

LEVEL II


BASIC

Reference

Manual

Radio Shack®

TRS-80
MICRO COMPUTER SYSTEM

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NOTE: Good data processing procedure dictates that the user test the program, run and test sample sets of data, and run the system in parallel with the system previously in use for a period of time adequate to insure that results of operation of the computer or program are satisfactory.

LEVEL III BASIC Reference Manual

Radio Shack
 A DIVISION OF TANDY CORPORATION

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This Reference Manual and You

We've prepared this Reference Manual with the assumption that you - the user - already have considerable experience with programming in BASIC. Our LEVEL I User's Manual was written for the total beginner - and has been greeted with wide acclaim. We freely admit this Manual has not been written from the same perspective.

If this is your first experience with programming, you may want to use the LEVEL I Users Manual to get the "hang" of it. First, read Chapter 1 in this book, to learn about powering up and to get an overview. Then go to the LEVEL I Users Manual, and start trying the early examples in that book.

Remember, there are important differences between LEVEL I and LEVEL II. If a LEVEL I example doesn't work, look up the BASIC keyword in this book (using the Index at the back). You'll soon learn how to make LEVEL I examples work on the LEVEL II computer. After that, you're ready to explore the LEVEL II language directly, using this book as a guide.

If you've had experience with other forms of the BASIC language (other microcomputers or time share systems) then you should be ready for our Reference Manual for LEVEL II.

LEVEL II is a far more powerful version of BASIC than was LEVEL I. If you have been working with LEVEL I for some time, be prepared for some pleasant surprises - and some differences that might throw you for awhile (for example, LEVEL I programs won't run as-is on a LEVEL II machine . . . you'll have to modify them). This Manual is a complete reference guide - it is not intended to be a complete step-by-step training manual or an applications book (that will come later).

If you have suggestions...criticism...questions...concerning this Manual or your TRS-80 — we'd be glad to hear from you.

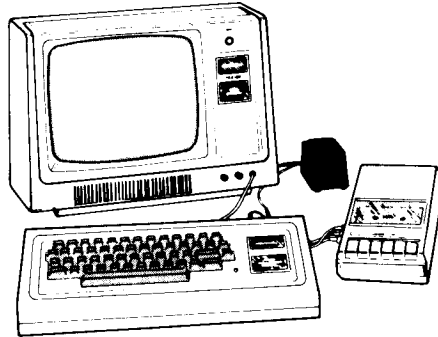
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Setting up the System

Carefully unpack the system. Remove all packing material. Be sure you locate all cables, papers, tapes, etc. Save the packing material in case you need to transport the system.

Connecting the Video Display and Keyboard:

1. Connect the power cord from the Video Display to a source of 120 volts, 60 Hz AC power. Note that one prong of the AC plug is wider than the other - the wide prong should go into the widest slot of the AC socket.
NOTE: If you use an AC extension cord, you may not be able to plug the Display's power cord in. Do not attempt to force **this wide prong into the extension cord**; use a wall outlet if at all possible.
2. Connect the power cord of the Power Supply to a source of 120 volts, 60 Hz AC power.
3. Connect the gray cable from the front of the Video Monitor to the **VIDEO** jack on the back of the Keyboard Assembly. **Take care to line up the pins correctly** (the plug fits only one way).
NOTE: Before the next step, be sure the **POWER** switch on the back of the Keyboard is off (button out).
4. Connect the gray cable from the Power Supply to the **POWER** jack on the back of the Keyboard Assembly. **Again, take care to mate the connection correctly.**



Connecting the Cassette Recorder:

NOTE: You do not need to connect the Cassette Recorder unless you plan to record programs or to load taped programs into the TRS-80.

In the directions below, the CTR-80 recorder is used as an example. If you use a different recorder, connection and operation may vary.

1. Connect the CTR-80 to a source of 120 volt AC power. (Batteries are not recommended for using Recorder with TRS-80.)
2. Connect the short cable (DIN plug on one end and 3 plugs on the other) to the **TAPE** jack on the back of the Keyboard Assembly. **Be sure you get the plug to mate correctly.**
3. The 3 plugs on the other end of this cable are for connecting to the CTR-80.

-
- A. Connect the **black plug** into the EAR jack on the side of the CTR-80. This connection provides the output signal from the CTR-80 to the TRS-80 (for loading Tape programs into the TRS-80).
 - B. Connect the larger **gray plug** into the AUX jack on the CTR-80. This connection provides the recording signal to record programs from the TRS-80 onto the CTR-80's tape.

Leave the AUX plug in whether you are recording or playing back cassette data.

- C. Connect the smaller **gray plug** into the smaller MIC jack on the CTR-80. This allows the TRS-80 to automatically control the CTR-80's motor (turn tape motion on and off for recording and playing tapes.)

NOTE: Do not plug a remote microphone or a dummy plug into the larger MIC jack.

Notes on Using the Recorder

There are a number of things you should be aware of as you use the Cassette Tape System

1. To play a tape (load a taped program into the TRS-80, **you must have the CTR-80's Volume control set to middle levels (approximately 4)**). Then press the CTR-80's PLAY key and then type **CLOAD** on the TRS-80 and ENTER this command. This will start the tape motion. An * will appear on the top line of the Monitor; a second * will blink, indicating the program is loading. When loading is done, the TRS-80 will automatically turn the CTR-80 off and flash **READY** on the screen. You are then ready to **RUN** the program (type in **RUN** and hit **ENTER**).
2. To record a program from the TRS-80, press the ENTER RECORD and PLAY keys simultaneously. Then type **CSAVE** followed by a one-letter "file-name" in quotes and **ENTER** this command. When the program has been recorded the TRS-80 will automatically turn the CTR-80 off and display **READY** on the screen. Now you have your program on tape (it still is in the TRS-80 also). Many computer users make a second or even a third recording of the tape, just to be sure they have a good recording.
3. Use the CTR-80's Tape Counter to aid you in locating programs on the tapes.
4. For best results, use Radio Shack's special 10 minute per side Computer Tape Cassettes (especially designed for recording computer programs). If you use standard audiotape cassettes, be sure to use top quality, such as Realistic SUPERTAPE. Keep in mind that audiocassettes have lead-ins on both ends (blue nonmagnetic Mylar material) — **you can not record on the leader portion of the tape**. Advance the tape past the leader before recording a program.

-
5. When you are not going to use a CTR-80 for loading or recording programs, do not leave RECORD or PLAY keys down (press STOP).
 6. REWIND and FAST-FORWARD are not under remote control; simply press the appropriate key until the tape has moved to the desired position.
 7. If you want to save a taped program permanently, break off the erase protect tab on the cassette (see CTR-80 Manual).
 8. Do not expose recorded tapes to magnetic fields. Avoid placing your tapes near the Power Supply.
 9. To check if a tape has a program recorded on it, you can disconnect the plug from the EAR jack (also disconnect the REM plug so you can control the CTR-80 with the keys) and Play the tape; you'll hear the program material from the speaker.
 10. For the best results when using a Recorder with the Computer, you should keep the Recorder's heads and tape handling mechanism very clean. A new Recorder should be cleaned before it is used the first time, and cleaned again after every four hours' use. In addition, the tape heads should be demagnetized periodically.

A complete line of recorder accessories (cleaning solution, cotton tipped swabs, demagnetizer-cassettes, etc.) is available at your local Radio Shack store.

Special Notes:

- 1) Before attempting to load a program from tape into the Computer, be sure the cassette is rewound to a **blank** portion of the tape preceding the program. If you try to start the load in the middle of a preceding program, you probably will get the Computer "hung up" (in which case you'll have to press Reset and start over). The same rule applies when you're using the CLOAD? command to compare a taped program with one stored in the Computer.
- 2) For best results when re-using tapes, erase the old program with a bulk tape eraser (such as Radio Shack Catalog Number 44-210).

WARNING

In dry climates, and especially in winter, static electricity can play havoc with computer data tapes. Handling a cassette when you are "charged" with static electricity can put clicks on the tape and make its data unreadable by the Computer.

Under such conditions, be sure to ground yourself (by touching a metal surface, etc.) before handling cassettes. You may also remove some of the causes of static electricity buildup, by using anti-static sprays on rugs, humidifying the air, etc.

1 / General Information

This chapter will provide you with an overview of LEVEL II BASIC - what some of its special features are, how it differs from LEVEL I, and generally, what you need to get going. In addition, there's a short glossary at the end of the chapter.

Power-Up

Connect Keyboard-Computer, Video Display and Power Supply as explained in the previous section. Plug Video Display and Power Supply into 120-volt AC outlets. If you have a Recorder connected to the TRS-80, **be sure it is in the Stop mode (not in Play, Rewind, etc.)** during power-up. This will prevent unnecessary wear of the tape control relay inside the TRS-80.

Press POWER buttons on Video Display and at the back of the Keyboard. Give the video tube a few seconds to warm up.

MEMORY SIZE? will appear on the screen.

This is your chance to protect a segment of memory so that machine-language programs may be loaded, using a special command, SYSTEM. You must **ENTER** 3 a value greater than or equal to 17430. (For more information on loading and executing machine-language programs, see page 2/6, SYSTEM command, and page 8/8, USR(x) command.)

For normal applications, you won't want to protect any memory, so just press the **ENTER** key without typing in any numbers. This will allow you to write BASIC programs using the full memory capacity of your Computer (for 4K Level II machines, that's 3284 bytes, for 16K LEVEL II machines, it's 15,572 bytes).

NOTE: In general, whenever you have typed something in via the keyboard and you want the Computer to "act" on your input, you must first hit the **ENTER** key just as you did with the Level I TRS-80. There are ways to have the Computer respond as soon as you hit a key (without **ENTER**), but these will be covered later.

RADIO SHACK LEVEL II BASIC

READY

>_

will appear on the screen. You are now ready to use LEVEL II BASIC.

Reset

The Reset button is on the back of the keyboard on the left side, next to the Expansion Card Edge. If your TRS-80 "freezes up" (you can't type anything) you can press Reset to return to the **MEMORY SIZE?** question. Any BASIC program in memory will be lost.

NOTE: If you have the Expansion Interface connected and you need to Reset the Computer, hold down the **BREAK** key before pressing Reset and keep it down until you release Reset.

Operating Modes

There are four operating modes: Command, Execute, Edit and Monitor. Command and Execute Modes are just like LEVEL I BASIC. In the Command Mode, the Computer responds to commands as soon as they are entered. This is the level you use to write programs and perform computations directly ("calculator mode" of LEVEL I). Whenever the >_ appears on the Display, you're in the Command Mode.

The Execute Mode is usually entered by typing **RUN**; this causes BASIC programs to be executed. Unlike LEVEL I, LEVEL II initializes all numeric variables to zero and sets all strings to null when you enter the command **RUN**.

The Edit Mode is a real timesaving feature of LEVEL II. It allows you to edit (alter, add to or delete) the contents of program lines. Instead of retyping an entire program line, you change just the part that needs changing.

NOTE: Whenever Computer encounters a Syntax error during execution, it will go into Edit Mode for that line. To get out of Edit Mode, type "Q" (without quotes).

The Monitor Mode lets you load machine language "object files" into memory. These routines or data can then be accessed by your BASIC programs, or they may be completely independent programs.

Special Function Keys

LEVEL II BASIC offers the same special function keys as LEVEL I plus a few extras. The function of the key depends on what mode the Computer is in.

Command Mode:

ENTER	Effects a carriage return; Computer "looks at" line just typed in and acts accordingly. If line just typed in has no line number, Computer will interpret and execute the statements contained in the line. If Line has a line number, Computer stores the line in program memory.
←	Backspaces the cursor and deletes last character typed in.
SHIFT ←	Deletes the line you are typing in, and returns cursor to beginning of logical line.
↓	Linefeed; moves cursor down to next physical line on the Display.
:	Separates BASIC statements contained on the same logical line, to allow multi-statement lines. E.g., PRINT "FIRST STATEMENT":PRINT "SECOND STATEMENT"
→	Moves cursor over to the next tab stop. Tab stops are at positions 0, 8, 16, 24, 32, 40, 48 and 56.
SHIFT →	Converts display to 32 character-per-line format.
CLEAR	Clears the Display and returns it to 64 character-per line format.

Execute Mode:

SHIFT @	Pause; stops program execution. Hitting any key causes execution to be resumed. Hitting SHIFT @ also freezes the Display during a LIST so you can examine program lines.
BREAK	Stops execution. Resume execution by typing CONT.
ENTER	When Computer is awaiting input from the keyboard, ENTER causes Computer to "look at" what you've typed in.

For Edit Mode special function keys, see Chapter 9.

NOTE: Shifted characters aren't always interchangeable with their unshifted counterparts. For example, shifted **@** isn't the same as **@** even though it looks OK on the screen. So, take care when using the **SHIFT** key.

Variable Names

Variable names must begin with a letter (A-Z) and may be followed by another letter or digit (0-9). So the following are all valid and distinct variable names:

A ZZ Z1 A2 AA AZ G9 GP M MU

Variable names may be longer than two characters, but only the first two characters will be used by the computer to distinguish between variables. For example "SUM", "SUB" and "SU" will be treated as one and the same variable by LEVEL II BASIC.

As you can imagine, this gives you plenty of variable names to use in LEVEL II (in the neighborhood of 900). **However, you cannot use variable names, which contain words with special meaning in the BASIC language.** For example, "XON" cannot be used as a variable name, since it contains the BASIC keyword "ON". The complete list of "reserved words" which cannot be used in variable names appears in Appendix A of this Manual.

Variable Types

There are four types of variables in LEVEL II: integer, single precision, double precision, and string variables. The first three types are used to store numerical values with various degrees of precision; the last type stores strings (sequences) of characters - letters, blanks, numbers and special symbols - up to 255 characters long. LEVEL I only allowed two string variables, A\$ and B\$ -but LEVEL II allows you to use any variable name for strings, simply by adding the string declaration character, \$, to the variable name. There are declaration characters for the other variable types, too: Here's a complete listing:

Variable Type	Declaration Character	Examples	Typical values stored
integer (whole numbers from -32768 to +32767)	%	A%, B9%	-30, 123, 3, 5001
single precision (6 significant figures)	! or E	A!, AA!, Z1!	1, -50, .123456, 353421, 1.23E-5
double precision (16 significant figures)	#	A#, ZZ#, C#	-300.12345678 3.141592653589 1.000000000000001
double precision with scientific notation (for entering constants or during output of large or small numbers)	D	"A#=1.2345678901D+12"	1.2345678901 x 10 ¹²
string (up to 255 characters)	\$	A1\$, GT\$, HI\$	"JOHN Q. DOE", "WHISTLE-STOP" "1+2=?"

The same variable name may be used for different variable types, and the Computer will still keep them distinct, **because of the type declaration character**: For example, A\$, A%, A!, A# are distinct variable names.

Variables without declaration characters are assumed to be single-precision; this assumption can be changed with DEFine statements (Chapter 4).

Arrays

Any valid variable name can be used to name an array in LEVEL II BASIC; and arrays are not limited to one dimension. The DIMension statement is used to define arrays at the beginning of a program. Depending on the variable type used, an array may contain strings, integers, double precision values, etc. A whole chapter of this Manual is devoted to arrays:

Examples: A\$(X,Y,Z) would be a three-dimensional array
 containing string values
 G3(I,J) would be a two-dimensional array containing
 numerical single-precision values
 G#(I) would be a one dimensional array of double
 precision values.

Arithmetic Operators

LEVEL II uses the same arithmetic operators as LEVEL I: + (addition), -(subtraction), * (multiplication) and / (division).

And there's a new, very handy operator: \uparrow (exponentiation: $2 \uparrow 3 = 8$).

The \uparrow operation is generally accurate to 6 significant digits. For example, to compute $6 \cdot 2^{1/3}$: **PRINT 6*2 \uparrow (1/3)**

NOTE: Some TRS-80's generate a [character instead of the \uparrow arrow.

Relational Operators

These are the same as LEVEL I.

< (less than)	> (greater than)	= (equal to)
<> (not equal to)	<= (less than or equal to)	>= (greater than or equal to)

These operators are useful both for IF ... THEN statements and for logical arithmetic.

Example:

```
100 IF C<=0 THEN C=127
```

Logical Operators

In LEVEL I BASIC, * and + were used to represent the logical operators AND and OR. In LEVEL II, we don't use symbols, we use AND and OR directly. We also have another operator, NOT.

Examples:

```
50 IF Q = 13 AND R2 = 0 THEN PRINT "READ"
```

```
100 Q = (G1<0) AND (G2<L)
```

Q = 1 if both expressions are True; otherwise Q = 0

```
200 Q = (G1<0) OR (G2<L)
```

Q = -1 if either expression is True; otherwise Q = 0

```
300 Q = NOT(C>3)
```

Q = 1 if the expression is False; Q = 0 if it is True

```
400 IF NOT (P AND Q) THEN PRINT "P AND Q ARE NOT BOTH EQUAL TO -1"
```

```
500 IF NOT (P OR Q) THEN PRINT "NEITHER P NOR Q EQUALS -1"
```

String Operators

Strings may be compared and concatenated ("strung together") in LEVEL II. A whole chapter of this Manual is devoted to string manipulations.

Symbol	Meaning	Example
<	precedes alphabetically	"A" < "B"
>	follows alphabetically	"JOE" > "JIM"
=	equals	B\$= "WIN"
<>	does not equal	IF A\$<>B\$ THEN PRINT A\$
<=	precedes or equals	IF A\$<=AZ\$ PRINT "DONE"
>=	follows or equals	IF L1\$>="SMITH" PRINT L1\$
+	concatenate the two strings	A\$ = C\$+C1\$ A\$ = "TRS-"+ "80"

Order of Operations

Operations in the innermost level of parentheses are performed first, then evaluation proceeds to the next level out, etc. Operations on the same nesting level are performed according to the following hierarchy:

Exponentiation: $A \uparrow B$

Negation: $-X$

*, / (left to right)

+, - (left to right)

<, >, =, <=, >=, <> (left to right)

NOT

AND

OR

Intrinsic Functions

Most of the subroutines in the LEVEL I manual are built-in to LEVEL II. They are faster, more accurate (to seven digits generally), and much easier to use. For example, SIN(X), COS(X), TAN(X) can be computed directly.

Graphics

Level II has the same SET, RESET and POINT functions as LEVEL I for turning graphics blocks on and off and determining whether an individual block is on or off. (There are a few differences - see Chapter 8.)

A big feature of LEVEL II is the selectable display – either 64 characters per line or 32 characters per line (c/l). When the machine is turned on it is in the 64 c/l mode; hit SHIFT and → simultaneously to change to 32 c/l. Display will return to 64 c/l whenever a **CLS** or **NEW** is executed or CLEAR key is hit. You can also shift to 32 c/l by executing a **PRINT CHR\$ (23)**. More on this in Chapter 5.

Error Messages

LEVEL I pointed out errors by printing **HOW?**, **WHAT?** or **SORRY** along with the offending program line with a question mark inserted at the point of error. LEVEL II gives you much more specific information about what type of error occurred, using a set of Error Codes (see Appendix). The offending program line is also pointed out, but it's up to you to locate the error in the line.

Abbreviations

Very few abbreviations are allowed in LEVEL II. Ex-LEVEL I users will have to forget about **R.**, **L.**, **P.**, etc. Although LEVEL II doesn't allow these short-forms, it stores the programs more efficiently than LEVEL I did, so you can still pack a lot of program into a small amount of memory space.

LEVEL II abbreviations are:

- ? for PRINT, and
- ' for : REM
- . for last line entered, listed, edited, or in which an error occurred.

Keyboard Rollover

With the LEVEL I TRS-80 (and many other computers) you have to release one key before the Computer will allow entry of another key. LEVEL II lets you hit the second key before you have released the first key. This is great for you touch typists.

This feature also makes some of the LEVEL II keyboards susceptible to "keybounce", multiple entries for a single keystroke. To eliminate this annoyance, use the machine-language program, KBFIX, included on tape with affected LEVEL II computers. Loading instructions are included with the tape.

Glossary for LEVEL II BASIC

- address** a value specifying the location of a byte in memory; decimal values are used in LEVEL II
- alphanumerics** the set of letters A-Z, the numerals 0-9, and various punctuation marks and special characters
- argument** the value which is supplied to a function and then operated on to derive a result
- array** an arrangement of elements in one or more dimensions
- ASCII** American Standard Code for Information Interchange; in LEVEL II BASIC, decimal values are used to specify ASCII codes
- assembler** a program that converts a symbolic-language program into a machine-language program
- BASIC** Beginners All-purpose Symbolic Instruction Code
- baud** signaling speed in bits per second; LEVEL II's cassette interface operates at 500 baud (500 bits per second)
- binary** number a number represented in the base-two number system using only binary digits "0" and "1"
- bit** binary-digit, the smallest memory cell in a computer
- byte** the smallest memory unit that can be addressed in BASIC, consisting of 8 consecutive bits
- decimal number** a number represented in the base-ten number system using the digits 0-9
- expression** a combination of one or more operations, constants and variables
- file** an organized collection of related data
- hexadecimal number** a number represented in the base-16 number system using the digits 0-9 plus A, B, C, D, E, F
- intrinsic function** a function (usually a complicated function) that may be "built-in" to the Computer's ROM and may be used directly in a BASIC statement
- logical expression** an expression which is either True or False: if True, -1 is returned; if False, 0 is returned
- machine language** the language used directly by the Computer, written as binary-coded instructions
- port** one of 256 channels through which data can be input to or output from the Computer
- RAM** Random Access Memory; memory available to the user for writing programs and storing data. RAM addresses start at 16384.
- ROM** Read Only Memory; memory which is permanently programmed and may be read but not written into; LEVEL II BASIC is stored in ROM, starting at address 0.
- routine** a sequence of instructions to carry out a certain function
- statement** a complete instruction in BASIC
- string** a sequence of alphanumeric characters ranging in length from zero (the "null" string) to 255
- subroutine** a sequence of instructions for performing a desired function; may be accessed many times from various points in a program
- variable** a quantity that can take on any of a given set of values
- variable name** the label by which a given variable is addressed

2 / Commands

Whenever a prompt > is displayed, your Computer is in the Command Mode. You can type in a command, **[ENTER]** it, and the Computer will respond immediately. This chapter describes the commands you'll use to control the Computer – to change modes, begin input and output procedures, alter program memory, etc. **All of these commands – except CONT – may also be used inside your program as statements.** In some cases, this is useful; other times it is just for very specialized applications.

The commands described in this chapter are:

AUTO	CONT	EDIT	SYSTEM
CLEAR	CSAVE	LIST	TROFF
CLOAD	DELETE	NEW	TRON
CLOAD?		RUN	

AUTO line number, increment

Turns on an automatic line numbering function for convenient entry of programs – all you have to do is enter the actual program statements. You can specify a beginning line number and an increment to be used between line numbers. Or you can simply type AUTO and hit **[ENTER]**, in which case line numbering will begin at 10 and use increments of 10. Each time you hit **[ENTER]**, the Computer will advance to the next line number.

Examples:	to use line numbers
AUTO	10, 20, 30, ...
AUTO 5,5	5, 10, 15, ...
AUTO 100	100, 110, 120, ...
AUTO 100,25	100, 125, 150, ...

To turn off the AUTO function, hit the BREAK key. (Note: When AUTO brings up a line number, which is already being used, an asterisk will appear beside the line number. If you do not wish to re-program the line, hit the BREAK key to turn off AUTO function.)

CLEAR *n*

When used without an argument (e.g., type CLEAR and hit **ENTER**), this command resets all numeric variables to zero, and all string variables to null.

When used with an argument (e.g., CLEAR 100), this command performs a second function in addition to the one just described: it makes the specified number of bytes available for string storage.

Example: CLEAR 100 makes 100 bytes available for strings. When you turn on the Computer a CLEAR 50 is executed automatically.

CLOAD "*file name*"

Let's you load a BASIC program stored on cassette. Place recorder/player in Play mode (be sure the proper connections are made and cassette tape has been re-wound to proper position). The file name may be any single character except the double-quotes (").

NOTE: In LEVEL II, CLOAD and CSAVE operate at a transfer rate of 500 baud. This is twice as fast as. LEVEL I's cassette transfer rate. Therefore, the Volume setting used during CLOAD should be correspondingly lower. For example, if you're using Radio Shack's CTR-80 Cassette Recorder, try a setting of between 4 and 6 on the Volume control when loading programs or data you placed on the tape. For loading pre-recorded programs, a higher Volume level may be required. Do a little experimenting.

Entering CLOAD will turn on the cassette machine and load the first program encountered. LEVEL II also lets you specify a desired "file" in your CLOAD command. For example, CLOAD "A" will cause the Computer to ignore programs on the cassette until it comes to one labeled "A". So no matter where file "A" is located on the tape, you can start at the beginning of the tape; file "A" will be picked out of all the files on the tape and loaded. As the Computer is searching for file "A", the names of the files encountered will appear in the upper right corner of the Display, along with a blinking "*".

Only the first character of the file name is used by the Computer for CLOAD, CLOAD?, and CSAVE operations.

Loading a program from tape automatically clears out the previously stored program. See also **CSAVE**.

See page 10/ 1 if you have the Expansion Interface for loading from 2 recorders.

CLOAD? "*file name*"

Lets you compare a program stored on cassette with one presently in the Computer. This is useful when you have dumped a program onto tape (using CSAVE) and you wish to check that the transfer was successful. If you labeled the file when you CSAVED it, you may specify CLOAD? "*file-name*". Otherwise, if you don't specify a file-name, the first program encountered will be tested. During CLOAD?, the program on tape and the program in memory are compared byte for byte. If there are any discrepancies (indicating a bad dump), the message "BAD" will be displayed. In this case, you should CSAVE the program again. (CLOAD?, unlike CLOAD, does not erase the program memory.)

Be sure to type the question mark or the Computer will interpret your command as CLOAD. It may record over your file instead of verifying it. See page 10/2 for verifying when you have 2 recorders.

CONT

When program execution has been stopped (by the BREAK key or by a STOP statement in the program), type CONT and **ENTER** to continue execution at the point where the stop or break occurred. During such a break or stop in execution, you may examine variable values (using PRINT) or change these values. Then type CONT and **ENTER** and execution will continue with the current variable values. CONT, when used with STOP and the BREAK key, is primarily a debugging tool.

NOTE: You cannot use CONT after EDITing your program lines or otherwise changing your program. CONT is also invalid after execution has ended normally. See also **STOP**.

CSAVE "*file name*"

Stores the resident program on cassette tape. (Cassette recorder must be properly connected, cassette loaded, and in the Record mode, before you enter the CSAVE command.) You must specify a file-name with this command. This file-name may be any alphanumeric character other than double-quotes ("). The program stored on tape will then bear the specified file-name, so that it can be located by a CLOAD command, which asks for that particular file-name. You should always write the appropriate file-names on the cassette case for later reference.

Examples:

CSAVE "1" dumps resident program and attaches label "1"

CSAVE "A" dumps resident program and attaches label "A"

See page 10/2 for saving programs when you have 2 recorders.

See also **CLOAD**.

DELETE *line number-line number*

Erases program lines from memory. You may specify an individual line or a sequence of lines, as follows:

DELETE <i>line number</i>	erases one line as specified
DELETE <i>line number-line number</i>	erases all program lines starting with first line number specified and ending with last number specified
DELETE- <i>line number</i>	erases all program lines up to and including the specified number

The upper line number to be deleted must be a currently used number.

Examples:

DELETE 5	erases line 5 from memory (error if line 5 not used)
DELETE 11-18	erases lines 11, 18 and every line in between

If you have just entered or edited a line, you may delete that line simply by entering DELETE. (use a period instead of the line number).

EDIT *line number*

Puts the Computer in the Edit Mode so you can modify your resident program. The longer and more complex your programs are, the more important EDIT will be. The Edit Mode has its own selection of subcommands, and we have devoted Chapter 9 to the subject.

LIST *line number-line number*

Instructs the Computer to display all program lines presently stored in memory. If you enter LIST without an argument, the entire program will scroll continuously up the screen. To stop the automatic scrolling, press SHIFT and @ simultaneously. This will freeze the display. Press any key to release the "pause" and continue the automatic scrolling.

To examine one line at a time, specify the desired line number as an argument in the LIST command. To examine a certain sequence of program lines, specify the first and last lines you wish to examine.

Examples

LIST 50	displays line 50
LIST 50-150	displays line 50, 150 and everything in between
LIST 50-	displays line 50 and all higher-numbered lines
LIST.	displays current line (line just entered or edited)
LIST -50	displays all lines up to and including line 50

NEW

Erases all program lines, sets numeric variables to zero and string variables to null. It does not change the string space allocated by a previous CLEAR *number* statement. NEW is used in the following program to provide password protection.

```
10 INPUT A$: IF A$<>"E" THEN 65520
.
.      (The rest of your program follows here)
.
65520 NEW
```

You can't run the rest of the program until you enter the correct password, in this case an E. Most of the other commands can also be used within a program.

RUN *line number*

Causes Computer to execute the program stored in memory. If no line number is specified, execution begins with lowest numbered program line. If a line number is specified, execution begins with the line number. (Error occurs if you specify an unused line number.) Whenever RUN is executed, Computer also executes a CLEAR.

Examples:

RUN execution begins at lowest-numbered line
RUN 100 execution begins at line 100

RUN may be used inside a program as a statement; it is a convenient way of starting over with a clean slate for continuous-loop programs such as games.

To execute a program without CLEARing variable, use GOTO. See page 4/7.

SYSTEM

Puts the Computer in the Monitor Mode, which allows you to load object files (machine-language routines or data). Radio Shack offers several machine-language software packages, such as the IN-MEMORY INFORMATION SYSTEM. You can also create your own object files using the TRS-80 EDITOR/ASSEMBLER, which is itself an object file.

To load an object file: Type **SYSTEM** and ENTER.

