

Chapter 10



Sketch Function

The sketch function lets you draw lines and graphs on an existing graph.

- Note that Sketch function operation in the **STAT**, **GRAPH**, **TABLE**, **RECUR** and **CONICS Modes** is different from Sketch function operation in the **RUN** and **PRGM Modes**.

10-1 Before Using the Sketch Function

10-2 Graphing with the Sketch Function

10-1 Before Using the Sketch Function

Press **[SHIFT]** **[F4]** (Sketch) to display the sketch menu.



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STAT, GRAPH, TABLE, RECUR, CONICS Mode

- **{Cls}** ... {clears drawn line and point}
- **{Tang}/****{Norm}/****{Inv}** ... {tangent}/(line normal to a curve)/(inverse graph)
- **{Tang}**, **{Norm}**, and **{Inv}** menus appear only when you display the sketch menu while in the **GRAPH** and **TABLE Modes**.

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- **{PLOT}** ... {plot menu}
- **{LINE}** ... {line menu}
- **{CrcI}/****{Vert}/****{HztI}** ... {circle}/(vertical line)/(horizontal line)
- **{PEN}** ... {freehand drawing}
- **{Text}** ... {comment text}

RUN, PRGM Mode

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- **{GRPH}** ... {graph command menu}
- **{PIXL}** ... {pixel menu}
- **{Test}** ... {tests pixel on/off status}
- Other menu items are identical to those in the **STAT, GRAPH, TABLE, RECUR, CONICS Mode** menu.

10-2 Graphing with the Sketch Function



The sketch function lets you draw lines and plot points on a graph that is already on the screen.

All the examples in this section that show operations in the STAT, GRAPH, TABLE, RECUR, and CONICS Modes are based on the assumption that the following function has already been graphed in the **GRAPH Mode**.

$$\text{Memory Area Y1} = x(x + 2)(x - 2)$$

The following are the View Window parameters used when drawing the graph.

$$\begin{array}{ll} \text{Xmin} = -5 & \text{Ymin} = -5 \\ \text{Xmax} = 5 & \text{Ymax} = 5 \\ \text{Xscale} = 1 & \text{Yscale} = 1 \end{array}$$

■ Tangent

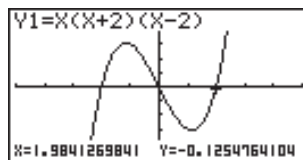
[Sketch]-[Tang]

This function lets you draw a line that is tangent to a graph at any point.

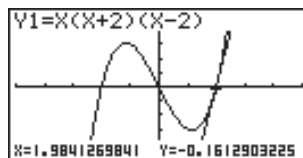
● To draw a tangent in the GRAPH or TABLE Mode

Example To draw a line that is tangent to point $(x = 2, y = 0)$ of $y = x(x + 2)(x - 2)$

1. After graphing the function, display the sketch menu and press $\boxed{F2}$ (Tang).
2. Use the cursor keys to move the pointer the position of the point where you want to draw the line.



3. Press \boxed{EXE} to draw the line.





● **To draw a tangent in the RUN or PRGM Mode**

The following is the command syntax for drawing a tangent in these modes.

Tangent <graph function>, <x-coordinate>

- Use the variable data (VARS) menu to specify the function to be graphed.

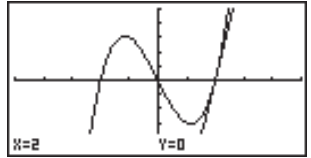
Example To draw a line that is tangent to point $(x = 2, y = 0)$ of $y = x(x + 2)(x - 2)$

1. In the RUN Mode, display the sketch menu, press **F2** (Tang), and then perform the following input.

VAR **F4** (GRPH) **F1** (Y) **1** **2**

Tangent Y1,2_

2. Press **EXE** to draw the tangent line.



■ **Line Normal to a Curve**

[Sketch]-[Norm]

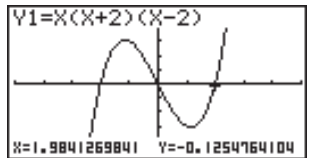
With this function you can draw a line that is normal to the curve at a specific point.

