac{1}{63}\right]$$

^ (power)

Value1 ^ *Value2* ⇒ *value*

List1 ^ *List2* ⇒ *list*

Returns the first argument raised to the power of the second argument.

Note: See also **Exponent template**, page 1.

For a list, returns the elements in *List1* raised to the power of the corresponding elements in *List2*.

In the real domain, fractional powers that have reduced exponents with odd denominators use the real branch versus the principal branch for complex mode.

$$4^2 \qquad 16$$

$$\{2,4,6\}^{\{1,2,3\}} \qquad \{2,16,216\}$$

Value ^ *List1* ⇒ *list*

Returns *Value* raised to the power of the elements in *List1*.

$$\pi^{\{1,2,-3\}} \qquad \{3.14159,9.8696,.032252\}$$

List1 ^ *Value* ⇒ *list*

Returns the elements in *List1* raised to the power of *Value*.

$$\{1,2,3,4\}^{-2} \qquad \left\{1,\frac{1}{4},\frac{1}{9},\frac{1}{16}\right\}$$

squareMatrix1 ^ *integer* ⇒ *matrix*

Returns *squareMatrix1* raised to the *integer* power.

squareMatrix1 must be a square matrix.

If *integer* = −1, computes the inverse matrix.
If *integer* < −1, computes the inverse matrix to an appropriate positive power.

$$\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}^2 \qquad \begin{bmatrix}7 & 10\\ 15 & 22\end{bmatrix}$$

$$\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}^{-1} \qquad \begin{bmatrix}-2 & 1\\ \frac{3}{2} & -\frac{1}{2}\end{bmatrix}$$

$$\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}^{-2} \qquad \begin{bmatrix}\frac{11}{2} & -\frac{5}{2}\\ \frac{-15}{4} & \frac{7}{4}\end{bmatrix}$$

x^2 (square)

Value1^2 ⇒ *value*

Returns the square of the argument.

List1^2 ⇒ *list*

Returns a list containing the squares of the elements in *List1*.

squareMatrix1^2 ⇒ *matrix*

Returns the matrix square of *squareMatrix1*. This is not the same as calculating the square of each element. Use .^2 to calculate the square of each element.

.+ (dot add)

Matrix1 **.+** *Matrix2* ⇒ *matrix*
Value **.+** *Matrix1* ⇒ *matrix*

Matrix1 **.+** *Matrix2* returns a matrix that is the sum of each pair of corresponding elements in *Matrix1* and *Matrix2*.

Value **.+** *Matrix1* returns a matrix that is the sum of *Value* and each element in *Matrix1*.

$$\begin{bmatrix}1 & 2\\3 & 4\end{bmatrix} .+ \begin{bmatrix}10 & 30\\20 & 40\end{bmatrix} \qquad \begin{bmatrix}11 & 32\\23 & 44\end{bmatrix}$$

$$5 .+ \begin{bmatrix}10 & 30\\20 & 40\end{bmatrix} \qquad \begin{bmatrix}15 & 35\\25 & 45\end{bmatrix}$$

.− (dot subt.)

Matrix1 **.−** *Matrix2* ⇒ *matrix*
Value **.−***Matrix1* ⇒ *matrix*

Matrix1 **.−***Matrix2* returns a matrix that is the difference between each pair of corresponding elements in *Matrix1* and *Matrix2*.

Value **.−***Matrix1* returns a matrix that is the difference of *Value* and each element in *Matrix1*.

$$\begin{bmatrix}1 & 2\\3 & 4\end{bmatrix} .- \begin{bmatrix}10 & 20\\30 & 40\end{bmatrix} \qquad \begin{bmatrix}-9 & -18\\-27 & -36\end{bmatrix}$$

$$5 .- \begin{bmatrix}10 & 20\\30 & 40\end{bmatrix} \qquad \begin{bmatrix}-5 & -15\\-25 & -35\end{bmatrix}$$

.· (dot mult.)

Matrix1 **.·** *Matrix2* ⇒ *matrix*
Value **.·** *Matrix1* ⇒ *matrix*

Matrix1 **.·** *Matrix2* returns a matrix that is the product of each pair of corresponding elements in *Matrix1* and *Matrix2*.

Value **.·** *Matrix1* returns a matrix containing the products of *Value* and each element in *Matrix1*.

$$\begin{bmatrix}1 & 2\\3 & 4\end{bmatrix} .\cdot \begin{bmatrix}10 & 20\\30 & 40\end{bmatrix} \qquad \begin{bmatrix}10 & 40\\90 & 160\end{bmatrix}$$

$$5 .\cdot \begin{bmatrix}10 & 20\\30 & 40\end{bmatrix} \qquad \begin{bmatrix}50 & 100\\150 & 200\end{bmatrix}$$

./ (dot divide)

Matrix1 **./** *Matrix2* ⇒ *matrix*
Value **./** *Matrix1* ⇒ *matrix*

Matrix1 **./** *Matrix2* returns a matrix that is the quotient of each pair of corresponding elements in *Matrix1* and *Matrix2*.

