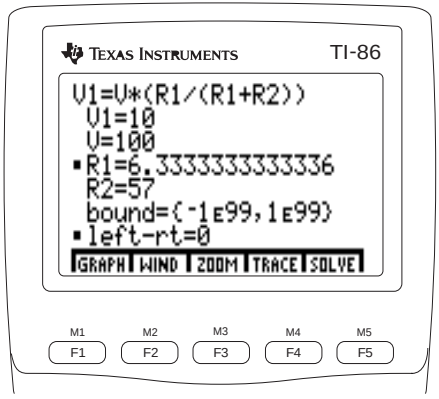
15 Equation Solving



Preview: The Equation Solver [2nd] [SOLVER]

With the equation solver, you can enter an expression or equation, store values to all but one variable in the expression or equation, and then solve for the unknown variable. These steps introduce the solver. For details, read this chapter.

The VARS EQU *menu is a menu version of the* VARS EQU *screen (Chapter 2).*

The example uses a formula for a voltage divider.

R1 *and* **R2** *represent resistors.*

V *and* **V1** *represent voltage.*

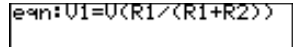
To solve for the unknown variable in an equation on the home screen or in the program editor, select **Solver(** *from the* CATALOG *(A to Z Reference).*

❶ Display the equation-entry editor. The VARS EQU menu is displayed on the bottom of the screen.

[2nd] [SOLVER]

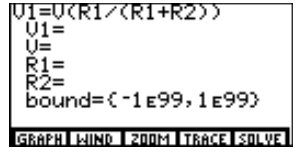
❷ Enter an equation. When you press [ENTER], the interactive-solver editor and solver menu are displayed.

[ALPHA] [V] **1** [ALPHA] [=] [ALPHA] [V] [(] [ALPHA] [R] **1** [÷] [(] [ALPHA] [R] **1** [+] [ALPHA] [R] **2** [)] [)] [ENTER]



❸ Enter values for each variable, except the unknown variable **R1**. Some variables may have values stored to them already.

10 [▼] **100** [▼] [▼] **57**

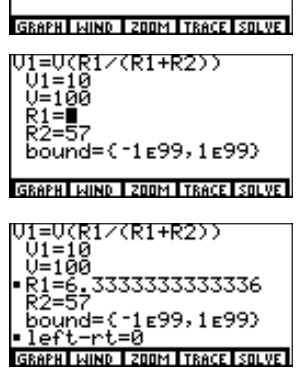


❹ Move the cursor to the variable for which you want to solve. You may enter a guess.

[▲]

❺ Solve the equation for the variable. Small squares mark both the solution variable and the equation **left–rt=0** (the left side of the equation minus the right side of the equation). If you edit a value or leave the screen, the squares disappear.

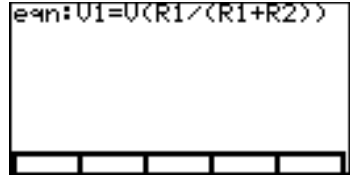
[F5]



Entering an Equation in the Equation-Entry Editor

The equation solver uses two editors: the equation-entry editor, where you enter and edit the equation you want to solve, and the interactive-solver editor, where you enter known variable values, select the variable for which you want to solve, and display the solution.

To display the equation-entry editor, press 2nd [SOLVER]. In this editor, you can:



- Enter an equation directly.
- Enter a defined equation variable's individual characters or select it from the VARS EQU menu.
- Recall the contents of a defined equation variable.

The equation can have more than one variable to the left of the equal sign, as in **A+B=C+sin D**.

As you enter or edit the equation, the TI-86 automatically stores it to the variable **eqn**.

You can display other menus in the equation-entry editor.

The VARS EQU menu is a menu version of the VARS EQU screen (Chapter 2). The items are all variables to which an equation is stored. This includes all selected and deselected equation variables defined in the equation editors of all four graphing modes (Chapters 5, 8, 9, and 10). The menu items are in alphanumeric order.

- If you select an equation variable from the menu, the variable is pasted to the cursor location, overwriting characters for the length of the variable name.
- If you press 2nd [RCL], select an equation variable from the menu, and then press ENTER, the variable contents are inserted at the cursor location.

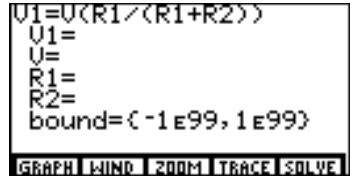
An ellipsis (...) indicates that an entered equation continues beyond the screen. To move directly to the start of the equation, press 2nd ◀; to move directly to the end, press 2nd ▶.

