

ALTAIR

BASIC

REFERENCE MANUAL

MITS ALTAIR BASIC

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MITS

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Introduction

Before a computer can perform any useful function, it must be "told" what to do. Unfortunately, at this time, computers are not capable of understanding English or any other "human" language. This is primarily because our languages are rich with ambiguities and implied meanings. The computer must be told precise instructions and the exact sequence of operations to be performed in order to accomplish any specific task. Therefore, in order to facilitate human communication with a computer, programming languages have been developed.

ALTAIR BASIC* is a programming language both easily understood and simple to use. It serves as an excellent "tool" for applications in areas such as business, science and education. With only a few hours of using BASIC, you will find that you can already write programs with an ease that few other computer languages can duplicate.

Originally developed at Dartmouth University, BASIC language has found wide acceptance in the computer field. Although it is one of the simplest computer languages to use, it is very powerful. BASIC uses a small set of common English words as its "commands". Designed specifically as an "interactive" language, you can give a command such as "PRINT 2 + 2", and ALTAIR BASIC will immediately reply with "4". It isn't necessary to submit a card deck with your program on it and then wait hours for the results. Instead the full power of the ALTAIR is "at your fingertips".

Generally, if the computer does not solve a particular problem the way you expected it to, there is a "Bug" or error in your program, or else there is an error in the data which the program used to calculate its answer. If you encounter any errors in BASIC itself, please let us know and we'll see that it's corrected. Write a letter to us containing the following information:

- 1) System Configuration
- 2) Version of BASIC
- 3) A detailed description of the error
Include all pertinent information such as a listing of the program in which the error occurred, the data placed into the program and BASIC's printout.

All of the information listed above will be necessary in order to properly evaluate the problem and correct it as quickly as possible. We wish to maintain as high a level of quality as possible with all of our ALTAIR software.

* BASIC is a registered trademark of Dartmouth University.

We hope that you enjoy ALTAIR BASIC, and are successful in using it to solve all of your programming needs.

In order to maintain a maximum quality level in our documentation, we will be continuously revising this manual. If you have any suggestions on how we can improve it, please let us know.

If you are already familiar with BASIC programming, the following section may be skipped. Turn directly to the Reference Material on page 22.

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If any immediate problems with MITS software are encountered, feel free to give us a call at (505) 265-7553. The Software Department is at Ext. 3; and the joint authors of the ALTAIR BASIC Interpreter, Bill Gates, Paul Allen and Monte Davidoff, will be glad to assist you.

**GETTING
STARTED
WITH
BASIC**

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This section is not intended to be a detailed course in BASIC programming. It will, however, serve as an excellent introduction for those of you unfamiliar with the language.

The text here will introduce the primary concepts and uses of BASIC enough to get you started writing programs. For further reading suggestions, see Appendix M.

If your ALTAIR does not have BASIC loaded and running, follow the procedures in Appendices A & B to bring it up.

We recommend that you try each example in this section as it is presented. This will enhance your "feel" for BASIC and how it is used.

Once your I/O device has typed "OK", you are ready to use ALTAIR BASIC.

NOTE: All commands to ALTAIR BASIC should end with a carriage return. The carriage return tells BASIC that you have finished typing the command. If you make a typing error, type a back-arrow (\leftarrow), usually shift/0, or an underline to eliminate the last character. Repeated use of " \leftarrow " will eliminate previous characters. An at-sign (@) will eliminate the entire line that you are typing.

Now, try typing in the following:

PRINT 10-4 (end with carriage return)

ALTAIR BASIC will immediately print:

6

OK

The print statement you typed in was executed as soon as you hit the carriage return key. BASIC evaluated the formula after the "PRINT" and then typed out its value, in this case 6.

Now try typing in this:

PRINT 1/2,3*10 ("*" means multiply, "/" means divide)

ALTAIR BASIC will print:

.5

30

As you can see, ALTAIR BASIC can do division and multiplication as well as subtraction. Note how a ", " (comma) was used in the print command to print two values instead of just one. The comma divides the 72 character line into 5 columns, each 14 characters wide. The last two of the positions on the line are not used. The result is a ", " causes BASIC to skip to the next 14 column field on the terminal, where the value 30 was printed.

Commands such as the "PRINT" statements you have just typed in are called Direct Commands. There is another type of command called an Indirect Command. Every Indirect command begins with a Line Number. A Line Number is any integer from 0 to 65529.

Try typing in the following lines:

```
10 PRINT 2+3  
20 PRINT 2-3
```

A sequence of Indirect Commands is called a "Program". Instead of executing indirect statements immediately, ALTAIR BASIC saves Indirect Commands in the ALTAIR's memory. When you type in RUN , BASIC will execute the lowest numbered indirect statement that has been typed in first, then the next highest, etc. for as many as were typed in.

Suppose we type in RUN now:

```
RUN .
```

ALTAIR BASIC will type out:

```
5  
-1
```

```
OK
```

In the example above, we typed in line 10 first and line 20 second. However, it makes no difference in what order you type in indirect statements. BASIC always puts them into correct numerical order according to the Line Number.

If we want a listing of the complete program currently in memory, we type in LIST . Type this in:

```
LIST
```

ALTAIR BASIC will reply with:

```
10 PRINT 2+3  
20 PRINT 2-3  
OK
```

Sometimes it is desirable to delete a line of a program altogether. This is accomplished by typing the Line Number of the line we wish to delete, followed only by a carriage return.

Type in the following:

```
10  
LIST
```

ALTAIR BASIC will reply with:

```
20 PRINT 2-3  
OK
```

We have now deleted line 10 from the program. There is no way to get it back. To insert a new line 10, just type in 10 followed by the statement we want BASIC to execute.

Type in the following:

```
10 PRINT 2*3  
LIST
```

ALTAIR BASIC will reply with:

```
10 PRINT 2*3  
20 PRINT 2-3  
OK
```

There is an easier way to replace line 10 than deleting it and then inserting a new line. You can do this by just typing the new line 10 and hitting the carriage return. BASIC throws away the old line 10 and replaces it with the new one.

Type in the following:

```
10 PRINT 3-3  
LIST
```

ALTAIR BASIC will reply with:

```
10 PRINT 3-3  
20 PRINT 2-3  
OK
```

It is not recommended that lines be numbered consecutively. It may become necessary to insert a new line between two existing lines. An increment of 10 between line numbers is generally sufficient.

If you want to erase the complete program currently stored in memory, type in " NEW ". If you are finished running one program and are about to read in a new one, be sure to type in " NEW " first. This should be done in order to prevent a mixture of the old and new programs.

Type in the following:

```
NEW
```

ALTAIR BASIC will reply with:

```
OK
```

Now type in:

LIST

ALTAIR BASIC will reply with:

OK

Often it is desirable to include text along with answers that are printed out, in order to explain the meaning of the numbers.

Type in the following:

PRINT "ONE THIRD IS EQUAL TO",1/3

ALTAIR BASIC will reply with:

ONE THIRD IS EQUAL TO .333333

OK

As explained earlier, including a " , " in a print statement causes it to space over to the next fourteen column field before the value following the " , " is printed.

If we use a " ; " instead of a comma, the value next will be printed immediately following the previous value.

NOTE: Numbers are always printed with at least one trailing space.
Any text to be printed is always to be enclosed in double quotes.

Try the following examples:

A) PRINT "ONE THIRD IS EQUAL TO";1/3
ONE THIRD IS EQUAL TO .333333

OK

B) PRINT 1,2,3
1 2 3

OK

...

C) PRINT 1;2;3
1 2 3

OK

D) PRINT -1;2;-3
-1 2 -3

OK

We will digress for a moment to explain the format of numbers in ALTAIR BASIC. Numbers are stored internally to over six digits of accuracy. When a number is printed, only six digits are shown. Every number may also have an exponent (a power of ten scaling factor).

The largest number that may be represented in ALTAIR BASIC is 1.70141×10^{38} , while the smallest positive number is 2.93874×10^{-39} .

When a number is printed, the following rules are used to determine the exact format:

- 1) If the number is negative, a minus sign (-) is printed.
If the number is positive, a space is printed.
- 2) If the absolute value of the number is an integer in the range 0 to 999999, it is printed as an integer.
- 3) If the absolute value of the number is greater than or equal to .1 and less than or equal to 999999, it is printed in fixed point notation, with no exponent.
- 4) If the number does not fall under categories 2 or 3, scientific notation is used.

Scientific notation is formatted as follows: SX.XXXXXESTT .
(each X being some integer 0 to 9)

The leading "S" is the sign of the number, a space for a positive number and a " - " for a negative one. One non-zero digit is printed before the decimal point. This is followed by the decimal point and then the other five digits of the mantissa. An "E" is then printed (for exponent), followed by the sign (S) of the exponent; then the two digits (TT) of the exponent itself. Leading zeroes are never printed; i.e. the digit before the decimal is never zero. Also, trailing zeroes are never printed. If there is only one digit to print after all trailing zeroes are suppressed, no decimal point is printed. The exponent sign will be " + " for positive and " - " for negative. Two digits of the exponent are always printed; that is zeroes are not suppressed in the exponent field. The value of any number expressed thus is the number to the left of the "E" times 10 raised to the power of the number to the right of the "E".

No matter what format is used, a space is always printed following a number. The 8K version of BASIC checks to see if the entire number will fit on the current line. If not, a carriage return/line feed is executed before printing the number.

The following are examples of various numbers and the output format ALTAIR BASIC will place them into:

| <u>NUMBER</u> | <u>OUTPUT FORMAT</u> |
|---------------|----------------------|
| +1 | 1 |
| -1 | -1 |
| 6523 | 6523 |
| -23.460 | -23.46 |
| 1E20 | 1E+20 |
| -12.3456E-7 | -1.23456E-06 |
| 1.234567E-10 | 1.23457E-10 |
| 1000000 | 1E+06 |
| 999999 | 999999 |
| .1 | .1 |
| .01 | 1E-02 |
| .000123 | 1.23E-04 |

A number input from the terminal or a numeric constant used in a BASIC program may have as many digits as desired, up to the maximum length of a line (72 characters). However, only the first 7 digits are significant, and the seventh digit is rounded up.

```
PRINT 1.2345678901234567890  
1.23457
```

OK

The following is an example of a program that reads a value from the terminal and uses that value to calculate and print a result:

```
10 INPUT R  
20 PRINT 3.14159*R*R  
RUN  
? 10  
314.159
```

OK

Here's what's happening. When BASIC encounters the input statement, it types a question mark (?) on the terminal and then waits for you to type in a number. When you do (in the above example 10 was typed), execution continues with the next statement in the program after the variable (R) has been set (in this case to 10). In the above example, line 20 would now be executed. When the formula after the PRINT statement is evaluated, the value 10 is substituted for the variable R each time R appears in the formula. Therefore, the formula becomes $3.14159 \times 10 \times 10$, or 314.159.

If you haven't already guessed, what the program above actually does is to calculate the area of a circle with the radius "R".

If we wanted to calculate the area of various circles, we could keep re-running the program over each time for each successive circle. But, there's an easier way to do it simply by adding another line to the program as follows:

```
30 GOTO 10
RUN
? 10
314.159
? 3
28.2743
? 4.7
69.3977
?
```

OK

By putting a "GOTO" statement on the end of our program, we have caused it to go back to line 10 after it prints each answer for the successive circles. This could have gone on indefinitely, but we decided to stop after calculating the area for three circles. This was accomplished by typing a carriage return to the input statement (thus a blank line).

NOTE: Typing a carriage return to an input statement in the 4K version of BASIC will cause a SN error (see Reference Material).

The letter "R" in the program we just used was termed a "variable". A variable name can be any alphabetic character and may be followed by any alphanumeric character.

In the 4K version of BASIC, the second character must be numeric or omitted. In the 8K version of BASIC, any alphanumeric characters after the first two are ignored. An alphanumeric character is any letter (A-Z) or any number (0-9).

Below are some examples of legal and illegal variable names:

LEGAL

IN 4K VERSION

A
Z1

ILLEGAL

% (1st character must be alphabetic)
Z1A (variable name too long)
QR (2nd character must be numeric)

IN 8K VERSION

TP
PSTG\$
COUNT

TO (variable names cannot be reserved words)
RGOTO (variable names cannot contain reserved words)

The words used as BASIC statements are "reserved" for this specific purpose. You cannot use these words as variable names or inside of any variable name. For instance, "FEND" would be illegal because "END" is a reserved word.

The following is a list of the reserved words in ALTAIR BASIC:

4K RESERVED WORDS

```
ABS   CLEAR   DATA   DIM   END   FOR   GOSUB   GOTO   IF   INPUT  
INT   LET     LIST   NEW   NEXT   PRINT  READ   REM   RESTORE  
RETURN  RND   RUN    SGN   SIN    SQR   STEP   STOP   TAB(  THEN  
TO    USR
```

8K RESERVED WORDS INCLUDE ALL THOSE ABOVE, AND IN ADDITION

```
ASC   AND   ATN   CHR$   CLOAD  CONT   COS   CSAVE  DEF   EXP  
FN    FRE   INP   LEFT$  LEN    LOG   MID$  NULL   ON    OR   NOT  
OUT   PEEK  POKE  POS    RIGHT$ SPC(  STR$  TAN   VAL   WAIT
```

Remember, in the 4K version of BASIC variable names are only a letter or a letter followed by a number. Therefore, there is no possibility of a conflict with a reserved word.

Besides having values assigned to variables with an input statement, you can also set the value of a variable with a LET or assignment statement.

Try the following examples:

A=5

OK

PRINT A,A*2

5 10

OK

LET Z=7

OK

PRINT Z, Z-A

7 2

OK

As can be seen from the examples, the "LET" is optional in an assignment statement.

BASIC "remembers" the values that have been assigned to variables using this type of statement. This "remembering" process uses space in the ALTAIR's memory to store the data.

The values of variables are thrown away and the space in memory used to store them is released when one of four things occur:

- 1) A new line is typed into the program or an old line is deleted
- 2) A CLEAR command is typed in
- 3) A RUN command is typed in
- 4) NEW is typed in

Another important fact is that if a variable is encountered in a formula before it is assigned a value, it is automatically assigned the value zero. Zero is then substituted as the value of the variable in the particular formula. Try the example below:

```
PRINT Q,Q+2,Q*2
      0          2          0
OK
```

Another statement is the REM statement. REM is short for remark. This statement is used to insert comments or notes into a program. When BASIC encounters a REM statement the rest of the line is ignored.

This serves mainly as an aid for the programmer himself, and serves no useful function as far as the operation of the program in solving a particular problem.

Suppose we wanted to write a program to check if a number is zero or not. With the statements we've gone over so far this could not be done. What is needed is a statement which can be used to conditionally branch to another statement. The "IF-THEN" statement does just that.

Try typing in the following program: (remember, type NEW first)

```
10 INPUT B
20 IF B=0 THEN 50
30 PRINT "NON-ZERO"
40 GOTO 10
50 PRINT "ZERO"
60 GOTO 10
```

When this program is typed into the ALTAIR and run, it will ask for a value for B. Type any value you wish in. The ALTAIR will then come to the "IF" statement. Between the "IF" and the "THEN" portion of the statement there are two expressions separated by a relation.

A relation is one of the following six symbols:

| <u>RELATION</u> | <u>MEANING</u> |
|-----------------|--------------------------|
| = | EQUAL TO |
| > | GREATER THAN |
| < | LESS THAN |
| <> | NOT EQUAL TO |
| <= | LESS THAN OR EQUAL TO |
| => | GREATER THAN OR EQUAL TO |

The IF statement is either true or false, depending upon whether the two expressions satisfy the relation or not. For example, in the program we just did, if 0 was typed in for B the IF statement would be true because $0=0$. In this case, since the number after the THEN is 50, execution of the program would continue at line 50. Therefore, "ZERO" would be printed and then the program would jump back to line 10 (because of the GOTO statement in line 60).

Suppose a 1 was typed in for B. Since $1=0$ is false, the IF statement would be false and the program would continue execution with the next line. Therefore, "NON-ZERO" would be printed and the GOTO in line 40 would send the program back to line 10.

Now try the following program for comparing two numbers:

```
10 INPUT A,B
20 IF A<=B THEN 50
30 PRINT "A IS BIGGER"
40 GOTO 10
50 IF A<B THEN 80
60 PRINT "THEY ARE THE SAME"
70 GOTO 10
80 PRINT "B IS BIGGER"
90 GOTO 10
```

When this program is run, line 10 will input two numbers from the terminal. At line 20, if A is greater than B, $A \leq B$ will be false. This will cause the next statement to be executed, printing "A IS BIGGER" and then line 40 sends the computer back to line 10 to begin again.

At line 20, if A has the same value as B, $A \leq B$ is true so we go to line 50. At line 50, since A has the same value as B, $A < B$ is false; therefore, we go to the following statement and print "THEY ARE THE SAME". Then line 70 sends us back to the beginning again.

At line 20, if A is smaller than B, $A \leq B$ is true so we go to line 50. At line 50, $A < B$ will be true so we then go to line 80. "B IS BIGGER" is then printed and again we go back to the beginning.

Try running the last two programs several times. It may make it easier to understand if you try writing your own program at this time using the IF-THEN statement. Actually trying programs of your own is the quickest and easiest way to understand how BASIC works. Remember, to stop these programs just give a carriage return to the input statement.

One advantage of computers is their ability to perform repetitive tasks. Let's take a closer look and see how this works.

Suppose we want a table of square roots from 1 to 10. The BASIC function for square root is "SQR"; the form being SQR(X), X being the number you wish the square root calculated from. We could write the program as follows:

```
10 PRINT 1,SQR(1)
20 PRINT 2,SQR(2)
30 PRINT 3,SQR(3)
40 PRINT 4,SQR(4)
50 PRINT 5,SQR(5)
60 PRINT 6,SQR(6)
70 PRINT 7,SQR(7)
80 PRINT 8,SQR(8)
90 PRINT 9,SQR(9)
100 PRINT 10,SQR(10)
```

This program will do the job; however, it is terribly inefficient. We can improve the program tremendously by using the IF statement just introduced as follows:

```
10 N=1
20 PRINT N,SQR(N)
30 N=N+1
40 IF N<=10 THEN 20
```

When this program is run, its output will look exactly like that of the 10 statement program above it. Let's look at how it works.

At line 10 we have a LET statement which sets the value of the variable N at 1. At line 20 we print N and the square root of N using its current value. It thus becomes 20 PRINT 1,SQR(1), and this calculation is printed out.

At line 30 we use what will appear at first to be a rather unusual LET statement. Mathematically, the statement N=N+1 is nonsense. However, the important thing to remember is that in a LET statement, the symbol " = " does not signify equality. In this case " = " means "to be replaced with". All the statement does is to take the current value of N and add 1 to it. Thus, after the first time through line 30, N becomes 2.

At line 40, since N now equals 2, N<=10 is true so the THEN portion branches us back to line 20, with N now at a value of 2.

The overall result is that lines 20 through 40 are repeated, each time adding 1 to the value of N. When N finally equals 10 at line 20, the next line will increment it to 11. This results in a false statement at line 40, and since there are no further statements to the program it stops.

This technique is referred to as "looping" or "iteration". Since it is used quite extensively in programming, there are special BASIC statements for using it. We can show these with the following program.

```
10 FOR N=1 TO 10
20 PRINT N,SQR(N)
30 NEXT N
```

The output of the program listed above will be exactly the same as the previous two programs.

At line 10, N is set to equal 1. Line 20 causes the value of N and the square root of N to be printed. At line 30 we see a new type of statement. The "NEXT N" statement causes one to be added to N, and then if $N \leq 10$ we go back to the statement following the "FOR" statement. The overall operation then is the same as with the previous program.

Notice that the variable following the "FOR" is exactly the same as the variable after the "NEXT". There is nothing special about the N in this case. Any variable could be used, as long as they are the same in both the "FOR" and the "NEXT" statements. For instance, "Z1" could be substituted everywhere there is an "N" in the above program and it would function exactly the same.

Suppose we wanted to print a table of square roots from 10 to 20, only counting by two's. The following program would perform this task:

```
10 N=10
20 PRINT N,SQR(N)
30 N=N+2
40 IF N<=20 THEN 20
```

Note the similar structure between this program and the one listed on page 12 for printing square roots for the numbers 1 to 10. This program can also be written using the "FOR" loop just introduced.

```
10 FOR N=10 TO 20 STEP 2
20 PRINT N,SQR(N)
30 NEXT N
```

Notice that the only major difference between this program and the previous one using "FOR" loops is the addition of the "STEP 2" clause.

This tells BASIC to add 2 to N each time, instead of 1 as in the previous program. If no "STEP" is given in a "FOR" statement, BASIC assumes that one is to be added each time. The "STEP" can be followed by any expression.

Suppose we wanted to count backwards from 10 to 1. A program for doing this would be as follows:

```
10 I=10
20 PRINT I
30 I=I-1
40 IF I>=1 THEN 20
```

Notice that we are now checking to see that I is greater than or equal to the final value. The reason is that we are now counting by a negative number. In the previous examples it was the opposite, so we were checking for a variable less than or equal to the final value.

The "STEP" statement previously shown can also be used with negative numbers to accomplish this same purpose. This can be done using the same format as in the other program, as follows:

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

"FOR" loops can also be "nested". An example of this procedure follows:

```
10 FOR I=1 TO 5  
20 FOR J=1 TO 3  
30 PRINT I,J  
40 NEXT J  
50 NEXT I
```

Notice that the "NEXT J" comes before the "NEXT I". This is because the J-loop is inside of the I-loop. The following program is incorrect; run it and see what happens.

```
10 FOR I=1 TO 5  
20 FOR J=1 TO 3  
30 PRINT I,J  
40 NEXT I  
50 NEXT J
```

It does not work because when the "NEXT I" is encountered, all knowledge of the J-loop is lost. This happens because the J-loop is "inside" of the I-loop.

It is often convenient to be able to select any element in a table of numbers. BASIC allows this to be done through the use of matrices.

A matrix is a table of numbers. The name of this table, called the matrix name, is any legal variable name, "A" for example. The matrix name "A" is distinct and separate from the simple variable "A", and you could use both in the same program.

To select an element of the table, we subscript "A" : that is to select the I'th element, we enclose I in parenthesis "(I)" and then follow "A" by this subscript. Therefore, "A(I)" is the I'th element in the matrix "A".

NOTE: In this section of the manual we will be concerned with one-dimensional matrices only. (See Reference Material)

"A(I)" is only one element of matrix A, and BASIC must be told how much space to allocate for the entire matrix.

This is done with a "DIM" statement, using the format "DIM A(15)". In this case, we have reserved space for the matrix index "I" to go from 0 to 15. Matrix subscripts always start at 0; therefore, in the above example, we have allowed for 16 numbers in matrix A.

If "A(I)" is used in a program before it has been dimensioned, BASIC reserves space for 11 elements (0 through 10).

As an example of how matrices are used, try the following program to sort a list of 8 numbers with you picking the numbers to be sorted.

```
10 DIM A(8)
20 FOR I=1 TO 8
30 INPUT A(I)
50 NEXT I
70 F=0
80 FOR I=1 TO 7
90 IF A(I)<=A(I+1) THEN 140
100 T=A(I)
110 A(I)= A(I+1)
120 A(I+1)=T
130 F=1
140 NEXT I
150 IF F=1 THEN 70
160 FOR I=1 TO 8
170 PRINT A(I),
180 NEXT I
```

When line 10 is executed, BASIC sets aside space for 9 numeric values, A(0) through A(8). Lines 20 through 50 get the unsorted list from the user. The sorting itself is done by going through the list of numbers and upon finding any two that are not in order, we switch them. "F" is used to indicate if any switches were done. If any were done, line 150 tells BASIC to go back and check some more.

If we did not switch any numbers, or after they are all in order, lines 160 through 180 will print out the sorted list. Note that a subscript can be any expression.

Another useful pair of statements are "GOSUB" and "RETURN". If you have a program that performs the same action in several different places, you could duplicate the same statements for the action in each place within the program.

The "GOSUB"- "RETURN" statements can be used to avoid this duplication. When a "GOSUB" is encountered, BASIC branches to the line whose number follows the "GOSUB". However, BASIC remembers where it was in the program before it branched. When the "RETURN" statement is encountered, BASIC goes back to the first statement following the last "GOSUB" that was executed. Observe the following program.

```
10 PRINT "WHAT IS THE NUMBER";
30 GOSUB 100
40 T=N
50 PRINT "WHAT IS THE SECOND NUMBER";
70 GOSUB 100
80 PRINT "THE SUM OF THE TWO NUMBERS IS",T+N
90 STOP
100 INPUT N
```

```
110 IF N = INT(N) THEN 140
120 PRINT "SORRY, NUMBER MUST BE AN INTEGER. TRY AGAIN."
130 GOTO 100
140 RETURN
```

What this program does is to ask for two numbers which must be integers, and then prints the sum of the two. The subroutine in this program is lines 100 to 130. The subroutine asks for a number, and if it is not an integer, asks for a number again. It will continue to ask until an integer value is typed in.

The main program prints "WHAT IS THE NUMBER", and then calls the subroutine to get the value of the number into N. When the subroutine returns (to line 40), the value input is saved in the variable T. This is done so that when the subroutine is called a second time, the value of the first number will not be lost.

"WHAT IS THE SECOND NUMBER" is then printed, and the second value is entered when the subroutine is again called.

When the subroutine returns the second time, "THE SUM OF THE TWO NUMBERS IS" is printed, followed by the value of their sum. T contains the value of the first number that was entered and N contains the value of the second number.

The next statement in the program is a "STOP" statement. This causes the program to stop execution at line 90. If the "STOP" statement was not included in the program, we would "fall into" the subroutine at line 100. This is undesirable because we would be asked to input another number. If we did, the subroutine would try to return; and since there was no "GOSUB" which called the subroutine, an RG error would occur. Each "GOSUB" executed in a program should have a matching "RETURN" executed later, and the opposite applies, i.e. a "RETURN" should be encountered only if it is part of a subroutine which has been called by a "GOSUB".

Either "STOP" or "END" can be used to separate a program from its subroutines. In the 4K version of BASIC, there is no difference between the "STOP" and the "END". In the 8K version, "STOP" will print a message saying at what line the "STOP" was encountered.

Suppose you had to enter numbers to your program that didn't change each time the program was run, but you would like it to be easy to change them if necessary. BASIC contains special statements for this purpose, called the "READ" and "DATA" statements.

Consider the following program:

```
10 PRINT "GUESS A NUMBER";
20 INPUT G
30 READ D
40 IF D=-999999 THEN 90
50 IF D<>G THEN 30
60 PRINT "YOU ARE CORRECT"
70 END
90 PRINT "BAD GUESS, TRY AGAIN."
95 RESTORE
```

```
100 GOTO 10
110 DATA 1,393,-39,28,391,-8,0,3.14,90
120 DATA 89,5,10,15,-34,-99999
```

This is what happens when this program is run. When the "READ" statement is encountered, the effect is the same as an INPUT statement. But, instead of getting a number from the terminal, a number is read from the "DATA" statements.

The first time a number is needed for a READ, the first number in the first DATA statement is returned. The second time one is needed, the second number in the first DATA statement is returned. When the entire contents of the first DATA statement have been read in this manner, the second DATA statement will then be used. DATA is always read sequentially in this manner, and there may be any number of DATA statements in your program.

The purpose of this program is to play a little game in which you try to guess one of the numbers contained in the DATA statements. For each guess that is typed in, we read through all of the numbers in the DATA statements until we find one that matches the guess.

If more values are read than there are numbers in the DATA statements, an out of data (OD) error occurs. That is why in line 40 we check to see if -999999 was read. This is not one of the numbers to be matched, but is used as a flag to indicate that all of the data (possible correct guesses) has been read. Therefore, if -999999 was read, we know that the guess given was incorrect.

Before going back to line 10 for another guess, we need to make the READ's begin with the first piece of data again. This is the function of the "RESTORE". After the RESTORE is encountered, the next piece of data read will be the first piece in the first DATA statement again.

DATA statements may be placed anywhere within the program. Only READ statements make use of the DATA statements in a program, and any other time they are encountered during program execution they will be ignored.

*THE FOLLOWING INFORMATION APPLIES TO THE 8K VERSION
OF BASIC ONLY*

A list of characters is referred to as a "String". MITS, ALTAIR, and THIS IS A TEST are all strings. Like numeric variables, string variables can be assigned specific values. String variables are distinguished from numeric variables by a "\$" after the variable name.

For example, try the following:

```
A$="ALTAIR 8800"
```

```
OK
PRINT A$
ALTAIR 8800
```

```
OK
```

In this example, we set the string variable A\$ to the string value "ALTAIR 8800". Note that we also enclosed the character string to be assigned to A\$ in quotes.

Now that we have set A\$ to a string value, we can find out what the length of this value is (the number of characters it contains). We do this as follows:

```
PRINT LEN(A$),LEN("MITS")
11      4
OK
```

The "LEN" function returns an integer equal to the number of characters in a string.

The number of characters in a string expression may range from 0 to 255. A string which contains 0 characters is called the "NULL" string. Before a string variable is set to a value in the program, it is initialized to the null string. Printing a null string on the terminal will cause no characters to be printed, and the print head or cursor will not be advanced to the next column. Try the following:

```
PRINT LEN(Q$);Q$;3
0 3
OK
```

Another way to create the null string is: Q\$=""

Setting a string variable to the null string can be used to free up the string space used by a non-null string variable.

Often it is desirable to access parts of a string and manipulate them. Now that we have set A\$ to "ALTAIR 8800", we might want to print out only the first six characters of A\$. We would do so like this:

```
PRINT LEFT$(A$,6)
ALTAIR
OK
```

"LEFT\$" is a string function which returns a string composed of the leftmost N characters of its string argument. Here's another example:

```
FOR N=1 TO LEN(A$):PRINT LEFT$(A$,N):NEXT N
A
AL
ALT
ALTA
ALTAI
ALTAIR
ALTAIR 8
ALTAIR 88
```

```
ALTAIR 8800  
ALTAIR 8800
```

OK

Since A\$ has 11 characters, this loop will be executed with N=1,2,3,...,10,11. The first time through only the first character will be printed, the second time the first two characters will be printed, etc.

There is another string function called "RIGHT\$" which returns the right N characters from a string expression. Try substituting "RIGHT\$" for "LEFT\$" in the previous example and see what happens.

There is also a string function which allows us to take characters from the middle of a string. Try the following:

```
FOR N=1 TO LEN(A$):PRINT MID$(A$,N):NEXT N  
ALTAIR 8800  
LTAIR 8800  
TAIR 8800  
AIR 8800  
IR 8800  
R 8800  
 8800  
 8800  
 800  
 00  
 0
```

OK

"MID\$" returns a string starting at the Nth position of A\$ to the end (last character) of A\$. The first position of the string is position 1 and the last possible position of a string is position 255.

Very often it is desirable to extract only the Nth character from a string. This can be done by calling MID\$ with three arguments. The third argument specifies the number of characters to return.

For example:

```
FOR N=1 TO LEN(A$):PRINT MID$(A$,N,1),MID$(A$,N,2):NEXT N  
A          AL  
L          LT  
T          TA  
A          AI  
I          IR  
R          R  
 8          8  
 8          80  
 0          00  
 0          0
```

OK

See the Reference Material for more details on the workings of "LEFT\$", "RIGHT\$" and "MID\$".

Strings may also be concatenated (put or joined together) through the use of the "+" operator. Try the following:

```
B$="MITS"+" "+A$
```

```
OK  
PRINT B$  
MITS ALTAIR 8800
```

```
OK
```

Concatenation is especially useful if you wish to take a string apart and then put it back together with slight modifications. For instance:

```
C$=LEFT$(B$,4)+"-"+MID$(B$,6,6)+"-"+RIGHT$(B$,4)
```

```
OK  
PRINT C$  
MITS-ALTAIR-8800
```

```
OK
```

Sometimes it is desirable to convert a number to its string representation and vice-versa. "VAL" and "STR\$" perform these functions.

Try the following:

```
STRING$="567.8"
```

```
OK  
PRINT VAL(STRING$)  
567.8
```

```
OK  
STRING$=STR$(3.1415)
```

```
OK  
PRINT STRING$,LEFT$(STRING$,5)  
3.1415      3.14
```

```
OK
```

"STR\$" can be used to perform formatted I/O on numbers. You can convert a number to a string and then use LEFT\$, RIGHT\$, MID\$ and concatenation to reformat the number as desired.

"STR\$" can also be used to conveniently find out how many print columns a number will take. For example:

```
PRINT LEN(STR$(3.157))  
6
```

OK

If you have an application where a user is typing in a question such as "WHAT IS THE VOLUME OF A CYLINDER OF RADIUS 5.36 FEET, OF HEIGHT 5.1 FEET?" you can use "VAL" to extract the numeric values 5.36 and 5.1 from the question. For further functions "CHR\$" and "ASC" see Appendix K.

The following program sorts a list of string data and prints out the sorted list. This program is very similar to the one given earlier for sorting a numeric list.

```
100 DIM A$(15):REM ALLOCATE SPACE FOR STRING MATRIX
110 FOR I=1 TO 15:READ A$(I):NEXT I:REM READ IN STRINGS
120 F=0:I=1:REM SET EXCHANGE FLAG TO ZERO AND SUBSCRIPT TO 1
130 IF A$(I)<=A$(I+1) THEN 180:REM DON'T EXCHANGE IF ELEMENTS
   IN ORDER
140 T$=A$(I+1):REM USE T$ TO SAVE A$(I+1)
150 A$(I+1)=A$(I):REM EXCHANGE TWO CONSECUTIVE ELEMENTS
160 A$(I)=T$
170 F=1:REM FLAG THAT WE EXCHANGED TWO ELEMENTS
180 I=I+1: IF I<15 GOTO 130
185 REM ONCE WE HAVE MADE A PASS THRU ALL ELEMENTS, CHECK
187 REM TO SEE IF WE EXCHANGED ANY. IF NOT, DONE SORTING.
190 IF F THEN 120:REM EQUIVALENT TO IF F<>0 THEN 120
200 FOR I=1 TO 15:PRINT A$(I):NEXT I: REM PRINT SORTED LIST
210 REM STRING DATA FOLLOWS
220 DATA APPLE,DOG,CAT,MITS,ALTAIR,RANDOM
230 DATA MONDAY,"***ANSWER***","FOO"
240 DATA COMPUTER,    FOO,ELP,MILWAUKEE,SEATTLE,ALBUQUERQUE
```


BASIC LANGUAGE

REFERENCE

MATERIAL

MITs
"Creative Electronics"

COMMANDS

A command is usually given after BASIC has typed OK. This is called the "Command Level". Commands may be used as program statements. Certain commands, such as LIST, NEW and CLOAD will terminate program execution when they finish.

| <u>NAME</u> | <u>EXAMPLE</u> | <u>PURPOSE/USE</u> |
|-------------|---|--|
| CLEAR | *(SEE PAGE 42 FOR EXAMPLES AND EXPLANATION) | |
| LIST | LIST LIST 100 | Lists current program optionally starting at specified line. List can be control-C'd (BASIC will finish listing the current line) |
| NULL | NULL 3 | (Null command only in 8K version, but paragraph applicable to 4K version also) Sets the number of null (ASCII 0) characters printed after a carriage return/line feed. The number of nulls printed may be set from 0 to 71. This is a must for hardcopy terminals that require a delay after a CRLF*. It is necessary to set the number of nulls typed on CRLF to 0 before a paper tape of a program is read in from a Teletype (<i>TELETYPE is a registered trademark of the TELETYPE CORPORATION</i>). In the 8K version, use the null command to set the number of nulls to zero. In the 4K version, this is accomplished by patching location 46 octal to contain the number of nulls to be typed plus 1. (Depositing a 1 in location 46 would set the number of nulls typed to zero.) When you punch a paper tape of a program using the list command, null should be set ≥ 3 for 10 CPS terminals, ≥ 6 for 30 CPS terminals. When not making a tape, we recommend that you use a null setting of 0 or 1 for Teletypes, and 2 or 3 for hard copy 30 CPS terminals. A setting of 0 will work with Teletype compatible CRT's. |
| RUN | RUN | Starts execution of the program currently in memory at the lowest numbered statement. Run deletes all variables (does a CLEAR) and restores DATA. If you have stopped your program and wish to continue execution at some point in the program, use a direct GOTO statement to start execution of your program at the desired line. |

*CRLF=carriage return/line feed

RUN 200

(8K version only) optionally starting at the specified line number

NEW NEW Deletes current program and all variables

THE FOLLOWING COMMANDS ARE IN THE 8K VERSION ONLY

CONT CONT Continues program execution after a control/C is typed or a STOP statement is executed. You cannot continue after any error, after modifying your program, or before your program has been run. One of the main purposes of CONT is debugging. Suppose at some point after running your program, nothing is printed. This may be because your program is performing some time consuming calculation, but it may be because you have fallen into an "infinite loop". An infinite loop is a series of BASIC statements from which there is no escape. The ALTAIR will keep executing the series of statements over and over, until you intervene or until power to the ALTAIR is cut off. If you suspect your program is in an infinite loop, type in a control/C. In the 8K version, the line number of the statement BASIC was executing will be typed out. After BASIC has typed out OK, you can use PRINT to type out some of the values of your variables. After examining these values you may become satisfied that your program is functioning correctly. You should then type in CONT to continue executing your program where it left off, or type a direct GOTO statement to resume execution of the program at a different line. You could also use assignment (LET) statements to set some of your variables to different values. Remember, if you control/C a program and expect to continue it later, you must not get any errors or type in any new program lines. If you do, you won't be able to continue and will get a "CN" (continue not) error. It is impossible to continue a direct command. CONT always resumes execution at the next statement to be executed in your program when control/C was typed.

THE FOLLOWING TWO COMMANDS ARE AVAILABLE IN THE 8K CASSETTE
VERSION ONLY

| | | |
|-------|---------|--|
| CLOAD | CLOAD P | Loads the program named P from the cassette tape. A NEW command is automatically done before the CLOAD command is executed. When done, the CLOAD will type out OK as usual. The one-character program designator may be any printing character. CSAVE and CLOAD use I/O ports 6 & 7. See Appendix I for more information. |
| CSAVE | CSAVE P | Saves on cassette tape the current program in the ALTAIR's memory. The program in memory is left unchanged. More than one program may be stored on cassette using this command. CSAVE and CLOAD use I/O ports 6 & 7. See Appendix I for more information |

OPERATORS

| <u>SYMBOL</u> | <u>SAMPLE STATEMENT</u> | <u>PURPOSE/USE</u> |
|-----------------------------------|--------------------------|--|
| = | A=100 LET Z=2.5 | Assigns a value to a variable The LET is optional |
| - | B=-A | Negation. Note that 0-A is subtraction, while -A is negation. |
| \uparrow (usually a shift/N) | 130 PRINT X \uparrow 3 | Exponentiation (8K version) (equal to X^X^X in the sample statement) $0\uparrow 0=1$ 0 to any other power = 0 $A\uparrow B$, with A negative and B not an integer gives an FC error. |
| * | 140 X=R*(B*D) | Multiplication |
| / | 150 PRINT X/1.3 | Division |
| + | 160 Z=R+T+Q | Addition |
| - | 170 J=100-I | Subtraction |

RULES FOR EVALUATING EXPRESSIONS:

- 1) Operations of higher precedence are performed before operations of lower precedence. This means the multiplication and divisions are performed before additions and subtractions. As an example, $2+10/5$ equals 4, not 2.4. When operations of equal precedence are found in a formula, the left hand one is executed first: $6-3+5=8$, not -2.

2) The order in which operations are performed can always be specified explicitly through the use of parentheses. For instance, to add 5 to 3 and then divide that by 4, we would use $(5+3)/4$, which equals 2. If instead we had used $5+3/4$, we would get 5.75 as a result (5 plus $3/4$).

The precedence of operators used in evaluating expressions is as follows, in order beginning with the highest precedence:

(Note: Operators listed on the same line have the same precedence.)

- 1) FORMULAS ENCLOSED IN PARENTHESIS ARE ALWAYS EVALUATED FIRST
- 2) \uparrow EXPONENTIATION (8K VERSION ONLY)
- 3) NEGATION $-X$ WHERE X MAY BE A FORMULA
- 4) * / MULTIPLICATION AND DIVISION
- 5) + - ADDITION AND SUBTRACTION
- 6) RELATIONAL OPERATORS: $=$ EQUAL
(equal precedence for all six) $<>$ NOT EQUAL
 $<$ LESS THAN
 $>$ GREATER THAN
 $<=$ LESS THAN OR EQUAL
 $>=$ GREATER THAN OR EQUAL

(8K VERSION ONLY) (These 3 below are Logical Operators)

- 7) NOT LOGICAL AND BITWISE "NOT"
LIKE NEGATION, NOT TAKES ONLY THE FORMULA TO ITS RIGHT AS AN ARGUMENT
- 8) AND LOGICAL AND BITWISE "AND"
- 9) OR LOGICAL AND BITWISE "OR"

In the 4K version of BASIC, relational operators can only be used once in an IF statement. However, in the 8K version a relational expression can be used as part of any expression.

Relational Operator expressions will always have a value of True (-1) or a value of False (0). Therefore, $(5=4)=0$, $(5=5)=-1$, $(4>5)=0$, $(4<5)=-1$, etc.

The THEN clause of an IF statement is executed whenever the formula after the IF is not equal to 0. That is to say, IF X THEN... is equivalent to IF $X \neq 0$ THEN... .

| <u>SYMBOL</u> | <u>SAMPLE STATEMENT</u> | <u>PURPOSE/USE</u> |
|---------------|-------------------------|--|
| = | 10 IF A=15 THEN 40 | Expression Equals Expression |
| <> | 70 IF A<>0 THEN 5 | Expression Does Not Equal Expression |
| > | 30 IF B>100 THEN 8 | Expression Greater Than Expression |
| < | 160 IF B<2 THEN 10 | Expression Less Than Expression |
| <=,=< | 180 IF 100<=B+C THEN 10 | Expression Less Than Or Equal To Expression |
| >=,=> | 190 IF Q=>R THEN 50 | Expression Greater Than Or Equal To Expression |
| AND | 2 IF A<5 AND B<2 THEN 7 | (8K Version only) If expression 1 (A<5) AND expression 2 (B<2) are <u>both</u> true, then branch to line 7 |
| OR | IF A<1 OR B<2 THEN 2 | (8K Version only) If <u>either</u> expression 1 (A<1) OR expression 2 (B<2) is true, then branch to line 2 |
| NOT | IF NOT Q3 THEN 4 | (8K Version only) If expression "NOT Q3" is true (because Q3 is false), then branch to line 4 Note: NOT -1=0 (NOT true=false) |

AND, OR and NOT can be used for bit manipulation, and for performing boolean operations.

These three operators 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 table shows the logical relationship between bits:

| <u>OPERATOR</u> | <u>ARG. 1</u> | <u>ARG. 2</u> | <u>RESULT</u> |
|-----------------|---------------|---------------|---------------|
| AND | 1 | 1 | 1 |
| | 0 | 1 | 0 |
| | 1 | 0 | 0 |
| | 0 | 0 | 0 |

(cont.)

| <u>OPERATOR</u> | <u>ARG. 1</u> | <u>ARG. 2</u> | <u>RESULT</u> |
|-----------------|---------------|---------------|---------------|
| OR | 1 | 1 | 1 |
| | 1 | 0 | 1 |
| | 0 | 1 | 1 |
| | 0 | 0 | 0 |
| 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 1111111111111110 (-2) equals binary 1111111111111111, or -1.
- NOT 0=-1 The bit complement of binary 0 to 16 places is sixteen 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 ALTAIR's input ports which reflect the state of some external device. 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 NOT (INP(5) AND 2) THEN 10

This line will execute over and over until bit 1 (masked or selected by the 2) becomes a 1. When that happens, we go to line 20.

20 PRINT "INTRUDER ALERT"

Line 20 will output "INTRUDER ALERT".

However, we can replace statement 10 with a "WAIT" statement, which has exactly the same effect.

10 WAIT 5,2

This line delays the execution of the next statement in the program until bit 1 of I/O port 5 becomes 1. The WAIT is much faster than the equivalent IF statement and also takes less bytes of program storage.

The ALTAIR's sense switches may also be used as an input device by the INP function. The program below prints out any changes in the sense switches.

```
10 A=300:REM SET A TO A VALUE THAT WILL FORCE PRINTING
20 J=INP(255):IF J=A THEN 20
30 PRINT J;:A=J:GOTO 20
```

The following is another useful way of using relational operators:

125 A==-(B>C)*B-(B<=C)*C This statement will set the variable A to MAX(B,C) = the larger of the two variables B and C.

STATEMENTS

Note: In the following description of statements, an argument of V or W denotes a numeric variable, X denotes a numeric expression, X\$ denotes a string expression and an I or J denotes an expression that is truncated to an integer before the statement is executed. Truncation means that any fractional part of the number is lost, e.g. 3.9 becomes 3, 4.01 becomes 4.

An expression is a series of variables, operators, function calls and constants which after the operations and function calls are performed using the precedence rules, evaluates to a numeric or string value.