Value **./** *Matrix1* returns a matrix that is the quotient of *Value* and each element in *Matrix1*.

$$\begin{bmatrix}1 & 2\\3 & 4\end{bmatrix} ./ \left(\begin{bmatrix}10 & 20\\30 & 40\end{bmatrix}\right) \qquad \begin{bmatrix}\frac{1}{10} & \frac{1}{10}\\\frac{1}{10} & \frac{1}{10}\end{bmatrix}$$

$$5 ./ \left(\begin{bmatrix}10 & 20\\30 & 40\end{bmatrix}\right) \qquad \begin{bmatrix}\frac{1}{2} & \frac{1}{4}\\\frac{1}{6} & \frac{1}{8}\end{bmatrix}$$

.^ (dot power)

Matrix1 **.^** *Matrix2* ⇒ *matrix*
Value **.^** *Matrix1* ⇒ *matrix*

Matrix1 **.^** *Matrix2* returns a matrix where each element in *Matrix2* is the exponent for the corresponding element in *Matrix1*.

Value **.^** *Matrix1* returns a matrix where each element in *Matrix1* is the exponent for *Value*.

$$\begin{bmatrix}1 & 2\\3 & 4\end{bmatrix} .\wedge \begin{bmatrix}0 & 2\\3 & -1\end{bmatrix} \qquad \begin{bmatrix}1 & 4\\27 & \frac{1}{4}\end{bmatrix}$$

$$5 .\wedge \begin{bmatrix}0 & 2\\3 & -1\end{bmatrix} \qquad \begin{bmatrix}1 & 25\\125 & \frac{1}{5}\end{bmatrix}$$

−(negate)

ans (−) key

−Value1 ⇒ *value*
−List1 ⇒ *list*
−Matrix1 ⇒ *matrix*

Returns the negation of the argument.

For a list or matrix, returns all the elements negated.

If the argument is a binary or hexadecimal integer, the negation gives the two's complement.

−2.43	−2.43
−{−1,.4,1.2E19}	{1,−.4,−1.2E19}

In Bin base mode:

Important: Zero, not the letter O

0b100101▶Dec	37
−0b100101	
0b1111111111111111111111111111111▶	
Ans▶Dec	−37

To see the entire result, press ▲ and then use ◀ and ▶ to move the cursor.

% (percent)

ctrl ∞ keys

Value1 **%** ⇒ *value*
List1 **%** ⇒ *list*
Matrix1 **%** ⇒ *matrix*

Returns $\frac{argument}{100}$

For a list or matrix, returns a list or matrix with each element divided by 100.

Press **Ctrl Enter** ctrl ≈ enter to evaluate:

13%	.13

Press **Ctrl Enter** ctrl ≈ enter to evaluate:

{{1,10,100}}%	{.01,.1,1.}

= (equal)

(=) key

Expr1 = *Expr2* ⇒ *Boolean expression*

List1 = *List2* ⇒ *Boolean list*

Matrix1 = *Matrix2* ⇒ *Boolean matrix*

Returns true if *Expr1* is determined to be equal to *Expr2*.

Returns false if *Expr1* is determined to not be equal to *Expr2*.

Anything else returns a simplified form of the equation.

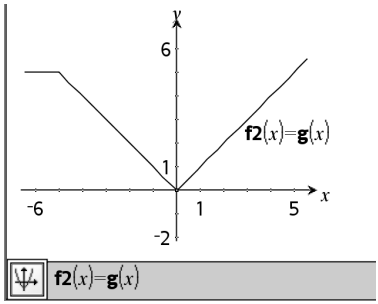
For lists and matrices, returns comparisons element by element.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing (↵) instead of (enter) at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

Example function that uses math test symbols: =, ≠, <, ≤, >, ≥

```
Define g(x)=Func
              If x≤-5 Then
              Return 5
              ElseIf x>-5 and x<0 Then
              Return -x
              ElseIf x≥0 and x≠10 Then
              Return x
              ElseIf x=10 Then
              Return 3
              EndIf
              EndFunc
                                        Done
```

Result of graphing g(x)



≠ (not equal)

ctrl (=) keys

Expr1 ≠ *Expr2* ⇒ *Boolean expression*

List1 ≠ *List2* ⇒ *Boolean list*

Matrix1 ≠ *Matrix2* ⇒ *Boolean matrix*

Returns true if *Expr1* is determined to be not equal to *Expr2*.

