TEXAS INSTRUMENTS COMPACT COMPUTER 40 USER'S GUIDE

ADDENDUM

The Wafertape™ Digital Tape Drive is not available.

ADDENDUM

Texas Instruments **Compact Computer 40 User's Guide**

Caution: *Read the information on static electricity on page 1-4 before working with your computer.*

The following notes provide additional information about using and programming your Texas Instruments Compact Computer 40.

Page 1-7

The optional AC adapter referred to is the Texas Instruments model AC9201; use *only* the AC9201 with your CC-40.

Page 5-34

Add the following sentence to the end of the third paragraph.

I/O *error-type* 255 is returned as 0.

Page 5-43

The following paragraph provides more information on GETMEM.

The memory reserved by GETMEM can be released during program execution by a call to RELMEM. Any of the following actions cause the reserved memory to be released.

- Editing the program or subprogram.
- Entering a NEW, OLD, RENUMBER, RUN, SAVE, or VERIFY command.
- Listing the program to a peripheral device.
- Calling the ADDMEM or CLEANUP subprogram.
- Turning the system off or pressing the reset key.

Page 5-48

The example at line 290 should be as shown below.

```
290 IF A$ = "Y" THEN COUNT = COUNT + 1:DISPLAY
    AT(4),"Enter value: ";:GOTO 400
```

Page 5-65

The following paragraph provides more information on *status-variable*.

When CALL KEY is executed, the keyboard is scanned for input. *Status-variable* is used to store a value that represents the status of the scan. A value of 0 means no key was pressed. A value of 1 means a different key was pressed since the last time the keyboard was scanned for input (e.g., since CALL KEY, KEY$, INPUT, or ACCEPT was last executed). A value of − 1 means the same key was pressed.

The following program segment provides more information on the use of the CALL KEY subprogram. This segment prompts twice for a key to be pressed. To determine that the responses are distinct, the status variable is compared to 1 (S<>1) in lines 520 and 560.

```
500 PRINT "MORE ENTRIES? (Y OR N)"
510 CALL KEY(K,S)
520 IF S<>1 THEN 510
530 IF K=ASC("Y") OR K=ASC("y") THEN 400
540 PRINT "END SESSION? (Y OR N)"
550 CALL KEY(K,S)
560 IF S<>1 THEN 550
570 IF K=ASC("Y") OR K=ASC("y") THEN STOP
```

Page 5-133

The example for line 330 should be as follows.

```
330 SUB PAYCHECK(DATE,Q,SSN,PAYRATE,TABLE(,))
```

Marks the beginning of a subprogram. The variables DATE, Q, SSN, PAYRATE, and the array TABLE with two dimensions may be used and/or have their values changed in the subprogram and their corresponding arguments in the calling statement changed. However, if the corresponding argument of DATE, Q, SSN, or PAYRATE is enclosed in parentheses in the CALL statement, the value of that argument cannot be changed. The corresponding array argument of TABLE *must* be passed by reference in the CALL statement and therefore any of its values can be changed in the subprogram.

Page I-4 (Appendix)

In the fifth line from the top, the address is the second breakpoint set, as shown below.

where *nnnn* is the address of the second breakpoint set.

Pages I-3,4

The following problem can occur when a breakpoint is set in assembly language software by either the breakpoint command or the single step command. If the register file stack is at register 9 and a breakpoint is executed, the program counter is destroyed. The most significant byte of the program counter is changed to the least significant byte plus one.

For example, if the breakpoint is set at address 1235_{16}, the breakpoint message is 3635 st 09:, where st is the appropriate status register value. The PC command can be used to change the program counter back to the correct address and program execution can continue.

To avoid this problem, use one of the following methods to be sure that the stack pointer does not point to register 9 when a breakpoint is executed.

- Begin the register file stack at register A_{16} instead of at register 1.
- If the position of the stack cannot be altered, add PUSH and POP instructions to the code to ensure that the stack does not use register 9 within the section of code being debugged. The added instructions can be removed after the code is debugged.
- Write the assembly language software such that the stack pointer stays on even byte boundaries.

Page I-5

The last paragraph should begin as shown below.

Then B can be typed to continue program execution...

Page K-6

The fifth error message paragraph should be changed as shown below.

- Invalid character in statement. For example "%","?","[","]","{", etc., are valid only within quoted strings or in an IMAGE or REM statement.

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Introduction

The Texas Instruments Compact Computer Model CC-40 is an affordable, textbook-size computer that puts the computing power of large systems right at your fingertips. With its advanced calculation capability, enhanced BASIC language, and flexible peripheral expansion, the CC-40 lets you perform data processing anywhere you need to.

In addition to its computer capabilities, the CC-40 provides calculator features from simple addition and subtraction to complex problem solving. Plug-in cartridges offer built-in problem solutions for business, engineering, scientific, and mathematical needs. A wide range of accessories, including a printer and a high-speed *Wafertape*™ digital tape drive, increases the capabilities and versatility of the CC-40.

The growing importance of computers in our lives is making it increasingly necessary that everyone become familiar and comfortable with computers. With the CC-40 you will discover how easy it is to use a computer to solve problems.

Features

- Textbook-size computer with a 2.5MHz TMS70C20 CMOS 8-bit microprocessor and 34K (over 34,000) bytes of Read-Only Memory (ROM).
- Memory expandable with installation of cartridges.
- Preprogrammed *Solid State Software*™ cartridges.
- International-language prompting in selected cartridges (available separately).
- *Constant Memory*™ feature that retains information stored in memory when the computer is turned off.
- Long battery life with inexpensive AA alkaline batteries.
- Optional AC adapter to extend battery life.
- Standard typewriter keyboard layout plus quick-entry numeric key pad and special keys.
- Keys that repeat when held down for approximately half a second.
- 31-character 5-by-8 dot matrix Liquid Crystal Display (LCD) that scrolls to show an 80-character line.
- Adjustable display contrast.
- ASCII character set, including both upper- and lower-case alphabetic characters. Special display characters include Greek letters, Japanese characters, plus characters you can define.
- Peripheral port for printers, mass storage devices, and other accessories.
- Enhanced BASIC language for easy programming and quick problem solving.
- Descriptive error messages.
- Fold-out tilt-stand for easy desk-top use.
- Audible tone for use in prompting.
- Assembly language programming capability with the optional Editor/Assembler cartridge.

Using this Manual

This manual explains how to use all the features of the CC-40. This chapter explains how to set up and care for the CC-40 and provides an introduction to the keyboard. Reading it will provide you with the fundamentals necessary to operate the CC-40.

The second chapter discusses how to use the CC-40 as a calculator. You'll find that the CC-40 can be used as a calculator for your quick calculation needs in addition to its use as a computer.

The third chapter discusses using optional cartridges and peripheral devices. *Solid State Software*™ cartridges offer a wide variety of professionally written programs and *Memory Expansion* cartridges are used to increase the memory capacity of the CC-40. Peripheral devices can greatly increase the flexibility and versatility of the CC-40.

The fourth chapter provides an overview of the CC-40's BASIC programming capability. If you are unfamiliar with BASIC, the book *Learn BASIC: A Guide to Programming the Texas Instruments Compact Computer* is available from local dealers. Even if you already know how to program, reading chapter 4 carefully will help you to use the features of the CC-40 which are not available on other computers.

The final chapter is an alphabetical reference section for BASIC programming with detailed explanations of each command, statement, and function.

The appendices contain information such as mathematical functions and error messages. Technical data is also provided for experienced computer users.

Care of the CC-40

With proper care your CC-40 will give you years of trouble-free operation. Treat your CC-40 and cartridges with the same care you give other precision electronic products.

- Avoid exposing your CC-40 to moisture, extreme temperatures, or dust.
- Use a damp lint-free cloth to clean your CC-40. Do not use solvents.
- Do not place objects other than cartridges in the cartridge port.

CAUTION: Electronic equipment can be damaged by static electricity discharges. To remove static charges, touch a metal object (such as a doorknob, a desk lamp, etc.) before working with your computer, connecting peripheral devices, handling a cartridge, inserting a cartridge, etc. Failure to do so may cause damage to the cartridge or the computer.

Setting Up the CC-40

The battery compartment is located on the back of the CC-40 as shown in the illustration.