A constant is either a number (3.14) or a string literal ("FOO").

| <u>NAME</u> | <u>EXAMPLE</u> | <u>PURPOSE/USE</u> |
|-------------|----------------------------|---|
| DATA | 10 DATA 1,3,-1E3,.04 | Specifies data, read from left to right. Information appears in data statements in the same order as it will be read in the program. IN THE 4K VERSION OF BASIC, DATA STATEMENTS MUST BE THE FIRST STATEMENTS ON A LINE. Expressions may also appear in the 4K version data statements. |
| | 20 DATA " FOO",Z00 | (8K Version) Strings may be read from DATA statements. If you want the string to contain leading spaces (blanks), colons (:) or commas (,), you must enclose the string in double quotes. It is impossible to have a double quote within string data or a string literal. (""MITS"" is illegal) |
| DEF | 100 DEF FNA(V)=V/B+C | (8K Version) The user can define functions like the built-in functions (SQR, SGN, ABS, etc.) through the use of the DEF statement. The name of the function is "FN" followed by any legal variable name, for example: FNX, FNJ7, FNK0, FNR2. User defined functions are restricted to one line. A function may be defined to be any expression, but may only have one argument. In the example B & C are variables that are used in the program. Executing the DEF statement defines the function. User defined functions can be redefined by executing another DEF statement for the same function. User defined string functions are not allowed. "V" is called the dummy variable. |
| | 110 Z=FNA(3) | Execution of this statement following the above would cause Z to be set to 3/B+C, but the value of V would be unchanged. |
| DIM | 113 DIM A(3),B(10) | Allocates space for matrices. All matrix elements are set to zero by the DIM statement. |
| | 114 DIM R3(5,5),D\$(2,2,2) | (8K Version) Matrices can have more than one dimension. Up to 255 dimensions are allowed, but due to the restriction of 72 characters per line the practical maximum is about 34 dimensions. |
| | 115 DIM Q1(N),Z(2*I) | Matrices can be dimensioned dynamically during program execution. If a matrix is not explicitly dimensioned with a DIM statement, it is assumed to be a single dimensioned matrix of whose single subscript |

117 A(8)=4

may range from 0 to 10 (eleven elements). If this statement was encountered before a DIM statement for A was found in the program, it would be as if a DIM A(10) had been executed previous to the execution of line 117. All subscripts start at zero (0), which means that DIM X(100) really allocates 101 matrix elements.

END

999 END

Terminates program execution without printing a BREAK message. (see STOP) CONT after an END statement causes execution to resume at the statement after the END statement. END can be used anywhere in the program, and is optional.

FOR

300 FOR V=1 TO 9.3 STEP .6

(see NEXT statement) V is set equal to the value of the expression following the equal sign, in this case 1. This value is called the initial value. Then the statements between FOR and NEXT are executed. The final value is the value of the expression following the TO. The step is the value of the expression following STEP. When the NEXT statement is encountered, the step is added to the variable.

310 FOR V=1 TO 9.3

If no STEP was specified, it is assumed to be one. If the step is positive and the new value of the variable is <= the final value (9.3 in this example), or the step value is negative and the new value of the variable is => the final value, then the first statement following the FOR statement is executed. Otherwise, the statement following the NEXT statement is executed. All FOR loops execute the statements between the FOR and the NEXT at least once, even in cases like FOR V=1 TO 0.

315 FOR V=10*N TO 3.4/Q STEP SQR(R)

Note that expressions (formulas) may be used for the initial, final and step values in a FOR loop. The values of the expressions are computed only once, before the body of the FOR....NEXT loop is executed.

320 FOR V=9 TO 1 STEP -1 When the statement after the NEXT is executed, the loop variable is never equal to the final value, but is equal to whatever value caused the FOR...NEXT loop to terminate. The statements between the FOR and its corresponding NEXT in both examples above (310 & 320) would be executed 9 times.

330 FOR W=1 TO 10: FOR W=1 TO :NEXT W:NEXT W Error: do not use nested FOR...NEXT loops with the same index variable.
FOR loop nesting is limited only by the available memory.
(see Appendix D)

GOTO 50 GOTO 100 Branches to the statement specified.
GOSUB 10 GOSUB 910 Branches to the specified statement (910) until a RETURN is encountered; when a branch is then made to the statement after the GOSUB. GOSUB nesting is limited only by the available memory.
(see Appendix D)

IF...GOTO
32 IF X<=Y+23.4 GOTO 92 (8K Version) Equivalent to IF...THEN, except that IF...GOTO must be followed by a line number, while IF...THEN can be followed by either a line number or another statement.

IF...THEN
IF X<10 THEN 5 Branches to specified statement if the relation is True.
20 IF X<0 THEN PRINT "X LESS THAN 0" Executes all of the statements on the remainder of the line after the THEN if the relation is True.
25 IF X=5 THEN 50:Z=A WARNING. The "Z=A" will never be executed because if the relation is true, BASIC will branch to line 50. If the relation is false Basic will proceed to the line after line 25.
26 IF X<0 THEN PRINT "ERROR, X NEGATIVE": GOTO 350 In this example, if X is less than 0, the PRINT statement will be executed and then the GOTO statement will branch to line 350. If the X was 0 or positive, BASIC will proceed to execute the lines after line 26.

| | | |
|-----------|--|--|
| INPUT | 3 INPUT V,W,W2 | Requests data from the terminal (to be typed in). Each value must be separated from the preceding value by a comma (,). The last value typed should be followed by a carriage return. A "?" is typed as a prompt character. In the 4K version, a value typed in as a response to an INPUT statement may be a formula, such as $2*\text{SIN}(.16)-3$. However, in the 8K version, only constants may be typed in as a response to an INPUT statement, such as $4.5E-3$ or "CAT". If more data was requested in an INPUT statement than was typed in, a "???" is printed and the rest of the data should be typed in. If more data was typed in than was requested, the extra data will be ignored. The 8K version will print the warning "EXTRA IGNORED" when this happens. The 4K version will not print a warning message. <i>(8K Version)</i> Strings must be input in the same format as they are specified in DATA statements. |
| | 5 INPUT "VALUE";V | <i>(8K Version)</i> Optionally types a prompt string ("VALUE") before requesting data from the terminal. If carriage return is typed to an input statement, BASIC returns to command mode. Typing CONT after an INPUT command has been interrupted will cause execution to resume at the INPUT statement. |
| LET | 300 LET W=X 310 V=5.1 | Assigns a value to a variable. "LET" is optional. |
| NEXT | 340 NEXT V 345 NEXT 350 NEXT V,W | Marks the end of a FOR loop. <i>(8K Version)</i> If no variable is given, matches the most recent FOR loop. <i>(8K Version)</i> A single NEXT may be used to match multiple FOR statements. Equivalent to NEXT V:NEXT W. |
| ON...GOTO | 100 ON I GOTO 10,20,30,40 | <i>(8K Version)</i> Branches to the line indicated by the I'th number after the GOTO. That is: IF I=1, THEN GOTO LINE 10 IF I=2, THEN GOTO LINE 20 IF I=3, THEN GOTO LINE 30 IF I=4, THEN GOTO LINE 40. |

If I=0 or I attempts to select a non-existent line ($>=5$ in this case), the statement after the ON statement is executed. However, if I is >255 or <0 , an FC error message will result. As many line numbers as will fit on a line can follow an ON...GOTO.

105 ON SGN(X)+2 GOTO 40,50,60

This statement will branch to line 40 if the expression X is less than zero, to line 50 if it equals zero, and to line 60 if it is greater than zero.

ON...GOSUB

110 ON I GOSUB 50,60 *(8K Version)* Identical to "ON...GOTO", except that a subroutine call (GOSUB) is executed instead of a GOTO. RETURN from the GOSUB branches to the statement after the ON...GOSUB.

OUT 355 OUT I,J *(8K Version)* Sends the byte J to the output port I. Both I & J must be $>=0$ and $<=255$.

POKE 357 POKE I,J *(8K Version)* The POKE statement stores the byte specified by its second argument (J) into the location given by its first argument (I). The byte to be stored must be $=>0$ and $<=255$, or an FC error will occur. The address (I) must be $=>0$ and $<=32767$, or an FC error will result. Careless use of the POKE statement will probably cause you to "poke" BASIC to death; that is, the machine will hang, and you will have to reload BASIC and will lose any program you had typed in. A POKE to a non-existent memory location is harmless. One of the main uses of POKE is to pass arguments to machine language subroutines. (see Appendix J) You could also use PEEK and POKE to write a memory diagnostic or an assembler in BASIC.

PRINT 360 PRINT X,Y;Z Prints the value of expressions on the terminal. If the list of values to be printed out does not end with a comma (,) or a semicolon (;), then a carriage return/line feed is executed after all the values have been printed. Strings enclosed in quotes ("") may also be printed. If a semicolon separates two expressions in the list, their values are printed next to each other. If a comma appears after an

370 PRINT

380 PRINT X,Y;

390 PRINT "VALUE IS";A

400 PRINT A2,B,

expression in the list, and the print head is at print position 56 or more, then a carriage return/line feed is executed. If the print head is before print position 56, then spaces are printed until the carriage is at the beginning of the next 14 column field (until the carriage is at column 14, 28, 42 or 56...). If there is no list of expressions to be printed, as in line 370 of the examples, then a carriage return/line feed is executed.

410 PRINT MID\$(A\$,2); (8K Version) String expressions may be printed.

| | | |
|---------|-----------------------------|---|
| READ | 490 READ V,W | Reads data into specified variables from a DATA statement. The first piece of data read will be the first piece of data listed in the first DATA statement of the program. The second piece of data read will be the second piece listed in the first DATA statement, and so on. When all of the data have been read from the first DATA statement, the next piece of data to be read will be the first piece listed in the second DATA statement of the program. Attempting to read more data than there is in all the DATA statements in a program will cause an OD (out of data) error. In the 4K version, an SN error from a READ statement can mean the data it was attempting to read from a DATA statement was improperly formatted. In the 8K version, the line number given in the SN error will refer to the line number where the error actually is located. |
| REM | 500 REM NOW SET V=0 | Allows the programmer to put comments in his program. REM statements are not executed, but can be branched to. A REM statement is terminated by end of line, but not by a ":". |
| | 505 REM SET V=0: V=0 | In this case the V=0 will never be executed by BASIC. |
| | 506 V=0: REM SET V=0 | In this case V=0 will be executed |
| RESTORE | 510 RESTORE | Allows the re-reading of DATA statements. After a RESTORE, the next piece of data read will be the first piece listed in the first DATA statement of the program. The second piece of data read will be the second piece listed in the first DATA statement, and so on as in a normal READ operation. |

| | | |
|--------|--------------------------------|--|
| RETURN | 50 RETURN | Causes a subroutine to return to the statement after the most recently executed GOSUB. |
| STOP | 9000 STOP | Causes a program to stop execution and to enter command mode. <i>(8K Version)</i> Prints BREAK IN LINE 9000. (as per this example) CONT after a STOP branches to the statement following the STOP. |
| WAIT | 805 WAIT I,J,K 806 WAIT I,J | <i>(8K Version)</i> This statement reads the status of input port I, exclusive OR's K with the status, and then AND's the result with J until a non-zero result is obtained. Execution of the program continues at the statement following the WAIT statement. If the WAIT statement only has two arguments, K is assumed to be zero. If you are waiting for a bit to become zero, there should be a one in the corresponding position of K. I, J and K must be =>0 and <=255. |

4K INTRINSIC FUNCTIONS

| | | |
|--------|------------------|---|
| ABS(X) | 120 PRINT ABS(X) | Gives the absolute value of the expression X. ABS returns X if X>=0, -X otherwise. |
| INT(X) | 140 PRINT INT(X) | Returns the largest integer less than or equal to its argument X. For example: INT(.23)=0, INT(7)=7, INT(-.1)=-1, INT(-2)=-2, INT(1.1)=1. The following would round X to D decimal places: INT(X*10 ^D +.5)/10 ^D |
| RND(X) | 170 PRINT RND(X) | Generates a random number between 0 and 1. The argument X controls the generation of random numbers as follows: X<0 starts a new sequence of random numbers using X. Calling RND with the same X starts the same random number sequence. X=0 gives the last random number generated. Repeated calls to RND(0) will always return the same random number. X>0 generates a new random number between 0 and 1. Note that (B-A)*RND(1)+A will generate a random number between A & B. |

| | | |
|--------|------------------|--|
| SGN(X) | 230 PRINT SGN(X) | Gives 1 if X>0, 0 if X=0, and -1 if X<0. |
| SIN(X) | 190 PRINT SIN(X) | Gives the sine of the expression X. X is interpreted as being in radians. Note: COS (X)=SIN(X+3.14159/2) and that 1 Radian =180/PI degrees=57.2958 degrees; so that the sine of X degrees= SIN(X/57.2958). |
| SQR(X) | 180 PRINT SQR(X) | Gives the square root of the argument X. An FC error will occur if X is less than zero. |
| TAB(I) | 240 PRINT TAB(I) | Spaces to the specified print position (column) on the terminal. May be used only in PRINT statements. Zero is the leftmost column on the terminal, 71 the rightmost. If the carriage is beyond position I, then no printing is done. I must be =>0 and <=255. |
| USR(I) | 200 PRINT USR(I) | Calls the user's machine language subroutine with the argument I. See POKE, PEEK and Appendix J. |

8K FUNCTIONS (*Includes all those listed under 4K INTRINSIC FUNCTIONS plus the following in addition.*)

| | | |
|--------|------------------|---|
| ATN(X) | 210 PRINT ATN(X) | Gives the arctangent of the argument X. The result is returned in radians and ranges from -PI/2 to PI/2. (PI/2=1.5708) |
| COS(X) | 200 PRINT COS(X) | Gives the cosine of the expression X. X is interpreted as being in radians. |
| EXP(X) | 150 PRINT EXP(X) | Gives the constant "E" (2.71828) raised to the power X. (E ^X) The maximum argument that can be passed to EXP without overflow occurring is 87.3365. |
| FRE(X) | 270 PRINT FRE(0) | Gives the number of memory bytes currently unused by BASIC. Memory allocated for STRING space is not included in the count returned by FRE. To find the number of free bytes in STRING space, call FRE with a STRING argument. (see FRE under STRING FUNCTIONS) |
| INP(I) | 265 PRINT INP(I) | Gives the status of (reads a byte from) input port I. Result is =>0 and <=255. |

| | | |
|---------------|--------------------------|--|
| LOG(X) | 160 PRINT LOG(X) | Gives the natural (Base E) logarithm of its argument X. To obtain the Base Y logarithm of X use the formula $\text{LOG}(X)/\text{LOG}(Y)$. Example: The base 10 (common) log of 7 = $\text{LOG}(7)/\text{LOG}(10)$. |
| PEEK | 356 PRINT PEEK(I) | The PEEK function returns the contents of memory address I. The value returned will be $=>0$ and $<=255$. If I is >32767 or <0 , an FC error will occur. An attempt to read a non-existent memory address will return 255. (see POKE statement) |
| POS(I) | 260 PRINT POS(I) | Gives the current position of the terminal print head (or cursor on CRT's). The leftmost character position on the terminal is position zero and the rightmost is 71. |
| SPC(I) | 250 PRINT SPC(I) | Prints I space (or blank) characters on the terminal. May be used only in a PRINT statement. X must be $=>0$ and $<=255$ or an FC error will result. |
| TAN(X) | 200 PRINT TAN(X) | Gives the tangent of the expression X. X is interpreted as being in radians. |

STRINGS (8K Version Only)

- 1) A string may be from 0 to 255 characters in length. All string variables end in a dollar sign (\$); for example, A\$, B9\$, K\$, HELLO\$.
- 2) String matrices may be dimensioned exactly like numeric matrices. For instance, DIM A\$(10,10) creates a string matrix of 121 elements, eleven rows by eleven columns (rows 0 to 10 and columns 0 to 10). Each string matrix element is a complete string, which can be up to 255 characters in length.
- 3) The total number of characters in use in strings at any time during program execution cannot exceed the amount of string space, or an OS error will result. At initialization, you should set up string space so that it can contain the maximum number of characters which can be used by strings at any one time during program execution.

| <u>NAME</u> | <u>EXAMPLE</u> | <u>PURPOSE/USE</u> |
|--------------------|--------------------------|---|
| DIM | 25 DIM A\$(10,10) | Allocates space for a pointer and length for each element of a string matrix. No string space is allocated. See Appendix D. |

| | | |
|-------|------------------------------------|---|
| LET | 27 LET A\$="FOO"+V\$ | Assigns the value of a string expression to a string variable. LET is optional. |
| = | | String comparison operators. Comparison is made on the basis of ASCII codes, a character at a time until a difference is found. If during the comparison of two strings, the end of one is reached, the shorter string is considered smaller. Note that "A " is greater than "A" since trailing spaces are significant. |
| > | | |
| < | | |
| <= | | |
| >= | | |
| <> | | |
| + | 30 LET Z\$=R#+Q\$ | String concatenation. The resulting string must be less than 256 characters in length or an LS error will occur. |
| INPUT | 40 INPUT X\$ | Reads a string from the user's terminal. String does not have to be quoted; but if not, leading blanks will be ignored and the string will be terminated on a "," or ":" character. |
| READ | 50 READ X\$ | Reads a string from DATA statements within the program. Strings do not have to be quoted; but if they are not, they are terminated on a "," or ":" character or end of line and leading spaces are ignored. See DATA for the format of string data. |
| PRINT | 60 PRINT X\$ 70 PRINT "FOO"+A\$ | Prints the string expression on the user's terminal. |

STRING FUNCTIONS (8K Version Only)

| | | |
|---------------|-------------------------|---|
| ASC(X\$) | 300 PRINT ASC(X\$) | Returns the ASCII numeric value of the first character of the string expression X\$. See Appendix K for an ASCII/number conversion table. An FC error will occur if X\$ is the null string. |
| CHR\$(I) | 275 PRINT CHR\$(I) | Returns a one character string whose single character is the ASCII equivalent of the value of the argument (I) which must be =>0 and <=255. See Appendix K. |
| FRE(X\$) | 272 PRINT FRE("") | When called with a string argument, FRE gives the number of free bytes in string space. |
| LEFT\$(X\$,I) | 310 PRINT LEFT\$(X\$,I) | Gives the leftmost I characters of the string expression X\$. If I<=0 or >255 an FC error occurs. |

| | | |
|----------------|--------------------------|---|
| LEN(X\$) | 220 PRINT LEN(X\$) | Gives the length of the string expression X\$ in characters (bytes). Non-printing characters and blanks are counted as part of the length. |
| MID\$(X\$,I) | 330 PRINT MID\$(X\$,I) | MID\$ called with two arguments returns characters from the string expression X\$ starting at character position I. If I>LEN(I\$), then MID\$ returns a null (zero length) string. If I<=0 or >255, an FC error occurs. |
| MID\$(X\$,I,J) | 340 PRINT MID\$(X\$,I,J) | MID\$ called with three arguments returns a string expression composed of the characters of the string expression X\$ starting at the Ith character for J characters. If I>LEN(X\$), MID\$ returns a null string. If I or J <=0 or >255, an FC error occurs. If J specifies more characters than are left in the string, all characters from the Ith on are returned. |
| RIGHT\$(X\$,I) | 320 PRINT RIGHT\$(X\$,I) | Gives the rightmost I characters of the string expression X\$. When I<=0 or >255 an FC error will occur. If I>=LEN(X\$) then RIGHT\$ returns all of X\$. |
| STR\$(X) | 290 PRINT STR\$(X) | Gives a string which is the character representation of the numeric expression X. For instance, STR\$(3.1)=" 3.1". |
| VAL(X\$) | 280 PRINT VAL(X\$) | Returns the string expression X\$ converted to a number. For instance, VAL("3.1")=3.1. If the first non-space character of the string is not a plus (+) or minus (-) sign, a digit or a decimal point (.) then zero will be returned. |

SPECIAL CHARACTERS

| <u>CHARACTER</u> | <u>USE</u> |
|------------------|--|
| @ | Erases current line being typed, and types a carriage return/line feed. An "@" is usually a shift/P. |
| ← | (backarrow or underline) Erases last character typed. If no more characters are left on the line, types a carriage return/line feed. "←" is usually a shift/O. |

| | |
|-----------------|---|
| CARRIAGE RETURN | A carriage return must end every line typed in. Returns print head or CRT cursor to the first position (leftmost) on line. A line feed is always executed after a carriage return. |
| CONTROL/C | Interrupts execution of a program or a list command. Control/C has effect when a statement finishes execution, or in the case of interrupting a LIST command, when a complete line has finished printing. In both cases a return is made to BASIC's command level and OK is typed. <i>(8K Version)</i> Prints "BREAK IN LINE XXXX" , where XXXX is the line number of the next statement to be executed. |
| : | (colon) A colon is used to separate statements on a line. Colons may be used in direct and indirect statements. The only limit on the number of statements per line is the line length. It is not possible to GOTO or GOSUB to the middle of a line. |
| | <i>(8K Version Only)</i> |
| CONTROL/O | Typing a Control/O once causes BASIC to suppress all output until a return is made to command level, an input statement is encountered, another control/O is typed, or an error occurs. |
| ? | Question marks are equivalent to PRINT. For instance, ? 2+2 is equivalent to PRINT 2+2. Question marks can also be used in indirect statements. 10 ? X, when listed will be typed as 10 PRINT X. |

MISCELLANEOUS

- 1) To read in a paper tape with a program on it (8K Version), type a control/O and feed in tape. There will be no printing as the tape is read in. Type control/O again when the tape is through. Alternatively, set nulls=0 and feed in the paper tape, and when done reset nulls to the appropriate setting for your terminal. Each line must be followed by two rubouts, or any other non-printing character. If there are lines without line numbers (direct commands) the ALTAIR will fall behind the input coming from paper tape, so this is not recommending.

Using null in this fashion will produce a listing of your tape in the 8K version (use control/O method if you don't want a listing). The null method is the only way to read in a tape in the 4K version.

To read in a paper tape of a program in the 4K version, set the number of nulls typed on carriage return/line feed to zero by patching location 46 (octal) to be a 1. Feed in the paper tape. When

APPENDICES

APPENDIX A

HOW TO LOAD BASIC

When the ALTAIR is first turned on, there is random garbage in its memory. BASIC is supplied on a paper tape or audio cassette. Somehow the information on the paper tape or cassette must be transferred into the computer. Programs that perform this type of information transfer are called loaders.

Since initially there is nothing of use in memory; you must toggle in, using the switches on the front panel, a 20 instruction bootstrap loader. This loader will then load BASIC.

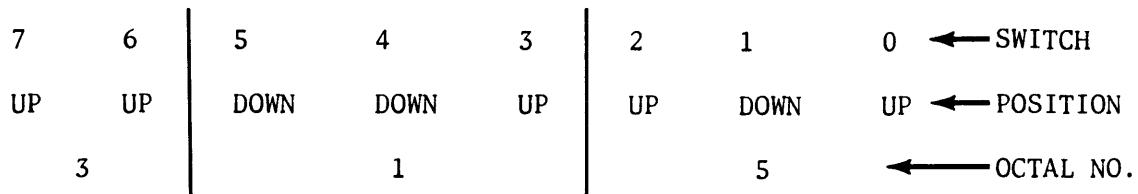
To load BASIC follow these steps:

- 1) Turn the ALTAIR on.
- 2) Raise the STOP switch and RESET switch simultaneously.
- 3) Turn your terminal (such as a Teletype) to LINE.

Because the instructions must be toggled in via the switches on the front panel, it is rather inconvenient to specify the positions of each switch as "up" or "down". Therefore, the switches are arranged in groups of 3 as indicated by the broken lines below switches 0 through 15. To specify the positions of each switch, we use the numbers 0 through 7 as shown below:

| <u>3 SWITCH GROUP</u> | | | <u>OCTAL NUMBER</u> |
|-----------------------|---------------|------------------|---------------------|
| <u>LEFTMOST</u> | <u>MIDDLE</u> | <u>RIGHTMOST</u> | |
| Down | Down | Down | 0 |
| Down | Down | Up | 1 |
| Down | Up | Down | 2 |
| Down | Up | Up | 3 |
| Up | Down | Down | 4 |
| Up | Down | Up | 5 |
| Up | Up | Down | 6 |
| Up | Up | Up | 7 |

So, to put the octal number 315 in switches 0 through 7, the switches would have the following positions:



Note that switches 8 through 15 were not used. Switches 0 through 7 correspond to the switches labeled DATA on the front panel. A memory address would use all 16 switches.

The following program is the bootstrap loader for users loading from paper tape, and not using a REV 0 Serial I/O Board.

| OCTAL ADDRESS | OCTAL DATA |
|---------------|------------------------------|
| 000 | 041 |
| 001 | 175 |
| 002 | 037 (for 8K; for 4K use 017) |
| 003 | 061 |
| 004 | 022 |
| 005 | 000 |
| 006 | 333 |
| 007 | 000 |
| 010 | 017 |
| 011 | 330 |
| 012 | 333 |
| 013 | 001 |
| 014 | 275 |
| 015 | 310 |
| 016 | 055 |
| 017 | 167 |
| 020 | 300 |
| 021 | 351 |
| 022 | 003 |
| 023 | 000 |

The following 21 byte bootstrap loader is for users loading from a paper tape and using a REV 0 Serial I/O Board on which the update changing the flag bits has not been made. If the update has been made, use the above bootstrap loader.

| OCTAL ADDRESS | OCTAL DATA |
|---------------|------------------------------|
| 000 | 041 |
| 001 | 175 |
| 002 | 037 (for 8K; for 4K use 017) |
| 003 | 061 |
| 004 | 023 |
| 005 | 000 |
| 006 | 333 |
| 007 | 000 |
| 010 | 346 |
| 011 | 040 |
| 012 | 310 |
| 013 | 333 |
| 014 | 001 |
| 015 | 275 |
| 016 | 310 |
| 017 | 055 |
| 020 | 167 |

| <u>OCTAL ADDRESS</u> | <u>OCTAL DATA</u> |
|----------------------|-------------------|
| (cont.) | |
| 021 | 300 |
| 022 | 351 |
| 023 | 003 |
| 024 | 000 |

The following bootstrap loader is for users with BASIC supplied on an audio cassette.

| <u>OCTAL ADDRESS</u> | <u>OCTAL DATA</u> |
|----------------------|-------------------------------|
| 000 | 041 |
| 001 | 256 355 |
| 002 | 037 (for 8K; for 4K use 017) |
| 003 | 061 |
| 004 | 022 |
| 005 | 000 |
| 006 | 333 |
| 007 | 006 |
| 010 | 017 |
| 011 | 330 |
| 012 | 333 |
| 013 | 007 |
| 014 | 275 |
| 015 | 310 |
| 016 | 055 |
| 017 | 167 |
| 020 | 300 |
| 021 | 351 |
| 022 | 003 |
| 023 | 000 |

To load a bootstrap loader:

- 1) Put switches 0 through 15 in the down position.
- 2) Raise EXAMINE.
- 3) Put 041 (data for address 000) in switches 0 through 7.
- 4) Raise DEPOSIT.
- 5) Put the data for the next address in switches 0 through 7.
- 6) Depress DEPOSIT NEXT.
- 7) Repeat steps 5 & 6 until the entire loader is toggled in.
- 8) Put switches 0 through 15 in the down position.
- 9) Raise EXAMINE.
- 10) Check that lights D0 through D7 correspond with the data that should

be in address 000. A light on means the switch was up, a light off means the switch was down. So for address 000, lights D1 through D4 and lights D6 & D7 should be off, and lights D0 and D5 should be on.

If the correct value is there, go to step 13. If the value is wrong, continue with step 11.

- 11) Put the correct value in switches 0 through 7.
- 12) Raise DEPOSIT.
- 13) Depress EXAMINE NEXT.
- 14) Repeat steps 10 through 13, checking to see that the correct data is in each corresponding address for the entire loader.
- 15) If you encountered any mistakes while checking the loader, go back now and re-check the whole program to be sure it is corrected.
- 16) Put the tape of BASIC into the tape reader. Be sure the tape is positioned at the beginning of the leader. The leader is the section of tape at the beginning with 6 out of the 8 holes punched.

If you are loading from audio cassette, put the cassette in the recorder. Be sure the tape is fully rewound.

- 17) Put switches 0 through 15 in the down position.
- 18) Raise EXAMINE.
- 19) If you have connected to your terminal a REV 0 Serial I/O Board on which the update changing the flag bits has not been made, raise switch 14; if you are loading from an audio cassette, raise switch 15 also.

If you have a REV 0 Serial I/O Board which has been updated, or have a REV 1 I/O Board, switch 14 should remain down and switch 15 should be raised only if you are loading from audio cassette.

- 20) Turn on the tape reader and then depress RUN. Be sure RUN is depressed while the reader is still on the leader. Do not depress run before turning on the reader, since this may cause the tape to be read incorrectly.

If you are loading from a cassette, turn the cassette recorder to Play. Wait 15 seconds and then depress RUN.

- 21) Wait for the tape to be read in. This should take about 12 minutes for 8K BASIC and 6 minutes for 4K BASIC. It takes about 4 minutes to load 8K BASIC from cassette, and about 2 minutes for 4K BASIC.

Do not move the switches while the tape is being read in.

- 22) If a C or an O is printed on the terminal as the tape reads in, the tape has been mis-read and you should start over at step 1 on page 46.
- 23) When the tape finishes reading, BASIC should start up and print MEMORY SIZE?. See Appendix B for the initialization procedure.
- 24) If BASIC refuses to load from the Audio Cassette, the ACR Demodulator may need alignment. The flip side of the cassette contains 90 seconds of 125's (octal) which were recorded at the same tape speed as BASIC. Use the Input Test Program described on pages 22 and 28 of the ACR manual to perform the necessary alignment.

APPENDIX B

INITIALIZATION DIALOG

STARTING BASIC

Leave the sense switches as they were set for loading BASIC (Appendix A). After the initialization dialog is complete, and BASIC types OK, you are free to use the sense switches as an input device (I/O port 255).

After you have loaded BASIC, it will respond:

MEMORY SIZE?

If you type a carriage return to MEMORY SIZE?, BASIC will use all the contiguous memory upwards from location zero that it can find. BASIC will stop searching when it finds one byte of ROM or non-existent memory.

If you wish to allocate only part of the ALTAIR's memory to BASIC, type the number of bytes of memory you wish to allocate in decimal. This might be done, for instance, if you were using part of the memory for a machine language subroutine.

There are 4096 bytes of memory in a 4K system, and 8192 bytes in an 8K system.

BASIC will then ask:

TERMINAL WIDTH?

This is to set the output line width for PRINT statements only. Type in the number of characters for the line width for the particular terminal or other output device you are using. This may be any number from 1 to 255, depending on the terminal. If no answer is given (i.e. a carriage return is typed) the line width is set to 72 characters.

Now ALTAIR BASIC will enter a dialog which will allow you to delete some of the arithmetic functions. Deleting these functions will give more memory space to store your programs and variables. However, you will not be able to call the functions you delete. Attempting to do so will result in an FC error. The only way to restore a function that has been deleted is to reload BASIC.

The following is the dialog which will occur:

4K Version

WANT SIN?

Answer " Y " to retain SIN, SQR and RND
If you answer " N ", asks next question

WANT SQR?

Answer " Y " to retain SQR and RND.
If you answer " N ", asks next question.

WANT RND?

Answer " Y " to retain RND.
Answer " N " to delete RND.

8K Version

WANT SIN-COS-TAN-ATN?

Answer " Y " to retain all four of
the functions, " N " to delete all four,
or " A " to delete ATN only.

Now BASIC will type out:
XXXX BYTES FREE

ALTAIR BASIC VERSION 3.0

[FOUR-K VERSION]

(or)

[EIGHT-K VERSION]

"XXXX" is the number of bytes
available for program, variables,
matrix storage and the stack. It
does not include string space.

OK

You will now be ready to begin using ALTAIR BASIC.

APPENDIX C

ERROR MESSAGES

After an error occurs, BASIC returns to command level and types OK. Variable values and the program text remain intact, but the program can not be continued and all GOSUB and FOR context is lost.

When an error occurs in a direct statement, no line number is printed.

Format of error messages:

Direct Statement ?XX ERROR

Indirect Statement ?XX ERROR IN YYYYY

In both of the above examples, "XX" will be the error code. The "YYYYYY" will be the line number where the error occurred for the indirect statement.

The following are the possible error codes and their meanings:

| <u>ERROR CODE</u> | <u>MEANING</u> |
|-------------------|----------------|
|-------------------|----------------|

4K VERSION

BS Bad Subscript. An attempt was made to reference a matrix element which is outside the dimensions of the matrix. In the 8K version, this error can occur if the wrong number of dimensions are used in a matrix reference; for instance, LET A(1,1,1)=Z when A has been dimensioned DIM A(2,2).

DD Double Dimension. After a matrix was dimensioned, another dimension statement for the same matrix was encountered. This error often occurs if a matrix has been given the default dimension 10 because a statement like A(I)=3 is encountered and then later in the program a DIM A(100) is found.

FC Function Call error. The parameter passed to a math or string function was out of range.
FC errors can occur due to:

- a) a negative matrix subscript (LET A(-1)=..)
- b) an unreasonably large matrix subscript (>32767)
- c) LOG-negative or zero argument
- d) SQR-negative argument

| | |
|--|--|
| | e) A+B with A negative and B not an integer |
| | f) a call to USR before the address of the machine language subroutine has been patched in |
| | g) calls to MID\$, LEFT\$, RIGHT\$, INP, OUT, WAIT, PEEK, POKE, TAB, SPC or ON...GOTO with an improper argument. |
| ID | Illegal Direct. You cannot use an INPUT or (<i>in 8K Version</i>) DEFFN statement as a direct command. |
| NF | NEXT without FOR. The variable in a NEXT statement corresponds to no previously executed FOR statement. |
| OD | Out of Data. A READ statement was executed but all of the DATA statements in the program have already been read. The program tried to read too much data or insufficient data was included in the program. |
| OM | Out of Memory. Program too large, too many variables, too many FOR loops, too many GOSUB's, too complicated an expression or any combination of the above. (see Appendix D) |
| OV | Overflow. The result of a calculation was too large to be represented in BASIC's number format. If an underflow occurs, zero is given as the result and execution continues without any error message being printed. |
| SN | Syntax error. Missing parenthesis in an expression, illegal character in a line, incorrect punctuation, etc. |
| RG | RETURN without GOSUB. A RETURN statement was encountered without a previous GOSUB statement being executed. |
| US | Undefined Statement. An attempt was made to GOTO, GOSUB or THEN to a statement which does not exist. |
| /0 | Division by Zero. |
| <i>8K VERSION (Includes all of the previous codes in addition to the following.)</i> | |
| CN | Continue error. Attempt to continue a program when none exists, an error occurred, or after a new line was typed into the program. |

| | |
|----|---|
| LS | Long String. Attempt was made by use of the concatenation operator to create a string more than 255 characters long. |
| OS | Out of String Space. Save your program on paper tape or cassette, reload BASIC and allocate more string space or use smaller strings or less string variables. |
| ST | String Temporaries. A string expression was too complex. Break it into two or more shorter ones. |
| TM | Type Mismatch. The left hand side of an assignment statement was a numeric variable and the right hand side was a string, or vice versa; or, a function which expected a string argument was given a numeric one or vice versa. |
| UF | Undefined Function. Reference was made to a user defined function which had never been defined. |

APPENDIX D

SPACE HINTS

In order to make your program smaller and save space, the following hints may be useful.

1) Use multiple statements per line. There is a small amount of overhead (5bytes) associated with each line in the program. Two of these five bytes contain the line number of the line in binary. This means that no matter how many digits you have in your line number (minimum line number is 0, maximum is 65529), it takes the same number of bytes. Putting as many statements as possible on a line will cut down on the number of bytes used by your program.

2) Delete all unnecessary spaces from your program. For instance:

```
10 PRINT X, Y, Z  
uses three more bytes than  
10 PRINTX,Y,Z
```

Note: All spaces between the line number and the first non-blank character are ignored.

3) Delete all REM statements. Each REM statement uses at least one byte plus the number of bytes in the comment text. For instance, the statement 130 REM THIS IS A COMMENT uses up 24 bytes of memory.

In the statement 140 X=X+Y: REM UPDATE SUM, the REM uses 14 bytes of memory including the colon before the REM.

4) Use variables instead of constants. Suppose you use the constant 3.14159 ten times in your program. If you insert a statement

```
10 P=3.14159
```

in the program, and use P instead of 3.14159 each time it is needed, you will save 40 bytes. This will also result in a speed improvement.

5) A program need not end with an END; so, an END statement at the end of a program may be deleted.

6) Reuse the same variables. If you have a variable T which is used to hold a temporary result in one part of the program and you need a temporary variable later in your program, use it again. Or, if you are asking the terminal user to give a YES or NO answer to two different questions at two different times during the execution of the program, use the same temporary variable A\$ to store the reply.

7) Use GOSUB's to execute sections of program statements that perform identical actions.

8) If you are using the 8K version and don't need the features of the 8K version to run your program, consider using the 4K version instead. This will give you approximately 4.7K to work with in an 8K machine, as opposed to the 1.6K you have available in an 8K machine running the 8K version of BASIC.

- 9) Use the zero elements of matrices; for instance, A(0), B(0,X).

STORAGE ALLOCATION INFORMATION

Simple (non-matrix) numeric variables like V use 6 bytes; 2 for the variable name, and 4 for the value. Simple non-matrix string variables also use 6 bytes; 2 for the variable name, 2 for the length, and 2 for a pointer.

Matrix variables use a minimum of 12 bytes. Two bytes are used for the variable name, two for the size of the matrix, two for the number of dimensions and two for each dimension along with four bytes for each of the matrix elements.

String variables also use one byte of string space for each character in the string. This is true whether the string variable is a simple string variable like A\$, or an element of a string matrix such as Q1\$(5,2).

When a new function is defined by a DEF statement, 6 bytes are used to store the definition.

Reserved words such as FOR, GOTO or NOT, and the names or the intrinsic functions such as COS, INT and STR\$ take up only one byte of program storage. All other characters in programs use one byte of program storage each.

When a program is being executed, space is dynamically allocated on the stack as follows:

- 1) Each active FOR...NEXT loop uses 16 bytes.
- 2) Each active GOSUB (one that has not returned yet) uses 6 bytes.
- 3) Each parenthesis encountered in an expression uses 4 bytes and each temporary result calculated in an expression uses 12 bytes.

APPENDIX E

SPEED HINTS

The hints below should improve the execution time of your BASIC program. Note that some of these hints are the same as those used to decrease the space used by your programs. This means that in many cases you can increase the efficiency of both the speed and size of your programs at the same time.

- 1) Delete all unnecessary spaces and REM's from the program. This may cause a small decrease in execution time because BASIC would otherwise have to ignore or skip over spaces and REM statements.
- 2) *THIS IS PROBABLY THE MOST IMPORTANT SPEED HINT BY A FACTOR OF 10.*
Use variables instead of constants. It takes more time to convert a constant to its floating point representation than it does to fetch the value of a simple or matrix variable. This is especially important within FOR...NEXT loops or other code that is executed repeatedly.
- 3) Variables which are encountered first during the execution of a BASIC program are allocated at the start of the variable table. This means that a statement such as 5 A=0:B=A:C=A, will place A first, B second, and C third in the symbol table (assuming line 5 is the first statement executed in the program). Later in the program, when BASIC finds a reference to the variable A, it will search only one entry in the symbol table to find A, two entries to find B and three entries to find C, etc.
- 4) *(8K Version)* NEXT statements without the index variable. NEXT is somewhat faster than NEXT I because no check is made to see if the variable specified in the NEXT is the same as the variable in the most recent FOR statement.
- 5) Use the 8K version instead of the 4K version. The 8K version is about 40% faster than the 4K due to improvements in the floating point arithmetic routines.
- 6) The math functions in the 8K version are much faster than their counterparts simulated in the 4K version. (see Appendix G)

APPENDIX F

DERIVED FUNCTIONS

The following functions, while not intrinsic to ALTAIR BASIC, can be calculated using the existing BASIC functions.

| <u>FUNCTION</u> | <u>FUNCTION EXPRESSED IN TERMS OF BASIC FUNCTIONS</u> |
|---------------------------------|---|
| 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 | $\text{ARCSIN}(X) = \text{ATN}(X/\text{SQR}(-X*X+1))$ |
| INVERSE COSINE | $\text{ARCCOS}(X) = -\text{ATN}(X/\text{SQR}(-X*X+1))+1.5708$ |
| INVERSE SECANT | $\text{ARCSEC}(X) = \text{ATN}(\text{SQR}(X*X-1)) + (\text{SGN}(X)-1)*1.5708$ |
| INVERSE COSECANT | $\text{ARCCSC}(X) = \text{ATN}(1/\text{SQR}(X*X-1)) + (\text{SGN}(X)-1)*1.5708$ |
| INVERSE COTANGENT | $\text{ARCCOT}(X) = -\text{ATN}(X)+1.5708$ |
| HYPERBOLIC SINE | $\text{SINH}(X) = (\text{EXP}(X)-\text{EXP}(-X))/2$ |
| HYPERBOLIC 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 | $\text{ARGSH}(X) = \text{LOG}(X+\text{SQR}(X*X+1))$ |
| INVERSE HYPERBOLIC COSINE | $\text{ARGCH}(X) = \text{LOG}(X+\text{SQR}(X*X-1))$ |
| INVERSE HYPERBOLIC TANGENT | $\text{ARTANH}(X) = \text{LOG}((1+X)/(1-X))/2$ |
| INVERSE HYPERBOLIC SECANT | $\text{ARGSECH}(X) = \text{LOG}((\text{SQR}(-X*X+1)+1)/X)$ |
| INVERSE HYPERBOLIC COSECANT | $\text{ARGCSCH}(X) = \text{LOG}((\text{SGN}(X)*\text{SQR}(X*X+1)+1)/X)$ |
| INVERSE HYPERBOLIC COTANGENT | $\text{ARGCOTH}(X) = \text{LOG}((X+1)/(X-1))/2$ |

APPENDIX G

SIMULATED MATH FUNCTIONS

The following subroutines are intended for 4K BASIC users who want to use the transcendental functions not built into 4K BASIC. The corresponding routines for these functions in the 8K version are much faster and more accurate. The REM statements in these subroutines are given for documentation purposes only, and should not be typed in because they take up a large amount of memory.

The following are the subroutine calls and their 8K equivalents:

| <u>8K EQUIVALENT</u> | <u>SUBROUTINE CALL</u> |
|----------------------|------------------------|
| P9=X9↑Y9 | GOSUB 60030 |
| L9=LOG(X9) | GOSUB 60090 |
| E9=EXP(X9) | GOSUB 60160 |
| C9=COS(X9) | GOSUB 60240 |
| T9=TAN(X9) | GOSUB 60280 |
| A9=ATN(X9) | GOSUB 60310 |

The unneeded subroutines should not be typed in. Please note which variables are used by each subroutine. Also note that TAN and COS require that the SIN function be retained when BASIC is loaded and initialized.

```
60000 REM EXPONENTIATION: P9=X9↑Y9
60010 REM NEED: EXP, LOG
60020 REM VARIABLES USED: A9,B9,C9,E9,L9,P9,X9,Y9
60030 P9=1 : E9=0 : IF Y9=0 THEN RETURN
60040 IF X9<0 THEN IF INT(Y9)=Y9 THEN P9=1-2*Y9+4*INT(Y9/2) : X9=-X9
60050 IF X9<>0 THEN GOSUB 60090 : X9=Y9*L9 : GOSUB 60160
60060 P9=P9*E9 : RETURN
60070 REM NATURAL LOGARITHM: L9=LOG(X9)
60080 REM VARIABLES USED: A9,B9,C9,E9,L9,X9
60090 E9=0 : IF X9<=0 THEN PRINT "LOG FC ERROR"; : STOP
60095 A9=1 : B9=2 : C9=.5 : REM THIS WILL SPEED UP THE FOLLOWING
60100 IF X9>=A9 THEN X9=C9*X9 : E9=E9+A9 : GOTO 60100
60110 IF X9<C9 THEN X9=B9*X9 : E9=E9-A9 : GOTO 60110
60120 X9=(X9-.707107)/(X9+.707107) : L9=X9*X9
60130 L9=((-.598979*L9+.961471)*L9+2.88539)*X9+E9-.5)*.693147
60135 RETURN
60140 REM EXPONENTIAL: E9=EXP(X9)
60150 REM VARIABLES USED: A9,E9,L9,X9
60160 L9=INT(1.4427*X9)+1 : IF L9<127 THEN 60180
60170 IF X9>0 THEN PRINT "EXP OV ERROR"; : STOP
60175 E9=0 : RETURN
60180 E9=.693147*L9-X9 : A9=1.32988E-3-1.41316E-4*E9
60190 A9=((A9*E9-8.30136E-3)*E9+4.16574E-2)*E9
60195 E9=((((A9-.166665)*E9+.5)*E9-1)*E9+1) : A9=2
60197 IF L9<=0 THEN A9=.5 : L9=-L9 : IF L9=0 THEN RETURN
```

```
60200 FOR X9=1 TO L9 : E9=A9*E9 : NEXT X9 : RETURN
60210 REM COSINE: C9=COS(X9)
60220 REM N.B. SIN MUST BE RETAINED AT LOAD-TIME
60230 REM VARIABLES USED: C9,X9
60240 C9=SIN(X9+1.5708) : RETURN
60250 REM TANGENT: T9=TAN(X9)
60260 REM NEEDS COS. (SIN MUST BE RETAINED AT LOAD-TIME)
60270 REM VARIABLES USED: C9,T9,X9
60280 GOSUB 60240 : T9=SIN(X9)/C9 : RETURN
60290 REM ARCTANGENT: A9=ATN(X9)
60300 REM VARIABLES USED: A9,B9,C9,T9,X9
60310 T9=SGN(X9) : X9=ABS(X9) : C9=0 : IF X9>1 THEN C9=1 : X9=1/X9
60320 A9=X9*X9 : B9=((2.86623E-3*A9-1.61657E-2)*A9+4.29096E-2)*A9
60330 B9=((((B9-7.5289E-2)*A9+.106563)*A9-.142089)*A9+.199936)*A9
60340 A9=((B9-.333332)*A9+1)*X9 : IF C9=1 THEN A9=1.5708-A9
60350 A9=T9*A9 : RETURN
```

APPENDIX H

CONVERTING BASIC PROGRAMS NOT WRITTEN FOR THE ALTAIR

Though implementations of BASIC on different computers are in many ways similar, there are some incompatibilities which you should watch for if you are planning to convert some BASIC programs that were not written for the ALTAIR.

