

ALTAIR

BASIC

REFERENCE MANUAL

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# MIT'S ALTAIR BASIC

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REFERENCE MANUAL

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# MIT'S

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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.

*NOTE: MITS ALTAIR BASIC is available under license or purchase agreements. Copying or otherwise distributing MITS software outside the terms of such an agreement may be a violation of copyright laws or the agreement itself.*

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 ( ← ), usually shift/O, or an underline to eliminate the last character. Repeated use of " ← " 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  $1.70141 \times 10^{38}$ , while the smallest positive number is  $2.93874 \times 10^{-39}$ .

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:

| <u>LEGAL</u>  | <u>ILLEGAL</u>                        |
|---------------|---------------------------------------|
| IN 4K VERSION |                                       |
| A             | % (1st character must be alphabetic)  |
| Z1            | Z1A (variable name too long)          |
|               | QR (2nd character must be numeric)    |
| IN 8K VERSION |                                       |
| TP            | TO (variable names cannot be reserved |
| PSTG\$        | words)                                |
| COUNT         | 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,  $A<=B$  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,  $A<=B$  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,  $A<=B$  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,  $N \leq 10$  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 sub-script 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,-999999

```

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
ALTAIR 8
ALTAIR 88
```

```
ALTAIR 880
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         88
 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

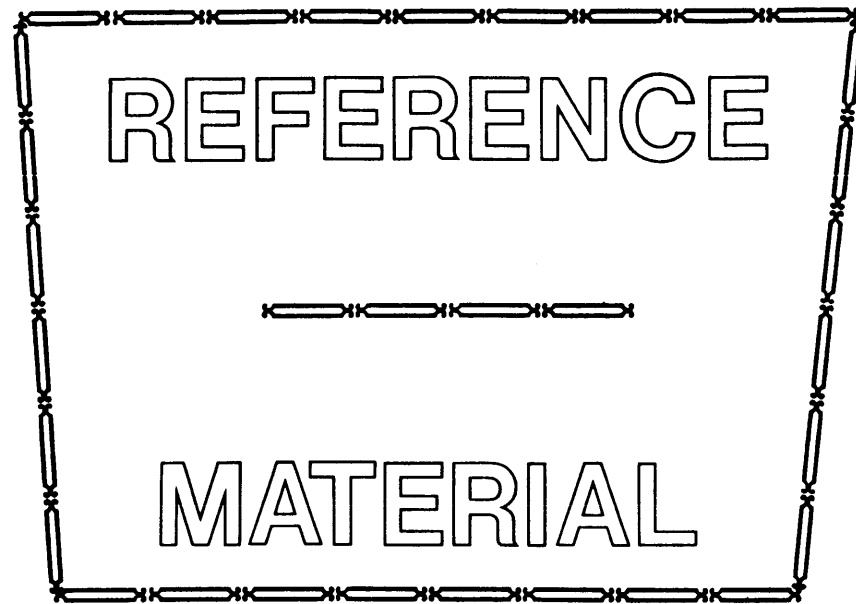
If you have an application where a user is typing in a question such as "WHAT IS THE VOLUME OF A CYLINDER OF RADIUS 5.36 FEET, OF HEIGHT 5.1 FEET?" you can use "VAL" to extract the numeric values 5.36 and 5.1 from the question. For further functions "CHR\$" and "ASC" see Appendix K.