***?** will be displayed. Now enter the file name (no quotes are necessary) and the tape will begin loading. During the tape load, the familiar asterisks will flash in the upper right-hand corner of the Video Display. When loading is complete, another

***?** will be displayed. Type in a slash-symbol / followed by the address (in decimal form) at which you wish execution to begin. Or you may simply hit the slash-symbol and ENTER without any address. In this case, execution will begin at the address specified by the object file.

NOTE: LEVEL II object files are stored as blocks rather than as continuous files as in LEVEL I. Further, each block has its own check sum. Should a check sum error occur while loading, the leftmost asterisk will change into the letter C. If this occurs you will have to reload the entire object file. (If the tape motion doesn't stop, you must first Reset the Computer.)

TROFF

Turns off the Trace function. See **TRON**.

TRON

Turns on a Trace function that lets you follow program-flow for debugging and execution analysis. Each time the program advances to a new program line, that line number will be displayed inside a pair of brackets.

For example, enter the following program:

```
10 PRINT "START"  
20 PRINT "GOING"  
30 GOTO 20  
40 PRINT "GONE"
```

Now type in TRON, ENTER, and RUN, ENTER.

```
<10> START  
<20> GOING  
<30> <20> GOING  
<30> <20> GOING
```

etc.

(Press SHIFT and @ simultaneously to pause execution and freeze display. Press any key to continue with execution.) As you can see from the display, the program is in an infinite loop.

The numbers show you exactly what is going on. (To stop execution, hit **BREAK** key.)

To turn off the Trace function, enter TROFF. TRON and TROFF may be used inside programs to help you tell when a given line is executed.

For example

```
50 TRON  
60 X=X*3.14159  
70 TROFF
```

might be helpful in pointing out every time line 60 is executed (assuming execution doesn't jump directly to 60 and bypass 50). Each time these three lines are executed, <60> <70> will be displayed. Without TRON, you wouldn't know whether the program was actually executing line 60. After a program is debugged, TRON and TROFF lines can be removed.

3 / Input-Output

The statements described in this chapter let you send data from Keyboard to Computer, Computer to Display, and back and forth between Computer and the Cassette interface. These will primarily be used inside programs to input data and output results and messages.

Statements covered in this chapter:

PRINT	INPUT
@ (PRINT modifier)	DATA
TAB (PRINT modifier)	READ
USING (PRINT formatter)	RESTORE
	PRINT # (Output to Cassette)
	INPUT # (Input to Cassette)

PRINT *item list*

Prints an item or a list of items on the Display. The items may be either string constants (messages enclosed in quotes), string variables, numeric constants (numbers), variables, or expressions involving all of the preceding items. The items to be PRINTed may be separated by commas or semi-colons. If commas are used, the cursor automatically advances to the next print zone before printing the next item. If semi-colons are used, no space is inserted between the items printed on the Display. In cases where no ambiguity would result, all punctuation can be omitted.

Examples:

50 X=5
100 PRINT 25; "IS EQUAL TO"; X ↑ 2

RUN

25 IS EQUAL TO 25

10 A\$="STRING"
20 PRINT A\$;A\$,A\$;" ";A\$

RUN

STRINGSTRING STRING STRING

```
-----
30 X=25
40 PRINT 25 "IS EQUAL TO" X
RUN
```

```
25 IS EQUAL TO 25
```

```
-----
70 A=5:B=10:C=3
80 PRINT ABC
RUN
0
```

Positive numbers are printed with a leading blank (instead of a plus sign); **all numbers** are printed with a trailing blank; and no blanks are inserted before or after **strings** (you can insert them with quotes as in line 20).

In lines 30 and 40 no punctuation is needed; but in lines 70 and 80 zero will print out because ABC is interpreted as a single variable which has not been assigned a value yet.

```
-----
10 PRINT "ZONE 1","ZONE 2","ZONE 3","ZONE 4","ZONE 1 ETC"
RUN
ZONE 1          ZONE 2          ZONE 3          ZONE 4
ZONE 1 ETC
```

There are four 16-character print zones per line.

```
-----
10 PRINT "ZONE 1","ZONE 3"
RUN
ZONE 1          ZONE 3
```

The cursor moves to the next print zone each time a comma is encountered.

```
-----
10 PRINT "PRINT STATEMENT #10 ";
20 PRINT "PRINT STATEMENT #20"
RUN
PRINT STATEMENT #10 PRINT STATEMENT #20
```

A trailing semi-colon over-rides the cursor-return so that the next PRINT begins where the last one left off (see line 10).

If no trailing punctuation is used with PRINT, the cursor drops down to the beginning of the next line.

PRINT @ *position, item list*

Specifies exactly where printing is to begin. (AT was used in LEVEL I BASIC.) The @ modifier must follow PRINT immediately, and the location specified must be a number from 0 to 1023. Refer to the Video Display worksheet, Appendix C, for the exact position of each location 0-1023:

```
100 PRINT @ 550, "LOCATION 550"
```

RUN this to find out where location 550 is.

Whenever you PRINT @ on the bottom line of the Display, there is an automatic line-feed, causing everything displayed to move up one line. To suppress this, use a trailing semi-colon at the end of the statement.

Example:

```
104 PRINT @ 1000, 1000;
```

NOTE: Be sure **not** to use a shifted @, as this will cause a syntax error.

PRINT TAB (*expression*)

Moves the cursor to the specified position on the current line (modulo 64 if you specify TAB positions greater than 63). TAB may be used several times in a PRINT list.

The value of *expression* must be between 0 and 255 inclusive.

Example:

```
10 PRINT TAB(5) "TABBED 5"; TAB(25) "TABBED 25"
```

No punctuation is required after a TAB modifier

```
5 X=3
```

```
10 PRINT TAB(X) X; TAB(X ↑ 2) X ↑ 2; TAB(X ↑ 3) X ↑ 3
```

Numerical expressions may be used to specify a TAB position. This makes TAB very useful for graphs of mathematical functions, tables, etc. TAB cannot be used to move the cursor to the left. If cursor is beyond the specified position, the TAB is ignored.

PRINT USING *string; item list*

PRINT USING – This statement allows you to specify a format for printing string and numeric values. It can be used in many applications such as printing report headings, accounting reports, checks ... or wherever a specific print format is required.

The PRINT USING statement uses the following format:

PRINT USING *string; value*

String and value may be expressed as variables or constants. This statement will print the expression contained in the string, inserting the numeric value shown to the right of the semicolon as specified by the field specifiers.

The following field specifiers may be used in the string:

This sign specifies the position of each digit located in the numeric value. The number of # signs you use establishes the numeric field. If the numeric field is greater than the number of digits in the numeric value, then the unused field positions to the left of the number will be displayed as spaces and those to the right of the decimal point will be displayed as zeros.

The decimal point can be placed anywhere in the numeric field established by the # sign. Rounding-off will take place when digits to the right of the decimal point are suppressed.

The comma – when placed in any position between the first digit and the decimal point - will display a comma to the left of every third digit as required. The comma establishes an additional position in the field.

** Two asterisks placed at the beginning of the field will cause all unused positions to the left of the decimal to be filled with asterisks. The two asterisks will establish two more positions in the field.

\$\$ Two dollar signs placed at the beginning of the field will act as a floating dollar sign. That is, it will occupy the first position preceding the number.

**\$ If these three signs are used at the beginning of the field, then the vacant positions to the left of the number will be filled by the * sign and the \$ sign will again position itself in the first position preceding the number.

↑↑↑↑ Causes the number to be printed in exponential (E or D) format.

-
- + When a + sign is placed at the beginning or end of the field, it will be printed as specified as a + for positive numbers or as a - for negative numbers.
 - When a - sign is placed at the end of the field, it will cause a negative sign to appear after all negative numbers and will appear as a space for positive numbers.
 - % spaces % To specify a string field of more than one character, % spaces % is used. The length of the string field will be 2 plus the number of spaces between the percent signs.
 - ! Causes the Computer to use the first string character of the current value.

Any other character that you include in the USING string will be displayed as a string literal.

The following program will help demonstrate these format specifiers:

```
10 INPUT A$, A
20 PRINT USING A$;A
30 GOTO 10
```

RUN this **program and try** various specifiers and strings for A\$ and various values for A.

For Example:

```
RUN
?##.##,12.12
12.12
?###.##,12.12
12.12
?##.##,121.21
%121.21
```

The % sign is automatically printed if the field is not large enough to contain the number of digits found in the numeric value. The entire number to the left of the decimal will be displayed preceded by this sign.

```
?##.##,12.127
12.13
```

Note that the number was rounded to two decimal places.

```

? +##.##,12.12
+12.12
? "THE ANSWER IS "+##.##,-12.12
THE ANSWER IS -12.12
? ##,##+,12.12
12.12+
? "THE ANSWER IS ##.##+.",-12.12
THE ANSWER IS 12.12-.
? "THE ANSWER IS ##.##-.",12.12
THE ANSWER IS 12.12.
? ##.##-,-12.12
12.12-
? "***## IN TOTAL.",12.12
** 12 IN TOTAL.
? ***##.##,1212.12
1212.12
? $$$##.##,12.12
$12.12
? "##,####",12121.2
12,121
? "####,# IN TOTAL.",12121.2
12,121 IN TOTAL.
? "### IN TOTAL.",1212
% 1212 IN TOTAL.

```

Another way of using the PRINT USING statement is with the string field specifiers "!" and % *spaces* %.

Examples:

```

PRINT USING "I"; String
PRINT USING "%      %"; string

```

The "!" sign will allow only the first letter of the string to be printed. The "% *spaces* %" allows spaces +2 characters to be printed. Again, the *string* and specifier can be expressed as string variables. The following program will demonstrate this feature:

```

10 INPUT A$, B$
20 PRINT USING A$; B$
30 GOTO 10

```

and RUN it:

```

? !, ABCDE
A
? %, ABCDE
AB
? % %, ABCD
ABCD

```

Multiple strings or string variables can be joined together (concatenated) by these specifiers. The "!" sign will allow only the first letter of each string to be printed. For example:

```
10 INPUT A$, B$, C$
20 PRINT USING "!";A$;B$;C$
```

And RUN it

```
? ABC,DEF,GHI
  ADG
```

By using more than one "!" sign, the first letter of each string will be printed with spaces inserted corresponding to the spaces inserted between the "!" signs. To illustrate this feature, make the following change to the last little program:

```
20 PRINT USING "! ! !";A$,B$,C$
```

And RUN it . . .

```
? ABC,DEF,GHI
  A D G
```

Spaces now appear between letters A, D and G to correspond with those placed between the three "!" signs.

Try changing "!!!" to "%%%" in line 20 and run the program.

The following program demonstrates one possible use for the PRINT USING statement.

```
10 CLS
20 A$ = "**$##,#####.## DOLLARS"
30 INPUT "WHAT IS YOUR FIRST NAME"; F$
40 INPUT "WHAT IS YOUR MIDDLE NAME"; M$
50 INPUT "WHAT IS YOUR LAST NAME"; L$
60 INPUT "ENTER THE AMOUNT PAYABLE"; P
70 CLS: PRINT "PAY TO THE ORDER OF ";
80 PRINT USING "!! ! "; F$; ". "; M$; ". ";
90 PRINT L$
100 PRINT: PRINT USING A$;P
110 GOTO 110
```

RUN the program. Remember, to save programming time, use the "?" sign for PRINT. Your display should look something like this:

```
WHAT IS YOUR FIRST NAME? JOHN
WHAT IS YOUR MIDDLE NAME? PAUL
```

WHAT IS YOUR LAST NAME? JONES
ENTER AMOUNT PAYABLE? 12345.6
PAY TO THE ORDER OF J. P. JONES
*****\$12,345.60 DOLLARS

If you want to use an amount greater than 999,999 without rounding off or going into scientific notation, then simply add the double precision sign (#) after the variable P in Lines 60 and 100. You will then be able to use amounts up to 16 decimal places long.

INPUT *item list*

Causes Computer to stop execution until, you enter the specified number of values via the keyboard. The INPUT statement may specify a list of string or numeric variables to be input. The items in the list must be separated by commas.

100 INPUT X\$, X1, Z\$, Z1

This statement calls for you to input a string-literal, a number, another string literal, and another number, in that order. When the statement is encountered, the Computer will display a

?_

You may then enter the values all at once or one at a time. To enter values all at once, separate them by commas. (If your string literal includes leading blanks, colons, or commas, you must enclose the string in quotes.)

For example, when line 100 (above) is RUN and the Computer is waiting for your input, you could type

JIM, 50, JACK, 40 (ENTER)

The Computer will assign values as follows:

X\$="JIM" X1=50 Z\$="JACK" Z1=40

If you ENTER the values one at a time, the Computer will display a

??_

... indicating that more data is expected. Continue entering data until all the variables have been set, at which time the Computer will advance to the next statement in your program.

Be sure to enter the correct type of value according to what is called for by the INPUT statement. For example, you can't input a string-value into a numerical variable. If you try to, the Computer will display a

?REDO

?_

and give you another chance to enter the correct type of data value, starting with the first value called for by the INPUT list.

NOTE: You cannot input an expression into a numerical value you must input a simple numerical constant. (LEVEL I allowed you to input an expression or even a variable into a numerical variable.)

Example:

```
100 INPUT X1,Y1$
```

```
200 PRINT X1,Y1$
```

RUN

```
?_ [you type:] 7+3 (ENTER)
```

```
? REDO
```

```
?_ [you type:] 10 (ENTER)
```

```
??_ [you type:] "THIS IS A COMMA: ,"
```

```
10 THIS IS A COMMA: ,
```

It was necessary to put quotes around "THIS IS A COMMA:," because the string contained a comma.

If you ENTER more data elements than the INPUT statement specifies, the Computer will display the message

?EXTRA IGNORED

and continue with normal execution of your program.

If you press ENTER without typing anything, the variables will have the value they were previously assigned.

You can also include a "prompting message" in your INPUT statement. This will make it easier to input the data correctly. The prompting message must immediately follow "INPUT", must be enclosed in quotes, and must be followed by a semi-colon.

Example:

```
100 INPUT "ENTER YOUR NAME AND AGE (NAME,AGE) ";N$,A
(RUN)
ENTER YOUR NAME AND AGE (NAME,AGE) ?_
```

DATA item list

Lets you store data inside your program to be accessed by READ statements. The data items will be read sequentially, starting with the first item in the first DATA statement, and ending with the last item in the last DATA statement. Items in a DATA list may be string or numeric constants - no expressions are allowed. If your string values include leading blanks, colons or commas, you must enclose these values in quotes.

It is important that the data types in a DATA statement match up with the variable types in the corresponding READ statement. DATA statements may appear anywhere it is convenient in a program. Generally, they are placed consecutively, but this is not required.

Examples:

```
500 READ N1$,N2$,N1,N2
1000 DATA "SMITH, J.R.", "WILSON, T.M."
2000 DATA 150,175
```

See **READ, RESTORE**.

READ item list

Instructs the Computer to read a value from a DATA statement and assign that value to the specified variable. The first time a READ is executed, the first value in the first DATA statement will be used; the second time, the second value in the DATA statement will be read. When all the items in the first DATA statement have been read, the next READ will use the first value in the second DATA statement; etc. (An Out-of-Data error occurs if there are more attempts to READ than there are DATA items.) The following program illustrates a common application for READ/DATA statements.

```
50  PRINT "NAME", "AGE"
100 READ N$
110 IF N$="END" PRINT "END OF LIST":END
120 READ AGE
130 IF AGE < 18 PRINT N$,AGE
140 GOTO100
150 DATA "SMITH, JOHN", 30, "ANDERSON, T.M.", 20
160 DATA "JONES, BILL", 15, "DOE, SALLY", 21
170 DATA "COLLINS, W.P.", 17, END
```

RUN

NAME	AGE
JONES, BILL	15
COLLINS, W.P.	17
END OF LIST	

READY

>_

The program locates and prints all the minors' names from the data supplied.
Note the use of an END string to allow READING lists of unknown length.

See **DATA, RESTORE**

RESTORE

Causes the next READ statement executed to start over with the first item in the first DATA statement. This lets your program re-use the same DATA lines.

Example:

```
100 READ X
110 RESTORE
120 READ Y
130 PRINT X,Y
140 DATA 50,60
```

RUN

50	50
----	----

READY

>_

Because of the RESTORE statement, the second READ statement starts over with the first DATA item.

See **READ, DATA**

PRINT #-1, *item list*

Prints the values of the specified variables onto cassette tape. (Recorder must be properly connected and set in Record mode when this statement is executed.) The PRINT# statement must always specify a device number. This is because the TRS-80 can actually input/output to two cassette machines, once you've added the Expansion Interface described in Chapter 10. For normal use with just one recorder connected, the device number must be -1, e.g., PRINT #-1 (followed by a comma and then the item list).

Example:

```
5  A1=-30.334:B$="STRING-VALUE"  
10 PRINT*-1,A1,B$,"THAT'S ALL"
```

This stores the current values of A1 and B\$, and also the string-literal "THAT'S ALL". The values may be input from tape later using the INPUT# statement. The INPUT# statement must be identical to the PRINT# statement in terms of **number** and **type of items** in the PRINT#/INPUT# lists. See INPUT#.

Special Note:

The values represented in item list must not exceed 248 characters total; otherwise, all characters after the first 248 will be truncated. For example, **#-1, A#, B#, C#, D#, E#, F#, G#, H#, I#, J#, A\$** will probably exceed the maximum record length if A\$ is longer than about 75 characters. If you have a lengthy list, you should break it up into two or more PRINT# statements.

INPUT #-1, *item list*

Inputs the specified number of values stored on cassette and assigns them to the specified variable names. Like the PRINT# statement, INPUT# requires that you specify a device number. (This will make more sense when you have added the Expansion Interface and are using a dual cassette system. See Chapter 10.) Use Device number -1 for normal applications without the Expansion Interface. e.g., INPUT#-1, *list*.

Example:

```
50 INPUT #-1,X,P$,T$
```

When this statement is executed, the Computer will turn on the tape machine, input values in the order specified, then turn off the tape machine and advance to the next statement. If a string is encountered when the INPUT list calls for a number, a bad file data error will occur. If there are not enough data items on the tape to "fill" the INPUT statement, an Out of Data error will occur.

The Input list must be identical to the Print list that created the taped data-block (same number and type of variables in the same sequence.)

Sample Program

Use the two-line program supplied in the **PRINT#** description to create a short data file. Then rewind the tape to the beginning of the data file, make all necessary connections, and put cassette machine in Play mode. Now run the following program.

```
10 INPUT#-1,A1,B$,L$
20 PRINT A1,B$,L$
30 IF L$="THAT'S ALL"END
40 GOTO 10
```

This program doesn't care how long or short the data file is, so long as:

- 1) the file was created by successive PRINT# statements **identical in form** to line 10
- 2) the last item in the last data triplet is "THAT'S ALL".

4 / Program Statements

LEVEL II BASIC makes several assumptions about how to run your programs. For example:

- * Variables are assumed to be single-precision (unless you use type declaration characters - see Chapter 1, "Variable Types").

- * A certain amount of memory is automatically set aside for strings and arrays - whether you use all of it or not.

- * Execution is sequential, starting with the first statement in your program and ending with the last.

The statements described in this chapter let you over-ride these assumptions, to give your programs much more versatility and power.

NOTE: All LEVEL II statements except INPUT and INPUT# can be used in the Command Mode as well as in the Execute Mode.

Statements described in this chapter:

Type Definition	Assignment & Allocation	Sequence of Execution	Tests (Conditional Statements)
DEFINT	CLEAR it	END	IF
DEFSNG	DIM	STOP	THEN
DEFDBL	LET	GOTO	ELSE
DEFSTR		GOSUB	
		RETURN	
		ON ... GOTO	
		ON ... GOSUB	
		FOR-NEXT-STEP	
		ERROR	
		ON ERROR GOTO	
		RESUME	
		REM	

This chapter also contains a discussion of data conversion in LEVEL II BASIC; this will let you predict and control the way results of expressions, constants, etc., will be stored - as integer, single precision or double precision.

DEFINT *letter range*

Variables beginning with any letter in the specified range will be stored and treated as integers, unless a type declaration character is added to the variable name. This lets you conserve memory, since integer values take up less memory than other numeric types. And integer arithmetic is faster than single or double precision arithmetic. However, a variable defined as integer can only take on values between -32768 and +32767 inclusive.

Examples:

10 DEFINT A,I,N

After line 10, all variables beginning with A, I or N will be treated as integers. For example, A1, AA, I3 and NN will be integer variables. However, A1#, AA#, I3# would still be double precision variables, because of the type declaration characters, which always over-ride DEF statements.

10 DEFINT I-N

Causes variables beginning with I, J, K, L, M or N to be treated as integer variables.

DEFINT may be placed anywhere in a program, but it may change the meaning of variable references without type declaration characters. Therefore it is normally placed at the beginning of a program.

See **DEFSNG**, **DEFDBL**, and Chapter 1, "Variable Types".

DEFSNG *letter range*

Causes any variable beginning with a letter in the specified range to be stored and treated as single precision, unless a type declaration character is added. Single precision variables and constants are stored with 7 digits of precision and printed out with 6 digits of precision. Since all numeric variables are assumed to be single precision unless DEFined otherwise, the DEFSNG statement is primarily used to re-define variables which have previously been defined as double precision or integer.

Example:

```
100 DEFSNG I,W-Z
```

Causes variables beginning with the letter I or any letter W through Z to be treated as single precision. However, I% would still be an integer variable, and I# a double precision variable, due to the use of type declaration characters.

See **DEFINT**, **DEFDBL**, and Chapter 1, "Variable Types".

DEFDBL *letter range*

Causes variables beginning with any letter in the specified range to be stored and treated as double-precision, unless a type declaration character is added. Double precision allows 17 digits of precision; 16 digits are displayed when a double precision variable is PRINTed.

Example:

```
10 DEFDBL S-Z, A-E
```

Causes variables beginning with one of the letters S through Z or A through E to be double precision.

DEFDBL is normally used at the beginning of a program, because it may change the meaning of variable references without type declaration characters.

See **DEFINT**, **DEFSNG**, and Chapter 1, "Variable Types".

DEFSTR *letter range*

Causes variables beginning with one of the letters in the specified range to be stored and treated as strings, unless a type declaration character is added. If you have CLEARed enough string storage space, each string can store up to 255 characters.

Example:

```
10 DEFSTR L-Z
```

Causes variables beginning with any letter L through Z to be string variables, unless a type declaration character is added. After line 10 is executed, the assignment L1 = "WASHINGTON" will be valid.

See CLEAR *n*, Chapter 1, "Variable Types", and Chapter 5.

CLEAR *n*

When used with an argument *n* (*n* can be a constant or an expression), this statement causes the Computer to set aside *n* bytes for string storage. In addition, all variables are set to zero. When the TRS-80 is turned on, 50 bytes are automatically set aside for strings.

The amount of string storage CLEARed must equal or exceed the greatest number of characters stored in string variables during execution; otherwise an Out of String Space error will occur.

Example:

```
10 CLEAR 1000
```

Makes 1000 bytes available for string storage.

By setting string storage to the exact amount needed, your program can make more efficient use of memory. A program which uses no string variables could include a CLEAR 0 statement, for example. The CLEAR argument must be non-negative, or an error will result.

DIM *name (dim1, dim2, ..., dimK)*

Lets you set the "depth" (number of elements allowed per dimension) of an array or list of arrays. If no DIM statement is used, a depth of 11 (subscripts 0-10) is allowed for each dimension of each array used.

Example:

```
10 DIM A(5),B(2,3),C$(20)
```

Sets up a one-dimension array A with subscripted elements 0-5; a two-dimension array B with subscripted elements 0,0 to 2,3; and a one-dimension string array C\$ with subscripted elements 0-20. Unless previously defined otherwise, arrays A and B will contain single-precision values.

DIM statements may be placed anywhere in your program, and the depth specifier may be a number or a numerical expression.

Example:

```
40 INPUT "NUMBER OF NAMES";N
50 DIM NA(N,2)
```

To re-dimension an array, you must first use a CLEAR statement, either with or without an argument. Otherwise, an error will result.

Example Program:

```
10 AA(4) = 11.8
20 DIM AA(7)
```

RUN

?DD ERROR IN 20

See Chapter 6, ARRAYS.

LET *variable* = *expression*

May be used when assigning values to variables. RADIO SHACK LEVEL II does not require LET with assignment statements, but you might want to use it to ensure compatibility with those versions of BASIC that do require it.

Examples:

```
100 LET A$="A ROSE IS A ROSE"
110 LET B1=1.23
120 LET X=X-Z1
```

In each case, the variable on the left side of the equals sign is assigned the value of the constant or expression on the right side.

END

Terminates execution normally (without a BREAK message). Some versions of BASIC require END as the last statement in a program; with LEVEL 11 it is optional. END is primarily used to force execution to terminate at some point other than the physical end of the program.

Example:

```
10  INPUT S1,S2
20  GOSUB 100
.
.
.
99  END
100 H=SQR(S1*S1+S2*S2)
110 RETURN
```

The END statement in line 99 prevents program control from "crashing" into the subroutine. Now line 100 can only be accessed by a branching statement such as 20 GOSUB 100.

STOP

Interrupts execution and prints a BREAK IN *line number* message. STOP is primarily a debugging aid. During the break in execution, you can examine or change variable values. The command CONT can then be used to re-start execution at the point where it left off. (If the program itself is altered during a break, CONT cannot be used.)

Example:

```
10  X=RND(10)
15  STOP
20  GOSUB 1000
```

RUN

BREAK IN 15

READY

>_

Suppose we want to examine what value for X is being passed to the subroutine beginning at line 1000. During the break, we can examine X with PRINT X. (You can delete line 15 after the program is debugged.)

GOTO *line number*

Transfers program control to the specified line number. Used alone, GOTO *line number* results in an unconditional (or automatic) branch; however, test statements may precede the GOTO to effect a conditional branch.

Example:

```
200 GOTO 10
```

When 200 is executed, control will automatically jump back to line 10.

You can use GOTO in the Command Mode as an alternative to RUN. GOTO *line number* causes execution to begin at the specified line number, without an automatic CLEAR. This lets you pass values assigned in the Command Mode to variables in the Execute Mode.

See **IF,THEN,ELSE,ON ... GOTO**.

GOSUB *line number*

Transfers program control to the subroutine beginning at the specified line number and stores an address to RETURN to after the subroutine is complete. When the Computer encounters a RETURN statement in the subroutine, it will then return control to the statement, which follows GOSUB.

If you don't RETURN, the previously stored address will not be deleted from the area of memory used for saving information, called the Stack. The Stack might eventually overflow, but, even more importantly, this address might be read incorrectly during another operation, causing a hard-to-find program error. So . . . always RETURN from your subroutines. GOSUB, like GOTO may be preceded by a test statement. See **IF,THEN,ELSE,ON ... GOSUB**.

Example Program:

```
100 GOSUB 200
110 PRINT "BACK FROM SUBROUTINE":END
200 PRINT "EXECUTING THE SUBROUTINE"
210 RETURN
```

(RUN)

```
EXECUTING THE SUBROUTINE
BACK FROM THE SUBROUTINE
```

Control branches from line 100 to the subroutine beginning at line 200. Line 210 instructs Computer to return to the statement immediately following GOSUB, that is, line 110.

RETURN

Ends a subroutine and returns control to statement immediately following the most recently executed GOSUB. If RETURN is encountered without execution of a matching GOSUB, an error will occur. See **GOSUB**.

ON *n* GOTO *line number, ..., line number*

This is a multi-way branching statement that is controlled by a test variable or expression. The general format for ON *n* GOTO is:

ON *expression* **GOTO** *1st line number, 2nd line number, ..., Kth line number*

expression must be between 0 and 255 inclusive.

When ON ... GOTO is executed, first the expression is evaluated and the integer portion ... INT(expression) ... is obtained. We'll refer to this integer portion as J. The Computer counts over to the Jth element in the line-number list, and then branches to the line number specified by that element. If there is no Jth element (that is, if J > K or J=0 in the general format above), then control passes to the next statement in the program.

If the test expression or number is less than zero, or greater than 255, an error will occur. The line-number list may contain any number of items. For example,

100 ON MI GOTO 150, 160, 170, 150, 180

says "Evaluate MI. If integer portion of MI equals 1 then go to line 150;
 If it equals 2, then go to 160;
 If it equals 3, then go to 170;
 If it equals 4, then go to 150;
 If it equals 5, then go to 180;
 If the integer portion of MI doesn't equal any of the
 numbers 1 through 5, advance to the next statement
 in the program."

Sample Program Using ON *n* GOTO

```
100 INPUT "ENTER A NUMBER";X
200 ON SGN(X)+2 GOTO 220,230,240
220 PRINT "NEGATIVE":END
230 PRINT "ZERO":END
240 PRINT "POSITIVE":END
```

SGN(X) returns -1 for X less than zero; 0 for X equal to zero; and +1 for X greater than 0. By adding 2, the expression takes on the values 1, 2, and 3, depending on whether X is negative, zero, or positive. Control then branches to the appropriate line number.

ON *n* GOSUB *line number*, ..., *line number*

Works like ON *n* GOTO, except control branches to one of the subroutines specified by the line numbers in the line-number list.

Example:

```
100 INPUT "CHOOSE 1,2 OR 3";I
105 ON I GOSUB 200,300,400
110 END
200 PRINT "SUBROUTINE #1":RETURN
300 PRINT "SUBROUTINE #2":RETURN
400 PRINT "SUBROUTINE #3":RETURN
```

The test object *n* may be a numerical constant, variable or expression. It must have a non-negative value or an error will occur.

See ON *n* GOTO.

FOR *counter* = *exp* TO *exp* STEP *exp* NEXT *counter*

Opens an iterative (repetitive) loop so that a sequence of program statements may be executed over and over a specified number of times. The general form is (brackets indicate optional material):

```
line #  FOR counter-variable = initial value TO final value [STEP increment]
.
.      [program statements]
.
line #  NEXT [counter-variable]
```

In the FOR statement, *initial value*, *final value* and *increment* can be constants, variables or expressions. The first time the FOR statement is executed, these three are evaluated and the values are saved; if the variables are changed by the loop, it will have no effect on the loop's operation. However, **the counter variable must not be changed** or the loop will not operate normally.