BATTERY COMPARTMENT
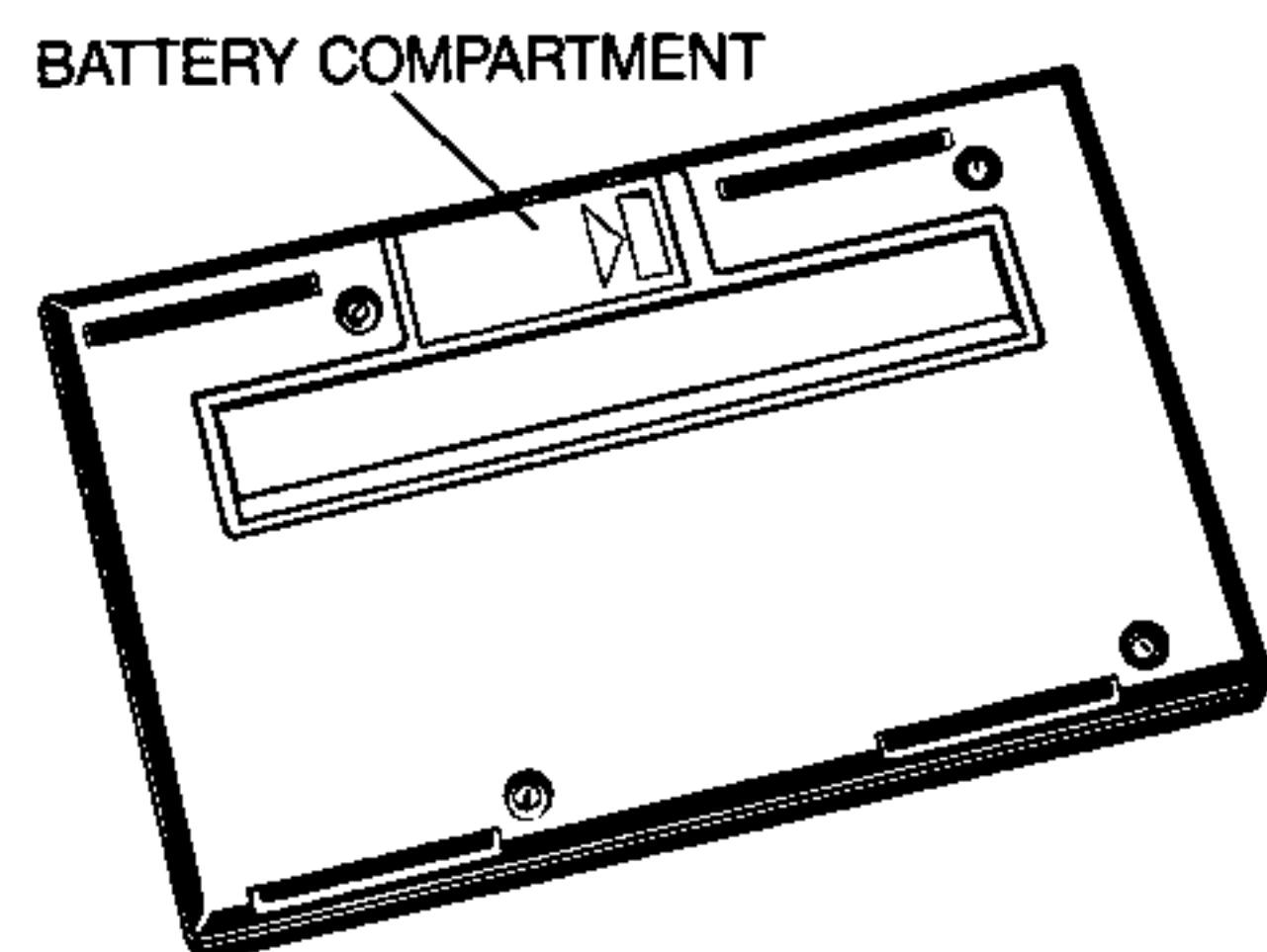
Battery Replacement

Your CC-40 requires four AA alkaline batteries. Replace the batteries when the low battery indicator is displayed or the display remains blank and cannot be made visible with the contrast control. Several hours of battery use remain when the low battery indicator first appears.

The battery replacement procedure is as follows.

1. Insert your thumbnail in the recess in front of the arrow. Press in the direction indicated by the arrow until the opposite end of the cover is released. Then remove the cover.
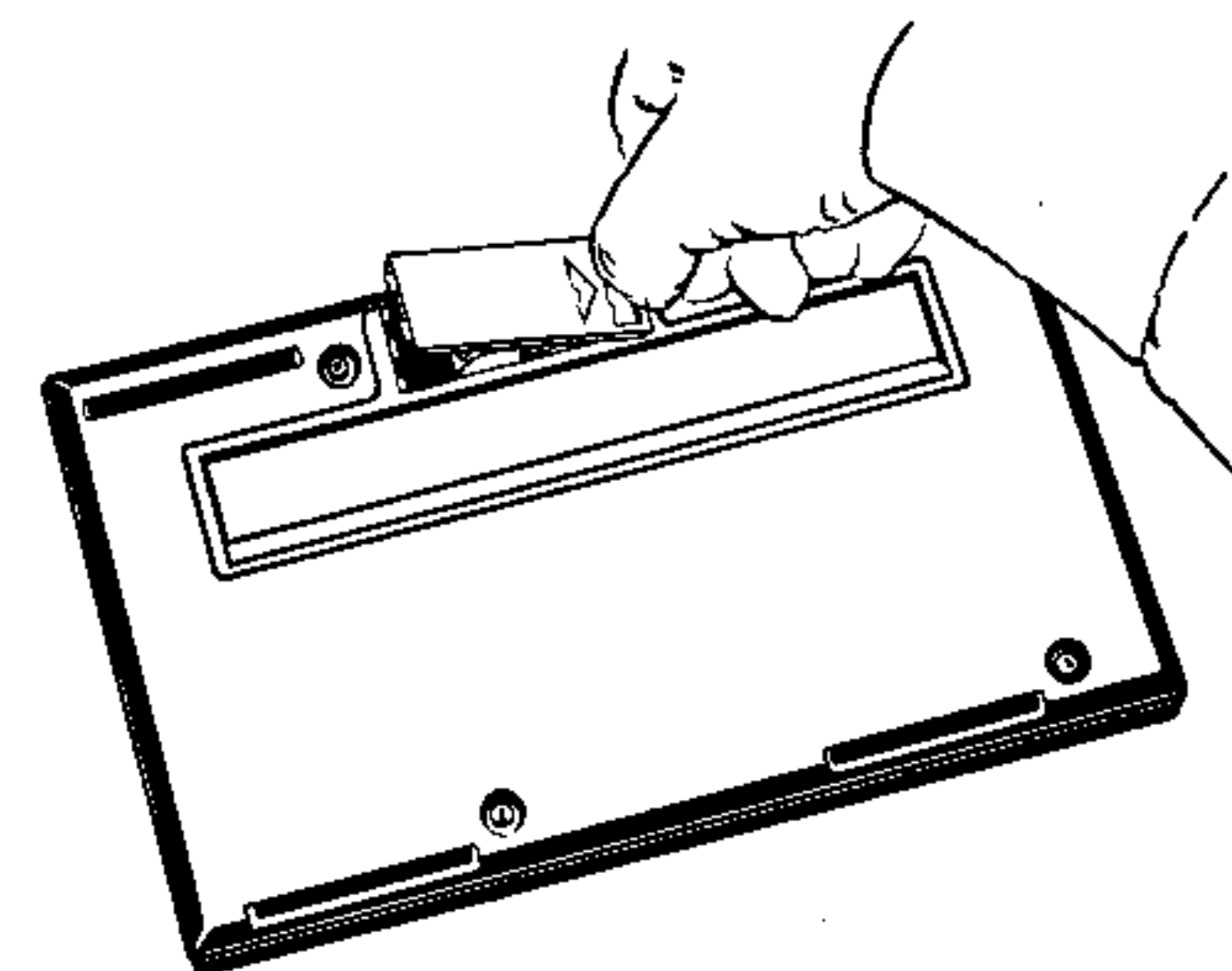
2. Remove the four batteries from the battery compartment.
3. Place four AA alkaline batteries in the battery compartment, as indicated in the bottom of the compartment.
4. Slide the arrow end of the cover under the unnotched side of the compartment. Press the loose end of the cover down until it snaps into place.

Peripheral Port

The peripheral port is located next to the AC adapter socket on the back of the CC-40. The larger opening is the peripheral port. It is used to connect peripheral devices to the CC-40.

Caution: The electronic components of the peripheral port can be damaged by discharges of static electricity. To avoid damage, do not touch the connector contacts or expose them to static electricity.

