

## Aplets and their views

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### Aplet views

This section examines the options and functionality of the three main views for the Function, Polar, Parametric, and Sequence aplets: Symbolic, Plot, and Numeric views.

### About the Symbolic view

The Symbolic view is the *defining view* for the Function, Parametric, Polar, and Sequence aplets. The other views are derived from the symbolic expression.

You can create up to ten different definitions for each Function, Parametric, Polar, and Sequence applet. You can graph any of the relations (in the same applet) simultaneously by selecting them.

### Setting up the angle measure

For the Function, Parametric, Polar, and Sequence aplets, the only setting for the Symbolic view is the angle measure. This is significant only if a trigonometric function is used.

To check or change the angle measure, press **[SHIFT] MODES**. The choices are Radians, Degrees, and Grads. *This setting can affect what the graph looks like, as well as the numerical values.*



The setup that you define for an applet is independent of the setups for other aplets. That is, you need to define the settings that you want for each applet. The exception is angle measure. The angle measure setting chosen in MODES is used for both the current applet and HOME view.

### Defining an expression (Symbolic view)

1. Display the Symbolic view (**[SYMB]**). If the highlight is on an existing expression, scroll to an empty line—unless

you don't mind writing over the expression. Or, clear one line (**DEL**) or all lines (**SHIFT** **CLEAR**).

- **For a Function definition**, enter an expression to define  $F(X)$ . The only independent variable in the expression is  $X$ .
- **For a Parametric definition**, enter a pair of expressions to define  $X(T)$  and  $Y(T)$ . The only independent variable in the expressions is  $T$ .
- **For a Polar definition**, enter an expression to define  $R(\theta)$ . The only independent variable in the expression is  $\theta$ .
- **For a Sequence definition**, either:

Enter the first and second terms for  $U$  ( $U1$ , or... $U9$ , or  $U0$ ). Define the  $n$ th term of the sequence in terms of  $N$  or of the prior terms,  $U(N-1)$  and  $U(N-2)$ . The expressions should produce real-valued sequences with integer domains.

or

Define the  $n$ th term as a non-recursive expression in terms of  $n$  only. The calculator inserts the first two terms based on the expression that you define.

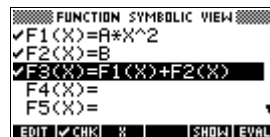
2. When you finish entering expressions, press **CHK** to place a check mark next to the expressions you want to work with. Press **CHK** on a selected expression to remove the check mark. *All check marked expressions are plotted.*

## Evaluating expressions

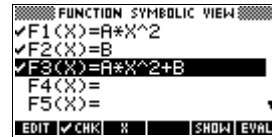
### In applets

In the Symbolic view, a variable is a symbol only, and does not represent one specific value. To evaluate a function in Symbolic view, press **EVAL**. If a function contains another variable, then **EVAL** substitutes the contents as shown in this example.

1. In Function Symbolic view. Enter these three expressions in the Function applet's Symbolic view.



- Highlight F3.
- Press EVAL

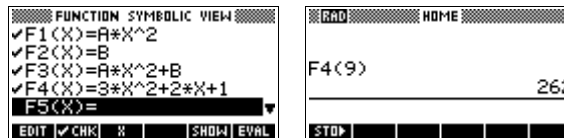


*Note: The values used for A and B will be the current contents of the variables A and B.*

### In HOME

You can also evaluate any expression in HOME by entering it into the edit line and pressing **ENTER**.






For example, define F4 as below. In HOME, type F4(9) and press **ENTER**. This evaluates the expression, substituting 9 in place of X into F4.




### SYMB view keys

The following table details the menu keys that you use to work with the Symbolic view.

Key	Meaning
<b>EDIT</b>	Copies the highlighted expression to the edit line for editing. Press <b>OK</b> when done.
<b>✓CHK</b>	Checks/unchecks the current expression (or set of expressions). Only checked expression(s) are evaluated in the Plot and Numeric views.
<b>X,T,θ, N</b>	Types for the independent variable. Or, you can use the <b>X,T,θ</b> key on the keyboard.
<b>SHOW</b>	Displays the current expression in standard mathematical form.