The FOR-NEXT-STEP loop works as follows: the first time the FOR statement is executed, the counter is set to the "initial value." Execution proceeds until a NEXT statement is encountered. At this point, the counter is incremented by the amount specified in the STEP *increment*. (If the *increment* has a negative value, then the counter is actually decremented.) If STEP *increment* is not used, an increment of 1 is assumed.

Then the counter is compared with the *final value* specified in the FOR statement. If the counter is greater than the *final value*, the loop is completed and execution continues with the statement following the NEXT statement. (If *increment* was a negative number, loop ends when counter is **less** than *final value*.) If the counter has not yet exceeded the *final value*, control passes to the first statement after the FOR statement.

Example Programs:

```
10  FOR I=10 TO 1 STEP -1
20  PRINT I;
30  NEXT
```

RUN

```
 10 9 8 7 6 5 4 3 2 1
```

READY

> _

```
10  FOR K=0 TO 1 STEP .3
20  PRINT K;
30  NEXT
```

```
RUN
```

```
0    .3    .6    .9
```

```
READY
```

```
>_
```

After K=.9 is incremented by .3, K=1.2. This is greater than the final value 1, therefore loop ends without ever printing final value.

```
-----
10  FORK = 4 TO 0
20  PRINT K;
30  NEXT
```

```
RUN
```

```
4
```

```
READY
```

```
>_
```

No STEP is specified, so STEP 1 is assumed After K is incremented the first time, its value is 5. Since 5 is greater than the final value 0, the loop ends.

```
-----
10  J=3 K=8 : L=2
20  FOR 1=J TO K+1 STEP L
25  J=0 : K=0 : L=0
30  PRINT I;
40  NEXT
```

```
RUN
```

```
3  5  7  9
```

```
READY
```

```
>_
```

The variables and expressions in line 20 are evaluated once and these values become constants for the FOR-NEXT-STEP loop. Changing the variable values later has no effect on the loop.

FOR-NEXT loops may be "nested":

```
10  FOR I=1TO3
20  PRINT"OUTER LOOP"
30      FOR J=1 TO 2
40      PRINT"  INNER LOOP"
50      NEXT J
60  NEXT I
```

RUN

```
OUTER LOOP
  INNER LOOP
  INNER LOOP
OUTER LOOP
  INNER LOOP
  INNER LOOP
OUTER LOOP
  INNER LOOP
  INNER LOOP
```

Note that each NEXT statement specifies the appropriate counter variable; however, this is just a programmer's convenience to help keep track of the nesting order. The counter variable may be omitted from the NEXT statements. But if you **do** use the counter variables, you **must** use them in the right order; i.e., the counter variable for the innermost loop must come first. It is also advisable to specify the counter variable with NEXT statements when your program allows branching to program lines outside the FOR-NEXT loop.

Another option with nested NEXT statements is to use a counter variable list.

Delete line 50 from the above program and change line 60:

```
60  NEXT J,I
```

Loops may be nested 3-deep, 4-deep, etc. The only limit is the amount of memory available.

ERROR *code*

Lets you "simulate" a specified error during program execution. The major use of this statement is for testing an ON ERROR GOTO routine. When the ERROR code statement is encountered, the Computer will proceed exactly as if that kind of error had occurred. Refer to Appendix B for a listing of error codes and their meanings.

Example Program:

```
100 ERROR 1
```

```
RUN
```

```
?NF ERROR
```

```
READY
```

```
>_
```

1 is the error code for "attempt to execute NEXT statement without a matching FOR statement".

See **ON ERROR GOTO, RESUME**.

ON ERROR GOTO *line number*

When the Computer encounters any kind of error in your program, it normally breaks out of execution and prints an error message. With ON ERROR GOTO, you can set up an error-trapping routine, which will allow your program to "recover" from an error and continue, without any break in execution. Normally you have a particular type of error in mind when you use the ON ERROR GOTO statement. For example, suppose your program performs some division operations and you have not ruled out the possibility of division by zero. You might want to write a routine to handle a division-by-zero error, and then use ON ERROR GOTO to branch to that routine when such an error occurs.

Example:

```
5   ON ERROR GOTO 100
```

```
10  C = 1/0
```

In this "loaded" example, when the Computer attempts to execute line 10, a divide-by-zero error will occur. But because of line 5, the Computer will simply ignore line 10 and branch to the errorhandling routine beginning at line 100.

NOTE: The ON ERROR GOTO must be executed **before** the error occurs or it will have no effect.

The ON ERROR GOTO statement can be disabled by executing an ON ERROR GOTO 0. If you use this inside an error-trapping routine, BASIC will handle the current error normally.

The error handling routine must be terminated by a RESUME statement. See **RESUME**.

RESUME *line number*

Terminates an error handling routine by specifying where normal execution is to resume.

RESUME without a line number and RESUME 0 cause the Computer to return to the statement in which the error occurred.

RESUME followed by a line number causes the Computer to branch to the specified line number.

RESUME NEXT causes the Computer to branch to the statement following the point at which the error occurred.

Sample Program with an Error Handling Routine

```
5   ON ERROR GOTO 100
10  INPUT"SEEKING SQUARE ROOT OF";X
20  PRINT SQR(X)
30  GOTO 10
100 PRINT "IMAGINARY ROOT: ";SQR(-X) ;"*I"
110 RESUME 10
```

RUN the program and try inputting a negative value.

You must place a RESUME statement at the end of your error trapping routine, so that later errors may also be trapped.

REM

Instructs the Computer to ignore the rest of the program line. This allows you to insert comments (REMARKs) into your program for documentation. Then, when you (or someone else) look at a listing of your program, it'll be a lot easier to figure out. If REM is used in a multi-statement program line, it must be the last statement.

Examples Program:

```
10 REM ** THIS REMARK INTRODUCES THE PROGRAM **
20 REM ** AND POSSIBLY THE PROGRAMMER, TOO.    **
30 REM **                                     **
40 REM ** THIS REMARK EXPLAINS WHAT THE        **
50 REM ** VARIOUS VARIABLES REPRESENT:         **
60 REM ** C = CIRCUMFERENCE R = RADIUS         **
70 REM ** D = DIAMETER                         **
80 REM
90 INPUT "RADIUS";R: REM THIS IS FIRST EXECUTABLE LINE
```

The above program shows some of the graphic possibilities of REM statements. Any alphanumeric character may be included in a REM statement, and the maximum length is the same as that of other statements: 255 characters total.

IN LEVEL II BASIC, an apostrophe '(SHIFT 7) may be used as an abbreviation for: REM.

```
100 'THIS TOO IS A REMARK
```

IF *true/false expression* THEN *action-clause*

Instructs the Computer to test the following logical or relational expression. If the expression is True, control will proceed to the "action" clause immediately following the expression. If the expression is False, control will jump to the matching ELSE statement (if there is one) or down to the next program line. In numerical terms, if the expression has a non-zero value, it is always equivalent to a logical True. Examples:

```
100 IF X>127 THEN PRINT "OUT OF RANGE": END
```

If X is greater than 127, control will pass to the PRINT statement and then to the END statement. But if X is not greater than 127, control will jump down to the next line in the program, skipping the PRINT and END statements.

```
100 IF 0<=X AND X<=90 THEN Y=X+180
```

If both expressions are True then Y will be assigned the value X+180. Otherwise, control will pass directly to the next program line, skipping the THEN clause.

NOTE: THEN is optional in the above and similar statements. However, THEN is sometimes required to eliminate an ambiguity. For example, **400 IF Y=M THEN M=O** won't work without THEN.

```
500 INPUT A$: IF A$="YES" THEN 100
600 INPUT A$: IF A$="YES" GOTO 100
```

The two statements have the same effect. **THEN** is not optional in line 500 and other **IF expression THEN line number** statements.

```
100 IF A>0 AND B>0 PRINT "BOTH POSITIVE"
```

The test expression may be composed of several relational expressions joined by logical operators AND and OR.

See **THEN, ELSE**.

THEN *statement or line number*

Initiates the "action clause" of an IF-THEN type statement. THEN is optional except when it is required to eliminate an ambiguity, as in **IF A<0 THEN 100**. THEN should also be used in IF-THEN-ELSE statements.

ELSE statement or line number

Used after IF to specify an alternative action in case the IF test fails. (When no ELSE statement is used, control falls through to the next program line after a test fails.)

Examples:

```
100 INPUT A$: IF A$="YES" THEN 300 ELSE END
```

In line 100, if A\$ equals "YES" then the program branches to line 300. But if A\$ does not equal "YES", program skips over to the ELSE statement which then instructs the Computer to end execution.

```
200 IF A<B PRINT"A<B"ELSE PRINT"B<=A"
```

If A is less than B, the Computer prints that fact, and then proceeds down to the next program line, **skipping** the ELSE statement. If A is not less than B, Computer jumps directly to the ELSE statement and prints the specified message. **Then** control passes to the next statement in the program.

```
200 IF A>.001 THEN B=1/A: A=A/5: ELSE 260
```

If A >.001 is True, then the next two statements will be executed, assigning new values to B and A. Then the program will drop down to the next line, skipping the ELSE statement. But if A >.001 is

False, the program jumps directly over to the ELSE statement, which then instructs it to branch to line 260. Note that GOTO is not required after ELSE.

IF-THEN-ELSE statements may be nested, but you have to take care to match up the IFs and ELSEs.

```
10 INPUT "ENTER TWO NUMBERS";A,B
20 IF A<=B THEN IF A<B PRINT A;:ELSE PRINT "NEITHER";:ELSE PRINT B;
30 PRINT"IS SMALLER"
```

RUN the program, inputting various pairs of numbers. The program picks out and prints the smaller of any two numbers you enter.

Note that the THEN statements and the colons may be omitted from line 20.

Data Conversion

Every number used during execution must be typed as either integer, single precision or double precision. Often this typing involves converting a number from one form to another. This may produce unexpected, confusing results - unless you understand the rules governing such automatic typing and type conversion.

Typing of Constants

Constants are the actual numbers (not the variable names) used by LEVEL II BASIC during execution. They may appear in your program (as in $X=1/3$, the right side of the equation) or they may be temporary (intermediate) constants created during the evaluation of an expression. In any case, the following rules determine how a constant is typed:

- I. If a constant contains 8 or more digits, or if D is used in the exponent, that number is stored as double precision. Adding a # declaration character also forces a constant to be stored as double precision.
- II. If the number is not double-precision, and if it is outside the range -32768 to +32767 or if it contains a decimal point, then the number is stored as single-precision. If number is expressed in exponential notation with E preceding the exponent, the number is single precision.
- III. If neither I nor II is true of the constant, then it is stored as an integer.

Example Program

```
10 PRINT 1.234567, 1.2345678
```

```
RUN
```

```
1.23457      1.2345678
```

```
READY
```

```
>_
```

The first constant contains 7 digits; so by Rules I and II, it becomes a single-precision number. Single precision numbers are printed as 6 digits with the least significant digit properly rounded. But the second constant contains 8 digits, therefore by Rule I it becomes a double precision number, stored internally as 1.2345678000000000. The number is printed out with all eight significant digits showing, and all the trailing zeros suppressed.

Type Conversion

When operations are performed on one or two numbers, the result must be typed as integer, double or single-precision.

When a +, -, or * operation is performed, the result will have the same degree of precision as the most precise operand. For example, if one operand is single-precision, and the other double-precision, the result will be double precision. Only when both operands are integers will a result be integer. If the result of an integer *, -, or + operation is outside the integer range, the operation will be done in single precision and the result stored as single precision.

Division follows the same rules as +, * and -, except that it is never done at the integer level: when both operators are integers, the operation is done in single precision with a single-precision result.

During a compare operation (<, >, =, etc.) the operands are converted to the same type before they are compared. The less precise type will always be converted to the more precise type.

If you are using logical operators for bit manipulations or Boolean operations (see Chapter 8, "Logical Operators"), you'll need to read the next paragraph; otherwise, skip it.

The logical operators AND, OR and NOT first convert their operands to integer form. If one of the operands is outside the allowable range for integers (-32768 to +32767) an overflow error occurs. The result of a logical operation is always an integer.

Effects of Type Conversions on Accuracy

When a number is converted to integer type, it is "rounded down"; i.e., the largest integer, which is not greater than the number is used. (This is the same thing that happens when the INT function is applied to the number.)

When a number is converted from double to single precision, it is "4/5 rounded" (the least significant digit is rounded up if the fractional part $\geq .5$. Otherwise, it is left unchanged).

In the following examples, keep in mind that single precision variables are stored with 7 digits of precision, but printed out with 6 digits (to allow for proper rounding). Similarly, double precision values are stored with 17 digits but printed out with only 16.

Example Programs:

```
10  A#=1.6666666666666667
20  B!=A#
30  C%=A#
40  PRINT B!,C%
```

RUN

```
1.66667      1
READY
>_
```

When a single precision number is converted to double precision, only the seven most significant digits will be accurate. And if the single precision number didn't contain seven significant digits, watch out!

Examples:

```
10  A!=1.3
20  A#=A!
30  PRINT A#
```

RUN

```
1.299999952316284
READY
>_
```

```
10  A#=2/3
20  PRINT A#
```

RUN

```
.6666666865348816
```

```
READY
```

```
>_
```

2/3 is converted to a single precision constant; therefore only the first seven digits of A# are accurate.

```
-----
```

```
10  A#=2/3#
```

```
20  PRINT A#
```

```
RUN
```

```
.66666666666666667
```

```
READY
```

```
>_
```

Since the expression 2/3# is evaluated as a double precision constant, all 16 digits of A# are accurate, with the least significant properly 4/5- rounded.

When assigning a constant value to a double precision variable, be sure to include as many significant digits as possible (up to 17). If your constant has seven or less significant digits, you might as well use single precision. Your constant will only be accurate for as many significant digits as you include, up to 17.

Examples:

```
10  PI#=3.1415926535897932
```

```
20  E#=2.7182818284590452
```

If you combine the # or other declaration character with a constant to force it to a certain type, you cannot space after the declaration character.

Examples:

```
10  PRINT 87.2345432117896#+90.35762#
```

```
20  PRINT 87.23658!-90.32!
```

```
30  PRINT 87.23658#/90.35762#
```

```
40  PRINT 87.23658!*90.35762!
```

You can't use the % (integer) declaration character in this way at all.

Assigning Double-Precision Values

Here are three ways to be sure double-precision values are stored without any trailing "garbage digits". The first two (lines 10 and 20) are for entering constants (either in assignment statements or via INPUT responses); the third (line 30) is for converting from singleprecision to double-precision values.

```
10  A#=0.1D0
20  B#=0.1000000
30  C#=VAL (STR$ (0.1) )
40  PRINT A#,B#,C#
```

RUN

```
.1           .1           .1
```

Line 30 forces BASIC to take a single-precision value (in this case, the constant 0.1 – but you could use any variable), convert it to a string representation, and then re-interpret this string as a doubleprecision value.

5 / Strings

"Without string-handling capabilities, a computer is just a super-powered calculator." There's an element of truth in that exaggeration; the more you use the string capabilities of LEVEL II, the truer the statement will seem.

LEVEL I BASIC offered two string variables, which could be input and output to make your programs look "friendly" (as in **HELLO, BOB!**). In LEVEL II you can do much more than that. First of all, you're not limited to two strings – any valid variable name can be used to contain string values, by the **DEFSTR** statement or by adding a type declaration character to the name. And each string can contain up to 255 characters.

Moreover, you can compare strings in LEVEL II, to alphabetize them, for example. You can take strings apart and string them together (concatenate them). For background material to this chapter, see Chapter 1, "Variable Types" and "Glossary", and Chapter 4, **DEFSTR**.

Subjects and functions covered in this chapter:

"String Input/Output"	FRE (string)	MID\$
"String Comparisons"	INKEY\$	RIGHT
"String Operations"	LEN	STR\$
"String Space"		
ASC	LEFT\$	STRING\$
CHR\$		VAL
		INSTRING Subroutine

NOTE: Whenever *string* is given as a function argument, you can use a string expression or constant.

String Input/Output

String constants -sequences of alphanumeric characters - may be input to a program just as numeric constants are input, using INPUT, READ/DATA, and INPUT # (input from cassette). They may generally be input without quotes:

```
10 INPUT "YES OR NO";R$
20 IF R$="YES"PRINT"THAT'S BEING POSITIVE!": END
30 PRINT "WHY NOT?"
```

RUN

```
YES OR NO?_ [you type] YES ENTER
THAT'S BEING POSITIVE!
READY
>_
```

However, to input a string constant, which contains commas, colons, or leading blanks, the string must be enclosed in quotes.

```
10 INPUT "LAST NAME, FIRST NAME";N$
20 PRINT N$
```

RUN

```
LAST NAME, FIRST NAME?_ [you type:] "SMITH, JOHN"
ENTER
SMITH, JOHN
READY
>_
```

The same rule regarding commas, colons and leading blanks applies to values input via DATA statements and INPUT # statements.

```
10 READ T$,N$,D$
20 PRINT T$;N$;D$
30 DATA "TOTAL IS: ", "ONE THOUSAND, TWO HUNDRED "
40 DATA DOLLARS.
```

T\$ requires quotes because of the colon;

N\$ requires quotes because of the comma.

String Comparisons

Strings may be compared for equality or alphabetic precedence. When they are checked for equality, every character, including any leading or trailing blanks, must be the same or the test fails.

```
600 IF Z$="END"THEN999
```

Strings are compared character-for-character from left to right. Actually, the ASCII codes for the characters are compared, and the character with the lower code number is considered to precede the other character. (See Appendix C, ASCII Codes.)

For example, the constant "A!" precedes the constant "A#", because "!" (ASCII code: decimal 33) precedes "#" (ASCII code: decimal 35). When strings of differing lengths are compared, the **shorter string is precedent** if its characters are the same as those in the longer string. For example, "A" precedes "A ".

The following relational symbols may be used to compare strings;

Note: Whenever a string constant is used in a comparison expression or an assignment statement, the constant must be enclosed in quotes:

```
A$="CONSTANT"
```

```
IF A$="CONSTANT" PRINT A$
```

(The quotes are required in both cases.)

String Operations

Not including the functions described below, there is only one string operation - concatenation, represented by the plus symbol +.

Example Programs:

```
10  CLEAR 75
20  A$="A ROSE"
30  B$=" IS A ROSE"
40  C$=A$+B$+B$+B$+" . '
50  PRINT C$

RUN

A ROSE IS A ROSE IS A ROSE IS A ROSE.
READY
>_
```

In line 40, the strings are concatenated - strung together.

```
10  T$="100"
20  SUB$="5"
30  CODE="32L"
40  LC$=T$+" . "+SUB$+CODE$
50  PRINT LC$

RUN

100.532L
READY
>_
```

String Space

50 bytes of memory are set aside automatically to store strings. If you run out of string space, you will get an OS error and you should use the CLEAR n command to save more space. See page 2/2.

To calculate the space you'll need, multiply the amount of space each variable takes (See page 8/13 VARPTR) by the number of string variables you are using, including temporary variables.

Temporary variables are created during the calculation of string functions. In the first example above, line 40, C\$ is the result of four calculations. For each of these four, the Computer uses memory space from the string storage area to store the temporary result. Therefore, even if you have only a few short string variables assigned in your program, you may run out of string space if you concatenate them several times.

ASC (*string*)

Returns the ASCII code (in decimal form) for the first character of the specified string. The string-argument must be enclosed in parentheses. A null-string argument will cause an error to occur.

```
100 PRINT ASC("A")
110 T$="AB": PRINT ASC(T$)
```

Lines 100 and 110 will print the same number.

The argument may be an expression involving string operators and functions:

```
200 PRINT ASC(RIGHT$(T$,1))
```

Refer to the ASCII Code Table, Appendix C. Note that the **ASCII** code for a lower-case letter is equal to that letter's upper-case **ASCII** code plus 32. So **ASC** may be used to convert upper-case values to lower-case values - useful in case you have a line printer with lowercase capabilities and the proper interfacing hardware /software).

ASC may also be used to create coding/decoding procedures (see example at end of this chapter).

CHR\$ (*expression*)

Performs the inverse of the **ASC** function: returns a one-character string whose character has the specified ASCII, control or graphics code. The argument may be any number from 0 to 255, or any variable expression with a value in that range. Argument must be enclosed in parentheses.

```
100 PRINT CHR$(35)           prints a number-sign #
```

Using **CHR\$**, you can even assign quote-marks (normally used as string-delimiters) to strings. The ASCII code for quotes - is 34. So **A\$=CHR\$(34)** assigns the value " to **A\$**.

```
100 A$=CHR$(34)
110 PRINT"HE SAID, ";A$;"HELLO.";A$
```

RUN

```
HE SAID, "HELLO."
```

READY

```
>_
```

CHR\$ may also be used to display any of the 64 graphics characters.
(See Appendix C, Graphics Codes.)

```
10  CLS
20  FOR I=129 TO 191
30  PRINT I;CHR$(I) ,
40  NEXT
50  GOTO 50
```

(RUN the program to see the various graphics characters.)

Codes 0-31 are display control codes. Instead of returning an actual display character, they return a control character. When the control character is PRINTed, the function is performed. For example, 23 is the code for 32 character-per-line format; so the command, PRINT CHR\$(23) converts the display format to 32 characters per line. (Hit CLEAR, execute CLS, or execute PRINT CHR\$(28) to return to 64 character-per-line format.)

FRE (*string*)

When used with a string variable or string constant as an argument, returns the amount of string storage space currently available. Argument must be enclosed in parentheses. FRE causes BASIC to start searching through memory for unused string space. If your program has done a lot of string processing, it may take several minutes to recover all the "scratch pad" type memory.

```
500 PRINT FRE(A$) , FRE(L$) , FRE("Z")
```

All return the same value.

The string used has no significance; it is a dummy variable. See Chapter 4, CLEAR n.

INKEY\$

Returns a one-character string determined by an instantaneous keyboard strobe. The last key pressed before the strobe is returned. If no key is pressed during the strobe, a null string (length zero) is returned. This is a very powerful function because it lets you input values while the Computer is executing - without using the ENTER key. The popular video games which let you fire at will, guide a moving dot through a maze, play tennis, etc., may all be simulated using the INKEY\$ function (plus a lot of other program logic, of course).

Characters typed to an INKEY\$ are not automatically displayed on the screen.

Because of the short duration of the strobe cycle (on the order of microseconds) INKEY\$ is invariably placed inside some sort of loop, so that the Keyboard is scanned repeatedly.

Example Program:

```
10  CLS
100 PRINT @540,INKEY$: GOTO 100
```

RUN the program; notice that the screen remains blank until the first time you hit a key. The last key hit remains on the screen until you hit another one. (The last key hit is always saved. The INKEY\$ function uses it until it is replaced by a new value.)

INKEY\$ may be used in sequences of loops to allow the user to build up a longer string.

Example:

```
90  PRINT "ENTER THREE CHARACTERS"
100 A$=INKEY$: IF A$="" THEN 100 ELSE PRINT A$;
110 B$=INKEY$: IF B$="" THEN 110 ELSE PRINT B$;
120 C$=INKEY$: IF C$="" THEN 120 ELSE PRINT C$;
130 D$=A$+B$+C$
```

A three-character string D\$ can now be entered via the keyboard without using the ENTER key.

NOTE: The statement **IF A\$=""** compares A\$ to the null string.

LEFT\$ (*string*, *n*)

Returns the first *n* characters of *string*. The arguments must be enclosed in parentheses. *string* may be a string constant or expression, and *n* may be a numeric expression

Example Program

```
10  A$="TIMOTHY"
20  B$=LEFT$(A$,3)
30  PRINTB$;"--THAT'S SHORT FOR ";A$
```

RUN

```
TIM--THAT'S SHORT FOR TIMOTHY
READY
>_
```

LEN (*string*) returns the character length of the specified string. The string variable, expression, or constant must be enclosed in parentheses.

```
10  A$=" "
20  B$="TOM"
30  PRINT A$,B$,B$+B$
40  PRINT LEN(A$),LEN(B$),LEN(B$+B$)
```

RUN

	TOM	TOMTOM
0	3	6

```
READY
>_
```

MID\$ (*string*, *p*, *n*)

Returns a substring of *string* with length *n* and starting at position *p*. The string name, length and starting position must be enclosed in parentheses. *string* may be a string constant or expression, and *n* and *p* may be numeric expressions or constants. For example, **M 1 D\$(L\$,3,1)** refers to a one-character string beginning with the 3rd character of L\$.

Example Program:

The first three digits of a local phone number are sometimes called the "exchange" of the number. This program looks at a complete phone number (area code, exchange, last four digits) and picks out the exchange of that number.

```
10 INPUT"AREA CODE AND NUMBERS (NO HYPHENS, PLEASE) ";PH$
20 EX$=MID$(PH$,4,3)
30 PRINT"NUMBER IS IN THE ";EX$;" EXCHANGE."
```

If no argument is specified for the length *n*, the entire string beginning at position *p* is returned.

RIGHT\$ (*string*, *n*)

Returns the last *n* characters of *string*. *string* and *n* must be enclosed in parentheses. *string* may be a string constant or variable, and *n* may be a numerical constant or variable. If LEN(*string*) is less than or equal to *n*, the entire *string* is returned.

RIGHT\$(ST\$,4) returns the last 4 characters of ST\$.

STR\$ (*expression*)

Converts a numeric expression or constant to a string. The numeric expression or constant must be enclosed in parentheses. STR\$(A), for example, returns a string equal to the character representation of the value of A. For example, if A=58.5, then STR\$(A) equals the string " 58.5". (Note that a leading blank is inserted before "58.5" to allow for the sign of A). While arithmetic operations may be performed on A, only string operations and functions may be performed on the string "58.5".

PRINT STR\$(X) prints X without a trailing blank; PRINT X prints X with a trailing blank.

Example Program

```
10  A=58.5: B=-58.5
20  PRINT STR$(A)
30  PRINT STR$(B)
40  PRINT STR$(A+B)
50  PRINT STR$(A)+STR$(B)
```

RUN

```
 58.5
-58.5
  0
58.5-58.5
```

READY

>_

Note that the leading blank is filled by the minus sign in STR\$(B).

STRING\$(*n*, "*character*" or *number*)

Returns a string composed of *n* *character*-symbols. For example, STRING\$(30,"*") returns "*****"
STRING\$ is useful in creating graphs, tables, etc.

The argument *n* is any numerical expression with a value of from zero to 255.

character can also be a number from 0-255; in this case, it will be treated as an ASCII, control, or graphics code.

Example:

STRING\$(64,191) returns a string composed of 64 graphics blocks.

VAL (*string*)

Performs the inverse of the STR\$ function: returns the number represented by the characters in a string argument. The numerical type of the result can be integer, single precision, or double precision, as determined by the rules for the typing of constants (see page 4/18). For example, if A\$="12" and B\$="34" then **VAL(A\$+ "."+B\$)** returns the value 12.34. **VAL(A\$+"E"+B\$)** returns the value 12E34, that is 12×10^{34} .

VAL operates a little differently on mixed strings - strings whose values consist of a number followed by alphanumeric characters. In such cases, only the leading number is used in determining VAL; the alphanumeric remainder is ignored.

For example: VAL("100 DOLLARS") returns 100.

This can be a handy short-cut in examining addresses, for example.

Example Program

```
10  REM "WHAT SIDE OF THE STREET?"
15  REM EVEN=NORTH.  ODD=SOUTH
20  INPUT "ADDRESS: NUMBER AND STREET"; AD$
30  C=INT (VAL (AD$) /2) *2
40  IF C=VAL (AD$) PRINT "NORTH SIDE": GOTO 20
50  PRINT "SOUTH SIDE": GOTO 20
```

RUN the program, entering street addresses like "1015 SEVENTH AVE".

If the string is non-numeric or null, VAL returns a zero.

Coding/Decoding Program

```
5   CLS: PRINT CHR$(23)
10  CLEAR 1000
20  INPUT "ENTER MESSAGE"; M$
30  FOR K=1 TO LEN(M$)
40  T$=MID$(M$, K, 1 )
60  CD=ASC(T$)+5: IF CD>255 CD=CD-255
70  NU$=NU$ + CHR$(CD)
80  NEXT
90  PRINT "THE CODED MESSAGE IS"
100 PRINT NU$
110 FOR K=1 TO LEN(NU$)
120 T$=MID$(NU$, K, 1)
130 CD=ASC(T$)-5: IF CD < 0 CD=CD+255
140 OLDS=OLDS+CHR$(CD)
150 NEXT
160 PRINT "THE DECODED MESSAGE IS"
170 PRINT OLDS
```

RUN the program.

Lines 30-80 and 110-150 demonstrate how you can "peel off" the characters of a string for examination. Lines 60 and 130 demonstrate manipulation of ASCII codes.

Instring Subroutine

Using the intrinsic string functions MID\$ and LEN, it's easy to create a very handy string-handling subroutine, INSTRING. This function takes two string arguments and tests to see whether one is contained in the other. When you are searching for a particular word, phrase or piece of data in a larger body of text or data, INSTRING can be very powerful. Here's the subroutine:

```
999  END 'THIS IS A PROTECTIVE END-BLOCK
1000 FOR I=1 TO LEN(X$)-LEN(Y$)+1
1010 IF Y$=MID$(X$,I,LEN(Y$)) RETURN
1020 NEXT: I=0 : RETURN
```

To use the subroutine, first assign the value of the larger string (the "search area") to X\$, and the value of the desired substring to Y\$. Then call the subroutine with GOSUB. The subroutine will return a value of I which tells you the starting position of Y\$ in the larger string X\$; or if Y\$ is not a substring of X\$, I is returned with a value of zero.

