Chapter 2: Using Calculator Functions in a Program

The *TI-95 User's Guide* describes the scientific-calculator functions and illustrates how to use them to perform manual calculations. This chapter discusses the use of those functions in a program. It also explains how you can stop a program to enter numbers or pause a program to display results.

Table of Contents

The scientific-calculator functions can be divided into two categories: functions accessed through conventional key sequences, such as [+] and [INV] [SIN], and functions accessed through system-menu keys, such as [CONV] ⟨MET⟩ ⟨G-L⟩. This section discusses the entry of conventional keys into a program.

Storing Primary Functions

To store a key's primary function in a program, simply press the key for that function while the calculator is in the learn mode. For example, if you press [SIN] in the learn mode, the following mnemonic is displayed.

```
SIN
```

Storing Second Functions

To store a second function in a program, press the [2nd] key followed by the key for that function. The mnemonic that is displayed represents the key's second function. For example, if you press [2nd] [CMS] in the learn mode, the following mnemonic is displayed.

```
CMS
```

Storing Inverse Functions

To store an inverse function in a program, press the [INV] key followed by the key or key sequence for that function. For most inverse functions, [INV] is stored as a separate instruction. (Only two inverse functions do not store [INV] as a separate instruction. These are the transfer instructions [INV] [2nd] [GTL] and [INV] [2nd] [SBL].)

For example, if you press [INV] [y^x] in the learn mode, the following mnemonics are displayed.

```
INV y^x
```

Storing Hyperbolic Functions

To store a hyperbolic function in a program, press the [HYP] key followed by the key or key sequence for that function. [HYP] is stored as a separate instruction.

For example, if you press [HYP] [INV] [SIN] in the learn mode, the following mnemonics are displayed.

```
HYP INV SIN
```

Storing Functions with Fields

To store a function with a field in a program, press the key or key sequence for the function and then enter the field. The calculator groups the field characters together in the display.

For example, if you press [STO] 007 in the learn mode, the following mnemonic is displayed.

```
STO 007
```

You do not have to enter leading zeros when you store a numeric field if you use short-form addressing. For example, if you press [RCL] 7 [x^2] in the learn mode, the following mnemonics are displayed.

```
RCL 007 x^2
```

(continued)

Example

Write a program to evaluate the following equation.

$B = 3A^2 + 12A - 12$

Assume that you enter the value of A into the display before you start the program. Because the equation uses A in two places, have the program store the value in a data register and recall it when it's needed again.

Procedure	Press	Display
Activate learn mode	[LEARN] ⟨1st⟩	
Clear program memory	[2nd] [CP]	
Store value of A	[STO] A	STO A
Square A	[x²]	STO A x^2
Multiply by 3	[×] 3	STO A x^2 *3
Add	[+]	STO A x^2 *3+
Enter second term	12 [×] [RCL] A	2 *3+12* RCL A
Enter third term	[−] 12	3+12* RCL A −12
Obtain result	[=]	+12* RCL A −12=
Stop execution	[HALT]	RCL A −12= HLT
Exit learn mode	[LEARN]	

Running the Example

To test the program, compute B for A = 5, A = 11, and A = 1024.

Procedure	Press	Display
Display **RUN** menu	[RUN]	SELECT:
Calculate value	5 ⟨PGM⟩	123.
Calculate value	11 ⟨PGM⟩	483.
Calculate value	1024 ⟨PGM⟩	3158004.

Using System-Menu Functions

When you include a function from a system menu in a program, the calculator stores only the function. The menu key is not stored in the program.

Storing Menu Functions

To store a system-menu function in a program, press the menu key and make the selection you want. The calculator displays a mnemonic for the function you select, but the keystrokes that you use to access the menu function are not stored in the program.

For example, if you press [CONV] ⟨MET⟩ ⟨G-L⟩ in the learn mode, the following mnemonic is displayed.

The calculator stores the function to convert gallons to liters in the program, but it does not store [CONV] and ⟨MET⟩.

Restoring the Program Counter Display

Pressing a system-menu key displays the menu functions on the second line of the display. If the calculator is in the learn mode, the menu functions replace the program counter. To restore the program counter, press [2nd] [PC]. [2nd] [PC] alternately displays and erases the program counter.

- If the counter is in the display when you press [2nd] [PC], the calculator erases the counter.
- If the counter is not displayed when you press [2nd] [PC], the calculator displays the counter.