- A line that is normal to the curve at a given point is one that is perpendicular to the tangent line at that point.

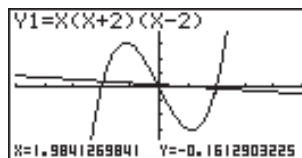
● **To draw a line normal to a curve in the GRAPH or TABLE Mode**

Example To draw a line that is normal to the curve at point $(x = 2, y = 0)$ of $y = x(x + 2)(x - 2)$

1. After graphing the function, display the sketch menu and press **F3** (Norm).
2. Use the cursor keys to move the pointer the position of the point where you want to draw the line.



3. Press $\boxed{\text{EXE}}$ to draw the line.



● **To draw a line normal to a curve in the RUN or PRGM Mode**

The following is the syntax for drawing a line normal to a curve in these modes.

Normal <graph function>, <x-coordinate>

- Use the variable data (VARS) menu to specify the function to be graphed.

■ **Graphing an Inverse Function**

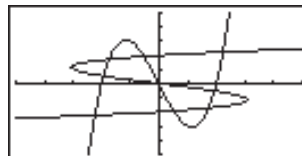
[Sketch]-[Inv]

This function lets you graph the inverse of the function used to produce your original graph.

● **To graph an inverse function in the GRAPH or TABLE Mode**

Example To graph the inverse of $y = x(x + 2)(x - 2)$

After graphing the function, display the sketch menu and press $\boxed{\text{F4}}$ (Inv).



- When graphing an inverse function when there is more than one graph function stored in memory, select one of the functions and then press $\boxed{\text{EXE}}$.

● **To graph an inverse function in the RUN or PRGM Mode**

The following is the syntax for graphing an inverse function in these modes.

Inverse <graph function>

- Use the variable data (VARS) menu to specify the function to be graphed.
- You can only graph the inverse of functions whose graph type is specified as rectangular coordinate type.



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■ Plotting Points

[Sketch]-[PLOT]

When plotting points on a graph, first display the sketch menu and then press **[F6]** (\triangleright) **[F1]** (PLOT) to display the plot menu.

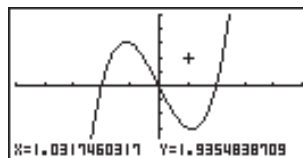
- **{Plot}** ... {plot a point}
- **{PI-On}** ... {plot point at specific coordinates}
- **{PI-Off}** ... {delete point at specific coordinates}
- **{PI-Chg}** ... {switch status of point at specific coordinates}

● To plot points in the STAT, GRAPH, TABLE, RECUR and CONICS Modes

[Sketch]-[PLOT]-[Plot]

Example To plot a point on the graph of $y = x(x + 2)(x - 2)$

1. After drawing the graph, display the sketch menu and press **[F6]** (\triangleright) **[F1]** (PLOT) **[F1]** (Plot) to display the pointer in the center of the screen.
2. Use the cursor keys to move the pointer the locations of the points you want to plot and press **[EXE]** to plot.
 - You can plot as many points as you want.



- The current x - and y -coordinate values are assigned respectively to variables X and Y .

● To plot points in the RUN or PRGM Mode

[Sketch]-[PLOT]-[Plot]

The following is the syntax for plotting points in these modes.

Plot $\langle x\text{-coordinate} \rangle, \langle y\text{-coordinate} \rangle$

Example To plot a point at (2, 2)

Use the following View Window parameters.

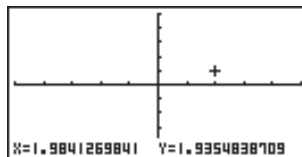
Xmin = -5	Ymin = -10
Xmax = 5	Ymax = 10
Xscale = 1	Yscale = 2

- After entering the RUN Mode, display the sketch menu and perform the following operation.