Here's a sample program using the INSTRING subroutine. (Type in the above lines 999-1020 plus the following.)

```
5  CLEAR 1000 : CLS
10 INPUT "ENTER THE LONGER STRING";X$
20 INPUT "NOW ENTER THE SHORTER STRING";Y$
30 GOSUB 1000
40 IF I=0 THEN 70
50 PRINT Y$;" IS A SUBSTRING OF ";X$
55 PRINT "STARTING POSITION:";I,
60 PRINT "ENDING POSITION: ";I+LEN(Y$)-1
65 PRINT: PRINT: GOTO 10
70 PRINT Y$;" IS NOT CONTAINED IN ";X$
80 GOTO 10
```

RUN the program, entering the string to be searched and then the desired substring.

6 / Arrays

An array is simply an ordered list of values. In LEVEL II these values may be either numbers or strings, depending on how the array is defined or typed. Arrays provide a fast and organized way of handling large amounts of data. To illustrate the power of arrays, this chapter traces the development of an array to store checkbook data: check numbers, dates written, and amounts for each check.

In addition, several matrix manipulation subroutines are listed at the end of this chapter. These sequences will let you add, multiply, transpose, and perform other operations on arrays.

Note: Throughout this chapter, zero-subscripted elements are generally ignored for the sake of simplicity. But you should remember they are available and should be used for the most efficient use of memory. For example, after DIM A(4), array A contains 5 elements: A(0), A(1), A(2), A(3), A(4).

For background information on arrays, see Chapter 4, **DIM**, and Chapter 1, "Arrays".

A Check-Book Array

Consider the following table of checkbook information:

Check #	Date Written	Amount
025	1-1-78	10.00
026	1-5-78	39.95
027	1-7-78	23.50
028	1-7-78	149.50
029	1-10-78	4.90
030	1-15-78	12.49

Note that every item in the table may be specified simply by reference to two numbers: the row number and the column number. For example, (row 3, column 3) refers to the amount 23.50. Thus, the number pair (3,3) may be called the "subscript address" of the value 23.50.

Let's set up an array, CK, to correspond to the checkbook information table. Since the table contains 6 rows and 3 columns, array CK will need two dimensions: one for row numbers, and one for column numbers. We can picture the array like this:

A(1,1)=025	A(1,2)=1.0178	A(1,3)=10.00
.	.	.
.	.	.
.	.	.
.	.	.
A(6,1)=030	A(6,2)=1.1578	A(6,3)=12.49

Notice that the date information is recorded in the form *mm.ddyy*, where *mm*=month number, *dd*=*day of month*, and *yy* = last two digits of year. **Since CK is a numeric array, we can't store the data with alpha-numeric characters such as dashes.**

Suppose we assign the appropriate values to the array elements. Unless we have used a DIM statement, the Computer will assume that our array requires a depth of 10 for each dimension. That is, the Computer will set aside memory locations to hold CK(7,1), CK(7,2), ..., CK(9,1), CK(9,2) and CK(9,3). In this case, we don't want to set aside this much space, so we use the DIM statement at the beginning of our program:

```
10  DIM CK(6,3) 'SETUP A 6 BY 3 ARRAY (EXCL. ZERO SUBSCRIPTS)
```

Now let's add program steps to read the values into the array CK:

```
20  FOR ROW=1 TO 6
30      FOR COL=1 TO 3
40          READ CK(ROW,COL)
50  NEXT COL,ROW
90  DATA 025, 1.0178, 10.00
91  DATA 026, 1.0578, 39.95
92  DATA 027, 1.0778, 23.50
93  DATA 028, 1.0778, 149.50
94  DATA 029, 1.1078, 4.90
95  DATA 030, 1.1578, 12.49
```

Now that our array is set up, we can begin taking advantage of its built-in structure. For example, suppose we want to add up all the checks written. Add the following lines to the program:

```
100 FOR ROW=1 TO 6
110     SUM=SUM+CK(ROW,3)
120 NEXT
130 PRINT"TOTAL OF CHECKS WRITTEN";
140 PRINT USING"$ $###.##";SUM
```

Now let's add program steps to print out all checks that were written on a given day.

```
200 PRINT "SEEKING CHECKS WRITTEN ON WHAT DATE (MM.DDYY) ";
210 INPUT DT
230 PRINT :PRINT"ANY CHECKS WRITTEN ARE LISTED BELOW:"
240 PRINT"CHECK #","AMOUNT" : PRINT
250 FOR ROW=1 TO 6
260     IF CK(ROW,2)=DT PRINT CK(ROW,1),CK(ROW,3)
270 NEXT
```

It's easy to generalize our program to handle checkbook information for all 12 months and for years other than 1978.

All we do is increase the size (or "depth") of each dimension as needed. Let's assume our checkbook includes check numbers 001 through 300, and we want to store the entire checkbook record. Just make these changes:

```
10  DIM CK(300,3) 'SET UP A 300 BY 3 ARRAY
20  FOR ROW=1 TO 300
```

and add DATA lines for check numbers 001 through 300. You'd probably want to pack more data onto each DATA line than we did in the above DATA lines.

And you'd change all the ROW counter final values:

```
100 FOR ROW=1 TO 300
.
.
250 FOR ROW=1 TO 300
```

Other Types of Arrays

Remember, in LEVEL II the number of dimensions an array can have (and the size or depth of the array), is limited only by the amount of memory available. Also remember that **string** arrays can be used. For example, C\$(X) would automatically be interpreted as a string array. And if you use DEFSTR A at the beginning of your program, any array whose name begins with A would also be a string array. One obvious application for a string array would be to store text material for access by a string manipulation program.

```
10  CLEAR 1200
20  DIM TXT$(10)
```

would set up a string array capable of storing 10 lines of text. 1200 bytes were CLEARED to allow for 10 sixty-character lines, plus 600 extra bytes for string manipulation with other string variables.

Array/Matrix Manipulation Subroutines

To use this subroutine, your main program must supply values for two variables N1 (number of rows) and N2 (number of columns). Within the subroutine, you can assign values to the elements in the array row by row by answering the INPUT statement.

```
30100 REM MATRIX INPUT SUBROUTINE (2 DIMENSION)
30110 FOR I=1 TO N1
30120 PRINT "INPUT ROW";I
30130   FOR J=1 TO N2
30140     INPUT A(I,J)
30160 NEXT J,I
30170 RETURN
```

To use this subroutine, your main program must supply values for three variables N1 (size of dim#1), N2 (size of dim#2) and N3 (size of dim#3). Within the subroutine, you can assign values to each element of the array using READ and DATA statements. You must supply I x J x K elements in the following order: row by row for K=1, row by row for K=2, row by row for K=3, and so on for each value of N3.

```
30200 REM MATRIX READ SUBROUTINE (3 DIMENSION)
30205 REM REQUIRES DATA STMTS.
30210 FOR K=1 TO N3
30220   FOR I=1 TO N1
30230     FOR J=1 TO N2
30240       READ A(I,J,K)
30270 NEXT J,I,K
30280 RETURN
```

Main program supplies values for variables N1, N2, N3, etc. The subroutine sets the value of each element to zero.

```
30300 REM MATRIX ZERO SUBROUTINE (3 DIMENSION)
30310 FOR K=1 TO N3
30320   FOR J=1 TO N2
30330     FOR I=1 TO N1
30340       A(I,J,K)=0
30370 NEXT I,J,K
30380 RETURN
```

Main program supplies values for variables N1, N2, N3. The subroutine prints the array.

```
30400 REM MATRIX PRINT SUBROUTINE (3 DIMENSION)
30410 FOR K=1 TO N3
30420   FOR I=1 TO N1
30430     FOR J=1 TO N2
30440       PRINT A(I,J,K) ,
30450     NEXT J:PRINT
30460   NEXT I:PRINT
30470 NEXT K:PRINT
30480 RETURN
```

Main program supplies values for variables N1 , N2, N3. Within the subroutine, you can assign values to each element of the array using the INPUT statement.

```
30500 REM MATRIX INPUT SUBROUTINE (3 DIMENSION)
30510 FOR K=1 TO N3
30520 PRINT "PAGE";K
30530   FOR I=1 TO N1
30540     PRINT "INPUT ROW";I
30550     FOR J=1 TO N2
30560       INPUT A(I,J,K)
30570     NEXT J
30580   NEXT I
30590 PRINT:NEXT K
30595 RETURN
```

Multiplication by a Single Variable: Scalar Multiplication (3 Dimensional)

```
30600 FOR K=1 TO N3:'N3=3RD DIMENSION
30610   FOR J=1 TO N2:'N2=2ND DIMENSION (COLUMNS)
30620     FOR I=1 TO N1:'N1=1ST DIMENSION (ROWS)
30630       B(I,J,K)=A(I,J,K)*X
30640     NEXT I
30650   NEXT J
30660 NEXT K
30670 RETURN
```

Multiplies each element in MATRIX A by X and constructs matrix B

Transposition of a Matrix (2 Dimensional)

```
30700 FOR I=1 TO N1
30710   FOR J=1 TO N2
30720     B(J,I)=A(I,J)
30730   NEXT J
30740 NEXT I
30750 RETURN
```

Transposes matrix A into matrix B

Matrix Addition (3 Dimensional)

```
30800 FOR K=1 TO N3
30810   FOR J = 1 TO N2
30820     FOR I=1 TO N1
30830       C(I,J,K)=A(I,J,K)+B(I,J,K)
30840     NEXT I
30850   NEXT J
30860 NEXT K
30870 RETURN
```

Array Element-wise Multiplication (3 Dimensional)

```
30900 FOR K=1 TO N3
30910   FOR J=1 TO N2
30920     FOR I=1 TO N1
30930       C(I,J,K)=A(I,J,K)*B(I,J,K)
30940     NEXT I
30950   NEXT J
30960 NEXT K
```

Multiplies each element in A times its corresponding element in B.

Matrix Multiplication (2 Dimensional)

```
40000 FOR I=1 TO N1
40010   FOR J=1 TO N2
40020     C(I,J)=0
40030     FOR K=1 TO N3
40040       C(I,J)=C(I,J)+A(I,K)*B(K,I)
40050     NEXT K
40060   NEXT J
40070 NEXT I
```

A must be an N1 by N3 matrix; B must be an N3 by N2 matrix. The resultant matrix C will be an N1 by N2 matrix. A, B, and C must be dimensioned accordingly.

7 / Arithmetic Functions

LEVEL II BASIC offers a wide variety of intrinsic ("built-in") functions for performing arithmetic and special operations. The special-operation functions are described in the next chapter.

All the common math functions described in this chapter return single-precision values **accurate to six decimal places**. ABS, FIX and INT return values whose precision depends on the precision of the argument.

The conversion functions (LINT, CDBL, etc.) return values whose precision depends on the particular function. Trig functions use or return radians, not degrees. A radian-degree conversion is given for each of the functions.

For all the functions, the argument must be enclosed in parentheses. The argument may be either a numeric variable, expression or constant.

Functions described in this chapter:

ABS	COS	INT	SGN
ATN	CSNG	LOG	SIN
CDBL	EXP	RANDOM	SQR
CINT	FIX	RND	TAN

ABS (*x*)

Returns the absolute value of the argument. ABS(X)=X for X greater than or equal to zero, and ABS(X)=-X for X less than zero.

```
100 IF ABS(X)<1E-6 PRINT "TOO SMALL"
```

ATN (*x*)

Returns the arctangent (in radians) of the argument; that is, ATN(X) returns "the angle whose tangent is X". To get arctangent in degrees, multiply ATN(X) by 57.29578.

```
100 Y=ATN(B/C)
```

CDBL (x)

Returns a double-precision representation of the argument. The value returned will contain 17 digits, but only the digits contained in the argument will be significant.

CDBL may be useful when you want to force an operation to be done in double-precision, even though the operands are single precision or even integers. For example CDBL (I%)/J% will return a fraction with 17 digits of precision.

```
100 FOR I%=1 TO 25: PRINT 1/CDBL(I%),: NEXT
```

CINT (x)

Returns the largest integer not greater than the argument. For example, LINT (1.5) returns 1; CINT(-1.5) returns -2. For the CINT function, the argument must be in the range -32768 to + 32767. The result is stored internally as a two-byte integer.

CINT might be used to speed up an operation involving single or double-precision operands without losing the precision of the operands (assuming you're only interested in an integer result).

```
100 K%=CINT(X#)+CINT(Y#)
```

COS (x)

Returns the cosine of the argument (argument must be in radians). To obtain the cosine of X when X is in degrees, use CGS(X*.01745329).

```
100 Y=COS(X+3.3)
```

CSNG (x)

Returns a single-precision representation of the argument. When the argument is a double-precision value, it is returned as six significant digits with "4/5 rounding" in the least significant digit. So CSNG(.6666666666666667) is returned as .666667; CSNG(.3333333333333333) is returned as .333333.

```
100 PRINT CSNG(A#+B#)
```

EXP (x)

Returns the "natural exponential" of X, that is, e^x . This is the inverse of the LOG function, so $X = \text{EXP}(\text{LOG}(X))$.

```
100 PRINT EXP (-X)
```

FIX (x)

Returns a truncated representation of the argument. All digits to the right of the decimal point are simply chopped off, so the resultant value is an integer. For non-negative X, $\text{FIX}(X) = \text{INT}(X)$. For negative values of X, $\text{FIX}(X) = \text{INT}(X) + 1$. For example, $\text{FIX}(2.2)$ returns 2, and $\text{FIX}(-2.2)$ returns -2.

```
100 Y=ABS (A-FIX (A) )
```

This statement gives Y the value of the fractional portion of A.

INT(x)

Returns an integer representation of the argument, using the largest whole number that is not greater than the argument. Argument is not limited to the range -32768 to +32767. The result is stored internally as a single-precision whole number. $\text{INT}(2.5)$ returns 2; $\text{INT}(-2.5)$ returns -3; and $\text{INT}(1000101.23)$ returns 1000101.

```
100 Z=INT (A*100+ .5) /100
```

Gives Z the value of A rounded to two decimal places (for nonnegative A).

LOG(x)

Returns the natural logarithm of the argument, that is, $\log_e(\text{argument})$. This is the inverse of the EXP function, so $X = \text{LOG}(\text{EXP}(X))$. To find the logarithm of a number to another base b, use the formula $\log_b(X) = \log_e(X) / \log_e(b)$. For example, $\text{LOG}(32767) / \text{LOG}(2)$ returns the logarithm to base 2 of 32767.

```
100 PRINT LOG (3.3*X)
```

RANDOM

RANDOM is actually a complete statement rather than a function. It reseeds the random number generator. If a program uses the RND function, you may want to put RANDOM at the beginning of the program. This will ensure that you get an unpredictable sequence of pseudo-random numbers each time you turn on the Computer, load the program, and run it.

```
10  RANDOM
20  C=RND ( 6 ) +RND ( 6 )
.
.
.
80  GOTO 20 'RANDOM NEEDS TO EXECUTE JUST ONCE
```

RND(*x*)

Generates a pseudo-random number using the current pseudo-random "seed number" (generated internally and not accessible to user). RND may be used to produce random numbers between 0 and 1, or random integers greater than 0, depending on the argument.

RND(0) returns a single-precision value between 0 and 1. RND(integer) returns an integer between 1 and *integer inclusive* (*integer* must be positive and less than 32768). For example, RND(55) returns a pseudo-random integer greater than zero and less than 56. RND(55.5) returns a number in the same range, because RND uses the INTeger value of the argument.

```
100 X=RND(2) : ON X GOTO 200,300
```

SGN (*x*)

The "sign" function: returns -1 for X negative, 0 for X zero, and +1 for X positive.

```
100 ON SGN(X)+2 GOTO 200,300,400
```

SIN(*x*)

Returns the sine of the argument (argument must be in radians). To obtain the sine of X when X is in degrees, use SIN(X*.01745329).

```
100 PRINT SIN(A*B-B)
```

SQR(*x*)

Returns the square root of the argument. SQR(X) is the same as $X^{1/2}$, only faster.

```
100 Y=SQR(X2-H2)
```

TAN(*x*)

Returns the tangent of the argument (argument must be in radians). To obtain the tangent of X when X is in degrees, use TAN(X*.01745329).

```
100 Z=TAN(2*A)
```

NOTE: A great many other functions may be created using the above functions. See Appendix F, "Derived Functions".

8 / Special Features

LEVEL II BASIC offers some unusual functions and operations that deserve special highlighting. Some may seem highly specialized; as you learn more about programming and begin to experiment with machine-language routines, they will take on more significance. Other functions in the chapter are of obvious benefit and will be used often (for example, the graphics functions). And then there are a couple of features, INP and OUT, that will be used primarily with the TRS-80 Expansion Interface.

Functions, statements and operators described in this chapter:

Graphics:	Error-Routine Functions:	Other Functions and Statements:
SET	ERL	INP
RESET	ERR	MEM
CLS		OUT
POINT	Logical Operators:	PEEK
		POKE
	AND	POS
	OR	USR
	NOT	VARPTR

SET(x,y)

Turns on the graphics block at the location specified by the coordinates x and y. For graphics purposes, the Display is divided up into a 128 (horizontal) by 48 (vertical) grid. The x-coordinates are numbered from left to right, 0 to 127. The y-coordinates are numbered from top to bottom, 0 to 47. Therefore the point at (0,0) is in the extreme upper left of the Display, while the point at (127,47) is in the extreme lower right corner. See the Video Display Worksheet in Appendix C.

The arguments x and y may be numeric constants, variables or expressions. They need not be integer values, because SET(x,y) uses the INTeger portion of x and y. SET (x,y) is valid for:

$0 \leq x < 128$

$0 \leq y < 48$

Examples:

```
100 SET (RND (128) -1 , RND (48) -1)
```

Lights up a random point on the Display.

```
100 INPUT X,Y: SET (X,Y)
```

RUN to see where the blocks are.

RESET(x,y)

Turns off a graphics block at the location specified by the coordinates x and y. This function has the same limits and parameters as SET(x,y).

```
200 RESET (X,3)
```

CLS

"Clear-Screen" – turns off all the graphics blocks on the Display and moves the cursor to the upper left corner. This wipes out alphanumeric characters as well as graphics blocks. CLS is very useful whenever you want to present an attractive Display output.

```
5   CLS
10  SET (RND (128) -1 , RND (48) -1)
20  GOTO 10
```

POINT(x, y)

Tests whether the specified graphics block is "on" or "off". If the block is "on" (that is, if it has been SET), then POINT returns a binary True (-1 in LEVEL II BASIC). If the block is "off", POINT returns a binary False (0 in LEVEL II BASIC). Typically, the POINT test is put inside an IF-THEN statement.

```
100 SET (50,28) : IF POINT (50,28) THEN PRINT "ON" ELSE PRINT "OFF"
```

This line will always print the message, "ON", because POINT(50,28) will return a binary True, so that execution proceeds to the THEN clause. If the test failed, POINT would return a binary False, causing execution to jump to the ELSE statement.

ERL

Returns the line number in which an error has occurred. This function is primarily used inside an error-handling routine accessed by an ON ERROR GOTO statement. If no error has occurred when ERL is called, line number 0 is returned. However, if an error has occurred since power-up, ERL returns the line number in which the error occurred. If error occurred in direct mode, 65535 is returned (largest number representable in two bytes).

Example Program using ERL

```
5      CLEAR 10
10     ON ERROR GOTO 1000
20     INPUT"ENTER YOUR MESSAGE";M$
30     INPUT"NOW ENTER A NUMBER";N: N=1/N
40     REM REST OF PROGRAM BEGINS HERE
.
.
.
999    END
1000   IF ERL=20 THEN 1010 ELSE IF ERL=30 THEN 1020
1005   ON ERROR GOTO 0
1010   PRINT "TRY AGAIN--KEEP MESSAGE UNDER 11 CHARACTERS"
1015   RESUME 20
1020   PRINT"FORGOT TO MENTION: NUMBER MUST NOT BE ZERO"
1025   RESUME 30
```

RUN the program. Try entering a long message; try entering zero when the program asks for a number. Note that ERL is used in line 1000 to determine where the error occurred so that appropriate action may be taken.

ERR /2+1

Similar to ERL, except ERR returns a value **related** to the **code** of the error rather than the line in which the error occurred. Commonly used inside an error handling routine accessed by an ON ERROR GOTO statement. See Appendix B, "Error Codes."

ERR/2+1 = true error code
(true error code -1)*2=ERR

Example Program

```
10  ON ERROR GOTO 1000
20  DIM A(15) : I=1
30  READ A(1)
40  I=I+1: GOTO 30
50  REM REST OF PROGRAM
100 DATA 2,3,5,7,1,13
999 END
1000 IF ERR/2+1=4 RESUME 50
1010 ON ERROR GOTO 0
```

Note line 1000: 4 is the error code for Out of Data.

INP(*port*)

Returns a byte-value from the specified port. The TRS-80 Expansion Interface is required to use INP effectively (with user-supplied peripheral hardware). There are 256 ports, numbered 0-255. For example

```
100 PRINT INP(50)
```

inputs a byte from port 50 and prints the decimal value of the byte.

The only port used for TRS-80 is FF(hex), or 255 (decimal), used for the cassette recorder. For a discussion of how to interface special-purpose hardware to the other ports and how to program this hardware using INP and OUT, see the **TRS-80 Microcomputer Technical Reference Handbook**, Catalog Number 26-2103.

MEM

Returns the number of unused and unprotected bytes in memory. This function may be used in the Command Mode to see how much space a resident program takes up; or it may be used inside the program to avert OM (Out of Memory) errors by allocating less string space, DIMensioning smaller array sizes, etc. MEM requires no argument.

Example:

```
100 IF MEM < 80 THEN 900
110 DIM A(15)
.
.
.
```

Enter the command PRINT MEM (in Command Mode) to find out the amount of memory not being used to store programs, variables, strings, stack, or reserved for object-files.

OUT *port, value*

Ouputs a byte value to the specified port. OUT is not a function but a statement complete in itself. It requires two arguments separated by a comma (no parenthesis): the port destination and the byte value to be sent.

Example:

```
OUT 250,1 0
```

sends the value "10" to port 250. Both arguments are limited to the range 0-255.

OUT, like INP, becomes useful when you add the TRS-80 Expansion Interface. See INP.

PEEK(*address*)

Returns the value stored at the specified byte address (in decimal form). To use this function, you'll need to refer to two sections of the Appendix: the Memory Map (so you'll know where to PEEK) and the Table of Function, ASCII and Graphics Codes (so you'll know what the values represent).

If you're using PEEK to examine object files, you'll also need a microprocessor instruction set manual (one is included with the TRS-80 Editor/Assembler Instruction Manual).

PEEK is valuable for linking machine language routines with LEVEL II BASIC programs. The machine language routine can store information in a certain memory location, and PEEK may be used inside your BASIC program to retrieve the information. For example,

A = PEEK(17999)

returns the value stored at location 17999 and assigns that value to the variable A.

Peek may also be used to retrieve information stored with a POKE statement. Using PEEK and POKE allows you to set up very compact, byte-oriented storage systems. Refer to the Memory Map in the Appendix to determine the appropriate locations for this type of storage. See **POKE**, **USR**.

POKE *address, value*

Loads a value into a specified memory location. POKE is not a function but a statement complete in itself. It requires two arguments: a byte address (in decimal form) and a value. The value must be between 0 and 255 inclusive. Refer to the Memory Map in the Appendix to see which addresses you'd like to POKE.

To POKE (or PEEK) an address **above** 32767, use the following formula: $-1 * (65536 - \text{desired address}) = \text{POKE OR PEEK address}$. For example, to POKE into address 32769, use POKE -32767, value

POKE is useful for LEVEL II graphics. Look at the Video Display Worksheet in the Appendix. In each of the 1024 PRINT locations there are 6 subdivisions. If we call each PRINT position a byte, then the smaller boxes are bits. We know that there are 8 bits per byte; so what happened to the other 2? One is used to identify the byte as a graphics or ASCII code. The other bit is not used. The remaining 6 bits contain either an ASCII, graphics or control code.

We can use POKE to turn on the entire PRINT position (6 bits) at one time. When we use SET, only 1 bit is turned on. Therefore POKE is about 6 times faster than SET. The following program demonstrates this speed.

```
10  CLS
20  FOR X=15360 TO 16383
30  POKE X,191
40  NEXT
50  GOTO 50
```

RUN the program to see how fast the screen is "painted" white. (191 is the code for "all bits on". 15360 to 16383 are the Video Display memory addresses.)

Since POKE can be used to store information anywhere in memory, it is very important when we do our graphics to stay in the range for display locations. If we POKE outside this range, we may store the byte in a critical place. We could be POKEing into our program, or even in worse places like the stack. Indiscriminate POKEing can be disastrous. You might have to reset or power off and start over again. Unless you know where you are POKEing - don't.

See PEEK, USR, SET, and Chapter 4, CHR\$ for background material.

POS(*x*)

Returns a number from 0 to 63 indicating the current cursor position on the Display. Requires a "dummy argument" (any numeric expression).

```
100 PRINT TAB(40) POS(0)
```

prints 40 at position 40. (Note that a blank is inserted before the "4" to accommodate the sign; therefore the "4" is actually at position 41.) The "0" in "POS(0)" is the dummy argument.

```
100 PRINT "THESE" TAB(POS(0)+5) "WORDS" TAB(POS(0)+5) "ARE" ;
110 PRINT TAB(POS(0)+5) "EVENLY" TAB(POS(0)+5) "SPACED"
```

RUN

```
THESE      WORDS      ARE      EVENLY      SPACED
READY
>_
```

USR (x)

This function lets you call a machine-language subroutine and then continue execution of your BASIC program.

"Machine language" is the low-level language used internally by your Computer. It consists of Z-80 microprocessor instructions. Machine-language subroutines are useful for special applications (things you can't do in BASIC) and simply because they can do things very fast (like white-out the Display).

Writing such routines requires familiarity with assembly-language programming and with the Z-80 instruction set. For more information on this subject, see the Radio Shack book, *TRS-80 Assembly-Language Programming*, by William Barden, Jr., and the instruction manuals for Radio Shack's TBUG (26-2001) and EDITOR-ASSEMBLER (26-2002).

Getting the USR routine into memory

1. You should first reserve the area in high memory where the routine will be located. This is done immediately after power-up by answering the MEMORY SIZE? question with the address **preceding the start address of your USR routine**. For example, if your routine starts at 32700, then type 32699 in response to MEMORY SIZE?.
2. Then load the routine into memory.
 - A. If it is stored on tape in the SYSTEM format (created with EDITOR-ASSEMBLER or TBUG), you must load it via the SYSTEM command, as described in Chapter 2. After the tape has loaded press **BREAK** to return to the BASIC command mode.
 - B. If it is a short routine, you may simply want to POKE it into high memory.

Telling BASIC where the USR routine starts

Before you can make the USR call, you have to tell BASIC the entry address to the routine. Simply POKE the two-byte address into memory locations 16526-16527: least significant byte (LSB) into 16526, most significant byte (MSB) into 16527.

For example, if the entry point is at 32700:

32700 decimal = 7FBC hexadecimal
LSB = BC hexadecimal = 188 decimal
MSB = 7F hexadecimal = 127 decimal

So use the statements:

POKE 16526, 188
POKE 16527, 127

to tell BASIC that the USR routine entry is at 32700.

Making the USR call

At the point in your BASIC program where you want to call the subroutine, insert a statement like

`X = USR(N)`

where N can be an expression and must have a value between -32768 and +32767 inclusive. This argument, N, can be used to pass a value to your routine (see below) or you can simply consider it a dummy argument and not use it at all.

When BASIC encounters your `X=USR(N)` statement, it will branch to the address stored at 16526-16527. At the point in your USR routine where you want to return to the BASIC program, insert a simple `RET` instruction – unless you want to return a value to BASIC, in which case, see below.

Passing an argument to the USR routine

If you want to pass the `USR(N)` argument to your routine, then include the following `CALL` instruction at the beginning of your USR routine:

`CALL 0A7FH`

This loads the argument N into the HL register pair as a two-byte signed integer.

Returning an argument from the USR routine

To return an integer value to the `USR(N)` function, load the value (a two-byte signed integer) into HL and place the following jump instruction at the end of your routine:

`JP 0A9AH`

Control will pass back to your program, and the integer in HL will replace USR(N). For example, if the call was X=USR(N) then X will be given the value in HL.

Sample USR routines

Listed below is an assembled program to white out the display (an "inverse" CLEAR key!).

```

                                00100 ;
                                00110 ; ZAP OUT SCREEN USR FUNCTION
                                00120 ;
7D00                            00130          ORG      7D00H
                                00140 ;
                                00150 ; EQUATES
                                00160 ;
3C00                            00170 VIDEO   EQU      3C00H          ;START OF VIDEO RAM
00BF                            00180 WHITE   EQU      0BFH           ;ALL WHITE GRAPHICS BYTE
03FF                            00190 COUNT   EQU      3FFH           ;NUMBER OF BYTES TO MOVE
                                00200 ;
                                00210 ; PROGRAM CHAIN MOVES X'BF' INTO ALL OF VIDEO RAM
                                00220 ;
7D00 21003C 00230 ZAP          LD      HL,VIDEO          ;SOURCE ADDRESS
7D03 36BF   00240              LD      (HL),WHITE        ;PUT OUT 1ST BYTE
7D05 11013C 00250              LD      DE,VIDEO+1        ;DESTINATION ADDRESS
7D08 01FF03 00260              LD      BC,COUNT          ;NUMBER OF ITERATIONS
7D0B EDB0   00270              LDIR                     ;DO IT TO IT!!!
                                00280
7D0D C9     00290              RET                        ;RETURN TO BASIC
7D00        00300              ENDZAP
```

This routine can be POKEd into RAM and accessed as a USR routine, as follows.