CARTRIDGE PORT

AC ADAPTER SOCKET
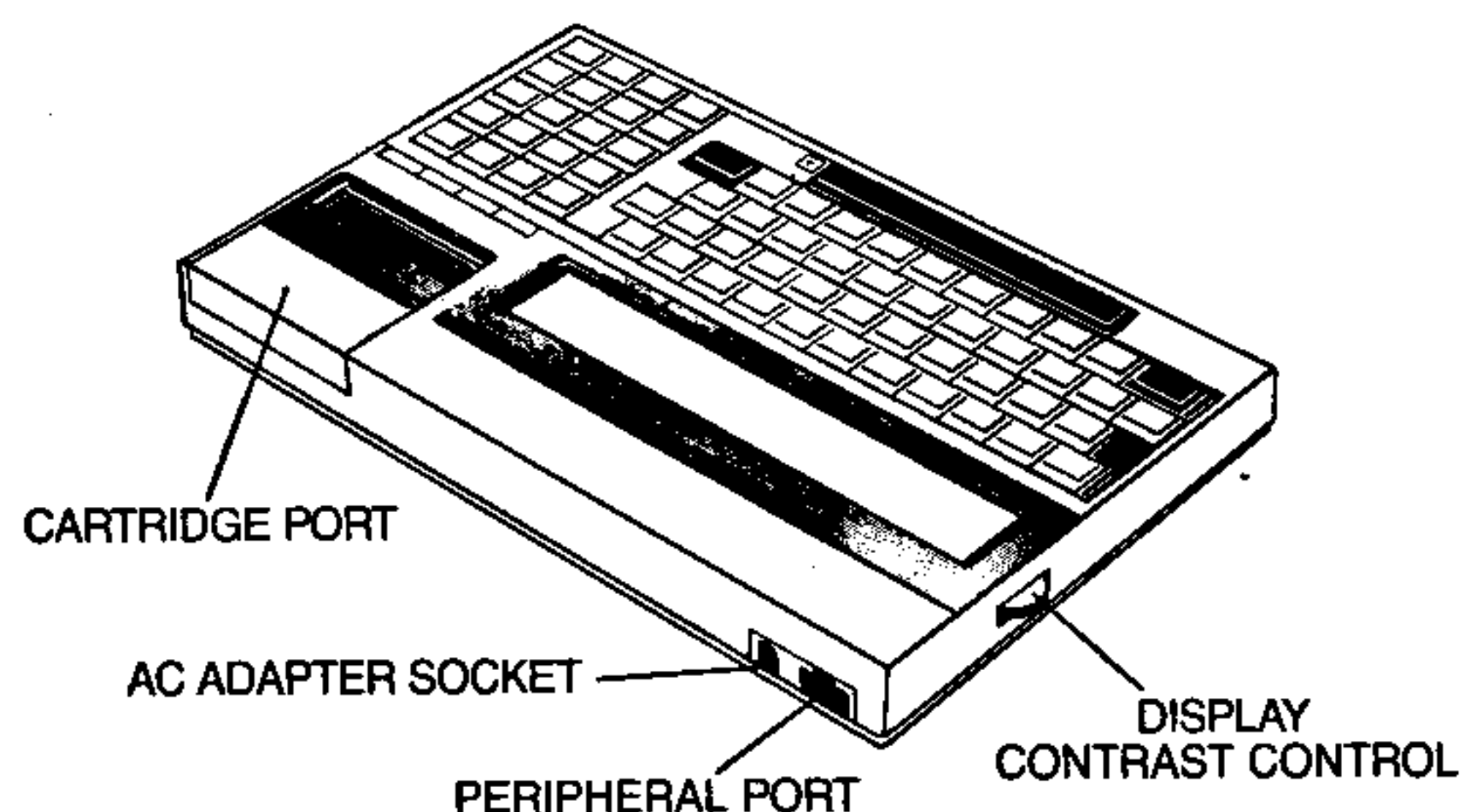
PERIPHERAL PORT

DISPLAY
CONTRAST CONTROL

AC Adapter Socket

The AC adapter socket is next to the peripheral port. The AC adapter allows the computer to operate from standard AC power instead of batteries.

Display Contrast Control

The display contrast control is located on the left side of the CC-40. It allows you to adjust the display contrast for your viewing angle.

Cartridge Port

The cartridge port, which accepts *Solid State Software* and *Memory Expansion* cartridges, is in the upper right corner of the CC-40. See chapter 3 for information on installing and using cartridges.

Keyboard Tour

The CC-40 keyboard resembles a typewriter keyboard. The CC-40, however, has additional keys to perform calculations, edit program lines, and quickly access BASIC commands, statements, and functions. The edit keys and all of the keys that enter characters in the display repeat as long as they are held down.

In this manual a key with a label that contains more than one character is represented by brackets [ ] with the symbol of the key printed inside the brackets such as [ON], [ENTER], [SHIFT], and [FN]. A key whose label is a single character is in bold face, such as A, 8, and →.

The next two pages show a diagram of the keyboard with its parts labeled. Following that are explanations of each part along with examples to help you become familiar with the features of the CC-40. Place the overlay provided with your CC-40 over the keys. The text and the examples that follow refer to this overlay. Try the examples to see what happens. You can't damage the CC-40 by pressing its keys.
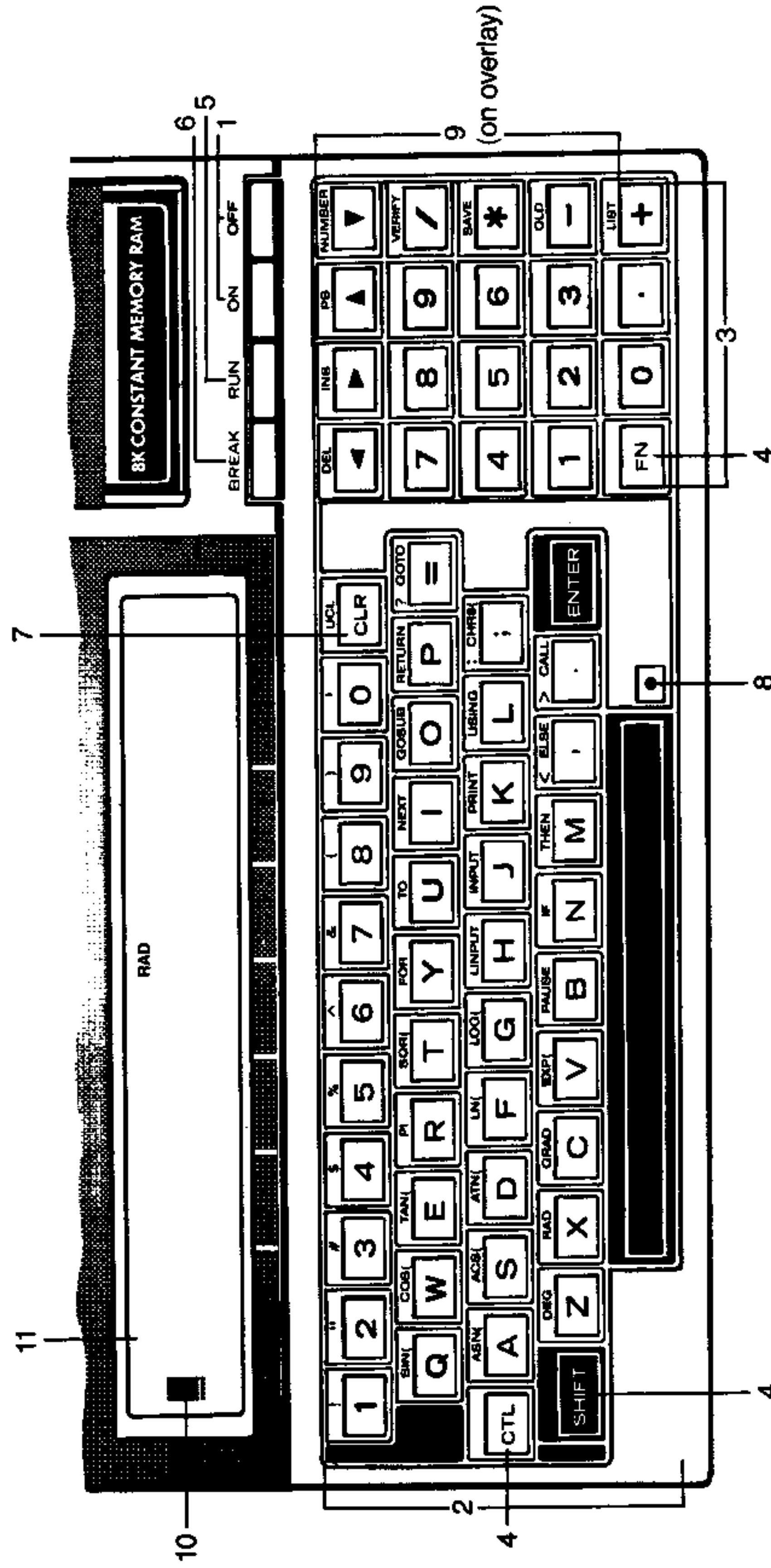
1. [ON] and [OFF] Keys

2. Typewriter Keys
   Alphanumeric Keys
   Space Bar
   [SHIFT] Key
   [UCL] (Upper Case Lock) Key
   [ENTER] Key

3. Numeric Key Pad
   Numeric Keys
   Arithmetic Operator Keys
   Edit Keys

4. Shift, Function, and Control Keys
   [SHIFT] Key
   [FN] (Function) Key
   [CTL] (Control) Key

5. [RUN] Key

6. [BREAK] Key

7. [CLR] (Clear) Key

8. Reset Key

9. BASIC Keyword Keys (on overlay)

10. Cursor

11. Display

1. [ON] and [OFF] Keys

The [ON] key turns the CC-40 on. When the computer is turned on, memory content is checked for loss of information. If no loss of memory is detected, the flashing cursor is displayed in column one. This cursor informs you that you may enter information from the keyboard.