$\boxed{\text{SHIFT}} \boxed{\text{F4}}$ (Sketch) $\boxed{\text{F6}}$ (\triangleright)
 $\boxed{\text{F1}}$ (PLOT) $\boxed{\text{F1}}$ (Plot) $\boxed{2}$ $\boxed{\blacktriangleright}$ $\boxed{2}$

Plot 2,2_

- Press $\boxed{\text{EXE}}$ and the pointer appears on the display. Press $\boxed{\text{EXE}}$ again to plot a point.



- You can use the cursor keys to move the pointer around the screen.
- If you do not specify coordinates, the pointer is located in the center of the graph screen when it appears on the display.
- If the coordinates you specify are outside the range of the View Window parameters, the pointer will not be on the graph screen when it appears on the display.
- The current x - and y -coordinate values are assigned respectively to variables X and Y .

■ Turning Plot Points On and Off

[Sketch]-[PLOT]-[PI-On]/[PI-Off]/[PI-Chg]

Use the following procedures to turn specific plot points on and off.

● To turn plot points on and off in the STAT, GRAPH, TABLE, RECUR and CONICS Modes

● To turn a plot point on

- After drawing the graph, display the sketch menu and press $\boxed{\text{F6}}$ (\triangleright) $\boxed{\text{F1}}$ (PLOT) $\boxed{\text{F2}}$ (PI-On) to display the pointer in the center of the screen.
- Use the cursor keys to move the pointer to the location where you want to plot a point and then press $\boxed{\text{EXE}}$.

● To turn a plot point off

Perform the same procedure as described under "To turn a plot point on" above, except press $\boxed{\text{F3}}$ (PI-Off) in place of $\boxed{\text{F2}}$ (PI-On).

● To change the on/off status of a plot point

Perform the same procedure as described under "To turn a plot point on" above, except press $\boxed{\text{F4}}$ (PI-Chg) in place of $\boxed{\text{F2}}$ (PI-On).



● **To turn plot points on and off in the RUN or PRGM Mode**

The following are the syntax for turning plot points on and off in these modes.

● **To turn a plot point on**

PlotOn <x-coordinate>, <y-coordinate>

● **To turn a plot point off**

PlotOff <x-coordinate>, <y-coordinate>

● **To change the on/off status of a plot point**

PlotChg <x-coordinate>, <y-coordinate>

■ **Drawing a Line**

[Sketch]-[LINE]

To draw a line on a graph, first display the sketch menu and then press **F6** (\triangleright) **F2** (LINE) to display the line menu.

- {Line} ... {Draw a line between two plotted points}
- {F-Line} ... {Draw a line}

● **To connect two plotted points with a line in the STAT, GRAPH, TABLE, RECUR and CONICS Modes**

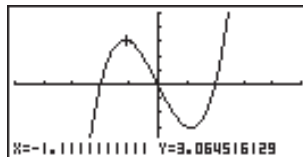
[Sketch]-[LINE]-[Line]

Example

To draw a line between the two points of inflection on the graph of $y = x(x + 2)(x - 2)$

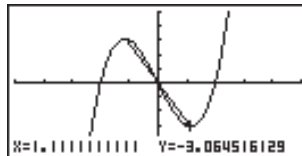
Use the same View Window parameters as in the example on page 155.

1. After drawing a graph, display the sketch menu and then press **F6** (\triangleright) **F1** (PLOT) **F1** (Plot) to display the pointer in the center of the screen.
2. Use the cursor keys to move the pointer to one of the points of inflection and press **EXE** to plot it.



3. Use the cursor keys to move the pointer to the other point of inflection.

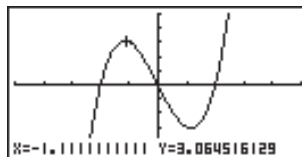
4. Display the sketch menu and then press **F6** (\triangleright) **F2** (LINE) **F1** (Line) to draw a line to the second dot.



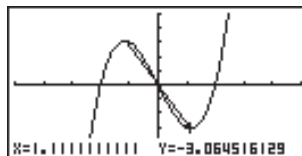
•To draw a line between any two points in the STAT, GRAPH, TABLE, RECUR and CONICS Modes [Sketch]-[LINE]-[F-Line]

Example To draw a line between two points of inflection on the graph of $y = x(x + 2)(x - 2)$

1. After drawing a graph, display the sketch menu and then press **F6** (\triangleright) **F2** (LINE) **F2** (F-Line) to display the pointer in the center of the screen.
2. Use the cursor keys to move the pointer to one of the points of inflection and press **EXE**.