Returns false if *Expr1* is determined to be equal to *Expr2*.

Anything else returns a simplified form of the equation.

For lists and matrices, returns comparisons element by element.

See "=" (equal) example.

< (less than)

(<) key

Expr1 < *Expr2* ⇒ *Boolean expression*

List1 < *List2* ⇒ *Boolean list*

Matrix1 < *Matrix2* ⇒ *Boolean matrix*

Returns true if *Expr1* is determined to be less than *Expr2*.

Returns false if *Expr1* is determined to be greater than or equal to *Expr2*.

Anything else returns a simplified form of the equation.

For lists and matrices, returns comparisons element by element.

See "=" (equal) example.

≤ (less or equal)

ctrl < keys

Expr1 ≤ *Expr2* ⇒ *Boolean expression*
List1 ≤ *List2* ⇒ *Boolean list*
Matrix1 ≤ *Matrix2* ⇒ *Boolean matrix*

Returns true if *Expr1* is determined to be less than or equal to *Expr2*.

Returns false if *Expr1* is determined to be greater than *Expr2*.

Anything else returns a simplified form of the equation.

For lists and matrices, returns comparisons element by element.

See "=" (equal) example.

> (greater than)

> key

Expr1 > *Expr2* ⇒ *Boolean expression*
List1 > *List2* ⇒ *Boolean list*
Matrix1 > *Matrix2* ⇒ *Boolean matrix*

Returns true if *Expr1* is determined to be greater than *Expr2*.

Returns false if *Expr1* is determined to be less than or equal to *Expr2*.

Anything else returns a simplified form of the equation.

For lists and matrices, returns comparisons element by element.

See "=" (equal) example.

≥ (greater or equal)

ctrl > keys

Expr1 ≥ *Expr2* ⇒ *Boolean expression*
List1 ≥ *List2* ⇒ *Boolean list*
Matrix1 ≥ *Matrix2* ⇒ *Boolean matrix*

Returns true if *Expr1* is determined to be greater than or equal to *Expr2*.

Returns false if *Expr1* is determined to be less than *Expr2*.

Anything else returns a simplified form of the equation.

For lists and matrices, returns comparisons element by element.

See "=" (equal) example.

! (factorial)

ctrl keys

Value1! ⇒ *value*
List1! ⇒ *list*
Matrix1! ⇒ *matrix*

Returns the factorial of the argument.

For a list or matrix, returns a list or matrix of factorials of the elements.

5!	120
{{5,4,3}}!	{120,24,6}
$\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix}$!	$\begin{bmatrix}1 & 2\\ 6 & 24\end{bmatrix}$

& (append)

ctrl keys

String1 & *String2* ⇒ *string*

Returns a text string that is *String2* appended to *String1*.

"Hello "&"Nick"	"Hello Nick"

√() (square root)

ctrl **$\sqrt{x^2}$** **keys**

$\sqrt{}$ (*Value1*) ⇒ *value*
$\sqrt{}$ (*List1*) ⇒ *list*

Returns the square root of the argument.

For a list, returns the square roots of all the elements in *List1*.

Note: See also **Square root template**, page 1.

Π() (product)

Catalog >

Π(*Expr1*, *Var*, *Low*, *High*) ⇒ *expression*

Evaluates *Expr1* for each value of *Var* from *Low* to *High*, and returns the product of the results.

Note: See also **Product template (Π)**, page 4.

$$\prod_{n=1}^{5}\left(\frac{1}{n}\right) \qquad \frac{1}{120}$$

$$\prod_{n=1}^{5}\left(\left\{\frac{1}{n},n,2\right\}\right) \qquad \left\{\frac{1}{120},120,32\right\}$$

Π(*Expr1*, *Var*, *Low*, *Low*−1) ⇒ 1

$$\prod_{k=4}^{3}(k) \qquad 1$$

Π(*Expr1*, *Var*, *Low*, *High*)
⇒ 1/Π(*Expr1*, *Var*, *High*+1, *Low*−1) if *High* < *Low*−1

$$\prod_{k=4}^{1}\left(\frac{1}{k}\right) \qquad 6$$

$$\prod_{k=4}^{1}\left(\frac{1}{k}\right)\cdot\prod_{k=2}^{4}\left(\frac{1}{k}\right) \qquad \frac{1}{4}$$

Σ() (sum)

Catalog >

Σ(*Expr1*, *Var*, *Low*, *High*) ⇒ *expression*

Evaluates *Expr1* for each value of *Var* from *Low* to *High*, and returns the sum of the results.