Key	Meaning (Continued)
<b>EVAL</b>	Resolves all references to other definitions in terms of variables and evaluates all arithmetic expressions.
 	Displays menu list for entering variable names, contents of variables, or math operations.
 <i>CHARS</i>	Displays special characters. To type one, place the cursor on it and press <b>OK</b> . To remain in the CHARS menu, type <b>ECHO</b> .
	Deletes the highlighted expression <i>or</i> the current character in the edit line.
 <i>CLEAR</i>	Deletes all expressions in the list <i>or</i> clears the edit line (if it was in use).

## About the Plot view


After entering and selecting (check marking) the expression in the Symbolic view, press . To adjust the appearance of the graph or the interval that is displayed, you can change the Plot view settings.


You can plot up to ten expressions at the same time. Select the expressions you want to be plotted together.

## Setting up the plot (Plot view setup)



Not all of the setup details below apply to the Statistics and Inference applets. For information on setting up a Statistics or Inference plot, see “Setting up the plot (Plot setup view)” on page 8-112.

Press  *SETUP-PLOT* to define any of the settings shown in the next two tables.

1. Use the arrow keys to move from field to field. Highlight the field to edit.
  - If there is a number to enter, type it in and press  or **OK**.

- If there is an option to choose, press **CHOOS**, highlight your choice, and press **ENTER** or **OK**. As a shortcut to **CHOOS**, just highlight the field to change and press **+** to cycle through options and select the different choices.
  - If there is an option to turn on/off, press **✓CHK** to check or uncheck it.
2. Press **PAGE▼** to view more settings.
  3. When done, press **PLOT** to view the new plot.

## Plot view settings

Field	Meaning
XRNG, YRNG	Specifies the minimum and maximum horizontal (X) and vertical (Y) values for the plotting window.
RES	For function plots: Resolution; “Faster” plots in alternate pixel columns; “More detail” plots in every pixel column.
TRNG	Parametric aplet: Specifies the t-values (T) for the graph.
θRNG,	Polar aplet: Specifies the angle (U) values for the graph.
NRNG	Sequence aplet: Specifies the index (N) values for the graph.
TSTEP θSTEP	For Parametric and Polar plots: intervals at which to use the independent variable to calculate the function.  Note that, for sequence plots, the interval is always 1 and cannot be changed.
SEQPLOT	For Sequence aplet: Stairstep or Cobweb types.
XTICK	Horizontal spacing for tickmarks.
YTICK	Vertical spacing for tickmarks.

Those items with space for a checkmark are settings you can turn on or off. Press **PAGE▼** to display the second page.

Key	Meaning
SIMULT	If more than one relation is being plotted, plots them simultaneously (otherwise sequentially).
INV. CROSS	Cursor crosshairs invert the status of the pixels they cover.
CONNECT	Connect the plotted points. (The Sequence applet always connects them.)
LABELS	Label the axes with XRNG and YRNG values.
AXES	Draw the axes.
GRID	Draw grid points using XTICK and YTICK spacing.

## Reset plot settings

To reset the default values for all plot settings, press **SHIFT CLEAR** in the Plot Setup view.

## Exploring the graph

Plot view gives you a selection of keys and menu keys to explore a graph further. *The options vary from applet to applet.*



## PLOT view keys

The following table details the menu keys that you use to work with the graph.

Key	Meaning
<b>SHIFT CLEAR</b>	Erases the plot and axes.
<b>VIEWS</b>	Offers additional pre-defined views for splitting the screen and for scaling (“zooming”) the axes.
<b>SHIFT ◀</b> <b>SHIFT ▶</b>	Moves cursor to <i>far left</i> or <i>far right</i> .
<b>PAUSE</b> or <b>ON</b>	Interrupts plotting.

Key	Meaning (Continued)
CONT	Continues plotting if interrupted.
MENU	<p>Turns menu-key labels on and off. When the labels are off, any top-row key turns them back on.</p> <ul style="list-style-type: none"> <li>Pressing <b>MENU</b> once displays the full row of labels.</li> <li>Pressing <b>MENU</b> a second time removes the row of labels to display only the graph.</li> <li>Pressing <b>MENU</b> a third time displays the coordinate mode.</li> </ul>
ZOOM	Displays ZOOM menu list.
TRACE	Turns trace mode on/off. A small white box appears next to the option when trace mode is on.
GOTO	Opens an input form for you to enter an $X$ (or $T$ or $\theta$ ) value. Enter the value and press <b>OK</b> . The cursor jumps to the point on the graph that you entered.
FCN	Function applet only: Turns on menu list for root-finding functions (see “” on page 3-62.
DEFN	Displays the current, <i>defining</i> expression. Press <b>MENU</b> to restore the menu.