NOTE: The following two BASIC programs require that you reserve memory addresses above 31999 for the USR Code. (Answer MEMORY SIZE? with 31999.)

```

100 ' PROGRAM: USR
110 ' EXAMPLE OF A USER MACHINE LANGUAGE FUNCTION
115 ' DEPRESS THE '@' KEY WHILE NUMBERS ARE PRINTING TO STOP
120 '
130 ' ***** POKE MACHINE PROGRAM INTO MEMORY *****
140 '
150 POKE 16526,0: POKE 16527,125
160 FOR X=32000 TO 32013      '71300 HEX EQUAL 32000 DECIMAL
```

```

170     READ A
180     POKE X,A
190 NEXT X
192 '
194 ' ***** CLEAR SCREEN & PRINT NUMBERS 1 THRU 100 *****
196 '
200 CLS
205 PRINT TAB(15);"WHITE-OUT USER ROUTINE": PRINT
210 FOR X=1 TO 100
220     PRINT X;
225     A$=INKEY$: IF A$="@" THEN END
230 NEXT X
240 '
250 ' ***** JUMP TO WHITE-OUT SUBROUTINE *****
260 '
270 X=USR (0)
280 FOR X=1 TO 1000: NEXT X    'DELAY LOOP
290 GOTO 200
300 '
310 ' ***** DATA IS DECIMAL CODE FOR HEX PROGRAM *****
320 '
330 DATA 33,0,60,54,191,17,1,60,1,255,3,237,176,201

```

RUN the program. An equivalent BASIC white out routine takes a long time by comparison!

Listed below is an assembled machine-language routine that will accept the argument from the USR call in BASIC, left-shift it one position, and return the result to BASIC.

```

                00100 ;
                00110 ; SHIFT FUNCTION
                00120 ;
                00130 ;      MACHINE CODE PROGRAM TO LEFT SHIFT
                00140 ;      AN ARGUMENT SENT FROM BASIC AND RETURN
                00150 ;      THE RESULT BACK TO BASIC
                00160 ;
7D00            00170                      ORG      7D00H
                00180 ;
                00190 ; EQUATES AND ENTRY POINTS
                00200 ;
0A7F            00210 GETARG EQU      0A7FH      ;GET ARGUMENT FROM BASIC
0A9A            00220 PUTANS EQU      0A9AH      ;RETURN ANSWER TO BASIC
                00230 ;
7D00 CD7F0A    00240 SHIFT  CALL      GETARG    ;GET NUMBER FROM BASIC

```

```

7D03 CB15      00250          RL      L          ;SHIFT L
7D05 CB14      00260          RL      H          ;SHIFT H - ANSWER IN HL
7D07 C39A0A    00270          JP      PUTANS     ;RETURN TO BASIC W/ANSWER
              00280 ;
7D00          00290          END      SHIFT

```

The following program includes the decimal code for the SHIFT routine. The code is POKEd into RAM and then accessed as a USR routine. RUN the program; to stop, enter a value of zero.

```

100 ' PROGRAM: SHIFT
110 ' MACHINE LANGUAGE USER FUNCTION TO LEFT SHIFT
120 '
130 ' ***** MACHINE CODE AT 71300 HEX *****
140 '
150 POKE 16526,0: POKE 16527,125
160 '
170 ' ***** POKE USER PROGRAM INTO MEMORY *****
180 '
190 FOR X=32000 TO 32009 '71300 HEX EQUALS 32000 DECIMAL
200     READ A
210     POKE X,A
220 NEXT X
230 '
240 ' ***** GET VALUE FROM USER *****
250 '
260 CLS: PRINT TAB(15);"USR LEFT-SHIFT FUNCTION"
270 PRINT: INPUT"ENTER INTEGER VALUE";V
280 IF V=0 THEN END
290 PRINT: "LEFT SHIFTED VALUE =" ;TAB(32);USR(V)
300 GOTO 270
310 '
320 ' ***** DATA IS DECIMAL CODE FOR HEX PROGRAM *****
330 '
340 DATA 205,127,10,203,21,203,20,195,154,10

```

USR routines are automatically allocated up to 8 stack levels or 16 bytes (a high and low memory byte for each stack level). If you need more stack space, you can save the BASIC stack pointer and set up your own stack. However, this gets complicated; be sure you know what you're doing. See Chapter 2, **SYSTEM**, and this chapter, **PEEK**, **POKE**.

VARPTR (*variable name*)

Returns an address-value, which will help you locate where the variable name and its value are stored in memory. If the variable you specify has not been assigned a value, an FC error will occur when this function is called.

If *VARPTR(integer variable)* returns address K:

Address K contains the least significant byte (LSB) of 2-byte *integer*.

Address K+1 contains the most significant byte (MSB) of *integer*.

You can display these bytes (two's complement decimal representation) by executing a PRINT PEEK (K) and a PRINT PEEK (K+1).

If *VARPTR(single precision variable)* returns address K:

(K)* = LSB of value

(K+1) = Next most sig. byte (Next MSB)

(K+2) = MSB with hidden (implied) leading one. Most significant bit is the sign of the number

(K+3) = exponent of value excess 128 (128 is added to the exponent).

If *VARPTR(double precision variable)* returns K:

(K) = LSB of value

(K+1) = Next MSB

(K+...)= Next MSB

(K+6) = MSB with hidden (implied) leading one. Most significant bit is the sign of the number.

(K+7) = exponent of value excess 128 (128 is added to the exponent).

For single and double precision values, the number is stored in normalized exponential form, so that a decimal is assumed before the MSB. 128 is added to the exponent. Furthermore, the high bit of MSB is used as a sign bit. It is set to 0 if the number is positive or to 1 if the number is negative. See examples below.

You can display these bytes by executing the appropriate PRINT PEEK(x) where x = the address you want displayed. Remember, the result will be the decimal representation of byte, with bit 7 (MSB) used as a sign bit. The number will be in normalized exponential form with the decimal assumed before the MSB. 128 is added to the exponent,

If *VARPTR(string variable,)* returns K:

K = length of string

(K+1) = LSB of string value starting address

(K+2) = MSB of string value starting address

*** (K) signifies "contents of address K"**

The address will probably be in high RAM where string storage space has been set aside. But, if your string variable is a constant (a string literal), then it will point to the area of memory where the program line with the constant is stored, in the program buffer area. Thus, program statements like A\$="HELLO" do not use string storage space.

For all of the above variables, addresses (K-1) and (K-2) will store the TRS-80 Character Code for the variable name. Address (K-3) will contain a descriptor code that tells the Computer what the variable type is. Integer is 02; single precision is 04; double precision is 08; and string is 03.

VARPTR(array *variable*) will return the address for the first byte of that element in the array. The element will consist of 2 bytes if it is an integer array; 3 bytes if it is a string array; 4 bytes if it is a single precision array; and 8 bytes if it is a double precision array.

The first element in the array is preceded by:

1. A sequence of two bytes per dimension, each two-byte pair indicating the "depth" of each respective dimension.
2. A single byte indicating the total number of dimensions in the array.
3. A two-byte pair indicating the total number of elements in the array.
4. A two-byte pair containing the ASCII-coded array name.
5. A one-byte type-descriptor (02=Integer, 03 = String, 04 = Single-Precision, 08 = Double-Precision).

Item (1) immediately precedes the first element, Item (2) precedes Item (1), and so on.

The elements of the array are stored sequentially with the first dimension-subscripts varying "fastest", then the second, etc.

Examples

A! = 2 will be stored as follows

2 = 10 Binary, normalized as .1 E2 = .1 x 2²

So exponent of A is 128+2 = 130 (called excess 128)

MSB of A is 10000000;

however, the high bit is changed to zero since the value is positive (called hidden or implied leading one).

So A! is stored as

Exponent (K+3)	MSB (K+2)	Next MSB (K+1)	LSB (K)
130	0	0	0

A! = -.5 will be stored as

Exponent (K+3)	MSB (K+2)	Next MSB (K+1)	LSB (K)
128	128	0	0

A! = 7 will be stored as

Exponent (K+3)	MSB (K+2)	Next MSB (K+1)	LSB (K)
131	96	0	0

A! = -7

Exponent (K+3)	MSB (K+2)	Next MSB (K+1)	LSB (K)
131	224	0	0

Zero is simply stored as a zero-exponent. The other bytes are insignificant.

Logical Operators

In Chapter 1 we described how AND, OR and NOT can be used with relational expressions. For example,

```
100 IF A=C AND NOT(B>40) THEN 60 ELSE 50
```

AND, OR and NOT can also be used for bit manipulation, bitwise comparisons, and Boolean operations. In this section, we will explain how such operations can be implemented using LEVEL II BASIC. However, we will not try to explain Boolean algebra, decimal-to-binary conversions, binary arithmetic, etc. If you need to learn about these subjects, Radio Shack's **Understanding Digital Computers** (Catalog Number 62-2027) would be a good place to start.

AND, OR and NOT convert their arguments to sixteen-bit, signed two's-complement integers in the range -32768 to +32767. They then perform the specified logical operation on them and return a result within the same range. If the arguments are not in this range, an "FC" error results.

The operations are performed in bitwise fashion; this means that each bit of the result is obtained by examining the bit in the same position for each argument.

The following truth tables show the logical relationship between bits:

OPERATOR	ARGUMENT 1	ARGUMENT 2	RESULT
AND	1	1	1
	0	1	0
	1	0	0
	0	0	0
OPERATOR	ARGUMENT 1	ARGUMENT 2	RESULT
OR	1	1	1
	1	0	1
	0	1	1
	0	0	0
OPERATOR	ARGUMENT		RESULT
NOT	1		0
	0		1

EXAMPLES:

(In all of the examples below, leading zeroes on binary numbers are not shown.)

63 AND 16 = 16	Since 63 equals binary 111111 and 16 equals binary 10000, the result of the AND is binary 10000 or 16.
15 AND 14 = 14	15 equals binary 1111 and 14 equals binary 1110, so 15 and 14 equals binary 1110 or 14.
-1 AND 8 = 8	-1 equals binary 1111111111111111 and 8 equals binary 1000, so the result is binary 1000 or 8 decimal.
4 AND 2 = 0	4 equals binary 100 and 2 equals binary 10, so the result is binary 0 because none of the bits in either argument match to give a 1 bit in the result.
4 OR 2 = 6	Binary 100 OR'd with binary 10 equals binary 110, or 6 decimal.
10 OR 10 = 10	Binary 1010 OR'd with binary 1010 equals binary 1010, or 10 decimal.
-1 OR -2 = -1	Binary 1111111111111111 (-1) OR'd with binary 111111111111110 (-2) equals binary 111111111111111, or -1.

NOT 0 = -1	The bit complement of binary 0 to 16 places is six-teen ones (1111111111111111) or -1. Also NOT -1=0.
NOT X	NOT X is equal to -(X+1). This is because to form the sixteen bit two's complement of the number, you take the bit (one's) complement and add one.
NOT 1 = -2	The sixteen bit complement of 1 is 1111111111111110, which is equal to -(1+1) or -2.

A typical use of the bitwise operators is to test bits set in the TRS-80's input ports which reflect the state of some external device. This requires the TRS-80 Expansion Interface.

Bit position 7 is the most significant bit of a byte, while position 0 is the least significant.

For instance, suppose bit 1 of I/O port 5 is 0 when the door to Room X is closed, and 1 if the door is open. The following program will print "Intruder Alert" if the door is opened:

```
10 IF INP(5) AND 2 THEN PRINT "INTRUDER ALERT": GOTO 100
20 GOTO 10
```

See Chapter 1, "Logical Operators".

9 / Editing

LEVEL I users undoubtedly spent lots of time retyping long program lines, all because of a typo, or maybe just to make a minor change. Once a line had been entered, there was no way to alter the line - without starting all over and retyping it.

LEVEL II's editing features eliminate much of this extra work. In fact, it's so easy to alter program lines, you'll probably be able to do much more experimenting with multi-statement lines, complex expressions, etc.

Commands, subcommands, and special function keys described in this chapter:

EDIT	L	<i>nD</i>
[ENTER]	X	<i>nC</i>
<i>nSpace-Bar</i>	I	<i>nSc</i>
<i>n ←</i>	A	<i>nKc</i>
SHIFT ↑	E	
	Q	
	H	

EDIT *line number*

This command puts you in the Edit Mode. You must specify which line you wish to edit, in one of two ways:

EDIT *line-number* **[ENTER]** Lets you edit the specified line. If line number is not in use, or an FC error occurs

EDIT. Lets you edit the current program line - last line entered or altered or in which an error has occurred.

For example, type in and **[ENTER]** the following line:

```
100 FOR I = 1 TO 10 STEP.5 : PRINT I, I↑2, I↑3 : NEXT
```

This line will be used in exercising all the Edit subcommands described below.

Now type EDIT 100 and hit **ENTER**. The Computer will display:

100 _

You are now in the Edit Mode and may begin editing line 100.

NOTE: EDITing a program line automatically clears all variable values and eliminates pending FOR/NEXT and GOSUB operations. If BASIC encounters a syntax error during program execution, it will automatically put you in the EDIT mode. Before EDITing the line, you may want to examine current variable values. In this case, you must type Q as your first EDIT command. This will return you to the command mode, where you may examine variable values. Any other EDIT command (typing E, pressing ENTER, etc.) will clear out all variables.

ENTER key

Hitting **ENTER** while in the Edit Mode causes the Computer to record all the changes you've made (if any) in the current line, and returns you to the Command Mode.

nSpace-bar

In the Edit Mode, hitting the Space-bar moves the cursor over one space to the right and displays any character stored in the preceding position. For example, using line 100 entered above, put the Computer in the Edit Mode so the Display shows:

100 _

Now hit the Space-Bar. The cursor will move over one space, and the first character of the program line will be displayed. If this character was a blank, then a blank will be displayed. Hit the SpaceBar until you reach the first non-blank character:

100 F_

is displayed. To move over more than one space at a time, hit the desired number of spaces first, and then hit the space-bar. For example, type 5 and hit Space-bar, and the display will show something like this (may vary depending on how many blanks you inserted in the line):

100 FOR I=_

Now type 8 and hit the Space-bar. The cursor will move over 8 spaces to the right, and 8 more characters will be displayed.

$n \leftarrow$ (Backspace)

Moves the cursor to the left by n spaces. If no number n is specified, the cursor moves back one space. When the cursor moves to the left, all characters in its "path" are erased from the display, but **they are not deleted from the program line**. Using this in conjunction with D or K or C can give misleading Video Displays of your program lines. So, be careful using it! For example, assuming you've used nSpace-Bar so that the Display shows:

```
100 FOR I=1 TO 10_
```

type 8 and hit the \leftarrow key. The Display will show something like this:

```
100 FOR I=_      (will vary depending on number of blanks in your line
                  100 )
```

SHIFT \uparrow

Hitting SHIFT and \uparrow keys together effects an escape from any of the Insert subcommands listed below: X, I and H. After escaping from an Insert subcommand, you'll still be in the Edit Mode, and the cursor will remain in its current position. (Hitting ENTER is another way to exit these Insert subcommands).

L (List Line)

When the Computer is in the Edit Mode, and is not currently executing one of the subcommands below, hitting L causes the remainder of the program line to be displayed. The cursor drops down to the next line of the Display, reprints the current line number, and moves to the first position of the line. For example, when the Display shows

```
100 _
```

hit L (without hitting `[ENTER]` key) and line 100 will be displayed:

```
100 FOR I=1 TO 10 STEP .5 : PRINT I, I↑2, I↑3 : NEXT  
100 _
```

This lets you look at the line in its current form while you're doing the editing.

X (Extend Line)

Causes the rest of the current line to be displayed, moves cursor to end of line, and puts Computer in the Insert subcommand mode so you can add material to the end of the line. For example, using line 100, when the Display shows

```
100 _
```

hit X (without hitting `[ENTER]`) and the entire line will be displayed; notice that the cursor now follows the last character on the line:

```
100 FOR I=1 TO 10 STEP .5 : PRINT I, I↑2, I↑3 : NEXT_
```

We can now add another statement to the line, or delete material from the line by using the `←` key. For example, type `PRINT"DONE"` at the end of the line. Now hit `[ENTER]`. If you now type LIST 100, the Display should show something like this:

```
100 FOR I=1 TO 10 STEP .5 : PRINT 1, 1↑2, 1↑3 : NEXT : PRINT"DONE"
```

I (Insert)

Allows you to insert material beginning at the current cursor position on the line. (Hitting ← will actually delete material from the line in this mode.) For example, type and ENTER the EDIT 100 command, then use the Space Bar to move over to the decimal point in line 100. The Display will show:

```
100 FOR I=1 TO 10 STEP . _
```

Suppose you want to change the increment from .5 to .25. Hit the I key (don't hit ENTER) and the Computer will now let you insert material at the current position. Now hit 2 so the Display shows:

```
100 FOR I=1 TO 10 STEP .2
```

You've made the necessary change, so hit SHIFT ↑ to escape from the Insert Subcommand. Now hit L key to display remainder of line and move cursor back to the beginning of the line:

```
100 FOR I=1 TO 10 STEP .25 : PRINT I, I↑2, I↑3 : NEXT : PRINT"DONE"  
100 _
```

You can also exit the Insert subcommand and save all changes by hitting ENTER. This will return you to Command mode.

A (Cancel and Restart)

Moves the cursor back to the beginning of the program line and cancels editing changes already made. For example, if you have added, deleted, or changed something in a line, and you wish to go back to the beginning of the line and cancel the changes already made: first hit SHIFT ↑ (to escape from any subcommand you may be executing); then hit A. (The cursor will drop down to the next line, display the line number and move to the first program character.

E (Save Changes and Exit)

Causes Computer to end editing and save all changes made. You must be in Edit Mode, not executing any subcommand, when you hit E to end editing.

Q (Cancel and Exit)

Tells Computer to end editing and cancel all changes made in the current editing session. If you've decided not to change the line, type Q to cancel changes and leave Edit Mode.

H (Hack and Insert)

Tells Computer to delete remainder of line and lets you insert material at the current cursor position. Hitting ← will actually delete a character from the line in this mode. For example, using line 100 listed above, enter the Edit Mode and space over to the last statement, PRINT"DONE". Suppose you wish to delete this statement and insert an END statement. Display will show:

```
100 FOR I=1 TO 10 STEP .25 : PRINT I, I↑2, I↑3 : NEXT : _
```

Now type H and then type END. Hit **ENTER** key. List the line:

```
100 FOR I=1 TO 10 STEP .25 : PRINT I, I↑2, I↑3 : NEXT : END
```

should be displayed.

nD (Delete)

Tells Computer to delete the specified number n characters to the right of the cursor. The deleted characters will be enclosed in exclamation marks to show you which characters were affected. For example, using line 100, space over to the PRINT command statement:

```
100 FOR I=1 TO 10 STEP .25 : _
```

Now type 19D. This tells the Computer to delete 19 characters to the right of the cursor. The display should show something like this:

```
100 FOR I=1 TO 10 STEP .25 : !PRINT I, I↑2, I↑3 : !_
```

When you list the complete line, you'll see that the PRINT statement has been deleted.

***n*C (Change)**

Tells the Computer to let you change the specified number of characters beginning at the current cursor position. If you type C without a preceding number, the Computer assumes you want to change one character. When you have entered *n* number of characters, the Computer returns you to the Edit Mode (so you're not in the *n*C Subcommand). For example, using line 100, suppose you want to change the final value of the FOR-NEXT loop, from " 10" to " 15". In the Edit Mode, space over to just before the "0" in "10".

```
100 FOR I=1 TO 1_
```

Now type C. Computer will assume you want to change just one character. Type 5, then hit L. When you list the line, you'll see that the change has been made.

```
100 FOR I=1 TO 15 STEP .25 : NEXT : END
```

would be the current line if you've followed the editing sequence in this chapter.

The ← does not work as a backspace under the C command in Edit mode. Instead, it replaces the character you want to change with a backspace. So it should not be used. If you make a mistake while typing in a change, Edit the line again to correct it, instead of using ←.

***n*Sc (Search)**

Tells the Computer to search for the *n*th occurrence of the character *c*, and move the cursor to that position. If you don't specify a value for *n*, the Computer will search for the first occurrence of the specified character. If character *c* is not found, cursor goes to the end of the line. Note: The Computer only searches through characters to the right of the cursor.

For example, using the current form of line 100, type EDIT 100 (ENTER) and then hit **2S**: . This tells the Computer to search for the second occurrence of the colon character. Display should show:

```
100 FOR I=1 TO 15 STEP.25 : NEXT _
```

You may now execute one of the subcommands beginning at the current cursor position. For example, suppose you want to add the counter variable after the NEXT statement. Type I to enter the Insert subcommand, then type the variable name, I. That's all you want to insert, so hit SHIFT ↑ to escape from the Insert subcommand. The next time you list the line, it should appear as:

```
100 FOR I=1 TO 15 STEP.25 : NEXT I : END
```

***nKc* (Search and "Kill")**

Tells the Computer to delete all characters up to the *n*th occurrence of character *c*, and move the cursor to that position. For example, using the current version of line 100, suppose we want to delete the entire line up to the END statement. Type EDIT 100 (ENTER), and then type **2K:** . This tells the Computer to delete all characters up to the 2nd occurrence of the colon. Display should show:

```
100 !FOR I=1 TO 15 STEP .25 : NEXT I!_
```

The second colon still needs to be deleted, so type D . The Display will now show:

```
100 !FOR I=1 TO 15 STEP .25 : NEXT I!!!_
```

Now hit ENTER and type LIST 100 (ENTER).

Line 100 should look something like this:

```
100 END
```

10 / Expansion Interface

An Expansion Interface is available for the TRS-80 LEVEL II Computer. This interface will allow the use of additional Input/Output devices. There is also a provision for adding RAM memory. The Interface will allow four major additions to the TRS-80:

1. An additional cassette deck
2. A TRS-80 Line Printer
3. Up to four Mini-Disks
4. Up to 48K bytes of RAM Memory
(32K in the Expansion Interface)

These devices are available through your Radio Shack store or dealer. To set up the Expansion Interface and any of the external devices, see the Expansion Interface instructions.

When the Expansion Interface is hooked up to the TRS-80, the Computer assumes that a Mini-Disk is interfaced. The Mini Disk will allow the use of additional commands and statements listed later. Even if you don't have a Mini Disk, the Computer will assume you do (because of the presence of the Disk Controller) and will try to input special instructions from the Disk Controller. Therefore, to use the Interface without a Mini Disk, hold down the BREAK key as you turn on the TRS-80. This will override the mini-disk mode and allow normal LEVEL II operation. Whenever you need to press the Reset button, you must also hold down the **BREAK** key.

Dual Cassettes

The use of two cassettes will allow a much more efficient and convenient manner of updating data stored on tape. For example, if you have payroll data stored on tape, the information can be read in one item at a time from cassette # 1 then changed or added and written out on cassette #2, one item at a time. The routine might look like this:

```
10 INPUT #-1,A,B,C,D
20 PRINT "MAKE CORRECTIONS HERE: RETYPE LINE"
30 INPUT A,B,C,D
40 PRINT "THE LINE NOW READS:" A,B,C,D
50 PRINT "STORING ON TAPE #2..."
60 PRINT #-2,A,B,C,D
70 GOTO 10
```

This is a very simple application; however, very powerful routines can be constructed to allow input and output of data using two tapes simultaneously.

Commands can also be given the device numbers to allow you to control the cassette decks. The cassette related commands are CLOAD, CSAVE, and CLOAD?. When given the cassette numbers (1 or 2) they will specify the cassette that is to operate. For example:

CLOAD #-1, "A"

(the position of the comma is very important) will load the file "A" from cassette # 1.

CSAVE #-2, "A"

will transfer the resident program to cassette tape #2.

CLOAD #-2, ?"A"

will verify a program on cassette #2.

See Chapter 2, **CLOAD, CLOAD?, CSAVE,**

Line Printer

A line printer can give you a hard copy of information generated by your TRS-80. There are several commands which allow various line printer applications. If you attempt to execute these commands when a line printer is not connected (or is turned off) the Computer will "freeze up". Either turn on the line printer, or if one isn't connected, Reset the Computer. If you have the Expansion Interface, you must hold down the Break key while you press Reset. Reset with the Expansion Interface connected will cause BASIC to lose your program.

LLIST

Works like LIST, but outputs to the Printer

LLIST	List current program to printer.
LLIST 100-	Will list line 100 to the end of the program to the line printer.
LLIST 100-200	Will list line 100 through 200 to the line printer.
LLIST.	Lists current line to the line printer.
LLIST-100	Lists all lines up to and including line 100 to the line printer.

See Chapter 2, LIST.

LPRINT

This command or statement allows you to output information to the Line Printer. For example, LPRINT A will list the value of A to the line printer. LPRINT can also be used with all the options available with **PRINT except PRINT @**.

Examples:

LPRINT *variable or expression* lists the variable or expression to the line printer.

LPRINT USING prints the information to the line printer using the form at specified.

LPRINT TAB will move the line printer carriage position to the right as indicated by the TAB expression.

The maximum TAB value for an LPRINT statement is 63. But there's a simple way to tab past column 63 on a line printer using the STRING\$ function.

Example:

```
10 LPRINT TAB(5) "NAME" TAB(30) "ADDRESS" STRING$(63,32) "BALANCE"
```

will print NAME at column 5, ADDRESS at column 30, and BALANCE at column 100.

See Chapter 3, **PRINT**.

Codes

Several codes are used to control the output of the line printer. You can LPRINT CHR\$(n) where n is the TRS-80 Control Code from the chart below to execute these functions.

LPRINT CHR\$(10)

will generate a line feed.

CODE	FUNCTION
10	line feed with carriage return
11	move carriage to top of form (page)
12	move carriage to top of form (page)
13	line feed with carriage return
138	interpreted as a carriage return/line feed

For example:

```
10 LPRINT "LINE ONE" CHR$(10) "LINE TWO" CHR$(10) "LINE THREE"
```

produces

```
LINE ONE  
LINE TWO  
LINE THREE
```

NOTE: At the end of a line, a line feed is automatically generated unless a semi-colon is used at the end of the PRINT statement.

The top of form code (11 or 12) must be the first item in an LPRINT list. Any preceding items will be ignored. For example, use

LPRINT CHR\$(11) "THIS IS THE FIRST LINE" and **not**
LPRINT "THIS IS THE FIRST LINE" CHR\$(11). In the second case, the sentence will be ignored.

The linefeed/carriage return codes (10 or 13) should not be placed at the beginning of an LPRINT or they will be ignored.

NOTE: CHR\$(138) will produce a carriage return wherever it is used in an LPRINT list.

The top of form codes (11 or 12) are passive codes. The Computer does not sense when it is at the end of a page and automatically advance to the next page. You must tell it each time you want it to advance using these codes.

But once you do this, the Computer will calculate the correct number of lines it needs to space to get to the next page. It keeps track of the number of lines that have already been printed on this page in the line counter, address 16425. At address 16424, it stores the number of lines allowed per page. By subtracting the number of lines already printed from the number allowed per

page, it figures the number of lines to leave blank and then it spaces down this amount to start the next page.

When the Computer is first powered up, the page size is initialized to 66 lines per page, but you can change this by using the POKE command to change the value stored at address 16424.

For example:

POKE 16424,40

changes the size to 39 lines per page. The value at 16424 = page length + 1.

At the beginning of your program you should set the line counter to 1. This only needs to be done once. The Computer will reset it to 1 each time you execute a form feed, LPRINT CHR\$(11). Initialize it by executing a POKE 16425,1.

The line printer will print 6 lines per inch. If each page is 11 inches high POKE 16424,67 for 66 lines/page. In general, multiply 6 by the number of inches in height of the page you are using and add 1 to get the value you should POKE into address 16424.

Some printers will respond to additional Control Codes in a similar way, using LPRINT CHR\$(control code). Check your printer manual to find out what functions it will perform and the decimal number control code to use them.

The line printer will print 6 lines per inch and 66 lines per page. If this format is not suitable, the number of lines per page can be changed by POKEing the new number of lines into memory location 16424.

Example:

POKE 16424,40

POKE 16425,0

This instructs the Line Printer to print 39 lines per page, and resets the line counter to zero.

Mini-Disks - (DISK BASIC)

The TRS-80 Mini Disk System is a small version of a floppy disk. The disk allows vast file storage space and much quicker access time than you get with tape storage. Drive 0 will contain about 58,880 bytes of free space for files. Each additional disk will have 83,060 bytes of file space. The disk system has its own set of commands, which allow manipulations of files and expanded abilities in file use. The TRS-80 Mini Disk System allows both sequential and random access. The disks will also allow use of several additional BASIC commands and functions, including:

Commands:

CLOSE	LSET	PUT
FIELD	NAME	RSET
GET	OPEN	MERGE
KILL	PRINT	LOAD
		SAVE

I/O Functions

CVD	LOF
CVI	MKD\$
CVS	MKI\$
EOF	MKS\$

Additions to LEVEL II

Ten USR calls – USR0 through USR9	INSTR (performs function of INSTRING subroutine – see Chapter 4)
&H (hex constants)	
&O (octal constants)	TIME\$ (Date and 24-Hr. Real-Time Clock.)
DEFUSR	
LINE INPUT	DEF FN (User Defined Functions)
MID\$ (on left side of equation)	

For explanation of these commands functions, see the TRS-80 Disk Operating System Manual.

Expansion of RAM Memory

The TRS-80 Expansion Interface has provisions for adding extra RAM memory. This is done by adding RAM memory chips. You can add up to 32,768 additional bytes of memory. For price information and free installation, see your Radio Shack store or dealer.

11 / Saving Time and Space

Most LEVEL II programs are faster and take up less memory space than their LEVEL I counterparts. But even with its inherently more efficient features, LEVEL II can be further streamlined by following a few simple guidelines when constructing your program.

Saving Memory Space

1) When your program is operating properly, delete all unnecessary REM statements from your running version.

2) Do not use unnecessary spaces between statements, operators, etc.

3) When possible, use multiple-statement program lines (with a colon between each two statements). Each time you enter a new line number it costs you 5 bytes.

4) Use integer variables whenever possible, for example,

FOR I% = 1 TO 10

Integers take only five bytes. Single precision takes 7 and double precision takes 11 bytes.

5) Using subroutines will save program space if the operation is called from different places several times. If a routine is always called from the same place, use unconditional branches (GOTO's). Each active GOSUB takes 6 bytes; a GOTO takes none at Run time.