If you enter an equation variable, the TI-86 automatically converts it to the equation **exp=***equationVariable*. If you enter an expression directly, the TI-86 automatically converts the expression to the equation **exp=***expression*.

Setting Up the Interactive-Solver Editor

In the example, the equation **V1=V(R1/(R1+R2))** *was entered in the equation-entry editor.*

If you entered an expression for **eqn**, *then* **exp=** *is the first variable prompt on the interactive-solver editor.*



After you have stored an equation to **eqn** in the equation-entry editor, press ENTER to display the interactive-solver editor.

The equation is displayed across the top of the editor. Each variable in the equation is displayed as a prompt. Values already stored to variables are displayed; undefined variables are blank. The solver menu is displayed on the bottom of the editor (page 206).

bound={-1E99,1E99} is a list containing the default lower bound (**-1E99**) and the default upper bound (**1E99**). You can edit the bounds (below).

Entering Variable Values

To solve for an unknown variable, you must define every other variable in the equation. When you enter or edit a variable value in the interactive-solver editor, the new value is stored to the variable in memory. For any variable, you may enter an expression, which is evaluated when you press ENTER, ▼, ▲, or EXIT. Expressions must resolve to real numbers at each step of the calculation.

Controlling the Solution with Bounds and a Guess

The solver seeks a solution only within the specified bounds. Whenever you display the interactive-solver editor, the default **bound={-1E99,1E99}** is displayed. These are the maximum bounds for the TI-86.

The TI-86 solves equations through an iterative process. To control that process, you can enter lower bounds and upper bounds that are close to the solution, and enter a guess within those bounds in the prompt for the unknown variable.

Controlling the process with specific bounds and a guess helps the TI-86 in two ways.

- It finds a solution more quickly.
- It is more likely to find the solution you want when an equation has multiple solutions.

lowerBound<upperBound must be true.

To set more precise bounds at the **bound=** prompt, the syntax is:

bound={*lowerBound*,*upperBound***}**

You can enter a list variable at the **bound=** *prompt if a valid two-element list is stored to it.*

At the prompt for the unknown variable, you may enter a guess or a list of two guesses. If you do not enter a guess, the TI-86 uses (*lowerBound*+*upperBound*)/2 as a guess.

On the solver graph (page 207), you can guess a solution by moving the free-moving cursor or trace cursor to a point on the graph between *lowerBound* and *upperBound*. To solve for the unknown variable using the new guess, select **SOLVE** from the solver graph menu. The solution is displayed on the interactive-solver editor.

Editing the Equation

If you exit the equation solver, any equation stored to eqn is displayed when you return to the equation solver.

To edit the equation stored to **eqn** when the interactive-solver editor is displayed, press ▲ until the cursor is on the equation. The equation-entry editor is displayed. The TI-86 automatically stores the edited equation to **eqn** as you edit.

If you store an equation to **eqn** by recalling the contents of an equation variable, such as **y1**, and then edit the equation stored to **eqn**, the original equation (in **y1**, for example) is not changed. Likewise, subsequently editing the contents of the equation variable (**y1**, for example) does not change **eqn**.

You can display other menus in the interactive-solver editor

The Solver Menu

2nd [SOLVER] *equation* ENTER

GRAPH	WIND	ZOOM	TRACE	SOLVE

- **GRAPH**: graphs the equation in **eqn**
- **WIND**: window editor
- **ZOOM**: solver zoom menu
- **TRACE**: graphs **eqn** and activates the trace cursor
- **SOLVE**: solves for the unknown variable or displays the interactive-solver editor

To display the window editor, select **WIND** from the solver menu.

When you select **GRAPH** or **WIND** from the solver menu, **EDIT** replaces the item you selected on the menu. To return to the interactive-solver editor from the graph or window editor, select **EDIT**.

Solving for the Unknown Variable

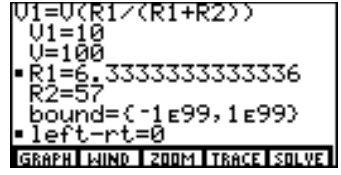
After you have stored all known variable values, set the bounds, and entered a guess (optional), move the cursor to the prompt for the unknown variable.

An ellipsis (...) indicates that the variable value continues beyond the screen. To scroll the value, press ▶ and ◀.

The squares disappear when you edit any value.

After solving, you can edit a variable value or edit the equation, and then solve for the same variable or another variable in the equation.

To solve, select **SOLVE** from the solver menu (F5).