- 1) Matrix subscripts. Some BASICs use "[" and "] " to denote matrix subscripts. ALTAIR BASIC uses " (" and ") ".
- 2) Strings. A number of BASICs force you to dimension (declare) the length of strings before you use them. You should remove all dimension statements of this type from the program. In some of these BASICs, a declaration of the form DIM A\$(I,J) declares a string matrix of J elements each of which has a length I. Convert DIM statements of this type to equivalent ones in ALTAIR BASIC: DIM A\$(J).

ALTAIR BASIC uses " + " for string concatenation, not " , " or " & ".

ALTAIR BASIC uses LEFT\$, RIGHT\$ and MID\$ to take substrings of strings. Other BASICs use A\$(I) to access the Ith character of the string A\$, and A\$(I,J) to take a substring of A\$ from character position I to character position J. Convert as follows:

| <u>OLD</u> | <u>NEW</u> |
|------------|--------------------|
| A\$(I) | MID\$(A\$,I,1) |
| A\$(I,J) | MID\$(A\$,I,J-I+1) |

This assumes that the reference to a substring of A\$ is in an expression or is on the right side of an assignment. If the reference to A\$ is on the left hand side of an assignment, and X\$ is the string expression used to replace characters in A\$, convert as follows:

| <u>OLD</u> | <u>NEW</u> |
|--------------|--|
| A\$(I)=X\$ | A\$=LEFT\$(A\$,I-1)+X\$+MID\$(A\$,I+1) |
| A\$(I,J)=X\$ | A\$=LEFT\$(A\$,I-1)+X\$+MID\$(A\$,J+1) |

- 3) Multiple assignments. Some BASICs allow statements of the form: 500 LET B=C=0. This statement would set the variables B & C to zero.

In 8K ALTAIR BASIC this has an entirely different effect. All the " '='s " to the right of the first one would be interpreted as logical comparison operators. This would set the variable B to -1 if C equaled 0. If C did not equal 0, B would be set to 0. The easiest way to convert statements like this one is to rewrite them as follows:

500 C=0:B=C.

- 4) Some BASICs use "\ " instead of " :" to delimit multiple statements per line. Change the "\'s " to " :'s " in the program.
- 5) Paper tapes punched by other BASICs may have no nulls at the end of each line, instead of the three per line recommended for use with ALTAIR BASIC.

To get around this, try to use the tape feed control on the Teletype to stop the tape from reading as soon as ALTAIR BASIC types a carriage return at the end of the line. Wait a second, and then continue feeding in the tape.

When you have finished reading in the paper tape of the program, be sure to punch a new tape in ALTAIR BASIC's format. This will save you from having to repeat this process a second time.

- 6) Programs which use the MAT functions available in some BASICs will have to be re-written using FOR...NEXT loops to perform the appropriate operations.

APPENDIX I
USING THE ACR INTERFACE

NOTE: The cassette features, CLOAD and CSAVE, are only present in 8K BASICs which are distributed on cassette.

8K BASIC on paper tape will give the user about 130 more bytes of free memory, but it will not recognize the CLOAD or CSAVE commands.

The CSAVE command saves a program on cassette tape. CSAVE takes one argument which can be any printing character. CSAVE can be given directly or in a program. Before giving the CSAVE command start your audio recorder on Record, noting the position of the tape.

CSAVE writes data on channel 7 and expects the device status from channel 6. Patches can easily be made to change these channel numbers.

When CSAVE is finished, execution will continue with the next statement. What is written onto the tape is BASIC's internal representation of the program in memory. The amount of data written onto the tape will be equal to the size of the program in memory plus seven.

Variable values are not saved on the tape, nor are they affected by the CSAVE command. The number of nulls being printed on your terminal at the start of each line has no affect on the CSAVE or CLOAD commands.

CLOAD takes its one character argument just like the CSAVE command. For example, CLOAD E.

The CLOAD command first executes a "NEW" command, erasing the current program and all variable values. The CLOAD command should be given before you put your cassette recorder on Play.

BASIC will read a byte from channel 7 whenever the character ready flag comes up on channel 6. When BASIC finds the program on the tape, it will read all characters received from the tape into memory until it finds three consecutive zeros which mark the end of the program. Then BASIC will return to command level and type "OK".

Statements given on the same line as a CLOAD command are ignored. The program on the cassette is not in a checksummed format, so the program must be checked to make sure it reads in properly.

If BASIC does not return to command level and type "OK", it means that BASIC either never found a file with the right filename character, or that BASIC found the file but the file never ended with three consecutive zeros. By carefully watching the front panel lights, you can tell if BASIC ever finds a file with the right name.

Stopping the ALTAIR and restarting it at location 0 will prevent BASIC from searching forever. However, it is likely that there will either be no program in the machine, or a partial program that has errors. Typing NEW will always clear out whatever program is in the machine.

Reading and writing data from the cassette is done with the INP, OUT and WAIT statements. Any block of data written on the tape should have its beginning marked with a character. The main thing to be careful of is allowing your program to fall behind while data passes by unread.

Data read from the cassette should be stored in a matrix, since

there isn't time to process data as it is being read in. You will probably want to detect the end of data on the tape with a special character.

APPENDIX JBASIC/MACHINE LANGUAGE INTERFACE

In all versions of BASIC the user can link to a machine language subroutine. The first step is to set aside enough memory for the subroutine. When BASIC asks "MEMORY SIZE?", you shouldn't type a return, because BASIC would then write into all of memory trying to find out how much memory your machine has and then use whatever memory it finds.

The memory that BASIC actually uses is constantly modified, so you cannot store your machine language routine in those locations.

BASIC always uses memory starting at location 0 and as high upwards as you let it. BASIC cannot use non-contiguous blocks of memory. Therefore, it is best to reserve the top locations of memory for your machine language program.

For example, if you have a 4K machine and want to use a 200 byte subroutine, you should set memory size to 3896. Remember, BASIC always accepts numbers in decimal and that 4K is really $2^{12}=4096$ rather than 4000. Now BASIC will not use any location ≥ 3896 .

If you try to allocate too much memory for your machine language program, you will get an OM (out of memory) error. This is because there is a certain amount of memory that BASIC must have or it will give an OM error and go back to the "MEMORY SIZE?" question.

The starting location of your routine must be stored in a location known as "USRLOC". The exact octal location of USRLOC will be given with each distributed version of BASIC. It is not the same for the 4K and 8K versions.

USRLOC for Version 3.0: 8K (both paper tape & cassette) = 111(octal)
4K = 103(octal)

Initially USRLOC is set up to contain the address of "ILLFUN", which is the routine that gives an FC (function call) error. USRLOC is the two byte absolute address of the location BASIC calls when USR is invoked.

USR is a function just like ABS or INT and is called as follows:
10 X=USR(3).

When your routine is called the stack pointer is set up and you are allowed to use up to 8 levels of stack (16 bytes). If you want to use more, you have to save BASIC's stack pointer (SP), set up your own, and restore BASIC's before you return back to BASIC.

All of the registers (A, B, C, D, E, H, L and PSW) can be changed. It is dangerous to modify locations in BASIC itself unless you know what you are doing. This is unlikely unless you have purchased a source copy of BASIC. Popping more entries off of the stack than you put on is almost guaranteed to cause trouble.

To retrieve the argument passed to USR, you must call the routine whose address is given in location 4 and 5 (DEINT). The low order 8 bits of an address are always stored in the lower address (4 in this case), and the high order 8 bits are stored in the next (higher) memory address (5 in this case).

The argument to USR is truncated to an integer (calling USR with 3.8 is the same as calling it with 3). If the argument is greater than 32767 or less than -32768, an FC error will result. When DEINT returns, the two byte signed value of the argument will be in registers D & E. The high order byte would be in D, the low order byte in E. For instance: if the argument to USR was -1, D would equal 255 and E would equal 255; if the argument was 400, D would equal 1 and E would equal 144.

To pass back a value from USR, set up a two byte value in registers A & B and call the routine whose address is given in locations 6 and 7. A & B should be set up in the same manner that D & E are when a value is passed to USR (A should contain the high order byte and B the low order byte).

If the routine whose address is given in locations 6 and 7 is not called, the function USR in the user's program will be an identity function. That is, USR(X) will equal X.

At the end of the USR routine a RET must be done to get back to BASIC. The BASIC program is completely stopped while USR is being executed and the program will not be continued until USR returns.

In the 4K version, the USR routine should not enable interrupts from a device. 4K BASIC uses the RST 7 location (56 decimal, 70 octal) to store a subroutine. If an interrupt occurs, this subroutine will be called which will have an undetermined and undesirable effect on the way BASIC behaves.

In the 8K BASIC, locations 56, 57 and 58 decimal have been set aside to store a JMP to a user-provided interrupt service routine. Initially a RET instruction is stored at location 56, so until a user sets up the call to his interrupt service routine, interrupts will have no effect.

Care must be taken in interrupt routines to save and restore the stack pointer, (A, B, C, D, E, H & L) and the PSW. Interrupt routines can pass data using PEEK, and can receive data using POKE.

The interrupt service routine should re-enable interrupts with an EI instruction before it returns, as interrupts are automatically disabled when the interrupt occurs. If this procedure is not followed, the interrupt service routine will never "see" another interrupt.

Though there is only one way of calling a machine language subroutine, this does not restrict the user to a single subroutine. The argument passed to USR can be used to determine which routine gets called. Multiple arguments to a machine language routine can be passed with POKE or through multiple calls to USR by the BASIC program.

The machine language routine can be loaded from paper tape or cassette before or after BASIC is loaded. The checksum loader, an unchecksummed loader, the console switches, or more conveniently the POKE function can be used to load the routine.

A common use of USR for 4K users will be doing IN's and OUT's to special devices. For example, on a 4K machine a user wants USR to pass back the value of the front panel switch register:

Answer to MEMORY SIZE? : 4050
USRLOC patched to contain [17,322]=7722 Base 8=4050 decimal

At location 4050=7722 Base 8 put:

| | | | |
|----------|------|-----|---------------------------------|
| 7722/333 | IN | 255 | ; (255 Base 10=377 Base 8) Get |
| 7723/377 | | | ;the value of the switches in A |
| 7724/107 | MOV | B,A | ;B gets low part of answer |
| 7725/257 | XRA | A | ;A gets high part of answer |
| 7726/052 | LHLD | 6 | ;get address of routine |
| 7727/006 | | | |
| 7730/000 | | | ;that floats [A,B] |
| 7731/351 | PCHL | | ;go to that routine which will |
| | | | ;return to BASIC |
| | | | ;with the answer |

MORE ON PEEK AND POKE (8K VERSION ONLY)

As mentioned before, POKE can be used to set up your machine language routine in high memory. BASIC does not restrict which addresses you can POKE. Modifying USRLOC can be accomplished using two successive calls to POKE. Patches which a user wishes to include in his BASIC can also be made using POKE.

Using the PEEK function and OUT statement of 8K BASIC, the user can write a binary dump program in BASIC. Using INP and POKE it is possible to write a binary loader.

PEEK and POKE can be used to store byte oriented information. When you initialize BASIC, answer the MEMORY SIZE? question with the amount of memory in your ALTAIR minus the amount of memory you wish to use as storage for byte formatted data.

You are now free to use the memory in the top of memory in your ALTAIR as byte storage. See PEEK and POKE in the Reference Material for a further description of their parameters.

APPENDIX K

ASCII CHARACTER CODES

| <u>DECIMAL</u> | <u>CHAR.</u> | <u>DECIMAL</u> | <u>CHAR.</u> | <u>DECIMAL</u> | <u>CHAR.</u> |
|----------------|--------------|----------------|--------------|----------------|--------------|
| 000 | @ | NUL | 043 | + | V |
| 001 | A | SOH | 044 | , | W |
| 002 | B | STX | 045 | - | X |
| 003 | C | ETX | 046 | . | Y |
| 004 | D | EOT | 047 | / | Z |
| 005 | E | ENQ | 048 | 0 | [|
| 006 | F | ACK | 049 | 1 | \ |
| 007 | G | BEL | 050 | 2 |] |
| 008 | H | BS | 051 | 3 | ↑ |
| 009 | I | HT | 052 | 4 | ← |
| 010 | J | LF | 053 | 5 | ‐ |
| 011 | K | VT | 054 | 6 | a |
| 012 | L | FF | 055 | 7 | b |
| 013 | M | CR | 056 | 8 | c |
| 014 | N | SO | 057 | 9 | d |
| 015 | O | SI | 058 | : | e |
| 016 | P | DLE | 059 | ; | f |
| 017 | Q | DC1 | 060 | < | g |
| 018 | R | DC2 | 061 | = | h |
| 019 | S | DC3 | 062 | > | i |
| 020 | T | DC4 | 063 | ? | j |
| 021 | U | NAK | 064 | @ | k |
| 022 | V | SYN | 065 | A | l |
| 023 | W | ETB | 066 | B | m |
| 024 | X | CAN | 067 | C | n |
| 025 | Y | EM | 068 | D | o |
| 026 | Z | SUB | 069 | E | p |
| 027 | (| ESCAPE | 070 | F | q |
| 028 |) | FS | 071 | G | r |
| 029 |) | GS | 072 | H | s |
| 030 | ↑ | RS | 073 | I | t |
| 031 | ← | US | 074 | J | u |
| 032 | | SPACE | 075 | K | v |
| 033 | ! | | 076 | L | w |
| 034 | " | | 077 | M | x |
| 035 | # | | 078 | N | y |
| 036 | \$ | | 079 | O | z |
| 037 | % | | 080 | P | { |
| 038 | & | | 081 | Q | |
| 039 | , | | 082 | R | } |
| 040 | (| | 083 | S | ~ |
| 041 |) | | 084 | T | |
| 042 | * | | 085 | U | DEL |

LF=Line Feed

FF=Form Feed

CR=Carriage Return

DEL=Rubout

CHR\$ is a string function which returns a one character string which contains the ASCII equivalent of the argument, according to the conversion table on the preceding page. ASC takes the first character of a string and converts it to its ASCII decimal value.

One of the most common uses of CHR\$ is to send a special character to the user's terminal. The most often used of these characters is the BEL (ASCII 7). Printing this character will cause a bell to ring on some terminals and a "beep" on many CRT's. This may be used as a preface to an error message, as a novelty, or just to wake up the user if he has fallen asleep. (Example: PRINT CHR\$(7);)

A major use of special characters is on those CRT's that have cursor positioning and other special functions (such as turning on a hard copy printer).

As an example, try sending a form feed (CHR\$(12)) to your CRT. On most CRT's this will usually cause the screen to erase and the cursor to "home" or move to the upper left corner.

Some CRT's give the user the capability of drawing graphs and curves in a special point-plotter mode. This feature may easily be taken advantage of through use of ALTAIR BASIC's CHR\$ function.

APPENDIX L

EXTENDED BASIC

When EXTENDED BASIC is sent out, the BASIC manual will be updated to contain an extensive section about EXTENDED BASIC. Also, at this time the part of the manual relating to the 4K and 8K versions will be revised to correct any errors and explain more carefully the areas users are having trouble with. This section is here mainly to explain what EXTENDED BASIC will contain.

INTEGER VARIABLES These are stored as double byte signed quantities ranging from -32768 to +32767. They take up half as much space as normal variables and are about ten times as fast for arithmetic. They are denoted by using a percent sign (%) after the variable name. The user doesn't have to worry about conversion and can mix integers with other variable types in expressions. The speed improvement caused by using integers for loop variables, matrix indices, and as arguments to functions such as AND, OR or NOT will be substantial. An integer matrix of the same dimensions as a floating point matrix will require half as much memory.

DOUBLE-PRECISION Double-Precision variables are almost the opposite of integer variables, requiring twice as much space (8bytes per value) and taking 2 to 3 times as long to do arithmetic as single-precision variables. Double-Precision variables are denoted by using a number sign (#) after the variable name. They provide over 16 digits of accuracy. Functions like SIN, ATN and EXP will convert their arguments to single-precision, so the results of these functions will only be good to 6 digits. Negation, addition, subtraction, multiplication, division, comparision, input, output and conversion are the only routines that deal with Double-Precision values. Once again, formulas may freely mix Double-Precision values with other numeric values and conversion of the other values to Double-Precision will be done automatically.

PRINT USING Much like COBOL picture clauses or FORTRAN format statements, PRINT USING provides a BASIC user with complete control over his output format. The user can control how many digits of a number are printed, whether the number is printed in scientific notation and the placement of text in output. All of this can be done in the 8K version using string functions such as STR\$ and MID\$, but PRINT USING makes it much easier.

DISK I/O EXTENDED BASIC will come in two versions, disk and non-disk. There will only be a copying charge to switch from one to the other. With disk features, EXTENDED BASIC will allow the user to save and recall programs and data files from the ALTAIR FLOPPY DISK. Random access as well as sequential access will be provided. Simultaneous use of multiple data files will be allowed. Utilities will format new disks, delete files and print directories. These will be BASIC programs using special BASIC functions to get access to disk information such as file length, etc. User programs can also access these disk functions, enabling the user to write his own file access method or other special purpose

disk routine. The file format can be changed to allow the use of other (non-floppy) disks. This type of modification will be done by MITS under special arrangement.

OTHER FEATURES Other nice features which will be added are:

- Fancy Error Messages
- An ELSE clause in IF statements
- LIST, DELETE commands with line range as arguments
- Deleting Matrices in a program
- TRACE ON/OFF commands to monitor program flow
- EXCHANGE statement to switch variable values (this will speed up string sorts by at least a factor of two).
- Multi-Argument, user defined functions with string arguments and values allowed

Other features contemplated for future release are:

- A multiple user BASIC
- Explicit matrix manipulation
- Virtual matrices
- Statement modifiers
- Record I/O
- Paramaterized GOSUB
- Compilation
- Multiple USR functions
- "Chaining"

EXTENDED BASIC will use about 11K of memory for its own code (10K for the non-disk version) leaving 1K free on a 12K machine. It will take almost 20 minutes to load from paper tape, 7 minutes from cassette, and less than 5 seconds to load from disk.

We welcome any suggestions concerning current features or possible additions of extra features. Just send them to the ALTAIR SOFTWARE DEPARTMENT.

APPENDIX M

BASIC TEXTS

Below are a few of the many texts that may be helpful in learning BASIC.

- 1) BASIC PROGRAMMING, John G. Kemeny, Thomas E Kurtz, 1967, p145
- 2) BASIC, Albrecht, Finkel and Brown, 1973
- 3) A GUIDED TOUR OF COMPUTER PROGRAMMING IN BASIC, Thomas A Dwyer and Michael S. Kaufman; Boston: Houghton Mifflin Co., 1973

Books numbered 1 & 2 may be obtained from:

People's Computer Company
P.O. Box 310
Menlo Park, California
94025

They also have other books of interest, such as:

101 BASIC GAMES, Ed. David Ahl, 1974 p250

WHAT TO DO AFTER YOU HIT RETURN or PCC's FIRST
BOOK OF COMPUTER GAMES

COMPUTER LIB & DREAM MACHINES, Theodore H. Nelson, 1974, p186

8/12/76

JGZ

+ recursive functions

+ M10B start?

+ INSTR

+ Has copy of \$4FF

+ Z = /

MODS TO ALTAIR MANUAL

1) NO NULL STATEMENT

2) AUTO 1000,100

GENERATE LINE NUMBERS STARTING AT 1000,

INCREMENTED BY 100. LINES INSERTED INTO

PROGRAM, TERMINATE ON 1C.

On entering line 1502,10 or changes auto params (alt+line ft)

3) OPERATORS ADDED ARE

MOD $x \text{ MOD } y = x - \text{INT}(x/y) * y$

MIN $x \text{ MIN } y = \text{IF}(x < y) \text{ THEN } x \text{ ELSE } y$

MAX $x \text{ MAX } y = \text{IF}(x > y) \text{ THEN } x \text{ ELSE } y$

4) DEF - ~~FN~~ Def statement redefined. The function

can have any two, determined from the name.

The function can have any number of arguments, including zero.

Example:

DEF FNuplft(\$1,b,e,u)=LEFT\$(S\$1,b-1)+u+\$1+^{M10B}RIGHT\$(S1,e)

DEF FNdls= SQR((X(I)-X(1))^2+(Y(I)-Y(1))^2)

5) INPUT PROMPT stream; to also verified

6) SET GOTO (off), tracing flag

SET PRINT (on); print flag

SET LIST 0 ; turns off auto line insertion

MID\$(stringvar, pos, len) = string expr
Index(PLT) = INSTR(string expr, string expr)

7) New functions

- HEX\$(byte) gives two character hex representation
- UPPER\$(string) gives upper case version of string

Special Characters

@GETX;↑C - BREAK

@BS;↑H - backspace input

D) EDIT [100/200] - copies 200 to 100 before editing now

tab \$ - copy until following char. recorded. (↓ source \$)

i - goto to insert mode

v - goto replace mode

l - del one char. or type character paragraph with ↵

blank - advance

g) @GETX;K abort

g) @CSC;↑K exits insert, replace modes

g) @CR;↑M repeat line, update if at begin.

D) Conditional Expression

= IF b THEN c ELSE d END

If b is true evaluates c, skips d

If b is false evaluate d, skipping c.

$$2^3 = 2 \times 3$$

edit [line#1, line#2]

if 2nd line appears, it is copied & given number of line#1
→ then may be edited.

C/R finishes edit if no changes made

INT aborts edit (none of the changes will be done)

space copies characters as-is

backspace can't be used

d deletes one char

i start inserting the following chars until C/R or escape

r start replacing with "

tob } skip over (like space) until char } found.

1st 3 characters are enough: edi lis , or / works for range: lis 50/75

| | | |
|-------------|-----------------------------|------------------------|
| list #1, #2 | 50, lis lists 50 to end | 50,70 lists 50 thru 70 |
| | ,50 lists beginning thru 50 | 50 lists 50 only, |

new erases program

deletes line

text of program replaced or insert line

delete #1, #2 deletes range of lines

auto #1, #2 prompts for inserting lines, starting at #1, incrementing by #2

If after its prompt you type #1 or #1, #2 it will
restart from those numbers.

To save a program on paper tape,

ready the punch by pressing in the red button,

then type to BASIC CSAVE "P"
P must be upper case.

Basic will punch the program on tape.

To save on WYLBUR, logon & COLLECT UNN CLEAR

then switch to Basic (>x) and type CSAVE "K"

The program will be transmitted to the Wylibur Active file.
Wylibur Active file must be upper case.

Then switch the keyboard to Wylibur by Repeat Int >k

and hit INT twice to stop Wylibur from collecting.

Then save the Active file (SAVE #stuff) for example.

```
;  
;  
; SYSTEM INTERFACE  
;  
; file "8K Basic"  
  
BASIC:                                ;FULL RESTART INITIALIZATION  
SYSINITJ:  
0000 C30000  JMP    INITIALZ  
REENTERBASIC:                          ;REENTER AFTER PAUSE  
0003 C30000  JMP    cmndrstr  
  
;  
; Monitor Routines  
;  
0006 0406  co    equ    406h    ;c -> screen  
0006 0409  cimb   equ    409h    ;keyboard -> ac, carry set if any  
0006 0538  dclr   equ    538h    ;clear screen  
0006 04F4  xco    equ    4f4h    ;c -> printer (blocking)  
;  
; NON-BLOCKING INPUT  
; CHAR IN AC IF NOT ZERO  
; ZERO SET IF NONE  
;  
SYSKEYIN:  
0006 C5      push   b  
0007 D5      push   d  
0008 E5      push   h  
0009 CD0904  call    cimb   ;get char  
000C D20000  jnc    syskeynone  
000F FE00    cpi    0  
0011 CA0000  jz     clearscreen  
0014 FE1F    cpi    1fh    ;us to break to fourteen  
0016 CA0000  jz     gomonitor  
    syskeyinret:  
0019 E1      pop    h  
001A D1      pop    d  
001B C1      pop    b  
001C C9      ret  
    syskeynone:  
001D 97      sub    a      ;set zero  
001E C31900  jmp    syskeyinret  
    clearscreen:  
0021 CD3805  call    dclr   ;clear screen  
0024 C31D00  jmp    syskeynone  
    gomonitor:  
0027 CF      rst    1      ;about using us (+)  
0028 00      nop  
0029 00      nop  
;  
; SEND AC TO SCREEN  
;  
SYSDISPL:  
002A F5      push   psw  
002B C5      push   b  
002C D5      push   d
```

```
002D E5      push   h
002E 4F      mov    c,a
002F CD0604  call   co     ;c to screen
0032 3A0000  lda    p3010 ;print on the 3010 if zero
0035 A7      ana    a
0036 CCF404  cz    xco    ;yes print
0039 E1      pop    h
003A D1      pop    d
003B C1      pop    b
003C F1      pop    psw
003D C9      RET
;
; CHECK FOR BREAK REQUEST
; SET ZERO TO BREAK
;
SYSBREAK:
003E CD0600  call   syskeyin
0041 CA0000  jz    nobreak
0044 97      sub    a
0045 C9      ret
nobreak:
0046 3E01  mvi   a,1
0048 B7      ora    a
0049 C9      ret
;
; DELAY
;
SYSWAIT:
004A C9      RET
;
; RETURN TO MONITOR
;
004B B400  MONITOR EQU    0B400H
SYSQUIT:
004B C300B4  JMP    MONITOR
```

| | | | |
|-----------|-----|-----|-----|
| 004E 000D | CR | EQU | 0DH |
| 004E 000A | LF | EQU | 0AH |
| 004E 0007 | BEL | EQU | 07H |
| 004E 0008 | BS | EQU | 08H |
| 004E 0009 | TAB | EQU | 09H |
| 004E 0009 | HT | EQU | 09H |
| 004E 0011 | DC1 | EQU | 11H |
| 004E 007F | DEL | EQU | 7FH |
| 004E 000F | SI | EQU | 0FH |
| 004E 0003 | ETX | EQU | 03H |
| 004E 000C | FF | EQU | 0CH |
| 004E 001B | ESC | EQU | 1BH |

004E 0080 KEYSTM EQU 80H ;STATEMENT CODES
004E 0080 KEYDAT EQU KEYSTM
004E 0081 KEYREM EQU KEYDAT+1
004E 0082 KEYLSAL EQU KEYREM+1
004E 0082 KEYEND EQU KEYLSAL
004E 0083 KEYFOR EQU KEYEND+1
004E 0084 KEYNEX EQU KEYFOR+1
004E 0085 KEYINPT EQU KEYNEX+1
004E 0086 KEYDIM EQU KEYINPT+1
004E 0087 KEYREA EQU KEYDIM+1
004E 0088 KEYLET EQU KEYREA+1
004E 0089 KEYGTO EQU KEYLET+1
004E 008A KEYRUN EQU KEYGTO+1
004E 008B KEYIF EQU KEYRUN+1
004E 008C KEYELS EQU KEYIF+1
004E 008D KEYRES EQU KEYELS+1
004E 008E KEYGSB EQU KEYRES+1
004E 008F KEYRET EQU KEYGSB+1
004E 0090 KEYSTOP EQU KEYRET+1
004E 0091 KEYON EQU KEYSTOP+1
004E 0092 KEYAUT EQU KEYON+1
004E 0093 KEYDEL EQU KEYAUT+1
004E 0094 KEYPLT EQU KEYDEL+1
004E 0095 KEYWAI EQU KEYPLT+1
004E 0096 KEYPRT EQU KEYWAI+1
004E 0097 KEYDEF EQU KEYPRT+1
004E 0098 KEYCON EQU KEYDEF+1
004E 0099 KEYLIS EQU KEYCON+1
004E 009A KEYEDI EQU KEYLIS+1
004E 009B KEYCLR EQU KEYEDI+1
004E 009C KEYCLD EQU KEYCLR+1
004E 009D KEYCSV EQU KEYCLD+1
004E 009E KEYNEW EQU KEYCSV+1
004E 009F KEYSET EQU KEYNEW+1
004E 00A0 KEYSUGR EQU KEYSET+1
004E 00A0 KEYLSBL EQU KEYSUGR
004E 00A0 KEYTHEN EQU KEYSUGR
004E 00A1 KEYTO EQU KEYTHEN+1
004E 00A2 KEYSTEP EQU KEYTO+1
004E 00A3 KEYLSBH EQU KEYSTEP+1
004E 00A3 KEYPRM EQU KEYLSBH
004E 00A4 KEYLINE EQU KEYPRM+1
004E 00A5 KEYLSAH EQU KEYLINE+1
004E 00A5 KEYTAB EQU KEYLSAH
004E 00A6 KEYSPC EQU KEYTAB+1
004E 00A7 KEYFN EQU KEYSPC+1
004E 00A8 KEYNOT EQU KEYFN+1
004E 00A9 KEYOFF EQU KEYNOT+1
;
004E 00AA KEYOPR EQU KEYOFF+1 ;OPERATOR CODES
004E 00AA KEYADD EQU KEYOPR
004E 00AB KEYSUB EQU KEYADD+1
004E 00AC KEYMUL EQU KEYSUB+1
004E 00AD KEYDIV EQU KEYMUL+1
004E 00AE KEYMOD EQU KEYDIV+1
004E 00AF KEYEXPT EQU KEYMOD+1

```
004E 00B0  KEYAND  EQU KEYEXPT+1
004E 00B1  KEYOR   EQU KEYAND+1
004E 00B2  KEYMAX  EQU KEYOR+1
004E 00B3  KEYMIN  EQU KEYMAX+1
;
004E 00B4  KEYREL  EQU KEYMIN+1      ;RELATION CODES
004E 00B4  KEYGT   EQU KEYREL
004E 00B5  KEYEQ   EQU KEYGT+1
004E 00B6  KEYLT   EQU KEYEQ+1
;
004E 00B7  KEYFCT  EQU KEYLT+1      ;FUNCTION CODES
004E 00B7  KEYSGN  EQU KEYFCT
004E 00B8  KEYINT  EQU KEYSGN+1
004E 00B9  KEYABS  EQU KEYINT+1
004E 00BA  KEYSQR  EQU KEYABS+1
004E 00BB  KEYRND  EQU KEYSQR+1
004E 00BC  KEYLOG  EQU KEYRND+1
004E 00BD  KEYEXP  EQU KEYLOG+1
004E 00BE  KEYCOS  EQU KEYEXP+1
004E 00BF  KEYSIN  EQU KEYCOS+1
004E 00C0  KEYTAN  EQU KEYSIN+1
004E 00C1  KEYATA  EQU KEYTAN+1
004E 00C2  KEYUSR  EQU KEYATA+1
004E 00C3  KEYFRE  EQU KEYUSR+1
004E 00C4  KEYPORT EQU KEYFRE+1
004E 00C5  KEYPOS  EQU KEYPORT+1
004E 00C6  KEYMEM  EQU KEYPOS+1
004E 00C7  KEYLEN  EQU KEYMEM+1
004E 00C8  KEYSTR  EQU KEYLEN+1
004E 00C9  KEYVAL  EQU KEYSTR+1
004E 00CA  KEYASC  EQU KEYVAL+1
004E 00CB  KEYCHR  EQU KEYASC+1
004E 00CC  KEYHEX  EQU KEYCHR+1
004E 00CD  KEYHXB  EQU KEYHEX+1
004E 00CE  KEYUPR  EQU KEYHXB+1
004E 00CF  KEYLFT  EQU KEYUPR+1
004E 00D0  KEYRIG  EQU KEYLFT+1
004E 00D1  KEYMID  EQU KEYRIG+1
004E 00D2  KEYINS  EQU KEYMID+1
;
004E 00D3  KEYS    EQU KEYINS+1      ;LAST ENTRY
```

| STMTABL: | | | ;STATEMENT ROUTINES |
|-----------|----|--------|--------------------------|
| 004E 0000 | DW | DATSTM | |
| 0050 0000 | DW | REMSTM | |
| | | | ;LISTED WITH BLANK AFTER |
| 0052 0000 | DW | ENDSTM | |
| 0054 0000 | DW | FORSTM | |
| 0056 0000 | DW | NEXSTM | |
| 0058 0000 | DW | INPSTM | |
| 005A 0000 | DW | DIMSTM | |
| 005C 0000 | DW | REASTM | |
| 005E 0000 | DW | LETSTM | |
| 0060 0000 | DW | GTOSTM | |
| 0062 0000 | DW | RUNSTM | |
| 0064 0000 | DW | IFSTM | |
| 0066 0000 | DW | ELSSTM | |
| 0068 0000 | DW | RESSTM | |
| 006A 0000 | DW | GSBSTM | |
| 006C 0000 | DW | RETSTM | |
| 006E 0000 | DW | STPSTM | |
| 0070 0000 | DW | ONSTM | |
| 0072 0000 | DW | AUTSTM | |
| 0074 0000 | DW | DELSTM | |
| 0076 0000 | DW | PLTSTM | |
| 0078 0000 | DW | WAISTM | |
| 007A 0000 | DW | PRTSTM | |
| 007C 0000 | DW | DEFSTM | |
| 007E 0000 | DW | CONSTM | |
| 0080 0000 | DW | LISSTM | |
| 0082 0000 | DW | EDISTM | |
| 0084 0000 | DW | CLRSTM | |
| 0086 0000 | DW | CLDSTM | |
| 0088 0000 | DW | CSVSTM | |
| 008A 0000 | DW | NEWSTM | |
| 008C 0000 | DW | SETSTM | |

OPRTABL: ;OPERATORS AND PRECEDENCE

| | | |
|-----------|----|--------|
| 008E 79 | DB | 79H |
| 008F 0000 | DW | ADDOPR |
| 0091 79 | DB | 79H |
| 0092 0000 | DW | SUBOPR |
| 0094 7B | DB | 7BH |
| 0095 0000 | DW | MULOPR |
| 0097 7B | DB | 7BH |
| 0098 0000 | DW | DIVOPR |
| 009A 7B | DB | 7BH |
| 009B 0000 | DW | MODOPR |
| 009D 7F | DB | 7FH |
| 009E 0000 | DW | EXPOPR |
| 00A0 50 | DB | 50H |
| 00A1 0000 | DW | ANDOPR |
| 00A3 46 | DB | 46H |
| 00A4 0000 | DW | ORNOPR |
| 00A6 76 | DB | 76H |
| 00A7 0000 | DW | MAXOPR |
| 00A9 76 | DB | 76H |
| 00AA 0000 | DW | MINOPR |

FCTTABL: ;FUNCTION ROUTINES

| | | |
|-----------|----|--------|
| 00AC 0000 | DW | SGNFCT |
| 00AE 0000 | DW | INTFCT |
| 00B0 0000 | DW | ABSFCT |
| 00B2 0000 | DW | SQRFCT |
| 00B4 0000 | DW | RNDFCT |
| 00B6 0000 | DW | LOGFCT |
| 00B8 0000 | DW | EXPFCT |
| 00BA 0000 | DW | COSFCT |
| 00BC 0000 | DW | SINFCT |
| 00BE 0000 | DW | TANFCT |
| 00C0 0000 | DW | ATNFCT |
| 00C2 0000 | DW | ERRAFC |
| 00C4 0000 | DW | FREFCT |
| 00C6 0000 | DW | PORFCT |
| 00C8 0000 | DW | POSFCT |
| 00CA 0000 | DW | MEMFCT |
| 00CC 0000 | DW | LENFCT |
| 00CE 0000 | DW | STRFCT |
| 00D0 0000 | DW | VALFCT |
| 00D2 0000 | DW | ASCFCT |
| 00D4 0000 | DW | CHRFCT |
| 00D6 0000 | DW | HEXFCT |
| 00D8 0000 | DW | HXVFCT |
| 00DA 0000 | DW | UPRFCT |
| 00DC 0000 | DW | LFTFCT |
| 00DE 0000 | DW | RIGFCT |
| 00E0 0000 | DW | MIDFCT |
| 00E2 0000 | DW | INSFCT |

KEYWADDS: ;POINTERS TO KEYWORD GROUPS

| | | |
|-------------|----|------------------------------------|
| 00E4 000000 | DW | KEYWRD0, KEYWRD1, KEYWRD2, KEYWRD3 |
| 00E7 000000 | | |
| 00EA 0000 | | |
| 00EC 000000 | DW | KEYWRD4, KEYWRD5, KEYWRD6, KEYWRD7 |
| 00EF 000000 | | |
| 00F2 0000 | | |
| 00F4 000000 | DW | KEYWRD8, KEYWRD9, KEYWRDA, KEYWRDB |
| 00F7 000000 | | |
| 00FA 0000 | | |
| 00FC 000000 | DW | KEYWRDC, KEYWRDD, KEYWRDE, KEYWRDF |
| 00FF 000000 | | |
| 0102 0000 | | |

KEYWORDS:

KEYWRD0:

| | | |
|-------------|----|--------------------------|
| 0104 94504C | DB | KEYPLT, "PLO", 'T+128 |
| 0107 4FD4 | | |
| 0109 965052 | DB | KEYPRT, "PRIN", 'T+128 |
| 010C 494ED4 | | |
| 010F A35052 | DB | KEYPRM, "PROMP", 'T+128 |
| 0112 4F4D50 | | |
| 0115 D4 | | |
| 0116 C4504F | DB | KEYPORT, "POR", 'T+128 |
| 0119 52D4 | | |
| 011B 45504F | DB | KEYPOS-80H, "PO", 'S+128 |
| 011E D3 | | |

KEYWRD1:

| | | |
|-------------|----|--------------------------|
| 011F 924155 | DB | KEYAUT, "AUT", 'O+128 |
| 0122 54CF | | |
| 0124 B0414E | DB | KEYAND, "AN", 'D+128 |
| 0127 C4 | | |
| 0128 B94142 | DB | KEYABS, "AB", 'S+128 |
| 012B D3 | | |
| 012C C14154 | DB | KEYATA, "AT", 'N+128 |
| 012F CE | | |
| 0130 4A4153 | DB | KEYASC-80H, "AS", 'C+128 |
| 0133 C3 | | |

KEYWRD2:

| | | |
|-------------|----|------------------------------|
| 0134 815245 | DB | KEYREM, "RE", 'M+128 |
| 0137 CD | | |
| 0138 875245 | DB | KEYREA, "REA", 'D+128 |
| 013B 41C4 | | |
| 013D 8A5255 | DB | KEYRUN, "RU", 'N+128 |
| 0140 CE | | |
| 0141 8D5245 | DB | KEYRES, "RESTOR", 'E+128 |
| 0144 53544F | | |
| 0147 52C5 | | |
| 0149 8F5245 | DB | KEYRET, "RETUR", 'N+128 |
| 014C 545552 | | |
| 014F CE | | |
| 0150 BB524E | DB | KEYRND, "RN", 'D+128 |
| 0153 C4 | | |
| 0154 505249 | DB | KEYRIG-80H, "RIGHT", '\$+128 |
| 0157 474854 | | |
| 015A A4 | | |

KEYWRD3:

| | | | |
|-----------------|----|-------------|------------------|
| 015B 905354 | DB | KEYSTOP, | "STO", 'P+128 |
| 015E 4FD0 | | | |
| 0160 98434F | DB | KEYCON, | "CON", 'T+128 |
| 0163 4ED4 | | | |
| 0165 98434C | DB | KEYCLR, | "CLEA", 'R+128 |
| 0168 4541D2 | | | |
| 016B 9D5341 | DB | KEYCSV, | "SAV", 'E+128 |
| 016E 56C5 | | | |
| 0170 9F5345 | DB | KEYSET, | "SE", 'T+128 |
| 0173 D4 | | | |
| 0174 A25354 | DB | KEYSTEP, | "STE", 'P+128 |
| 0177 45D0 | | | |
| 0179 A65350 | DB | KEYSPC, | "SP", 'C+128 |
| 017C C3 | | | |
| 017D B75347 | DB | KEYSGN, | "SG", 'N+128 |
| 0180 CE | | | |
| 0181 BA5351 | DB | KEYSQR, | "SQ", 'R+128 |
| 0184 D2 | | | |
| 0185 BE434F | DB | KEYCOS, | "CO", 'S+128 |
| 0188 D3 | | | |
| 0189 BF5349 | DB | KEYSIN, | "SI", 'N+128 |
| 018C CE | | | |
| 018D C85354 | DB | KEYSTR, | "STR", '\$+128 |
| 0190 52A4 | | | |
| 0192 4B4348 | DB | KEYCHR-80H, | "CHR", '\$+128 |
| 0195 52A4 | | | |
| KEYWRD4: | | | |
| 0197 804441 | DB | KEYDAT, | "DAT", 'A+128 |
| 019A 54C1 | | | |
| 019C 864449 | DB | KEYDIM, | "DI", 'M+128 |
| 019F CD | | | |
| 01A0 934445 | DB | KEYDEL, | "DELET", 'E+128 |
| 01A3 4C4554 | | | |
| 01A6 C5 | | | |
| 01A7 974445 | DB | KEYDEF, | "DE", 'F+128 |
| 01AA C6 | | | |
| 01AB A05448 | DB | KEYTHEN, | "THE", 'N+128 |
| 01AE 45CE | | | |
| 01B0 A154CF | DB | KEYTO, | "T", 'O+128 |
| 01B3 A55441 | DB | KEYTAB, | "TA", 'B+128 |
| 01B6 C2 | | | |
| 01B7 405441 | DB | KEYTAN-80H, | "TA", 'N+128 |
| 01BA CE | | | |
| KEYWRD5: | | | |
| 01BB 82454E | DB | KEYEND, | "EN", 'D+128 |
| 01BE C4 | | | |
| 01BF 8C454C | DB | KEYELS, | "ELS", 'E+128 |
| 01C2 53C5 | | | |
| 01C4 9A4544 | DB | KEYEDI, | "EDI", 'T+128 |
| 01C7 49D4 | | | |
| 01C9 BD4558 | DB | KEYEXP, | "EX", 'P+128 |
| 01CC D0 | | | |
| 01CD C25553 | DB | KEYUSR, | "US", 'R+128 |
| 01D0 D2 | | | |
| 01D1 4E5550 | DB | KEYUPR-80H, | "UPPER", '\$+128 |
| 01D4 504552 | | | |

0107 A4

KEYWRD6:

| | | | |
|-------------|----|-------------|--------------|
| 0108 83464F | DB | KEYFOR, | "FO", 'R+128 |
| 010B D2 | | | |
| 010C A746CE | DB | KEYFN, | "F", 'N+128 |
| 010F C34652 | DB | KEYFRE, | "FR", 'E+128 |
| 01E2 C5 | | | |
| 01E3 495641 | DB | KEYVAL-80H, | "VA", 'L+128 |
| 01E6 CC | | | |

KEYWRD7:

| | | | |
|-------------|----|-------------|----------------|
| 01E7 89474F | DB | KEYGTO, | "GOT", 'O+128 |
| 01EA 54CF | | | |
| 01EC 8E474F | DB | KEYGSB, | "GOSU", 'B+128 |
| 01EF 5355C2 | | | |
| 01F2 155741 | DB | KEYWAI-80H, | "WAI", 'T+128 |
| 01F5 49D4 | | | |

KEYWRD8:

| | | | |
|-------------|----|-------------|----------------|
| 01F7 CC4845 | DB | KEYHEX, | "HEX", '\$+128 |
| 01FA 58A4 | | | |
| 01FC 4D4845 | DB | KEYHXV-80H, | "HEX", 'V+128 |
| 01FF 58D6 | | | |

KEYWRD9:

| | | | |
|-------------|----|-------------|----------------|
| 0201 85494E | DB | KEYINPT, | "INPU", 'T+128 |
| 0204 5055D4 | | | |
| 0207 8B49C6 | DB | KEYIF, | "I", 'F+128 |
| 020A B8494E | DB | KEYINT, | "IN", 'T+128 |
| 020D D4 | | | |
| 020E 52494E | DB | KEYINS-80H, | "INST", 'R+128 |
| 0211 5354D2 | | | |

KEYWRDA:

| | | | |
|-----------|----|-------------|--------|
| 0214 2CAA | DB | KEYMUL-80H, | '*+128 |
|-----------|----|-------------|--------|

KEYWRDB:

| | | | |
|-----------|----|-------------|--------|
| 0216 2AAB | DB | KEYADD-80H, | '++128 |
|-----------|----|-------------|--------|