$$\sum_{n=1}^{5}\left(\frac{1}{n}\right) \qquad \frac{137}{60}$$

Σ(*Expr1*, *Var*, *Low*, *Low*−1) ⇒ 0

$$\sum_{k=4}^{3}(k) \qquad 0$$

Σ() (sum)

Catalog >

Σ(*Expr1*, *Var*, *Low*, *High*)
⇒ −**Σ(***Expr1*, *Var*, *High*+1, *Low*−1) if *High* < *Low*−1

$$\sum_{k=4}^{1}(k) \qquad -5$$

$$\sum_{k=4}^{1}(k)+\sum_{k=2}^{4}(k) \qquad 4$$

ΣInt()

Catalog >

ΣInt(*NPmt1*, *NPmt2*, *N*, *I*, *PV* ,[*Pmt*], [*FV*], [*PpY*], [*CpY*], [*PmtAt*], [*roundValue*]) ⇒ *value*

ΣInt(*NPmt1*,*NPmt2*,*amortTable*) ⇒ *value*

Amortization function that calculates the sum of the interest during a specified range of payments.

NPmt1 and *NPmt2* define the start and end boundaries of the payment range.

N, *I*, *PV*, *Pmt*, *FV*, *PpY*, *CpY*, and *PmtAt* are described in the table of TVM arguments, page 86.

- If you omit *Pmt*, it defaults to *Pmt*=**tvmPmt(***N*,*I*,*PV*,*FV*,*PpY*,*CpY*,*PmtAt***)**.
- If you omit *FV*, it defaults to *FV*=0.
- The defaults for *PpY*, *CpY*, and *PmtAt* are the same as for the TVM functions.

roundValue specifies the number of decimal places for rounding. Default=2.

ΣInt(*NPmt1*,*NPmt2*,*amortTable***)** calculates the sum of the interest based on amortization table *amortTable*. The *amortTable* argument must be a matrix in the form described under **amortTbl()**, page 5.

Note: See also **ΣPrn()**, below, and **Bal()**, page 10.

ΣInt(1,3,12,4.75,20000,,12,12) −213.48

tbl:=amortTbl(12,12,4.75,20000,,12,12)

0	0.	0.	20000.
1	−77.49	−1632.43	18367.6
2	−71.17	−1638.75	16728.8
3	−64.82	−1645.1	15083.7
4	−58.44	−1651.48	13432.2
5	−52.05	−1657.87	11774.4
6	−45.62	−1664.3	10110.1
7	−39.17	−1670.75	8439.32
8	−32.7	−1677.22	6762.1
9	−26.2	−1683.72	5078.38
10	−19.68	−1690.24	3388.14
11	−13.13	−1696.79	1691.35
12	−6.55	−1703.37	−12.02

ΣInt(1,3,*tbl*) −213.48

ΣPrn()

Catalog >

ΣPrn(*NPmt1*, *NPmt2*, *N*, *I*, *PV*, [*Pmt*], [*FV*], [*PpY*], [*CpY*], [*PmtAt*], [*roundValue*]**)** ⇒ *value*

ΣPrn(*NPmt1*,*NPmt2*,*amortTable***)** ⇒ *value*

Amortization function that calculates the sum of the principal during a specified range of payments.

NPmt1 and *NPmt2* define the start and end boundaries of the payment range.

N, *I*, *PV*, *Pmt*, *FV*, *PpY*, *CpY*, and *PmtAt* are described in the table of TVM arguments, page 86.

- If you omit *Pmt*, it defaults to *Pmt*=**tvmPmt(***N*,*I*,*PV*,*FV*,*PpY*,*CpY*,*PmtAt***)**.
- If you omit *FV*, it defaults to *FV*=0.
- The defaults for *PpY*, *CpY*, and *PmtAt* are the same as for the TVM functions.

roundValue specifies the number of decimal places for rounding. Default=2.

ΣPrn(*NPmt1*,*NPmt2*,*amortTable***)** calculates the sum of the principal paid based on amortization table *amortTable*. The *amortTable* argument must be a matrix in the form described under **amortTbl()**, page 5.

Note: See also **ΣInt()**, above, and **Bal()**, page 10.

$\Sigma\text{Prn}(1,3,12,4.75,20000,,12,12)$ -4916.28

$tbl:=\text{amortTbl}(12,12,4.75,20000,,12,12)$

0	0.	0.	20000.
1	-77.49	-1632.43	18367.57
2	-71.17	-1638.75	16728.82
3	-64.82	-1645.1	15083.72
4	-58.44	-1651.48	13432.24
5	-52.05	-1657.87	11774.37
6	-45.62	-1664.3	10110.07
7	-39.17	-1670.75	8439.32
8	-32.7	-1677.22	6762.1
9	-26.2	-1683.72	5078.38
10	-19.68	-1690.24	3388.14
11	-13.13	-1696.79	1691.35
12	-6.55	-1703.37	-12.02

$\Sigma\text{Prn}(1,3,tbl)$ -4916.28

(indirection)

ctrl keys

*varNameString*

Refers to the variable whose name is *varNameString*. This lets you use strings to create variable names from within a function.