If there is a memory loss, the memory is cleared and the message System initialized is displayed. To proceed, press the [CLR] key. The display is cleared and the flashing cursor appears in column one.

If programs and data *may* have been lost from memory, the CC-40 warns you with the message Memory contents may be lost. (Pressing the reset key usually causes this message to be displayed.) You may then choose either to use what is in memory or to clear memory. To clear the warning message from the display, press [CLR]. Then if you wish to clear the contents of memory, type **NEW ALL** or **NEW** and press [ENTER].

The [OFF] key turns the CC-40 off. To conserve battery life, the *Automatic Power Down*™ (APD) feature turns the computer off automatically after approximately ten minutes of waiting for input. The effect is the same as pressing the [OFF] key. However, the CC-40 cannot be turned off by either the APD feature or the [OFF] key when a program is running.

Note: The APD feature can be disabled by typing **CALL POKE(2096,1)** and pressing [ENTER]. The APD feature is restored when the system is initialized or you enter **NEW ALL** or **CALL POKE(2096,0)**.

When the CC-40 is turned off, the *Constant Memory*™ feature retains programs, user-assigned strings, and assembly language subprograms stored in memory. It does not retain the values of variables or the contents of the display.

2. Typewriter Keys

The keyboard is used to enter information such as data, BASIC program lines, messages, and formulas into your computer. The information typed appears in the display, character by character, just as you type it. The computer does not use the data in the display until you press [ENTER], so the display contents can be edited, as described later, before you press [ENTER].

These keys are arranged like the keys of a standard typewriter. The number and punctuation keys are across the top row.

Alphanumeric Keys

In computer usage, the letter, digit, sign, and symbol keys are called alphanumeric keys. Alphanumeric keys are used the same as standard typewriter keys. For example, type the word **hello** by pressing the appropriate keys and hello appears in the display. To clear the display, press the [CLR] key. Enter the number **456398** by pressing the top row of numeric keys. To clear the display, press [CLR].

Space Bar

The space bar places a space in the display. If the space bar is pressed while the cursor is positioned over another character, that character is replaced with a blank.

[SHIFT] Key

You can type capital letters and the special characters above the numeric and punctuation keys by pressing [SHIFT] and the desired key. Note that there is only one [SHIFT] key.

When [SHIFT] is pressed, the SHIFT indicator appears in the display to indicate that the shift state is in effect so that the next key you press is shifted. The shift state is in effect until another key is pressed. The shift state can be cancelled by pressing [SHIFT] a second time. The [SHIFT] key may be held down simultaneously with the desired keys.

For example, type the following using the [SHIFT] key as needed.

How are you?

To clear the display, press [CLR].

[UCL] (Upper Case Lock) Key

There is no shift lock key on the CC-40. However, the Upper Case Lock [UCL] key is similar to a shift lock key. Upper Case Lock causes all alphabetic keys to be interpreted as upper case and the [SHIFT] key to be ignored if it is pressed before an alphabetic key. Upper Case Lock does not affect the operation of punctuation or number keys.

To activate the Upper Case Lock, press the [SHIFT] key and then the [CLR] key. The UCL indicator appears in the display to indicate that the Upper Case Lock state is in effect. Press [SHIFT] [UCL] again to cancel the Upper Case Lock state.

Type the following after pressing [SHIFT] [UCL]. You will have to use the [SHIFT] key to type the !, ", and #.

UCL TYPES CAPS, NOT !, ", OR #

To clear the display, press [CLR].

[ENTER] Key

The [ENTER] key is located at the right of the keyboard. [ENTER] is used to indicate that you have finished typing the data on the current line and are ready for it to be processed.

3. Numeric Key Pad

The right side of the keyboard consists of digit keys arranged in calculator format, edit keys for correcting entries, arithmetic operator keys, and the [FN] key.

Numeric Keys

The numeric keys are arranged in calculator format to provide for rapid entry of numbers. This set of numeric keys and the set on the top row of the typewriter keyboard can be used interchangeably. The special characters above the numeric keys of the typewriter keyboard are also available with the keys on the numeric key pad.

Type the following using either set of numeric keys.

2301.5713

To clear the display, press [CLR].

Arithmetic Operator Keys

The arithmetic operator keys are used to perform simple arithmetic. To add, use the + key. To subtract, use the − key. To multiply, use the ∗ key. To divide, use the / key. You can raise a number to a power or calculate a root by pressing the [SHIFT] and ∧ keys. These keys are described in chapter 2.

For example, to find $2 + 2^5$, type the following.

2 + 2 ∧ 5

To display the answer, 34, press [ENTER]. To clear the display, press [CLR].

Edit Keys

The edit keys, →, ←, [SHIFT] [INS], [SHIFT] [DEL], and [SHIFT] [PB], are used to change the characters in the display. The cursor does not have to be repositioned to the end of the line before pressing [ENTER].

→(right arrow) moves the cursor one position to the right. The cursor does not erase or change characters as it passes over them. When the cursor reaches the right side of the display, holding → down scrolls the *display* to the left until the end of the 80-character line is reached.

←(left arrow) moves the cursor one position to the left. The cursor does not erase or change characters as it passes over them. If the cursor is at the beginning of a line, holding ← down does not move it.

For example, type the following.

Information is 555-1212

Press and hold → until all the displayed text has scrolled to the left. Notice the left arrow indicator in the display is turned on to inform you that text has scrolled to the left. Next hold down ← until the text is again displayed. The left arrow indicator is turned off.

To change the text in the display to Information: 555-1212, press ← or → until the cursor is positioned in the column after Information. Press [SHIFT] : and the space bar twice. To clear the display, press [CLR].

[SHIFT] [INS] (insert) is used to insert characters. Each subsequent key that you type is inserted at the current cursor position, shifting all characters following the inserted character(s) one position to the right. Insertion continues with each character typed until [ENTER], [CLR], [BREAK], ←, or → is pressed. If insertions cause the line to exceed its 80-character limit, the characters at the end are lost.

[SHIFT] [DEL] (delete) deletes the character that the cursor is on and shifts all characters to the right of the cursor one position to the left.

For example, type the following (do not press [ENTER]).

> **2 + 2 is not equal to 5.**

To change this entry to But 2 + 2 is equal to 4., first position the cursor over the first 2. Press [SHIFT] [INS] and then type **But** followed by a space. Move the cursor to the n in not. Press and hold [SHIFT] as you press [DEL] four times to delete not and the space. Move the cursor over the 5 and type **4**. To clear the display, press [CLR].

[SHIFT] [PB] is used to exchange the last series of characters entered in the display with the current display contents.

For example, type the following.

> **5 + 255 − 375∗5**

Press [ENTER] and the answer, −1615, appears in the display. Press [SHIFT] [PB] to recall the series of characters that you entered. To alter the calculation by changing the 375 to 365, position the cursor over the 7 and press **6**. Press [ENTER] to display the answer, −1565. To clear the display, press [CLR].

Note: The characters recalled by [SHIFT] [PB] are normally the last characters you typed. However, if a PRINT or DISPLAY statement has placed characters in the display (see chapters 4 and 5), then those characters are recalled.

4. Shift, Function, and Control Keys

The [SHIFT], [FN], and [CTL] keys can be pressed and released before or at the same time as the keys they modify.

[SHIFT] Key

The [SHIFT] key is used to allow the entry of "shifted" characters in the display from both the typewriter keyboard and the numeric key pad. When [SHIFT] is pressed, the SHIFT display indicator appears in the display, the same as with the [FN] and [CTL] keys. The shift state can be cancelled by pressing [SHIFT] a second time. If [SHIFT] is held down while several other keys are pressed, the SHIFT indicator is turned off after the first key. However, the shift state remains in effect until [SHIFT] is released.

[FN] (Function) Key

The [FN] (Function) key is used to enter certain BASIC keywords into the display. These keywords appear on the separate keyboard overlay above the alphabetic and punctuation characters. When [FN] is pressed, the FN display indicator appears in the display, the same as with the [SHIFT] and [CTL] keys. The function state can be cancelled by pressing [FN] a second time. If [FN] is held down while several other keys are pressed, the FN indicator is turned off after the first key. However, the function state remains in effect until [FN] is released.

To access one of the BASIC keywords printed on the overlay, press [FN] and then the key corresponding to the desired keyword. For example, to find the square root of 9, press the following keys.

> [FN] T (which is usually denoted [FN] [SQR( ].)

SQR(appears in the display. Type **9** and). To have the CC-40 process the data you have typed, press [ENTER]. The answer, 3, is displayed. To clear the display, press [CLR].

[FN] can also be used to assign a series of characters to the numeric keys. This feature is discussed later in this chapter.