KEYWRDC:

| | | | |
|-------------|----|-------------|-----------------|
| 0218 884C45 | DB | KEYLET, | "LE", 'T+128 |
| 021B D4 | | | |
| 021C 994C49 | DB | KEYLIS, | "LIS", 'T+128 |
| 021F 53D4 | | | |
| 0221 9C4C4F | DB | KEYCLD, | "LOA", 'D+128 |
| 0224 41C4 | | | |
| 0226 A44C49 | DB | KEYLINE, | "LIN", 'E+128 |
| 0229 4EC5 | | | |
| 022B B6BC | DB | KEYLT, | '<+128 |
| 022D BC4C4F | DB | KEYLOG, | "LO", 'G+128 |
| 0230 C7 | | | |
| 0231 C74C45 | DB | KEYLEN, | "LE", 'N+128 |
| 0234 CE | | | |
| 0235 4F4C45 | DB | KEYLFT-80H, | "LEFT", '\$+128 |
| 0238 4654A4 | | | |

KEYWRDD:

| | | | |
|-------------|----|---------|--------------|
| 023B ABAD | DB | KEYSUB, | '--+128 |
| 023D AE4D4F | DB | KEYMOD, | "MO", 'D+128 |
| 0240 C4 | | | |
| 0241 B24D41 | DB | KEYMAX, | "MA", 'X+128 |
| 0244 D8 | | | |
| 0245 B34D49 | DB | KEYMIN, | "MI", 'N+128 |

0248 CE
0249 B5BD DB KEYEQ, '=-+128
024B C64D45 DB KEYMEM, "ME", 'M+128
024E CD
024F 514D49 DB KEYMID-80H, "MID", '\$+128
0252 44A4

KEYWRDE:

0254 844E45 DB KEYNEX, "NEX", 'T+128
0257 58D4
0259 9E4E45 DB KEYNEW, "NE", 'W+128
025C D7
025D A84E4F DB KEYNOT, "NO", 'T+128
0260 D4
0261 AFDE DB KEYEXPT, '↑+128
0263 34BE DB KEYGT-80H, '>+128

KEYWRDF:

0265 96BF DB KEYPRT, '?+128
0267 914FCE DB KEYON, "O", 'N+128
026A A94F46 DB KEYOFF, "OF", 'F+128
026D C6
026E ADAF DB KEYDIV, '/+128
0270 314FD2 DB KEYOR-80H, "O", 'R+128

ERRN: ;ERROR CODES
ERRNCN:
0273 434F4E DB "CONTINUE",0 ;CONTINUE ERROR
0276 54494E
0279 554500
ERRNSL:
027C 444556 DB "DEVICE",0 ;SAVE/LOAD DEVICE ERROR
027F 494345
0282 00
ERRNDD:
0283 44494D DB "DIMENSION",0 ;DOUBLE DIMENSION
0286 454E53
0289 494F4E
028C 00
ERRNID:
028D 444952 DB "DIRECT",0 ;ILLEGAL DIRECT
0290 454354
0293 00
ERRNDO:
0294 444956 DB "DIVIDE BY 0",0 ;DIVISION BY ZERO
0297 494445
029A 204259
029D 203000
ERRNFC:
02A0 46554E DB "FUNCTION CALL",0 ;FUNCTION CALL
02A3 435449
02A6 4F4E20
02A9 43414C
02AC 4C00
ERRNLS:
02AE 4C4F4E DB "LONG STRING",0 ;LONG STRING
02B1 472053
02B4 545249
02B7 4E4700
ERRNOM:
02BA 4D454D DB "MEMORY SPACE",0 ;OUT OF MEMORY
02BD 4F5259
02C0 205350
02C3 414345
02C6 00
ERRNNF:
02C7 4E4558 DB "NEXT W/O FOR",0 ;NEXT WITHOUT FOR
02CA 542057
02CD 2F4F20
02D0 464F52
02D3 00
ERRNOD:
02D4 4F5554 DB "OUT OF DATA",0 ;OUT OF DATA
02D7 204F46
02DA 204441
02DD 544100
ERRNOV:
02E0 4F5645 DB "OVERFLOW",0 ;OVERFLOW
02E3 52464C
02E6 4F5700
ERRNRG:

02E9 524554 DB "RETN W/O GOSUB",0 ;RETURN WITHOUT GOSUB
02EC 4E2057
02EF 2F4F20
02F2 474F53
02F5 554200
ERRNOS:
02F8 535452 DB "STRING SPACE",0 ;OUT OF STRING SPACE
02FB 494E47
02FE 205350
0301 414345
0304 00
ERRNST:
0305 535452 DB "STRING TEMPS",0 ;STRING TEMPORARIES
0308 494E47
030B 205445
030E 4D5053
0311 00
ERRNBS:
0312 535542 DB "SUBSCRIPT",0 ;BAD SUBSCRIPT
0315 534352
0318 495054
0318 00
ERRNSN:
031C 53594E DB "SYNTAX",0 ;SYNTAX ERROR
031F 544158
0322 00
ERRNTM:
0323 545950 DB "TYPE",0 ;TYPE MISMATCH
0326 4500
ERRNUF:
0328 554E44 DB "UNDFND FUNCTION",0 ;UNDEFINED FUNCTION
032B 464E44
032E 204655
0331 4E4354
0334 494F4E
0337 00
ERRNUS:
0338 554E44 DB "UNDFND LINE",0 ;UNDEFINED STATEMENT
033B 464E44
033E 204C49
0341 4E4500
ERRNUV:
0344 554E44 DB "UNDFND VARIABLE",0 ;UNDEFINED VARIABLE
0347 464E44
034A 205641
034D 524941
0350 424C45
0353 00
ERRNFI:
0354 46696C DB "File not Saved",0 ;unknown file name
0357 65206E
035A 6F7420
035D 536176
0360 656400

```
; ; INTERPRETER VARIABLES  
;  
; ; VARIABLES MARKED WITH SAME CHARACTER IN COLUMN 71  
; ; ARE FIXED IN THAT ORDER.  
;
```

| | | | | |
|-----------|-----------|-----|-------------|--------------------------------|
| 0363 01 | p3010: | db | 1 | ;0 to print on 3010 |
| 0364 00 | REAINPFL: | DB | 0 | ;READ/INPUT FLAG |
| 0365 00 | PRINTFLG: | DB | 0 | ;PRINT/NO PRINT FLAG |
| 0366 01 | TRACEFLG: | DB | 1 | ;TRACE/NO TRACE FLAG |
| 0367 00 | SCANPFLG: | DB | 0 | ;SCAN/NOSCAN PARENTHESIS FLAG |
| 0368 01 | SCANPFLE: | DB | 1 | ;ARRAY NAME FOR ERASE |
| 0369 00AB | SCANPFLD | EQU | KEYS-'(| ;NO ARRAY ELEMENTS WANTED |
| 0369 00 | MATSCCNT: | DB | 0 | ;SUBSCRIPT COUNT |
| 036A 00 | MATDMFLG: | DB | 0 | ;SCANNING FOR VAR/DIMENSION V |
| 036B 00 | TYPEFLG: | DB | 0 | ;TYPE FLAG V |
| 036C 0002 | TYPEINTG | EQU | 2 | ;TYPE OF INTEGER |
| 036C 0003 | TYPESTRG | EQU | 3 | ;TYPE OF STRING |
| 036C 0004 | TYPESING | EQU | 4 | ;TYPE OF SINGLE FLOATING POINT |
| 036C 0008 | TYPEDUBL | EQU | 8 | ;TYPE OF DOUBLE FLOATING POINT |
| 036C 0020 | TYPEDEF | EQU | 080H/4 | ;MARKING BIT FOR USER-FUNCTION |
| | | | | |
| 036C 00 | STRGTMPL: | DB | 0 | ;TEMP STRING DESCRPTR, LEN S |
| 036D 0000 | STRGTPA: | DW | 0 | ;TEMP STRING DESCRPTR, ADDR S |
| 036F 0000 | SCANPTR1: | DW | 0 | ;SCAN POINTER |
| 0371 0000 | SCANPTR2: | DW | 0 | ;SCAN POINTER |
| 0373 FFFF | CURLINE: | DW | -1 | ;CURRENT LINE NUMBER |
| 0375 0000 | CURLINES: | DW | 0 | ;SAVED CURRENT LINE NUMBER |
| 0377 0000 | PROGCNTR: | DW | ENDINTRP+12 | ;CURRENT PROGRAM LOCATION |
| 0379 0377 | VARINDEX | EQU | PROGCNTR | ;INDEX VARIABLE OF FOR |
| 0379 0000 | PROGCNTS: | DW | 0 | ;SAVED CURRENT PROGRAMLOCATION |
| 037B 0000 | CURDATA: | DW | 0 | ;CURRENT DATA LINE NUMBER |
| 037D 0000 | CURDATAP: | DW | ENDINTRP | ;CURRENT DATA POINTER |
| 037F 0000 | INPTBUFR: | DW | INITSTSP | ;INPUT BUFFER ADDRESS |
| 0381 0064 | PREDREL | EQU | 064H | ;PRECEDENCE OF RELATION |
| 0381 0070 | PREDNUM | EQU | 070H | ;LOWER BNDRY OF NUM OP PREC. |
| 0381 005A | PREDNOT | EQU | 05AH | ;PRECEDENCE OF NOT OPERATOR |
| 0381 007D | PREDUMIN | EQU | 07DH | ;PRECEDENCE OF UNARY MINUS |
| 0381 009D | LINESYZE | EQU | 79+78 | ;DEFAULT LINESIZE |
| 0381 000E | ITEMSIZE | EQU | 14 | ;DEFAULT WIDTH OF PRINT ITEM |

```
;      : MEMORY ALLOCATION POINTERS
;      :

0381 8000  LIMLOWER    EQU      08000H
0381 AF00  LIMUPPER    EQU      0AF00H
;
;      : MEMORY LAYOUT
;
;      : ENCODE BUFFER
;      : PROGRAM
;      : VARIABLES
;      : ARRAYS
;      : FREE SPACE / STACK (INCLUDING BUFFERS)
;      : FREE STRING SPACE
;      : STRINGS
;      : STRING TEMPORARIES
;      : FREE STRING TEMPORARIES
;
0381 0000  PROGBASE:   DW       ENDINTRP+13   ;BASE OF PROGRAM SPACE
0383 0000  VARTABLE:   DW       ENDINTRP+15   ;BASE OF VARIABLE TABLE
0385 0000  MATTABLE:   DW       ENDINTRP+15   ;BASE OF ARRAY TABLE
0387 0000  FREELIMT:   DW       ENDINTRP+15   ;LOWER LIMIT OF FREE SPACE
0389 0000  STCKBASE:   DW       INITSTCK     ;BASE OF STACK
038B 0000  STRGFREE:   DW       INITSTCK+10  ;FIRST FREE STRING SPACE
038D 0000  STRGBASE:   DW       INITSTCK+10  ;BASE OF STRING SPACE
038F 0000  STRGTMPP:   DW       INITSTCK+11  ;STRING TEMPORARY ALLOC PTR
0391 0000  STRGTLIM:   DW       INITSTCK+10+2*3 ;STRING TEMPORARY LIMIT

0393 0000  ACCUMLTR:   DB       0,0      ;ACCUMULATOR          A
0395 00  FLACCMBS:   DB       0        ;SIGN-BIT/HIGH-ORDER MANTISSA  A
0396 00  FLACCEXP:   DB       0        ;EXPONENT            A
0397 00  FLACCSSV:   DB       0        ;SAVED SIGN          A
;
0398 01  NULLCNT:   DB       1        ;# OF NULLS TO INSERT AFTER (CR)
0399 01  CURSPOS:   DB       1        ;CHARACTER CURSOR POSITION C
039A 63  CURSLIM:   DB       -LINESIZE ;OUTPUT CURSOR LIMIT   C
;
039B 00  FLSCR0:    DB       0        ;FLOATING POINT SCRATCH AREA
039C 01  FLSCR1:    DB       1
039D 02  FLSCR2:    DB       2
039E 03  FLSCR3:    DB       3
;
039F 039B  INOTINS:   EQU      FLSCR0  ;INPUT/OUTPUT INSTRUCTIONS
039F 00DB  OPCINP:   EQU      0DBH    ;INPUT INSTRUCTION
039F 00D3  OPCOUT:   EQU      0D3H    ;OUTPUT INSTRUCTION
039F 00C9  OPCRET:   EQU      0C9H    ;RETURN INSTRUCTION
;
039F 52C74F  RNDFCTS:  DB       052h, 0c7h, 04fh, 080h ;RANDOM SEED
03A2 80
```

```
; GENERAL USE SUBROUTINES

; SCAN ONE CHARACTER AND CLASSIFY

SCANNXTV:
03A3 7E    MOV    A,M      ;SCAN CURRENT BYTE,
03A4 E3    XTHL
03A5 BE    CMP    M        ;VERIFY MATCH,
03A6 23    INX    H
03A7 E3    XTHL
03A8 C20000 JNZ    ERRASN ;SQUAWK ABOUT SYNTAX ERROR

SCANNXT:
03AB 23    INX    H      ;SCAN FOR NEXT NON-BLANK CHAR
03AC 7E    MOV    A,M      ;C=NUMERIC CHARACTER
03AD FE3A    CPI    ":"      ;Z=END OF STATEMENT
03AF D0    RNC
03B0 FE20    CPI    " "
03B2 CAAB03 JZ    SCANNXT
03B5 FE30    CPI    "0"
03B7 3F    CMC
03B8 3C    INR    A
03B9 3D    DCR    A
03BA C9    RET
```

```

;
; TEST FOR ALPHABETIC CHARACTER
;

ALPHACHK:
03BB 7E      MOV     A,M      ;TEST FOR ALPHABETIC CHARACTER
ALPHACHA:
03BC FE7B      CPI     'z+1    ;LOWER CASE
03BE D0      RNC
03BF FE61      CPI     "a"     ;LOWER CASE
03C1 D20000    JNC     ALPHACHL
03C4 FE5B      CPI     'Z+1    ;C=ALPHABETIC
03C6 D0      RNC
03C7 FE41      CPI     "A"     ;UPPER CASE
03C9 3F      CMC
03CA C9      RET

ALPHACHL:
03CB C6E0      ADI     'A-'a   ;CONVERT LOWER TO UPPER
03CD C9      RET

;
; MATCH CHARACTER OF BUFFER AGAINST CHARACTER IN A
;

CHARMTCH:
03CE AE      XRA     M      ;MAKE MATCH TEST
03CF C8      RZ      ;Z=SUCCESS]
03D0 FE20      CPI     'a-'A   ;LOWER CASE - UPPER CASE
03D2 C0      RNZ      ;NOT LOWER-UPPER DIFFERENCE
03D3 CDBB03    CALL    ALPHACHK  ;ALPHABETIC?
03D6 9F      SBB     A
03D7 3C      INR     A      ;Z=C,S=0
03D8 C9      RET

;
; CHECK TYPE OF EXPRESSION
; RETURNS: S => INTEGER          LEN  CHAR
;           Z => STRING            3    $
;           PO => SINGLE           4    @
;           NC => DOUBLE           8    #
;

TYPECHK:
03D9 3A6B03    LDA     TYPEFLG
TYPECHKA:
03DC FE05      CPI     TYPESING+1
03DE 3D      DCR     A
03DF 3D      DCR     A
03E0 3D      DCR     A
03E1 B7      ORA     A
03E2 37      STC
03E3 C9      RET

```

```
; SCAN A PAIR OF LINE NUMBER PARAMETERS
;
SCANLPRZ:
03E4 010000 LXI B,0      ;DEFAULT SECOND IS FIRST
SCANLPRM:
03E7 C40000 CNZ SCANLINN    ;DEFAULT FIRST IS IN DE
03EA F5      PUSH PSW
03EB 78      MOV A,B
03EC B1      ORA C        ;ZERO DEFAULT IS FIRST PARAMETER
03ED C20000 JNZ SCANLPR1
03F0 42      MOV B,D
03F1 4B      MOV C,E
SCANLPR1:
03F2 F1      POP PSW
03F3 EB      XCHG
03F4 E3      XTHL      ;PUT FIRST ONTO STACK
03F5 E5      PUSH H
03F6 EB      XCHG
03F7 50      MOV D,B
03F8 59      MOV E,C
03F9 C8      RZ
03FA FEAD    CPI KEYDIV ;SEPARATOR MUST BE "/",
03FC CA0000    JZ SCANLPR2
03FF CDA303   CALL SCANNXTV ;bscan (val)
0402 2C      DB  ","
0403 2B      DCX H
SCANLPR2:
0404 11FFFF    LXI D,0FFFH ;EMPTY SECOND OPERAND = END
0407 CDAB03    CALL SCANNXT ;bscan ,
040A C8      RZ

;
; SCAN A LINE NUMBER
;
SCANLINN:
040B 2B      DCX H      ;SCAN LINE # IN COMMAND/STATEMENT
SCANLINR:
040C 110000    LXI D,0      ;DEFAULT LINE IS 0, INITIALIZE
SCANLINL:
040F CDAB03    CALL SCANNXT ;bscan ,
0412 D0      RNC
0413 E5      PUSH H
0414 F5      PUSH PSW
0415 219819    LXI H,0FFFH/10-1
0418 CD0000    CALL CMHLLTDE
041B DA0000    JC ERRASN
041E 62      MOV H,D
041F 6B      MOV L,E      ;HL=10*DE
0420 19      DAD D
0421 29      DAD H
0422 19      DAD D
0423 29      DAD H
0424 F1      POP PSW
0425 D630      SUI "0"      ;GET VALUE OF NEXT DIGIT
```

| | | |
|-------------|------|------------------|
| 0427 5F | MOV | E,A |
| 0428 1600 | MVI | D,000H |
| 042A 19 | DAD | D ;AND ADD IT ON |
| 042B EB | XCHG | |
| 042C E1 | POP | H |
| 042D C30F04 | JMP | SCANLINL |

```
; SEARCH FOR A GIVEN LINE NUMBER
;
LINESRCH:
0430 2A8103 LHLD PROGBASE ;LOOK FOR LINE NUMBER IN DE
LINESRCL:
0433 E5 PUSH H ;C=LINE FOUND
0434 CD0000 CALL LINELINK ;BC=LINE LOCATION, IF FOUND
0437 CA0000 JZ POPHLRET ;=NEXT LINE, IF NOT FOUND
043A C5 PUSH B ;ADDRESS OF NEXT LINE
043B 7E MOV A,M ;GET NUMBER OF CURRENT LINE
043C 23 INX H
043D 66 MOV H,M ;(from HL,MA)
043E 6F MOV L,A
043F CD0000 CALL CMHLLTDE
0442 E1 POP H ;HL=NEXT LINE
0443 C1 POP B
0444 3F CMC
0445 C8 RZ
0446 D23304 JNC LINESRCL
0449 60 MOV H,B
044A 69 MOV L,C
044B 3F CMC
044C C9 RET

;
; LINK TO NEXT LINE
;
LINELINK:
044D E5 PUSH H ;FIND ADDRESS OF NEXT LINE
044E 4E MOV C,M ;Z=END OF PROGRAM
044F 23 INX H
0450 46 MOV B,M
0451 23 INX H
0452 E3 XTHL
0453 09 DAD B ;ADD LENGTH TO ADDRESS
0454 E3 XTHL
0455 78 MOV A,B
0456 B1 ORA C
0457 C1 POP B
0458 C9 RET
```

```
; INSERT/REPLACE LINE OF PROGRAM
;
LINEINS:
0459 D5      PUSH   D      ;DE=LINE NUMBER
045A D40000  CNC    KEYSAN ;C=ALREADY KEY-SCANNED
045D CDAB03  CALL   SCANNXT ;bscan ,           ;NC=MUST BE KEY-SCANNED
0460 D1      POP    D
0461 E5      PUSH   H      ;HL=TEXT TO INSERT
0462 D5      PUSH   D
0463 C5      PUSH   B      ;BC=LENGTH OF TEXT
0464 F5      PUSH   PSW   ;Z=DELETE, NO REPLACE
0465 CD3004  CALL   LINESRCH ;LOOK FOR LINE
0468 C5      PUSH   B      ;SAVE LOCATION
0469 DC0000  CC    LINEDEL ;DELETE IF PRESENT
046C D1      POP    D
046D F1      POP    PSW
046E CA0000  JZ    POPHL3RT ;EXIT IF NOTHING MORE
0471 2A8703 LHLD  FREELIMT ;PULL APART FOR NEW LINE
0474 E3      XTHL
0475 C1      POP    B
0476 E5      PUSH   H
0477 09      DAD   B
0478 CD0000  CALL   COPYCHK
047B EB      XCHG
047C C1      POP    B
047D 71      MOV    M,C   ;BEGINNING OF NEW LINE
047E 23      INX
047F 70      MOV    M,B
0480 23      INX
0481 D1      POP    D
0482 73      MOV    M,E   ;INSERT LINE NUMBER
0483 23      INX
0484 72      MOV    M,D
0485 23      INX
0486 EB      XCHG
0487 E1      POP    H      ;RECOVER TEXT POINTER
LINEINSL:
0488 7E      MOV    A,M   ;INSERT TEXT OF NEW LINE
0489 12      STAX  D
048A 23      INX
048B 13      INX
048C B7      ORA    A
048D C28804  JNZ   LINEINSL
0490 C30000  JMP   LINEDELU
```

```
; DELETE TEXT FROM PROGRAM
;
LINEDEL:
0493 EB      XCHG      ;BC=BEGINNING OF TEXT TO REMOVE
0494 79      MOV       A,C
0495 93      SUB       E          ;COMPUTE NEGATIVE OF
0496 6F      MOV       L,A      ;NUMBER OF BYTES DELETED
0497 78      MOV       A,B
0498 9A      SBB       D
0499 67      MOV       H,A
049A E5      PUSH      H
049B 2A8703  LHLD      FREELIMT    ;HL=BEGINNING OF TEXT SURVIVING
;
LINEDELL:
049E 1A      LDAX      D
049F 02      STAX      B
04A0 03      INX       B
04A1 13      INX       D
04A2 CD0000  CALL      CMHLLTDE
04A5 D29E04  JNC       LINEDELL
04A8 C1      POP       B
;
LINEDELU:
04A9 2A8703  LHLD      FREELIMT    ;UPDATE DATA POINTERS
04AC 09      DAD       B          ;BC=INCREMENT
04AD 228703  SHLD      FREELIMT
04B0 2A8503  LHLD      MATTABLE
04B3 09      DAD       B
04B4 228503  SHLD      MATTABLE
04B7 2A8303  LHLD      VARTABLE
04BA 09      DAD       B
04BB 228303  SHLD      VARTABLE
04BE C30000  JMP       CLEARPCN
;
; MAKE SIXTEEN BIT COMPARISON
;
CMHLLTDE:
04C1 7C      MOV       A,H      ;COMPARE DE VS HL
04C2 92      SUB       D          ;C=HL<DE
04C3 C0      RNZ
04C4 7D      MOV       A,L
04C5 93      SUB       E
04C6 C9      RET
```

```
; MOVE LONG TO HIGHER ADDRESS
;
COPYCHK:
04C7 CD0000    CALL    SPACECHK
COPYTEXT:
04CA C5        PUSH    B      ;COPY SECTION DE-BC TO AREA
04CB E3        XTHL    ;ENDING AT HL
04CC C1        POP     B
COPYTXTL:
04CD CDC104    CALL    CMHLLTDE
04D0 7E        MOV     A,M
04D1 02        STAX    B
04D2 C8        RZ
04D3 0B        DCX    B
04D4 2B        DCX    H
04D5 C3CD04    JMP     COPYTXTL

; CHECK SPACE FOR STACK ALLOCATION
;
SPACESTK:
04D8 E5        PUSH    H      ;VERIFY STACK HAS ROOM ENOUGH
04D9 2A8703    LHLD    FREELIMT ;C=NUMBER OF WORDS NEEDED
04DC 0600    MVI     B,000H
04DE 09        DAD    B
04DF 09        DAD    B
04E0 CD0000    CALL    SPACECHK
04E3 E1        POP     H
04E4 C9        RET

; CHECK SPACE FOR PROGRAM OR VARIABLE ALLOCATION
;
SPACECHK:
04E5 D5        PUSH    D      ;CHECK THAT ENOUGH SPACE IS LEFT
04E6 EB        XCHG    ;ON STACK ABOVE HL
04E7 21DAFF    LXI    H,-38
04EA 39        DAD    SP
04EB CDC104    CALL    CMHLLTDE
04EE EB        XCHG
04EF D1        POP     D
04F0 D0        RNC
ERRAOM:
04F1 1E47    MVI     E,ERRNOM-ERRN
04F3 C30000    JMP     ERRMSG
```

```
; RE-INITIALIZATION ROUTINES
;
NEWSTM:
04F6 C0      RNZ          ;NEW COMMAND
CLEARPGM:
04F7 2A8103  LHLD  PROGBASE    ;CLEAR PROGRAM
04FA AF      XRA   A
04FB 77      MOV   M,A
04FC 23      INX   H
04FD 77      MOV   M,A
04FE 23      INX   H
NEWLOAD:
04FF 228303  SHLD  VARTABLE
CLEARSET:
0502 CD0000  CALL  CLEARPCN   ;CLEAR PROGRAM POINTERS
CLEARVST:
0505 227703  SHLD  PROGCNTR   ;UPDATE PROGRAM COUNTER
0508 CD0000  CALL  CLEARVAR   ;CLEAR VARIABLES
CLEARSTK:
050B C1      POP   B           ;RESET STACK,
050C 2A8903  LHLD  STCKBASE
050F F9      SPHL
0510 2160FF  LXI   H,0-LINESIZE-3
0513 39      DAD   SP
0514 F9      SPHL   ;CREATE INPUT BUFFER
0515 227F03  SHLD  INPTBUFR
0518 2A8D03  LHLD  STRGBASE   ;CLEAR STRING TEMPORARIES,
051B 23      INX   H
051C 228F03  SHLD  STRGTMPP
051F 210000  LXI   H,0
0522 E5      PUSH  H
0523 227903  SHLD  PROGCNTS   ;SET NO CONTINUE.
0526 2A7703  LHLD  PROGCNTR
0529 C5      PUSH  B
052A C9      RET
CLEARVAR:
052B 2A8303  LHLD  VARTABLE   ;CLEAR ALL VARIABLES
052E 228503  SHLD  MATTABLE
0531 228703  SHLD  FREELIMT
0534 2A8D03  LHLD  STRGBASE
0537 228B03  SHLD  STRGFREE
053A C9      RET
CLEARPCN:
053B 210000  LXI   H,0       ;CLEAR PROGRAM POINTERS
053E 227903  SHLD  PROGCNTS
0541 2A8103  LHLD  PROGBASE
0544 28      DCX   H
0545 3600  MVI   M,0       ;END OF LINE -1
0547 227703  SHLD  PROGCNTR
054A AF      XRA   A
```

```
;      : RESTORE: REWIND DATA STATEMENTS
;
;RESSTM:
054B CA0000  JZ      RESSTMDF      ;RESTORE STATEMENT
054E CD0B04  CALL    SCANLINN
0551 E5      PUSH    H
0552 CD3004  CALL    LINESRCH
0555 D20000  JNC     ERRAUS
0558 E1      POP     H
0559 EB      XCHG
055A C30000  JMP    RESSTMBU
;
RESSTMDF:
055D EB      XCHG      ;DEFAULT IS RESTORE TO BEGINNING
055E 2A8103  LHLD    PROGBASE
;
RESSTMBU:
0561 2B      DCX     H       ;BACK UP BEFORE LINE
;
RESDTPTR:
0562 227D03  SHLD    CURDATAP   ;SET DATA POINTER
0565 EB      XCHG
0566 C9      RET
;
;
;      : CLEAR: CLEAR VARIABLES, REALLOCATE STRING SPACE
;
;CLRSTM:
0567 CA0505  JZ      CLEARVST     ;CLEAR STATEMENT
056A CD0000  CALL    VALINTDE
056D 2B      DCX     H       ;bscan -
056E CDAB03  CALL    SCANNXT  ;bscan ,
0571 C0      RNZ
0572 E5      PUSH    H
0573 2A8D03  LHLD    STRGBASE
0576 7D      MOV     A,L
0577 93      SUB     E
0578 5F      MOV     E,A
0579 7C      MOV     A,H
057A 9A      SBB     D
057B 57      MOV     D,A
057C DA0000  JC      ERRASN
057F 2A8303  LHLD    VARTABLE
0582 012800  LXI    B,40
0585 09      DAD    B
0586 CDC104  CALL    CMHLLTDE
0589 D2F104  JNC     ERRAOM
058C EB      XCHG
058D 228903  SHLD    STCKBASE
0590 E1      POP     H
0591 C30505  JMP    CLEARVST
```

```
; ; LOW-LEVEL CHARACTER I/O ROUTINES
;
; PRNTCHRI:
0594 E3      XTHL
0595 7E      MOV    A,M
0596 23      INX    H
0597 E3      XTHL
;
; PRNTCHRA:
0598 F5      PUSH   PSW    ;TRANSMIT CHARACTER
0599 3A6503  LDA    PRINTFLG
059C B7      ORA    A
059D C20000  JNZ    POPAFRET
05A0 F1      POP    PSW
05A1 F5      PUSH   PSW
05A2 FE20      CPI    " "
05A4 DA0000  JC     PRNTCHRW
05A7 E5      PUSH   H
05A8 2A9903  LHLD   CURSPOS ;LINE TOO LONG?
05AB 7C      MOV    A,H
05AC 85      ADD    L
05AD 7D      MOV    A,L
05AE E1      POP    H
05AF DC0000  CC     PRNTCRLF
05B2 3C      INR    A
05B3 329903  STA    CURSPOS
;
; PRNTCHRW:
05B6 F1      POP    PSW    ;SEND CHARACTER
05B7 CD2A00  CALL   SYSDISPL
05BA C9      RET
```

```
INPTCHAR:
05BB CD0600  CALL   SYSKEYIN   ;RECEIVE A CHARACTER
05BE CABB05  JZ    INPTCHAR   ;WAIT FOR ONE
05C1 FEOF      CPI    SI
05C3 C0      RNZ
05C4 3A6503  LDA    PRINTFLG
05C7 2F      CMA
05C8 326503  STA    PRINTFLG
05CB C3BB05  JMP    INPTCHAR
```

```
;      ;  ERROR PROCESSING
;
MSGERROR:
05CE 204552    DB      " ERROR",0
05D1 524F52
05D4 00
      MSGIN:
05D5 20494E    DB      " IN ",0
05D8 2000
      MSGOK:
05DA 0D0A4F    DB      CR,LF,"OK",CR,LF,0
05DD 4B0DOA
05E0 00
      MSGBREAK:
05E1 0D0A42    DB      CR,LF,"BREAK",0
05E4 524541
05E7 4B00

ERRDATA:
05E9 2A7B03    LHLD    CURLDATA
05EC 227303    SHLD    CURLINE
ERRASN:
05EF 1EA9      MVI     E,ERRNSN-ERRN
ERRMSG:
05F1 CD0B05    CALL    CLEARSTK
05F4 AF        XRA     A
05F5 326503    STA     PRINTFLG      ;TURN ON PRINTING
05F8 326703    STA     SCANPFLG     ;ALLOW SUBSCRIPTING
05FB CD0000    CALL    PRNTCRLF
05FE 217302    LXI     H,ERRN
0601 57        MOV     D,A
0602 CD9405    CALL    PRNTCHRI     ;print (val)
0605 3F        DB      "?"
0606 19        DAD     D          ;PRINT ERROR CODE
0607 CD0000    CALL    PRNTMSG
060A 21CE05    LXI     H,MSGERROR
ERRMSGPR:
060D CD0000    CALL    PRNTMSG
0610 2A7303    LHLD    CURLINE
0613 7C        MOV     A,H
0614 A5        ANA     L
0615 3C        INR     A
0616 C40000    CNZ     ERRMSGIN
```

```
; COMMAND/LINE INPUT
;
CMNDSTRT:
0619 AF      XRA    A      ;TOP LEVEL EXECUTIVE
061A 326503  STA    PRINTFLG   ;TURN ON PRINTING
061D 326703  STA    SCANPFLG  ;ALLOW SUBSCRIPTING
0620 21FFFF  LXI    H,-1
0623 227303  SHLD   CURLINE
0626 21DA05  LXI    H,MSGOK
0629 CD0000  CALL   PRNTMSG ;REQUEST COMMAND
CMNDINPT:
062C 110000  LXI    D,MSGSTARS+2 ;INPUT COMMAND
062F CD0000  CALL   INPTRQST
0632 DA2C06  JC    CMNDINPT
0635 CDAB03  CALL   SCANNXT ;bscan ,
0638 F5      PUSH   PSW
0639 CD0B04  CALL   SCANLINN ;SCAN OFF LINE NUMBER
063C D5      PUSH   D
063D CD0000  CALL   KEYSAN ;SCAN STATEMENT
0640 D1      POP    D
0641 F1      POP    PSW
0642 D20000  JNC   EXECUTE ;DIRECT IF NO LINE NUMBER
0645 CD5904  CALL   LINEINS ;INSERT LINE AS REQUESTED
0648 C32C06  JMP    CMNDINPT

CMNDRSTR:
064B CD0B05  CALL   CLEARSTK ;ENTRY FOR RESTARTING
064E CD0000  CALL   PRNTCRLF
0651 210000  LXI    H,MSGREDO+11 ;TELL HIM WE'RE STARTING
0654 C30D06  JMP    ERRMSGPR
```

```
; AUTOMATIC LINE-NUMBERED INPUT
;
AUTSTMN:
0657 D5      PUSH   D      ;SAVE LINE NUMBER
0658 CD5904  CALL    LINEINS ;INSERT LINE
065B E1      POP    H      ;RECOVER LINE NUMBER,
065C D1      POP    D      ;INCREMENT
065D 19      DAD   D
065E DA0000  JC    ERRAOV
0661 C30000  JMP   AUTSTMN

AUTSTM:
0664 C1      POP    B      ;REMOVE CALLER
AUTSTMS:
0665 11E803  LXI   D,1000 ;DEFAULT STARTING LINE NUMBER
0668 016400  LXI   B,100  ;DEFAULT INCREMENT VALUE
066B CDE703  CALL   SCANLPRM ;SCAN PARAMETERS
066E C2EF05  JNZ   ERRASN
0671 E1      POP    H
0672 CD0000  CALL   PRNTCRLF
AUTSTMN:
0675 D5      PUSH   D      ;SAVE INCREMENT
0676 E5      PUSH   H      ;AND NEXT LINE NUMBER
0677 CD0000  CALL   ENCODEHL ;PROMPT WITH LINE NUMBER
067A EB      XCHG
067B 13      INX
067C CD0000  CALL   INPTRQST
067F D1      POP    D
0680 DA0000  JC    AUTSTMNR
0683 CDAB03  CALL   SCANNXT ;bscan ,
0686 D25706  JNC   AUTSTMN
0689 3F      CMC
AUTSTMNR:
068A D1      POP    D      ;TAKE A BREAK
068B DA1906  JC    CMNDSTRT ;END OF AUTO
068E C36506  JMP   AUTSTMS ;GET NEW LINE NUMBER, INCREMENT
```

```

;
; LEXICAL SCANNER / KEYWORD RECOGNITION
;

KEYSCAN:
0691 0E05    MVI    C,5      ;SCAN INPUT LINE FOR KEYWORDS,
0693 54      MOV    D,H      ;CONDENSE LINE ON TOP OF SELF
0694 5D      MOV    E,L
0695 28      DCX    H       ;bscan -
0696 E5      PUSH   H
0697 CDAB03  CALL   SCANNXT ;bscan +
KEYSCANL:
069A 7E      MOV    A,M
069B FE20  CPI   "
069D CA0000 JZ    KEYSCHANH ;DELETE BLANKS
06A0 47      MOV    B,A
06A1 FE22  CPI   "
06A3 CA0000 JZ    KEYSCHANI ;SWALLOW WHOLE STRING
06A6 B7      ORA   A
06A7 CA0000 JZ    KEYSCHANX
06AA FE30  CPI   "0" ;NON-KEYWORD
06AC DA0000 JC    KEYSCHANK
06AF FE3C  CPI   "<" ; SO WE DON'T SCAN
06B1 DA0000 JC    KEYSCHANP
KEYSCANK:
06B4 C5      PUSH   B      ;SCAN FOR MATCHING KEYWORD
06B5 D5      PUSH   D
06B6 E5      PUSH   H
06B7 E60F  ANI   00FH    ;HASH CHARACTER
06B9 5F      MOV    E,A
06BA 1600  MVI   D,0
06BC 21E400 LXI   H,KEYWADDS ;ADDRESS C"SPONDING KEYWORDS
06BF 19      DAD   D
06C0 19      DAD   D
06C1 5E      MOV    E,M
06C2 23      INX   H
06C3 56      MOV    D,M
06C4 EB      XCHG
06C5 C30000 JMP   KEYSCHANB

KEYSCANZ:
06C8 1A      LDAX
06C9 B7      ORA
06CA F20000 JP    KEYSCHANN
KEYSCANM:
06CD 78      MOV    A,B      ;MATCH, GET SYMBOL NUMBER
06CE F680  ORI   080H
06D0 C30000 JMP   KEYSCHANF
KEYSCANN:
06D3 23      INX   H      ;ADDRESS NEXT CHAR IN LINE
06D4 13      INX   D
06D5 0C      INR   C
KEYSCANC:
06D6 1A      LDAX
06D7 E67F  ANI   07FH
06D9 CDCE03 CALL   CHARMTCH ;COMPARE CHARACTERS

```

```

06DC CAC806    JZ      KEYSANZ
06DF 79        MOV     A,C      ;MATCH ENOUGH YET?
06EO FE03        CPI     3
06E2 DA0000    JC      KEYSANA

06E5 CDBB03    CALL    ALPHACHK      ;STOP ON BREAK CHAR OK
06E8 2B        DCX     H
06E9 D2CD06    JNC      KEYSANM

KEYSCANA:
06EC EB        XCHG
KEYSCANW:
06ED B6        ORA     M      ;SKIP OVER REST OF KEYWORD
06EE 23        INX     H
06EF F2ED06    JP      KEYSANW
06F2 A8        XRA     B

KEYSCANB:
06F3 46        MOV     B,M    ;GET CODE FOR KEYWORD
06F4 23        INX     H
06F5 EB        XCHG
06F6 E1        POP    H      ;RESTORE STARTING POSITION
06F7 E5        PUSH   H
06F8 0E00    MVI    C,0
06FA F2D606    JP      KEYSANC
06FD 7E        MOV     A,M    ;NO MATCH, GET CHARACTER

KEYSCANF:
06FE D1        POP    D      ;RECOVER OUTPUT POINTER
06FF D1        POP    D
0700 C1        POP    B
0701 063A    MVI    B,":" ;CHECK FOR SPECIAL PROCESSING
0703 FE8C    CPI     KEYELS
0705 C20000    JNZ      KEYSAND
0708 EB        XCHG
0709 70        MOV     M,B    ;INSERT COLON BEFORE ELSE
070A EB        XCHG
070B 13        INX     D
070C 0C        INR     C

KEYSCAND:
070D FE80    CPI     KEYDAT
070F CA0000    JZ      KEYSANI
0712 0600    MVI     B,0
0714 FE81    CPI     KEYREM
0716 CA0000    jz      keyscani
0719 FE9C    cpi     keycld ;pass file name in load and save
071B CA0000    jz      keyscani
071E FE9D    cpi     keycsv

KEYSCANI:
0720 CC0000    CZ      KEYSANV
0723 B7        ORA     A
0724 CA0000    JZ      KEYSANX

KEYSCANP:
0727 12        STAX   D      ;INSERT SYMBOL IN MEMORY
0728 13        INX     D
0729 0C        INR     C

KEYSCANH:
072A 23        INX     H
072B C39A06    JMP      KEYSANL

```

KEYSCANX:

| | | | |
|---------|------|-----|---------------------------|
| 072E E1 | POP | H | ;EXIT KEYWORD TRANSLATION |
| 072F 12 | STAX | D | ;END OF STATEMENT |
| 0730 13 | INX | D | |
| 0731 12 | STAX | D | ;END OF "PROGRAM" |
| 0732 13 | INX | D | |
| 0733 12 | STAX | D | |
| 0734 47 | MOV | B,A | ;LENGTH IN BC |
| 0735 C9 | RET | | |

;
; COPY BUFFER TEXT WITHOUT PROCESSING
;

KEYSCANV:

| | | | |
|-------------|------|----------|-----------------------------------|
| 0736 12 | STAX | D | ;COPY TEXT VERBATIM TO STOPPER |
| 0737 0C | INR | C | |
| 0738 13 | INX | D | |
| 0739 23 | INX | H | |
| 073A 7E | MOV | A,M | |
| 073B B7 | ORA | A | |
| 073C C8 | RZ | | |
| 073D B8 | CMP | B | |
| 073E C8 | RZ | | |
| 073F FE22 | CPI | " " | ;STRING WITHIN TEXT? |
| 0741 C23607 | JNZ | KEYSCANV | |
| 0744 C5 | PUSH | B | |
| 0745 47 | MOV | B,A | |
| 0746 CD3607 | CALL | KEYSCANV | |
| 0749 F1 | POP | PSW | |
| 074A 47 | MOV | B,A | |
| 074B 7E | MOV | A,M | |
| 074C B7 | ORA | A | ;STRING TERMINATE ON END OF LINE? |
| 074D C8 | RZ | | |
| 074E C33607 | JMP | KEYSCANV | |

```
; LINE INPUT ROUTINE
;
INPTLNBS:
0751 2B      DCX    H      ;DELETE A CHARACTER FROM INPUT
0752 05      DCR    B
0753 CA0000  JZ     INPTLNRD
0756 CD9405  CALL   PRNTCHRI      ;print (val)
0759 5C      DB     '\
075A 0C      inr   c      ;char count
075B C30000  JMP    INPTLINL
;
INPTLNRD:
075E 210000  LXI    H,MSGSTARS ;BREAK ENTERED
0761 CD0000  CALL   PRNTMSG ;TELL HIM WE GOT IT
0764 05      DCR    B      ;BREAK AT BEGINNING MEANS BREAK
0765 CA0000  JZ     INPTEXIT
;
INPTCRLF:
0768 CD0000  CALL   PRNTCRLF      ;ON THE NEXT LINE
;
INPTRQST:
076B 62      MOV    H,D
076C 6B      MOV    L,E      ;PRINT USER'S PROMPT MESSAGE
076D CD0000  CALL   PRNTMSG
0770 2A7F03  LHLD   INPTBUFR      ;INPUT A LINE FROM RECEIVER
0773 010001  LXI    B,1*256
0776 CD9405  CALL   PRNTCHRI      ;print (val)
0779 20      DB     " "      ;OK, WE'RE READY FOR INPUT
;
INPTLINL:
077A 3600  MVI    M,O      ;MAINTAIN ENDING ZERO
077C CDBB05  CALL   INPTCHAR
;
INPTLINC:
077F FE07  CPI    BEL
0781 CA0000  JZ     INPTLNST      ;BELL'S OK
0784 FE0D  CPI    CR
0786 CA0000  JZ     INPTCRTN      ;CARRIAGE RTN IS END OF LINE
0789 FE08  CPI    BS
078B CA5107  JZ     INPTLNBS      ;BACKSPACE IS DELETE
078E FE03  CPI    ETX      ;CONTROL C IS ABORT
0790 CA5E07  JZ     INPTLNRD      ;FORGET THIS LINE, START OVER
0793 FE0C  CPI    FF      ;FORM FEEDS ARE ECHOED
0795 CA0000  JZ     INPTLNEC
0798 FE20  CPI    " "
079A DA7A07  JC     INPTLINL      ;IGNORE OTHER CONTROL CHARS
```

INPTLNST:

```
079D 77      MOV    M,A      ;STORE THE CHARACTER
079E 78      MOV    A,B
079F FE9D      CPI    LINESIZE
07A1 3E07      MVI    A,BEL
07A3 D20000      JNC    INPTLNEC
07A6 04      INR    B
07A7 B1      ORA    C
07A8 4E      MOV    C,M
07A9 23      INX    H
07AA 3EOA      MVI    A,LF
07AC FC9805      CM    PRNTCHRA
07AF 79      MOV    A,C
      INPTLNEC:
07B0 CD9805      CALL   PRNTCHRA      ;ac -> screen      ;ECHO CHARACTER
07B3 C37A07      JMP    INPTLINL
```

INPTCRTN:

```
07B6 05      DCR    B      ;CARRIAGE RETURN AT BEGINNING
07B7 CA6807      JZ    INPTCRLF      ;GETS ANOTHER TURN
      INPTEXIT:
07BA 2A7F03      LHLD   INPTBUFR
07BD 2B      DCX    H
07BE CD0000      CALL   PRNTCRLF
07C1 90      SUB    B      ;SET CONDITION CODES
07C2 3F      CMC    ;S=C=NZ = BREAK
07C3 9F      SBB    A      ;NS=NC=Z = NON-EMPTY LINE
07C4 C9      RET
```