## Trace a graph

You can trace along a function using the  or  key which moves the cursor along the graph. The display also shows the current coordinate position ( $x$ ,  $y$ ) of the cursor. Trace mode and the coordinate display are automatically set when a plot is drawn.

*Note: Tracing might not appear to exactly follow your plot if the resolution (in Plot Setup view) is set to Faster. This is because RES: FASTER plots in only every other column, whereas tracing always uses every column.*

**In Function and Sequence Aplets:** You can also scroll (move the cursor) left or right beyond the edge of the display window in trace mode, giving you a view of more of the plot.

### To move between relations

If there is more than one relation displayed, press  or  to move between relations.

### To jump directly to a value

To jump straight to a value rather than using the Trace function, use the **GOTO** menu key. Press **GOTO**, then enter an *X* value. Press **OK** to jump to the value.

### To turn trace on/off

(If the menu labels are not displayed, press **MENU** first.)

- Turn off trace mode by pressing **TRACE**.
- Turn on trace mode by pressing **TRACE**.
- To turn the coordinate display off again, press **MENU**.

## Zoom within a graph

One of the menu key options is **ZOOM**. Zooming redraws the plot on a larger or smaller scale. It is a shortcut for changing the Plot Setup, and it also changes those settings.

With the Set Factors option you can specify the factors that determine the extent of zooming, and whether the zoom is centered about the cursor.

### ZOOM options

Press **ZOOM**, select an option, and press **OK**. (If **ZOOM** is not displayed, press **MENU**.) Not all **ZOOM** options are available in all aplets.

Option	Meaning
Center	Re-centers the plot around the current position of the cursor <i>without</i> changing the scale.
Box...	Lets you draw a box to zoom into boundaries. See “Other views for scaling and splitting the graph” on page 2-48.
In	Divides horizontal and vertical scales by the X-factor and Y-factor (in “Set Factors”, below). For instance, if zoom factors are 4, then zooming in results in 1/4 as many units depicted per pixel.



Option	Meaning (Continued)
Out	Multiplies horizontal and vertical scales by the X-factor and Y-factor (see Set Factors).
X-Zoom In	Divides horizontal scale only, using X-factor.
X-Zoom Out	Multiplies horizontal scale, using X-factor.
Y-Zoom In	Divides vertical scale only, using Y-factor.
Y-Zoom Out	Multiplies vertical scale only, using Y-factor.
Square	Changes the vertical scale to match the horizontal scale. (Use this after doing a Box Zoom, X-Zoom, or Y-Zoom.)
Set Factors...	Sets the X-Zoom and Y-Zoom factors for zooming. Includes option to recenter the plot before zooming.
Auto Scale	<p>Rescales the vertical axis so that the display shows a representative piece of the plot, for the supplied <math>x</math> axis settings. (For Sequence and Statistics applets, autoscaling rescales both axes.)</p> <p>The autoscale process uses the first selected function only to determine the best scale to use.</p>
Decimal	Rescales both axes so each pixel = 0.1 unit. Resets default values for XRNG (-6.5 to 6.5) and YRNG (-3.1 to 3.2). (Not in Sequence or Statistics applets.)
Integer	Rescales horizontal axis only, making each pixel = 1 unit. (Not available in Sequence or Statistics applets.)
Trig	Rescales horizontal axis so 1 pixel = $\pi/24$ radian, 7.58, or $8^{1/3}$ grads; rescales vertical axis so 1 pixel = 0.1 unit. (Not in Sequence or Statistics applets.)

Option	Meaning (Continued)
Un-zoom	Returns the display to the previous zoom.

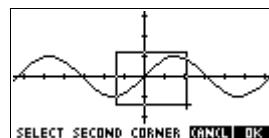
## To zoom in/out

In the Plot view, press **MENU** (if necessary) **ZOOM** for a choice of zooming options. To switch to a predefined axis scaling (such as Trig or Integer), press **[VIEWS]**.