[CTL] (Control) Key

The [CTL] (Control) key allows the use of special control functions. When [CTL] is pressed, the CTL display indicator appears in the display, the same as with the [FN] and [SHIFT] keys. The control state can be cancelled by pressing [CTL] a second time. If [CTL] is held down while several other keys are pressed, the CTL indicator is turned off after the first key. However, the control state remains in effect until [CTL] is released.

For example, press [CTL] and hold down 5 until the display fills with underlines. Press [CTL] → (tab) and the display moves to the next higher tab position. The left arrow display indicator is turned on to show that text has scrolled off the display. To clear the display, press the [CLR] key. A list of all of the character codes that can be accessed with the [CTL] key is in appendix D.

5. [RUN] Key

The [RUN] key followed by [ENTER] causes the computer to perform or execute the program that is stored in memory. [RUN] can also be followed by several options. It can be followed by a line number to start program execution at a specific line, a device and filename to load and execute a program from an external storage device, or a program name to run a program from a *Solid State Software* cartridge (see chapter 3).

6. [BREAK] Key

The [BREAK] key is used to stop a program that is executing.

7. [CLR] (Clear) Key

The [CLR] (Clear) key clears all the characters from the display when no program is running. When a program is waiting for input, the characters in the input field are cleared.

8. Reset Key

Reset is used to restart the computer when a problem occurs in which normal operation is interrupted. Pressing the reset key usually causes the message Memory contents may be lost to be displayed. *You* must determine if the situation which caused you to press reset was likely to have destroyed the memory contents. The reset key is flush with the case so that you will not press it accidentally.

9. BASIC Keyword Keys

The BASIC keyword keys provide a convenient entry method for BASIC commands, statements, and functions.

Some BASIC keywords are printed on the separate keyboard overlay. To access these keywords, press the [FN] key and the key below the desired keyword.

For example, one of the BASIC keywords is PRINT. To access this keyword, rather than typing each letter, you can press [FN] [PRINT]. The word PRINT appears in the display. Type the following using the BASIC keyword PRINT and the appropriate keys and then press [ENTER].

    PRINT "The answer is"

To clear the display, press [CLR].

10. Cursor

There are two cursors. One is a flashing rectangle that indicates you can enter data. The other is an underline that indicates the system is waiting for you to acknowledge a pause by pressing [ENTER] or [CLR].

11. Display

The display shows 31 characters of the 80-character line.

Eighteen display indicators are provided to indicate certain conditions. These indicators appear if certain controls are in effect, such as SHIFT, DEG, and FN. The display of the CC-40 is shown below with labels and descriptions.
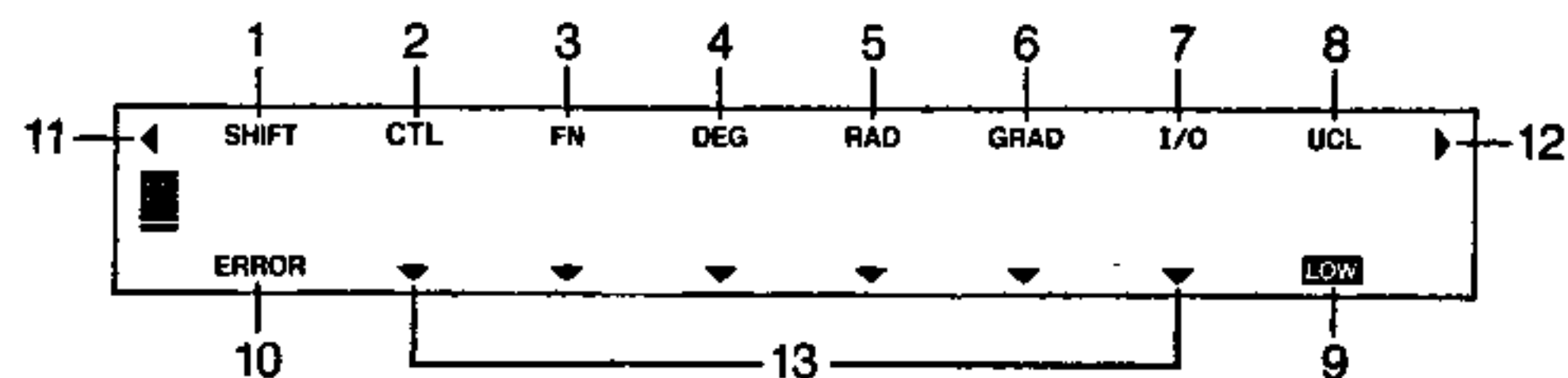
	Indicator	Meaning
1.	SHIFT	The shift state is in effect.
2.	CTL	The control state is in effect.
3.	FN	The function state is in effect.
4.	DEG	The unit of angular measure is degrees.
5.	RAD	The unit of angular measure is radians.
6.	GRAD	The unit of angular measure is grads.
7.	I/O	Peripheral input or output is in progress.
8.	UCL	Upper Case Lock is in effect.
9.	LOW	Battery power is low.
10.	ERROR	An error has been detected.
11.	◀	Text has scrolled off the display to the left.
12.	▶	Text has scrolled off the display to the right.
13.	▼	An indicator that has been set. See chapter 4 and INDIC in chapter 5.

User-Assigned Strings

The user-assigned string feature of the CC-40 allows you to assign text to each of the number keys 0 through 9. Commonly used numbers, expressions, and text assigned to these keys can later be recalled from the keyboard using the **[FN]** key. The assigned text is retained even when the CC-40 is turned off.

To assign text to a number key use the following procedure.

1. Place up to 80 displayable characters in the display.
2. Hold down **[SHIFT]** and **[FN]** simultaneously until both the SHIFT and FN indicators appear in the display. Then release the keys.

3. Press the desired digit key. The characters are assigned to the indicated digit, the display is blanked, and the SHIFT and FN display indicators are turned off.

To display the assigned text, press **[FN]** and the digit key that was assigned. The text is placed in the display, starting at the current cursor position. You may repeat this key sequence as often as you wish to display the assigned text.

For example, assign the message "Frank— —555—1212" to digit key **6** using the procedure below.

Press	Display	Comments
1. Frank--555-1212	Frank--555-1212	
2. [SHIFT] [FN] 6	blank	Hold down both [SHIFT] and [FN] until the SHIFT and FN indicators appear in the display, then press 6.
3. [FN] 6	Frank--555-1212	Assigned characters are displayed.

You can delete a user-assigned string by performing the assignment when the display is blank. For example, if **[SHIFT] [FN] 6** is pressed when the display is blank, the string assigned to key **6** is deleted. All user-assigned strings are cleared when **NEW ALL** is entered or the system is initialized.

The following examples illustrate other kinds of text that can be assigned to the number keys.

Examples	Comment
LIST "50.R=C" RUN "1.MYFILE"	Frequently used commands and statements
FV=PV*(1+i)∧n SQR(a∧2+b∧2)	Commonly used mathematical expressions
100 INPUT "Variable= ";X 330 ACCEPT AT(15) BEEP,N	BASIC program lines
179.234*3422.14-A PV/(1+.10)∧10	Repetitive calculations
Ambulance 555-1212 Budget meeting at 4 pm	Memos

Introduction

The calculating capabilities of the CC-40 are enhanced by a wide range of built-in mathematical functions. These functions range from simple arithmetic operators to logarithmic and trigonometric functions. You can use these functions in a BASIC program as well as directly from the keyboard. Repetitive calculations are easily performed on the CC-40.

Entering Numeric Data

The number keys, 0 through 9, are located both on the right side of the console (called the numeric keypad) and across the top row of the keyboard and can be used interchangeably. The decimal point on the numeric keypad and the period on the keyboard can also be used interchangeably.

The value π to eleven decimal places, equal to 3.14159265359, can be included in a calculation by typing PI. (Note that the value of π is displayed as 3.141592654.) The value of π is substituted for PI when a calculation is performed.

Negative values are entered into the display by preceding the number with the minus (−) sign located on the numeric keypad.

If you need to correct an erroneous entry, use the ←, →, [SHIFT] [INS], and [SHIFT] [DEL] keys. See chapter 1.

Numeric Variable Assignments

Numeric values can be used directly in a calculation or can be assigned to variables for use in later calculations. For example, entering X = 3 stores the value 3 in the variable X. Then X can be used in a calculation such as $X^2 + 3X - 2$ (entered as x∧2+3∗x−2), giving a result of 16.

The result of an equation or calculation can also be assigned to a variable. For example, Y = m∗x + b assigns the result of the equation m∗x + b to the variable Y. The previously defined variables m, x, and b supply the data necessary to evaluate the equation. See chapter 4 for details concerning variable assignments.

Simple Arithmetic Calculations

The +, −, *, /, and [SHIFT] ∧ keys are used to perform simple arithmetic calculations. The following examples show how to use these keys.