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



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

OPERATORS

| <u>SYMBOL</u>            | <u>SAMPLE STATEMENT</u> | <u>PURPOSE/USE</u>                                                                                                                                                        |
|--------------------------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| =                        | A=100<br>LET Z=2.5      | Assigns a value to a variable<br>The LET is optional                                                                                                                      |
| -                        | B=-A                    | Negation. Note that 0-A is subtraction, while -A is negation.                                                                                                             |
| ↑<br>(usually a shift/N) | 130 PRINT X↑3           | Exponentiation (8K version)<br>(equal to X*X*X in the sample statement)<br>0↑0=1 0 to any other power = 0<br>A↑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                 |
| $<>$ | NOT EQUAL             |
| $<$  | LESS THAN             |
| $>$  | GREATER THAN          |
| $<=$ | LESS THAN OR EQUAL    |
| $>=$ | GREATER THAN OR EQUAL |

*(equal precedence for all six)*

*(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  $X<>0$  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<br>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 (mask-
                                     ed or selected by the 2) be-
                                     comes 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 " F00",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 execu-  
 tion 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 exe-  
 cution to resume at the statement after  
 the END statement. END can be used any-  
 where 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 expres-  
 sion following the equal sign, in  
 this case 1. This value is called  
 the initial value. Then the state-  
 ments 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 encoun-  
 tered, 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  $\leq$  the final value (9.3  
 in this example), or the step value  
 is negative and the new value of  
 the variable is  $\geq$  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 in-  
 itial, final and step values in a  
 FOR loop. The values of the ex-  
 pressions are computed only once,  
 before the body of the FOR....NEXT  
 loop is executed.

|                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre> 320 FOR V=9 TO 1 STEP -1 </pre>                                                                                                                        | <p>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 &amp; 320) would be executed 9 times.</p>                                                                                                                                                                                                                                                                              |
| <pre> 330 FOR W=1 TO 10: FOR W=1 TO :NEXT W:NEXT W </pre>                                                                                                    | <p>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)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <pre> GOTO      50 GOTO 100 </pre>                                                                                                                           | <p>Branches to the statement specified.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <pre> GOSUB     10 GOSUB 910 </pre>                                                                                                                          | <p>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)</p>                                                                                                                                                                                                                                                                                                                                                                        |
| <pre> IF...GOTO 32 IF X&lt;=Y+23.4 GOTO 92 </pre>                                                                                                            | <p>(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.</p>                                                                                                                                                                                                                                                                                                                                                                                                         |
| <pre> IF...THEN IF X&lt;10 THEN 5 20 IF X&lt;0 THEN PRINT "X LESS THAN 0" 25 IF X=5 THEN 50:Z=A 26 IF X&lt;0 THEN PRINT "ERROR, X NEGATIVE": GOTO 350 </pre> | <p>Branches to specified statement if the relation is True.</p> <p>Executes all of the statements on the remainder of the line after the THEN if the relation is True.</p> <p>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.</p> <p>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.</p> |

INPUT        3 INPUT V,W,W2

Requests data from the terminal (to be typed in). Each value must be separated from the preceeding 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  $4.5\text{E}-3$  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. (8K Version) Strings must be input in the same format as they are specified in DATA statements.

5 INPUT "VALUE";V

(8K Version) 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.  
(8K Version) If no variable is given, matches the most recent FOR loop.  
(8K Version) 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 (8K Version) 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 ( $\geq 5$  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  $\geq 0$  and  $\leq 255$ .