$xyz:=12$	12
$\#("x"\&"y"\&"z")$	12

Creates or refers to the variable xyz .

$10\rightarrow r$	10
$"r"\rightarrow s1$	"r"
$\#s1$	10

Returns the value of the variable (r) whose name is stored in variable s1.

E (scientific notation)

EE key

*mantissa***E***exponent*

Enters a number in scientific notation. The number is interpreted as *mantissa* × $10^{exponent}$.

Hint: If you want to enter a power of 10 without causing a decimal value result, use 10^*integer*.

23000.	23000.
2300000000.+4.1E15	4.1E15
$3\cdot 10^4$	30000

ᵍ (gradian)

ctrl keys

*Expr1*ᵍ ⇒ *expression*
*List1*ᵍ ⇒ *list*
*Matrix1*ᵍ ⇒ *matrix*

This function gives you a way to specify a gradian angle while in the Degree or Radian mode.

In Radian angle mode, multiplies *Expr1* by π/200.

In Degree angle mode, multiplies *Expr1* by g/100.

In Gradian mode, returns *Expr1* unchanged.

In Degree, Gradian or Radian mode:

$\cos(50^g)$ → .707107

$\cos(\{0,100^g,200^g\})$ → $\{1,0.,-1.\}$

ʳ (radian)

ctrl keys

*Value1*ʳ ⇒ *value*
*List1*ʳ ⇒ *list*
*Matrix1*ʳ ⇒ *matrix*

This function gives you a way to specify a radian angle while in Degree or Gradian mode.

In Degree angle mode, multiplies the argument by 180/π.

In Radian angle mode, returns the argument unchanged.

In Gradian mode, multiplies the argument by 200/π.

Hint: Use ʳ if you want to force radians in a function definition regardless of the mode that prevails when the function is used.

In Degree, Gradian or Radian angle mode:

$\cos\left(\frac{\pi}{4^r}\right)$ → .707107

$\cos\left(\left\{0^r,\frac{\pi}{12}^r,-(\pi)^r\right\}\right)$ → $\{1,.965926,-1.\}$

° (degree)

ctrl keys

Value1° ⇒ *value*
List1° ⇒ *list*
Matrix1° ⇒ *matrix*

This function gives you a way to specify a degree angle while in Gradian or Radian mode.

In Radian angle mode, multiplies the argument by π/180.

In Degree angle mode, returns the argument unchanged.

In Gradian angle mode, multiplies the argument by 10/9.

In Degree, Gradian or Radian angle mode:

$\cos(45^\circ)$ → .707107

In Radian angle mode:

$\cos\left(\left\{0,\frac{\pi}{4},90^\circ,30.12^\circ\right\}\right)$ → $\{1.,.707107,0.,.864976\}$

°, ', '' (degree/minute/second)

ctrl keys

dd°*mm*'*ss.ss*'' ⇒ *expression*

dd A positive or negative number

mm A non-negative number

ss.ss A non-negative number

Returns *dd*+(*mm*/60)+(*ss.ss*/3600).

This base-60 entry format lets you:

- Enter an angle in degrees/minutes/seconds without regard to the current angle mode.
- Enter time as hours/minutes/seconds.

Note: Follow ss.ss with two apostrophes (''), not a quote symbol (").

In Degree angle mode:

$25^\circ13'17.5''$ → 25.2215

$25^\circ30'$ → $\frac{51}{2}$

∠ (angle)

ctrl keys

[*Radius*,∠θ_*Angle*] ⇒ *vector*
(polar input)

[*Radius*,∠θ_*Angle*,*Z_Coordinate*] ⇒ *vector*
(cylindrical input)

[*Radius*,∠θ_*Angle*,∠θ_*Angle*] ⇒ *vector*
(spherical input)

Returns coordinates as a vector depending on the Vector Format mode setting: rectangular, cylindrical, or spherical.

In Radian mode and vector format set to:
rectangular

$$[5 \quad \angle 60° \quad \angle 45°] \\ [1.76777 \quad 3.06186 \quad 3.53553]$$

cylindrical

$$[5 \quad \angle 60° \quad \angle 45°] \\ [3.53553 \quad \angle 1.0472 \quad 3.53553]$$

spherical

$$[5 \quad \angle 60° \quad \angle 45°] \\ [5. \quad \angle 1.0472 \quad \angle .785398]$$

(*Magnitude* ∠ *Angle*) ⇒ *complexValue*
(polar input)

Enters a complex value in (r∠θ) polar form. The *Angle* is interpreted according to the current Angle mode setting.