## To box zoom

The Box Zoom option lets you draw a box around the area you want to zoom in on by selecting the endpoints of one diagonal of the zoom rectangle.

1. If necessary, press **MENU** to turn on the menu-key labels.
2. Press **ZOOM** and select **BOX** . . .
3. Position the crosshairs on one corner of the rectangle. Press **OK**.
4. Use the cursor keys (**▼**, etc.) to drag to the opposite corner.



5. Press **OK** to zoom in on the boxed area.



## To set zoom factors

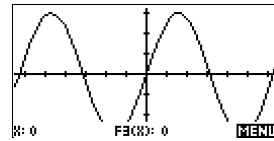
1. In the Plot view, press **MENU ZOOM**. Select Set Factors... and press **OK**.
2. Enter the zoom factors. There is one zoom factor for the horizontal scale (XZOOM) and one for the vertical scale (YZOOM).

Zooming out *multiplies* the scale by the factor, so that a greater scale distance appears on the screen. Zooming in *divides* the scale by the factor, so that a shorter scale distance appears on the screen.

## ZOOM examples

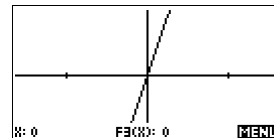
The following screens show the effects of zooming options on a plot of  $\text{SIN}(X)$ . Assume each zoom starts from an “un-zoomed” plot.

Plot of  $3*\sin(X)$



**Zoom In:**

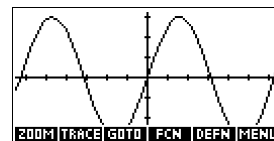
MENU ZOOM In OK



**Un-zoom:**

ZOOM Un-zoom OK

(Press **SHIFT** **▼** to move to the bottom of the Zoom list.)



**Zoom Out:**

ZOOM Out OK

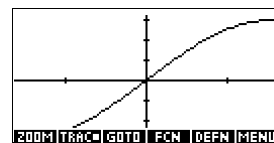
Now un-zoom.



**X-Zoom In:**

ZOOM X-Zoom In OK

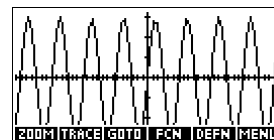
Now un-zoom.



**X-Zoom Out:**

ZOOM X-Zoom Out OK

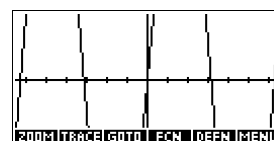
Now un-zoom.



**Y-Zoom In:**

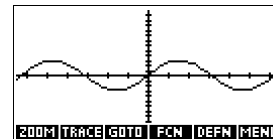
ZOOM Y-Zoom In OK

Now un-zoom.



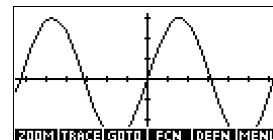
### Y-Zoom Out:

ZOOM Y-Zoom Out OK



### Zoom Square:

ZOOM Square OK



## Other views for scaling and splitting the graph

The preset viewing options menu (**VIEWS**) contains options for drawing the plot using certain pre-defined configurations. This is a shortcut for changing Plot view setting. For instance, if you have defined a trigonometric function, then you could select **Trig** to plot your function on a trigonometric scale. It also contains split-screen options.

In certain applets, for example those that you download from the world wide web, the preset viewing options menu can also contain options that relate to the applet.

### VIEWS menu options

Press **VIEWS**, select an option, and press **OK**.

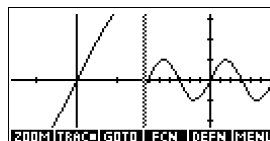
Option	Meaning
Plot-Detail	Splits the screen into the plot and a close-up.
Plot-Table	Splits the screen into the plot and the data table.
Overlay Plot	Plots the current expression(s) <i>without</i> erasing any pre-existing plot(s).

Option	Meaning (Continued)
Auto Scale	Rescales the vertical axis so that the display shows a representative piece of the plot, for the supplied $x$ axis settings. (For Sequence and Statistics aplets, autoscaling rescales both axes.)  The autoscale process uses the first selected function only to determine the best scale to use.
Decimal	Rescales both axes so each pixel = 0.1 unit. Resets default values for $\text{XRNG}$ (-6.5 to 6.5) and $\text{YRNG}$ (-3.1 to 3.2). (Not in Sequence or Statistics aplets.)
Integer	Rescales horizontal axis only, making each pixel = 1 unit. (Not available in Sequence or Statistics aplets.)
Trig	Rescales horizontal axis so 1 pixel = $\pi/24$ radian, 7.58, or $8\frac{1}{3}$ grads; rescales vertical axis so 1 pixel = 0.1 unit. (Not in Sequence or Statistics aplets.)