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  $\geq 0$  and  $\leq 255$ , or an FC error will occur. The address (I) must be  $\geq 0$  and  $\leq 32767$ , 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  
370 PRINT  
380 PRINT X,Y;  
390 PRINT "VALUE IS";A  
400 PRINT A2,B,

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

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.<br>(8K Version) 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<br>806 WAIT I,J | (8K Version) 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 $\geq 0$ and $\leq 255$ . |

#### 4K INTRINSIC FUNCTIONS

|        |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ABS(X) | 120 PRINT ABS(X) | Gives the absolute value of the expression X. ABS returns X if $X \geq 0$ , -X otherwise.                                                                                                                                                                                                                                                                                                                                                                                                        |
| INT(X) | 140 PRINT INT(X) | Returns the largest integer less than or equal to its argument X. For example:<br>INT(.23)=0, INT(7)=7, INT(-.1)=-1, INT(-2)=-2, INT(1.1)=1.<br>The following would round X to D decimal places:<br>$\text{INT}(X * 10^D + .5) / 10^D$                                                                                                                                                                                                                                                           |
| 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:<br>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.<br>Note that $(B-A)*\text{RND}(1)+A$ 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 $\Rightarrow 0$ and $\leq 255$ . |
| 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 $\Rightarrow 0$ and $\leq 255$ .                                                                                                                                                             |

|        |                   |                                                                                                                                                                                                                                            |
|--------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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 LOG(X)/LOG(Y). Example: The base 10 (common) log of 7 = LOG(7)/ 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\$="F00"+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\$<br>70 PRINT "F00"+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.                                                                                           |

|                                                          |                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>LEN(X\$)    220 PRINT LEN(X\$)</p>                    | <p>Gives the length of the string expression X\$ in characters (bytes). Non-printing characters and blanks are counted as part of the length.</p>                                                                                                                                                                                                                                     |
| <p>MID\$(X\$,I)<br/>      330 PRINT MID\$(X\$,I)</p>     | <p>MID\$ called with two arguments returns characters from the string expression X\$ starting at character position I. If I&gt;LEN(X\$), then MID\$ returns a null (zero length) string. If I&lt;=0 or &gt;255, an FC error occurs.</p>                                                                                                                                               |
| <p>MID\$(X\$,I,J)<br/>      340 PRINT MID\$(X\$,I,J)</p> | <p>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&gt;LEN(X\$), MID\$ returns a null string. If I or J &lt;=0 or &gt;255, an FC error occurs. If J specifies more characters than are left in the string, all characters from the Ith on are returned.</p> |
| <p>RIGHT\$(X\$,I)<br/>      320 PRINT RIGHT\$(X\$,I)</p> | <p>Gives the rightmost I characters of the string expression X\$. When I&lt;=0 or &gt;255 an FC error will occur. If I&gt;=LEN(X\$) then RIGHT\$ returns all of X\$.</p>                                                                                                                                                                                                              |
| <p>STR\$(X)    290 PRINT STR\$(X)</p>                    | <p>Gives a string which is the character representation of the numeric expression X. For instance, STR\$(3.1)=" 3.1".</p>                                                                                                                                                                                                                                                             |
| <p>VAL(X\$)    280 PRINT VAL(X\$)</p>                    | <p>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.</p>                                                                                                                                          |

#### 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.                                                                    |
| ←                | ( <i>backarrow or underline</i> ) 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.  
(8K Version) 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.
- (8K Version Only)
- 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</u>  |
|-----------------------|---------------|------------------|---------------|
| <u>LEFTMOST</u>       | <u>MIDDLE</u> | <u>RIGHTMOST</u> | <u>NUMBER</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:

|    |    |      |      |    |    |      |    |             |
|----|----|------|------|----|----|------|----|-------------|
| 7  | 6  | 5    | 4    | 3  | 2  | 1    | 0  | ← SWITCH    |
| UP | UP | DOWN | DOWN | UP | UP | DOWN | UP | ← POSITION  |
|    | 3  |      | 1    |    |    | 5    |    | ← OCTAL NO. |



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.

| <u>OCTAL ADDRESS</u> | <u>OCTAL DATA</u>            |
|----------------------|------------------------------|
| 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.

| <u>OCTAL ADDRESS</u> | <u>OCTAL DATA</u>            |
|----------------------|------------------------------|
| 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 <del>175</del>           |
| 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 "YYYYY" 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>                                                                                                                                                                                                                                                                                                                                               |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>4K VERSION</i> |                                                                                                                                                                                                                                                                                                                                                              |
| 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.<br>FC errors can occur due to: <ul style="list-style-type: none"><li>a) a negative matrix subscript (LET A(-1)=0)</li><li>b) an unreasonably large matrix subscript (&gt;32767)</li><li>c) LOG-negative or zero argument</li><li>d) SQR-negative argument</li></ul> |

- e)  $A \uparrow B$  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 *(in 8K Version)* 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.