Example

The random-number function of the calculator generates numbers that are fractional values. By using the expression given below, you can generate random integers that lie between 1 and a given upper limit:

$N = INT(L \times R\# + 1)$

where N = the generated random integer, L = the selected upper limit, and R# = the random number produced by the calculator.

Using the formula given above, write a program that generates random integers between 1 and 6.

Procedure	Press	Display
Activate learn mode	[LEARN] ⟨1st⟩	
Clear program	[2nd] [CP]	
Enter upper limit	[(] 6 [×]	(6*
Random number	[NUM] ⟨R#⟩	(6* R#
Add 1	[+] 1 [)]	(6* R# +1)
Integer	⟨INT⟩	(6* R# +1) INT
Restore PC	[2nd] [PC]	(6* R# +1) INT
Stop execution	[HALT]	R# +1) INT HLT
Exit learn mode	[LEARN]	

(continued)

Running the Example

Run the program. The sequence of numbers shown by your calculator will probably differ from the sample shown below.

Procedure	Press	Display
Display **RUN** menu	RUN	SELECT:
Generate number	⟨PGM⟩	3.
Generate number	⟨PGM⟩	6.
Generate number	⟨PGM⟩	1.

Keyboard Commands versus Program Instructions

Not all functions operate the same in a program as they do when executed from the keyboard. Several examples are listed in this section. Other differences between the keyboard and program operation of a function are discussed in the chapters in which the functions are defined.

The Help Function

From the keyboard, HELP displays the prompt **SET NORMAL MODE?** and a menu from which you can choose ⟨YES⟩, ⟨NO⟩, or ⟨ESC⟩. If you press ⟨YES⟩, the calculator resets the system parameters to their default settings. If you press ⟨NO⟩, the calculator displays all parameters that are not set to their default condition and lets you choose between resetting the parameter or leaving it unchanged. Pressing ⟨ESC⟩ clears the menu.

HELP as a program instruction resets the system parameters to their default settings and resets the partitions (excluding file space) to one-half data registers and one-half program memory. This is identical to pressing HELP ⟨YES⟩ from the keyboard.

The Status Function

From the keyboard, the LIST ⟨ST⟩ (status) function lists all parameters that are not already set to their default condition and displays the error number of the most recent error.

⟨ST⟩ as a program instruction places the number of the most recent error in the numeric display register. It does not list any status information.

The QAD and CUB Functions

From the keyboard, the ⟨QAD⟩ and ⟨CUB⟩ selections of the FUNC menu prompt you to enter coefficients and display a message to identify the roots as real or complex.

In a program, no prompts or messages appear. Instead, the ⟨QAD⟩ and ⟨CUB⟩ functions get the coefficients from data registers 0, 1, 2, and 3. The results are stored in the same registers. For details, refer to Chapter 2 of the *TI–95 User's Guide*.

Making a Program Wait for Numeric Input

This section explains how to interrupt a program so that you can enter numbers into the program.

Using [BREAK] to Enter Numbers

Many problems require you to enter a number after a sequence of keystrokes has already been performed. To solve this type of problem in a program, you need an instruction that:

- Interrupts the program at the point where you want to enter the number.
- Permits you to perform manual calculator operations such as entering a number into the display.
- Allows you to continue execution from the point in the program where it was interrupted.

The [BREAK] instruction is designed for this purpose.

[BREAK] interrupts program execution and defines [F1] as ⟨GO⟩. By placing a [BREAK] instruction in a program, you can stop execution temporarily. When you are ready to restart the program, just press ⟨GO⟩. If you clear ⟨GO⟩ by pressing a system-menu key before you restart the program, you can restore ⟨GO⟩ by pressing [BREAK].

The use of a [BREAK] instruction to enter a number into a program is illustrated below.

```
[RUN] ⟨PGM⟩
      ⋮          (Program Executes)
    BRK
Enter Number
    ⟨GO⟩
      ⋮          (Program Executes)
    HLT
```


Example

Write a program to solve the following problem.

$Z = \text{SIN } X - \text{TAN } Y$

This problem requires you to enter values for X and Y. Design the program so that you enter X before you run the program and Y after execution starts.