### Split the screen

The Plot-Detail view can give you two simultaneous views of the plot.

1. Press **VIEWS**. Select Plot-Detail and press **OK**. The graph is plotted twice. You can now zoom in on the right side.
2. Press **MENU ZOOM** to select the zoom method and press **OK** or **ENTER**. This zooms the left side. Here is an example of split screen with Zoom In.



- The Plot menu keys are available as for the full plot (for tracing, coordinate display, equation display, and so on).

- **[SHIFT]** **[◀]** moves the leftmost cursor to the screen's left edge and **[SHIFT]** **[▶]** moves the rightmost cursor to the screen's right edge.
  - The **[<--]** menu key copies the right plot to the left plot.
3. To un-split the screen, press **[PLOT]**. The left side takes over the whole screen.

### Overlay plots

If you want to plot over an existing plot *without erasing* that plot, then use **[VIEWS]** **Overlay Plot** instead of **[PLOT]**. Note that tracing follows only the current functions from the current applet.

### Decimal scaling

Decimal scaling is the default scaling. If you have changed the scaling to Trig or Integer, you can change it back with Decimal.

### Integer scaling

Integer scaling compresses the axes so that each pixel is  $1 \times 1$  and the origin is near the screen center.

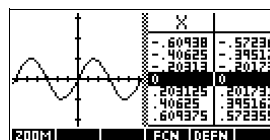
### Trigonometric scaling

Use trigonometric scaling whenever you are plotting an expression that includes trigonometric functions. Trigonometric plots are more likely to intersect the axis at points factored by  $\pi$ .

### Splitting the screen

The Split Screen view gives you two simultaneous views.

1. In the Symbolic view of the appropriate applet, make sure the function(s) you want are checkmarked.
2. Press **[VIEWS]**.  
Select Plot-Table and press **OK**.



3. To move up and down the table, use the **[◀]** and **[▶]** cursor keys. These keys move the trace point left or right along the plot, and in the table, the corresponding values are highlighted.
4. To move between functions, use the **[▲]** and **[▼]** cursor keys to move the cursor from one graph to another.
5. To return to a full Numeric (or Plot) view, press **[NUM]** (or **[PLOT]**).

## About the numeric view

After entering and selecting (check marking) the expression or expressions that you want to explore in the Symbolic view, press **NUM** to view a table of data values for the independent ( $X$ ,  $T$ ,  $\theta$ , or  $N$ ) and dependent variables.

Use the Numeric view to display data values.

X	F1	F2	
0	1	2	
1	1.9	2.61	
2	3.6	5.24	
3	5.1	7.89	
4	6.5	10.56	
5	7.9	13.25	

## Setting up the table (numeric view setup)

Press **SHIFT** **NUM** to define any of the table settings. Use the Numeric Setup input form to configure the table.

FUNCTION NUMERIC SETUP	
NUMSTART:	0
NUMSTEP:	1
NUMTYPE:	Automatic
NUMZOOM:	4
ENTER STARTING VALUE FOR TABLE	
EDIT	PLOT►

To reset the default values for all table settings, press

**SHIFT** **CLEAR**.

- Use the arrow keys to move from field to field. Highlight the field to edit.
  - If there is a number to enter, type it in and press **ENTER** or **OK**. To modify an existing number, press **EDIT**.
  - If there is an option to choose, press **CHOOS**, highlight your choice, and press **ENTER** or **OK**.
  - Shortcut:** Press the **PLOT►** key to copy values from the Plot Setup into NUMSTART and NUMSTEP. Effectively, the **PLOT►** menu key allows you to make the table match the pixel columns in the graph view.
- When done, press **NUM** to view the table of numbers.

## Numeric view settings

The following table details the menu keys on the Numeric Setup input form.

Field	Meaning
NUMSTART	Where to start the independent variable's first value.