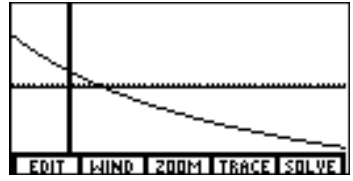


- A small square marks the variable for which you solved. The solution value is displayed.
- A small square also marks the **left–rt=** prompt. The value at this prompt is the value of the left side of the equation minus the value of the right side of the equation, evaluated at the new value of the variable for which you solved. If the solution is precise, **left–rt=0** is displayed.

Some equations have more than one solution. To look for additional solutions, you can enter a new guess or set new bounds, and then solve for the same variable.

Graphing the Solution

The graph to the right plots the solution from the example on page 202. The window variable values are: **xMin=–10 yMin=–50 xMax=50 yMax=50**



When you select **GRAPH** from the solver menu (F1), the solver graph is displayed with the free-moving cursor.

- The vertical axis represents the result of the left side of the equation minus the right side of the equation (left–right) at each independent variable value.
- The horizontal axis represents the independent variable for which you solved the equation.

On the graph, solutions exist for the equation where **left–rt=0**, which is where the graph intersects the x-axis. The solver graph:

- Uses the current window and format settings (Chapter 5).
- Does not graph the solution according to the current graphing mode.
- Always graphs a solution as a function graph.
- Does not graph selected functions or turned on stat plots along with the solution.

Solver Graph Tools

You can use the free-moving cursor or trace cursor to select a guess on the graph.

You can explore the graph of a solution with the free-moving cursor, as you would on any other graph. When you do, the coordinate values for the variable (the x-axis) and the value **left–rt** (the y-axis) are updated.

To activate the trace cursor, select **TRACE** from the solver menu. Panning, QuickZoom, and entering a specific value (Chapter 6) are available with the trace cursor on the solver graph.

To return to the solver menu from a trace, press EXIT.

The Solver ZOOM Menu

2nd [SOLVER] *equation* ENTER F3

GRAPH	WIND	ZOOM	TRACE	SOLVE
BOX	ZIN	ZOUT	ZFACT	ZSTD

Chapter 6 and the A to Z Reference describe these features in detail.

BOX Draws a box to redefine the viewing window (Chapter 6)

ZIN Magnifies the graph around the cursor by factors of **xFact** and **yFact** (Chapter 6)

ZOUT Displays more of the graph around the cursor by factors of **xFact** and **yFact** (Chapter 6)

ZFACT Displays the ZOOM FACTORS screen (Chapter 6)

ZSTD Displays the graph in standard dimensions; resets the default window variable values for **Func** graphing mode

The Simultaneous Equation Solver 2nd [SIMULT]

The simultaneous equation solver solves systems of up to 30 linear equations with 30 unknowns.

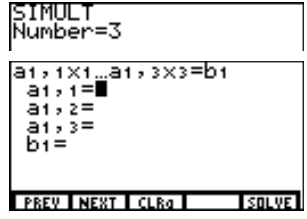
Entering Equations to Solve Simultaneously

The SIMULT *coefficients are not variables.*

You can display other menus in the coefficients-entry screen.

❶ Display the SIMULT number screen. 2nd [SIMULT]

❷ Enter an integer ≥ 2 and ≤ 30 for the number of equations. The coefficients-entry editor for the first equation (for a system of n equations and n unknowns) is displayed. The SIMULT ENTRY menu also is displayed. **3** ENTER



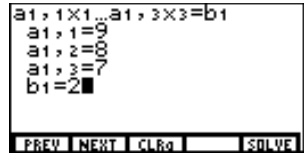
To move from the coefficients-entry editor for one equation to the editor for another equation, select **PREV** *or* **NEXT**.

To move among coefficients, press ▼, ▲, *or* ENTER. *From the last or first coefficient, these keys move to the next or previous coefficients-entry screen, if possible.*

Ellipses indicate that a value continues beyond the screen. Press ▶ *and* ◀ *to scroll the value.*

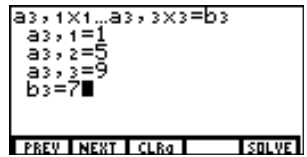
❸ Enter a real or complex value (or an expression that resolves to one) for each coefficient in the equation and for $\mathbf{b_1}$, which is the solution to that equation.

9 ▼ **8** ▼ **7** ▼ **2**



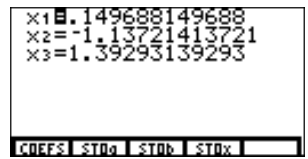
❹ Display the coefficients-entry screen for the second and third equation, and enter values for them.

▼ (or ENTER or F2) **5** ▼ (−) **6** ▼ (−) **4** ▼ **2** ▼ **1** ▼ **5** ▼ **9** ▼ **7**



❺ Solve the equations. The results of the polynomial are calculated and displayed on the result screen. Results are not stored to variables and cannot be edited. The SIMULT RESULT menu is displayed.