- 8K VERSION (Includes all of the previous codes in addition to the following.)*
- 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.

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## APPENDIX E

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### 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)

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APPENDIX F

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DERIVED FUNCTIONS

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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<br>SINE      | $\text{ARCSINH}(X) = \text{LOG}(X+\text{SQR}(X*X+1))$                         |
| INVERSE HYPERBOLIC<br>COSINE    | $\text{ARGCOSH}(X) = \text{LOG}(X+\text{SQR}(X*X-1))$                         |
| INVERSE HYPERBOLIC<br>TANGENT   | $\text{ARGTANH}(X) = \text{LOG}((1+X)/(1-X))/2$                               |
| INVERSE HYPERBOLIC<br>SECANT    | $\text{ARGSECH}(X) = \text{LOG}((\text{SQR}(-X*X+1)+1)/X)$                    |
| INVERSE HYPERBOLIC<br>COSECANT  | $\text{ARGCSCH}(X) = \text{LOG}((\text{SGN}(X)*\text{SQR}(X*X+1)+1)/X)$       |
| INVERSE HYPERBOLIC<br>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 : 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 read 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 J

BASIC/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  $2 \times 12 = 4096$  rather than 4000. Now BASIC will not use any location  $\geq 3896$ .

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

| DECIMAL | CHAR. | DECIMAL | CHAR. | DECIMAL | CHAR. |     |
|---------|-------|---------|-------|---------|-------|-----|
| 000     | @     | NUL     | 043   | +       | 086   | V   |
| 001     | A     | SOH     | 044   | ,       | 087   | W   |
| 002     | B     | STX     | 045   | -       | 088   | X   |
| 003     | C     | ETX     | 046   | .       | 089   | Y   |
| 004     | D     | EOT     | 047   | /       | 090   | Z   |
| 005     | E     | ENQ     | 048   | 0       | 091   | [   |
| 006     | F     | ACK     | 049   | 1       | 092   | \   |
| 007     | G     | BEL     | 050   | 2       | 093   | ]   |
| 008     | H     | BS      | 051   | 3       | 094   | ↑   |
| 009     | I     | HT      | 052   | 4       | 095   | ←   |
| 010     | J     | LF      | 053   | 5       | 096   | `   |
| 011     | K     | VT      | 054   | 6       | 097   | a   |
| 012     | L     | FF      | 055   | 7       | 098   | b   |
| 013     | M     | CR      | 056   | 8       | 099   | c   |
| 014     | N     | SO      | 057   | 9       | 100   | d   |
| 015     | O     | SI      | 058   | :       | 101   | e   |
| 016     | P     | DLE     | 059   | ;       | 102   | f   |
| 017     | Q     | DC1     | 060   | <       | 103   | g   |
| 018     | R     | DC2     | 061   | =       | 104   | h   |
| 019     | S     | DC3     | 062   | >       | 105   | i   |
| 020     | T     | DC4     | 063   | ?       | 106   | j   |
| 021     | U     | NAK     | 064   | @       | 107   | k   |
| 022     | V     | SYN     | 065   | A       | 108   | l   |
| 023     | W     | ETB     | 066   | B       | 109   | m   |
| 024     | X     | CAN     | 067   | C       | 110   | n   |
| 025     | Y     | EM      | 068   | D       | 111   | o   |
| 026     | Z     | SUB     | 069   | E       | 112   | p   |
| 027     | (     | ESCAPE  | 070   | F       | 113   | q   |
| 028     | \     | FS      | 071   | G       | 114   | r   |
| 029     | )     | GS      | 072   | H       | 115   | s   |
| 030     | ↑     | RS      | 073   | I       | 116   | t   |
| 031     | ←     | US      | 074   | J       | 117   | u   |
| 032     |       | SPACE   | 075   | K       | 118   | v   |
| 033     | !     |         | 076   | L       | 119   | w   |
| 034     | "     |         | 077   | M       | 120   | x   |
| 035     | #     |         | 078   | N       | 121   | y   |
| 036     | \$    |         | 079   | O       | 122   | z   |
| 037     | %     |         | 080   | P       | 123   | {   |
| 038     | &     |         | 081   | Q       | 124   |     |
| 039     | '     |         | 082   | R       | 125   | }   |
| 040     | (     |         | 083   | S       | 126   | ~   |
| 041     | )     |         | 084   | T       | 127   | DEL |
| 042     | *     |         | 085   | U       |       |     |

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 preceeding 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, comparison, 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
- Parameterized 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

JEZ

## MODS TO ALTAIR MANUAL

+ recursive functions

+ MIOB stuff?