Field	Meaning (Continued)
NUMSTEP	The size of the increment from one independent variable value to the next.
NUMTYPE	Type of numeric table: Automatic or Build Your Own. To build your own table, you must type each independent value into the table yourself.
NUMZOOM	Allows you to zoom in or out on a selected value of the independent variable.

## Reset numeric settings

To reset the default values for all table settings, press **SHIFT** *CLEAR*.

## Exploring the table of numbers

### NUM view keys

The following table details the menu keys that you use to work with the table of numbers.

Key	Meaning
<b>ZOOM</b>	Displays ZOOM menu list.
<b>BIG</b>	Toggles between two character sizes.
<b>DEFN</b>	Displays the <i>defining</i> function expression for the highlighted column. To cancel this display, press <b>DEF....</b>

### Zoom within a table

Zooming redraws the table of numbers in greater or lesser detail.



**ZOOM options**

Option	Meaning
In	Decreases the intervals for the independent variable so a narrower range is shown. Uses the NUMZOOM factor in Numeric Setup.
Out	Increases the intervals for the independent variable so that a wider range is shown. Uses the NUMZOOM factor in Numeric Setup.
Decimal	Changes intervals for the independent variable to 0.1 unit. Starts at zero. (Shortcut to changing NUMSTART and NUMSTEP.)
Integer	Changes intervals for the independent variable to 1 unit. Starts at zero. (Shortcut to changing NUMSTEP.)
Trig	Changes intervals for independent variable to $\pi/24$ radian or 7.5 degrees or $8\frac{1}{3}$ grads. Starts at zero.
Un-zoom	Returns the display to the previous zoom.

The display on the right is a Zoom In of the display on the left. The NUMSTEP factor is 4.

X	F1		
0	0		
.1	.0998334		
.2	.1986693		
.3	.2955202		
.4	.3894183		
.5	.4794255		
9.98334166468E-2			
ZOOM		BIG	DEFN

X	F1		
.075	.0748282		
.1	.0998334		
.125	.1248747		
.15	.1494381		
.175	.1741081		
.2	.1986693		
9.98334166468E-2			
ZOOM		BIG	DEFN



To jump to an independent variable value in the table, use the arrow keys to place the cursor in the independent variable column, then enter the value to jump to.

### Automatic recalculation

You can enter any new value in the *X* column for the independent variable. When you then press **ENTER**, the values for the dependent variables are recalculated, and the entire table is regenerated with the same interval between *X* values.

## Building your own table of numbers

The default NUMTYPE is “Automatic”, which fills the table with data for regular intervals of the independent (*X*, *T*,  $\theta$ , or *N*) variable. With the NUMTYPE option set to “Build Your Own”, you fill the table yourself by typing in the independent-variable values you want, and the dependent values are then calculated and displayed.

### Build a table

1. Start with an expression defined (in Symbolic view) in the applet of your choice. *Note: Function, Polar, Parametric, and Sequence applets only.*
2. In the Numeric Setup (**SHIFT****NUM**), choose NUMTYPE: Build Your Own.
3. Open the Numeric view (**NUM**). To clear existing data in the table, press **SHIFT****CLEAR**.
4. Enter the independent values in the left-hand column. Type in the number and press **ENTER**. You do not have to enter them in order, because the SORT function can rearrange them. To insert a number between two others, use **INS**.

You enter numbers into the *X* column variable

X	F1	F2
-2	3	-1
3.7	-2.7	42.89
100	-94	10607
6	-5	79

EDIT INS SORT BIG DEFN

F1 and F2 entries are generated automatically

### Clear data

Press **SHIFT****CLEAR** to erase the data from a table.

## “Build Your Own” Keys

Key	Meaning
EDIT	Puts the highlighted independent value (X, T, $\theta$ , or N) into the edit line. Pressing <b>ENTER</b> replaces this variable with its current value.
INS	Inserts a row of zero values at the position of the highlight. Replace the zero by typing the number you want and pressing <b>ENTER</b> .
SORT	Automatically rearranges the left-hand column into values in ascending (getting larger) or descending (getting smaller) order.
BIG	Toggles between two character sizes.
DEFN	Displays the defining function expression for the highlighted column.
<b>DEL</b>	Deletes the highlighted row.
<b>SHIFT CLEAR</b>	Clears <i>all</i> data from the table.