MSGSTARS:

```
07C5 2A2A2A      DB    "****",0
07C8 00
```

```
; SET OPTIONS COMMAND
;
SETSTM:
07C9 CAEF05 JZ ERRASN ;TURN OPTION ON OR OFF
07CC FE99 CPI KEYLIS
07CE CA0000 JZ SETSTMLS
07D1 F5 PUSH PSW ;SAVE OPTION
07D2 CDAB03 CALL SCANNXT ;bscan ,
07D5 CAEF05 JZ ERRASN
07D8 D691 SUI KEYON
07DA 47 MOV B,A ;SAVE FLAG
07DB CDAB03 CALL SCANNXT ;bscan +
07DE F1 POP PSW ;WHICH OPTION
07DF FE89 CPI KEYGTO
07E1 CA0000 JZ SETSTMGT ;GOTO
07E4 FE96 CPI KEYPRT
07E6 C2EF05 JNZ ERRASN
SETSTMGT:
07E9 78 MOV A,B
07EA 326303 sta p3010 ;used to be printfg **
07ED C9 RET
SETSTMGT:
07EE 78 MOV A,B
07EF 326603 STA TRACEFLG
07F2 C9 RET
SETSTMLS:
07F3 23 INX H
07F4 CD0000 CALL VALBYTE ;FIND NEGATIVE OF BYTE
07F7 2F CMA
07F8 3C INR A
07F9 329A03 STA CURSLIM
07FC C9 RET

; DELETE COMMAND PROCESSOR
;
DELSTM:
07FD 11FFFF LXI D,0FFFH ;DELETE COMMAND
0800 CDE403 CALL SCANLPRZ ;SAVE SCAN POINTER
0803 E3 XTHL
0804 EB XCHG
0805 CDC104 CALL CMHLLTDE ;VERIFY FIRST<=LAST
0808 DAEF05 JC ERRASN
080B E5 PUSH H
080C CD3004 CALL LINESRCH ;LOOK FOR FIRST LINE
080F D1 POP D
0810 C5 PUSH B
0811 CD3004 CALL LINESRCH ;LOOK FOR LAST LINE
0814 C1 POP B
0815 CD9304 CALL LINEDEL
0818 E1 POP H
0819 C9 RET
```

```
; LIST COMMAND PROCESSOR
;
LISSTM:
081A 110000 LXI D,0      ;LIST COMMAND
081D 01FFFF LXI B,0FFFFH    ;TOTAL DEFAULT IS ENTIRE FILE
0820 CA0000 JZ LISSTMSC
0823 010000 LXI B,0      ;ELSE DEFAULT IS ONLY ONE LINE
LISSTMSC:
0826 CDE703 CALL SCANLPRM   ;SCAN LINE PARAMETERS
0829 C2EF05 JNZ ERRASN
082C E3 XTHL
082D EB XCHG
082E E5 PUSH H
082F CD3004 CALL LINESRCH
0832 C5 PUSH B
LISSTMLP:
0833 C1 POP B      ;MOVE ON TO NEXT LINE
0834 D1 POP D
0835 E1 POP H
0836 CD3E00 CALL SYSBREAK    ;ALLOW BREAK
0839 CA0000 JZ EXECUTEB
083C C5 PUSH B
083D E3 XTHL
083E CD4D04 CALL LINELINK
0841 CA0000 JZ POPHLRET    ;END OF PROGRAM, QUIT
0844 D5 PUSH D
0845 C5 PUSH B
0846 E5 PUSH H      ;SAVE TEXT FOR LATER
0847 4E MOV C,M      ;FETCH LINE NUMBER
0848 23 INX H
0849 46 MOV B,M
084A 60 MOV H,B
084B 69 MOV L,C
084C EB XCHG
084D CDC104 CALL CMHLLTDE
0850 DA0000 JC LISSTMXT    ;LAST LINE REACHED?
0853 CD0000 CALL PRNTCRLF   ;LIST CURRENT LINE
0856 EB XCHG
0857 CD0000 CALL PRINTINT    ;PRINT LINE NUMBER
085A CD9405 CALL PRNTCHRI   ;print (val)
085D 20 DB " "      ;FOLLOWED BY BLANK
085E E1 POP H
085F CD0000 CALL LISEDIXP    ;EXPAND TEXT
0862 CD0000 CALL PRNTMSG ;AND PRINT IT
0865 21A000 LXI H,0+LINESYZE+3
0868 39 DAD SP
0869 F9 SPHL          ;DEALLOCATE EXPANDED TEXT
086A C33308 JMP LISSTMLP
```

LISSTMXT:
086D E1 POP H
POPHL3RT:
086E E1 POP H
086F E1 POP H
POPHLRET:
0870 E1 POP H
0871 C9 RET

; ; EXPAND KEYWORDS IN LINE / INVERSE OF KEYS offense
; ;
LISEDIXP:
0872 0E4E MVI C,LINESIZE/2 ;SPACE ENOUGH TO EXPAND LINE?
0874 CDD804 CALL SPACESTK
0877 EB XCHG ;SAVE POINTER TO LINE TO EXPAND
0878 C1 POP B ;AND CALLER
0879 2160FF LXI H,0-LINESIZE-3
087C 39 DAD SP
087D F9 SPHL ;CREATE TEXT BUFFER ON STACK
087E C6 PUSH B ;PUT BACK CALLER
087F EB XCHG
0880 23 INX H
0881 23 INX H ;plus 2
0882 E5 PUSH H ;SAVE TEXT POINTER
0883 210400 LXI H,4 ;CREATE POINTER TO EXPAND TEXT
0886 39 DAD SP
0887 EB XCHG
0888 069D MVI B,LINESIZE ;INITIALIZE LENGTH COUNTER
088A C30000 JMP LISEDIKD
LISEDISC:
088D CD0000 CALL LISEDIST ;STUFF ONE CHARACTER OF LINE
LISEDIKD:
0890 E1 POP H ;DO REST OF LINE
0891 7E MOV A,M
LISEDINC:
0892 23 INX H
0893 FE3A CPI ":"
0895 C20000 JNZ LISEDIKT
0898 7E MOV A,M
0899 FE8C CPI KEYELS ;:ELSE BECOMES ELSE
089B CA9208 JZ LISEDINC
089E 3E3A MVI A,":"
LISEDIKT:
08A0 A7 ANA A ;MOVE HIGH ORDER INTO S-FLAG
08A1 CA0000 JZ LISEDIXT
08A4 E5 PUSH H
08A5 F28D08 JP LISEDISC
08A8 4F MOV C,A

```

08A9 21A0A3   LXI    H,KEYLSBH*256+KEYLSBL
08AC CD0000   CALL   LISEDIISB      ;OPTIONAL BLANK BEFORE KEYWORD
08AF 210401   LXI    H,KEYWORDS     ;SEARCH FOR KEYWORD
08B2 C30000   JMP    LISEDIKS
LISEDIKL:
08B5 B6       ORA    M
08B6 23       INX    H
08B7 F2B508   JP     LISEDIKL
LISEDIKS:
08BA 7E       MOV    A,M      ;FETCH KEYWORD NUMBER
08BB F680   ORI    080H
08BD 23       INX    H
08BE A9       XRA    C
08BF C2B508   JNZ    LISEDIKL
LISEDIKY:
08C2 7E       MOV    A,M      ;EXPAND KEYWORD
08C3 07       RLC
08C4 A7       ANA    A        ;HIGH-ORDER TO CARRY
08C5 1F       RAR
08C6 CD0000   CALL   LISEDIST     ;STUFF THIS CHARACTER
08C9 23       INX    H
08CA D2C208   JNC    LISEDIKY     ;DO THEM ALL
08CD 79       MOV    A,C
08CE 2182A5   LXI    H,KEYLSAH*256+KEYLSAL
08D1 CD0000   CALL   LISEDIISB    ;OPTIONAL BLANK AFTER KEYWORD
08D4 C39008   JMP    LISEDIKD
LISEDISB:
08D7 BD       CMP    L        ;INSERT BLANK IN LINE IF
08D8 D8       RC     ;L <= A < H
08D9 BC       CMP    H
08DA D0       RNC
08DB 3E20   MVI    A," "    ;GENERATE BLANK
LISEDIST:
08DD 12       STAX   D
08DE 13       INX    D
08DF 05       DCR    B
08E0 C0       RNZ    ;TRUNCATE TOO LONG A LINE
08E1 04       INR    B
08E2 2B       DCX    H
08E3 C9       RET
LISEDIXT:
08E4 12       STAX   D
08E5 3E9E   MVI    A,LINESYZE+1 ;COMPUTE LENGTH OF OUTPUT
08E7 90       SUB    B
08E8 47       MOV    B,A
08E9 210200   LXI    H,2      ;CREATE POINTER TO EXPAND TEXT
08EC 39       DAD    SP
08ED C9       RET    ;AND RETURN

```

```
; EDIT COMMAND PROCESSOR
;
EDISTM:
08EE 110000 LXI D,0 ;SCAN PARAMETERS
08F1 CDE403 CALL SCANLPRZ
08F4 E3 XTHL ;SAVE SCAN,
08F5 226F03 SHLD SCANPTR1 ;AND OUTPUT LINE NUMBER
08F8 CD3004 CALL LINESRCH ;LOOK UP LINE
08FB D20000 JNC ERRAUS ;NOT FOUND...
08FE 60 MOV H,B
08FF 69 MOV L,C
0900 23 INX H
0901 23 INX H ;plus 2
0902 CD7208 CALL LISEDIXP ;EXPAND LINE
0905 2A6F03 LHLD SCANPTR1 ;RECOVER LINE NUMBER
0908 E5 PUSH H
EDISTMLS:
0909 CD0000 CALL EDISTMCR ;GIVE HIM A LOOK AT IT
090C CD0000 CALL PRNTMSG ;PRINT COPY OF TEXT
090F CD0000 CALL EDISTMCR ;A NEW EDIT LINE
0912 0E01 MVI C,1 ;POSITION COUNTER
EDISTMNX:
0914 CD0000 CALL EDISTMCH ;OK MASTER, TELL ME WHAT TO DO
0917 FE20 CPI " " ;MOVE ALONG
0919 CA0000 JZ EDISTMAD
091C CDBC03 CALL ALPHACHA ;CONVERT LOWER TO UPPER
091F FE44 CPI "D" ;DELETE
0921 CA0000 JZ EDISTMDL
0924 FE49 CPI "I" ;INSERT
0926 CA0000 JZ EDISTMIN
0929 FE52 CPI "R" ;REPLACE
092B CA0000 JZ EDISTMRP
EDISTMER:
092E 3E07 MVI A,BEL ;SQUAWK ABOUT ERROR
EDISTMEC:
0930 CD9805 CALL PRNTCHRA ;ac -> screen
0933 C31409 JMP EDISTMNX
;
; ADVANCE
;
EDISTMAD:
0936 79 MOV A,C
0937 B8 CMP B ;CAN WE STILL ADVANCE?
0938 D22E09 JNC EDISTMER
093B 0C INR C ;ADVANCE POSITION COUNTER
093C 7E MOV A,M
093D 23 INX H ;PRINT CHARACTER PASSED OVER
093E C33009 JMP EDISTMEC
```

```
; DELETE
;
EDISTMDL:
0941 79      MOV    A,C
0942 B8      CMP    B      ;ANYTHING TO DELETE?
0943 D22E09   JNC    EDISTMER
0946 05      DCR    B      ;DECREASE CHARACTER COUNT
0947 E5      PUSH   H      ;SAVE CURRENT POSITION
0948 7E      MOV    A,M
0949 CD9805   CALL   PRNTCHRA ;LIST CHARACTER DELETED
094C 54      MOV    D,H
094D 5D      MOV    E,L
EDISTMDM:
094E 23      INX    H
094F 7E      MOV    A,M      ;MOVE THIS CHARACTER DOWNWARD
0950 12      STAX   D
0951 13      INX    D
0952 B7      ORA    A
0953 C24E09   JNZ    EDISTMDM
0956 E1      POP    H
0957 C31409   JMP    EDISTMNX

; INSERT
;
EDISTMIN:
095A CD0000   CALL   EDISTMCH ;GET SOMETHING TO PUT IN
095D 57      MOV    D,A      ;SAVE COPY OF CHARACTER
EDISTMRI:
095E 78      MOV    A,B
095F FE9D   CPI    LINESIZE ;ROOM AT THE INNPUT BUFFER?
0961 D22E09   JNC    EDISTMER
0964 04      INR    B      ;COUNT NEWCOMER
0965 0C      INR    C      ;NEXT ONE GOES AFTER HIM
0966 7A      MOV    A,D
0967 CD9805   CALL   PRNTCHRA ;ac -> screen ;PRINT NEWCOMER
096A E5      PUSH   H      ;SAVE CURRENT POSITION
EDISTMIM:
096B 5E      MOV    E,M
096C 77      MOV    M,A      ;MOVE CHARACTERS UP ONE BYTE
096D B7      ORA    A
096E 7B      MOV    A,E
096F 23      INX    H
0970 C26B09   JNZ    EDISTMIM
0973 E1      POP    H
0974 23      INX    H
0975 C35A09   JMP    EDISTMIN
```

```
; REPLACE
;
EDISTMRP:
0978 CD0000 CALL EDISTMCH ;GET UPDATE CHARACTER
097B 57 MOV D,A
097C 79 MOV A,C
097D B8 CMP B ;REPLACING END OF LINE?
097E D25E09 JNC EDISTMRI ;IF SO, GO TO INSERT
0981 72 MOV M,D ;UPDATE THE CHARACTER
0982 0C INR C
0983 23 INX H
0984 7A MOV A,D
0985 CD9805 CALL PRNTCHRA ;ac -> screen ;PRINT NEWCOMER
0988 C37809 JMP EDISTMRP

; SEARCH
;
EDISTMSR:
098B CD0000 CALL EDISTMCH ;FIND CHARACTER TO SEARCH FOR
098E CDBC03 CALL ALPHACHA ;CONVERT TO STANDARD CASE
0991 57 MOV D,A
0992 1E00 MVI E,0
EDISTMSL:
0994 79 MOV A,C
0995 B8 CMP B
0996 D22E09 JNC EDISTMER ;NO MORE, TERMINATE SEARCH
0999 CDBB03 CALL ALPHACHK ;FETCH CHARACTER IN STANDARD CASE
099C BB CMP E
099D CA1409 JZ EDISTMNX ;GOTTA MATCH?
09A0 CD9805 CALL PRNTCHRA ;ac -> screen ;LIST FAILURES
09A3 0C INR C
09A4 23 INX H
09A5 5A MOV E,D
09A6 C39409 JMP EDISTMSL ;AND KEEP LOOKING
```

```

EDISTMXT:
09A9 0D      DCR    C      ;BEGINNING CR MEANS DONE, UPDATE
09AA C20909   JNZ    EDISTMLS ;OTHERWISE, LIST, MORE EDITS
09AD D1      POP    D      ;RETRIEVE LINE NUMBER
09AE 210000   LXI    H,0
09B1 39      DAD    SP     ;POINT TO TEXT
09B2 CD5904   CALL   LINEINS ;AND REINSERT

EDISTMQT:
09B5 21A000   LXI    H,0+LINESYZE+3
09B8 39      DAD    SP
09B9 F9      SPHL   ;DEALLOCATE TEXT BUFFER
09BA E1      POP    H      ;RECOVER SCAN POINTER
09BB C9      RET
; LIST LINE, PREPARE FOR UPDATES
;

EDISTMCR:
09BC D1      POP    D
09BD E1      POP    H      ;RETRIEVE COPY OF LINE NUMBER
09BE E5      PUSH   H      ;SAVE IT,
09BF D5      PUSH   D
09C0 C5      PUSH   B      ;AND LINE LENGTH
09C1 CD0000   CALL   PRNTCRLF
09C4 CD0000   CALL   PRINTINT ;PRINT LINE NUMBER
09C7 CD9405   CALL   PRNTCHRI ;print (val)
09CA 20      DB    "
09CB 210600   LXI    H,6
09CE 39      DAD    SP     ;CREATE POINTER TO TEXT BUFFER
09CF C1      POP    B
09D0 C9      RET

; GET OPTION CHARACTER
;

EDISTMCH:
09D1 CDBB05   CALL   INPTCHAR ;GET CHARACTER ROUTINE
09D4 FE20      CPI   "
09D6 D0      RNC   ;NOT CONTROL, RETURN
09D7 FE07      CPI   BEL
09D9 C8      RZ
09DA D1      POP    D      ;REMOVE CALLER
09DB FE09      CPI   HT    ;SEARCH (TAB)
09DD CA8B09   JZ    EDISTMSR
09E0 FE0D      CPI   CR    ;LIST, OR UPDATE
09E2 CAA909   JZ    EDISTMXT
09E5 FE1B      CPI   ESC   ;TERMINATE OPTION
09E7 CA1409   JZ    EDISTMNX
09EA FE03      CPI   ETX   ;ABORT, NO UPDATE
09EC C22E09   JNZ   EDISTMER
09EF 21C507   LXI    H,MSGSTARS ;TYPE BREAK MESSAGE
09F2 CD0000   CALL   PRNTMSG
09F5 D1      POP    D
09F6 C3B509   JMP   EDISTMQT

```

```

;
; SCAN STACK FOR "FOR" LOOP
;

09F9 0010 FORBLCK EQU 16 ;SIZE OF "FOR" STACK ENTRY

FORCHK:
09F9 210400 LXI H,4 ;LOOK FOR MARK ON STACK
09FC 39 DAD SP

FORCHKL:
09FD 7E MOV A,M
09FE 23 INX H
09FF FE83 CPI KEYFOR
0A01 C0 RNZ
0A02 3E04 MVI A,TYPESING
0A04 326B03 STA TYPEFLG ;SET CORRECT TYPE FLAG
0A07 4E MOV C,M ;MARK IS PRESENT
0A08 23 INX H
0A09 46 MOV B,M
0A0A 23 INX H
0A0B E5 PUSH H
0A0C 60 MOV H,B
0A0D 69 MOV L,C
0A0E 7A MOV A,D ;LOOKING FOR PARTICULAR VARIABLE?
0A0F B3 ORA E
0A10 EB XCHG
0A11 CA0000 JZ FORCHKXT
0A14 EB XCHG ;IS THIS IT?
0A15 CDC104 CALL CMHLLTDE

FORCHKXT:
0A18 010D00 LXI B,FORBLCK-3
0A1B E1 POP H
0A1C C8 RZ
0A1D 09 DAD B
0A1E C3FD09 JMP FORCHKL

;
; FOR STATEMENT PROCESSOR
;

FORSTM:
0A21 3EAB MVI A,SCANPFLD ;FOR STATEMENT
0A23 326703 STA SCANPFLG
0A26 CD0000 CALL LETSTM
0A29 CDD903 CALL TYPECHK
0A2C EA0000 JPE ERRATM ;MUST BE SINGLE INDEX
0A2F E3 XTHL ;SAVE SCANPTR, REMOVE CALLER
0A30 EB XCHG
0A31 227703 SHLD VARINDEX
0A34 EB XCHG
0A35 CDF909 CALL FORCHK
0A38 D1 POP D
0A39 C20000 JNZ FORSTMNF
0A3C 09 DAD B
0A3D F9 SPHL

FORSTMNF:
0A3E EB XCHG
0A3F 0E08 MVI C,FORBLCK+1/2

```

0A41 CDD804 CALL SPACESTK
0A44 E5 PUSH H
0A45 CD0000 CALL DATSTM ;FIND FIRST STATEMENT IN FOR LOOP
0A48 E3 XTHL ;AND SAVE
0A49 E5 PUSH H
0A4A 2A7303 LHLD CURLINE ;SAVE CURRENT LINE NUMBER
0A4D E3 XTHL
0A4E CDA303 CALL SCANNXTV ;bscan (val)
0A51 A1 DB KEYTO ;SCAN LIMIT VALUE,
0A52 CD0000 CALL VALNUMBR ;bscan numbr
0A55 E5 PUSH H
0A56 CD0000 CALL LDRGAC
0A59 E1 POP H
0A5A C5 PUSH B ;SAVE ON STACK
0A5B D5 PUSH D
0A5C 010081 LXI B,08100H ;LOAD DEFAULT STEP=1.0
0A5F 51 MOV D,C
0A60 5A MOV E,D
0A61 7E MOV A,M
0A62 FEA2 CPI KEYSTEP ;CHECK FOR EXPLICIT STEP SIZE
0A64 3E01 MVI A,001H
0A66 C20000 JNZ FORSTMST
0A69 CDAB03 CALL SCANNXT ;bscan +
0A6C CD0000 CALL VALNUMBR ;bscan numbr
0A6F E5 PUSH H
0A70 CD0000 CALL LDRGAC
0A73 E1 POP H
0A74 CD0000 CALL SIGNACC
FORSTMST:
0A77 C5 PUSH B ;SAVE STEP SIZE ON STACK
0A78 D5 PUSH D
0A79 F5 PUSH PSW ;SAVE DIRECTION
0A7A 33 INX SP
0A7B E5 PUSH H
0A7C 2A7703 LHLD VARINDEX ;SAVE INDEX VARIABLE
0A7F E3 XTHL
FORMARK:
0A80 0683 MVI B,KEYFOR ;MARK STACK WITH "FOR"
0A82 C5 PUSH B
0A83 33 INX SP

```
; INTERPRETER EXECUTIVE

; EXECUTEL:
0A84 CD0000 CALL BREAKCHK ;USER HAVE ANY COMMENTS?
0A87 227703 SHLD PROGCNTR
0A8A 7E MOV A,M
0A8B FE3A CPI ":";
0A8D CA0000 JZ EXECUTE ;MULTIPLE STATEMENTS ON LINE?
0A90 B7 ORA A
0A91 C2EF05 JNZ ERRASN
0A94 23 INX H ;END OF LINE,
0A95 7E MOV A,M
0A96 23 INX H
0A97 B6 ORA M
0A98 23 INX H
0A99 CA0000 JZ ENDPROGM ;END OF PROGRAM?
0A9C 5E MOV E,M
0A9D 23 INX H
0A9E 56 MOV D,M
0A9F EB XCHG
0AA0 227303 SHLD CURLINE ;MOVE TO NEXT LINE
0AA3 EB XCHG

; EXECUTE:
0AA4 CDAB03 CALL SCANNXT ;bscan , ;EXECUTE STATEMENT
0AA7 11840A LXI D,EXECUTEL
0AAA D5 PUSH D

; EXECUTEC:
0AAB C8 RZ

; EXECUTES:
0AAC FE80 CPI KEYSTM ;WHAT KIND OF STATEMENT?
0AAE DA0000 JC LETSTM
0AB1 FEA0 CPI KEYSUGR
0AB3 D20000 JNC EXECUTE2
0AB6 87 ADD A
0AB7 4F MOV C,A
0AB8 0600 MVI B,000H
0ABA EB XCHG
0ABB 214E00 LXI H,STMTABL
0ABE 09 DAD B
0ABF 4E MOV C,M
0AC0 23 INX H
0AC1 46 MOV B,M
0AC2 C5 PUSH B
0AC3 EB XCHG
0AC4 C3AB03 JMP SCANNXT
```

BREAKCHK:
0AC7 CD3E00 CALL SYSBREAK ;TIME TO TAKE A BREAK?
STPSTM:
0ACA C0 RNZ ;STOP STATEMENT
0ACB 3C INR A
EXECUTEB:
0ACC 227703 SHLD PROGCNTR
INPSTMNR:
0ACF C1 POP B ;THROW AWAY CALLER
ENDPROGM:
0AD0 F5 PUSH PSW
0AD1 2A7303 LHLD CURLINE
0AD4 7D MOV A,L
0AD5 A4 ANA H
0AD6 3C INR A
0AD7 CA0000 JZ ENDSTMC
0ADA 227503 SHLD CURLINES ;SAVE INFORMATION FOR CONTINUE
0ADD 2A7703 LHLD PROGCNTR
0AE0 227903 SHLD PROGCNTS
ENDSTMC:
0AE3 AF XRA A
0AE4 326503 STA PRINTFLG
0AE7 F1 POP PSW
0AE8 21E105 LXI H,MSGBREAK
0AEB C20D06 JNZ ERRMSGPR
0AEE C31906 JMP CMNDSTRT

CONSTM:
0AF1 C0 RNZ ;CONT COMMAND
0AF2 1E00 MVI E,ERRNCN-ERRN
0AF4 2A7903 LHLD PROGCNTS
0AF7 7C MOV A,H
0AF8 B5 ORA L
0AF9 CAF105 JZ ERRMSG
0AFC EB XCHG
0AFD 2A7503 LHLD CURLINES
0B00 227303 SHLD CURLINE
0B03 EB XCHG
0B04 C9 RET

RUNSTM:
0B05 CA0205 JZ CLEARSET ;RUN COMMAND
0B08 CD0505 CALL CLEARVST
0B0B 01840A LXI B,EXECUTEL
0B0E C30000 JMP RUNSTMC

ENDSTM:
0B11 CACCOA JZ EXECUTEB ;END STATEMENT
0B14 CDA303 CALL SCANNXTV ;bscan (val)
0B17 8A DB KEYRUN
0B18 C34B00 JMP SYSQUIT

```
; GOSUB/GOTO STATEMENTS
;
GSBSTM:
0B1B 0E03    MVI    C,3      ;GOSUB STATEMENT
0B1D CDD804   CALL   SPACESTK
0B20 C1       POP    B
0B21 E5       PUSH   H
0B22 E5       PUSH   H
0B23 2A7303   LHLD   CURLINE
0B26 E3       XTHL
0B27 168E    MVI    D,KEYGSB      ;MARK STACK WITH GOSUB
0B29 D5       PUSH   D
0B2A 33       INX    SP
RUNSTMC:
0B2B C5       PUSH   B
GTOSTM:
0B2C CD0B04   CALL   SCANLINN     ;GOTO STATEMENT
0B2F D5       PUSH   D
0B30 CD0000   CALL   REMSTM
0B33 D1       POP    D
0B34 E5       PUSH   H
0B35 CD0000   CALL   TRACE
0B38 2A7303   LHLD   CURLINE
0B3B CDC104   CALL   CMHLLTDE
0B3E E1       POP    H
0B3F 23       INX    H
0B40 DC3304   CC     LINESRCL
0B43 D43004   CNC    LINESRCH
0B46 60       MOV    H,B
0B47 69       MOV    L,C
0B48 2B       DCX    H
0B49 D8       RC
ERRAUS:
0B4A 1EC5    MVI    E,ERRNUIS-ERRN
0B4C C3F105   JMP    ERRMSG
;
; RETURN STATEMENT
;
RETSTM:
0B4F C0       RNZ    ;RETURN STATEMENT
0B50 16FF    MVI    D,OFFH
0B52 CDF909   CALL   FORCHK ;KILL ACTIVE FOR LOOPS
0B55 F9       SPHL   ;INSIDE SUBROUTINE
0B56 FE8E    CPI    KEYGSB
0B58 1E76    MVI    E,ERRNRG-ERRN
0B5A C2F105   JNZ    ERRMSG
0B5D D1       POP    D
0B5E CD0000   CALL   TRACE
0B61 EB       XCHG
0B62 227303   SHLD   CURLINE
0B65 21840A   LXI    H,EXECUTEL
0B68 E3       XTHL
; JMP    DATSTM
```

```
; ; DATA/ELSE/REM STATEMENTS
;
DATSTM:
0B69 0E3A    MVI    C,":" ;DATA STATEMENT
0B6B C30000    JMP    SCAN2KEY
ELSSTM:
;
REMSTM:
0B6E 0E00    MVI    C,000H ;REM STATEMENT
SCAN2KEY:
0B70 0600    MVI    B,000H ;SKIP TO KEYWORD IN C
DATRSKST:
0B72 79      MOV    A,C    ;SET UP TERMINATING BYTE
0B73 48      MOV    C,B
0B74 47      MOV    B,A
DATRSKIP:
0B75 7E      MOV    A,M    ;SKIP TO TERMINATING BYTE
0B76 B7      ORA    A
0B77 C8      RZ
0B78 B8      CMP    B
0B79 C8      RZ
0B7A 23      INX    H
0B7B FE22    CPI    '"     ;STRING TO SKIP?
0B7D CA720B    JZ    DATRSKST
0B80 FE8B    CPI    KEYIF
0B82 C2750B    JNZ   DATRSKIP
0B85 14      INR    D     ;COUNT NUMBER OF IFS WE SKIP
0B86 C3750B    JMP    DATRSKIP
;
; PROGRAM BRANCH TRACING
;
TRACE:
0B89 3A6603    LDA    TRACEFLG      ;TRACING?
0B8C B7      ORA    A
0B8D C0      RNZ
0B8E C5      PUSH   B
0B8F D5      PUSH   D     ;SAVE DESTINATION LINE NUMBER
0B90 CD9405    CALL   PRNTCHRI    ;print (val)
0B93 5B      DB    "["     ;LEFT BRACKET
0B94 2A7303    LHLD   CURLINE
0B97 CD0000    CALL   PRINTINT    ;PRINT CURRENT LINE NUMBER
0B9A CD9405    CALL   PRNTCHRI    ;print (val)
0B9D 2C      DB    ","
0B9E E1      POP    H
0B9F E5      PUSH   H
0BA0 CD0000    CALL   PRINTINT    ;PRINT DESTINATION LINE NUMBER
0BA3 CD9405    CALL   PRNTCHRI    ;print (val)
0BA6 5D      DB    "]"     ;RIGHT BRACKET
POPDEBCR:
0BA7 D1      POP    D
0BA8 C1      POP    B
0BA9 C9      RET
```

```
;      ; ASSIGNMENT STATEMENT PROCESSOR
;
;LETSTM:
OBAA CD0000  CALL    VARSCAN ;LET STATEMENT
OBAD CDA303  CALL    SCANNXTV   ;bscan (val)
OBBO B5      DB      KEYEQ
ASSIGNVL:
OBBA 3A6B03  LDA     TYPEFLG
OBBB F5      PUSH   PSW
OBBC D5      PUSH   D
OBBD E5      PUSH   H ;SAVE VARIABLE
OBBE CD0000  CALL    COERCE
OBBC1 C20000 JNZ    LETSTMNM
OBBC4 CD0000  CALL    STRGUNIQ  ;REMOVE CONFLICT PROBLEMS
OBBC7 CD0000  CALL    STRGRELT  ;RELEASE STRING TEMPORARY
OBBCA E1     POP    H ;COPY DESCRIPTOR TO DESTINATION
OBBCB CD0000  CALL    COPYVAL
OBCE E1     POP    H
OBCF C9     RET

LETSTMNM:
OBDO CD0000  CALL    LDMMAC  ;MAKE NUMERIC ASSIGNMENT
OBDD3 D1     POP    D
OBDD4 E1     POP    H
OBDD5 C9     RET

STRGUNIQ:
OBDD6 2A9303 LHLD   ACCUMLTR ;GET STRING DESCRIPTOR
OBDD9 EB      XCHG   ;IS STRING IN STRING SPACE?
OBDA CD0000  CALL    STRGTEST
OBDD D0      RNC
OBDE CDC104  CALL    CMHLLTDE ;VARIABLE REFERENCE?
OBEE D40000  CNC    STRGSTOR ;IF SO, MAKE NEW COPY
OBE4 C9     RET
```

```
; COERCE ACCUMULATOR TO TYPE IN A
;
COERCE:
OBEB CDDC03    CALL    TYPECHK
COERCEF:
OBE8 E20000    JPO    CSINGLE
OBEB CA0000    JZ     CSTRING
OBEE C30000    JMP    ERRATM

VALNUMBR:
OBF1 CD0000    CALL    VALEXPR ;bscan expr
CSINGLE:
OBF4 CDD903    CALL    TYPECHK
OBF7 E0        RPO
OBF8 C30000    JMP    ERRATM

CSTRING:
OBFB CDD903    CALL    TYPECHK
OBFE C8        RZ
OBFF C30000    JMP    ERRATM

ERRATM:
OC02 1EB0      MVI    E,ERRNTM-ERRN
OC04 C3F105    JMP    ERRMSG

VALINTDE:
OC07 CDF10B    CALL    VALNUMBR      ;bscan numbr EVAL POSITIVE INTEGER EXPR
CINTPOS:
OC0A CD0000    CALL    SIGNACC ;CONVERT TO INTEGER
OC0D FA0000    JM     ERRAFC
CINTEGER:
OC10 3A9603    LDA    FLACCEXP
OC13 FE90      CPI    090H
OC15 DA0000    JC     FIXAC
OC18 018090    LXI    B,09080H
OC1B 110000    LXI    D,00000H
OC1E CD0000    CALL    FLCMP
OC21 51        MOV    D,C
OC22 C8        RZ

ERRAFC:
OC23 1E2D      MVI    E,ERRNFC-ERRN
OC25 C3F105    JMP    ERRMSG

VALBYTE2:
OC28 CDA303    CALL    SCANNXTV ;bscan (val)
OC2B 2C        DB     ","
VALBYTE:
OC2C CDF10B    CALL    VALNUMBR      ;bscan numbr EVAL BYTE EXPRESSION
CBYTE:
OC2F CDOA0C    CALL    CINTPOS ;CONVERT ACC TO BYTE
OC32 7A        MOV    A,D
OC33 B7        ORA    A
OC34 C2230C    JNZ    ERRAFC
```

```

0C37 2B      DCX      H
0C38 CDAB03  CALL     SCANNXT ;bscan ,
0C3B 7B      MOV      A,E
0C3C C9      RET

EXECUTE2:
0C3D FEC4    CPI      KEYPORT ;PORT OUTPUT?
0C3F CA0000  JZ      PORSTM
0C42 FEC6    CPI      KEYMEM ;MEMORY ALTERATION?
0C44 CA0000  JZ      MEMSTM

; MID-STRING ASSIGNMENT STATEMENT
;

MIDSTM:
0C47 CDA303  CALL    SCANNXTV ;bscan (val)
0C4A D1      DB      KEYMID ;ENTER POINTING TO "MID$"
0C4B CDA303  CALL    SCANNXTV ;bscan (val)
0C4E 28      DB      "("
0C4F CD0000  CALL    VARSCAN ;SCAN VARIABLE TO UPDATE
0C52 CDFB0B  CALL    CSTRING ;MAKE SURE IT'S A STRING
0C55 D5      PUSH   D ;SAVE REFERENCE
0C56 E5      PUSH   H
0C57 CD0000  CALL    STRGTEST ;WHERE IS STRING NOW?
0C5A D5      PUSH   D ;SHOULDN'T BE IN PROGRAM
0C5B D40000  CNC    STRGSTOR ;OR ELSE WE MODIFY OURSELF
0C5E E1      POP    H
0C5F CD0000  CALL    COPYVAL
0C62 E1      POP    H ;CONTINUE SCAN
0C63 CD280C  CALL    VALBYTE2 ;SCAN STARTING POSITION
0C66 B7      ORA    A
0C67 CA230C  JZ      ERRAFC ;MUST BE NON-ZERO
0C6A D5      PUSH   D
0C6B 1EFF    MVI    E,OFFH
0C6D 7E      MOV    A,M
0C6E FE29    CPI    ")" ;DEFAULT LENGTH?
0C70 C4280C  CNZ    VALBYTE2 ;SCAN LENGTH, IF GIVEN
0C73 CDA303  CALL    SCANNXTV ;bscan (val)
0C76 29      DB      ")"
0C77 C1      POP    B ;CONDENSE STACK
0C78 51      MOV    D,C
0C79 D5      PUSH   D
0C7A CDA303  CALL    SCANNXTV ;bscan (val)
0C7D B5      DB      KEYEQ
0C7E CD0000  CALL    VALEXPR ;bscan expr ;EVALUATE RIGHT HAND SIDE
0C81 226F03  SHLD   SCANPTR1
0C84 CD0000  CALL    LENFCTC ;RELEASE STRING RESOURCE
0C87 4E      MOV    C,M ;AND LOAD DESCRIPTOR
0C88 23      INX    H
0C89 46      MOV    B,M
0C8A D1      POP    D ;GET BACK LENGTH, START
0C8B BB      CMP    E
0C8C D20000  JNC    MIDSTMLN ;LENMOV = MIN(LENI, LENS)
0C8F 5F      MOV    E,A
;

MIDSTMLN:
0C90 E1      POP    H ;RECOVER DESTINATION DESCRIPTOR

```

```
0C91 7E      MOV     A,M      ;GET ITS LENGTH
0C92 15      DCR     D
0C93 92      SUB     D      ;SUBTRACT STARTING POSITION
0C94 DA0000  JC      MIDSTMXT    ;NOTHING TO DO IF BEYOND
```

```
0C97 BB      CMP    E
0C98 D20000  JNC    MIDSTMML
0C9B 5F      MOV    E,A
MIDSTMML:
0C9C C5      PUSH   B      ;SAVE SOURCE ADDRESS
0C9D CD0000  CALL   LDICBMM ;COMPUTE DESTINATION ADDRESS
0CA0 6A      MOV    L,D
0CA1 2600  MVI    H,0
0CA3 09      DAD    B
0CA4 EB      XCHG
0CA5 C1      POP    B
0CA6 CD0000  CALL   COPYSTRG ;COPY STRING
MIDSTMXT:
0CA9 2A6F03  LHLD   SCANPTR1
0CAC C9      RET

;
; LOCATE STRING REFERENCED BY DE
;

STRGTEST:
0CAD D5      PUSH   D      ;DE=STRING REFERENCE
0CAE EB      XCHG
0CAF 23      INX    H      ;GET ADDRESS OF STRING
0CB0 5E      MOV    E,M
0CB1 23      INX    H
0CB2 56      MOV    D,M
0CB3 2A8703  LHLD   FREELIMT ;BOUNDARY
0CB6 CDC104  CALL   CMHLLTDE ;NC = STRING IN PROGRAM
0CB9 D1      POP    D      ;C = STRING IN BUFFER
0CBA C9      RET
```

```

; CASE/CONDITIONAL STATEMENT PROCESSORS
;
ONSTM:
OCBB CD2C0C    CALL  VALBYTE ;ON STATEMENT
OCBE 7E         MOV   A,M
OCBF 47         MOV   B,A
OCC0 FE8E    CPI   KEYGSB ;GOSUB RATHER THAN GOTO?
OCC2 CA0000    JZ    ONNSTMC
OCC5 CDA303    CALL  SCANNXTV ;bscan (val)
OCC8 89         DB    KEYGTO ;MUST BE GOTO...
OCC9 2B         DCX   H
;
ONNSTMC:
OCCA 4B         MOV   C,E
;
ONNSTMSL:
OCCB 0D         DCR   C      ;LOOK FOR RIGHT LINE NUMBER
OCCC 78         MOV   A,B
OCCD CAAC0A    JZ    EXECUTES ;THEN EXECUTE STATEMENT
OCD0 CD0C04    CALL  SCANLINR
OCD3 FE2C         CPI   ","
OCD5 C0         RNZ
OCD6 C3CB0C    JMP   ONNSTMSL

;
IFSTM:
OCD9 CDF10B    CALL  VALNUMBR ;bscan numbr ;IF STATEMENT
OCDC 7E         MOV   A,M
O CDDL FE89    CPI   KEYGTO
OCDL CA0000    JZ    IFNSTMC
OCE2 CDA303    CALL  SCANNXTV ;bscan (val)
OCE5 A0         DB    KEYTHEN
;
IFNSTMC:
OCE6 CD0000    CALL  SIGNACC ;TEST CONDITION
OCE9 C20000    JNZ
OCEC 1601    MVI   D,1
;
IFNSTMSK:
OCEE 0E8C    MVI   C,KEYELS
OCFO CD700B    CALL  SCAN2KEY ;SKIP TO CORRESPONDING ELSE
OCF3 B7         ORA   A
OCF4 C8         RZ
OCF5 CDAB03    CALL  SCANNXT ;bscan +
OCF8 15         DCR   D
OCF9 C2EE0C    JNZ
IFNSTMSK:
OCFC 2B         DCX   H      ;bscan -
OCFD CDAB03    CALL  SCANNXT ;bscan , ;CHOICE MADE
OD00 DA2C0B    JC    GTOSTM ;GOTO A LABEL,
OD03 C3AB0A    JMP   EXECUTEC ;OR EXECUTE A STATEMENT

```

```

;
; PRINT STATEMENT PROCESSOR
;

PRTSTMN:
0D06 FEA5      CPI    KEYTAB ;TAB OPTION?
0D08 CA0000    JZ     PRNTOPTN
0D0B FEA6      CPI    KEYSPEC ;SPACE OPTION?
0D0D CA0000    JZ     PRNTOPTN
0D10 E5        PUSH   H
0D11 FE2C      CPI    ","
0D13 CA0000    JZ     PRNTCOMA
0D16 FE3B      CPI    ";"
0D18 CA0000    JZ     PRNTSEMI
0D1B C1        POP    B
0D1C CD0000    CALL   VALEXPR ;bscan expr
0D1F 2B        DCX   H ;bscan -
0D20 E5        PUSH   H
0D21 CDD903    CALL   TYPECHK
0D24 CA0000    JZ     PRTSTRNG
0D27 CD0000    CALL   VALSTRGN ;CREATE STRING FROM NUMBER
0D2A 2A9303    LHLD   ACCUMLTR ;VERIFY ROOM ENOUGH ON LINE
0D2D 7E        MOV    A,M
0D2E 219903    LXI   H,CURSPOS
0D31 86        ADD    M
0D32 23        INX    H
0D33 86        ADD    M
0D34 DC0000    CC    PRNTCRLF ;NO ROOM, FIND ANOTHER LINE
0D37 CD0000    CALL   PRNTSTRT
0D3A CD9405    CALL   PRNTCHRI ;print (val)
0D3D 20        DB    "
0D3E 3C        INR    A
PRTSTRNG:
0D3F CC0000    CZ    PRNTSTRT ;SEND OUTPUT STRING
0D42 E1        POP    H
0D43 CDAB03    CALL   SCANNXT ;bscan ,
PRTSTM:
0D46 C2060D    JNZ   PRTSTMN ;PRINT STATEMENT
PRNTCRLF:
0D49 CD9405    CALL   PRNTCHRI ;print (val)
0D4C 0D        DB    CR ;PRINT A CR, LF
0D4D CD9405    CALL   PRNTCHRI ;print (val)
0D50 0A        DB    LF
PRNTNULLS:
0D51 3A9803    LDA   NULLCNT ;PRINT NULLS AFTER CR
PRNTNULL:
0D54 3D        DCR   A
0D55 329903    STA   CURSPOS
0D58 C8        RZ
0D59 F5        PUSH   PSW
0D5A AF        XRA   A
0D5B CD9805    CALL   PRNTCHRA ;ac -> screen
0D5E F1        POP    PSW
0D5F C3540D    JMP   PRNTNULL

```

PRNTCOMA:
0D62 3A9903 LDA CURSPOS ;COMMA SEPARATOR
0D65 FE8C CPI LINESIZE/ITEMSIZE-1*ITEMSIZE
0D67 D4490D CNC PRNTCRLF
0D6A D20000 JNC PRNTSEMI
PRNTCOML:
0D6D D60E SUI ITEMSIZE
0D6F D26D0D JNC PRNTCOML
0D72 2F CMA
0D73 C30000 JMP PRNTCOMC

PRNTOPTN:
0D76 F5 PUSH PSW
0D77 CDAB03 CALL SCANNXT ;bscan +
0D7A CD0000 CALL VALPARNs ;GET OPTION PARAMETER
0D7D CDF40B CALL CSINGLE
0D80 CD2FOC CALL CBYTE
0D83 2B DCX H
0D84 F1 POP PSW
0D85 FEA6 CPI KEYSPEC
0D87 E5 PUSH H
0D88 7B MOV A,E
0D89 CA0000 JZ PRNTBLNK
0D8C 3A9903 LDA CURSPOS
0D8F 2F CMA
0D90 83 ADD E
0D91 D20000 JNC PRNTSEMI
PRNTCOMC:
0D94 3C INR A
PRNTBLNK:
0D95 47 MOV B,A ;PAD OUTPUT WITH A BLANKS
0D96 B7 ORA A
0D97 CA0000 JZ PRNTSEMI
0D9A 3E20 MVI A," "
PRNTBLNL:
0D9C CD9805 CALL PRNTCHRA ;ac -> screen
0D9F 05 DCR B
0DA0 C29C0D JNZ PRNTBLNL
PRNTSEMI:
0DA3 E1 POP H
0DA4 CDAB03 CALL SCANNXT ;bscan ,
0DA7 C8 RZ
0DA8 C3060D JMP PRTSTMN

```

PRNTNUMS:
ODAB 23      INX    H      ;SEND STRING TO TRANSMITTER
PRNTMSG:
ODAC C5      PUSH   B
ODAD D5      PUSH   D
ODAE 01A70B   LXI   B,POPDEBCR
ODB1 C5      PUSH   B
ODB2 CD0000   CALL   VALSTRGZ    ;STRING ENDS ON ZERO
PRNTSTRT:
ODB5 CD0000   CALL   STRGRELA
ODB8 CD0000   CALL   LDDCBMM
ODBB 14      INR    D
PRNTSTRL:
ODBC 15      DCR    D
ODBD C8      RZ
ODBE 0A      LDAX   B
ODBF CD9805   CALL   PRNTCHRA    ;ac -> screen
ODC2 FE0D      CPI   CR
ODC4 CC510D   CZ    PRNTNULS
ODC7 03      INX    B
ODC8 C3BC0D   JMP    PRNTSTRL

;
; RETURN CURRENT POSITION ON OUTPUT LINE
;
POSFCT:
ODCB 3A9903   LDA    CURSPOS ;POS FUNCTION
FLOATA:
ODCE 47      MOV    B,A      ;RETURN BYTE ANSWER
ODCF AF      XRA    A
ODD0 C30000   JMP    FLOATTAB

;
; PLOT STATEMENT
;
PLTSTM:
ODD3 CDF10B   CALL   VALNUMBR    ;bscan numbr  ;GET X-COORDINATE
ODD6 CD100C   CALL   CINTEGER
ODD9 D5      PUSH   D
ODDA CDA303   CALL   SCANNXTV   ;bscan (val)
ODDD 2C      DB    ","
ODEE CDF10B   CALL   VALNUMBR    ;bscan numbr  ;GET Y-COORDINATE
ODE1 CD100C   CALL   CINTEGER
ODE4 D5      PUSH   D
ODE5 CDA303   CALL   SCANNXTV   ;bscan (val)
ODE8 2C      DB    ","
ODE9 CDF10B   CALL   VALNUMBR    ;bscan numbr  ;GET OPERATION
ODEC CD100C   CALL   CINTEGER
ODEF 7B      MOV    A,E
ODFO D1      POP    D
ODF1 C1      POP    B
ODF2 E5      PUSH   H
; CALL   SYSPLOT
ODF3 E1      POP    H
ODF4 C9      RET