6) Structure your calculations so as to use as few parentheses as possible (refer to Chapter 1, "Arithmetic Operators"). It takes 4 bytes to process parentheses. And since these operations inside parentheses are done first, the result of each parenthetical expression must be stored (this takes 12 bytes).

7) Dimension arrays sparingly. When you set up a matrix, the Computer reserves 11 subscript addresses for each DIMension, even if the space is not filled. Use the zero subscripted elements, since they are always available.

8) Use DEF statements when you will be working with values other than single precision (strings, integers and double precision). A DEF statement takes 6 bytes but this is made up for fairly quickly since you don't need to use type declaration characters with the variable names.

Speeding Up Execution

The speed at which a program is processed will depend on the complexity of the operations and the number of instructions. In most simple programs, speed will not be a factor. It will seem as though the answer is returned the moment you enter RUN. However, as you begin writing longer and more intricate programs, speed will become a significant factor. Here are some suggestions to guide you in designing speedier programs.

- 1) Delete all unnecessary lines in the program (REM statements, etc.)
- 2) Combine multi-statement program lines when practical.
- 3) Use variables rather than constants in operations (very important). Your TRS-80 normally operates using floating decimal point values. It takes a lot less time to access a variable than to convert a constant to floating point representation. For example: if you will use π a lot in a program, define π as a variable (PI=3.14159) and use the variable (PI) in the operations.
- 4) Use POKE graphics. This can speed up your graphics displays by a factor of 6.
- 5) Define the most commonly used variables first. When a variable is defined it is located at the top of the variable table. The second will be just below that. When variables are accessed, the table will be searched to find the variable. Therefore, you will save time by locating frequently used variables at the top of the table (by defining them first). The Computer will not have to look as far to find them.
- 6) Use integer variables, especially in FOR-NEXT loops, when possible. This is most important of all.

Appendix

A / Level II Summary

Command Mode	Function	Page
ENTER	Return carriage and interpret command	1/3
←	Cursor backspace and delete last character typed	1/3
SHIFT ←	Cursor to beginning of line; erase line	1/3
↓	Linefeed	1/3
:	Statement delimiter; use between statements on same logical line	1/3
→	Move cursor to next tab stop. Tab stops are at positions 0, 8, 16, 24, 32, 48, and 56.	1/3
SHIFT →	Convert display to 32 characters per line	1/3
CLEAR	Clear Display and convert to 64 characters per line	1/3

Execute Mode	Function	Page
SHIFT @	Pause in execution; freeze display during LIST	1/3
BREAK	Stop execution	1/3
ENTER	Interpret data entered from Keyboard with INPUT statement	1/3

Abbreviations	Function	Page
?	Use in place of PRINT.	1/8
'	Use in place of :REM	1/8
.	"current line"; use in place of line number with LIST, EDIT, etc.	1/8

Type Declaration Characters

Character	Type	Examples	Page
\$	String	A\$, ZZ\$	1/4
%	Integer	A1%, SUM%	1/4
!	Single-Precision	B!, N1!	1/4
#	Double-Precision	A#, 1/3#	1/4
D	Double-Precision (exponential notation)	1.23456789D-12	1/4
E	Single-Precision (exponential notation)	1.23456E+30	1/4

Arithmetic Operators Page

+	add	1/5
-	subtract	1/5
*	multiply	1/5
/	divide	1/5
↑	exponentiate (e.g., $2^3 = 8$)	1/5

String Operator page

+	concatenate (string together)	"2" + "2" = "22"	1/7
---	-------------------------------	------------------	-----

Relational Operators

Symbol	in numeric expressions	in string expressions	Page
<	is less than	precedes	1/6-7
>	is greater than	follows	1/6-7
=	is equal to	equals	1/6-7
< = or <	is less than or equal to	precedes or equals	1/6-7
> = or >	is greater than or equal to	follows or equals	1/6-7
< > or > <	does not equal	does not equal	1/6-7

Order of Operations	Page
↑ (Exponentiation)	1/7
– (Negation)	1/7
*, /	1/7
+, -	1/7
Relational operators	1/7
NOT	1/7
AND	1/7
OR	1/7
Precedence order is from left to right for operators on the same level	1/7

Commands

Command/Function	Examples	Page
AUTO mm,nn Turn on automatic line numbering beginning with mm, using increment of nn.	AUTO AUTO 10 AUTO 5,5 AUTO . , 10	2/1
CLEAR Set numeric variables to zero, strings to null.	CLEAR	2/2
CLEAR n Same as CLEAR but also sets aside n bytes for strings.	CLEAR 500 CLEAR MEM/4	2/2
CLOAD Load a BASIC program from tape	CLOAD "A" CLOAD#-1, "A" (with expansion interface)	2/2
CLOAD? Verifies BASIC program on tape to one in memory	CLOAD? "A" CLOAD#-2, ? "A" (with expansion interface)	2/3
CONT Continue after BREAK or STOP in execution.	CONT	2/3

Command/Function	Examples	Page
CSAVE Save a BASIC program on tape	CSAVE "A" CSAVE #-2,"A" (with expansion interface)	2/4
DELETE mm-nn Delete program line from line mm to line nn.	DELETE 100 DELETE 10-50 DELETE .	2/4
EDIT mm Enter Edit Mode for line mm. See Edit Mode Sub-commands below.	EDIT 100 EDIT .	2/5
LIST mm-nn List all program lines from mm to nn.	LIST LIST 30-60 LIST 30- LIST -90 LIST .	2/5
NEW Delete entire program and reset all variables, pointers etc.	NEW	2/5
RUN mm Execute program beginning at lowest numbered line or mm if specified.	RUN RUN 55	2/6
SYSTEM Enter Monitor Mode for loading of machine-language file from cassette.	See Chapter 2	2/6
TROFF Turn off Trace	TROFF	2/7
TRON Turn on Trace	TRON	2/7

Edit Mode Subcommands and Function Keys

Sub-Command	Function	Page
ENTER	End editing and return to Command Mode.	9/2
SHIFT ↑	Escape from X, I, and H subcommands and remain in Edit Mode.	9/3
<i>n</i>Space-Bar	Move cursor <i>n</i> spaces to right.	9/2
<i>n</i> ←	Move cursor <i>n</i> spaces to left.	9/3
L	List remainder of program line and return to beginning of line.	9/4
X	List remainder of program line, move cursor to end of line, and start Insert subcommand.	9/4
I	Insert the following sequence of characters at current cursor position; use Escape to exit this subcommand.	9/5
A	Cancel changes and return cursor to beginning of line	9/5
E	End editing, save all changes and return to Command Mode.	9/5
Q	End editing, cancel all changes made and return to Command Mode.	9/6
H	Delete remainder of line and insert following sequence of characters; use Escape to exit this subcommand.	9/6
<i>n</i>D	Delete specified number of characters <i>n</i> beginning at current cursor position.	9/6
<i>n</i>C	Change (or replace) the specified number of characters <i>n</i> using the next <i>n</i> characters entered.	9/7
<i>n</i>Sc	Move cursor to <i>n</i> th occurrence of character <i>c</i> , counting from current cursor position.	9/7
<i>n</i>Kc	Delete all characters from current cursor position up to <i>n</i> th occurrence of character <i>c</i> , counting from current cursor position.	9/8

Input/Output Statements

Statement/Function	Examples	Page
PRINT <i>exp</i>* Output to Display the value of <i>exp</i> . <i>Exp</i> may be a numeric or string expression or constant, or a list of such items. Comma serves as a PRINT modifier. Causes cursor to advance to next print zone. Semi-colon serves as a PRINT modifier. Inserts a space after a numeric item in PRINT list. Inserts no space after a string item. At end of PRINT list, suppresses the automatic carriage return.	PRINT A\$ PRINT X+3 PRINT "D=" D PRINT 1,2,3,4 PRINT "1","2" PRINT 1,,2 PRINT X;"=ANSWER" PRINT X;Y;Z PRINT "ANSWER IS";	3/1-2
PRINT @ <i>n</i> PRINT modifier; begin PRINTing at specified display position <i>n</i> .	PRINT @540,"CENTER" PRINT @N+3,X*3	3/3
PRINT TAB <i>n</i> Print modifier: moves cursor to specified Display position <i>n</i> (expression).	PRINT TAB(N) N	3/3
PRINT USING <i>string;exp</i> PRINT format specifier; output <i>exp</i> in form specified by string field (see below).	PRINT USING A\$;X PRINT USING "#.#";Y+Z	3/4-8
INPUT "<i>message</i>";<i>variable</i> Print message (if any) and await input from Keyboard.	INPUT"ENTER NAME";A\$ INPUT"VALUE";X INPUT"ENTER NUMBERS";X,Y INPUT A,B,C,D\$	3/8-10
PRINT #-1 Output to Cassette #1.	PRINT #-1,A,B,C,D\$	3/12
INPUT #-1 Input from Cassette #1.	INPUT #-1,A.B,C,DS	3/12-13

**exp* may be a string of numeric constant or variable, or a list of such items.

Statement/Function	Examples	Page
DATA <i>item list</i> Hold data for access by READ statement	DATA 22,33,11,1.2345 DATA "HALL ", "SMITH ", "DOE	3/10
READ <i>variable list</i> Assign value(s) to the specified variable(s), starting with current DATA element.	READ A,A1,A2,A3 READ A\$,B\$,C\$,D	3/10-11
RESTORE Reset DATA pointer to first item in first DATA statement.	RESTORE	3/11

Field Specifiers for PRINT USING statements

Numeric Character	Function	Example	Page
#	Numeric field (one digit digit per #).	###	3/4
.	Decimal point position.	##.###	3/4
+	Print leading or trailing signs (plus for positive numbers, minus for negative numbers).	+#.### #.###+ -#.### #.###-	3/5
-	Print trailing sign only if value printed is negative.	###.##-	3/5
**	Fill leading blanks with asterisk.	**###.##	3/4
\$\$	Place dollar sign immediately to left of leading digit	\$\$#####.##	3/4
**\$	Dollar sign to left of leading digit and fill leading blanks with asterisks.	**\$#####.##	3/4
↑↑↑↑	Exponential format, with one significant digit to left of decimal.	#.##↑↑↑↑	3/4

String Character	Function	Example	Page
!	Single character.	!	3/5
%spaces%	String with length equal to 2 plus number of spaces between % symbols.	% %	3/5

Program Statements

Statement/Function	Examples	Page
(Type Definition)		
DEFDBL <i>letter list or range</i> Define as double-precision all variables beginning with specified letter, letters or range of letters.	DEFDBL J DEFDBL X,Y,A DEFDBL A-E,J	4/3
DEFINT <i>letter list or range</i> Define as integer all variables beginning with specified letter, letters or range of letters.	DEFINT A DEFINT C,E,G DEFINT A-K	4/2
DEFSNG <i>letter list or range</i> Define as single-precision all variables beginning with specified letter, letters or range of letters	DEFSNG L DEFSNG A-L,Z DEFSNG P,R,A-K	4/3
DEFSTR <i>letter list or range</i>	DEFSTR A-J	4/4
(Assignment and Allocation)		
CLEAR <i>n</i> Set aside specified number of bytes <i>n</i> for string storage. Clears value and type of all variables.	CLEAR 750 CLEAR MEM/10 CLEAR 0	4/4
DIM <i>array(dim#1, ...,dim#k)</i> Allocate storage for k-dimensional <i>array</i> with the specified size per dimension: dim#1, dim#2, ..., etc. DIM may be followed by a list of arrays separated by commas.	DIM A(2,3) DIM A1(15),A2(15) DIM B(X+2),C(J,K) DIM T(3,3,5)	4/4-5 6/1-7

Statement/Function	Examples	Page
LET <i>variable=expression</i> Assign value of expression to variable. LET is optional in LEVEL II BASIC.	LET A\$="CHARLIE" LET B1=C1 LET A%=I#	4/5
(Sequence of Execution)		
END End execution, return to Command Mode.	99 END	4/6
STOP Stop execution, print Break message with current line number. User may continue with CONT.	100 STOP	4/6
GOTO <i>line-number</i> Branch to specified line-number.	GOTO 100	4/7
GOSUB <i>line-number</i> Branch to sub-routine beginning at line-number.	GOSUB 3000	4/7
RETURN Branch to statement following last-executed GOSUB.	RETURN	4/8
ON <i>exp</i> GOTO <i>line#1, ...,line#k</i> Evaluate expression; if INT (<i>exp</i>) equals one of the numbers 1 through <i>k</i> , branch to the appropriate line number. Otherwise go to next statement.	ON K+1 GOTO 100,200,300	4/8
ON <i>exp</i> GOSUB <i>line#1, ...,line#k</i> Same as ON ... GOTO except branch is sub-routine beginning at <i>line#1, line#2, ..., or line#k</i> , depending on <i>exp</i> .	ON J GOSUB 330,700	4/9
FOR <i>var=exp</i> TO <i>exp</i> STEP <i>exp</i> Open a FOR-NEXT loop. STEP is optional; if not used, increment of one is used.	FOR I=1 TO 50 STEP 1.5 FOR M%=J% TO K%-1	4/10-12

Statement/Functions	Examples	Page
NEXT <i>variable</i> Close FOR-NEXT loop. Variable may be omitted. To close nested loops, a variable list may be used. See Chapter 4.	NEXT NEXT I NEXT I,J,K	4/10-12
ERROR (<i>code</i>) Simulate the error specified by code (See Error Code Table).	ERROR (14)	4/ 13
ON ERROR GOTO <i>line-number</i> If an error occurs in subsequent program lines, branch to error routine beginning at line-number.	ON ERROR GOTO 999	4/13
RESUME <i>n</i> Return from error routine to line specified by <i>n</i> . If <i>n</i> is zero or not specified, return to statement containing error. If <i>n</i> is "NEXT", return to statement following error-statement.	RESUME RESUME 0 RESUME 100 RESUME NEXT	4/14
RANDOM Reseeds random number generator.	RANDOM	7/4
REM REMark indicator; ignore rest of line.	REM A IS ALTITUDE	4/15
(Tests - Conditional Statements)		
IF <i>exp-1</i> THEN <i>statement-1</i> ELSE <i>statement-2</i> Tests <i>exp-1</i> : If True, execute <i>statement-1</i> then jump to next program line (unless <i>statement-1</i> was a GOTO). If <i>exp-1</i> is False, jump directly to ELSE <i>statement-2</i> and execute subsequent statements.	IF A=0 THEN PRINT "ZERO" ELSE PRINT "NOT ZERO"	4/15-17

Statement/Function	Examples	Page
(Graphics Statements)		
CLS Clear Video Display	CLS	8/2
RESET(<i>x,y</i>) Turn off the graphics block with horizontal coordinate <i>x</i> and vertical coordinate <i>y</i> , 0 <= X < 128 and 0 <= Y < 48	RESET (8+B,11)	8/2
SET(<i>x,y</i>) Turn on the graphics block specified by coordinates <i>x</i> and <i>y</i> . Same argument limits as RESET	SET (A*2,B+C)	8/1-2
(Special Statements)		
POKE <i>location, value</i> Load <i>value</i> into memory <i>location</i> (both arguments in decimal form) 0 <= <i>value</i> <=255.	POKE 15635,34 POKE 17770,A+N	8/6
OUT <i>port, value</i> Send <i>value</i> to <i>port</i> (both arguments between 0 and 255 inclusive)	OUT 255,10 OUT 55,A	8/5

String Functions

Function	Operation	Examples	Page
<i>ASC(string)</i>	Returns ASCII code of first character in string argument.	ASC (B\$) ASC ("H")	5/5
<i>CHR\$(code exp)</i>	Returns a one-character string defined by code. If code specifies a control function, that function is activated.	CHR\$ (34) CHR\$ (I)	5/5-6
<i>FRE(string)</i>	Returns amount of memory available for string storage Argument is a dummy variable.	FRE (A\$)	5/6
<i>INKEY\$</i>	Strobes Keyboard and returns a one-character string corresponding to key pressed during strobe (null string if no key is pressed).	INKEY\$	5/7
<i>LEFT\$(string,n)</i>	Returns first n characters of string.	LEFT\$ (A\$, 1) LEFT\$ (L1\$+C\$, 8) LEFT\$ (A\$,M+L)	5/8
<i>LEN(string)</i>	Returns length of string (zero for null string).	LEN (A\$+B\$) LEN ("HOURS")	5/8
<i>MID\$(string,p,n)</i>	Returns substring of string with length n and starting at position pin string.	MID\$ (M\$, 5 , 2) MID\$ (M\$+B\$, P , L-1)	5/9
<i>RIGHTS(string,n)</i>	Returns last n characters of string.	RIGHT\$ (NA\$, 7) RIGHT\$ (AB\$,M2)	5/9
<i>STR\$(numeric exp)</i>	Returns a string representation of the evaluated argument.	STR\$ (1 . 2345) STR\$ (A+B*2)	5/9-10
<i>STRING\$(n,char)</i>	Returns a sequence of n char symbols using first character of char.	STRING\$ (30 , " . ") STRING\$ (25 , "A") STRING\$ (5 , C\$)	5/10
<i>VAL(string)</i>	Returns a numeric value corresponding to a numeric-valued string.	VAL ("1 "+A\$+" . "+C\$) VAL (A\$+B\$) VAL (G1\$)	5/11

**string* may be a string variable, expression, or constant:

Arithmetic Functions*

Function	Operation (unless noted otherwise, -1.7E+38 <= <i>exp</i> <= 1.7E+38)	Examples	Page
ABS(<i>exp</i>)	Returns absolute value.	ABS (L* . 7) ABS (SIN (X))	7/1
ATN(<i>exp</i>)	Returns arctangent in radians.	ATN (2 . 7) ATN (A*3)	7/1
CDBL(<i>exp</i>)	Returns double-precision representation of <i>exp</i> .	CDBL (A) CDBL (A+1/3#)	7/2
CINT(<i>exp</i>)	Returns largest integer not greater than <i>exp</i> . Limits: -32768 <= <i>exp</i> <+32768.	CINT (A#+B)	7/2
COS(<i>exp</i>)	Returns the cosine of <i>exp</i> ; assumes <i>exp</i> is in radians.	COS (2*A) COS (A/57.29578)	7/2
CSNG(<i>exp</i>)	Returns single-precision representation, with 5/4 rounding in least significant decimal when <i>exp</i> is double-precision.	CSNG (A#) CSNG (.33*B#)	7/2
EXP(<i>exp</i>)	Returns the natural exponential, $e^{\text{exp}} = \text{EXP}(\text{exp})$.	EXP (34 . 5) EXP (A*B*C-1)	7/3
FIX(<i>exp</i>)	Returns the integer equivalent to truncated <i>exp</i> (fractional part of <i>exp</i> is chopped off).	FIX (A-B)	7/3
INT(<i>exp</i>)	Returns largest integer not greater than <i>exp</i> .	INT (A+B*C)	7/3
LOG(<i>exp</i>)	Returns natural logarithm (base e) of <i>exp</i> . Limits: <i>exp</i> must be positive.	LOG (12 . 33) LOG (A* B+B)	7/3
RND(0)	Returns a pseudo-random number between 0.000001 and 0.999999 inclusive.	RND (0)	7/4
RND(<i>exp</i>)	Returns a pseudo-random number between 1 and INT(<i>exp</i>) inclusive. Limits: 1 <= <i>exp</i> 32768.	RND (40) RND (A+B)	7/4

**exp* is any numeric-valued expression or constant.

Function	Operation	Examples	Page
SGN(<i>exp</i>)	Returns -1 for negative <i>exp</i> ; 0 for zero <i>exp</i> ; +1 for positive <i>exp</i> .	SGN (A*B+3) SGN (COS (X))	7/4
SIN(<i>exp</i>)	Returns the sine of <i>exp</i> ; assumes <i>exp</i> is in radians.	SIN (A/B) SIN (90/57.29578)	7/4
SQR(<i>exp</i>)	Returns square root of <i>exp</i> . Limits: <i>exp</i> must be non-negative.	SQR (A*A-B*B)	7/5
TAN(<i>exp</i>)	Returns the tangent of <i>exp</i> ; assumes <i>exp</i> is in radians.	TAN (X) TAN (X*.01745329)	7/5

Special Functions

Function	Operation and Limits	Examples	Page
ERL	Returns line number of current error.	ERL	8/3
ERR	Returns a value related to current error code (if error has occurred). ERR=(error code-1)*2. Also: (ERR/2)+1=error code.	ERR/2+1	8/4
INP(<i>port</i>)	Inputs and returns the current value from the specified <i>port</i> . Both argument and result are in the range 0 to 255 inclusive.	INP (55)	8/4
MEM	Returns total unused and unprotected bytes in memory. Does not include unused string storage space.	MEM	8/5
PEEK(<i>location</i>)	Returns value stored in the specified memory byte. <i>location</i> must be a valid memory address in decimal form (see Memory Map in Appendix D).	PEEK (15370)	8/6
POINT(<i>x,y</i>)	Checks the graphics block specified by horizontal coordinate <i>x</i> and vertical coordinate <i>y</i> . If block is "on", returns a True (-1); if block is "off", returns a False (0). Limits: $0 \leq x < 128$; $0 \leq y < 48$.	POINT (A*2 ,B+C)	8/2
POS(0)	Returns a number indicating the current cursor position. The argument "0" is a dummy variable.	POS (0)	8/7

Function	Operation and Limits	Examples	Page
USR(<i>n</i>)	Branches to machine language sub-routine. See Chapter 8.	USR(0)	8/8-12
VARPTR(<i>var</i>)	Returns the address where the specified variable's name, value and pointer are stored, <i>var</i> must be a valid variable name.	VARPTR(A\$) VARPTR(N1)	8/13-15

LEVEL II Reserved Words*

@	FIX	PEEK
ABS	FOR	POINT
AND	FORMAT	POKE
ASC	FRE	POS
ATN	FREE	POSN
AUTO	GET	PRINT
CDBL	GOSUB	PUT
CHR\$	GOTO	RANDOM
CINT	IF	READ
CLEAR	INKEY\$	REM
CLOCK	INP	RENAME
CLOSE	INPUT	RESET
CLS	INSTR	RESTORE
CMD	INT	RESUME
CONT	KILL	RETURN
COS	LEFT \$	RIGHT \$
CSNG	LET	RND
CVD	LSET	RSET
CVI	LEN	SAVE
CVS	LINE	SET
DATA	LIST	SGN
DEFDBL	LOAD	SIN
DEFFN	LOC	SQR
DEFINT	LOF	STEP
DEFSNG	LOG	STOP
DEFUSR	MEM	STRING\$
DEFSTR	MERGE	STR\$
DELETE	MID\$	TAB
DIM	MKD\$	TAN
EDIT	MKI\$	THEN
ELSE	MKS\$	TIME\$
END	NAME	TO
EOF	NEW	TROFF
ERL	NEXT	TRON
ERR	NOT	USING
ERROR	ON	USR
EXP	OPEN	VAL
FIELD	OR	VARPTR
FIX	OUT	VERIFY

- * Many of these words have no function in LEVEL II BASIC; they are reserved for use in LEVEL II DISK BASIC. None of these words can be used inside a variable name. You'll get a syntax error if you try to use these words as variables.

Program Limits and Memory Overhead

RANGES

Integers	-32768 to +32767 inclusive
Single Precision	-1.701411E±38 to +1.701411E±38 inclusive
Double Precision	-1.701411834544556E+38 to +1.701411834544556E+38 inclusive

String Range: Up to 255 characters

Line Numbers Allowed: 0 to 65529 inclusive

Program Line Length: Up to 255 characters

MEMORY OVERHEAD

Program lines require 5 bytes minimum, as follows:

- Line Number - 2 bytes
- Line Pointer - 2 bytes
- Carriage Return - 1 byte

In addition, each reserved word, operator, variable name, special character and constant character requires one byte.

DYNAMIC (RUN-TIME) MEMORY ALLOCATION

Integer variables: 5 bytes each
(2 for value, 3 for variable name)

Single-precision variables: 7 bytes each
(4 for value, 3 for variable name)

Double-precision variables: 11 bytes each
(8 for value, 3 for variable name)

String variables: 6 bytes minimum
(3 for variable name, 3 for stack and variable pointers, 1 for each character)

Array variables: 12 bytes minimum
(3 for variable name, 2 for total size, 1 for number of dimensions,
2 for size of each dimension, and 2, 3, 4 or 8 [depending on array type]
for each element in the array)

Each active FOR-NEXT loop requires 16 bytes.

Each active (non-returned) GOSUB requires 6 bytes.

Each level of parentheses requires 4 bytes plus 12 bytes for each temporary value.

B / Error Codes

CODE	ABBREVIATION	ERROR
1	NF	NEXT without FOR
2	SN	Syntax error
3	RG	Return without GOSUB
4	OD	Out of data
5	FC	Illegal function call
6	OV	Overflow
7	OM	Out of memory
8	UL	Undefined line
9	BS	Subscript out of range
10	DD	Redimensioned array
11	/0	Division by zero
12	ID	Illegal direct
13	TM	Type mismatch
14	OS	Out of string space
15	LS	String too long
16	ST	String formula too complex
17	CN	Can't continue
18	NR	NO RESUME
19	RW	RESUME without error
20	UE	Unprintable error
21	MO	Missing operand
22	FD	Bad file data
23	L3	Disk BASIC only

Explanation of Error Messages

- NF NEXT without FOR: NEXT is used without a matching FOR statement. This error may also occur if NEXT *variable* statements are reversed in a nested loop.
- SN Syntax Error: This usually is the result of incorrect punctuation, open parenthesis, an illegal character or a mis-spelled command.
- RG RETURN without GOSUB: A RETURN statement was encountered before a matching GOSUB was executed.
- OD Out of Data. A READ or INPUT # statement was executed with insufficient data available. DATA statement may have been left out or all data may have been read from tape or DATA.
- FC Illegal Function Call: An attempt was made to execute an operation using an illegal parameter. Examples: square root of a negative argument, negative matrix dimension, negative or zero LOG arguments, etc. Or USR call without first POKEing the entry point.
- OV Overflow: The magnitude of the number input or derived is too large for the Computer to handle. NOTE: There is no underflow error. Numbers smaller than $\pm 1.701411\text{E-}38$ single precision or $\pm 1.701411834544556\text{E-}38$ double precision are rounded to 0. See /0 below.
- OM Out of Memory: All available memory has been used or reserved. This may occur with very large matrix dimensions, nested branches such as GOTO, GOSUB, and FOR-NEXT Loops.
- UL Undefined Line: An attempt was made to refer or branch to a non-existent line.
- BS Subscript out of Range: An attempt was made to assign a matrix element with a subscript beyond the DIMensioned range.
- DD Redimensioned Array: An attempt was made to DIMension a matrix, which had previously been dimensioned by DIM or by default statements. It is a good idea to put all dimension statements at the beginning of a program.
- /0 Division by Zero: An attempt was made to use a value of zero in the denominator. NOTE: If you can't find an obvious division by zero check for division by numbers smaller than allowable ranges. See OV above and RANGES page A/17.
- ID Illegal Direct: The use of INPUT as a direct command.
- TM Type Mismatch: An attempt was made to assign a non-string variable to a string or vice-versa.
- OS Out of String Space: The amount of string space allocated was exceeded.

LS	String Too Long: A string variable was assigned a string value which exceeded 255 characters in length.
ST	String Formula Too Complex: A string operation was too complex to handle. Break up the operation into shorter steps.
CN	Can't Continue: A CONT was issued at a point where no continuable program exists, e.g., after program was ENDED or EDITed.,
NR	No RESUME: End of program reached in error-trapping mode.
RW	RESUME without ERROR: A RESUME was encountered before ON ERROR GOTO was executed.
UE	Unprintable Error: An attempt was made to generate an error using an ERROR statement with an invalid code.
MO	Missing Operand: An operation was attempted without providing one of the required operands.
FD	Bad File Data: Data input from an external source (i.e., tape) was not correct or was in improper sequence, etc.
L3	DISK BASIC only: An attempt was made to use a statement, function or command which is available only when the TRS-80 Mini Disk is connected via the Expansion Interface.

Hard-To-Find Errors

Shifted-characters aren't always interchangeable with their unshifted counterparts. For example, PRINT @ won't work with a shifted-@ even though it looks OK on the Video.

If you can't find anything wrong with a line that causes a syntax error, try retyping it and watch out for the SHIFT key.

Spaces are sometimes important in LEVEL II BASIC. For example,

IF D<0D=0

will not work because 0D in the middle is interpreted as double precision zero. Change it to

IF D<0 THEN D=0

C / TRS-80 Character Codes

Bit-Pattern Codes

The following table illustrates the bit pattern for each of the 128 TRS-80 characters. The remaining 128 codes represent special graphics and space compression characters, as described later.

See Notes.

To use the table: Combine the most significant and least significant bit-patterns for a given character. For example, the character Q is represented by the pattern: 1010001 (decimal 81).