Example	Press	Display	Comment
2 + 3	2 + 3 [ENTER]	5	Addition
145 − 98	145 − 98 [ENTER]	47	Subtraction
3945 × −5	3945* −5 [ENTER]	−19725	Multiplication
7 ÷ π	7/PI [ENTER]	2.228169203	Division
5$^{-3.25}$	5 ∧ −3.25 [ENTER]	.0053499224	Exponentiation
$\sqrt[3]{8}$	8 ∧ (1/3) [ENTER]	2	Root

A problem is evaluated when the [ENTER] key is pressed. You do not need to press the = key.

Note: A negative value cannot be raised to a non-integer power.

Order of Operations

The CC-40 uses standard algebraic hierarchy to evaluate mathematical problems. This evaluation method permits you to enter an equation or problem into the display in an order similar to the way it is written on paper—from left to right.

The CC-40 uses the following order of precedence when evaluating mathematical operations.

Operation	Example	Entry
1. Functions	$\sqrt{25}$	SQR(25)
2. Exponentiation	8$^{(1/3)}$	8 ∧ (1/3)
3. Unary minus	− 17	− 17
4. Multiplication and division	6*4 ÷ 3	6*4/3
5. Addition and subtraction	3 + 7 − 2	3 + 7 − 2

When [ENTER] is pressed, the CC-40 employs these rules to evaluate the problem in the display. Operations with the same priority are evaluated from left to right.

For example, to evaluate $2 + 3*8/2^2 - 4$, the CC-40 first performs exponentiation, followed by multiplication and division, and then addition and subtraction. This problem is evaluated in the following manner.

Problem	$2 + 3*8/2 \wedge 2 - 4$
Exponentiation first	2 + 3*8/4 − 4
Multiplication/division from left to right	2 + 24/4 − 4
	2 + 6 − 4
Addition/subtraction from left to right	8 − 4
	4

You can change the normal order of evaluation by enclosing part of a calculation in parentheses. Any expression in parentheses is evaluated first. For example, to calculate $2*(8 + 3)*2$, the CC-40 first evaluates the contents of the parentheses. This problem is evaluated in the following manner.

Problem	$2*(8 + 3)*2$
Contents of parentheses evaluated	2*11*2
Multiplication/division from left to right	22*2
	44

Scientific Notation

Scientific notation allows you to represent very small and very large numbers in an easy-to-read format. Scientific notation is especially useful in scientific and engineering applications, where such numbers are often used.

These numbers are expressed in a format in which a number (the mantissa) is multiplied by 10 raised to a power (the exponent). For example, the sun is approximately 92,900,000 miles away from the earth. This number can be represented in scientific notation as 9.29×10^7 where 9.29 is the mantissa and 7 is the exponent.

Numbers in scientific notation are entered into the display of the CC-40 with the mantissa followed by E (or e) and the exponent. For example, 9.29×10^7 can be expressed as 9.29E + 07 or, more conveniently, as 9.29e7. Like other numbers, values expressed in scientific notation must not contain spaces. The following table gives other examples of scientific notation.

Standard Notation	Scientific Notation
- 512340000000	- 5.1234E + 11
.00000000000188	1.88E - 12
- .000000000000123	- 1.23E - 13

Scientific notation allows you to enter and evaluate calculations on numbers with magnitudes as small as ± 1E - 128 or as large as ± 9.9999999999999E + 127. The computer automatically displays numbers in scientific notation when more significant digits can be displayed than in the usual ten-digit format.

Mathematical Functions

There are two ways to access the mathematical functions of the CC-40. You can either type the function name or press [FN] and the alphabetic key under the desired function shown on the overlay, as described in chapter 1. Note that some functions are not available using the [FN] key; you have to type them.

Several of the mathematical functions are described below. For more information on these and the other functions (listed in appendix B), see chapter 5.

When the [FN] key is used, the keystrokes shown in the examples describe the function accessed and not the key actually pressed. For example, pressing [FN] and then **R** to access PI is shown as [FN] [PI].

Many mathematical functions require an argument. If an argument is required, it must be enclosed in a set of parentheses. For example, ABS(- 4) calculates the absolute value of - 4. Both the open and close parentheses are required. The message Unmatched parenthesis is displayed when a parenthesis is omitted.

If you use the [FN] key to place a function name, such as ABS, into the display, the computer provides the open parenthesis. Thus, pressing [FN] [ABS(] places ABS(in the display. You then provide the argument and closing parenthesis, and press [ENTER] to evaluate the expression.

Square Root

SQR is used to calculate the square root of a number.

Example	Press	Display
$\sqrt{5}$	[FN] [SQR(]	SQR(
	5)	SQR(5)
	[ENTER]	2.236067978
$\sqrt{25}$	SQR(25) [ENTER]	5

The first example illustrates using the [FN] [SQR(] sequence to calculate the square root. In the second example, the [FN] key is not used.

Logarithms and Antilogarithms

LOG is used to calculate the common logarithm (base 10) of X. Ten raised to a number is used to calculate the common antilogarithm.

Example	Press	Display
LOG(2.4)	LOG(2.4) [ENTER]	.3802112417
$10^{1.17}$	10 ∧ 1.17 [ENTER]	14.79108388

LN is used to calculate the natural logarithm (base e) of X. **EXP** (the exponential function, e^x) is used to calculate the natural antilogarithm of X.

Example	Press	Display
LN(2.4)	LN(2.4) [ENTER]	.8754687374
$e^{.25}$	EXP(.25) [ENTER]	1.284025417

Trigonometric Functions

The CC-40 evaluates trigonometric functions in either radian, degree, or grad (RAD, DEG, or GRAD) angle units. The RAD angle setting is selected when **NEW ALL** is entered or the system is initialized. The angle setting remains in effect until you change it or the system is initialized.

When you use a trigonometric function, check the angle setting indicator in the display to make certain that the desired angle setting has been selected. If you wish to choose a different setting, you may either use the **[FN]** key or manually type the desired setting as RAD, DEG, or GRAD.

SIN, **COS**, and **TAN** are used to compute the sine, cosine, and tangent of an angle. The angles are measured in the units of the indicated angle setting. The following example finds the sine of 50 degrees.

Example	Press	Display	Comments
	[DEG] [ENTER]	DEG indicator set	Set degree mode.
SIN(50°)	SIN(50) [ENTER]	.7660444431	Sine of 50°.

The formulas for secant, cosecant, cotangent, and hyperbolic functions are given in appendix E.

ASN, **ACS**, and **ATN** are used to compute the arcsine ($\sin^{-1}$), arccosine ($\cos^{-1}$), and arctangent ($\tan^{-1}$) of a value. The result is calculated according to the angle units (RAD, DEG, or GRAD) selected prior to using these functions. The following example finds the arcsine of .5 with radians as the trigonometric unit.

Example	Press	Display	Comments
	[RAD] [ENTER]	RAD indicator set	Select radian mode.
ASN(.5)	ASN(.5) [ENTER]	.5235987756	Arcsine of .5.

The formulas for arcsecant, arccosecant, arccotangent, and inverse hyperbolic functions are given in appendix E.

Chain Calculations

The CC-40 provides you with the capability to chain keyboard calculations. Chain calculations are often used when the result of one calculation is needed in another calculation. A loss of accuracy occasionally results when you chain calculations. See appendix F for accuracy information.

When the result of a keyboard calculation is displayed, it is followed by the flashing cursor. You can press any of the arithmetic operators ($+$, $-$, $*$, $/$, or $\wedge$), or the **[SHIFT] [INS]**, $\rightarrow$, or $\leftarrow$ keys to use the displayed result in another calculation. If an alphanumeric key is pressed, the display is cleared and that key entered into the display. If **[SHIFT] [INS]** is pressed, the cursor is automatically positioned to column 1, where characters can be inserted.

For example, the formula $h = \sqrt{a^2 + b^2}$ is used to calculate the length of the hypotenuse of a right triangle. When $a = 3$ and $b = 4$, h can be calculated by entering **SQR(3 $\wedge$ 2 + 4 $\wedge$ 2)**. To illustrate how to chain calculations, this problem is divided into three steps. First, $3 \wedge 2$ is calculated. Next, the result of $4 \wedge 2$ is added to the displayed result of $3 \wedge 2$. Then the square root of that sum is calculated.

Press	Display	Comment
3$\wedge$2	3$\wedge$2	
[ENTER]	9	Result of 3^2 followed by the flashing cursor.
+4$\wedge$2	9+4$\wedge$2	
[ENTER]	25	Result of $3^2 + 4^2$ followed by the flashing cursor.
[SHIFT] [INS]		Flashing cursor moves to column 1.
[SQR( ]	SQR(25	Insert SQR(.
$\rightarrow\rightarrow$	SQR(25	Move cursor past the 5.
)	SQR(25)	Enter close parenthesis.
[ENTER]	5	Result of SQR($3^2 + 4^2$) followed by the flashing cursor.

If no other calculations are to be performed, press **[CLR]** to clear the display.