In Radian angle mode and Rectangular complex format:

$$5+3\cdot i-\left(10 \angle \frac{\pi}{4}\right) \qquad -2.07107-4.07107\cdot i$$

10^()

Catalog >

10^ (*Value1***)** ⇒ *value*
10^ (*List1***)** ⇒ *list*

Returns 10 raised to the power of the argument.

For a list, returns 10 raised to the power of the elements in *List1*.

$$10^{1.5} \qquad 31.6228$$

10^(*squareMatrix1***)** ⇒ *squareMatrix*

Returns 10 raised to the power of *squareMatrix1*. This is not the same as calculating 10 raised to the power of each element. For information about the calculation method, refer to **cos()**.

squareMatrix1 must be diagonalizable. The result always contains floating-point numbers.

$$10^{\begin{bmatrix} 1 & 5 & 3 \\ 4 & 2 & 1 \\ 6 & -2 & 1 \end{bmatrix}} \\ \begin{bmatrix} 1.14336\text{E}7 & 8.17155\text{E}6 & 6.67589\text{E}6 \\ 9.95651\text{E}6 & 7.11587\text{E}6 & 5.81342\text{E}6 \\ 7.65298\text{E}6 & 5.46952\text{E}6 & 4.46845\text{E}6 \end{bmatrix}$$

^-1 (reciprocal)

Catalog >

Value1 ^-1 ⇒ *value*
List1 ^-1 ⇒ *list*

Returns the reciprocal of the argument.

For a list, returns the reciprocals of the elements in *List1*.

$$(3.1)^{-1} \qquad .322581$$

squareMatrix1 ^-1 ⇒ *squareMatrix*

Returns the inverse of *squareMatrix1*.

squareMatrix1 must be a non-singular square matrix.

$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}^{-1} \qquad \begin{bmatrix} -2 & 1 \\ \frac{3}{2} & \frac{-1}{2} \end{bmatrix}$$

| ("with")

(|) key

Expr | *BooleanExpr1* [**and** *BooleanExpr2*]...[**and** *BooleanExprN*]

The "with" (|) symbol serves as a binary operator. The operand to the left of | is an expression. The operand to the right of | specifies one or more relations that are intended to affect the simplification of the expression. Multiple relations after | must be joined by a logical "and".

$x+1|x=3$ → 4

$x+55|x=\sin(55)$ → 54.0002

The "with" operator provides three basic types of functionality: substitutions, interval constraints, and exclusions.

Substitutions are in the form of an equality, such as x=3 or y=sin(x). To be most effective, the left side should be a simple variable. *Expr* | *Variable* = *value* will substitute *value* for every occurrence of *Variable* in *Expr*.

$x^3-2\cdot x+7\rightarrow f(x)$ → *Done*

$f(x)|x=\sqrt{3}$ → 8.73205

Interval constraints take the form of one or more inequalities joined by logical "**and**" operators. Interval constraints also permit simplification that otherwise might be invalid or not computable.

$\text{nSolve}(x^3+2\cdot x^2-15\cdot x=0,x)$ → 0.

$\text{nSolve}(x^3+2\cdot x^2-15\cdot x=0,x)|x>0 \text{ and } x<5$ → 3.

Exclusions use the "not equals" (/= or ≠) relational operator to exclude a specific value from consideration.

→ (store)

ctrl stor var key

Value → *Var*
List → *Var*
Matrix → *Var*
Expr → *Function*(*Param1*,...)
List → *Function*(*Param1*,...)
Matrix → *Function*(*Param1*,...)

If the variable *Var* does not exist, creates it and initializes it to *Value*, *List*, or *Matrix*.

If the variable *Var* already exists and is not locked or protected, replaces its contents with *Value*, *List*, or *Matrix*.

$\frac{\pi}{4}\rightarrow myvar$ → .785398

$2\cdot\cos(x)\rightarrow y1(x)$ → *Done*

$\{1,2,3,4\}\rightarrow lst5$ → $\{1,2,3,4\}$

$\begin{bmatrix}1&2&3\\4&5&6\end{bmatrix}\rightarrow matg$ → $\begin{bmatrix}1&2&3\\4&5&6\end{bmatrix}$

"Hello" → *str1* → "Hello"

:= (assign)

: = keys

Var := *Value*
Var := *List*
Var := *Matrix*
Function(*Param1*,...) := *Expr*
Function(*Param1*,...) := *List*
Function(*Param1*,...) := *Matrix*

If variable *Var* does not exist, creates *Var* and initializes it to *Value*, *List*, or *Matrix*.