```

```
; INPUT/READ STATEMENT PROCESSORS
;
MSGQUES:
0DF5 3F3F00    DB      "??",0
MSGREDO:
0DF8 3F5245    DB      "?REDO FROM START",CR,LF,0
0DF8 444F20
0DFE 46524F
0E01 4D2053
0E04 544152
0E07 540DOA
0E0A 00
MSGEXTRA:
0E0B 3F4558    DB      "?EXTRA IGNORED",CR,LF,0
0E0E 545241
0E11 204947
0E14 4E4F52
0E17 45440D
0E1A 0A00
; INPUT
;
INPSTM:
0E1C AF        XRA    A      ;INPUT STATEMENT
0E1D 326503    STA    PRINTFLG   ;TURN ON PRINTING
INPSTMRD:
0E20 E5        PUSH   H      ;SAVE SCAN IN CASE OF ERROR
0E21 0E4E    MVI    C,LINESIZE/2
0E23 CDD804    CALL   SPACESTK
0E26 EB        XCHG
0E27 2A7F03    LHLD   INPTBUFR ;SAVE ADDRESS OF CURRENT BUFFER
0E2A E5        PUSH   H
0E2B 2160FF    LXI    H,0-LINESIZE-3
0E2E 39        DAD    SP
0E2F F9        SPHL   ;AND CREATE A NEW BUFFER
0E30 227F03    SHLD   INPTBUFR
0E33 EB        XCHG
0E34 7E        MOV    A,M
0E35 FE22    CPI    "
0E37 CA0000    JZ     INPSTMNR
0E3A FEA3    CPI    KEYPRM
0E3C 11F60D    LXI    D,MSGQUES+1
0E3F C20000    JNZ    INPSTMN
0E42 CDAB03    CALL   SCANNXT ;bscan +
INPSTMNR:
0E45 CD0000    CALL   VALEXPR ;bscan expr    ;OPTIONAL PROMPT STRING
0E48 CDFB0B    CALL   CSTRING
0E4B CDA303    CALL   SCANNXTV ;bscan (val)
0E4E 3B        DB    ;;
0E4F E5        PUSH   H
0E50 CDB50D    CALL   PRNTSTRT
0E53 E1        POP    H
0E54 11F70D    LXI    D,MSGQUES+2
INPSTMN:
0E57 E5        PUSH   H
0E58 CD0000    CALL   DATAINPT
```

```

OE5B C30000    JMP     REAINPFS

; READ
;
REASTM:
OE5E E5        PUSH    H      ;READ STATEMENT
OE5F 2AD03     LHLD    CURDATAP
OE62 7E        MOV     A,M
OE63 B7        ORA     A
OE64 CC0000    CZ      DATASRCH   ;GET DATA IF NECESSARY

REAINPFS:
OE67 326403    STA     REAINPFL
OE6A C30000    JMP     REAINPLQ

REAINPLP:
OE6D CDA303    CALL    SCANNXTV   ;bscan (val)
OE70 2C        DB      ","
OE71 E3        XTHL
OE72 7E        MOV     A,M
OE73 FE2C     CPI     ","
OE75 C40000    CNZ     DATAGET

REAINPLQ:
OE78 E3        XTHL
OE79 7E        MOV     A,M
OE7A FEA4     CPI     KEYLINE ;LINE OPTION?
OE7C CA0000    JZ      INPSTMNL
OE7F CD0000    CALL    VARSCAN ;FIND NEXT VARIABLE TO BE INPUT
OE82 E3        XTHL   ;SAVE INPUT LIST POINTER
OE83 D5        PUSH    D      ;SAVE VARIABLE POINTER,
OE84 3A6B03    LDA     TYPEFLG ;AND TYPE
OE87 F6        PUSH    PSW
OE88 CD0000    CALL    REAINPDC ;DECODE INPUT

REAINPLA:
OE8B F1        POP     PSW     ;ASSIGN VALUE
OE8C D1        POP     D
OE8D CDDB0B    CALL    ASSIGN
OE90 2B        DCX    H      ;bscan -
OE91 CDAB03    CALL    SCANNXT ;bscan ,
OE94 CA0000    JZ      REAINPCM
OE97 FE2C     CPI     ","     ;DATA ITEMS SEPARATED BY COMMAS
OE99 C20000    JNZ     REAINPER

REAINPCM:
OE9C E3        XTHL
OE9D 2B        DCX    H      ;bscan - ;MORE VARIABLES?
OE9E CDAB03    CALL    SCANNXT ;bscan ,
OEAE C26DOE    JNZ     REAINPLP
OEAF D1        POP     D      ;END OF VARLIST
OEAA 3A6403    LDA     REAINPFL
OEAB B7        ORA     A
OEAC EB        XCHG
OEAD C26205    JNZ     RESDTPTR
OEAE D5        PUSH    D
OEAF F5        PUSH    PSW
OEAF B6        ORA     M
OEBO 210B0E    LXI    H,MSGEXTRA

INPSTMER:

```

| | | |
|-------------|-----|---------|
| 0EB3 C4AC0D | CNZ | PRNTMSG |
| 0EB6 F1 | POP | PSW |

```

INPSTMXT:
OEB7 D1      POP    D      ;RECOVER SCAN POINTER
OEB8 21A000   LXI    H,0+LINESIZE+3
OEBB 39      DAD    SP
OEBc F9      SPHL   ;DEALLOCATE BUFFER
OEBD E1      POP    H
OEBE 227F03   SHLD   INPTBUFR ;AND RESTORE ADDRESS OF OLD
OEC1 EB      XCHG
OEC2 D1      POP    D
OEC3 C8      RZ
OEC4 FACFOA   JM    INPSTMNR ;BREAK TIME...
OEC7 EB      XCHG
OEC8 C3200E   JMP   INPSTMRD ;OR REDO THE INPUT

REAINPER:
OECB 3A6403   LDA   REAINPFL
OECF B7      ORA   A
OECF C2E905   JNZ   ERRDATA
OED2 21F80D   LXI   H,MSGREDO
OED5 3C      INR   A
OED6 F5      PUSH  PSW
OED7 C3B30E   JMP   INPSTMER

; SEARCH FOR DATA STATEMENT
;

DATAGET:
OEDA 3A6403   LDA   REAINPFL
OEDD B7      ORA   A ;READ OR INPUT?
OEE1 11F50D   LXI   D,MSGQUES
OEE1 CA0000   JZ    DATAINPT ;INPUT

DATASRCH:
OEE4 CD690B   CALL  DATSTM ;LOOK FOR NEXT DATA STATEMENT
OEE7 B7      ORA   A
OEE8 C20000   JNZ   DATASRCK
OEEB 23      INX   H
OEEC 7E      MOV   A,M
OEEF 23      INX   H
OEEE B6      ORA   M
OEEF 23      INX   H
OEOF 1E61   MVI   E,ERRNOD-ERRN
OEF2 CAF105   JZ    ERRMSG
OEF5 5E      MOV   E,M
OEF6 23      INX   H
OEF7 56      MOV   D,M
OEF8 EB      XCHG
OEF9 227B03   SHLD  CURLDATA
OEFc EB      XCHG

DATASRCK:
OEFd CDAB03   CALL  SCANNXT ;bscan ,
OFO0 FE80   CPI   KEYDAT
OFO2 C2E40E   JNZ   DATASRCH
OF05 C9      RET

DATAINPT:

```

```
0F06 CD6B07    CALL   INPTRQST
0F09 C8        RZ     ;INPUT OK, RETURN
0F0A C1        POP    B      ;BREAK ***
0F0B C3B70E    JMP    INPSTMXT

REAINPDC:
0F0E CDAB03    CALL   SCANNXT ;bscan ,
0F11 CDD903    CALL   TYPECHK
0F14 7E        MOV    A,M
0F15 C20000    JNZ   DECODE ;READ/INPUT A NUMBER
0F18 FE22        CPI   ''
0F1A CA0000    JZ    VALSTRGC
0F1D 163A        MVI   D,":"
0F1F 062C        MVI   B,"."
0F21 2B        DCX   H
0F22 C30000    JMP   VALSTRGS ;READ/INPUT A STRING

INPSTMNLN:
0F25 3A6403    LDA   REAINPFL ;LINE OPTION VALID ONLY
0F28 B7        ORA   A      ;FOR INPUT STATEMENT
0F29 C2EF05    JNZ   ERRASN
0F2C CDAB03    CALL  SCANNXT ;bscan +
0F2F CD0000    CALL  VARSCAN
0F32 E3        XTHL
0F33 D5        PUSH  D
0F34 3A6B03    LDA   TYPEFLG
0F37 F5        PUSH  PSW
0F38 0600    MVI   B,0
0F3A CD0000    CALL  VALSTRGY ;SWALLOW REST OF INPUT LINE
0F3D C38B0E    JMP   REAINPLA ;AND ASSIGN TO STRING VARIABLE
```

```
;      ; NEXT STATEMENT PROCESSOR
;
NEXSTM:
OF40 110000    LXI    D,0      ;NEXT STATEMENT
NEXSTM1:
OF43 C40000    CNZ    VARSCAN
OF46 227703    SHLD   PROGCNTR
OF49 CDF909    CALL   FORCHK  ;VERIFY WE'RE IN FOR LOOP
OF4C C20000    JNZ    ERRANF
OF4F F9        SPHL   ;BACK UP STACK
OF50 D5        PUSH   D
OF51 7E        MOV    A,M    ;RECOVER SIGN OF STEPSIZE
OF52 23        INX    H
OF53 F5        PUSH   PSW
OF54 D6        PUSH   D
OF55 CD0000    CALL   LDRGACMM ;RECOVER STEP SIZE
OF58 E3        XTHL
OF59 E5        PUSH   H
OF5A CD0000    CALL   FLADDM ;INCREMENT CONTROL VARIABLE
OF5D E1        POP    H
OF5E CD0000    CALL   LDMMAC
OF61 E1        POP    H
OF62 CD0000    CALL   LDRGMM
OF65 E5        PUSH   H
OF66 CD0000    CALL   FLCMP
OF69 E1        POP    H
OF6A C1        POP    B
OF6B 90        SUB    B
OF6C CD0000    CALL   LDRGMM ;RECOVER LINE NUMBR, PROGRAM CNTR
OF6F CA0000    JZ    NEXSTMC ;CHECK LIMIT
OF72 CD890B    CALL   TRACE
OF75 EB        XCHG
OF76 227303    SHLD   CURLINE
OF79 60        MOV    H,B
OF7A 69        MOV    L,C
OF7B C3800A    JMP    FORMARK

ERRANF:
OF7E 1E54        MVI    E,ERRNNF-ERRN
OF80 C3F105      JMP    ERRMSG

NEXSTMC:
OF83 F9        SPHL   ;END OF LOOP...
OF84 2A7703    LHLD   PROGCNTR
OF87 7E        MOV    A,M
OF88 FE2C        CPI    ","
OF8A C2840A    JNZ    EXECUTEL ;MORE INDICES?
OF8D CDAB03    CALL   SCANNXT ;bscan ,
OF90 CD430F    CALL   NEXSTM1
```

```
; EVALUATE AN EXPRESSION
;
VALEXPR:
OF93 2B      DCX     H      ;SCAN & EVALUATE AN EXPRESSION
OF94 1600    MVI     D,0    ;INITIAL PRECEDENCE=0
;
VALEXPRL:
OF96 D5      PUSH    D
OF97 0E01    MVI     C,1
OF99 CDD804   CALL    SPACESTK
OF9C CD0000   CALL    VALPRMRY      ;bscan prmry
OF9F 227103  SHLD   SCANPTR2
;
VALEXPRC:
OFA2 2A7103 LHLD   SCANPTR2
;
VALEXPRD:
OFA5 C1      POP     B      ;PREVIOUS PRECEDENCE
OFA6 78      MOV     A,B
OFA7 FE70    CPI     PREDNUM
OFA9 D4F40B   CNC     CSINGLE
OFAc 7E      MOV     A,M
OFAE 1600    MVI     D,000H
;
VALEXPRR:
OFAF D6B4    SUI     KEYREL ;RELATION?
OFB1 DA0000   JC      VALEXPRO
OFB4 FE03    CPI     KEYFCT-KEYREL
OFB6 D20000   JNC    VALEXPRO
OFB9 FE01    CPI     1      ;YES
OFBB 17      RAL
OFBC AA      XRA     D      ;CONVERT 0,1,2 TO 1,2,4
OFBD BA      CMP     D
OFBE 57      MOV     D,A
OFBF DAEF05   JC      ERRASN
OFC2 226F03   SHLD   SCANPTR1
OFC5 CDAB03   CALL   SCANNXT ;bscan ,
OFC8 C3AF0F   JMP    VALEXPRR
;
VALEXPRO:
OFCB 7A      MOV     A,D
OFCC B7      ORA     A
OFC0 C20000  JNZ    VALREL
OFD0 7E      MOV     A,M
OFD1 226F03  SHLD   SCANPTR1
OFD4 D6AA    SUI     KEYOPR ;OPERATOR?
OFD6 D8      RC
OFD7 FE0A    CPI     KEYREL-KEYOPR
OFD9 D0      RNC
OFDA 5F      MOV     E,A    ;YES
OFD8 CDD903   CALL   TYPECHK ;STRING OPERANDS?
OFG0 B3      ORA     E      ;AND CATENATION OPERATOR?
OFGF 7B      MOV     A,E
OFE0 CA0000   JZ     VALCONCT ;YES
OFE3 83      ADD     E
OFE4 83      ADD     E
OFE5 5F      MOV     E,A
OFE6 218E00   LXI    H,OPRTABL
```

| | | |
|-----------------------|------|-------------------------------------|
| 0FE9 19 | DAD | D |
| 0FEA 78 | MOV | A,B |
| 0FEB 56 | MOV | D,M |
| 0FEC BA | CMP | D |
| 0FED D0 | RNC | |
| 0FEE 23 | INX | H |
| 0FEF CDF40B | CALL | CSINGLE |
| VALEXPR2: | | |
| 0FF2 C5 | PUSH | B ;STACK OPERATION, |
| 0FF3 01A20F | LXI | B,VALEXPRL ;EVALUATE SECOND OPERAND |
| 0FF6 C5 | PUSH | B |
| 0FF7 42 | MOV | B,D |
| 0FF8 4B | MOV | C,E |
| 0FF9 CD0000 | CALL | PUSHAC |
| 0FFC 50 | MOV | D,B |
| 0FFD 59 | MOV | E,C |
| 0FFE 4E | MOV | C,M |
| 0FFF 23 | INX | H |
| 1000 46 | MOV | B,M |
| 1001 C5 | PUSH | B |
| 1002 2A6F03 | LHLD | SCANPTR1 |
| 1005 C3960F | JMP | VALEXPRL |
| ; | | |
| ; EVALUATE A RELATION | | |
| ; | | |
| VALREL: | | |
| 1008 210000 | LXI | H,RELOPR ;SCAN & EVALUATE RELATION |
| 100B 3A6B03 | LDA | TYPEFLG |
| 100E 07 | RLC | |
| 100F 07 | RLC | |
| 1010 07 | RLC | |
| 1011 B2 | ORA | D |
| 1012 5F | MOV | E,A |
| 1013 1664 | MVI | D,PREDREL |
| 1015 78 | MOV | A,B |
| 1016 BA | CMP | D |
| 1017 D0 | RNC | |
| 1018 C3F20F | JMP | VALEXPR2 |
| RELOPRXT: | | |
| 101B 3C | INR | A ;MATCH RESULT OF COMPARISON |
| 101C 8F | ADC | A ;-1,0,1 TO 1,2,4 |
| 101D C1 | POP | B ;VERSUS RELATION TO BE TESTED |
| 101E A0 | ANA | B |
| 101F C6FF | ADI | -1 |
| 1021 9F | SBB | A |
| 1022 C30000 | JMP | FLOATBYT |

RELOPR:
1025 0000 DW RELOPRC ;COMPUTE RELATION
RELOPRC:
1027 79 MOV A,C
1028 C1 POP B
1029 D1 POP D
102A F5 PUSH PSW
102B 0F RRC
102C 0F RRC
102D 0F RRC
102E E60F ANI 00FH
1030 CDE50B CALL COERCE
1033 211B10 LXI H,RELOPRXT
1036 E5 PUSH H
1037 C20000 JNZ FLCMP ;NUMERIC COMPARISON?
103A 3E04 MVI A,TYPESING ;NO, STRING
103C 326B03 STA TYPEFLG
103F D5 PUSH D
1040 CD0000 CALL STRGRELA ;RELEASE TEMP OF SECOND OPERAND
1043 D1 POP D
1044 4E MOV C,M
1045 23 INX H
1046 C5 PUSH B ;SAVE LENGTH
1047 4E MOV C,M
1048 23 INX H
1049 46 MOV B,M
104A C5 PUSH B ;AND ADDRESS
104B CD0000 CALL STRGRELD ;RELEASE TEMP OF FIRST OPERAND
104E CD0000 CALL LDDCBMM
1051 E1 POP H
1052 E3 XTHL
1053 5D MOV E,L
1054 E1 POP H
RELOPRSL:
1055 7B MOV A,E ;COMPARE CHARACTER BY CHARACTER
1056 B2 ORA D
1057 C8 RZ
1058 7B MOV A,E
1059 D601 SUI 1
105B D8 RC
105C AF XRA A
105D BA CMP D
105E 3C INR A
105F D0 RNC
1060 15 DCR D
1061 1D DCR E
1062 0A LDAX B
1063 BE CMP M
1064 23 INX H
1065 03 INX B
1066 CA5510 JZ RELOPRSL
1069 3F CMC
106A C30000 JMP CMPXT

```
; EVALUATE A PRIMARY
;
VALPRMRY:
106D 3E04    MVI    A,TYPESING      ;SCAN & EVALUATE A PRIMARY
106F 326B03   STA    TYPEFLG
1072 CDAB03   CALL   SCANNXT ;bscan ,
1075 DA0000   JC     DECODE ;NUMERIC CONSTANT?
1078 CDBB03   CALL   ALPHACHK
107B DA0000   JC     VALVAR ;VARIABLE?
107E FEAA    CPI    KEYADD
1080 CA6D10   JZ    VALPRMRY
1083 FE2E    CPI    "."
1085 CA0000   JZ    DECODE
1088 FEAB    CPI    KEYSUB
108A CA0000   JZ    VALUMINS
108D FE22    CPI    '\"' ;STRING CONSTANT?
108F CA0000   JZ    VALSTRGC
1092 FEA8    CPI    KEYNOT
1094 CA0000   JZ    VALUNOT
1097 FEA7    CPI    KEYFN ;DEFINED FUNCTION?
1099 CA0000   JZ    VALFCTD
109C FE8B    CPI    KEYIF ;CONDITIONAL EXPRESSION?
109E CA0000   JZ    VALCOND
10A1 D6B7    SUI    KEYFCT ;INTRINSIC FUNCTION?
10A3 D20000   JNC    VALFCTN
;
VALPARNs:
10A6 CDA303   CALL   SCANNXTV ;bscan (val)
10A9 28      DB     "("
;
VALPARN2:
10AA CD930F   CALL   VALEXPR ;bscan expr
10AD CDA303   CALL   SCANNXTV ;bscan (val)
10B0 29      DB     ")"
10B1 C9      RET
;
VALUMINS:
10B2 167D   MVI    D,PREDUMIN ;EVALUATE UNARY MINUS
10B4 CD960F   CALL   VALEXPRL
10B7 2A7103   LHLD   SCANPTR2
10BA E5      PUSH   H
10BB CD0000   CALL   CMACCS
;
VALRETNM:
10BE CDF40B   CALL   CSINGLE
10C1 E1      POP    H
10C2 C9      RET
```

```
; EVALUATE A VARIABLE
;
VALVAR:
10C3 CD0000  CALL  VARSCAN ;SCAN & EVALUATE VARIABLE
10C6 E5      PUSH  H
10C7 D5      PUSH  D
10C8 EB      XCHG
10C9 1ED1    MVI   E,ERRNUV-ERRN
10CB C2F105  JNZ   ERRMSG
10CE 229303  SHLD  ACCUMLTR
10D1 CDD903  CALL  TYPECHK
10D4 EB      XCHG
10D5 219303  LXI   H,ACCUMLTR
10D8 C40000  CNZ   COPYVAL
10DB D1      POP   D
10DC E1      POP   H
10DD C9      RET

;
; EVALUATE CONDITIONAL EXPRESSION
;
VALCOND:
10DE CDAB03  CALL  SCANNXT ;bscan , EVAL CONDITIONAL EXPRESSION
10E1 CDF10B  CALL  VALNUMBR ;bscan numbr
10E4 CDA303  CALL  SCANNXTV ;bscan (val)
10E7 A0      DB    KEYTHEN
10E8 CD0000  CALL  SIGNACC
10EB CA0000  JZ    VALCOND
10EE CD930F  CALL  VALEXPR ;bscan expr ;TRUE, EVALUATE THEN PORTION
10F1 1601    MVI   D,1
VALCNDL:
10F3 0E82    MVI   C,KEYEND
10F5 CD700B  CALL  SCAN2KEY ;SKIP ELSE PORTION
10F8 CDA303  CALL  SCANNXTV ;bscan (val)
10FB 82      DB    KEYEND
10FC 15      DCR   D
10FD C2F310  JNZ   VALCNDL
1100 C9      RET

VALCOND:
1101 1601    MVI   D,1
VALCNDL:
1103 0E8C    MVI   C,KEYELS ;FALSE, SKIP THEN PORTION
1105 CD700B  CALL  SCAN2KEY
1108 CDA303  CALL  SCANNXTV ;bscan (val)
110B 8C      DB    KEYELS
110C 15      DCR   D
110D C20311  JNZ   VALCNDL
1110 CD930F  CALL  VALEXPR ;bscan expr ;EVALUATE ELSE PORTION
1113 CDA303  CALL  SCANNXTV ;bscan (val)
1116 82      DB    KEYEND
1117 C9      RET
```

```
; EVALUATE INTRINSIC FUNCTION
;
VALFCTN:
1118 0600    MVI      B,000H      ;Scan & EVALUATE INTRINSIC FUNCTION CALL
111A 07      RLC
111B 4F      MOV      C,A
111C C5      PUSH     B
111D CDAB03  CALL     SCANNXT ;bscan ,
1120 79      MOV      A,C
1121 FE2F      CPI     KEYLFT-KEYFCT*2-1      ;LEFT$, MID$, or RIGHT$
1123 DA0000  JC      VALFCTR
1126 CDA303  CALL     SCANNXTV      ;bscan (val)
1129 28      DB      "("
112A CD930F  CALL     VALEXPR ;bscan expr
112D CDFB0B  CALL     CSTRING
1130 EB      XCHG
1131 2A9303  LHLD     ACCUMLTR
1134 E3      XTHL     ;PUSH STRING ONTO STACK
1135 C30000  JMP      VALFCTLK

VALFCTR:
1138 CDA610  CALL     VALPARNs      ;EVALUATE ARGUMENT TO FUNCTION
113B E3      XTHL
113C 11BE10  LXI      D,VALRETNM
113F D5      PUSH     D
VALFCTLK:
1140 01AC00  LXI      B,FCTTABL      ;BRANCH TO APPROPRIATE ROUTINE
1143 09      DAD
1144 4E      MOV      C,M
1145 23      INX
1146 66      MOV      H,M
1147 69      MOV      L,C
1148 E9      PCHL     ;CALL FUNCTION
```

```
; PROCESS STRING CONSTANT
;
VALSTRGN:
1149 CD0000 CALL ENCODE ;CREATE STRING FROM NUMBER
VALSTRGZ:
114C 0680 MVI B,080H
114E 2B DCX H
114F C30000 JMP VALSTRGY

VALSTRGC:
1152 0622 MVI B,'" ;SCAN & DECODE A STRING CONSTANT
VALSTRGY:
1154 50 MOV D,B
VALSTRGS:
1155 E5 PUSH H
1156 0EFF MVI C,-1
VALSTRGL:
1158 23 INX H ;FIND STRING LENGTH
1159 7E MOV A,M
115A 0C INR C
115B B7 ORA A
115C CA0000 JZ VALSTRGE
115F BA CMP D
1160 CA0000 JZ VALSTRGE
1163 B8 CMP B
1164 C25811 JNZ VALSTRGL
VALSTRGE:
1167 FE22 CPI ''
1169 CCAB03 CZ SCANNXT
116C E3 XTHL
116D 23 INX H
116E EB XCHG
116F 79 MOV A,C
1170 CD0000 CALL STRSTCDS
1173 EB XCHG
1174 CDADOC CALL STRGTEST ;LOCATE STRING
1177 3F CMC
1178 1F RAR
1179 B0 ORA B
117A F40000 CP STRGSTOR ;MAKE A COPY OF CERTAIN BUFFERS
```

```
: ALLOCATE STRING TEMPORARY
:
STRGALOT:
117D 116C03 LXI D,STRGTMPL ;USE CURRENT DESCRIPTOR
STRGALOU:
1180 D5 PUSH D
1181 3E03 MVI A,TYPESTRG ;RETURN STRING RESULT
1183 326B03 STA TYPEFLG
1186 2A8F03 LHLD STRGTMP ;IN A NEW STRING TEMPORARY
1189 229303 SHLD ACCUMLTR
118C EB XCHG
118D 2A9103 LHLD STRGTLIM ;ANY MORE TEMPORARIES?
1190 CDC104 CALL CMHLLTDE
1193 DA0000 JC ERRAST
1196 EB XCHG
1197 D1 POP D ;GET DESCRIPTOR
1198 CD0000 CALL COPYVAL ;COPY IT
119B 228F03 SHLD STRGTMPP
119E E1 POP H
119F C9 RET

STRGALOV:
11A0 E5 PUSH H
11A1 C38011 JMP STRGALOU

ERRAST:
11A4 1E92 MVI E,ERRNST-ERRN
11A6 C3F105 JMP ERRMSG
```

```
; RELEASE STRING RESOURCES
;
STRGREL:A
11A9 2A9303 LHLD ACCMULTR
STRGRELH:
11AC EB XCHG
STRGRELDD:
11AD CD0000 CALL STRGRELT ;RELEASE TEMPORARY
11B0 EB XCHG
11B1 C0 RNZ ;NOT OUR BOY
11B2 D5 PUSH D
11B3 50 MOV D,B
11B4 59 MOV E,C
11B5 1B DCX D
11B6 4E MOV C,M
11B7 2A8B03 LHLD STRGFREE
11BA CDC104 CALL CMHLLTDE
11BD C27008 JNZ POPHLRET
11C0 47 MOV B,A ;RELEASE STRING SPACE
11C1 09 DAD B
11C2 228B03 SHLD STRGFREE
11C5 E1 POP H
11C6 C9 RET

; RELEASE STRING TEMPORARY
;
STRGRELT:
11C7 2A8F03 LHLD STRGTMPP ;RELEASE STRING TEMPORARY
11CA 2B DCX H
11CB 46 MOV B,M
11CC 2B DCX H
11CD 4E MOV C,M
11CE 2B DCX H
11CF CDC104 CALL CMHLLTDE
11D2 C0 RNZ
11D3 228F03 SHLD STRGTMPP ;RELEASE STRING TEMPORARY
11D6 C9 RET
```

```

;
; EVALUATE A CATENATION
;

VALCONCT:
11D7 C5      PUSH   B      ;EVALUATE A CONCATENATION
11D8 E5      PUSH   H
11D9 2A9303  LHLD   ACCUMLTR    ;SAVE FIRST OPERAND,
11DC E3      XTHL
11DD CD6D10  CALL   VALPRMRY   ;bscan prmry   ;EVALUATE SECOND
11E0 E3      XTHL
11E1 CDFB0B  CALL   CSTRING
11E4 7E      MOV    A,M    ;ADD LENGTHS,
11E5 E5      PUSH   H
11E6 2A9303  LHLD   ACCUMLTR
11E9 E5      PUSH   H
11EA 86      ADD    M
11EB 1E3B  MVI    F,ERRNLS-ERRN
11ED DAF105 JC     ERMSG
11F0 CD0000  CALL   STRNGEN ;AND ALLOCATE OUTPUT STRING
11F3 D1      POP    D
11F4 CDAD11  CALL   STRGRELD  ;RELEASE STRING TEMPORARIES
11F7 E3      XTHL
11F8 CDAC11  CALL   STRGRELH
11FB E5      PUSH   H
11FC 2A6D03  LHLD   STRGTMPA   ;COPY STRINGS TO OUTPUT STRING
11FF EB      XCHG
1200 CD0000  CALL   VALCONCP
1203 CD0000  CALL   VALCONCP
1206 21A50F  LXI    H,VALEXPRD
1209 E3      XTHL
120A E5      PUSH   H
120B C37D11  JMP    STRGALOT

VALCONCP:
120E E1      POP    H      ;COPY STRING FOR CATENATION
120F E3      XTHL
1210 7E      MOV    A,M    ;GET LENGTH,
1211 23      INX    H
1212 4E      MOV    C,M    ;ADDRESS OF STRING
1213 23      INX    H
1214 46      MOV    B,M
1215 6F      MOV    L,A

COPYSTRG:
1216 2C      INR    L      ;COPY A STRING OF LENGTH L
COPYSTRL:
1217 2D      DCR    L      ;FROM BC TO DE
1218 C8      RZ
1219 0A      LDAX   B
121A 12      STAX   D
121B 03      INX    B
121C 13      INX    D
121D C31712  JMP    COPYSTRL

```

```
; DIMENSION STATEMENT PROCESSING
;
DIMSTM:
1220 2B      DCX    H
1221 CDAB03  CALL   SCANNXT ;bscan ,
1224 C8      RZ
1225 CDA303  CALL   SCANNXTV      ;bscan (val)
1228 2C      DB    ","
DIMSTM:
1229 012012  LXI    B,DIMSTM . ;DIM STATEMENT
122C C5      PUSH   B
122D 3E80    MVI    A,080H
122F C30000  JMP    VARSCANI

;
; SCAN A VARIABLE NAME
;
VARSCAN:
1232 AF      XRA    A      ;SCAN FOR VARIABLE
VARSCANI:
1233 326A03  STA    MATDMFLG
1236 0600    MVI    B,0*TYPEDEF
VARSCNDF:
1238 CDBB03  CALL   ALPHACK      ;ENTRY TO SCAN FOR DEFINED FCT
123B D2EF05  JNC    ERRASN
123E B0      ORA    B
123F 47      MOV    B,A
1240 0E3F    MVI    C,"?"
1242 1604    MVI    D,TYPESING    ;ASSUME NUMERIC VARIABLE
1244 CDAB03  CALL   SCANNXT ;bscan ,
1247 DA0000  JC    VARSCAND
124A CDBB03  CALL   ALPHACK
124D D20000  JNC    VARSCANS
VARSCAND:
1250 4F      MOV    C,A
VARSKIPL:
1251 CDAB03  CALL   SCANNXT ;bscan ,      ;SKIP EXTRA ALPHANUMERIC
1254 DA5112  JC    VARSKIPL     ;CHARACTERS IN NAME
1257 CDBB03  CALL   ALPHACK
125A DA5112  JC    VARSKIPL
VARSCANS:
125D D624    SUI    $"      ;STRING VARIABLE?
125F C20000  JNZ    VARNAME
1262 1603    MVI    D,TYPESTRG    ;YES
1264 CDAB03  CALL   SCANNXT ;bscan ,

VARNAME:
1267 78      MOV    A,B      ;TRANSLATE IDENT TO INTERNAL FORM
1268 D640    SUI    "@"      ;DEF/VARIABLE IS FIRST BIT
126A 07      RLC
126B 07      RLC
126C 47      MOV    B,A
126D 79      MOV    A,C      ;SECOND CHAR IS NEXT SIX BITS
126E D630    SUI    "0"
```

```
1270 0F      RRC
1271 0F      RRC
1272 0F      RRC
1273 0F      RRC
1274 4F      MOV    C,A
1275 A8      XRA    B      ;PACK THREE BYTES INTO TWO
1276 E603      ANI    003H
1278 A8      XRA    B
1279 47      MOV    B,A
127A 7A      MOV    A,D
127B 326B03  STA    TYPEFLG
127E A9      XRA    C      ;TYPE IS LAST FOUR BITS
127F E60F      ANI    00FH
1281 A9      XRA    C
1282 4F      MOV    C,A

1283 3A6703  LDA    SCANPFLG
1286 86      ADD    M
1287 FE28      CPI    "("      ;SUBSCRIPTED?
1289 CA0000  JZ     MATSCANP
128C FE5B      CPI    "["      ;BY LEFT BRACKET?
128E CA0000  JZ     MATSCANB
1291 AF      XRA    A
1292 326703  STA    SCANPFLG
1295 E5      PUSH   H

;
; LOOK UP VARIABLE IN TABLE
;

1296 2A8303  LHLD   VARTABLE
1297 VARSCANT:
1299 EB      XCHG
129A 2A8503  LHLD   MATTABLE
129D CDC104  CALL   CMHLLTDE      ;LOOK THROUGH VARIABLE TABLE
12A0 CA0000  JZ     VARSCANF
12A3 1A      LDAX   D
12A4 6F      MOV    L,A
12A5 B9      CMP    C
12A6 13      INX    D
12A7 C20000  JNZ    VARSCANM
12AA 1A      LDAX   D
12AB B8      CMP    B
12AC VARSCANM:
12AD 13      INX    D
12AE CA0000  JZ     VARSCANX
12B0 7D      MOV    A,L
12B1 E60F      ANI    00FH      ;ADDRESS NEXT ENTRY
12B3 6F      MOV    L,A
12B4 2600  MVI    H,O
12B6 19      DAD
12B7 C39912  JMP    VARSCANT

12BA VARSCANF:
12BB C5      PUSH   B      ;NOT FOUND, CREATE ENTRY
12BC 79      MOV    A,C
12BD E60F      ANI    00FH
```

```

12BE C602      ADI      2
12C0 4F        MOV      C,A
12C1 0600      MVI      B,0
12C3 EB        XCHG
12C4 2A8703    LHLD    FREELIMT
12C7 E5        PUSH    H
12C8 09        DAD     B
12C9 C1        POP     B
12CA E5        PUSH    H
12CB CDC704    CALL    COPYCHK ;MOVE ARRAYS FOR SPACE
12CE E1        POP     H
12CF 228703    SHLD    FREELIMT
12D2 60        MOV     H,B
12D3 69        MOV     L,C
12D4 228503    SHLD    MATTABLE      ;ALLOCATE, ZERO ENTRY
                                         VARALLOC:
12D7 2B        DCX    H
12D8 3600      MVI    M,000H
12DA CDC104    CALL   CMHLLTDE
12DD C2D712    JNZ    VARALLOC
12E0 D1        POP     D
12E1 73        MOV     M,E
12E2 23        INX    H
12E3 72        MOV     M,D
12E4 23        INX    H
12E5 EB        XCHG    ;EXIT VARIABLE SCAN
12E6 B3        ORA     E      ;NZ=VAR NOT FOUND, CREATED
                                         VARSCANX:
12E7 E1        POP     H      ;HL=SCAN POINTER
12E8 C9        RET     ;BE=VARIABLE REFERENCE

;
; LOOK UP ARRAY IN TABLE
;

MATSCANB:
12E9 C601      ADI    ']-'[+'(-')      ;(got me?)

MATSCANP:
12EB C601      ADI    ')-'(
12ED E5        PUSH   H      ;SCAN SUBSCRIPT OF VARIABLE
12EE 2A6A03    LHLD   MATDMFLG
12F1 B5        ORA    L
12F2 6F        MOV    L,A
12F3 E3        XTHL   ;SAVE DIMFLAG, CLOSE CHAR, TYPE
12F4 1600      MVI    D,000H
                                         MATSCANL:
12F6 D5        PUSH   D      ;SCAN SUBSCRIPT LIST
12F7 C5        PUSH   B
12F8 CDAB03    CALL   SCANNXT ;bscan ,
12FB CD070C    CALL   VALINTDE ;EVALUATE SUBSCRIPT
12FE C1        POP    B
12FF F1        POP    PSW
1300 EB        XCHG
1301 E3        XTHL
1302 E5        PUSH   H
1303 EB        XCHG
1304 3C        INR    A      ;COUNT NUMBER OF SUBSCRIPTS

```

1305 57 MOV D,A
1306 7E MOV A,M
1307 FE2C CPI ","
1309 CAF612 JZ MATSCANL
130C E3 XTHL
130D 226A03 SHLD MATDMFLG ;RESTORE DIMFLAG, TYPE
1310 7D MOV A,L
1311 E1 POP H
1312 AE XRA M
1313 87 ADD A ;CHECK FOR CORRECT CLOSER
1314 C2EF05 JNZ ERRASN
1317 227103 SHLD SCANPTR2
131A D5 PUSH D
131B 2A8503 LHLD MATTABLE ;LOOK FOR NAME IN
131E C30000 JMP MATSCANO ;MAT VARIABLE TABLE

MATSANN:
1321 19 DAD D
MATSANO:
1322 EB XCHG
1323 2A8703 LHLD FREELIMT
1326 EB XCHG
1327 CDC104 CALL CMHLLTDE
132A CA0000 JZ MATSCANC
132D 7E MOV A,M
132E B9 CMP C
132F 23 INX H
1330 C20000 JNZ MATSCANM
1333 7E MOV A,M
1334 B8 CMP B

MATSANM:
1335 23 INX H
1336 5E MOV E,M
1337 23 INX H
1338 56 MOV D,M
1339 23 INX H
133A C22113 JNZ MATSCANN
133D 3A6A03 LDA MATDMFLG ;NAME FOUND
1340 B7 ORA A
1341 1E10 MVI E,ERRNDD-ERRN
1343 FAF105 JM ERRMSG
1346 F1 POP PSW ;RIGHT NUMBER OF SUBSCRIPTS?
1347 BE CMP M
1348 CA0000 JZ MATSCANI

ERRABS:
134B 1E9F MVI E,ERRNBS-ERRN
134D C3F105 JMP ERRMSG

MATSANC:
1350 79 MOV A,C ;NAME NOT FOUND, CREATE NEW ENTRY
1351 E60F ANI 00FH
1353 5F MOV E,A
1354 1600 MVI D,0
1356 71 MOV M,C
1357 23 INX H
1358 70 MOV M,B
1359 23 INX H

135A F1 POP PSW
135B 326903 STA MATSCCNT
135E 4F MOV C,A
135F CDD804 CALL SPACESTK
1362 226F03 SHLD SCANPTR1
1365 23 INX H
1366 23 INX H ;plus 2
1367 41 MOV B,C
1368 70 MOV M,B
1369 23 INX H
MATSCNSB:
136A 3A6A03 LDA MATDMFLG ;SET SUBSCRIPT RANGES
136D B7 ORA A
136E 78 MOV A,B
136F 010B00 LXI B,11 ;DEFAULT RANGE=0-10
1372 F20000 JP MATCNSD
1375 C1 POP B
1376 03 INX B
MATCNSD:
1377 71 MOV M,C
1378 23 INX H
1379 70 MOV M,B
137A 23 INX H
137B F5 PUSH PSW
137C E5 PUSH H
137D CD0000 CALL MUL16 ;UPDATE ARRAY SIZE
1380 EB XCHG H
1381 E1 POP B
1382 C1 POP B
1383 05 DCR B
1384 C26A13 JNZ MATCNSB
1387 42 MOV B,D
1388 4B MOV C,E
1389 EB XCHG ;ALLOCATE ARRAY,
138A 19 DAD D
138B DA4B13 JC ERRABS
138E CDE504 CALL SPACECHK
1391 228703 SHLD FREELIMT
MATSCANZ:
1394 2B DCX H ;AND ZERO
1395 3600 MVI M,000H
1397 CDC104 CALL CMHLLTDE
139A C29413 JNZ MATSCANZ
139D 03 INX B ;SAVE ENTRY SIZE
139E 67 MOV H,A
139F 3A6A03 LDA MATDMFLG
13A2 B7 ORA A
13A3 3A6903 LDA MATSCCNT
13A6 6F MOV L,A
13A7 29 DAD H
13A8 09 DAD B
13A9 EB XCHG
13AA 2A6F03 LHLD SCANPTR1 ;AT BEGINNING OF ENTRY
13AD 73 MOV M,E
13AE 23 INX H
13AF 72 MOV M,D

```
13B0 23      INX      H
13B1 FA0000   JM       MATSCANX    ;DIM ONLY?
                MATSCANI:
13B4 23      INX      H      ;INITIALIZE SUBSCRIPT COMPUTATION
13B5 010000   LXI      B,0
13B8 C30000   JMP       MATSCANS
                MATSCANR:
13BB E1      POP      H      ;COMPUTE SPECIFIC REFERENCE
                MATSCANS:
13BC 5E      MOV      E,M
13BD 23      INX      H
13BE 56      MOV      D,M
13BF 23      INX      H
13C0 E3      XTHL
13C1 F5      PUSH     PSW
13C2 CDC104  CALL     CMHLLTDE
13C5 D24B13  JNC      ERRABS
13C8 E5      PUSH     H
13C9 CD0000  CALL     MUL16
13CC D1      POP      D
13CD 19      DAD      D
13CE F1      POP      PSW
13CF 3D      DCR      A
13D0 44      MOV      B,H
13D1 4D      MOV      C,L
13D2 C2BB13  JNZ      MATSCANR
13D5 3A6B03  LDA      TYPEFLG
13D8 5F      MOV      E,A
13D9 1600  MVI      D,0
13DB CD0000  CALL     MUL16    ;MULTIPLY BY ENTRY SIZE
13DE C1      POP      B
13DF 09      DAD      B
13E0 EB      XCHG
                MATSCANX:
13E1 2A7103  LHLD     SCANPTR2
13E4 CDAB03  CALL     SCANNXT ;bscan ,
13E7 BF      CMP      A
13E8 C9      RET
                MUL16:
13E9 210000  LXI      H,0      ;MULTIPLY BC*DE GIVING HL
13EC 78      MOV      A,B
13ED B1      ORA      C
13EE C8      RZ
13EF 3E10  MVI      A,16
                MUL16LP:
13F1 29      DAD      H
13F2 DA4B13  JC       ERRABS
13F5 EB      XCHG
13F6 29      DAD      H
13F7 EB      XCHG
13F8 D20000  JNC      MUL16XT
13FB 09      DAD      B
13FC DA4B13  JC       ERRABS
                MUL16XT:
13FF 3D      DCR      A
```