Repetitive Calculations

The CC-40 provides two ways to perform repetitive calculations. The [SHIFT] [PB] key can be used to display the contents of the previous display, or the user-assigned keys can be used to store and recall frequently used expressions and data.

Playback

The playback feature can be used when you need to perform the same calculation repeatedly with different values. When a keyboard calculation is performed, the result is displayed and you can press [SHIFT] [PB] to recall the calculation that was last in the display. The calculation can be altered using the edit keys and a new result obtained.

For example, suppose you want to find the equivalent Celsius temperature for a Fahrenheit temperature. The formula for converting to Celsius is shown below.

$$C = (F - 32)*5/9$$

To convert 212° Fahrenheit to Celsius, enter the following.

$$(212 - 32)*5/9$$

The answer, 100, is displayed.

To change another Fahrenheit reading to Celsius, press [SHIFT] [PB] to display the last line that was entered, (212-32)*5/9. Use the edit keys to change 212 to 100 and press [ENTER]. The result of this calculation, 37.77777778, is displayed.

To change another Fahrenheit reading to Celsius, press [SHIFT] [PB] to display the last line that was entered, (100-32)*5/9, and use the edit keys to change the 100 to another temperature.

This type of repetitive calculation is appropriate when you do not have to enter values for variables. When you enter a value, that value becomes the contents of the last display, and will be displayed when [SHIFT] [PB] is pressed. To perform a repetitive calculation with variables, use the user-assigned keys.

User-Assigned Keys

User-assigned keys are used to reduce time spent typing commonly used expressions or strings. You can assign a string of up to 80 characters to each of the number keys 0 through 9 and recall those characters with the [FN] key (see chapter 1). This capability is especially useful for storing mathematical expressions.

For example, the following formula can be used to calculate the inverse secant.

$$SGN(X)*ACS(1/X)$$

You can calculate the inverse secant for different values of X by assigning this formula to a numeric key (0-9) and then entering different values for X. The following example illustrates assigning the formula to key 1 and finding the inverse secant of 5 and 10 in radians.

Press	Comments
SGN(X)*ACS(1/X)	Place string in the display.
[SHIFT] [FN] 1	Hold down both [SHIFT] and [FN] until the SHIFT and FN indicators appear in the display, then press 1.
[RAD] [ENTER]	Select radian mode.
X = 5 [ENTER]	Define X to be 5.
[FN] 1	Recall string.
[ENTER]	Displays 1.369438406.
X = 10 [ENTER]	Define X to be 10.
[FN] 1	Recall string.
[ENTER]	Displays 1.470628906.

All user-assigned strings are cleared when **NEW ALL** is entered or the system is initialized.

Introduction

The memory capacity and problem-solving capabilities of the CC-40 can be greatly increased by installing optional *Solid State Softwâre*™ or *Memory Expansion* cartridges in its cartridge port. The peripheral devices available for use with the CC-40 also enhance its versatility and usefulness.

Solid State Software cartridges give you rapid access to professionally-written programs in areas such as mathematics, engineering, and finance. The programs in these cartridges take full advantage of the alphanumeric display capability of the CG-40 to provide descriptive prompting for data entries and labeling of results. Illustrative examples and detailed instructions for using each of the cartridge programs are provided in the owner's manual supplied with each cartridge.

Memory Expansion cartridges can increase the Random Access Memory (RAM) capacity of your CC-40. Like the *Solid State Software* cartridges, *Memory Expansion* cartridges are installed in the cartridge port of the CC-40.

Peripheral devices available for use with the CC-40 allow you to expand the capabilities of the computer. The peripheral expansion flexibility of the CC-40 enables you to expand your system to print information, store and retrieve programs and data, communicate with other computers, print graphs and charts, and view data on a CRT (television) display. The computer communicates with peripheral devices through the TI *HEX-BUS*™ Intelligent Peripheral Interface (the peripheral port). The *HEX-BUS* interface is a standardized interconnection system with a uniform set of cabling conventions, control signals, and message structures.

Caring for Cartridges and Peripherals

Even though the cartridges and peripherals are durable devices, you should handle them with care. Follow these precautions when handling cartridges or peripherals.

- **BE SURE THAT YOUR BODY IS FREE OF STATIC ELECTRICITY.** Prior to handling any cartridge or peripheral, touch some metal object to discharge any static electricity you may be carrying.

- Keep the cartridge port cover secure on the computer to keep the cartridge port dust-free.

- Keep the contact area of the cartridges clean. A buildup of debris or foreign particles on the contacts can impair their operation. Keep the cartridges stored either in the original container or in the computer's cartridge port.

- Use a cotton swab soaked in alcohol to clean the cartridge and cartridge port contacts when necessary. After the alcohol has dried, remove any remaining lint with a clean, soft-bristled brush.

   CAUTION: Do not use any other liquid substance to clean the contacts.

- Check the peripheral manuals for special maintenance instructions for the peripherals.

Installing or Replacing a Cartridge

Both *Solid State Software*™ and *Memory Expansion* cartridges are installed in the cartridge port of the CC-40. Turn the computer off when installing or replacing a cartridge. Installing a cartridge while the computer is on may result in memory loss.

Use the following procedure when installing a cartridge.

1. Turn the computer off.

2. Slide the cartridge port cover back and remove it from the computer as shown in the diagram below.
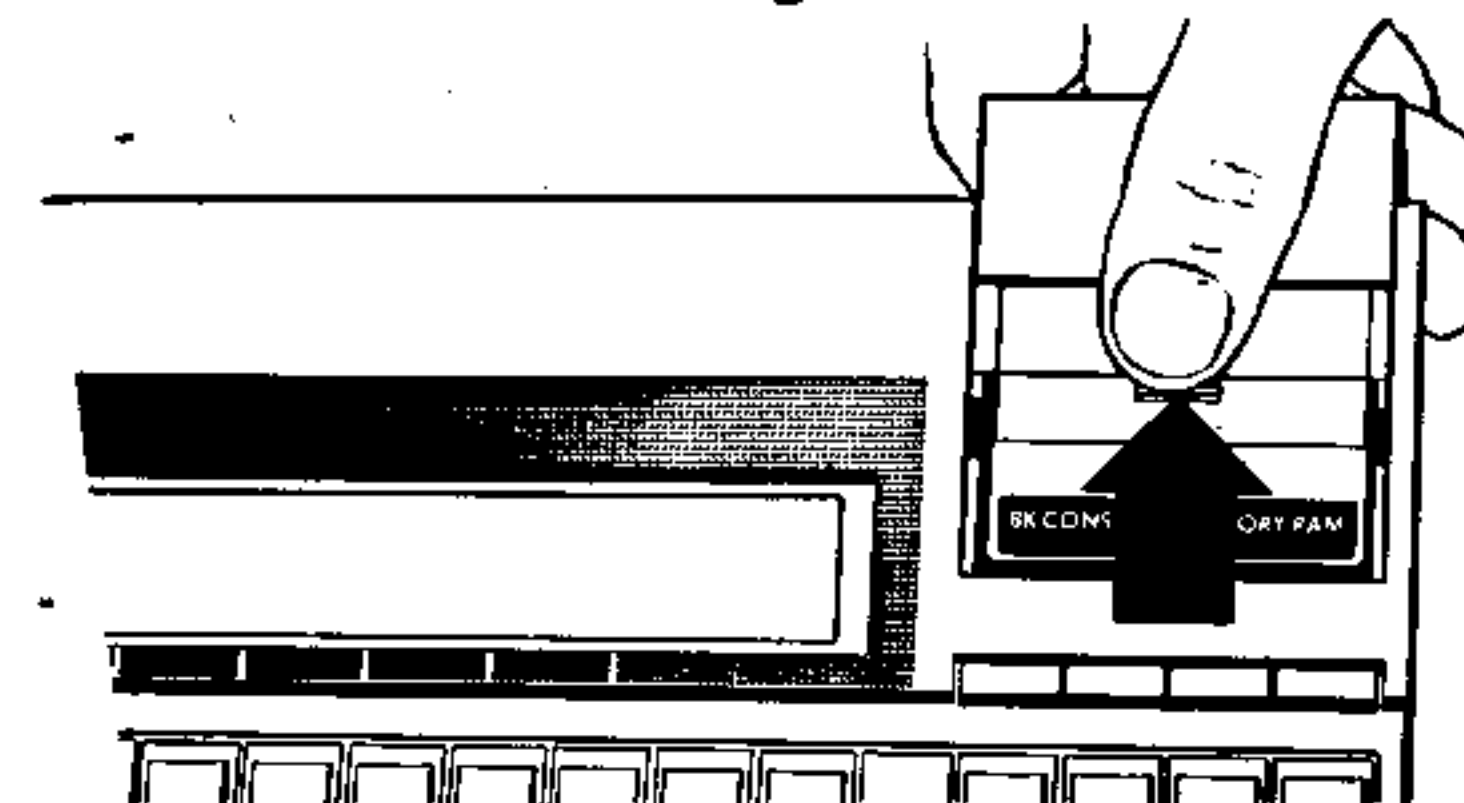
3. If a cartridge is already installed, remove it by pushing the cartridge away from the keyboard until it is released. Lift the cartridge from the cartridge port.