		MOST SIGNIFICANT BITS (b ₇ - b ₅)							
		000	001	010	011	100	101	110	111
LEAST SIGNIF. BITS (b ₄ - b ₁)	0000	NULL	OLE	SP	0	@	P	@	p
	0001	BREAK	DC1	!	1	A	Q	a	q
	0010	STX	DC2	"	2	B	R	b	r
	0011	ETX	DC3	#	3	C	S	c	s
	0100	EOT	DC4	\$	4	D	T	d	t
	0101	ENO	NAK	%	5	E	U	e	u
	0110	ACK	SYN	&	6	F	V	f	v
	0111	BEL	ETB	'	7	G	W	g	w
	1000	BKSP	CAN	(	8	H	X	h	x
	1001	HT	EM	)	9	I	Y	i	y
	1010	LF	SUB	*	:	J	Z	j	z
	1011	VT	ESC	+	;	K	↑	k	↑
	1100	FF	HOME	,	<	L	↓	I	↓
	1101	CR	BOL	-	=	M	←	m	←
	1110	CURON	EREOL	.	>	N	→	n	→
	1111	CUROFF	EREOF	/	?	O	_	o	DEL

Decimal/Hexadecimal Codes

Dec. Code	Hex. Code	Char.	Dec. Code	Hex. Code	Char.	Dec. Code	Hex. Code	Char.
0	00	NULL	32	20	SPACE	64	40	@
1	01	BREAK	33	21	!	65	41	A
2	02	STX	34	22	"	66	42	B
3	03	ETX	35	23	#	67	43	C
4	04	EOT	36	24	\$	68	44	D
5	05	ENO	37	25	%	69	45	E
6	06	ACK	38	26	&	70	46	F
7	07	BEL	39	27	'	71	47	G
8	08	BKSP	40	28	(	72	48	H
9	09	HT	41	29	)	73	49	I
10	0A	LF	42	2A	*	74	4A	J
11	0B	VT	43	2B	+	75	4B	K
12	0C	FF	44	2C	,	76	4C	L
13	0D	CR	45	2D	-	77	4D	M
14	0E	CURON	46	2E	.	78	4E	N
15	0F	CUROF	47	2F	/	79	4F	O
16	10	DLE	48	30	0	80	50	P
17	11	DC1	49	31	1	81	51	Q
18	12	DC2	50	32	2	82	52	R
19	13	DC3	51	33	3	83	53	S
20	14	DC4	52	34	4	84	54	T
21	15	NAK	53	35	5	85	55	U
22	16	SYN	54	36	6	86	56	V
23	17	ETB	55	37	7	87	57	W
24	18	CAN	56	38	8	88	58	X
25	19	EM	57	39	9	89	59	Y
26	1A	SUB	58	3A	:	90	5A	Z
27	1B	ESC	59	3B	;	91	5B	↑
28	1C	HOME	60	3C	<	92	5C	↓
29	1D	BOL	61	3D	=	93	5D	←
30	1E	EREOL	62	3E	>	94	5E	→
31	1F	EREOF	63	3F	?	95	5F	

Note: 96-127 (hex 60-7F) are lower-case counterparts to 64-95 (hex 40-5F).; however, only upper-case characters are displayable.

Notes
















The TRS-80 character set may be subdivided into the following functional groups:

<u>decimal code</u>	<u>hex code</u>	<u>function</u>
0-31	00-1F	Control characters
32-95	20-5F	Keyboard /display characters
96-127	60-7F	Non-displayable (code-32 is displayed instead); can be printed as lower case on a line printer that handles lower case characters.
128-191	80-BF	Graphics characters
192-255	C0-FF	Space-compression codes

Control Codes: 0-31

Dec. Code	Hex Code	Function
0-7	00-07	None
8	08	Backspace and erases current character
9	09	None
10	0A	Line feed with carriage return
11	0B	Move carriage to top of form (page)
12	0C	Move carriage to top of form (page)
13	0D	Line feed with carriage return
14	0E	Turns on cursor
15	0F	Turns off cursor
16-22	10-16	None
23	17	Converts to 32 character/line mode (Certain features work differently in 32 cpl. CHR\$(25) spaces only one-half to the right.)
24	18	Backspace ← Cursor
25	19	Advance. → Cursor
26	1A	Downward ↓ linefeed (not applicable to line printer)
27	1B	Upward ↑ linefeed (not applicable to line printer)
28	1C	Home, return cursor to display position (0,0) Also converts to 64 cpl
29	1D	Move cursor to beginning of line
30	1E	Erases to the end of the line
31	1F	Clear to the end of the frame
138	8A	Interpreted by line printer as a line feed with carriage return

The following control characters may be entered directly from the Keyboard:

Character	Key	Character	Key
BREAK		EM	 
BKSP		SUB	 
HT		ESC	 
LF		EREOF	
CR		SP	
CAN	 		

Graphics Codes: 128-191

For a description of the **graphics characters**, run the following program. If you do not have a line printer connected, change all LPRINTs to PRINTS and use the shift-@ key to pause the display. These codes are also displayed on a later page.

```
10 CLS: DEFINT A-Z
20 FORI=128 TO 191
30 POKE 15360,1
35 LPRINT CHR$(138)
40 LPRINT"GRAPHICS CODE # ": I
45 LPRINT CHR$(138)
50 A1=POINT(0,0): A2=POINT(1,0)
60 A3=POINT(0,1): A4=POINT(1,1)
70 A5=POINT(0,2): A6=POINT(1,2)
80 LPRINTTAB(8)CHR$(A1*(-40)+48);CHR$(A2*(-40)+48)
90 LPRINTTAB(8)CHR$(A3*(-40)+48);CHR$(A4*(-40)+48)
100 LPRINTTAB(8)CHR$(A5*(-40)+48);CHR$(A6*(-40)+48)
110 NEXT
```

Space Compression Codes: 192 to 255

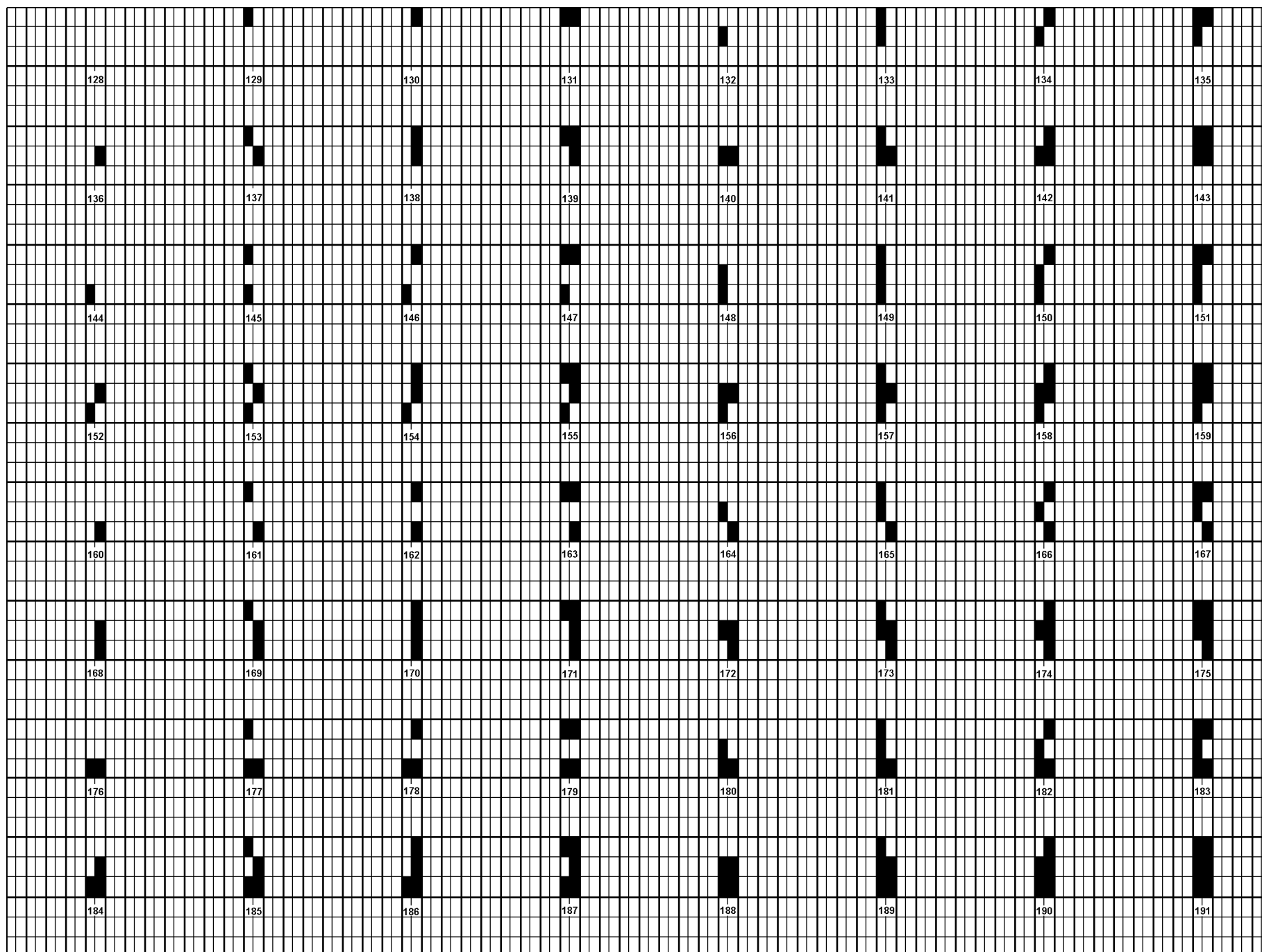
Decimal Codes	Hex Codes	Function
192-255	C0-FF	Tabs for 0 to 63 spaces, respectively

The space-compression codes provide a compact means of representing strings of blanks from zero to 63 blanks.

For example,

```
PRINT CHR$(192) produces zero blanks;  
PRINT CHR$(193), one blank;  
PRINT CHR$(194), two blanks; ...  
PRINT CHR$(225), 63 blanks.
```


Graphic Characters



		0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63																																																																
TAB →																																																																		
PRINT AT X →																																																																		
↓		0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63																																																																
0	0																																																																	0
	1																																																																	1 63
	2																																																																	2
64	3																																																																	3
	4																																																																	4 127
	5																																																																	5
128	6																																																																	6
	7																																																																	7 191
	8																																																																	8
192	9																																																																	9
	10																																																																	10 255
	11																																																																	11
256	12																																																																	12
	13																																																																	13 319
	14																																																																	14
320	15																																																																	15
	16																																																																	16 383
	17																																																																	17
384	18																																																																	18
	19																																																																	19 447
	20																																																																	20
448	21																																																																	21
	22																																																																	22 511
	23																																																																	23
512	24																																																																	24
	25																																																																	25 575
	26																																																																	26
576	27																																																																	27
	28																																																																	28 639
	29																																																																	29
640	30																																																																	30
	31																																																																	31 703
	32																																																																	32
704	33																																																																	33
	34																																																																	34 767
	35																																																																	35
768	36																																																																	36
	37																																																																	37 831
	38																																																																	38
832	39																																																																	39
	40																																																																	40 895
	41																																																																	41
896	42																																																																	42
	43																																																																	43 959
	44																																																																	44
960	45																																																																	45
	46																																																																	46 1023
	47																																																																	47
↑ Y		0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63																																																																
106		0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63																																																																

D / Memory Map

Decimal Address		Hex Address
0	LEVEL II ROM	0000
12287		3000
12288	RESERVED FOR MEMORY-MAPPED I/O	3001
15359		3BFF
15360	VIDEO MEMORY	3C00
16383		3FFF
16384	BASIC VECTORS (RST's 1-7)	4000
16405	KEYBOARD DCB	4015
16413	VIDEO DCB	4010
16421	LINE PRINTER DCB	4025
16429	RESERVED	402D
16870	I/O BUFFER	41EC
17129	BASIC PROGRAM TEXT	42E9
	SIMPLE VARIABLES	
	ARRAYS	
	FREE MEMORY	
	STACK	
	STRING SPACE	
	RESERVED WITH MEM. SIZE OPTION	
20479	END "4K" SYSTEMS	4FFF
32767	END "16K" SYSTEMS	7FFF
49151	END "32K" SYSTEMS	BFFF
65535	END "48K" SYSTEMS	FFFF

Important Addresses

Decimal	Hexadecimal		
14302	37DE	Communication Status Address	
14303	37DF	Communication Data Address	
14304	37E0	Interrupt Latch Address	
14305	37E1	Disk Drive Select Latch	
14308	37E4	Cassette Select Latch	
14312	37E8	Line Printer Address	
14316	37EC	Floppy Disk Controller Address	
16405	4015	DCB Type	Keyboard Device Control Block
16406	4016	Driver Address (LSB)	
16407	4017	Driver Address (MSB)	
16408	4018	0	
16409	4019	0	
16410	401A	0	Display Device Control Block
16411	401B	'K' (Character Code 75)	
16412	401C	'T' (Character Code 73)	
16413	401D	DCB Type	
16414	401E	Driver Address (LSB)	
16415	401F	Driver Address (MSB)	Printer Device Control Block
16416	4020	Cursor Position N (LSB)	
16417	4021	Cursor Position N (MSB)	
16418	4022	Cursor Character	
16419	4023	'D' (Character Code 68)	
16420	4024	'O' (Character Code 79)	Printer Device Control Block
16421	4025	DCB Type	
16422	4026	Driver Address (LSB)	
16423	4027	Driver Address (MSB)	
16424	4028	Lines/Page	
16425	4029	Line Counter	Printer Device Control Block
16426	402A	0	
16427	402B	'P' (Character Code 80)	
16428	402C	'R' (Character Code 82)	
16464	4050	FDC Interrupt Vector	
16466	4052	Communications Interrupt Vector	
16478	405E	25 mSec Heartbeat Interrupt	
17128	42E8	Always Zero	

E / Internal Codes for BASIC Keywords

The following are the internal codes that the Computer uses to store BASIC keywords. If you PEEK at the program buffer area (starting at address 17129 in decimal) you will find your program stored in the following codes.

Dec. Code	BASIC Keyword	Dec. Code	BASIC Keyword
129	FOR	167	LOAD
130	RESET	168	MERGE
131	SET	169	NAME
132	CLS	170	KILL
133	CMD	171	LSET
134	RANDOM	172	RSET
135	NEXT	173	SAVE
136	DATA	174	SYSTEM
137	INPUT	175	LPRINT
138	DIM	176	DEF
139	READ	177	POKE
140	LET	178	PRINT
141	GOTO	179	CONT
142	RUN	180	LIST
143	IF	181	LLIST
144	RESTORE	182	DELETE
145	GOSUB	183	AUTO
146	RETURN	184	CLEAR
147	REM	185	CLOAD
148	STOP	186	CSAVE
149	ELSE	187	NEW
150	TRON	188	TAB
151	TROFF	189	TO
152	DEFSTR	190	FN
153	DEFINT	191	USING
154	DEFSNG	192	VARPTR
155	DEFDBL	193	USR
156	LINE	194	ERL
157	EDIT	195	ERR
158	ERROR	196	STRING\$
159	RESUME	197	INSTR
160	OUT	198	POINT
161	ON	199	TIME\$
162	OPEN	200	MEM
163	FIELD	201	INKEY\$
164	GET	202	THEN
165	PUT	203	NOT
166	CLOSE	204	STEP

Dec. Code	BASIC Keyword	Dec. Code	BASIC Keyword
205	+	231	CVS
206	—	232	CVD
207	*	233	EOF
208	/	234	LOC
209	↑	235	LOF
210	AND	236	MKI\$
211	OR	237	MKS\$
212	>	238	MKD\$
213	=	239	CINT
214	<	240	CSNG
215	SGN	241	CDBL
216	INT	242	FIX
217	ABS	243	LEN
218	FRE	244	STR\$
219	INP	245	VAL
220	POS	246	ASC
221	SQR	247	CHR\$
222	RND	248	LEFT\$
223	LOG	249	RIGHT\$
224	EXP	250	MID\$
225	COS		
226	SIN		
227	TAN		
228	ATN		
229	PEEK		
230	CVI		

F / Derived Functions

Function	Function Expressed in Terms of Level II Basic Functions
SECANT	$\text{SEC}(X) = 1/\text{COS}(X)$
COSECANT	$\text{CSC}(X) = 1/\text{SIN}(X)$
COTANGENT	$\text{COT}(X) = 1/\text{TAN}(X)$
INVERSE SINE	$\text{ARCSIN}(X) = \text{ATN}(X/\text{SQR}(-X^2+1))$
INVERSE COSINE	$\text{ARCCOS}(X) = -\text{ATN}(X/\text{SQR}(-X^2+1))+1.5708$
INVERSE SECANT	$\text{ARCSEC}(X) = \text{ATN}(\text{SQR}(X^2-1))+(\text{SGN}(X)-1)*1.5708$
INVERSE COSECANT	$\text{ARCCSC}(X) = \text{ATN}(1/\text{SQR}(X^2-1))+(\text{SGN}(X)-1)*1.5708$
INVERSE COTANGENT	$\text{ARCCOT}(X) = -\text{ATN}(X)+1.5708$
HYPERBOLIC SINE	$\text{SINH}(X) = (\text{EXP}(X)-\text{EXP}(-X))/2$
HYPOBOLIC COSINE	$\text{COSH}(X) = (\text{EXP}(X)+\text{EXP}(-X))/2$
HYPERBOLIC TANGENT	$\text{TANH}(X) = -\text{EXP}(-X)/(\text{EXP}(X)+\text{EXP}(-X))^2+1$
HYPERBOLIC SECANT	$\text{SECH}(X) = 2/(\text{EXP}(X)+\text{EXP}(-X))$
HYPERBOLIC COSECANT	$\text{CSCH}(X) = 2/(\text{EXP}(X)-\text{EXP}(-X))$
HYPERBOLIC COTANGENT	$\text{COTH}(X) = \text{EXP}(-X)/(\text{EXP}(X)-\text{EXP}(-X))^2+1$
INVERSE HYPERBOLIC SINE	$\text{ARGSINH}(X) = \text{LOG}(X+\text{SQR}(X^2+1))$
INVERSE HYPERBOLIC COSINE	$\text{ARGCOSH}(X) = \text{LOG}(X+\text{SQR}(X^2-1))$
INVERSE HYPERBOLIC TANGENT	$\text{ARGTANH}(X) = \text{LOG}((1+X)/(1-X))/2$
INVERSE HYPERBOLIC SECANT	$\text{ARGSECH}(X) = \text{LOG}((\text{SQR}(-X^2+1)+1)/X)$
INVERSE HYPERBOLIC COSECANT	$\text{ARGCSCH}(X) = \text{LOG}((\text{SGN}(X)*\text{SQR}(X^2+1)+1)/X)$
INVERSE HYPERBOLIC COTANGENT	$\text{ARGCOTH}(X) = \text{LOG}((X+1)/(X-1))/2$

G / Base Conversions

The following table lists base conversions for all one-byte values.

DEC.	BINARY	HEX.	OCT.	DEC.	BINARY	HEX.	OCT.
0	00000000	00	000	41	00101001	29	051
1	00000001	01	001	42	00101010	2A	052
2	00000010	02	002	43	00101011	2B	053
3	00000011	03	003	44	00101100	2C	054
4	00000100	04	004	45	00101101	2D	055
5	00000101	05	005	46	00101110	2E	056
6	00000110	06	006	47	00101111	2F	057
7	00000111	07	007	48	00110000	30	060
8	00001000	08	010	49	00110001	31	061
9	00001001	09	011	50	00110010	32	062
10	00001010	0A	012	51	00110011	33	063
11	00001011	0B	013	52	00110100	34	064
12	00001100	0C	014	53	00110101	35	065
13	00001101	0D	015	54	00110110	36	066
14	00001110	0E	016	55	00110111	37	067
15	00001111	0F	017	56	00111000	38	070
16	00010000	10	020	57	00111001	39	071
17	00010001	11	021	58	00111010	3A	072
18	00010010	12	022	59	00111011	3B	073
19	00010011	13	023	60	00111100	3C	074
20	00010100	14	024	61	00111101	3D	075
21	00010101	15	025	62	00111110	3E	076
22	00010110	16	026	63	00111111	3F	077
23	00010111	17	027	64	01000000	40	100
24	00011000	18	030	65	01000001	41	101
25	00011001	19	031	66	01000010	42	102
26	00011010	1A	032	67	01000011	43	103
27	00011011	1B	033	68	01000100	44	104
28	00011100	1C	034	69	01000101	45	105
29	00011101	1D	035	70	01000110	46	106
30	00011110	1E	036	71	01000111	47	107
31	00011111	1F	037	72	01001000	48	110
32	00100000	20	040	73	01001001	49	111
33	00100001	21	041	74	01001010	4A	112
34	00100010	22	042	75	01001011	4B	113
35	00100011	23	043	76	01001100	4C	114
36	00100100	24	044	77	01001101	4D	115
37	00100101	25	045	78	01001110	4E	116
38	00100110	26	046	79	01001111	4F	117
39	00100111	27	047	80	01010000	50	120
40	00101000	28	050	81	01010001	51	121

DEC.	BINARY	HEX.	OCT.	DEC.	BINARY	HEX.	OCT.
82	01010010	52	122	129	10000001	81	201
83	01010011	53	123	130	10000010	82	202
84	01010100	54	124	131	10000011	83	203
85	01010101	55	125	132	10000100	84	204
86	01010110	56	126	133	10000101	85	205
87	01010111	57	127	134	10000110	86	206
88	01011000	58	130	135	10000111	87	207
89	01011001	59	131	136	10001000	88	210
90	01011010	5A	132	137	10001001	89	211
91	01011011	5B	133	138	10001010	8A	212
92	01011100	5C	134	139	10001011	8B	213
93	01011101	5D	135	140	10001100	8C	214
94	01011110	5E	136	141	10001101	8D	215
95	01011111	5F	137	142	10001110	8E	216
96	01100000	60	140	143	10001111	8F	217
97	01100001	61	141	144	10010000	90	220
98	01100010	62	142	145	10010001	91	221
99	01100011	63	143	146	10010010	92	222
100	01100100	64	144	147	10010011	93	223
101	01100101	65	145	148	10010100	94	224
102	01100110	66	146	149	10010101	95	225
103	01100111	67	147	150	10010110	96	226
104	01101000	68	150	151	10010111	97	227
105	01101001	69	151	152	10011000	98	230
106	01101010	6A	152	153	10011001	99	231
107	01101011	6B	153	154	10011010	9A	232
108	01101100	6C	154	155	10011011	9B	233
109	01101101	6D	155	156	10011100	9C	234
110	01101110	6E	156	157	10011101	9D	235
111	01101111	6F	157	158	10011110	9E	236
112	01110000	70	160	159	10011111	9F	237
113	01110001	71	161	160	10100000	A0	240
114	01110010	72	162	161	10100001	A1	241
115	01110011	73	163	162	10100010	A2	242
116	01110100	74	164	163	10100011	A3	243
117	01110101	75	165	164	10100100	A4	244
118	01110110	76	166	165	10100101	A5	245
119	01110111	77	167	166	10100110	A6	246
120	01111000	78	170	167	10100111	A7	247
121	01111001	79	171	168	10101000	A8	250
122	01111010	7A	172	169	10101001	A9	251
123	01111011	7B	173	170	10101010	AA	252
124	01111100	7C	174	171	10101011	AB	253
125	01111101	7D	175	172	10101100	AC	254
126	01111110	7E	176	173	10101101	AD	255
127	01111111	7F	177	174	10101110	AE	256
128	10000000	80	200	175	10101111	AF	257

DEC.	BINARY	HEX.	OCT.	DEC.	BINARY	HEX.	OCT.
176	10110000	B0	260	216	11011000	D8	330
177	10110001	B1	261	217	11011001	D9	331
178	10110010	B2	262	218	11011010	DA	332
179	10110011	B3	263	219	11011011	DB	333
180	10110100	B4	264	220	11011100	DC	334
181	10110101	B5	265	221	11011101	DD	335
182	10110110	B6	266	222	11011110	DE	336
183	10110111	B7	267	223	11011111	DF	337
184	10111000	B8	270	224	11100000	E0	340
185	10111001	B9	271	225	11100001	E1	341
186	10111010	BA	272	226	11100010	E2	342
187	10111011	BB	273	227	11100011	E3	343
188	10111100	BC	274	228	11100100	E4	344
189	10111101	BD	275	229	11100101	E5	345
190	10111110	BE	276	230	11100110	E6	346
191	10111111	BF	277	231	11100111	E7	347
192	11000000	C0	300	232	11101000	E8	350
193	11000001	C1	301	233	11101001	E9	351
194	11000010	C2	302	234	11101010	EA	352
195	11000011	C3	303	235	11101011	EB	353
196	11000100	C4	304	236	11101100	EC	354
197	11000101	C5	305	237	11101101	ED	355
198	11000110	C6	306	238	11101110	EE	356
199	11000111	C7	307	239	11101111	EF	357
200	11001000	C8	310	240	11110000	F0	360
201	11001001	C9	311	241	11110001	F1	361
202	11001010	CA	312	242	11110010	F2	362
203	11001011	CB	313	243	11110011	F3	363
204	11001100	CC	314	244	11110100	F4	364
205	11001101	CD	315	245	11110101	F5	365
206	11001110	CE	316	246	11110110	F6	366
207	11001111	CF	317	247	11110111	F7	367
208	11010000	D0	320	248	11111000	F8	370
209	11010001	D1	321	249	11111001	F9	371
210	11010010	D2	322	250	11111010	FA	372
211	11010011	D3	323	251	11111011	FB	373
212	11010100	D4	324	252	11111100	FC	374
213	11010101	D5	325	253	11111101	FD	375
214	11010110	D6	326	254	11111110	FE	376
215	11010111	D7	327	255	11111111	FF	377

H / User Programs

Special Keyboard Input Routine

Here's a general-purpose keyboard input routine (lines 100-175) for use in any program where the user will need to input a specific number of characters. Lines 1000-1040 contain a demonstrator program, which calls the routine.

When the main program asks for the field length, you can type in either a negative or positive number. If you type a negative number, the input routine will only let you enter numeric characters (including a leading + or _ sign-character, one decimal point, and the digits 0-9). If you type a positive number for the field length, only any alphanumeric characters may be input.

The routine returns the input string in the variable IN\$.

```
1 ' EXAMPLE OF RADIO SHACK'S INKEY ROUTINE
2 '
5 CLS: CLEAR 500: GOTO 1000
70 '
80 ' *** INKEY ROUTINE - LINES 100 THROUGH 175
90 '
100 IN$="":W$=INKEY$:W=14:WD=0:WS=WD:WL%=WD:IFFL=WDTHENFL=1
105 PRINTSTRING$(BBS(FL),136);STRING$(RBS(FL),24);
110 PRINTCHR$(W);:FORW%=1TO25:W$=INKEY$:IFW$<>" "THEN115ELSENEXT:
    PRINTCHR$(i5);:FORW%=1TO25:W$=INKEY$:IFW$<>" "THEN115ELSENEXT:
    GOT0110
115 PRINTCHR$(W);:IFABS(FL)=WL%THEN125
    ELSEIFFL>0ANDW$>=" "ANDW$<="Z"THEN170
    ELSEIFFL<0ANDW$>"/"ANDW$<":"THEN170
117 IFW$=","THENPRINTW$;:WL%=WL%+1:GOT0175
120 IFW$="."ANDWD=0THENWD=1:GOT0170
123 IF(W$="-"ORW$="+")ANDWS=0ANDWL%=0THENWS=1:GOT0170
125 IFW$<>CHR$(B)THEN150ELSEIFWL%=0THEN110ELSEPRINTCHR$(24);:
    IFFL>0THEN135ELSEIFPEEK(16418)=44THEN140
130 IFPEEK(16418)=46THENWD=0:GOT0135
    ELSEIFPEEK(16418)=43ORPEEK(16418)=45THENWS=0
135 IN$=LEFT$(IN$,LEN(IN$)-1)
140 WL%=WL$-1:POKE16418,136:GOT0110
150 IFW$=CHR$(24)THENPRINTSTRING$(WL%,CHR$(24));:GOT0100
155 IFW$<>CHR$(13)THEN110ELSEPRINTSTRING$(ABS(FL)-WL%,32);
160 PRINTCHR$(15);:W%=25:NEXT:RETURN
170 PRINTW$;:IN$=IN$+W$:WL%=WL%+1
175 IFABS(FL)=1THEN166ELSE110
```

```

700 '
800 '          *** MAIN PROGRAM ***
900 '
1000 PRINT: FL$="": INPUT"FIELD-LENGTH (FL) = ";FL$
1005 IF FLT<>" " THEN FL=VAL(FL$) ELSE PRINTTAB(20);CHR$(27);FL
1006 IF ABS(FL) > 63 THEN PRINT
      "ENTER A VALUE IN THE RANGE <-63,+63>": GOTO 1000
1007 IF FL=0 THEN END
1010 GOSUB 100: PRINT: PRINT TAB(16)"LENGTH ="LEN(IN$)
1020 PRINT TAB(16)"STRING = "CHR$(136)IN$;CHR$(136)
1030 PRINT TAB(16)" VALUE = "VAL(IN$)
1040 GOTO 1000

```

Storing a USR Routine in a String

This program illustrates a special technique for storing machine language routines inside strings, instead of POKEing them into high memory. You do not need to reserve memory via MEMORY SIZE to use this technique. However, **you must not change the string variable, which** contains the machine-language code. In other words, don't re-assign another value to this string (in this program, P\$ is used).

For the sake of example, (this user routine accomplishes a "partial scroll": only the bottom half of the screen is scrolled as you input text, leaving the top unchanged. Don't input more than two lines without pressing ENTER).

```

10 ' EXAMPLE OF A MACHINE LANGUAGE ROUTINE IN A STRING VARIABLE
20 '
50 '          THIS DATA IS THE DECIMAL EQUIVALENT OF THE MACHINE
53 '          LANGUAGE PROGRAM & PERFORMS A HALF-SCROLL OF VIDEO
55 '
60 DATA 33,128,62,17,64,62,1,128,1,237,176,201
70 '
90 CLS: CLEAR 200: DEFINT A-Z
100 CLS: PRINTTAB(15)"HALF-SCROLL PROGRAM": PRINT: PRINT
110 PRINT"    NOTE THAT THE UPPER PART OF THE SCREEN WILL NEVER
120 PRINT"CHANGE AS YOU ENTER LINES Or TEXT BELOW. THE BOTTOM OF
130 PRINT"SCREEN WILL SCROLL INDEPENDENTLY OF THE TOP OF THE SCREEN
140 PRINT"WHEN IT IS FULL.
150 PRINT@512,STRING$(64,176);: N=0
151 '
152 ' *** READ MACHINE LANGUAGE PROGRAM INTO P$ ***
153 '
155 P$="": FOR I=1 TO 12: READ J: P$=P$+CHR$(J): NEXT

```

```

157 '
160 INPUTA$: IF A$="END" THEN PRINT@576,CHR$(31);: END
170 IF N<6 THEN N=N+1
174 '
175 ' IF BOTTOM OF SCREEN HAS 6 LINES. THEN SCROLL
176 '
180 IF N=6 THEN GOSUB 1000: PRINT@896,CHR$(31);
190 GOT0160
700
800 ' *** SCROLL ROUTINE ***
900 '
1000 POKE 16526 PEEK(VARPTR<P$)+1) ' SET UP ENTRY ADDRESS
1010 POKE 16527,PEEK(VARPTRCP$)+2)
1020 J=USR(I):RETURN

```

Sort Routine

This program sorts any set of numbers, and prints them out from smallest to largest. Simply store the number of items to be sorted in line 350, and the actual data in line 370. Add DATA lines as required.