1400 C2F113 JNZ MUL16LP
1403 C9 RET

```
; USER-DEFINED FUNCTION DEFINITION
;
DEFSTM:
1404 CD0000 CALL SCANFNN ;DEF STATEMENT
1407 E5 PUSH H ;CHECK IF IN DIRECT MODE
1408 2A7303 LHLD CURLINE ;Z=DIRECT MODE
140B 23 INX H
140C 7C MOV A,H
140D B5 ORA L
140E E1 POP H
140F CA0000 JZERRAID
1412 EB XCHG ;SAVE REFERENCE TO DEFINITION
1413 73 MOV M,E
1414 23 INX H
1415 72 MOV M,D
1416 EB XCHG
1417 7E MOV A,M
1418 FE28 CPI "(" ;CHECK FOR VARLIST
DEFSTM:
141A C2690B JNZ DATSTM
141D CDAB03 CALL SCANNXT ;bscan ,
1420 CD3212 CALL VARSCAN ;DEFINE VARIABLES IN LIST
1423 7E MOV A,M
1424 FE2C CPI ","
1426 C31A14 JMP DEFSTM

; USER-DEFINED FUNCTION EVALUATION
;
VALFCTD:
1429 CD0000 CALL SCANFNN SCAN ;& EVALUATE USER DEFINED FUNCTION
142C 3A6B03 LDA TYPEFLG ;SAVE TYPE OF FUNCTION
142F B7 ORA A
1430 F5 PUSH PSW
1431 E5 PUSH H ;SAVE CALL ARGUMENTS
1432 EB XCHG
1433 7E MOV A,M
1434 23 INX H
1435 66 MOV H,M ;FETCH FUNCTION DEFINITION
1436 6F MOV L,A
1437 B4 ORA H
1438 1EB5 MVI E,ERRNUF-ERRN
143A CAF105 JZERRMSG ;MUST BE DEFINED ...
```

```
143D 7E      MOV    A,M
143E FE28      CPI    "(" ;PARAMETERS NEEDED?
1440 C20000    JNZ    VALFCTNA ;APPARENTLY NOT
1443 CDAB03    CALL   SCANNXT ;bscan ,
1446 E3        XTHL
1447 CDA303    CALL   SCANNXTV ;bscan (val)
144A 28        DB     "(" ;MUST BE PARAMETERS IN CALL
144B E3        XTHL
144C C30000    JMP    VALFCTDM

; ARGUMENT SCANNING
;

VALFCTDL:
144F CDA303    CALL   SCANNXTV ;bscan (val)
1452 2C        DB     "," ;COMMAS BETWEEN ARGUMENTS
1453 E3        XTHL
1454 CDA303    CALL   SCANNXTV ;bscan (val)
1457 2C        DB     "," ;AND BETWEEN PARAMETERS

VALFCTDM:
1458 0E04      MVI    C,4 ;VERIFY SPACE ON STACK
145A CDD804    CALL   SPACESTK
145D 3EAB      MVI    A,SCANPFLD ;SCAN NEXT PARAMETER
145F 326703    STA    SCANPFLG
1462 CDC310    CALL   VALVAR ;GET CURRENT VALUE OF PARAMETER
1465 226F03    SHLD  SCANPTR1 ;SAVE PARAMETER SCAN
1468 E1        POP   H
1469 227103    SHLD  SCANPTR2 ;SAVE ARGUMENT SCAN
146C CDD903    CALL   TYPECHK
146F CA0000    JZ    VALFCTPS ;PUSH STRINGS DIFFERENTLY
1472 CD0000    CALL   PUSHAC1 ;PUSH NUMERIC ACCUMULATOR
1475 E5        PUSH  H ;SAVE VARIABLE'S ADDRESS
1476 C30000    JMP    VALFCTPT

VALFCTPS:
1479 CDA011    CALL   STRGALOV ;COPY DESCRIPTOR TO TEMPORARY
147C AF        XRA   A ;ELIMINATE ORIGINAL DESCRIPTOR
147D 1B        DCX   D
147E 1B        DCX   D
147F 1B        DCX   D ;plus 3
1480 12        STAX  D
1481 2A9303    LHLD  ACCUMLTR ;GET ADDRESS OF DESCRIPTOR
1484 E5        PUSH  H
1485 D5        PUSH  D ;PUT IT BACK HERE LATER
```

```
VALFCTPT:  
1486 3A6B03 LDA TYPEFLG ;SAVE TYPE OF PARAMETER  
1489 37 STC  
148A D1 POP D  
148B D5 PUSH D ;GET COPY OF ADDRESS  
148C F5 PUSH PSW  
148D 2A6F03 LHLD SCANPTR1 ;SAVE PARAMETER SCAN  
1490 E5 PUSH H  
1491 2A7103 LHLD SCANPTR2  
1494 CDB10B CALL ASSIGNVL ;UPDATE VALUE OF PARAMETER  
1497 7E MOV A,M  
1498 FE29 CPI ")"  
149A C24F14 JNZ VALFCTDL ;MORE ARGUMENTS  
149D CDAB03 CALL SCANNXT ;bscan ,  
14A0 E3 XTHL  
14A1 CDA303 CALL SCANNXTV ;bscan (val)  
14A4 29 DB ")" ;MUST BE END OF PARAMETERS TOO  
  
; EVALUATE EXPRESSION  
;  
VALFCTNA:  
14A5 CDA303 CALL SCANNXTV ;bscan (val)  
14A8 B5 DB KEYEQ ;LOOK FOR EQUALS SIGN  
14A9 CD930F CALL VALEXPR ;bscan expr ;EVALUATE FUNCTION  
14AC 2B DCX H  
14AD CDAB03 CALL SCANNXT ;bscan ,  
14B0 C2EF05 JNZ ERRASN  
14B3 E1 POP H  
14B4 226F03 SHLD SCANPTR1  
14B7 CDD903 CALL TYPECHK  
14BA C20000 JNZ VALFCTRL  
14BD CDD60B CALL STRGUNIQ  
14C0 EB XCHG  
14C1 229303 SHLD ACCUMLTR
```

```
; RESTORE PARAMETERS
;
VALFCTRL:
14C4 F1      POP    PSW      ;RESTORE VALUES OF PARAMETERS
14C5 D20000  JNC    VALFCTCR
14C8 E1      POP    H
14C9 CDDC03  CALL   TYPECHKA
14CC CA0000  JZ     VALFCTRS
14CF C1      POP    B
14D0 D1      POP    D
14D1 73      MOV    M,E      ;RESTORE NUMERIC VALUE
14D2 23      INX    H
14D3 72      MOV    M,D
14D4 23      INX    H
14D5 71      MOV    M,C
14D6 23      INX    H
14D7 70      MOV    M,B
14D8 C3C414  JMP    VALFCTRL

VALFCTRS:
14DB D1      POP    D      ;RESTORE STRING VALUE
14DC EB      XCHG
14DD 228F03  SHLD   STRGTMPP      ;DEALLOCATE TEMPORARY
14E0 EB      XCHG
14E1 0603  MVI   B,TYPESTRG
14E3 CD0000  CALL   COPYVALL
14E6 C3C414  JMP    VALFCTRL

VALFCTCR:
14E9 2A6F03  LHLD   SCANPTR1      ;COERCE RESULT TO CORRECT TYPE
14EC CDDC03  CALL   TYPECHKA
14EF C2E80B  JNZ    COERCEF
14F2 CDFB0B  CALL   CSTRING ;STRING FUNCTION
14F5 E5      PUSH   H
14F6 2A9303  LHLD   ACCUMLTR
14F9 EB      XCHG
14FA CDC711  CALL   STRGRELT
14FD C38011  JMP    STRGALOU

ERRAID:
1500 1E1A  MVI   E,ERRNID-ERRN
1502 C3F105 JMP   ERRMSG

SCANFNN:
1505 CDA303  CALL   SCANNXTV      ;bscan (val)
1508 A7      DB    KEYFN
1509 3EAB  MVI   A,SCANPFLD
150B 326703  STA    SCANPLG
150E 0620  MVI   B,TYPEDEF
1510 C33812  JMP   VARSCNDF
```

```
; GENERATE A NEW CURRENT STRING
;
STRNGEN:
1513 CD0000 CALL STRGALOC ;GENERATE A NEW STRING,
;STRSTCDS:
1516 216C03 LXI H,STRGTMPL ;SET CURRENT STRING DESCRIPTOR
1519 E5 PUSH H
151A 77 MOV M,A
151B 23 INX H
151C 73 MOV M,E
151D 23 INX H
151E 72 MOV M,D
151F E1 POP H
1520 C9 RET

; ALLOCATE STORAGE IN STRING SPACE
;
STRGALOC:
1521 B7 ORA A ;ALLOCATE SPACE FOR STRING,
1522 C30000 JMP STRGALAH ;SIZE IN A
;STRGALAG:
1525 F1 POP PSW ;ENTER FOR SECOND TRY
STRGALAH:
1526 F5 PUSH PSW
1527 2A8903 LHLD STCKBASE
152A EB XCHG
152B 2A8B03 LHLD STRGFREE
152E 2F CMA
152F 4F MOV C,A
1530 06FF MVI B,0FFH
1532 09 DAD B
1533 23 INX H
1534 CDC104 CALL CMHLLTDE
1537 DA0000 JC STRGALGC
153A 228B03 SHLD STRGFREE
153D 23 INX H
153E EB XCHG ;RETURNS: DE=STRING ADDRESS
;POPAFRET:
153F F1 POP PSW
1540 C9 RET

;STRGALGC:
1541 F1 POP PSW ;COLLECT GARBAGE IN STRING SPACE
1542 1E85 MVI E,ERRNOS-ERRN
1544 CAF105 JZ ERRMSG
1547 BF CMP A
1548 F5 PUSH PSW
1549 012515 LXI B,STRGALAG ;THEN TRY ALLOCATION
154C C5 PUSH B
```

```

;
; COLLECT GARBAGE IN STRING SPACE
;

STRGGBCL:
154D 2A8D03 LHLD STRGBASE      ;MAKE ALL STRINGS UNSAFE
STRGGLP:
1550 228B03 SHLD STRGFREE      ;FIND HIGHEST UNSAFE STRING
1553 210000 LXI H,0
1556 E5 PUSH H
1557 2A8903 LHLD STCKBASE
155A E5 PUSH H
155B 2A8D03 LHLD STRGBASE      ;SCAN TEMPORARIES,
155E 23 INX H

STRGGBTL:
155F EB XCHG
1560 2A8F03 LHLD STRGTMPP
1563 EB XCHG
1564 CDC104 CALL CMHLLTDE
1567 015F15 LXI B,STRGGBTL
156A C20000 JNZ STRGGBHI
156D 2A8303 LHLD VARTABLE      ;SCAN REGULAR VARIABLES,
STRGGBVR:
1570 EB XCHG
1571 2A8503 LHLD MATTABLE
1574 EB XCHG
1575 CDC104 CALL CMHLLTDE
1578 CA0000 JZ STRGGNAV
157B 7E MOV A,M
157C 23 INX H
157D E60F ANI 00FH
157F D603 SUI TYPESTRG
1581 5F MOV E,A
1582 9F SBB A
1583 57 MOV D,A
1584 7E MOV A,M
1585 23 INX H
1586 E680 ANI 080H      ;DEFINITIONS ARE STRINGS
1588 19 DAD D
1589 B3 ORA E
158A CD0000 CALL STRGGBHV
158D C37015 JMP STRGGBVR

STRGGBAL:
1590 C1 POP B
STRGGNAV:
1591 EB XCHG      ;SCAN ARRAY VARIABLES
1592 2A8703 LHLD FREELIMT
1595 EB XCHG
1596 CDC104 CALL CMHLLTDE
1599 CA0000 JZ STRGGBMV
159C CD0000 CALL LDRGMM
159F 7B MOV A,E
15A0 E5 PUSH H
15A1 09 DAD B
15A2 E60F ANI 00FH

```

| | | |
|-------------|------|------------------------------------|
| 15A4 FE03 | CPI | TYPESTRG |
| 15A6 C29015 | JNZ | STRGGBAL |
| 15A9 226F03 | SHLD | SCANPTR1 |
| 15AC E1 | POP | H |
| 15AD 4E | MOV | C,M |
| 15AE 0600 | MVI | B,000H |
| 15B0 09 | DAD | B |
| 15B1 09 | DAD | B |
| 15B2 23 | INX | H |
| STRGGBAS: | | |
| 15B3 EB | XCHG | ;LOOK THROUGH ENTIRE ARRAY |
| 15B4 2A6F03 | LHLD | SCANPTR1 |
| 15B7 EB | XCHG | |
| 15B8 CDC104 | CALL | CMHLLTDE |
| 15BB CA9115 | JZ | STRGGNAV |
| 15BE 01B315 | LXI | B,STRGGBAS |
| STRGGBH1: | | |
| 15C1 C5 | PUSH | B ;COMPARE THIS STRING ADDR TO MAX |
| 15C2 AF | XRA | A |
| STRGGBH1V: | | |
| 15C3 4E | MOV | C,M ;LOAD STRING DESCRIPTOR |
| 15C4 23 | INX | H |
| 15C5 5E | MOV | E,M |
| 15C6 23 | INX | H |
| 15C7 56 | MOV | D,M |
| 15C8 23 | INX | H |
| 15C9 C0 | RNZ | ;NOT A STRING VARIABLE |
| 15CA 79 | MOV | A,C |
| 15CB B7 | ORA | A ;CHECK FOR ZERO LENGTH |
| 15CC C8 | RZ | |
| 15CD 44 | MOV | B,H ;ALREADY SAFE? |
| 15CE 4D | MOV | C,L |
| 15CF 2A8B03 | LHLD | STRGFREE |
| 15D2 CDC104 | CALL | CMHLLTDE |
| 15D5 60 | MOV | H,B |
| 15D6 69 | MOV | L,C |
| 15D7 D8 | RC | |
| 15D8 E1 | POP | H ;COMPARE WITH HIGHEST UNSAFE |
| 15D9 E3 | XTHL | |
| 15DA CDC104 | CALL | CMHLLTDE |
| 15DD E3 | XTHL | |
| 15DE E5 | PUSH | H |
| 15DF 60 | MOV | H,B |
| 15E0 69 | MOV | L,C |
| 15E1 D0 | RNC | |
| 15E2 C1 | POP | B ;SAVE NEW HIGHEST UNSAFE ADDR |
| 15E3 F1 | POP | PSW |
| 15E4 F1 | POP | PSW |
| 15E5 E5 | PUSH | H |
| 15E6 D5 | PUSH | D |
| 15E7 C5 | PUSH | B |
| 15E8 C9 | RET | |

STRGGBMV:

```
15E9 D1      POP    D      ;MAKE HIGHEST UNSAFE SAFE
15EA E1      POP    H
15EB 7D      MOV    A,L
15EC B4      ORA    H
15ED C8      RZ     ;ANY UNSAFE?
15EE 2B      DCX    H      ;LOAD DESCRIPTOR
15EF 46      MOV    B,M
15F0 2B      DCX    H
15F1 4E      MOV    C,M
15F2 E5      PUSH   H
15F3 2B      DCX    H
15F4 6E      MOV    L,M    ;FIND END OF STRING
15F5 2600    MVI    H,000H
15F7 09      DAD    B
15F8 50      MOV    D,B
15F9 59      MOV    E,C
15FA 2B      DCX    H
15FB 44      MOV    B,H
15FC 4D      MOV    C,L
15FD 2A8B03  LHLD   STRGFREE    ;COPY IT TO END OF SAFE AREA
1600 CDCA04  CALL   COPYTEXT
1603 E1      POP    H
1604 71      MOV    M,C
1605 23      INX    H
1606 70      MOV    M,B
1607 60      MOV    H,B
1608 69      MOV    L,C
1609 2B      DCX    H
160A C35015  JMP    STRGGBLP    ;EXTEND SAFE AREA
```

```
; VARIOUS NUMERIC/STRING CONVERSION FUNCTIONS
;

; FIND LENGTH OF STRING
;

LENFCT:
160D 01CE0D LXI B,FLOATA ;LEN FUNCTION
1610 C5 PUSH B

LENFCTC:
1611 CDFB0B CALL CSTRING
1614 CDA911 CALL STRGRELA
1617 3E04 MVI A,TYPESING
1619 326B03 STA TYPEFLG
161C 7E MOV A,M
161D B7 ORA A
161E 23 INX H
161F C9 RET

;

; CONVERT CHARACTER TO BYTE
;

ASCFCT:
1620 CD1116 CALL LENFCTC ;ASC FUNCTION
1623 CA230C JZ ERRafc
1626 4E MOV C,M ;FETCH ADDRESS
1627 23 INX H
1628 46 MOV B,M
1629 0A LDAX B ;THEN THE FIRST CHARACTER
162A C3CE0D JMP FLOATA

;

; CONVERT BYTE TO CHARACTER
;

CHRFCT:
162D 3E01 MVI A,1 ;CHR$ FUNCTION
162F CD1315 CALL STRNGEN
1632 CD2FOC CALL CBYTE
1635 2A6D03 LHLD STRGTMPA
1638 73 MOV M,E

VALRETST:
1639 C1 POP B ;STRING FUNCTION, REMOVE CSINGLE
163A C37D11 JMP STRGALOT
```

```
; ; DECODE NUMBER FROM STRING
;
;VALFCT:
163D CD1116  CALL    LENFCTC ;VAL FUNCTION
1640 CA0000  JZ     ZEROAC
1643 5F      MOV     E,A
1644 1600  MVI     D,0
1646 4E      MOV     C,M
1647 23      INX     H
1648 46      MOV     B,M
1649 C5      PUSH    B
164A 60      MOV     H,B
164B 69      MOV     L,C
164C 19      DAD     D
164D 46      MOV     B,M
164E 72      MOV     M,D
164F E3      XTHL
1650 C5      PUSH    B
1651 7E      MOV     A,M
1652 CD0000  CALL    DECODE
1655 C1      POP     B
1656 E1      POP     H
1657 70      MOV     M,B
1658 C9      RET

;
; ENCODE NUMBER IN STRING
;
;STRFCT:
1659 CDF40B  CALL    CSINGLE ;STR$ FUNCTION
165C CD4911  CALL    VALSTRGN ;CREATE STRING FROM NUMBER
165F CDA911  CALL    STRGRELA
1662 013916  LXI    B,VALRETST
1665 C5      PUSH    B
1666 EB      XCHG
;STRGSTOR:
1667 EB      XCHG
1668 7E      MOV     A,M    ;STORE STRING INTO STRING SPACE,
1669 E5      PUSH    H      ;LEAVE DESCRIPTOR IN STRGTM
166A CD2115  CALL    STRGALOC
166D E1      POP     H
166E CD0000  CALL    LDICBMM ;LOAD BUFFER ADDRESS
1671 CD1615  CALL    STRSTCDS
1674 E5      PUSH    H
1675 6F      MOV     L,A
1676 CD1612  CALL    COPYSTRG
;POPDERET:
1679 D1      POP     D
167A C9      RET
```

```
; CONVERT HEX STRING TO NUMBER
;
HXVFCT:
167B CD1116 CALL LENFCTC ;DO INITIAL PROCESSING
167E CA0000 JZ ZEROAC
1681 5F MOV E,A
1682 4E MOV C,M
1683 23 INX H
1684 46 MOV B,M
1685 210000 LXI H,0 ;INITIAL OUTPUT TO ZERO
HXVFCTL:
1688 0A LDAX B ;FETCH CHARACTER
1689 03 INX B
168A FE3A CPI ":" ; VERIFY THAT IT'S HEX
168C D40000 CNC HXVFCTCH
168F D2230C JNC ERRafc ;IF NOT, COMPLAIN
1692 D630 SUI "0"
1694 DA230C JC ERRafc ;MUST BE AT LEAST ZERO
1697 29 DAD H
1698 29 DAD H ;INCORPORATE NEW DIGIT
1699 29 DAD H
169A 29 DAD H
169B B5 ORA L
169C 6F MOV L,A
169D 1D DCR E ;COUNT DIGITS
169E C28816 JNZ HXVFCTL
FLOATHL:
16A1 7C MOV A,H ;CONVERT INTEGER IN HL TO FLOAT
16A2 45 MOV B,L
16A3 C30000 JMP FLOATAB

HXVFCTCH:
16A6 CDBC03 CALL ALPHACHA ;CONVERT ANY ALPHA TO UPPER
16A9 D0 RNC
16AA D607 SUI 'A-'9-1 ; MOVE ALPHA TO AFTER DIGITS
16AC FE40 CPI '0+16 ;SET FLAGS CORRECTLY
16AE C9 RET
```

```
;      ; CONVERT BYTE TO TWO HEX CHARACTERS
;
HEXFCT:
16AF 3E02    MVI   A,2      ;ALLOCATE OUTPUT STRING
16B1 CD1315    CALL  STRNGEN
16B4 3A9603    LDA   FLACCEXP
16B7 CD0000    CALL  FIXAC  ;GET INPUT BYTE
16BA 213916    LXI   H,VALRETST
16BD E5        PUSH  H
16BE 2A6D03    LHLD  STRGTMPA
16C1 CD0000    CALL  HEXFCTL
HEXFCTL:
16C4 7B        MOV   A,E      ;CONVERT ONE DIGIT
16C5 07        RLC
16C6 07        RLC
16C7 07        RLC
16C8 07        RLC
16C9 5F        MOV   E,A
16CA E60F    ANI   00FH
16CC FEOA    CPI   10
16CE 3F        CMC
16CF CE30    ACI   "0"      ;CONVERT TO CHARACTER FORM
16D1 27        DAA
16D2 77        MOV   M,A
16D3 23        INX   H
16D4 C9        RET

;
;      ; TRANSLATE STRING TO UPPER CASE
;
UPRFCT:
16D5 CDFB0B    CALL  CSTRING
16D8 2A9303    LHLD  ACCUMLTR      ;GET LENGTH OF OPERAND
16DB E5        PUSH  H
16DC 7E        MOV   A,M
16DD CD1315    CALL  STRNGEN ;ALLOCATE OUTPUT STRING
16E0 D1        POP   D
16E1 CDAD11    CALL  STRGRELD      ;RELEASE INPUT STRING
16E4 CD0000    CALL  LDDCBMM
16E7 2A6D03    LHLD  STRGTMPA
16EA 14        INR   D
UPRFCTL:
16EB 15        DCR   D      ;TRANSLATE WHILE COPYING
16EC CA3916    JZ    VALRETST    ;DONE
16EF 0A        LDAX  B
16F0 CDBC03    CALL  ALPHACHA      ;CONVERT LOWER TO UPPER
16F3 77        MOV   M,A
16F4 03        INX   B
16F5 23        INX   H
16F6 C3EB16    JMP   UPRFCTL
```

```
; SUBSTRING FUNCTIONS
;
LFTFCT:
16F9 CD0000 CALL LEFRIGAR ;LEFT$ FUNCTION
16FC AF XRA A ;LEFT(X,N)=MID(X,1,N)
LEFRIGMR:
16FD E3 XTHL
16FE 4F MOV C,A ;C=START-1, B=LEN
LEFRIGMD:
16FF E5 PUSH H ;RESOLVE DESIRED LEN WITH STRING
1700 7E MOV A,M
1701 B8 CMP B
1702 DA0000 JC LEFRIGMC
1705 78 MOV A,B
1706 C30000 JMP LEFRIGMB

LEFRIGAR:
1709 EB XCHG ;INITIAL COMMON PROCESSING
170A CD280C CALL VALBYTEZ ;FOR LEFT$, RIGHT$
170D 43 MOV B,E
170E CDA303 CALL SCANNXTV ;bscan (val)
1711 29 DB ")"
1712 C9 RET

LEFRIGMC:
1713 0E00 MVI C,0
LEFRIGMB:
1715 C5 PUSH B
1716 CD2115 CALL STRGALOC ;ALLOCATE ANSWER STRING
1719 C1 POP B
171A E1 POP H
171B E5 PUSH H
171C 23 INX H
171D 46 MOV B,M ;COMPUTE ADDRESSES FOR COPY
171E 23 INX H
171F 66 MOV H,M
1720 68 MOV L,B ;(from HL,MB)
1721 0600 MVI B,0
1723 09 DAD B
1724 44 MOV B,H
1725 4D MOV C,L
1726 CD1615 CALL STRSTCDS
1729 6F MOV L,A
172A CD1612 CALL COPYSTRG ;COPY
172D D1 POP D
172E CDAD11 CALL STRGRELD
1731 C37D11 JMP STRGALOT
```

RIGFCT:

```
1734 CD0917 CALL LEFRIGAR ;RIGHT$ FUNCTION
1737 D1 POP D
1738 D5 PUSH D
1739 1A LDAX D
173A 90 SUB B ;RIGHT(X,N)=MID(X,LEN(X)-N+1,N)
173B C3FD16 JMP LEFRIGMR
```

MIDFCT:

```
173E EB XCHG ;MID$ FUNCTION
173F CD280C CALL VALBYTE2 ;SCAN STARTING POSITION
1742 43 MOV B,E
1743 B7 ORA A ;NON-ZERO STARTING POSITION?
1744 CA230C JZERRAF C
1747 C5 PUSH B
1748 1EFF MVI E,OFFH
174A 7E MOV A,M
174B FE29 CPI ")"
174D C4280C CNZ VALBYTE2 ;SCAN OPTIONAL THIRD ARGUMENT
1750 CDA303 CALL SCANNXTV ;bscan (val)
1753 29 DB ")"
1754 F1 POP PSW ;COMPUTE STARTING BYTE AND LENGTH
1755 E3 XTHL
1756 01FF16 LXI B,LEFRIGMD
1759 C5 PUSH B
176A 3D DCR A
176B BE CMP M
176C 0600 MVI B,0 ;START > LENI => LENO=0
176E D0 RNC
176F 4F MOV C,A
1760 7E MOV A,M
1761 91 SUB C
1762 BB CMP E
1763 47 MOV B,A
1764 D8 RC ;LENO = MIN(LENI-START,LENR)
1765 43 MOV B,E
1766 C9 RET
```

```

;
; INDEX OF STRING FUNCTION
;

INSFCT:
1767 EB      XCHG
1768 CDA303  CALL  SCANNXTV    ;bscan (val)
176B 2C      DB    ","
176C CDAA10  CALL  VALPARN2   ;SCAN SECOND ARGUMENT
176F E3      XTHL  ;SHUFFLE RETURN STACK
1770 017008  LXI   B,POPHLRET
1773 C5      PUSH  B
1774 E5      PUSH  H
1775 CD1116  CALL  LENFCTC   ;PROCESS SECOND STRING
1778 E3      XTHL
1779 F5      PUSH  PSW
177A CA0000  JZ    INSFCTXT
177D CDAC11  CALL  STRGRELH  ;WORK ON FIRST STRING
1780 7E      MOV   A,M
1781 C1      POP   B
1782 D1      POP   D
1783 90      SUB   B      ;COMPARE LENGTHS
1784 DA0000  JC    ZEROAC   ;TEST IS LONGER, NO MATCHES
1787 3C      INR   A
1788 4F      MOV   C,A      ;SAVE NUMBER OF ATTEMPTS
1789 C5      PUSH  B
178A CD0000  CALL  LDICBMM   ;GET ADDRESS OF TARGET
178D EB      XCHG
178E 5E      MOV   E,M      ;GET ADDRESS OF MATCHER
178F 23      INX   H
1790 56      MOV   D,M
1791 EB      XCHG
1792 D1      POP   D      ;RECOVER LENGTH, COUNTER
1793 3E01  MVI   A,1

INSFCTSL:
1795 D5      PUSH  D      ;SAVE LENGTH, COUNTER
1796 F5      PUSH  PSW    ;SAVE POSITION
1797 C5      PUSH  B      ;SAVE ADDRESSES
1798 E5      PUSH  H
1799 5A      MOV   E,D
179A CD5510  CALL  RELOPRSL  ;COMPARE STRINGS
179D E1      POP   H      ;RECOVER ADDRESSES
179E C1      POP   B

INSFCTXT:
179F D1      POP   D
17A0 7A      MOV   A,D      ;RECOVER POSITION
17A1 D1      POP   D      ;AND LENGTH, COUNTER
17A2 CACE0D  JZ    FLOATA   ;ANSWER FOUND, GIVE IT BACK
17A5 3C      INR   A      ;INCREMENT POSITION
17A6 03      INX   B
17A7 1D      DCR   E      ;COUNT ATTEMPTS
17A8 C29517  JNZ   INSFCTSL ;KEEP TRYING
17AB C30000  JMP   ZEROAC  ;OR NOMATCH

```

```

; FUNCTION RETURNING AMOUNT OF REMAINING FREE SPACE
; FREFCT:
17AE 2A8503 LHLD MATTABLE ;FRE FUNCTION
17B1 EB XCHG
17B2 210000 LXI H,0
17B5 39 DAD SP
17B6 CDD903 CALL TYPECHK
17B9 C20000 JNZ FREFCTNS
17BC CDA911 CALL STRGREL A ;RETURN BYTES OF FREE STRNG SPACE
17BF CD4D15 CALL STRGBCL
17C2 2A8903 LHLD STCKBASE
17C5 EB XCHG
17C6 2A8B03 LHLD STRGFREE
; FREFCTNS:
17C9 7D MOV A,L
17CA 93 SUB E
17CB 47 MOV B,A
17CC 7C MOV A,H
17CD 9A SBB D
; FLOATTAB:
17CE 50 MOV D,B
17CF 1E00 MVI E,000H
17D1 216B03 LXI H,TYPEFLG
17D4 3604 MVI M,TYPESING
17D6 0690 MVI B,090H
17D8 C30000 JMP FLOATINT

; MEMORY DIDDLING FACILITIES
; MEMFCT:
17DB CDD903 CALL TYPECHK ;MEM FUNCTION
17DE CA0000 JZ MEMFCTC
17E1 CD100C CALL CINTEGER
17E4 1A LDAX D
17E5 C3CE0D JMP FLOATA
; MEMFCTC:
17E8 CD1116 CALL LENFCTC ;RELEASE ARGUMENT
17EB 2A8103 LHLD PROGBASE
17EE CAA116 JZ FLOATHL ;ZERO LENGTH STRING=PROGBASE
17F1 2A9103 LHLD STRGTLIM
17F4 C3A116 JMP FLOATHL ;OTHERWISE=UPPER LIMIT

; MEMSTM:
17F7 CDAB03 CALL SCANNXT ;bscan + ;MEM STATEMENT
17FA CDA610 CALL VALPARN
17FD CD100C CALL CINTEGER
1800 D5 PUSH D
1801 CDA303 CALL SCANNXTV ;bscan (val)
1804 B5 DB KEYEQ
1805 CD2C0C CALL VALBYTE
1808 D1 POP D
1809 12 STAX D

```

180A C9

RET

; DIRECT I/O FACILITIES
;

PORFCT:

180B CD2FOC CALL CBYTE ;PORT FUNCTION
180E 16DB MVI D,OPCINP
1810 CD0000 CALL INOTGEN
1813 CD9B03 CALL INOTINS
1816 C3CE0D JMP FLOATA

PORSTM:

1819 CDAB03 CALL SCANNXT ;bscan + ;PORT STATEMENT
181C CDA610 CALL VALPARNS
181F CD2FOC CALL CBYTE
1822 D5 PUSH D
1823 CDA303 CALL SCANNXTV ;bscan (val)
1826 B5 DB KEYEQ
1827 CD2C0C CALL VALBYTE
182A D1 POP D
182B 16D3 MVI D,OPCOUT
182D CD0000 CALL INOTGEN
1830 C39B03 JMP INOTINS

WAISTM:

1833 CD2C0C CALL VALBYTE ;WAIT STATEMENT
1836 D5 PUSH D
1837 CD280C CALL VALBYTE2
183A F5 PUSH PSW
183B 1E00 MVI E,0
183D C4280C CNZ VALBYTE2
1840 C1 POP B
1841 4B MOV C,E
1842 D1 POP D
1843 16DB MVI D,OPCINP
1845 CD0000 CALL INOTGEN
WAISTMIN:
1848 CD4A00 CALL SYSWAIT ;DO A SYSTEM WAIT
184B CD9B03 CALL INOTINS ;THEN CHECK DEVICE
184E A9 XRA C
184F A0 ANA B
1850 CA4818 JZ WAISTMIN
1853 C9 RET

INOTGEN:

1854 E5 PUSH H ;GENERATE INPUT/OUTPUT FOLLOWED
1855 219B03 LXI H,INOTINS ;BY RETURN
1858 72 MOV M,D
1859 23 INX H
185A 73 MOV M,E
185B 23 INX H
185C 36C9 MVI M,OPCRET
185E E1 POP H
185F C9 RET

```
: CSAVE/CLOAD PROCESSORS
: save filename - save on diskette
: load filename - get from diskette
:
: Load and save programs from the disk
:
1860 B400 d14base equ 0b400h
1860 B000 fsrom equ 0b000h
1860 B39B bootstart equ fsrom+39bh ;load image files
1860 B8E0 directorylookup equ d14base+4e0h ;find filename
1860 B796 opens equ d14base+396h ;open stream
1860 B7DC puts equ d14base+3dch ;put char
1860 B82D closes equ d14base+42dh ;close stream
:
:cldstm:
1860 CD0000 call setfilename ;parse filename
1863 CDE0B8 call directorylookup
1866 D20000 jnc namenotfound
1869 CD9BB3 call bootstart
186C CD0000 call checkprogram
186F CDFF04 call newload ;reset program pointers
1872 C31906 jmp cmndstrt
:
namenotfound:
1875 1EE1 mvi e,errnfi-errn ;file not saved
1877 C3F105 jmp errmsg
:
csvstm:
187A CD0000 call setfilename
187D 0602 mvi b,2 ;write enable
187F CD96B7 call opens ;open stream (only one in D14)
1882 D20000 jnc cannotopen ; -disk full or other bad stuff
1885 CD0000 call checkprogram
1888 E5 push h ;save end pointer
1889 2A8103 lhld progbase ;first address
188C 4D mov c,1
188D CDDCB7 call puts
1890 4C mov c,h
1891 CDDCB7 call puts
1894 0E00 mvi c,0 ;start address = 0 for no start
1896 CDDCB7 call puts
1899 CDDCB7 call puts
189C D1 pop d ;de has end address+1
:
saveloop:
189D 4E mov c,m ;get char
189E 23 inx h
189F CDDCB7 call puts ;and send to file
18A2 7C mov a,h ;is this the end?
18A3 BA cmp d
18A4 C29D18 jnz saveloop
18A7 7D mov a,1
18A8 BB cmp e
18A9 C29D18 jnz saveloop
18AC CD2DB8 call closes ;yes
```

```
18AF C31906    jmp     cmndstrt
                cannotopen:
18B2 1E09      mvi     e,errnsl-errn
18B4 C3F105    jmp     errmsg

; setfilename
; returns h1 set to a filename string
; setfilename:
18B7 110000    lxi     d,filename+1
18BA 0600      mvi     b,0
                sfnloop:
18BC 7E         mov     a,m           ;look at char
18BD FE00      cpi     0
18BF CA0000    jz      sfndone
18C2 FE20      cpi     " "
18C4 CA0000    jz      sfndone
18C7 04         inr     b             ;up count
18C8 23         inx     h
18C9 12         stax    d
18CA 13         inx     d
18CB C3BC18    jmp     sfnloop
                sfndone:
18CE 210000    lxi     h,filename
18D1 AF         xra     a             ;is the name non zero
18D2 B0         ora     b
18D3 CAEF05    jz      errasn       ;yes
18D6 77         mov     m,a           ;store count
18D7 C9         ret

; checkprogram
; walk over the program looking for the end
; return last byte+1 in h1
; checkprogram:
18D8 2A8103    lhld   progbase      ;starts here
                cprogloop:
18DB 7E         mov     a,m           ;pick up line length
18DC 23         inx     h
18DD B6         ora     m
18DE 23         inx     h
18DF CA0000    jz      cprogok      ;if zero then all done
18E2 23         inx     h             ;skip line number
                cprogloop2:
18E4 7E         mov     a,m
18E5 B7         ora     a
18E6 23         inx     h
18E7 CADB18    jz      cprogloop    ;zero at the end of the line
18EA C3E418    jmp     cprogloop2
                cprogok:
18ED C9         ret
1929 00         filename: ds     60
```

;
; LOGICAL OPERATORS
;

ORNOPR:
 192A B7 ORA A ;OR OPERATOR
 192B C30000 JMP LOGOPRIC
 ANDOPR:
 192E AF XRA A ;AND OPERATOR
 LOGOPRIC:
 192F F5 PUSH PSW
 1930 CDF40B CALL CSINGLE
 1933 CD100C CALL CINTEGER
 1936 F1 POP PSW
 1937 EB XCHG
 1938 C1 POP B
 1939 E3 XTHL
 193A EB XCHG
 193B CD0000 CALL LDACRG
 193E F5 PUSH PSW
 193F CD100C CALL CINTEGER
 1942 F1 POP PSW
 1943 C1 POP B
 1944 79 MOV A,C
 1945 C20000 JNZ ORNOPRFN
 1948 A3 ANA E
 1949 4F MOV C,A
 194A 78 MOV A,B
 194B A2 ANA D
 194C C30000 JMP LOGOPRXT ;RETURN FROM AND

ORNOPRFN:
 194F B3 ORA E
 1950 4F MOV C,A
 1951 78 MOV A,B
 1952 B2 ORA D
 LOGOPRXT:
 1953 41 MOV B,C
 1954 C3CE17 JMP FLOATAB ;RETURN FROM OR

VALUNOT:
 1957 165A MVI D,PREDNOT ;EVALUATE UNARY NOT
 1959 CD960F CALL VALEXPRL
 195C CDF40B CALL CSINGLE
 195F CD100C CALL CINTEGER
 1962 7B MOV A,E
 1963 2F CMA
 1964 4F MOV C,A
 1965 7A MOV A,D
 1966 2F CMA
 1967 CD5319 CALL LOGOPRXT
 196A C1 POP B
 196B C3A20F JMP VALEXPRC

;
; MOD, MAXIMUM, MINIMUM OPERATORS
;

MODOPR:

| | | | |
|-------------|------|----------|-------------------|
| 196E C1 | POP | B | ;MODULO FUNCTION |
| 196F D1 | POP | D | ;X MOD Y = |
| 1970 D5 | PUSH | D | ;X - INT(X/Y) * Y |
| 1971 C5 | PUSH | B | |
| 1972 2A9303 | LHLD | ACCMLTR | |
| 1975 E5 | PUSH | H | |
| 1976 2A9503 | LHLD | FLACCMSP | |
| 1979 E5 | PUSH | H | |
| 197A CD0000 | CALL | FLDIV | |
| 197D CD0000 | CALL | INTFCT | |
| 1980 C1 | POP | B | |
| 1981 D1 | POP | D | |
| 1982 CD0000 | CALL | FLMUL | |
| 1985 C30000 | JMP | SUBOPR | |

MAXOPR:

| | | | |
|-------------|------|--------|---------------------|
| 1988 C1 | POP | B | |
| 1989 D1 | POP | D | |
| 198A CD0000 | CALL | FLCMP | ;COMPARE OPERANDS |
| 198D C8 | RZ | | ;NO DIFFERENCE |
| 198E DA0000 | JC | LDACRG | ;REGISTERS LARGER |
| 1991 C30000 | JMP | LDRGAC | ;ACCUMULATOR LARGER |

MINOPR:

| | | | |
|-------------|------|--------|----------------------|
| 1994 C1 | POP | B | |
| 1995 D1 | POP | D | |
| 1996 CD0000 | CALL | FLCMP | ;COMPARE OPERANDS |
| 1999 C8 | RZ | | ;NO DIFFERENCE |
| 199A D20000 | JNC | LDACRG | ;REGISTERS SMALLER |
| 199D C30000 | JMP | LDRGAC | ;ACCUMULATOR SMALLER |

```
;          ; FLOATING POINT ADD/SUBTRACT ROUTINES
;

FLADDHLF:
19A0 210000  LXI    H,FLHALF
FLADDM:
19A3 CD0000  CALL   LDRGMM
19A6 C30000  JMP    FLADD

FLMMAAC:
19A9 CD0000  CALL   LDRGMM ;COMPUTE MM-AC
19AC C30000  JMP    FLSUB

SUBOPR:
19AF C1      POP    B
19B0 D1      POP    D
FLSUB:
19B1 CD0000  CALL   CMACCS ;SUBTRACT ACC FROM REGISTERS
FLADD:
19B4 78      MOV    A,B    ;ADD ACCUMULATOR TO REGISTERS
19B5 B7      ORA    A
19B6 C8      RZ
19B7 3A9603  LDA    FLACCEXP
19BA B7      ORA    A
19BB CA0000  JZ     LDACRG
19BE 90      SUB    B
19BF D20000  JNC    FLADDMG
19C2 2F      CMA    ;NEED LARGER IN AC, INTERCHANGE
19C3 3C      INR    A
19C4 EB      XCHG
19C5 CD0000  CALL   PUSHAC
19C8 EB      XCHG
19C9 CD0000  CALL   LDACRG
19CC C1      POP    B
19CD D1      POP    D
FLADDMG:
19CE FE19  CPI    019H  ;ARE MAGNITUDES ARE COMMENSURATE?
19D0 D0      RNC
19D1 F5      PUSH   PSW
19D2 CD0000  CALL   SIGNIFY
19D5 67      MOV    H,A
19D6 F1      POP    PSW
19D7 CD0000  CALL   SHIFTRO
19DA B4      ORA    H
19DB 219303  LXI    H,ACCMLTR
19DE F20000  JP     FLADDIFF
19E1 CD0000  CALL   ADDM2CDE
19E4 D20000  JNC    FLROUND
19E7 23      INX    H
19E8 34      INR    M
19E9 CA0000  JZ     ERRAOV
19EC 2E01  MVI    L,001H
19EE CD0000  CALL   SHIFTRLB
19F1 C30000  JMP    FLROUND
```

FLADDIFF:

```

19F4 AF      XRA    A      ;FIND DIFFERENCE
19F5 90      SUB    B
19F6 47      MOV    B,A
19F7 7E      MOV    A,M
19F8 9B      SBB    E
19F9 5F      MOV    E,A
19FA 23      INX    H
19FB 7E      MOV    A,M
19FC 9A      SBB    D
19FD 57      MOV    D,A
19FE 23      INX    H
19FF 7E      MOV    A,M
1A00 99      SBB    C
1A01 4F      MOV    C,A
NORMALZI:
1A02 DC0000  CC    CMREGS
NORMALIZ:
1A05 68      MOV    L,B    ;NORMALIZE REGISTERS
1A06 63      MOV    H,E
1A07 AF      XRA    A
NORMAL8:
1A08 47      MOV    B,A    ;NORMALIZE BY BYTES
1A09 79      MOV    A,C
1A0A B7      ORA    A
1A0B C20000  JNZ    NORMAL1
1A0E 4A      MOV    C,D
1A0F 54      MOV    D,H
1A10 65      MOV    H,L
1A11 6F      MOV    L,A
1A12 78      MOV    A,B
1A13 D608    SUI    008H
1A15 FEE0    CPI    0E0H
1A17 C2081A  JNZ    NORMAL8
ZEROAC:
1A1A AF      XRA    A    ;ZERO ACCUMULATOR
LDACCE:
1A1B 329603  STA    FLACCEXP
1A1E C9      RET

NORMAL1L:
1A1F 05      DCR    B    ;NORMALIZE BY BITS
1A20 29      DAD    H
1A21 7A      MOV    A,D
1A22 17      RAL
1A23 57      MOV    D,A
1A24 79      MOV    A,C
1A25 8F      ADC    A
1A26 4F      MOV    C,A
NORMAL1:
1A27 F21F1A  JP    NORMAL1L
1A2A 78      MOV    A,B
1A2B 5C      MOV    E,H
1A2C 45      MOV    B,L
1A2D B7      ORA    A

```

```
1A2E CA0000    JZ      FLROUND
1A31 219603    LXI     H,FLACCEXP
1A34 86        ADD     M
1A35 77        MOV     M,A
1A36 D21A1A    JNC     ZEROAC
1A39 C8        RZ
FLROUND:
1A3A 78        MOV     A,B      ;ROUND RESULT
FLROUNDV:
1A3B 219603    LXI     H,FLACCEXP
1A3E B7        ORA     A
1A3F FC0000    CM      INCCDE
1A42 46        MOV     B,M
1A43 23        INX     H
1A44 7E        MOV     A,M
1A45 E680    ANI      080H
1A47 A9        XRA     C
1A48 4F        MOV     C,A
1A49 C30000    JMP     LDACRG

INCCDE:
1A4C 1C        INR     E      ;INCREMENT CDE
1A4D C0        RNZ
1A4E 14        INR     D
1A4F C0        RNZ
1A50 0C        INR     C
1A51 C0        RNZ
1A52 0E80    MVI     C,080H
1A54 34        INR     M
1A55 C0        RNZ

ERRAOV:
1A56 1E6D    MVI     E,ERRNOV-ERRN
1A58 C3F105   JMP     ERRMSG

ADDM2CDE:
1A5B 7E        MOV     A,M      ;ADD MEMORY TO CDE
1A5C 83        ADD     E
1A5D 5F        MOV     E,A
1A5E 23        INX     H
1A5F 7E        MOV     A,M
1A60 8A        ADC     D
1A61 57        MOV     D,A
1A62 23        INX     H
1A63 7E        MOV     A,M
1A64 89        ADC     C
1A65 4F        MOV     C,A
1A66 C9        RET
```

CMREGS:

| | | | |
|-------------|-----|------------|------------------------------|
| 1A67 219703 | LXI | H,FLACCSSV | ;COMPLEMENT SAVED SIGN, CDEB |
| 1A6A 7E | MOV | A,M | |
| 1A6B 2F | CMA | | |
| 1A6C 77 | MOV | M,A | |
| 1A6D AF | XRA | A | |
| 1A6E 6F | MOV | L,A | |
| 1A6F 90 | SUB | B | |
| 1A70 47 | MOV | B,A | |
| 1A71 7D | MOV | A,L | |
| 1A72 9B | SBB | E | |
| 1A73 5F | MOV | E,A | |
| 1A74 7D | MOV | A,L | |
| 1A75 9A | SBB | D | |
| 1A76 57 | MOV | D,A | |
| 1A77 7D | MOV | A,L | |
| 1A78 99 | SBB | C | |
| 1A79 4F | MOV | C,A | |
| 1A7A C9 | RET | | |

SHIFTR0:

| | | | |
|-----------|-----|--------|--|
| 1A7B 0600 | MVI | B,000H | |
|-----------|-----|--------|--|

SHIFTR:

| | | | |
|-------------|-----|---------|-----------------------------|
| 1A7D D608 | SUI | 008H | ;SHIFT CDEB RIGHT BY A BITS |
| 1A7F DA0000 | JC | SHIFTRB | |
| 1A82 43 | MOV | B,E | |
| 1A83 5A | MOV | E,D | |
| 1A84 51 | MOV | D,C | |
| 1A85 0E00 | MVI | C,000H | |
| 1A87 C37D1A | JMP | SHIFTR | |

SHIFTRB:

| | | | |
|-----------|-----|------|--|
| 1A8A C609 | ADI | 009H | |
| 1A8C 6F | MOV | L,A | |

SHIFTRBL:

| | | | |
|---------|-----|-----|--|
| 1A8D AF | XRA | A | |
| 1A8E 2D | DCR | L | |
| 1A8F C8 | RZ | | |
| 1A90 79 | MOV | A,C | |