F5



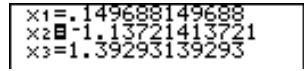
Storing Equation Coefficients and Results to Variables

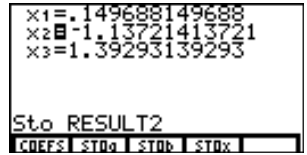
- To store coefficients $\mathbf{a}_{1,1}$; $\mathbf{a}_{1,2}$;...;$\mathbf{a}_{n,n}$ to an $n \times n$ matrix, select **STOa**.
- To store solutions $\mathbf{b}_1,\mathbf{b}_2,...,\mathbf{b}_n$ to a vector of dimension n, select **STOb**.
- To store the results $\mathbf{x}_1$, $\mathbf{x}_2$,..., $\mathbf{x}_n$ to a vector of dimension n, select **STOx**.

To store a single value on the coefficients-entry screen or result screen, follow these steps.

To switch to the coefficients-entry screen, select **COEFS** *from the* SIMULT RESULT *menu.*

❶	Move the cursor to the = sign next to the coefficient or result you want to store.	▼
❷	Display the variable **Name=** prompt. ALPHA-lock is on.	STO▸
❸	Enter the variable to which you want to store the value.	[R][E][S][U][L][T] ALPHA **2**
❹	Store the value. The variable name becomes an item on the VARS REAL screen or VARS CPLX screen.	ENTER





To solve equations simultaneously on the home screen or in a program, select **simult(** *from the* CATALOG.

To return to the coefficients-entry screen, where you can edit coefficients and calculate new solutions, select **COEFS** from the SIMULT RESULT menu.

The Polynomial Root-Finder [2nd] [POLY]

The root finder solves up to 30th-order real or complex polynomials.

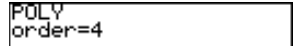
Entering and Solving a Polynomial

The POLY *coefficients are not variables.*

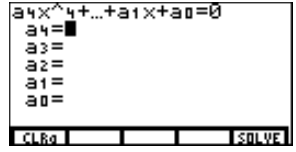
You can display other menus in the coefficients-entry editor.

Ellipses indicate that a value continues beyond the screen. Press ▶ and ◀ to scroll the value.

❶ Display the POLY order screen. [2nd] [POLY]

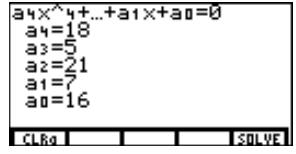


❷ Enter an integer between 2 and 30. The coefficients-entry editor is displayed with the equation across the top, the coefficient prompts along the left side, and the POLY ENTRY menu on the bottom. **4** [ENTER]

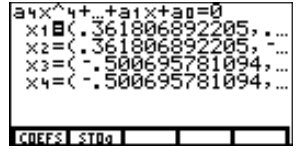


❸ Enter a real or complex value (or an expression that resolves to one) for each coefficient. **18** ▼ **5** ▼ **21** ▼ **7** ▼ **16**

To clear all coefficients, select **CLRa** from the POLY ENTRY menu.



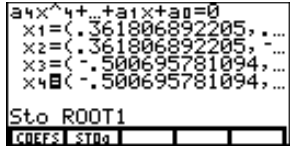
❹ Solve the equation. The roots of the polynomial are calculated and displayed. Results are not stored to variables and you cannot edit them. Also, the POLY RESULT menu is displayed. Results can be complex numbers. [F5]



Storing a Polynomial Coefficient or Root to a Variable

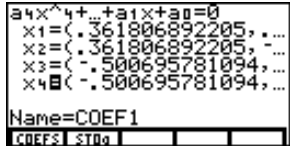
To switch to the coefficients-entry screen, select **COEFS** *from the* POLY RESULT *menu.*

❶	Move the cursor to the = sign next to the coefficient or root value you want to store.	▼ ▼ ▼
❷	Display the **Sto** prompt. ALPHA-lock is on.	STO▸
❸	Enter the variable to which you want to store the value.	[R][O][O][T] ALPHA **1**
❹	Store the value.	ENTER



To find roots on the home screen or in a program, select **poly** *from the* CATALOG.

❺	Display the **Name=** prompt for the coefficents list name. ALPHA-lock is on.	F2
❻	Enter the list variable name to which you want to store the coefficients.	[C][O][E][F] ALPHA **1**
❼	Store the polynomial coefficient values.	ENTER



To return to the coefficients-entry screen, where you can edit coefficients and calculate new solutions, select **COEFS** from the POLY RESULT menu.