Procedure	Press	Display
Activate learn mode	[LEARN] ⟨1st⟩	
Clear program	[2nd] [CP]	
Calculate sine	[SIN]	SIN
Subtract	[−]	SIN −
Stop for number	[BREAK]	SIN − BRK
Calculate tangent	[TAN]	SIN − BRK TAN
Final result	[=]	SIN − BRK TAN =
Stop execution	[HALT]	BRK TAN = HLT
Exit learn mode	[LEARN]	

(continued)

Running the Example

Before running the program, set the angle units to grads by pressing [2nd] [DRG] until **GRAD MODE** appears in the display. Then use the program to calculate Z for the following values of X and Y.

Value of X	Value of Y
206 Grads	94 Grads
45 Grads	101 Degrees

Procedure	Press		Display
Set grad mode	[2nd] [DRG]*	GRAD MODE	
Display **RUN** menu	[RUN]	SELECT:	
Enter X	206 ⟨PGM⟩		–.0941083133
Enter Y	94 ⟨GO⟩		–10.67300331
Display **RUN** menu	[RUN]	SELECT:	
Enter X	45 ⟨PGM⟩		.6494480483
Select **ANG** menu	[CONV] ⟨ANG⟩	ANGULAR	
Convert to grads	101 ⟨D–G⟩	Grd=	112.2222222
Redisplay ⟨GO⟩	[BREAK]	Grd=	112.2222222
Restart program	⟨GO⟩		5.794002064

*Repeat until **GRAD MODE** appears in the display.

Note: Running a program does not clear calculations in progress. Therefore, if you decide to rerun the program after it has been stopped by the BRK instruction, press [CLEAR] first to clear the pending calculation.

Pausing a Program to Display Results

This section explains how to use the pause instruction to display numeric information during program execution. For details on using pause to display messages, refer to the next chapter of this guide.

Using Pause Instructions

A [2nd] [PAUSE] instruction stops program execution for one second to display a numeric result (or message). A pause instruction does not affect pending numeric operations, so you can use it to display intermediate results as well as final calculations.

If you want a program to pause for more than one second, include additional pause instructions in the program. For example, placing three pause instructions together in a program creates a three-second pause.

Example

Write a program to evaluate the following equation.

$A = B^2 * 5$

Design the program to display the value of B^2 for one second before the final result is calculated.

Procedure	Press	Display
Activate learn mode	[LEARN] ⟨1st⟩	
Clear program	[2nd] [CP]	
Square value	[x^2]	x^2
Pause	[2nd] [PAUSE]	x^2 PAU
Multiply by 5	[×] 5	x^2 PAU *5
Final result	[=]	x^2 PAU *5=
Stop execution	[HALT]	^2 PAU *5= HLT
Exit learn mode	[LEARN]	

(continued)

Running the Example

Run the program using B = 55 and B = −456.

Procedure	Press	Display
Display **RUN** menu	[RUN] SELECT:	
Enter B	55 ⟨PGM⟩	3025.
		15125.
Enter B	456 [+/−] ⟨PGM⟩	207936.
		1039680.

Reference Section

Use this section as a source of reference information about entering calculator functions into a program, interrupting a program to enter numbers, and pausing a program to display numeric values.

Restore PC

[2nd] [PC]—Alternately displays and erases the current value of the program counter in the second line of the display. This function operates only in the learn mode. (Use this function to restore the program counter if it has been cleared by using a system-menu key.)

Break

[BREAK]—Interrupts program execution and defines the [F1] key as ⟨GO⟩. The address where the program was interrupted is stored internally. To resume execution from that location, press ⟨GO⟩. If the ⟨GO⟩ definition is cleared by subsequent manual calculator operations, it can be restored by pressing [BREAK].

You can use [BREAK] as a keyboard command to stop a running program or a listing function. If you press [BREAK] to stop a program, you can resume execution from the interrupted location by pressing ⟨GO⟩.

The instruction mnemonic for [BREAK] is BRK.

Using [BREAK] and [HALT]

Although [BREAK] and [HALT] both stop program execution, the functions have differences that make them suitable for different applications:

- [BREAK] should be used when you want to stop a program to perform a manual calculator operation (such as entering a number) and then resume execution from the interrupted location.
- [HALT] should be used at the end of a program and in cases when you want to stop a program without affecting the definitions of the function keys.

Pause

[2nd] [PAUSE]—Stops program execution for one second. The information displayed during the one-second pause depends upon the instructions that have been executed previously.

The instruction mnemonic for [2nd] [PAUSE] is PAU.