INSTR

Has any/all 34FF

53 = 1

1) NO NULL STATEMENT

2) AUTO 1000,100

GENERATE LINE NUMBERS STARTING AT 1000,

INCREMENTED BY 100. LINES INSERTED INTO

PROGRAM, TERMINATE ON ↑C.

on entering line, 1500, 10 c/c changes auto params (after line #)

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 any number of arguments, including zero.

Example:

$$\text{DEF FN uplt} \uparrow(S, b, e, u) = \text{LEFT} \uparrow(S, b-1) + u \uparrow + \text{MIOB} \uparrow(S, e, u)$$

$$\text{DEF FNA}_5 = \text{SQRT}((X(E) - X(U)) \uparrow 2 + (Y(U) - Y(D)) \uparrow 2)$$

5) INPUT PROMPT STREAM; is also defined

6) SET GOTO (ON/OFF); tracing flag

SET PRINT (ON/OFF); print flag

SET LIST 0; turns off auto c/c motion

MID\$(string, pos, len) = string expr

Index (PL#) = 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

@CTX = ↑C - BREAK

@BS = ↑H - backspace input

1) EDIT ~~← 100~~ [200] ← copies 200 to 100 before editing now line 100.

tab = - copy until following char reached (i.e. search)

i - goto to insert mode

r - goto replace mode

d - delete some char - type character preceded with \

blank - advances

2) @CTX; K abort

3) @ESC; ↑K exits insert, replace modes

4) @CR = ↑M reprint line, update if at lagging.

## 1) Conditional Expression

= IF b THEN c ELSE d END

if b is true evaluate c, skip d

if b is false evaluate d, skip c.

$$2^3 = 213$$

edit <sup>line#1, line#2</sup>

if 2nd line appears, it is copied a 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 "

tab ~~3~~ } 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,  | lists 50 to end        | 50, 70 | lists 50 thru 70 |
|             | , 50 | list 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"`  
↑ must be upper case.

Basic will punch the program on tape.