3. Use the cursor keys to move the pointer to the other point of inflection and press **EXE** to draw the line.



•To draw a line in the RUN or PRGM Mode

The following is the syntax for drawing lines in these modes.

F-Line <x-coordinate 1>, <y-coordinate 1>, <x-coordinate 2>, <y-coordinate 2>

■ Drawing a Circle

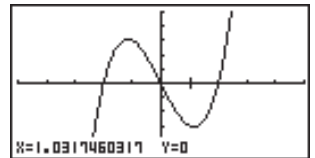
[Sketch]-[Crcl]

You can use the following procedures to draw a circle on a graph.

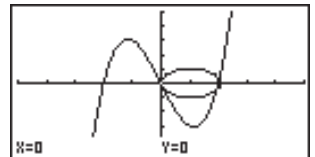
● To draw a circle in the STAT, GRAPH, TABLE, RECUR and CONICS Modes

Example To draw a circle with a radius of $R = 1$ centered at point $(1, 0)$ on the graph of $y = x(x + 2)(x - 2)$

1. After drawing a graph, display the sketch menu and then press **[F6]** (\triangleright) **[F3]** (Crcl) to display the pointer in the center of the screen.
2. Use the cursor keys to move the pointer to the location where you want the center point of the circle to be and press **[EXE]** to plot it.



3. Use the cursor keys to move the pointer to a point on the circumference of the circle (here to point $x = 0$) and then press **[EXE]** to draw the circle.



● To draw a circle in the RUN or PRGM Mode

The following is the syntax for drawing circles in these modes.

Circle <center point x -coordinate>, <center point y -coordinate>, <radius R value>

- • Certain View Window parameters can make a circle appear as an ellipse.



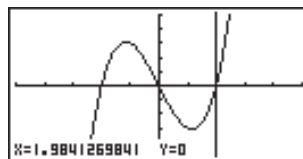
■ Drawing Vertical and Horizontal Lines [Sketch]-[Vert]/[Hztl]

The procedures presented here draw vertical and horizontal lines that pass through a specific coordinate.

● **To draw vertical and horizontal lines in the STAT, GRAPH, TABLE, RECUR and CONICS Modes**

Example To draw a vertical line on the graph of $y = x(x + 2)(x - 2)$

1. After drawing a graph, display the sketch menu and then press **[F6]** (\triangleright) **[F4]** (Vert) to display the pointer along with a vertical line in the center of the screen.
2. Use the \blacktriangleleft and \blacktriangleright cursor keys to move the line left and right, and press **[EXE]** to draw the line at the current location.



To draw a horizontal line, simply press **[F5]** (Hztl) in place of **[F4]** (Vert), and use the \blacktriangleup and \blacktriangledown cursor keys to move the horizontal line on the display.

● **To draw vertical and horizontal lines in the RUN or PRGM Mode**

The following is the syntax for drawing vertical and horizontal lines in these modes.

• **To draw a vertical line**

Vertical <x-coordinate>

• **To draw a horizontal line**

Horizontal <y-coordinate>

■ Freehand Drawing [Sketch]-[PEN]

This function lets you make freehand drawings on a graph, just as if you were using a pen.

- Freehand drawing is available only in the **STAT, GRAPH, TABLE, RECUR** and **CONICS Modes**.

Example To draw on the graph of $y = x(x + 2)(x - 2)$

1. After drawing a graph, display the sketch menu and then press **F6** (\triangleright) **F6** (\triangleright) **F1** (PEN) to display the pointer in the center of the screen.
2. Use the cursor keys to move the pointer to the location where you want to start drawing and press **EXE** to plot it.
3. Use the cursor keys to move the pointer, drawing a line as it moves. Press **EXE** to stop the draw operation of the pointer.