SHIFTRLB:

| | | | |
|-------------|-----|----------|--|
| 1A91 1F | RAR | | |
| 1A92 4F | MOV | C,A | |
| 1A93 7A | MOV | A,D | |
| 1A94 1F | RAR | | |
| 1A95 57 | MOV | D,A | |
| 1A96 7B | MOV | A,E | |
| 1A97 1F | RAR | | |
| 1A98 5F | MOV | E,A | |
| 1A99 78 | MOV | A,B | |
| 1A9A 1F | RAR | | |
| 1A9B 47 | MOV | B,A | |
| 1A9C C38D1A | JMP | SHIFTRLB | |

```
;          ; FLOATING POINT MULTIPLY ROUTINE
;

MULOPR:
1A9F C1      POP    B
1AA0 D1      POP    D
FLMUL:
1AA1 CD0000  CALL   SIGNACC ;MULTIPLY REGISTERS BY ACC
1AA4 C8      RZ
1AA5 2E00  MVI    L,000H
1AA7 CD0000  CALL   FLMULDVEX
1AAA 79      MOV    A,C
1AAB 329B03  STA    FLSCRO
1AAE EB      XCHG
1AAF 229C03  SHLD   FLSCR1
1AB2 010000  LXI    B,0
1AB5 50      MOV    D,B
1AB6 59      MOV    E,C
1AB7 21051A  LXI    H,NORMALIZ ;NORMALIZE ANSWER AFTER
1ABA E5      PUSH   H
1ABB 210000  LXI    H,FLMULLP ;THREE TIMES THROUGH LOOP
1ABE E5      PUSH   H
1ABF E5      PUSH   H
1AC0 219303  LXI    H,ACCUMLTR
FLMULLP:
1AC3 7E      MOV    A,M
1AC4 23      INX
1AC5 B7      ORA
1AC6 CA0000  JZ    FLMULXT
1AC9 E5      PUSH   H
1ACA 2E08  MVI    L,008H
FLMULLQ:
1ACC 1F      RAR    ;NEXT BIT OF MULTIPLIER
1ACD 67      MOV    H,A
1ACE 79      MOV    A,C
1ACF D20000  JNC   FLMULNA
1AD2 E5      PUSH   H
1AD3 2A9C03  LHLD   FLSCR1 ;BIT ON, ADD MULTIPLICAND
1AD6 19      DAD    D
1AD7 EB      XCHG
1AD8 E1      POP    H
1AD9 3A9B03  LDA    FLSCRO
1ADC 89      ADC    C
FLMULNA:
1ADD 1F      RAR    ;SHIFT CDEB RIGHT ONE BIT
1ADE 4F      MOV    C,A
1ADF 7A      MOV    A,D
1AE0 1F      RAR
1AE1 57      MOV    D,A
1AE2 7B      MOV    A,E
1AE3 1F      RAR
1AE4 5F      MOV    E,A
1AE5 78      MOV    A,B
1AE6 1F      RAR
```

```
1AE7 47      MOV    B,A
1AE8 2D      DCR    L
1AE9 7C      MOV    A,H
1AEA C2CC1A   JNZ    FLMULLQ
1AED E1      POP    H
1AEE C9      RET
```

FLMULXT:

```
1AEF 43      MOV    B,E
1AF0 5A      MOV    E,D
1AF1 51      MOV    D,C
1AF2 4F      MOV    C,A
1AF3 C9      RET
```

FLMLDVEX:

```
1AF4 78      MOV    A,B      ;COMPUTE EXP FOR MULTIPLY/DIVIDE
1AF5 B7      ORA    A
1AF6 CA0000   JZ     FLMLDVEZ
1AF9 7D      MOV    A,L
1AFA 219603  LXI    H,FLACCEXP
1AFD AE      XRA    M
1AFE 80      ADD    B
1AFF 47      MOV    B,A
1B00 1F      RAR
1B01 A8      XRA    B
1B02 78      MOV    A,B
1B03 F20000  JP     FLMLDVEY
1B06 C680    ADI    080H
1B08 77      MOV    M,A
1B09 CA7008  JZ     POPLRRET
1B0C CD0000  CALL   SIGNIFY
1B0F 77      MOV    M,A
1B10 2B      DCX
1B11 C9      RET
```

EXPRNEXC:

```
1B12 CD0000  CALL   SIGNACC ;RANGE EXCEEDED FOR EXP FUNCTION
1B15 2F      CMA
1B16 E1      POP    H
1B17 B7      ORA    A
1B18 E1      POP    H
1B19 F21A1A   JP     ZEROAC
1B1C C3561A   JMP   ERRAOV
```

FLMLDVEY:**FLMLDVEZ:**

```
;      ; FLOATING POINT DIVIDE ROUTINE
;

FLDIVB10:
1B1F CD0000  CALL   PUSHAC ;COMPUTE AC/10
1B22 012084  LXI    B,08420H
1B25 110000  LXI    D,00000H
1B28 CD0000  CALL   LDACRG
        DIVOPR:
1B2B C1      POP    B
1B2C D1      POP    D
FLDIV:
1B2D CD0000  CALL   SIGNACC ;DIVIDE REGISTERS BY ACCUMULATOR
1B30 CA0000  JZ    ERRADO
1B33 2EFF    MVI    L,0FFH
1B35 CDF41A  CALL   FLMLDVEX
1B38 34      INR    M
1B39 34      INR    M      ;plus 2
1B3A 2B      DCX    H
1B3B 7E      MOV    A,M
1B3C 2F      CMA
1B3D 329D03  STA    FLSCR2
1B40 2B      DCX    H
1B41 7E      MOV    A,M
1B42 2F      CMA
1B43 329C03  STA    FLSCR1
1B46 2B      DCX    H
1B47 7E      MOV    A,M
1B48 2F      CMA
1B49 329B03  STA    FLSCR0
1B4C 41      MOV    B,C
1B4D EB      XCHG
1B4E AF      XRA    A
1B4F 4F      MOV    C,A
1B50 57      MOV    D,A
1B51 5F      MOV    E,A
1B52 329E03  STA    FLSCR3
FLDIVLP:
1B55 E5      PUSH   H
1B56 C5      PUSH   B
1B57 37      STC
1B58 3A9B03  LDA    FLSCR0
1B5B 8D      ADC    L
1B5C 6F      MOV    L,A
1B5D 3A9C03  LDA    FLSCR1
1B60 8C      ADC    H
1B61 67      MOV    H,A
1B62 3A9D03  LDA    FLSCR2
1B65 88      ADC    B
1B66 47      MOV    B,A
1B67 3A9E03  LDA    FLSCR3
1B6A CEFF    ACI    OFFH
1B6C D20000  JNC    FLDIVSF
1B6F 329E03  STA    FLSCR3
```

1872 F1 POP PSW ;TRIAL SUBTRACT SUCCEEDED,
1873 F1 POP PSW ;THROW AWAY SAVED DIVIDEND
1874 37 STC
1875 C30000 JMP FLDIVSS
FLDIVSF:
1878 C1 POP B ;TRIAL SUBTRACT FAILED, RESTORE
1879 E1 POP H
FLDIVSS:
187A 79 MOV A,C
187B 3C INR A
187C 3D DCR A
187D 1F RAR
187E FA3B1A JM FLROUNDV
1881 17 RAL
1882 7B MOV A,E
1883 17 RAL
1884 5F MOV E,A
1885 7A MOV A,D
1886 17 RAL
1887 57 MOV D,A
1888 79 MOV A,C
1889 17 RAL
188A 4F MOV C,A
188B 29 DAD H
188C 78 MOV A,B
188D 17 RAL
188E 47 MOV B,A
188F 3A9E03 LDA FLSCR3
1892 17 RAL
1893 329E03 STA FLSCR3
1896 79 MOV A,C
1897 B2 ORA D
1898 B3 ORA E
1899 C2551B JNZ FLDIVLP
189C E5 PUSH H
189D 219603 LXI H,FLACCEXP
18A0 35 DCR M
18A1 E1 POP H
18A2 C2551B JNZ FLDIVLP
18A5 C3561A JMP ERRAOV

ERRADO:

18A8 1E21 MVI E,ERRNDO-ERRN
18AA C3F105 JMP ERMSG

```
; MISCELLANEOUS AUXILIARY ROUTINES
;

; COPY ACCUMULATOR TO STACK
;

PUSHAC:
1BAD EB      XCHG          ;PUSH ACCUMULATOR ONTO STACK
PUSHAC1:
1BAE 2A9303   LHLD  ACCUMLTR
1BB1 E3      XTHL
1BB2 E5      PUSH   H
1BB3 2A9503   LHLD  FLACCMSB
1BB6 E3      XTHL
1BB7 E5      PUSH   H
1BB8 EB      XCHG
1BB9 C9      RET

; LOAD ACCUMULATOR
;

LDRGACMM:
1BBA CD0000   CALL   LDRGMM ;LOAD FLOATING ACC AND REGISTERS
LDACRG:
1BBD EB      XCHG          ;LOAD ACCUMULATOR FROM REGISTERS
1BBE 229303   SHLD  ACCUMLTR
1BC1 60      MOV    H,B
1BC2 69      MOV    L,C
1BC3 229503   SHLD  FLACCMSB
1BC6 EB      XCHG
1BC7 C9      RET

; LOAD REGISTERS
;

LDRGAC:
1BC8 219303   LXI   H,ACCUMLTR ;LOAD REGISTERS FROM ACCUMULATOR
LDRGMM:
1BCB 5E      MOV    E,M      ;LOAD REGISTERS FROM FLOAT NUMBER
1BCC 23      INX    H
LDDCBMM:
1BCD 56      MOV    D,M      ;LOAD REGISTERS FROM STRING
LDICBMM:
1BCE 23      INX    H
1BCF 4E      MOV    C,M
1BD0 23      INX    H
1BD1 46      MOV    B,M
INCHLRET:
1BD2 23      INX    H
1BD3 C9      RET
```

```
; STORE ACCUMULATOR / COPY A VALUE
;
LDMMAC:
1BD4 119303 LXI D,ACCUMLTR ;LOAD MEMORY FROM ACCUMULATOR
COPYVAL:
1BD7 3A6B03 LDA TYPEFLG ;COPY VALUE FROM (DE) TO (HL)
1BDA 47 MOV B,A
COPYVALL:
1BDB 1A LDAX D
1BDC 77 MOV M,A
1BDD 13 INX D
1BDE 23 INX H
1BDF 05 DCR B
1BE0 C2DB1B JNZ COPYVALL
1BE3 C9 RET

;
; TURN ON HIGH ORDER MANTISSA BITS OF ACCUMULATOR/REGISTERS
;
SIGNIFY:
1BE4 219503 LXI H,FLACCMSB ;SET ON HIGH-ORDER MANTISSA BITS,
1BE7 7E MOV A,M ;AND SAVE SIGN IN FLACCSSV
1BE8 07 RLC
1BE9 37 STC
1BEA 1F RAR
1BEB 77 MOV M,A ;FIRST ACCUMULATOR,
1BEC 3F CMC
1BED 1F RAR
1BEE 23 INX H
1BEF 23 INX H
1BF0 77 MOV M,A
1BF1 79 MOV A,C
1BF2 07 RLC
1BF3 37 STC
1BF4 1F RAR
1BF5 4F MOV C,A ;THEN REGISTERS
1BF6 1F RAR
1BF7 AE XRA M
1BF8 C9 RET
```

; FLOATING POINT COMPARISON: REGISTERS VS ACCUMULATOR
;

FLCMP:

| | | | |
|-------------|------|------------|-------------------------------|
| 1BF9 78 | MOV | A,B | ;FLOATING COMPARE REGS TO ACC |
| 1BFA B7 | ORA | A | |
| 1BFB CA0000 | JZ | SIGNACC | |
| 1BFE 210000 | LXI | H,FLCMPXT | |
| 1C01 E5 | PUSH | H | |
| 1C02 CD0000 | CALL | SIGNACC | |
| 1C05 79 | MOV | A,C | |
| 1C06 C8 | RZ | | |
| 1C07 219503 | LXI | H,FLACCMSP | |
| 1C0A AE | XRA | M | |
| 1C0B 79 | MOV | A,C | |
| 1C0C F8 | RM | | |
| 1C0D CD0000 | CALL | FLCMPM | |
| 1C10 1F | RAR | | |
| 1C11 A9 | XRA | C | |
| 1C12 C9 | RET | | |

FLCMPM:

| | | | |
|---------|-----|-----|--------------------|
| 1C13 23 | INX | H | ;COMPARE MANTISSAS |
| 1C14 78 | MOV | A,B | |
| 1C15 BE | CMP | M | |
| 1C16 C0 | RNZ | | |
| 1C17 2B | DCX | H | |
| 1C18 79 | MOV | A,C | |
| 1C19 BE | CMP | M | |
| 1C1A C0 | RNZ | | |
| 1C1B 2B | DCX | H | |
| 1C1C 7A | MOV | A,D | |
| 1C1D BE | CMP | M | |
| 1C1E C0 | RNZ | | |
| 1C1F 2B | DCX | H | |
| 1C20 7B | MOV | A,E | |
| 1C21 96 | SUB | M | |
| 1C22 C0 | RNZ | | |
| 1C23 E1 | POP | H | |
| 1C24 E1 | POP | H | |
| 1C25 C9 | RET | | |

; COMPUTE INTEGER PART OF ACCUMULATOR

FIXAC:

| | | | |
|-------------|------|---------|-------------------------|
| 1C26 47 | MOV | B,A | ;LOAD REGS WITH FIX(AC) |
| 1C27 4F | MOV | C,A | |
| 1C28 57 | MOV | D,A | |
| 1C29 5F | MOV | E,A | |
| 1C2A B7 | ORA | A | |
| 1C2B C8 | RZ | | |
| 1C2C E5 | PUSH | H | |
| 1C2D CDC81B | CALL | LDRGAC | |
| 1C30 CDE41B | CALL | SIGNIFY | |
| 1C33 AE | XRA | M | |
| 1C34 67 | MOV | H,A | |
| 1C35 FC0000 | CM | DECCKDE | |
| 1C38 3E98 | MVI | A,098H | |
| 1C3A 90 | SUB | B | |
| 1C3B CD7B1A | CALL | SHIFTRO | |
| 1C3E 7C | MOV | A,H | |
| 1C3F 17 | RAL | | |
| 1C40 DC4C1A | CC | INCCDE | |
| 1C43 0600 | MVI | B,000H | |
| 1C45 DC671A | CC | CMREGS | |
| 1C48 E1 | POP | H | |
| 1C49 C9 | RET | | |

DECCKDE:

| | | | |
|---------|-----|-----|----------------|
| 1C4A 1B | DCX | D | ;DECREMENT CDE |
| 1C4B 7A | MOV | A,D | |
| 1C4C A3 | ANA | E | |
| 1C4D 3C | INR | A | |
| 1C4E C0 | RNZ | | |
| 1C4F 0D | DCR | C | |
| 1C50 C9 | RET | | |

FLMULB10:

| | | | |
|-------------|------|------------|--------------------------------|
| 1C51 CDC81B | CALL | LDRGAC | ;MULTIPLY CONTENTS OF AC BY 10 |
| 1C54 78 | MOV | A,B | |
| 1C55 B7 | ORA | A | |
| 1C56 C8 | RZ | | |
| 1C57 C602 | ADI | 002H | |
| 1C59 DA561A | JC | ERRAOV | |
| 1C5C 47 | MOV | B,A | |
| 1C5D CDB419 | CALL | FLADD | ;AC=AC+4*AC |
| 1C60 219603 | LXI | H,FLACCEXP | |
| 1C63 34 | INR | M | ;AC=2*AC |
| 1C64 C0 | RNZ | | |
| 1C65 C3561A | JMP | ERRAOV | |

SIGNACC:

| | | | |
|-------------|-----|----------|---------------------------|
| 1C68 3A9603 | LDA | FLACCEXP | ;FIND SIGN OF ACCUMULATOR |
| 1C6B B7 | ORA | A | |
| 1C6C C8 | RZ | | |
| 1C6D 3A9503 | LDA | FLACCMSB | |

```

1C70 C30000    JMP      SIGNXTND
1C73 2F        FLCMPXT:
1C74 17        CMA
1C75 9F        SIGNXTND:
1C76 C0        RAL
1C77 3C        CMPXT:
1C78 C9        SBB     A
1C79 210000    INR     A
1C7D E9        RET

CMANSWR:
1C79 210000    LXI     H,CMACCS      ;F(X)=-F(0)
1C7C E3        XTHL
1C7D E9        PCHL

SGNFCT:
1C7E CD681C    CALL    SIGNACC
1C81 0688    FLOATBYT:
1C83 110000    MVI     B,088H
1C86 219603    LXI     H,FLACCEXP   ;CONVERT INTEGER IN ADE TO FLOAT,
1C89 4F        MOV     C,A
1C8A 70        MOV     M,B      ;EXPONENT ASSUMED IN B
1C8B 0600    MVI     B,000H
1C8D 23        INX     H
1C8E 3680    MVI     M,080H
1C90 17        RAL
1C91 C3021A    JMP     NORMALZI

;           ; COMPUTE ABSOLUTE VALUE OF ACCUMULATOR
;           ; ABSFCT:
1C94 CD681C    CALL    SIGNACC ;ABS FUNCTION
1C97 F0        RP
1C98 219503    CMACCS:
LXI     H,FLACCMSB   ;CHANGE SIGN OF ACCUMULATOR
1C9B 7E        MOV     A,M
1C9C EE80    XRI     080H
1C9E 77        MOV     M,A
1C9F C9        RET

INTFCT:
1CA0 219603    LXI     H,FLACCEXP   ;INT FUNCTION
1CA3 7E        MOV     A,M
1CA4 FE98    CPI     098H
1CA6 3A9303    LDA     ACCUMLTR
1CA9 D0        RNC
1CAA 7E        MOV     A,M
1CAB CD261C    CALL    FIXAC
1CAE 3698    MVI     M,098H
1CB0 7B        MOV     A,E
1CB1 F5        PUSH   PSW
1CB2 79        MOV     A,C

```

```
1CB3 17      RAL
1CB4 CD021A   CALL   NORMALZI
1CB7 F1      POP    PSW
1CB8 C9      RET
```

```
; ; FLOATING POINT DECODE ROUTINE
;

DECODE:
1CB9 FE2D CPI   "-"      ;DECODE EXTERNAL FORM OF NUMBER
1CBB F5 PUSH    PSW
1CBC CA0000 JZ    DECODEIN
1CBF FE2B CPI   "+"
1CC1 CA0000 JZ    DECODEIN
1CC4 2B DCX    H
DECODEIN:
1CC5 CD1A1A CALL   ZEROAC
1CC8 47 MOV    B,A
1CC9 57 MOV    D,A
1CCA 5F MOV    E,A
1CCB 2F CMA
1CCC 4F MOV    C,A
DECODELP:
1CCD CDAB03 CALL   SCANNXT ;bscan ,
1CD0 DA0000 JC    DECDIGIT
1CD3 FE2E CPI   "."
1CD5 CA0000 JZ    DECODEPT
1CD8 FE45 CPI   "E"      ;UPPER CASE E
1CDA CA0000 JZ    DECODEXP
1CDD FE65 CPI   "e"      ;LOWER CASE E
1CDF C20000 JNZ   DECODVAL
DECODEXP:
1CE2 CDAB03 CALL   SCANNXT ;bscan ,
1CE5 E5 PUSH    H
1CE6 210000 LXI   H,DECODEXL
1CE9 E3 XTHL
1CEA 15 DCR    D
1CEB FEAB CPI   KEYSUB
1CED C8 RZ
1CEE FE2D CPI   "--"
1CF0 C8 RZ
1CF1 14 INR    D
1CF2 FE2B CPI   "+"
1CF4 C8 RZ
1CF5 FEAA CPI   KEYADD
1CF7 C8 RZ
1CF8 F1 POP    PSW
1CF9 2B DCX    H
DECODEXL:
1CFA CDAB03 CALL   SCANNXT ;bscan ,          ;SCAN EXPONENT
1CFD D20000 JNC   DECODEXQ
1D00 7B MOV    A,E      ;DECODE EXPONENT DIGIT
1D01 07 RLC   A,E      ;E=10^E+VAL(M)
1D02 07 RLC
1D03 83 ADD    E
1D04 07 RLC
1D05 86 ADD    M
1D06 D630 SUI   "0"
1D08 5F MOV    E,A
```

```
1D09 C3FA1C    JMP    DECODEXL
DECODEXL:
1D0C 14        INR    D
1D0D C20000    JNZ    DECODVAL
1D10 AF        XRA    A
1D11 93        SUB    E
1D12 5F        MOV    E,A
1D13 0C        INR    C
DECODEPT:
1D14 0C        INR    C      ;DECODE DECIMAL POINT
1D15 CACD1C    JZ     DECODELP
DECODVAL:
1D18 E5        PUSH   H
1D19 7B        MOV    A,E
1D1A 90        SUB    B
DECDEXPA:
1D1B F40000    CP     DECMULUP    ;COMBINE MANTISSA, EXPONENT
1D1E F20000    JP     DECDEXAL
1D21 F5        PUSH   PSW
1D22 CD1F1B    CALL   FLDIVB10
1D25 F1        POP    PSW
1D26 3C        INR    A
DECDEXAL:
1D27 C21B1D    JNZ    DECDEXPA
1D2A D1        POP    D
1D2B F1        POP    PSW
1D2C CC981C    CZ     CMACCS
1D2F EB        XCHG
1D30 C9        RET
```

DECMULUP:
1D31 C8 RZ
FLMLB10C:
1D32 F5 PUSH PSW
1D33 CD511C CALL FLMULB10
1D36 F1 POP PSW
1D37 3D DCR A
1D38 C9 RET

DECDDIGIT:
1D39 D5 PUSH D ; DECODE DIGIT OF NUMBER
1D3A 57 MOV D,A
1D3B 78 MOV A,B
1D3C 89 ADC C
1D3D 47 MOV B,A
1D3E C5 PUSH B
1D3F E5 PUSH H
1D40 D5 PUSH D
1D41 CD511C CALL FLMULB10
1D44 F1 POP PSW
1D45 D630 SUI "0"
1D47 CD0000 CALL DECDGADD
1D4A E1 POP H
1D4B C1 POP B
1D4C D1 POP D
1D4D C3CD1C JMP DECODELP

DECDGADD:
1D50 CDAD1B CALL PUSHAC
1D53 CD811C CALL FLOATBYT
ADDOPR:
1D56 C1 POP B
1D57 D1 POP D
1D58 C3B419 JMP FLADD

```
;          ; FLOATING POINT ENCODE ROUTINE
;
;ERRMSGIN:
1D6B E5      PUSH   H      ;PRINT CUR LINE NUMBER IN ERROR
1D5C 21D505  LXI    H,MSGIN
1D5F CDAC0D  CALL   PRNTMSG
1D62 E1      POP    H
;
;PRINTINT:
1D63 E5      PUSH   H      ;PRINT AN INTEGER
1D64 21AB00  LXI    H,PRNTNUMS
1D67 E3      XTHL
;
;ENCODEHL:
1D68 EB      XCHG   ;ENCODE AN INTEGER
1D69 AF      XRA
1D6A 0698  MVI    B,098H
1D6C CD861C  CALL   FLOATINT
;
;ENCODE:
1D6F 11F3FF  LXI    D,-13  ;ENCODE AC IN EXTERNAL FORM
1D72 2A8103  LHLD   PROGBASE
1D75 19      DAD    D      ;CREATE POINTER TO ENCODE BUFFER
1D76 E5      PUSH   H
1D77 CD681C  CALL   SIGNACC
1D7A 3620  MVI    M," "
1D7C F20000  JP     ENCODFRS
1D7F 362D  MVI    M,"-"
;
;ENCODFRS:
1D81 23      INX    H
1D82 3630  MVI    M,"0"
1D84 CA0000  JZ     ENCODZXT
1D87 E5      PUSH   H
1D88 FC981C  CM     CMACCS
1D8B AF      XRA
1D8C F5      PUSH   PSW
1D8D CD0000  CALL   ENDOCMP
;
;ENCODUPL:
1D90 014391  LXI    B,09143H  ;FORCE NUMBER TO RANGE
1D93 11F84F  LXI    D,04FF8H  ;10**5 <= AC BY MULTIPLICATION
1D96 CDF91B  CALL   FLCMP
1D99 3D      DCR    A
1D9A F20000  JP     ENCODRND
1D9D F1      POP    PSW
1D9E CD321D  CALL   FLMLB10C
1DA1 F5      PUSH   PSW
1DA2 C3901D  JMP    ENCODUPL
;
;ENCODDNL:
1DA5 CD1F1B  CALL   FLDIVB10  ;FORCE NUMBER TO RANGE
1DA8 F1      POP    PSW      ;AC < 10**6 BY DIVISION
1DA9 3C      INR    A
1DAA F5      PUSH   PSW
1DAB CD0000  CALL   ENDOCMP
;
;ENCODRND:
1DAE CDA019  CALL   FLADDHLF  ;ROUND UP RESULT
1DB1 3C      INR    A
```

```
1DB2 CD261C    CALL    FIXAC
1DB5 CDBD1B    CALL    LDACRG
1DB8 010602    LXI    B,00206H      ;D.DDDDD
1DBB F1        POP     PSW
1DBC 81        ADD     C
1DBD FA0000    JM     ENCDEXPS
1DC0 FE07        CPI    007H
1DC2 D20000    JNC    ENCDEXPS
1DC5 3C        INR     A
1DC6 47        MOV     B,A
1DC7 3E01    MVI    A,001H
ENCDEXPS:
1DC9 3D        DCR     A
1DCA E1        POP     H
1DCB F5        PUSH    PSW
1DCC 110000    LXI    D,ENCDCOEFF
ENCODDGL:
1DCF 05        DCR     B
1DD0 362E    MVI    M, "."
1DD2 CCD21B    CZ     INCHLRET
1DD5 C5        PUSH    B
1DD6 E5        PUSH    H
1DD7 D5        PUSH    D
1DD8 CDC81B    CALL    LDRGAC
1DDB E1        POP     H
1DDC 062F    MVI    B,'0-1 ;GENERATE NEXT DIGIT
ENCODSBL:
1DDE 04        INR     B
1DDF 7B        MOV     A,E
1DE0 96        SUB     M
1DE1 5F        MOV     E,A
1DE2 23        INX     H
1DE3 7A        MOV     A,D
1DE4 9E        SBB     M
1DE5 57        MOV     D,A
1DE6 23        INX     H
1DE7 79        MOV     A,C
1DE8 9E        SBB     M
1DE9 4F        MOV     C,A
1DEA 2B        DCX     H
1DEB 2B        DCX     H
1DEC D2DE1D    JNC    ENCODSBL
1DEF CD5B1A    CALL    ADDM2CDE
1DF2 23        INX     H
1DF3 CDBD1B    CALL    LDACRG
1DF6 EB        XCHG
1DF7 E1        POP     H
1DF8 70        MOV     M,B
1DF9 23        INX     H
1DFA C1        POP     B
1DFB 0D        DCR     C
1DFC C2CF1D    JNZ    ENCODDGL
1DFF 05        DCR     B
1E00 CA0000    JZ     ENCODEXP
ENCODRTZR:
1E03 2B        DCX     H      ;REMOVE TRAILING ZEROES
```

```
1E04 7E      MOV    A,M
1E05 FE30    CPI    "0"
1E07 CA031E   JZ     ENCDRTZR
1E0A FE2E    CPI    ";" REMOVE TRAILING DECIMAL POINT
1E0C C4D21B   CNZ    INCHLRET

        ENCODEXP:
1EOF F1      POP    PSW    ;ENCODE EXPONENT
1E10 CA0000   JZ     ENCODEXT
1E13 3645    MVI    M,"E"
1E15 23      INX    H
1E16 362B    MVI    M, "+"
1E18 F20000   JP     ENCOEXPP
1E1B 362D    MVI    M, "-"
1E1D 2F      CMA
1E1E 3C      INR    A
        ENCOEXPP:
1E1F 062F    MVI    B,'0-1
        ENCDEXPL:
1E21 04      INR    B
1E22 D60A    SUI    10
1E24 D2211E   JNC    ENCDEXPL
1E27 C63A    ADI    '9+1
1E29 23      INX    H
1E2A 70      MOV    M,B
        ENCODZXT:
1E2B 23      INX    H
1E2C 77      MOV    M,A
1E2D 23      INX    H
        ENCODEXT:
1E2E 71      MOV    M,C
1E2F E1      POP    H
1E30 C9      RET

        ENCODCMP:
1E31 017494   LXI    B,09474H    ;10**6
1E34 11F723   LXI    D,023F7H
1E37 CDF91B   CALL   FLCMP
1E3A E1      POP    H
1E3B 3D      DCR    A
1E3C F2A51D   JP     ENCODDNL
1E3F E9      PCHL

        FLHALF:
1E40 000000   DB     000h, 000h, 000h, 080h ;1/2
1E43 80      ENCDCOEF:
1E44 A08601   db     0a0h, 086h, 001h    ;10**5
1E47 102700   db     010h, 027h, 000h    ;10**4
1E4A E80300   db     0e8h, 003h, 000h    ;10**3
1E4D 640000   db     064h, 000h, 000h    ;10**2
1E50 0A0000   db     00ah, 000h, 000h    ;10**1
1E53 010000   db     001h, 000h, 000h    ;10**0
```

; ; FLOATING POINT LOGARITHM ROUTINE
;

LOGCOEF:

| | | |
|-------------|----|------------------------|
| 1E56 03 | DB | 3 |
| 1E57 AA5619 | db | Oaah, 056h, 019h, 080h |
| 1E5A 80 | | |
| 1E5B F12276 | db | 0f1h, 022h, 076h, 080h |
| 1E5E 80 | | |
| 1E5F 45AA38 | db | 045h, Oaah, 038h, 082h |
| 1E62 82 | | |

FLONE:

| | | |
|-------------|----|-----------------------------|
| 1E63 000000 | db | 000h, 000h, 000h, 081h ;1.0 |
| 1E66 81 | | |

LOGFCT:

| | | |
|-------------|------|---------------------------|
| 1E67 CD681C | CALL | SIGNACC ;LOG FUNCTION |
| 1E6A 3D | DCR | A |
| 1E6B FA230C | JM | ERRAFC |
| 1E6E 219603 | LXI | H,FLACCEXP |
| 1E71 7E | MOV | A,M |
| 1E72 013580 | LXI | B,08035H |
| 1E75 11F304 | LXI | D,004F3H |
| 1E78 90 | SUB | B |
| 1E79 F5 | PUSH | PSW |
| 1E7A 70 | MOV | M,B |
| 1E7B D5 | PUSH | D |
| 1E7C C5 | PUSH | B |
| 1E7D CDB419 | CALL | FLADD |
| 1E80 C1 | POP | B |
| 1E81 D1 | POP | D |
| 1E82 04 | INR | B |
| 1E83 CD2D1B | CALL | FLDIV |
| 1E86 21631E | LXI | H,FLONE |
| 1E89 CDA919 | CALL | FLMMMAC |
| 1E8C 21561E | LXI | H,LOGCOEF |
| 1E8F CD0000 | CALL | FCTPOLY2 |
| 1E92 018080 | LXI | B,08080H |
| 1E95 110000 | LXI | D,00000H |
| 1E98 CDB419 | CALL | FLADD |
| 1E9B F1 | POP | PSW |
| 1E9C CD501D | CALL | DEC DGADD |
| FLMULLN2: | | |
| 1E9F 013180 | LXI | B,08031H ;LN(2)=0.6931472 |
| 1EA2 111872 | LXI | D,07218H |
| 1EA5 C3A11A | JMP | FLMUL |

; ; FLOATING POINT SQUARE ROOT/EXPONENTIATION ROUTINE
;

SQRFCT:
1EA8 CDAD1B CALL PUSHAC ;SQR FUNCTION
1EAB 21401E LXI H,FLHALF ;SQR(X)=X**1/2
1EAE CDBA1B CALL LDRGACMM
EXPOPR:
1EB1 C1 POP B ;X**Y=EXP(LOG(X)*Y)
1EB2 D1 POP D
1EB3 CD681C CALL SIGNACC
1EB6 CA0000 JZ EXPFCT
1EB9 78 MOV A,B
1EBA B7 ORA A
1EBB CA1B1A JZ LDACCE
1EBE D5 PUSH D
1EBF C5 PUSH B
1EC0 79 MOV A,C
1EC1 F67F ORI 07FH
1EC3 CDC81B CALL LDRGAC
1EC6 F20000 JP EXPEXPOS
1EC9 D5 PUSH D
1ECA C5 PUSH B
1ECB CDA01C CALL INTFCT
1ECE C1 POP B
1ECF D1 POP D
1ED0 F5 PUSH PSW
1ED1 CDF91B CALL FLCMP
1ED4 E1 POP H
1ED5 7C MOV A,H
1ED6 1F RAR
EXPEXPOS:
1ED7 E1 POP H
1ED8 229503 SHLD FLACCMSP
1EDB E1 POP H
1EDC 229303 SHLD ACCUMLTR
1EDF DC791C CC CMANSWR
1EE2 CC981C CZ CMACCS
1EE5 D5 PUSH D
1EE6 C5 PUSH B
1EE7 CD671E CALL LOGFCT
1EEA C1 POP B
1EEB D1 POP D
1EEC CDA11A CALL FLMUL

; EXPONENTIAL FUNCTION ROUTINE
;

EXPFC:

| | | |
|-------------|------|----------------------------|
| 1EEF CDAD1B | CALL | PUSHAC ;EXP FUNCTION |
| 1EF2 013881 | LXI | B,08138H ;LOG(2)E=1.442695 |
| 1EF5 113BAA | LXI | D,0AA3BH |
| 1EF8 CDA11A | CALL | FLMUL |
| 1EFB 3A9603 | LDA | FLACCEXP |
| 1EFE FE88 | CPI | 088H |
| 1F00 D2121B | JNC | EXPRNEXC |
| 1F03 CDA01C | CALL | INTFCT |
| 1F06 C680 | ADI | 080H |
| 1F08 C602 | ADI | 002H |
| 1F0A DA121B | JC | EXPRNEXC |
| 1F0D F5 | PUSH | PSW |
| 1F0E 21631E | LXI | H,FNONE |
| 1F11 CDA319 | CALL | FLADDM |
| 1F14 CD9F1E | CALL | FLMULLN2 |
| 1F17 F1 | POP | PSW |
| 1F18 C1 | POP | B |
| 1F19 D1 | POP | D |
| 1F1A F5 | PUSH | PSW |
| 1F1B CDB119 | CALL | FLSUB |
| 1F1E CD981C | CALL | CMACCS |
| 1F21 210000 | LXI | H,EXPCOEF |
| 1F24 CD0000 | CALL | FCTPOLY1 |
| 1F27 110000 | LXI | D,0 |
| 1F2A C1 | POP | B |
| 1F2B 4A | MOV | C,D |
| 1F2C C3A11A | JMP | FLMUL |

EXPCOEF:

| | | |
|-------------|----|------------------------|
| 1F2F 08 | DB | 8 |
| 1F30 402E94 | db | 040h, 02eh, 094h, 074h |
| 1F33 74 | | |
| 1F34 704F2E | db | 070h, 04fh, 02eh, 077h |
| 1F37 77 | | |
| 1F38 6E0288 | db | 06eh, 002h, 088h, 07ah |
| 1F3B 7A | | |
| 1F3C E6A02A | db | 0e6h, 0a0h, 02ah, 07ch |
| 1F3F 7C | | |
| 1F40 50AAAA | db | 050h, 0aah, 0aah, 07eh |
| 1F43 7E | | |
| 1F44 FFFF7F | db | 0ffh, 0ffh, 07fh, 07fh |
| 1F47 7F | | |
| 1F48 000080 | db | 000h, 000h, 080h, 081h |
| 1F4B 81 | | |
| 1F4C 000000 | db | 000h, 000h, 000h, 081h |
| 1F4F 81 | | |

;
; FLOATING POINT POLYNOMINAL EVALUATORS
;

FCTPOLY2:
1F50 CDAD1B CALL PUSHAC ;POLYNOMIAL EVALUATOR
1F53 119F1A LXI D,MULOPR ;EVALUATE P(X**2)*X
1F56 D5 PUSH D
1F57 E5 PUSH H
1F58 CDC81B CALL LDRGAC
1F5B CDA11A CALL FLMUL
1F5E E1 POP H
FCTPOLY1:
1F5F CDAD1B CALL PUSHAC ;EVALUATE P(X)
1F62 7E MOV A,M
1F63 23 INX H
1F64 CDBA1B CALL LDRGACMM
FCTPOLYL:
1F67 C1 POP B
1F68 D1 POP D
1F69 3D DCR A
1F6A C8 RZ
1F6B D5 PUSH D
1F6C C5 PUSH B
1F6D F5 PUSH PSW
1F6E E5 PUSH H
1F6F CDA11A CALL FLMUL
1F72 E1 POP H
1F73 CDCB1B CALL LDRGM
1F76 E5 PUSH H
1F77 CDB419 CALL FLADD
1F7A E1 POP H
1F7B F1 POP PSW
1F7C C3671F JMP FCTPOLYL

```
; RANDOM NUMBER GENERATOR
;

RNDFCT:
1F7F CD681C    CALL   SIGNACC ;RND FUNCTION
1F82 FA0000    JM    RNDFCTUS ;<0 - INITIALIZE SEED
1F85 219F03    LXI    H,RNDFCTSD
1F88 CDBA1B    CALL   LDRGACMM
1F8B C8        RZ    ;=0 - PREVIOUS VALUE
1F8C 013598    LXI    B,09835H
1F8F 117A44    LXI    D,0447AH
1F92 CDA11A    CALL   FLMUL ;>0 - NEXT VALUE
1F95 012868    LXI    B,06828H
1F98 1146B1    LXI    D,0B146H
1F9B CDB419    CALL   FLADD
RNDFCTUS:
1F9E CDC81B    CALL   LDRGAC ;CHANGE SEED
1FA1 7B        MOV    A,E
1FA2 59        MOV    E,C
1FA3 4F        MOV    C,A
1FA4 3680    MVI    M,080H
1FA6 2B        DCX
1FA7 46        MOV    B,M
1FA8 3680    MVI    M,080H
1FAA CD051A    CALL   NORMALIZ
1FAD 219F03    LXI    H,RNDFCTSD
1FB0 C3D41B    JMP    LDMMAC
```

```

; FLOATING POINT SINE/COSINE ROUTINES
;

COSFCT:
1FB3 210000  LXI    H,PIOVER2      ;COS FUNCTION
1FB6 CDA319  CALL    FLADDM
SINFCT:
1FB9 CDAD1B  CALL    PUSHAC  ;SIN FUNCTION
1FBC 014983  LXI    B,08349H     ;Y=X*2*PI
1FBF 11DB0F  LXI    D,00FDBH
1FC2 CDBD1B  CALL    LDACRG
1FC5 C1      POP     B
1FC6 D1      POP     D
1FC7 CD201B  CALL    FLDIV
1FCA CDAD1B  CALL    PUSHAC  ;Y=Y MOD 1
1FCD CDA01C  CALL    INTFCT
1FD0 C1      POP     B
1FD1 D1      POP     D
1FD2 CDB119  CALL    FLSUB
1FD5 210000  LXI    H,FLQUART
1FD8 CDA919  CALL    FLMMMAC
1FDB CD681C  CALL    SIGNACC
1FDE 37      STC
1FDF F20000  JP     SINFCTC
1FE2 CDA019  CALL    FLADDHLF
1FE5 CD681C  CALL    SIGNACC
1FE8 B7      ORA     A
SINFCTC:
1FE9 F5      PUSH   PSW
1FEA F4981C  CP     CMACCS
1FED 210000  LXI    H,FLQUART
1FF0 CDA319  CALL    FLADDM
1FF3 F1      POP     PSW
1FF4 D4981C  CNC   CMACCS
1FF7 210000  LXI    H,COSCOEF
1FFA C3501F  JMP   FCTPOLY2

PIOVER2:
1FFD DB0F49  db    0dbh, 00fh, 049h, 081h ;PI/2
2000 81

FLQUART:
2001 000000  db    000h, 000h, 000h, 07fh ;1/4
2004 7F

COSCOEF:
2005 05      DB     5
2006 BAD71E  db    0bah, 0d7h, 01eh, 086h
2009 86
200A 642699  db    064h, 026h, 099h, 087h
200D 87
200E 583423  db    058h, 034h, 023h, 087h
2011 87
2012 E05DA5  db    0e0h, 05dh, 0a5h, 086h
2015 86

```

2016 DA0F49 db Odah, 00fh, 049h, 083h
2019 83

```

;          ;
;  FLOATING POINT TANGENT/ARCTANGENT ROUTINES
;

```

TANFCT:

```

201A CDAD1B    CALL   PUSHAC ;TAN FUNCTION
201D CDB91F    CALL   SINFCT
2020 C1         POP    B      ;TAN(X) = SIN(X)/COS(X)
2021 E1         POP    H
2022 CDAD1B    CALL   PUSHAC
2025 EB         XCHG
2026 CDBD1B    CALL   LDACRG
2029 CDB31F    CALL   COSFCT
202C C32B1B    JMP    DIVOPR

```

ATNFCT:

```

202F CD681C    CALL   SIGNACC
2032 FC791C    CM     CMANSWR
2035 FC981C    CM     CMACCS
2038 3A9603    LDA    FLACCEXP
203B FE81         CPI   081H
203D DA0000    JC    ATNFCTC
2040 010081    LXI   B,08100H
2043 51         MOV    D,C
2044 59         MOV    E,C
2045 CD2D1B    CALL   FLDIV
2048 21A919    LXI   H,FLMMMAC
204B E5         PUSH   H
ATNFCTC:
204C 210000    LXI   H,ATNCOEF
204F CD501F    CALL   FCTPOLY2
2052 21FD1F    LXI   H,PIOVER2
2055 C9         RET

```

ATNCOEF:

```

2056 09         DB    9
2057 4AD73B    db    04ah, 0d7h, 03bh, 078h
205A 78
205B 026E84    db    002h, 06eh, 084h, 07bh
205E 7B
205F FEC12F    db    0feh, 0c1h, 02fh, 07ch
2062 7C
2063 74319A    db    074h, 031h, 09ah, 07dh
2066 7D
2067 843D5A    db    084h, 03dh, 05ah, 07dh
206A 7D
206B C87F91    db    0c8h, 07fh, 091h, 07eh
206E 7E
206F E4BB4C    db    0e4h, 0bbh, 04ch, 07eh
2072 7E
2073 6CAAAA    db    06ch, 0aah, 0aah, 07fh
2076 7F
2077 000000    db    000h, 000h, 000h, 081h
207A 81

```

VERSNDAT:
207B 30322F DB "02/03/78",0
207E 30332F
2081 373800
ENDINTRP:
2084 00 DB 0 ;END OF INTERPRETER

```
; INITIALIZATION
;
INITIALZ:
2085 21FFFF LXI H,0FFFFH
2088 227303 SHLD CURLINE
208B 210000 LXI H,INITSTCK
208E F9 SPHL
208F 228903 SHLD STCKBASE
2092 AF XRA A
2093 326503 STA PRINTFLG
2096 CD3805 call dclr
2099 CD490D CALL PRNTCRLF
209C 2100AF LXI H,LIMUPPER ;ADDRESS LAST BYTE
209F 229103 SHLD STRGLIM
20A2 11E2FF LXI D,-10*3
20A5 19 DAD D
20A6 228D03 SHLD STRGBASE
20A9 228B03 SHLD STRGFREE
20AC 1100FF LXI D,-256
20AF 19 DAD D
20B0 D2F104 JNC ERRAOM
20B3 E5 PUSH H
20B4 210080 LXI H,LIMLOWER ;ADDRESS FIRST BYTE
20B7 110C00 LXI D,12
20BA 19 DAD D
20BB 3600 MVI M,000H
20BD 23 INX H
20BE 228103 SHLD PROGBASE
20C1 E3 XTHL
20C2 D1 POP D
20C3 F9 SPHL
20C4 228903 SHLD STCKBASE
20C7 21F3FF LXI H,-13
20CA 39 DAD SP
20CB F9 SPHL
20CC EB XCHG
20CD CDE504 CALL SPACECHK
20D0 7B MOV A,E
20D1 95 SUB L
20D2 6F MOV L,A
20D3 7A MOV A,D
20D4 9C SBB H
20D5 67 MOV H,A
20D6 01FOFF LXI B,-16
20D9 09 DAD B
20DA CD490D CALL PRNTCRLF
20DD CD631D CALL PRINTINT
20E0 210000 LXI H,INITMFRE
20E3 CDAC0D CALL PRNTMSG
20E6 217B20 LXI H,VERSNDAT
20E9 CDAC0D CALL PRNTMSG
20EC CDF704 CALL CLEARPGM
20EF 214B06 LXI H,CMNDRSTR
```

20F2 220100 SHLD SYSINITJ+1
20F5 E9 PCHL

INITMFRE:
20F6 204259 DB " BYTES FREE"
20F9 544553
20FC 204652
20FF 4545
2101 0D0A0A DB CR,LF,LF
2104 424153 db "BASIC, Version of ", 0
2107 49432C
210A 205665
210D 727369
2110 6F6E20
2113 6F6620
2116 00
INITSTSP:
21EF 00 DS 30*2+LINESIZE ;INITIALIZATION STACK SPACE
INITSTCK:
2203 00 DS 20

2204 2204 END