To save on WYLBUR, `login + COLLECT UNN CLEAR`

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

The program will be transmitted to the <sup>↑ upper case</sup>

Wylbur Active file. Then switch the keyboard to Wylbur by `Repeat Int >K`

and hit INT twice to stop Wylbur 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 cinb 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 cinb ;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 KEYSPP EQU KEYTAB+1
004E 00A7 KEYFN EQU KEYSPP+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 KEYHXV EQU KEYHEX+1
004E 00CE KEYUPR EQU KEYHXV+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 9B434C | 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 |    |             |                  |



01D7 A4

## KEYWRD6:

|             |    |             |              |
|-------------|----|-------------|--------------|
| 01D8 83464F | DB | KEYFOR,     | "FO", 'R+128 |
| 01DB D2     |    |             |              |
| 01DC A746CE | DB | KEYFN,      | "F", 'N+128  |
| 01DF 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     |         |                   |                         |
|             | ERRND0: |                   |                         |
| 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
031B 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   STRGTMPA:   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   CURLDATA:   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   LINESIZE    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 FLACMSB: DB 0 ;SIGN-BIT/HIGH-ORDER MANTISSA A
0396 00 FLACCEXP: DB 0 ;EXPONENT A
0397 00 FLACSSV: 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 FLSCRO: 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 FLSCRO ;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 RNDFACTSD: 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 CD8B03  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      2  %
;          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      ",",      ; OR ",",
0403 2B        DCX     H
SCANLPR2:
0404 11FFFF    LXI     D,0FFFFH      ;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,0FFFFH/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       KEYSCAN   ;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     FREELMT    ;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       H
047F 70      MOV       M,B
0480 23      INX       H
0481 D1      POP       D
0482 73      MOV       M,E        ;INSERT LINE NUMBER
0483 23      INX       H
0484 72      MOV       M,D
0485 23      INX       H
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       H
048B 13      INX     D
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        FREELMT      ;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  LHL D    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     VARIABLE
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  LHL D     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  LHL D     STRGBASE      ;CLEAR STRING TEMPORARIES,
051B 23      INX      H
051C 228F03  SHLD     STRGMTMP
051F 210000  LXI      H,0
0522 E5      PUSH     H
0523 227903  SHLD     PROGCNTR      ;SET NO CONTINUE.
0526 2A7703  LHL D     PROGCNTR
0529 C5      PUSH     B
052A C9      RET

CLEARVAR:
052B 2A8303  LHL D     VARTABLE      ;CLEAR ALL VARIABLES
052E 228503  SHLD     MATTABLE
0531 228703  SHLD     FREELIMT
0534 2A8D03  LHL D     STRGBASE
0537 228B03  SHLD     STRGFREE
053A C9      RET

CLEARPCN:
053B 210000  LXI      H,0      ;CLEAR PROGRAM POINTERS
053E 227903  SHLD     PROGCNTR
0541 2A8103  LHL D     PROGBASE
0544 2B      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     ERRASUS
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 FE0F     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 4B0D0A
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 SUBSCRIBTING  
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     KEYSCAN ;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      PRNTRCLF

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       D
067C CD0000   CALL      INPTRQST
067F D1      POP       D
0680 DA0000   JC        AUTSTMBR
0683 CDAB03   CALL      SCANNXT ;bscan ,
0686 D25706   JNC       AUTSTMN
0689 3F      CMC

AUTSTMBR:
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 2B        DCX      H          ;bscan -
0696 E5        PUSH     H
0697 CDAB03    CALL     SCANNXT ;bscan +

KEYSCANL:
069A 7E        MOV      A,M
069B FE20      CPI      " "
069D CA0000    JZ       KEYSCANH ;DELETE BLANKS
06A0 47        MOV      B,A
06A1 FE22      CPI      " "
06A3 CA0000    JZ       KEYSCANI ;SWALLOW WHOLE STRING
06A6 B7        ORA      A
06A7 CA0000    JZ       KEYSCANX
06AA FE30      CPI      "0" ;NON-KEYWORD
06AC DA0000    JC       KEYSCANK
06AF FE3C      CPI      "<" ; SO WE DON'T SCAN
06B1 DA0000    JC       KEYSCANP

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,KEYWADD ;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      KEYSCANB

KEYSCANZ:
06C8 1A        LDAX     D
06C9 B7        ORA      A
06CA F20000    JP       KEYSCANN

KEYSCANM:
06CD 78        MOV      A,B ;MATCH, GET SYMBOL NUMBER
06CE F680      ORI      080H
06D0 C30000    JMP      KEYSCANF

KEYSCANN:
06D3 23        INX      H          ;ADDRESS NEXT CHAR IN LINE
06D4 13        INX      D
06D5 0C        INR      C

KEYSCANC:
06D6 1A        LDAX     D          ;COMPARE LINE WITH KEYWORD
06D7 E67F      ANI      07FH
06D9 CDCE03    CALL     CHAMTCH ;COMPARE CHARACTERS

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06DC CAC806      JZ      KEYSCANZ
06DF 79          MOV     A,C      ;MATCH ENOUGH YET?