If *Var* already exists and is not locked or protected, replaces its contents with *Value*, *List*, or *Matrix*.

$myvar:=\frac{\pi}{4}$ → .785398

$y1(x):=2\cdot\cos(x)$ → *Done*

$lst5:=\{1,2,3,4\}$ → $\{1,2,3,4\}$

$matg:=\begin{bmatrix}1&2&3\\4&5&6\end{bmatrix}$ → $\begin{bmatrix}1&2&3\\4&5&6\end{bmatrix}$

str1:="Hello" → "Hello"

© (comment)

ctrl keys

© [*text*]

© processes *text* as a comment line, allowing you to annotate functions and programs that you create.

© can be at the beginning or anywhere in the line. Everything to the right of ©, to the end of the line, is the comment.

Note for entering the example: In the Calculator application on the handheld, you can enter multi-line definitions by pressing ↵ instead of enter at the end of each line. On the computer keyboard, hold down **Alt** and press **Enter**.

```
Define g(n)=Func
    © Declare variables
    Local i,result
    result:=0
    For i,1,n,1 ©Loop n times
    result:=result+i^2
    EndFor
    Return result
    EndFunc
                                    Done
g(3)                                14
```

0b, 0h

0 B keys, 0 H keys

0b *binaryNumber*
0h *hexadecimalNumber*

Denotes a binary or hexadecimal number, respectively. To enter a binary or hex number, you must enter the 0b or 0h prefix regardless of the Base mode. Without a prefix, a number is treated as decimal (base 10).

Results are displayed according to the Base mode.

In Dec base mode:

```
0b10+0hF+10                         27
```

In Bin base mode:

```
0b10+0hF+10                         0b11011
```

In Hex base mode:

```
0b10+0hF+10                         0h1B
```

Error codes and messages

When an error occurs, its code is assigned to variable *errCode*. User-defined programs and functions can examine *errCode* to determine the cause of an error. For an example of using *errCode*, See Example 2 under the **Try** command, page 84.

Note: Some error conditions apply only to TI-Nspire™ CAS products, and some apply only to TI-Nspire™ products.

Error code	Description
10	A function did not return a value
20	A test did not resolve to TRUE or FALSE. Generally, undefined variables cannot be compared. For example, the test If a<b will cause this error if either a or b is undefined when the If statement is executed.
30	Argument cannot be a folder name.
40	Argument error
50	Argument mismatch Two or more arguments must be of the same type.
60	Argument must be a Boolean expression or integer
70	Argument must be a decimal number
90	Argument must be a list
100	Argument must be a matrix

Error code	Description
130	Argument must be a string
140	Argument must be a variable name. Make sure that the name: • does not begin with a digit • does not contain spaces or special characters • does not use underscore or period in invalid manner • does not exceed the length limitations See the Calculator section in the documentation for more details.
160	Argument must be an expression
165	Batteries too low for sending or receiving Install new batteries before sending or receiving.
170	Bound The lower bound must be less than the upper bound to define the search interval.
180	Break The  key was pressed during a long calculation or during program execution.
190	Circular definition This message is displayed to avoid running out of memory during infinite replacement of variable values during simplification. For example, a+1->a, where a is an undefined variable, will cause this error.
200	Constraint expression invalid For example, solve(3x^2-4=0,x) | x<0 or x>5 would produce this error message because the constraint is separated by "or" instead of "and."
210	Invalid Data type An argument is of the wrong data type.
220	Dependent limit
230	Dimension A list or matrix index is not valid. For example, if the list {1,2,3,4} is stored in L1, then L1[5] is a dimension error because L1 only contains four elements.
235	Dimension Error. Not enough elements in the lists.
240	Dimension mismatch Two or more arguments must be of the same dimension. For example, [1,2]+[1,2,3] is a dimension mismatch because the matrices contain a different number of elements.
250	Divide by zero
260	Domain error An argument must be in a specified domain. For example, **rand(0)** is not valid.
270	Duplicate variable name
280	Else and ElseIf invalid outside of If...EndIf block
290	EndTry is missing the matching Else statement
295	Excessive iteration
300	Expected 2 or 3-element list or matrix
310	First argument of nSolve must be an equation in a single variable. The first argument must be an equation, and the equation cannot contain a non-valued variable other than the variable of interest.
320	First argument of solve or cSolve must be an equation or inequality For example, solve(3x^2-4,x) is invalid because the first argument is not an equation.
345	Inconsistent units