To sort string values, change A() to string array A\$(), TEMP to TEMP\$, and put string values in the data lines 370, etc.

```

10 '      SHELL SORT
20 '
30 '      REF: BERZTISS, R.T., DATA STRUCTURES THEORY AND PRACTICE
40 '      2ND ED., ACADEMIC PRESS, NY, 1975, P. 464,465
60 CLEAR 500: DEFINT I-N: CLS
70 READ N          'N = NUMBER OF ELEMENTS TO BE SORTED
80 PRINT"SHELL SORT OF"N"ELEMENTS. STANDBY . . ."
90 DIM A(N)        'DIMENSION ARRAY TO BE SORTED
100 FOR I=1 TO N
110     READ A(I)   'READ IN ARRAY ELEMENTS
120 NEXT I
130 '      SORT ROUTINE
140 '
150 D = 1
160 D = 2*D: IF D<N THEN 160
170 D = INT((D-1)/2)
180 IF D=0 THEN 270
190 IT = N-D
200 FOR I=1 TO IT
210     J = I
220     L = J+D

```

```

230     IF A(L) < A(J) THEN
        TEMP = R(J) :
        A(J) = A(L) :
        A(L) = TEMP :
        J = J-D :
        IF J>0 THEN 220
240 NEXT I
250 GOTO 170
260 END
270 '     PRINT SORTED ARRAY
280 '
290 PRINT: INPUT"PRESS 'ENTER' TO LIST SORTED ARRAY";A$
300 FOR I=1 TO N
310     PRINT A(I) ,
320 NEXT I
330 END
340 ' STORE NUMBER OF DATA ELEMENTS HERE
350 DATA 10
360 ' STORE ACTUAL DATA HERE
370 DATA 10.8,9,8.7,8.3,7,3.333,2.010,2,10,0.98

```

Space-Ship Lander

This challenging program lets you simulate a landing sequence on any of four planetary bodies: Earth, Moon, Mars, and the asteroid Vesta. Before each 10-second "burn" interval, you are given the following information:

Elapsed Time (seconds)
 Altitude (kilometers)
 Velocity (kilometers/hour –
 negative amount indicates motion
 away from planetary body)
 Remaining Fuel (kilograms)

Using this information, you select a "burn rate" (kilograms of fuel/ second). For example, a 10 Kg/sec burn rate consumes 100 Kg during the 10-second mandatory burn interval. Burns must be in the range 0-100 Kg/sec, (over 100 Kg/sec would cause the "G" force to become too great.)

Hints:

- A negative velocity indicates you burned too much fuel and are moving away from the planetary body.
- Fuel burns may include fractional parts (e.g., 15.5 Kg/sec)
- As you consume fuel, the weight of the lander decreases. Therefore subsequent burns will be increasingly effective

- Landing conditions are different for each planetary body because each has its own particular gravity: Earth = 980 cm/sect ; Moon = 162 cm/sect ; Mars = 372 cm/sect ; Vesta = 17.5 cm/sect .
- The up arrow ↑ appears as a left bracket [in this printout. Remember to enter it as an up arrow (for exponentiation).

Good luck, Commander!

```

100 CLS
110 PRINT@ 20, " * * * LANDER
120 PRINT : PRINT "TYPE 1 FOR EARTH 2 FOR MOON 3 FOR MARS, 4 FOR VESTA"
140 INPUT X : ON X GOTO 500, 600, 700, 800
145 CLS
147 PRINT@ 980, A$;
150 G2 = G1/36,
160 G3 = SQR(G2) * 100 : G3=FIX(G3) : IF G3<175 THEN G3=175
170 G4 = G3 * 55 : G4=FIX(G4) : IF G4<10000 THEN G4=10000
180 G5 = G4 * (LOG(G1)/20) + 10000
190 A1 = -6400 : A2 = 5000 : A3 = 15000 : A4 = 10
200 B4 = A4 : B2 = A2 : N3 = G3 : N4 = G4
205 PRINT@ 0, "ELAPSED      ALTITUDE      VELOCITY      REMAINING      INPUT FUEL":
206 PRINT@ 64, "TIME          (KM)          (KM/HR)          FUEL          BURN: (KG/SEC) ";
210 PRINT@ 128+Q , T1; TAB(10) N3; TAB(24) B2; TAB(39) N4: TAB(53) ;: INPUT F
250 IF F=0 GOTO 280
260 IF F<0 OR F>100 GOTO 320
270 T = N4/F : IF T<10 THEN B4=T
280 N4 = N4 - (F*B4)
285 V1=B3
286 T1=T1+B4
290 B5 = (G2+ ((G2 * N3)/(A5 * -2))) - <(F * G5)/(A3 + N4))
295 B3 = B2 + (B5 * B4)
298 N5=N3
300 N3 = N3+ <((B3 + B2) / A1) * B4)
305 B2=B3
307 IF N3<0 GOTO 450
310 IF N4 <= 0 GOTO 400
312 Q=Q+64 : IF Q + 128 > 960 THEN Q=832
315 GOTO 205
320 PRINT " -->> ILLEGAL FUEL BURN - DUMMY!--TRY AGAIN (0 TO 100)" : GOTO 210
400 V2 = SQR (B2[2 + N3 * G2 * 5650) : PRINT "OUT OF FUEL AT"; T1 : "SECONDS"
410 V3 = ABS(V2) * 10000 / 3600
420 T1 = T1 + LOG ((V3 * N3 * 10000) / G1)
430 GOTO 1000
450 V2 = SQR (ABS (N5 / (26 * B5))) * (26 * B5) + V1 : GOTO 1000
460 T1=T1-(10-B4)
500 G1 = 980.7 : A5 = 6371 : A$="EARTH" : GOTO145
600 G1 = 162 : A5 = 1738 : A$="MOON" : GOTO 145
700 G1 = 374 : A5 = 3380 : A$="MARS" : GOTO 145
800 G1 = 17.5 : A5 = 195 : A$="VESTA" : GOTO 145
1000 PRINT : PRINT "YOU HAVE ";
1010 IF V2<20 PRINT "LANDED" : GOTO 1100
1020 IF V2<100 PRINT "CRASHED" : GOTO 1140
1030 IF V2<250 PRINT "BEEN OBLITERATED" : GOTO 5000

```

```

1040 IF V2<5000 PRINT "MADE A NEW CRATER" : GOTO 5000
1050 IF V2>4999 PRINT "BORED A HOLE INTO THE PLANET" : GOTO 5000
1100 IF V2<1 PRINT "NICE TOUCH--VERY GOOD" : GOTO 5000
1110 IF V2<5 PRINT "NOT TOO BAD" : GOTO 5000
1120 PRINT "KIND OF ROUGH" : GOTO 5000
1140 IF V2<30 PRINT "YOU WILL NOT BE ABLE TO TAKE OFF" : GOTO 5000
1150 IF V2<45 PRINT "YOU ARE INJURED. THE LANDER IS ON FIRE" : GOTO 5000
1160 PRINT "THERE ARE NO SURVIVORS"
5000 PRINT "VELOCITY AT IMPACT * * *" TAB(40); ABS(V2) ;"KM/HR"
5010 PRINT "ELAPSED TIME * * * * *" TAB(40); T1 ;"SECONDS"
5020 END

```

Customer Information

This program allows you (or your customers) to store information in a file for future reference. It stores Name, Address and Phone Number; the file can be recalled, modified, etc., by specifying the desired action using the "Menu" (Table of Commands).

This would be a handy way to create a mailing/phone list.

```

10 CLEAR 1000 :CLS :DIM N$(50) :DIM A$(50) :DIM P$(50)
20 CLS :PRINT@ 10,"* * MENU * *" :PRINT :PRINT
30 PRINT "TO BUILD A FILE TYPE 1
40 PRINT "TO SEE THE ENTIRE FILE TYPE 2
50 PRINT "TO SEE AN INDIVIDUAL NAME TYPE 3
60 PRINT "TO MAKE CORRECTIONS TYPE 4
70 PRINT "TO SAVE THE CURRENT FILE ON TAPE TYPE 5
80 PRINT "TO INPUT A FILE FROM TAPE TYPE 6
90 INPUT Q : ON Q GOTO 100, 200, 300, 400, 500, 600
100 INPUT"WHEN READY, HIT ENTER (TO CLOSE THE FILE TYPE 9999 FOR NAME)";X
110 FOR I=1 TO 50 :CLS :PRINT"ENTER YOUR NAME (LAST FIRST NO COMMAS PLEASE)
112 PRINT"THEN HIT THE 'ENTER' KEY" ;:INPUT N$(I)
115 IF N$(I)="9999" THEN P1=I :GOTO150
120 INPUT"ENTER YOUR ADDRESS (NO COMMAS)"; A$(I)
130 INPUT"ENTER YOUR PHONE # "; P$(I)
135 IF FRE(X$) < 100 GOTO150
140 NEXT
150 PRINT"FILE CLOSED --" :INPUT"TO SEE THE MENU HIT ENTER": X
160 GOTO20
200 CLS :FOR I=1 TO P1 :PRINT N$(I). A$(I). P$(I) :NEXT
210 INPUT"TO SEE THE MENU HIT ENTER": X :GOTO20
300 CLS :INPUT"ENTER THE NAME. LAST FIRST (NO COMMAS)"; N$
310 FOR I=1 TO P1 :IF N$(I)=N$ THEN330
315 NEXT
320 PRINT"NAME NOT IN FILE" :GOTO340
330 PRINT N$(I), A$(I), P$(I)
340 PRINT :PRINT"FOR ANOTHER NAME TYPE 1. OTHERWISE 0"; :INPUT X
350 IF X=1 GOTO300 ELSE20
400 CLS :PRINT"ENTER THE NAME FOR THE LINE YOU WISH TO CHANGE (NO COMMAS)"
405 INPUT N$

```

```

410 FOR I=1 TO P1 :IF N$=N$(I) GOTO430
415 NEXT
420 PRINT"NAME NOT IN FILE" :GOTO460
430 PRINT"ENTER THE CORRECTED INFO.: NAME, ADDRESS, PHONE"
440 INPUT N$(I), A$(I), P$(I)
450 PRINT"THE LINE NOW READS :" :PRINT N$(I), A$(I), P$(I)
460 INPUT"FOR ANOTHER CORRECTION TYPE 1. OTHERWISE 0"; X
470 IF X=1 GOTO400
480 GOTO20
500 CLS :INPUT "MAKE PREPARATIONS FOR CASSETTE WHEN READY HIT ENTER": X
510 PRINT"COPYING..."
520 PRINT #-1, P1
530 FOR I=1 TO P1 :PRINT #-1, N$(I), A$(I), P$(I) :NEXT
540 PRINT"COMPLETE -- NOTE TAPE LOCATION"
550 INPUT"TO SEE THE MENU, HIT ENTER"; X :GOTO20
600 CLS :INPUT"WHEN READY, HIT ENTER"; X
610 PRINT"INPUTING ..."
620 INPUT #-1, P1
630 FOR I=1 TO P1 :INPUT #-1, N$(I), A$(I), P$(I) :NEXT
640 PRINT"COMPLETE":INPUT"TO SEE MENU, HIT ENTER"; X :GOTO20

```

Triangle Computation with Graphics

This program illustrates the use of math functions as well as graphics. It's a great way to investigate the geometry of triangles (might be good for high-school students). (Note: up arrow ↑ = [in this printout.)

```

10 CLS
100 PRINT"THIS PROGRAM CALCULATES THE AREA OF A TRIANGLE
110 PRINT"GIVEN 3 PARAMETERS AND DRAWS THE TRIANGLE TO SCALE
120 PRINT:PRINT"FOR 3 SIDES TYPE: SSS. FOR 2 SIDES AND 1 ANGLE TYPE: SAS,
130 PRINT"FOR 1 SIDE AND 2 ANGLES TYPE: ASA.
140 INPUT At :IF AS="SAS" GOSUB300
150 IF A$="ASA" GOSUB400
200 `SSS
210 PRINT"ENTER 3 SIDES (LONGEST SIDE FIRST):
220 INPUT L1, L2, L3
225 IF L2>L1 OR L3>L1 PRINT "*" * * LONGEST FIRST PLEASE ..." : PRINT : GOTO 210
230 S=(L1+L2+L3)/2
235 IF S <= L1 PRINT " * * * NOT A TRIANGLE * * *" : PRINT : GOTO 210
240 Y3 = 2 * SQR( S * (S-L2) * (S-L1) * (S-L3)) / L1
250 A = Y3/L2 :A = ATN( A / SQR(-A * A+1))
260 X3 = COS(A) * L2
270 AR = (L1 * Y3) /2
280 GOTO500
300 'SRS
310 PRINT"ENTER 2 SIDES AND 1 ANGLE: AB, AC, THETA:(LARGEST SIDE FIRST)
320 INPUT L1, L2, T
325 T = (T * 3.14159) / 180
330 Y3 = L2 * SIN(T)
340 X3 = COS(T) * L2
350 AR = (L1 * Y3) /2
360 GOT0500

```

```

400 'ASA
410 PRINT"ENTER 2 ANGLES AND 1 SIDE: THETA1, THETR2, AB:
420 INPUT T1, T2, L2
425 T1 = (T1 * 3.14159) / 180 : T2 = (T2 * 3.14159) / 180
430 Y3 = L2 * SIN(T1)
440 B1 = COSC(T1) * L2
450 B2 = Y3 / TAN(T2)
460 L1 = B1 + B2 : X3 = B1 : IF L2 > L1 THEN X = L1 : L1 = L2 : L2 = X
470 AR = (L2 * Y3) / 2
500 CLS : F=1 : IF L1>50 OR Y3>30 OR L2>50 THEN GOSUB708
510 VC = (3.14159 * ( L1 * F - X3 * F) * (Y3 * F) C2) / 3
520 VS = (3.14159 (X3 * F) * (Y3      F) [2] /3: VT = VC + VS
525 IF F=6 GOTO610
530 S1=Y3 / X3 : S2=Y3 / (X3 - L1)
532 IF INT(X3) = 0 THEN1100
533 IF INT<X3) = INT(L1) THEN1000
534 IF X3<0 THEN1299
535 IF X3>L1 THEN1199
537 IF X3=L2 THEN1000
540 FOR Y=20 TO L1 * 2+20 STEP 2 : SET (Y , Y3+5) : NEXT
550 FOR X=0 TO X3 : SET (X * 2+20 , S1 * (X3-X) +5) : NEXT
560 FOR X=X3 TO L1 : SET (X * 2+20 , Y3+ (S2 * (L1-X) +5)) : NEXT
590 PRINT@ 64 * INT((Y3+5) / 3) + 69. "A(0,0)" : TAB(L1); "BC": L1 * F : ",0)"
600 PRINT@ <X3 + 20) / 2, "C (" : X3 * F : ",": Y3 * F ;")"
610 PRINT@ 832, "AREA =" ; AR ;" SQ UNITS"
620 PRINT@ 896, "THE VOLUME OF THE SOLID CREATED BY REVOLVING THE TRIANGLE ":
625 PRINT"ABOUT THE X AXIS (LINE AB) =" ;VT;"CUBIC UNITS";
630 PRINT@ 768, "*" ;: INPUT "TO RUN AGAIN, TYPE 1": B6 : IF B6=1 THEN10
640 STOP : GOTO10
700 IF L1<100 THEN F=2 : GOTO750
710 IF L1<150 THEN F=3 : GOTO750
720 IF L1<200 THEN F=4 : GOTO750
730 IF L1<250 THEN F=5 : GOTO750
740 PRINT "SORRY SCALE TOO LARGE TO BE DRAWN" ;: F=6 : GOTO510
750 L1=L1/F : Y1=Y1/F : Y2=Y2/F : Y3=Y3/F : X1=X1/F : X2=X2/F : X3=X3/F
760 RETURN
1000 FOR Y=5 TO Y3+5 : SET(X3 * 2 + 20 , Y) : NEXT : GOTO540
1100 FOR Y=5 TO Y3+5 : SET(20 , Y) : NEXT : GOTO540
1199 IF X3>127 GOSUB700
1200 FOR X=L1 TO X3 : SET(X * 2 + 20 , Y3 + (S2 * (L1-X) +5)) : NEXT : GOTO540
1299 IF X3 < -10 GOSUB700
1300 FOR X=X3 TO 0 : SET(X * 2 + 20 , Y3+ (S1 * (0-X) +5)) : NEXT : GOTO540

```

Target Practice

This program uses the INKEY\$ function to simulate one of the popular "video games". Notice how few lines are required. This program could easily be "dressed up" - let the user choose a Fast Target, Slow Target; keep score, print special messages, etc. To change the speed of the target, change line 40 as follows: instead of "RND(10)/10", use "RND(0)*S1". For a slow-moving target, let S1 be small (less than 1); for a faster target, let S1 be greater than 1. S1 should not exceed 1.5 or the target will advance to the next line.

```

1 CLS:PRINT : PRINT CHR$(23) ; "HIT 'Z' KEY TO AIM LEFT."
2 PRINT "HIT '/' KEY TO RIM RIGHT."
3 PRINT "HIT SPACE BAR TO FIRE."
4 FOR I = 1 TO 5000 : NEXT
10 CLS : CA=928 : I=1 : PRINT @ CA, "*" ; : PRINT @ 991, "****";
20 F=0
30 IF I >= 15 PRINT @ 124, "          "; : I=1
40 PRINT @ 64 + I * 4, "          "; : I=I+RND(10)/10 : PRINT@ 64+I*4," --> ";
50 IF F=0 THEN 200
60 RESET(MX,MY) : MX=MX-MD : MY=MY-8 : IF MX<=0 OR MX>=127 THEN20
70 IF MY>2 SET(MX,MY) : GOTO 30
80 IF ABS( I*8-MX)>4 THEN 20
90 FOR J=1 TO 6 : PRINT@ 64+4*I,"****"; : FOR K=1 TO 50 : NEXT
95 PRINT@ 64+4* I, "          " : FOR K=1 TO 50 : NEXT K,J
100 GOTO10
200 Y$=INKEY$
205 IF F=1 STOP
210 IF Y$<>"Z" THEN 250
220 IF CA < 922 THEN 30
230 PRINT@ CA, " "; : CR=CA-1 : GOTO 280
250 IF Y$<>"/" THEN 300
260 IF CA>934 THEN 30
270 PRINT@ CA, " "; : CA=CA+1
280 PRINT@ CA, "*"; : GOTO30
300 IF Y$<>" " THEN 30
310 F=1 : MD=928-CA : MY=40 : MX=64-3*MD : SET(MX,MY) : GOTO30
311 END

```

Ready-Aim-Fire (Bouncing Dot Revisited)

Remember the LEVEL I Bouncing Dot program? This program takes that idea and turns it into a game for one or more players by means of the INKEY\$ function. The object is to enter the correct 3-digit combination that will cause your missile to destroy the bouncing dot. (The 3-digit number corresponds to the X-axis of the display and therefore should be in the range 001 to 126 - and be sure to enter leading zeros for 1- or 2-digit numbers.)

The Computer always takes the first shot; then it's Player Number 1's turn.

```

5 DIM N$(4)
6 CLS : INPUT "ENTER THE NO. OF PLAYERS"; X1 : PRINT"ENTER"; X1 ;"1ST NAMES :"
7 FOR XI=1 TO X1 : INPUT N$(XI) : NEXT : XI=1
10 CLS
20 FOR M=0 TO 127 : SET(M,0) : SET(M,47) : NEXT
30 FOR M=0 TO 47 : SET(0,M) : SET(127,M) : NEXT
35 FOR X=1 TO 121 STEP 10 : RESET(X,0) : NEXT
40 RANDOM : Y= RND(40) +1 : X= RND(110) +4
50 D=1 : Q=1 : Z=64
60 RESET (Z,Y-D) : RESET (X- Q * 4, 24)
70 SET (Z, Y) : SET (X, 24) : GOSUB 500
80 Y=Y+D : X=X+Q
90 IF X=123 OR X=4 THEN GOSUB 700

```

```

100 IF Y=47 THEN 120
105 IF Y=0 GOSUB 900
110 IF Y <> -1 OR X <> -1 THEN 60
120 Y= Y- 2 * D : D= -D : GOTO 60
500 IF X=Z OR X=Q+Z OR X=2 * Q+Z OR X=3 * Q+Z OR X=Q * 4+Z THEN IF Y=24 GOSUB 600
510 IF Y=23 OR Y=24 OR Y=25 THEN IF X=Z GOSUB 600
520 RETURN
600 X=1
610 FOR Z=1 TO 50 : PRINT@ 550,"HIT !!!"; : NEXT
620 FOR Z=1 TO 25 : PRINT@ 550,"      ";; NEXT
630 X=X+1 : IF X<5 GOTO 610
640 GOTO 2000
700 X=X-2 * Q : Q= -Q : RETURN
900 T$ = INKEY$ : A$ = "" : B$ = "" : C$ = ""
1000 A$= INKEY$ : IF LEN(A$) = 0 THEN 1000
1005 PRINT@ 0, A$;
1010 B$= INKEY$ : IF LEN(B$)=0 THEN 1010
1015 PRINT@ 1, B$;
1020 C$= INKEY$ : IF LEN(C$)=0 THEN 1020
1025 PRINT@ 2, C$;
1030 RESET(Z,1) : X$= A$+B$+C$ : Z=VAL(X$) : IF Z>126 GOTO 1100
1033 PX=PX+1
1035 GOTO120
1040 RETURN
1100 FOR X=1 TO 50 : PRINT@ 70, "TOO LARGE, TRY AGAIN" : NEXT
1110 PRINT@ 70, "      " : Z=1 : GOTO 1000
2000 IF PX=0 GOSUB 3000
2010 CLS : PRINT "          * * * "; N$(XI) : " * * *" : PRINT : PRINT
2017 PX(XI) = PX+PX(XI) : PH(XI) = PH(XI)+1
2020 PRINT, "SHOTS      HITS      PERCENTAGE"
2030 PRINT : PRINT "THIS ROUND "; TAB(17) PX; TAB(28)"1"; TAB(42) (1/PX) * 100
2035 IFPX(1)=0THENPX(1)=1
2040 PRINT : PRINT "TOTAL      "; TAB(17) PX(XI);
2042 PRINT TAB(28) PH(XI): TAB(42) (PH(XI) / PX(XI)) * 100
2045 FOR X=1 TO 2500 : NEXT
2050 XI=XI+1
2060 IF XI>X1 THEN XI=1
2065 PX=0
2070 GOTO10
2115 IF PX=0 GOSUB 3000
3000 PRINT@ 0, "WHAT LUCK !!!" : PX=1 : RETURN

```

I / Converting LEVEL I Programs

Because of the differences between LEVEL I BASIC and LEVEL II BASIC, you will need to use the CONV program to translate LEVEL I programs to run under LEVEL II BASIC. Even after converting a program, you'll need to make minor changes in punctuation, syntax and function arguments before the program will run. The following is a list of the kinds of changes you'll need to make on the converted program.

1. Change commas following TAB functions to semi-colons or omit punctuation altogether. Example:

change **PRINT TAB(10) , "HELLO"**

to **PRINT TAB(10) "HELLO"**

2. Every IF statement should be followed by an explicit THEN statement. Example:

change **IF A=B B=0**

to **IF A=B THEN B=0**

3. Be sure PRINT AT is converted to PRINT@. There are some LEVEL I constructions which will cause CONV to leave PRINT AT unchanged. examples:

change **PRINT AT 475 , "CENTER"**

to **PRINT@475 , "CENTER"**

change **PRINT AT 0 , "FIRST" ; AT 30 , "SECOND"**

to **PRINT@0 , "FIRST" : PRINT@30 , "SECOND"**

4. Graphics functions SET(x,y), RESET(x,y) and POINT(x,y) will not "wrap around" in LEVEL II. Therefore be sure to restrict the arguments x and y as follows:

$0 \leq x < 128$

$0 \leq y < 48$

5. If your LEVEL I program uses the array A() with subscripts higher than 10, you will need to add a DIM A(x) statement to the beginning of your converted program (where x is the highest subscript used). Example:

DIM A(30)

This statement would allow you to use array elements A(0) through A(30). Of course, you can use any variable name as an array name in LEVEL II BASIC.

6. In LEVEL I, an INPUT statement allows you to type in variables and expressions, not just constants. In LEVEL II, you have to type in a constant, either string or numeric, depending on the INPUT variable. Example:

	Y=1: N=0: INPUT "YES OR NO (Y/N)";R
change	IF R=1 THEN PRINT "THAT'S BEING POSITIVE!"
to	INPUT "YES OR NO (Y/N)";R\$
	IF R\$="Y" THEN PRINT "THAT'S BEING POSITIVE!"

7. In LEVEL II, DATA statements must contain constants only no variables or expressions.
8. In LEVEL I, a True logical expression is evaluated as a 1; in LEVEL II, the same expression has the value -1. Therefore if your LEVEL I program uses such expressions, you need to change them accordingly in the converted program. Example, to compute MAX(A,B):

change	M = (A<B)*B + (B<A)*A
to	M = (A<B)*B - (B<A)*A

9. In LEVEL I, POINT(x,y) returns 1 when graphics block (x,y) is ON, and 0 when it is OFF. But in LEVEL II, POINT (x,y) returns -1 for (x,y) ON, and 0 for (x,y) OFF. So be sure to allow for this difference. Example:

change	C = C + POINT(X,Y)
to	C = C - POINT(X,Y)

if you want to increment C each time (x,y) is ON.

J / Important Information for Cassette Users

Free Modification for LEVEL II Units

A modification that helps cassette loads in LEVEL II computers is available free to TRS-80 LEVEL II owners. This modification makes the volume setting less critical so that variations in different tapes usually will not require volume readjustments.

Some of the more recent LEVEL II Keyboard units have had this modification factory-installed. To see if the modification has been included in your computer, look at the catalog number on the bottom of the keyboard case. The modification has been made if the number ends in -1. For example, if the number is 26-1004-1, the modification has already been installed; if the number is 26-1004, the modification has not been installed.

If the number does not end in -1 and you have not already had the cassette modification installed by Radio Shack, you may arrange for installation at your local Radio Shack store.

Using Your Cassette Deck

Many factors affect the performance of a cassette system. The most significant one is volume. Too low a volume may cause some of the information to be missed. Too high a volume may cause distortion and result in the transfer of background noise as valid information.

Three different cassette models have been supplied with the TRS-80 system the CTR-40, CTR-41 and CTR-80. Each model has its own loading characteristics. The table on the next page gives suggested volume ranges for each of the CTR models. Figures are for systems **without** the CLOAD modification.

Notice that volume ranges for LEVEL I and LEVEL II are different. This is because the LEVEL II data transfer rate is faster (500 baud vs. 250 baud). Also, notice that pre-recorded Radio Shack programs need a slightly **higher** volume setting than that required by your own CSAVED tapes. The prerecorded tapes are produced with high-speed audio equipment at a slightly lower level than the CSAVE process provides.

RECORDER MODEL	USER-GENERATED TAPES		PRE-RECORDED RADIO SHACK TAPES	
	LEVEL I	LEVEL II	LEVEL I	LEVEL II
CTR-40	YELLOW LINE	RED LINE	YELLOW LINE	RED LINE
CTR-41	6 - 8	4 - 6	6½ - 8½	5 - 7
CTR-80	4½ - 6½	3 - 5	5½ - 7½	2½ - 5

Recommended Volume Settings for RADIO SHACK Cassette Decks

(With CTR-40 and CTR 80, to increase volume, turn the control to the left. With CTR-41, turn control to the right.)

When information is being loaded from the cassette tape, two asterisks will appear on the screen. The one on the right will flash on or off each time a new line of data or program is read in. With SYSTEM tapes, the right asterisk blinks slowly. If the asterisks do not appear, or the one on the right does not flash, then the volume setting is probably too low. If the asterisks appear but one is not flashing, try increasing the volume setting. Use the reset button to stop the cassette and return control to you if loading problems occur.

Radio Shack programs are recorded at least twice on each tape (usually twice on each side). You should do the same when you record programs on tape. This will give you a back-up if one does not load properly or if it becomes damaged.

Important Note: The CTR-41 requires that you keep the supplied "dummy plug" in the MIC jack at all times. However, the CTR-40 and the CTR-80 should never be used with the "dummy plug."

LEVEL I

Sometimes you will get an error message during an attempted CLOAD. This means that some information was lost or garbled. Adjust the volume level slightly and try again.

LEVEL II

In case of an error message, proceed as above. With SYSTEM tapes, a "C" will appear in place of one asterisk. In LEVEL II, there is also a rare case in which the program has not loaded correctly *even though no error is generated*. So after CLOADing a program, be sure to LIST it. If some data was garbled, at some point in the listing the display will be filled with meaningless words and characters. Adjust the volume and try again.

Hints and Tips

Computer tapes should be stored in a relatively dust-free area (a cassette case is recommended) and protected from high temperatures. Magnetic and electrical fields may alter recorded information, so avoid them (i.e. household appliances, power sources such as transformers and television sets, etc.).

The cassette deck supplied with the TRS-80 is very compatible with the system and will perform its duties with great success. To keep the cassette deck in top condition and thus minimize your problems, you should periodically perform some routine maintenance on it. Dirty heads can cause as much as a 50% loss in volume. Also, heads become magnetized with use and may cause distortion. We recommend that you clean the head, capstan and pinch roller after every four hours of operation. Heads on new recorders should always be cleaned before use.

Note: Cassette cleaning and demagnetizing accessories are available from your local Radio Shack store.

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