06E0 FE03        CPI      3
06E2 DA0000      JC      KEYSCANA

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

KEYSCANA:
06EC EB          XCHG
KEYSCANW:
06ED B6          ORA      M      ;SKIP OVER REST OF KEYWORD
06EE 23          INX      H
06EF F2ED06      JP      KEYSCANW
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      KEYSCANC
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      KEYSCAND
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      KEYSCANI
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      KEYSCANV
0723 B7          ORA      A
0724 CA0000      JZ      KEYSCANX

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      KEYSCANL

```

```
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,0      ;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      LINESYZE
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 3E0A    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

SETSTMPR:
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
07F7 2F        CMA      ;FIND NEGATIVE OF BYTE
07F8 3C        INR     A
07F9 329A03    STA     CURSLIM
07FC C9        RET

;
; DELETE COMMAND PROCESSOR
;
DELSTM:
07FD 11FFFF    LXI     D,0FFFFH ;DELETE COMMAND
0800 CDE403    CALL    SCANLPRZ
0803 E3        XTHL      ;SAVE SCAN POINTER
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

LISSTMPLP:
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 LISEDXP ;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 LISSTMPLP

```

```

      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 KEYSKAN
;
LISEDIXP:
0872 0E4E      MVI      C,LINESYZE/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-LINESYZE-3
087C 39        DAD      SP
087D F9        SPHL      ;CREATE TEXT BUFFER ON STACK
087E C5        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,LINESYZE      ;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   LISEDISB      ;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   LISEDISB      ;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

      LISEDIKT:
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 LISEDXP ;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     LINESYZE      ;ROOM AT THE INNPOT 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 B8        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+LINESIZE+3
09B8 39      DAD      SP
09B9 F9      SPHL     ;DEALLOCATE TEXT BUFFER
09BA E1      POP      H      ;RECOVER SCAN POINTER
09BB C9      RET      ;AND RETURN

; 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,TYPE$ING
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
INPSTM:
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     PROGCNTR
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     PROGCNTR
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 CACC0A    JZ       EXECUTEB      ;END STATEMENT
0B14 CDA303    CALL     SCANNXTV      ;bscan (val)
0B17 8A        DB
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
;
RUNSTM:
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,ERRNUS-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:
OBB1 3A6B03    LDA      TYPEFLG
OBB4 F5        PUSH     PSW
OBB5 D5        PUSH     D
OBB6 CD0000    CALL     VALEXPR ;bscan expr
OBB9 D1        POP      D
OBBA F1        POP      PSW

ASSIGN:
OBBD EB        XCHG      ;MAKE THE ASSIGNMENT
OBBC D5        PUSH     D ;SAVE SCAN
OBBD E5        PUSH     H ;SAVE VARIABLE
OBBE CD0000    CALL     COERCE
OBC1 C20000    JNZ      LETSTMNM
OBC4 CD0000    CALL     STRGUNIQ ;REMOVE CONFLICT PROBLEMS
OBC7 CD0000    CALL     STRGRELT ;RELEASE STRING TEMPORARY
OBCE E1        POP      H ;COPY DESCRIPTOR TO DESTINATION
OBCB CD0000    CALL     COPYVAL
OBCE E1        POP      H
OBCF C9        RET

LETSTMNM:
OBD0 CD0000    CALL     LDMMAC ;MAKE NUMERIC ASSIGNMENT
OBD3 D1        POP      D
OBD4 E1        POP      H
OBD5 C9        RET

STRGUNIQ:
OBD6 2A9303    LHLD     ACCUMLTR ;GET STRING DESCRIPTOR
OBD9 EB        XCHG      ;IS STRING IN STRING SPACE?