4. Lay the cartridge to be installed in the cartridge port, with the cartridge name facing up and toward the keyboard.

5. Press firmly on the back of the cartridge and slide it toward the keyboard until the tabs on the cartridge enter the slots provided and the cartridge locks into place. Replace the cartridge port cover and check that its tabs also fit into the slots.

TABS MUST FIT INTO SLOTS
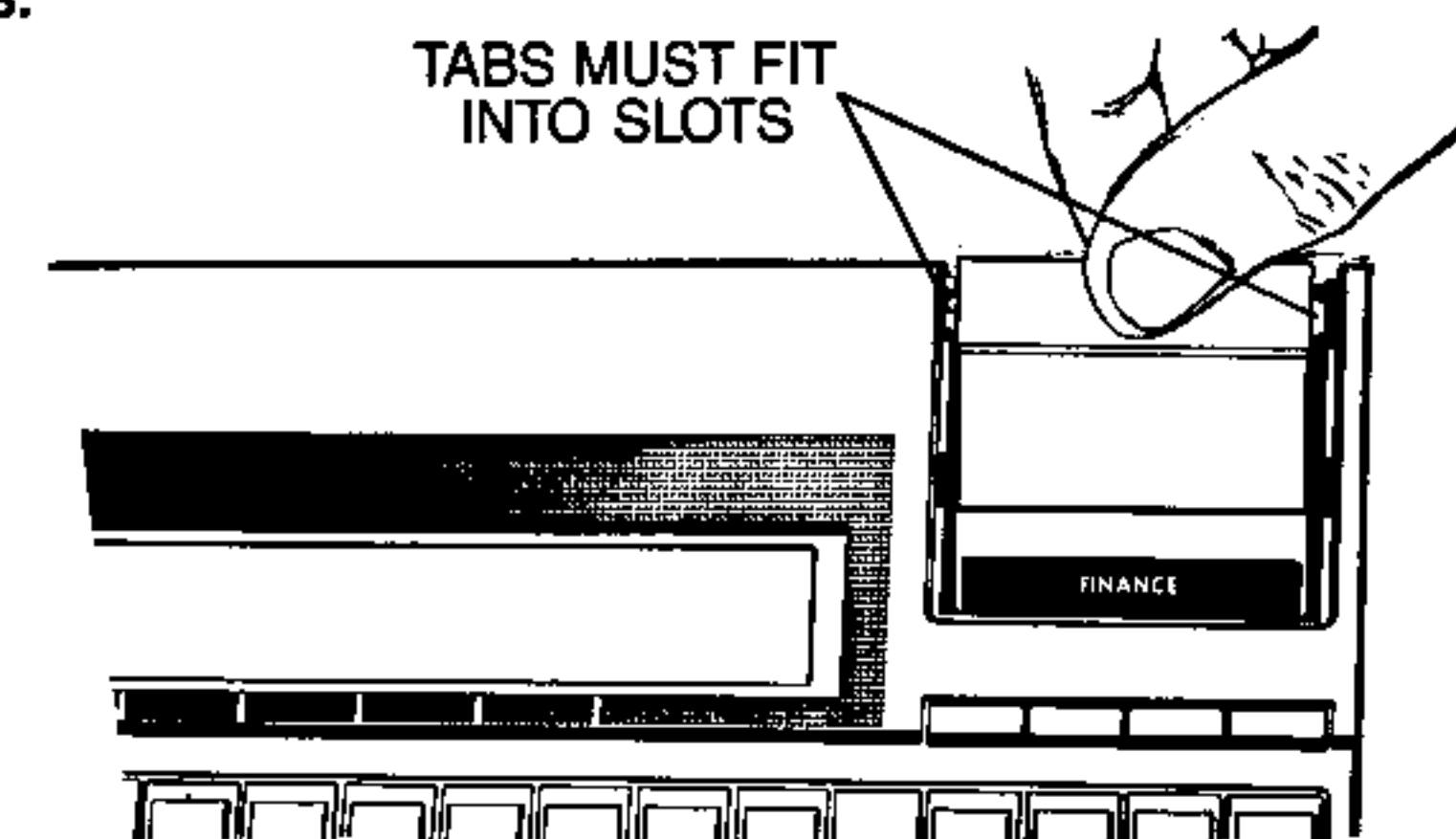
Using *Solid State Software* Programs and Subprograms

The programs in **some** *Solid State Software*™ cartridges start running as soon as you turn on the computer. Instead of a blank display with the cursor, you see a message. See the owner's manual that comes with the cartridge for instructions on how to proceed.

You must run the programs in other cartridges by typing **RUN**, quotation marks, the name of the program, and quotation marks, and then pressing **[ENTER]**. The owner's manual gives the name of the program that you need to run and describes how to use the program.

Most cartridges contain several programs and subprograms, each described in the owner's manual. You can run the programs from the keyboard or from a program. Subprograms are called from programs. Refer to chapter 4 for how to run programs and use subprograms in a program.

To run a program in a *Solid State Software* cartridge, type **RUN**, quotation marks, the program name, and quotation marks, and then press **[ENTER]**. For example, you can run the normal distribution program in the Statistics cartridge by typing **RUN "normal"** and then pressing **[ENTER]**. If the cartridge is installed, NORMAL DISTRIBUTION is displayed. If the cartridge is not installed, Program not found is displayed.

Using *Memory Expansion* Cartridges

Memory Expansion cartridges can be installed in the cartridge port of the CC-40 to expand the resident memory and allow you to write and use larger programs. Cartridge memory is appended to the resident memory when the ADDMEM subprogram is called (see chapter 5). This link between resident memory and cartridge memory is broken when **NEW ALL** is entered, the reset key is pressed, or the cartridge is removed.

Set-up Instructions for Peripherals

Setting up the CC-40 peripherals is a simple process. First you connect the device to the *HEX-BUS*™ Intelligent Peripheral Interface; then you check its operation. This section describes the steps involved in setting up peripherals.

Connecting Peripheral Devices

The devices in the TI *HEX-BUS* system have identical eight-pin recessed connectors for the cable through which they communicate. The computer has one such connector, while each peripheral device has two of them so that a series of devices may be attached to the computer.

Before connecting any peripherals, turn off the computer. Then wait for *all* peripheral activity to cease before you turn off the peripherals. You may link peripherals to the computer in any order. The first peripheral is plugged directly into the computer using a cable. Then another cable is plugged into the other connector on the peripheral. The other end of the cable is plugged into the next peripheral you are connecting. The plugs are keyed so that you can insert them only one way. The last peripheral has one connector free.

Peripherals are normally arranged in a stack next to the computer, using the cables supplied with the peripheral devices. Longer cables are available separately if you prefer to arrange the peripherals differently.

CAUTION

To prevent damage, disconnect all devices before moving any part of the *HEX-BUS* system. Even though the computer and peripherals are light and portable and easily carried in a briefcase, the cables and connectors are subject to accidental strain if not detached. For shipment over long distances, repack the system securely, preferably in its original packing materials.

Checking the Operation of a Peripheral

The IO subprogram in the CC-40 can be used to determine if a peripheral is attached correctly to the computer. The IO subprogram is accessed by entering **CALL IO** with the device number of the peripheral you are testing. For example, **CALL IO(1,1)** is used to test peripheral device 1 and **CALL IO(7,1)** is used to test peripheral device 7. Refer to the peripheral manuals for the device numbers of your peripherals.

Use the following procedure to check if a peripheral is connected correctly.

1. Turn on the peripherals and the computer. All attached peripherals should be turned on for proper operation.
2. To test a peripheral device, enter **CALL IO** with the number of the device. For example, to test device 20 (the RS232 peripheral), type **CALL IO(20,1)** and press **[ENTER]**. The ERROR indicator is turned on and the following message is then displayed if the peripheral is attached correctly.

    I/O error 4 "20"

    Note: **CALL IO(20,1)** is an attempt to end access to the RS232 peripheral. Since it has just been turned on at this point, the device is not yet enabled for access. In returning error code 4 (device not open), the peripheral is operating as it should.
3. Press **[CLR]** to clear the error message and restore the cursor. The peripheral is ready for use.

If the correct error code is not displayed when the **CALL IO** instruction is entered, the device may not be connected properly. Check the cabling between the computer and the peripheral. Refer to the peripheral manual for more information.

If the I/O display indicator stays on while the rest of the display remains blank, the system has "locked up" at some point in the test sequence. The computer cannot respond to input from the keyboard while in this state. Turn the peripheral off momentarily to clear the condition. Then check the cabling connection and try the operational check once more. If this procedure does not correct the situation, you may have a hardware problem in the cable or the peripheral. Refer to *In Case of Difficulty* in the peripheral manual for information.