- Press **AC** to quit the freehand draw operation.

■ Comment Text

[Sketch]-[Text]

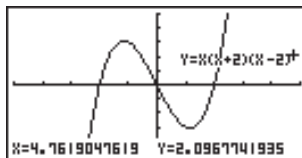
Use the following procedure to insert text for comments and labels into a graph.

●To insert text in the STAT, GRAPH, TABLE, RECUR and CONICS Modes

Example To insert the graph function as comment text into the graph of $y = x(x + 2)(x - 2)$

1. After drawing a graph, display the sketch menu and then press **F6** (\triangleright) **F6** (\triangleright) **F2** (Text) to display the pointer in the center of the screen.
2. Use the cursor keys to move the pointer to the location where you want to insert the comment text, and then input the text.

\blacktriangleright ~ \blacktriangleright \blacktriangle ~ \blacktriangle
ALPHA **Y** **SHIFT** **=** **X,θ,T**
 \langle **X,θ,T** **+** **2** \rangle \langle **X,θ,T** **=** **2** \rangle



● To insert text in the RUN or PRGM Mode

The following is the syntax for inserting text in these modes.

Text <line number>, <column number>, "<text>"

- The line number can be specified within the range of 1 to 63, while the column number can be specified in the range of 1 to 127.



- The following are the characters that can be used inside of comment text in the STAT, GRAPH, TABLE, RECUR, or CONICS Mode.

A~Z, r , θ , space, 0~9, ., +, -, \times , \div , (-), EXP, π , Ans, \downarrow , (,), [,], {, }, comma, \rightarrow , x^2 , \wedge , log, ln, $\sqrt{\quad}$, $\sqrt[x]{\quad}$, 10^x , e^x , $\sqrt[3]{\quad}$, x^{-1} , sin, cos, tan, \sin^{-1} , \cos^{-1} , \tan^{-1}

- A newline operation cannot be performed when inserting comment text. To input multiple lines, you have to perform the above comment text insert operation more than once.

■ Turning Pixels On and Off**[Sketch]-[PIXL]**

The following procedure lets you turn each individual screen pixel on and off. You can specify any pixel from the upper left-hand corner (1, 1) to the lower right-hand corner (63, 127) of the screen.

Line range: 1 to 63

Column range: 1 to 127

- Note that you can turn pixels on and off only in the RUN and PRGM Modes.

When turning pixels on and off, first display the sketch menu and then press **[F6]** (\triangleright) **[F6]** (\triangleright) **[F3]** (PIXL) to display the pixel menu.

- **{On}** ... {turns specified pixel on}
- **{Off}** ... {turns specified pixel off}
- **{Chg}** ... {switches status of specified pixel}

● To turn pixels on and off**[Sketch]-[PIXL]-[On]/[Off]/[Chg]****• To turn a pixel on**

PxlOn <line number>, <column number>

• To turn a pixel off

PxlOff <line number>, <column number>

• To change the on/off status of a pixel

PxlChg <line number>, <column number>

●To check the on/off status of a pixel**[Sketch]-[Test]**

While the sketch menu is on the screen, press **F6** (▷) **F6** (▷) **F4** (Test) and then input the command shown below to check the status of the specified pixel. 1 is returned when the pixel is on, and 0 is returned when the pixel is off.

PxlTest <line number>, <column number>



- Specify a line in the range of 1 to 63 and a column in the range of 1 to 127.
- Trying to perform one of the above operations without specifying a line and column number results in an error.
- Pixel operations are valid only within the allowable line and column ranges.

■ Clearing Drawn Lines and Points**[Sketch]-[CIs]**

The following operation clears all drawn lines and points from the screen.

●To clear lines and points in the STAT, GRAPH, TABLE, RECUR and CONICS Modes

Lines and points drawn using sketch menu functions are temporary. Display the sketch menu and press **F1** (CIs) to clear drawn lines and points, leaving only the original graph.

●To clear drawn lines and points in the RUN or PRGM Mode

The following is the syntax for clearing drawn lines and points, as well as the graph itself.

CIs EXE