Error code	Description
350	Index out of range
360	Indirection string is not a valid variable name
380	Undefined Ans Either the previous calculation did not create Ans, or no previous calculation was entered.
390	Invalid assignment
400	Invalid assignment value
410	Invalid command
430	Invalid for the current mode settings
435	Invalid guess
440	Invalid implied multiply For example, x(x+1) is invalid; whereas, x*(x+1) is the correct syntax. This is to avoid confusion between implied multiplication and function calls.
450	Invalid in a function or current expression Only certain commands are valid in a user-defined function.
490	Invalid in Try..EndTry block
510	Invalid list or matrix
550	Invalid outside function or program A number of commands are not valid outside a function or program. For example, **Local** cannot be used unless it is in a function or program.
560	Invalid outside Loop..EndLoop, For..EndFor, or While..EndWhile blocks For example, the Exit command is valid only inside these loop blocks.
565	Invalid outside program
570	Invalid pathname For example, \var is invalid.
575	Invalid polar complex
580	Invalid program reference Programs cannot be referenced within functions or expressions such as 1+p(x) where p is a program.
600	Invalid table
605	Invalid use of units
610	Invalid variable name in a Local statement
620	Invalid variable or function name
630	Invalid variable reference
640	Invalid vector syntax
650	Link transmission A transmission between two units was not completed. Verify that the connecting cable is connected firmly to both ends.
665	Matrix not diagonalizable
670	Low Memory 1. Delete some data in this document 2. Save and close this document If 1 and 2 fail, pull out and re-insert batteries

Error code	Description
680	Missing (
690	Missing)
700	Missing "
710	Missing]
720	Missing }
730	Missing start or end of block syntax
740	Missing Then in the If..EndIf block
750	Name is not a function or program
765	No functions selected
780	No solution found
800	Non-real result For example, if the software is in the Real setting, $\sqrt{(-1)}$ is invalid. To allow complex results, change the "Real or Complex" Mode Setting to RECTANGULAR or POLAR.
830	Overflow
850	Program not found A program reference inside another program could not be found in the provided path during execution.
855	Rand type functions not allowed in graphing
860	Recursion too deep
870	Reserved name or system variable
900	Argument error Median-median model could not be applied to data set.
920	Text not found
930	Too few arguments The function or command is missing one or more arguments.
940	Too many arguments The expression or equation contains an excessive number of arguments and cannot be evaluated.
950	Too many subscripts
955	Too many undefined variables
960	Variable is not defined No value is assigned to variable. Use one of the following commands: • sto → • **:=** • **Define** to assign values to variables.
965	Unlicensed OS
970	Variable in use so references or changes are not allowed
980	Variable is protected
990	Invalid variable name Make sure that the name does not exceed the length limitations
1000	Window variables domain

Error code	Description
1010	Zoom
1020	Internal error
1030	Protected memory violation
1040	Unsupported function. This function requires Computer Algebra System. Try TI-Nspire™ CAS.
1045	Unsupported operator. This operator requires Computer Algebra System. Try TI-Nspire™ CAS.
1050	Unsupported feature. This operator requires Computer Algebra System. Try TI-Nspire™ CAS.
1060	Input argument must be numeric. Only inputs containing numeric values are allowed.
1070	Trig function argument too big for accurate reduction
1080	Unsupported use of Ans.This application does not support Ans.
1090	Function is not defined. Use one of the following commands: • **Define** • **:=** • sto → to define a function.
1100	Non-real calculation For example, if the software is in the Real setting, $\sqrt{(-1)}$ is invalid. To allow complex results, change the "Real or Complex" Mode Setting to RECTANGULAR or POLAR.
1110	Invalid bounds
1120	No sign change
1130	Argument cannot be a list or matrix
1140	Argument error The first argument must be a polynomial expression in the second argument. If the second argument is omitted, the software attempts to select a default.
1150	Argument error The first two arguments must be polynomial expressions in the third argument. If the third argument is omitted, the software attempts to select a default.
1160	Invalid library pathname A pathname must be in the form *xxx**yyy*, where: • The *xxx* part can have 1 to 16 characters. • The *yyy* part can have 1 to 15 characters. See the Library section in the documentation for more details.
1170	Invalid use of library pathname • A value cannot be assigned to a pathname using **Define**, **:=**, or sto →. • A pathname cannot be declared as a Local variable or be used as a parameter in a function or program definition.
1180	Invalid library variable name. Make sure that the name: • Does not contain a period • Does not begin with an underscore • Does not exceed 15 characters See the Library section in the documentation for more details.
1190	Library document not found: • Verify library is in the MyLib folder. • Refresh Libraries. See the Library section in the documentation for more details.

Error code	Description
1200	Library variable not found: • Verify library variable exists in the first problem in the library. • Make sure library variable has been defined as LibPub or LibPriv. • Refresh Libraries. See the Library section in the documentation for more details.

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