OBDA CD0000    CALL     STRGTEST
OBDD D0        RNC
OBDE CDC104    CALL     CMHLLTDE ;VARIABLE REFERENCE?
OBE1 D40000    CNC       STRGSTOR ;IF SO, MAKE NEW COPY
OBE4 C9        RET

```



```

;
; COERCE ACCUMULATOR TO TYPE IN A
;
COERCE:
0BE5 CDDC03    CALL    TYPECHKA
COERCEF:
0BE8 E20000    JPO     CSINGLE
0BEB CA0000    JZ      CSTRING
0BEE C30000    JMP     ERRATM

VALNUMBR:
0BF1 CD0000    CALL    VALEXPR ;bscan expr
CSINGLE:
0BF4 CDD903    CALL    TYPECHK
0BF7 E0        RPO
0BF8 C30000    JMP     ERRATM

CSTRING:
0BFB CDD903    CALL    TYPECHK
0BFE C8        RZ
0BFF C30000    JMP     ERRATM

ERRATM:
0C02 1E80      MVI     E,ERRNTM-ERRN
0C04 C3F105    JMP     ERRMSG

VALINTDE:
0C07 CDF10B    CALL    VALNUMBR      ;bscan numbr EVAL POSITIVE INTEGER EXPR
CINTPOS:
0C0A CD0000    CALL    SIGNACC ;CONVERT TO INTEGER
0C0D FA0000    JM      ERR AFC
CINTEGER:
0C10 3A9603    LDA     FLACCEXP
0C13 FE90      CPI     090H
0C15 DA0000    JC      FIXAC
0C18 018090    LXI     B,09080H
0C1B 110000    LXI     D,00000H
0C1E CD0000    CALL    FLCMP
0C21 51        MOV     D,C
0C22 C8        RZ

ERRAFC:
0C23 1E2D      MVI     E,ERRNFC-ERRN
0C25 C3F105    JMP     ERRMSG

VALBYTE2:
0C28 CDA303    CALL    SCANNXTV      ;bscan (val)
0C2B 2C        DB      ", " ;EVAL LATER BYTE ARGUMENTS
VALBYTE:
0C2C CDF10B    CALL    VALNUMBR      ;bscan numbr EVAL BYTE EXPRESSION
CBYTE:
0C2F CD0A0C    CALL    CINTPOS ;CONVERT ACC TO BYTE
0C32 7A        MOV     A,D
0C33 B7        ORA     A
0C34 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       ERR AFC      ;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      MIDSTMLM
0C9B 5F      MOV      E,A
                MIDSTMLM:
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   LHL     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   LHL     FREELIMT      ;BOUNDARY
0CB6 CDC104   CALL     CMHLLTDE      ;NC = STRING IN PROGRAM
0CB9 D1      POP      D          ;C = STRING IN BUFFER
0CBA C9      RET                ;OR STRING SPACE
```

```

;
; CASE/CONDITIONAL STATEMENT PROCESSORS
;
ONSTM:
0CBB CD2C0C    CALL    VALBYTE ;ON STATEMENT
0CBE 7E        MOV     A,M
0CBF 47        MOV     B,A
0CC0 FE8E      CPI     KEYGSB ;GOSUB RATHER THAN GOTO?
0CC2 CA0000    JZ      ONNSTMC
0CC5 CDA303    CALL    SCANNXTV ;bscan (val)
0CC8 89        DB      KEYGTO ;MUST BE GOTO...
0CC9 2B        DCX     H
0CCA 4B        ONNSTMC: MOV     C,E
0CCB 0D        ONNSTMSL: DCR     C ;LOOK FOR RIGHT LINE NUMBER
0CCC 78        MOV     A,B
0CCD CAAC0A    JZ      EXECUTES ;THEN EXECUTE STATEMENT
0CD0 CD0C04    CALL    SCANLINR
0CD3 FE2C      CPI     ","
0CD5 C0        RNZ
0CD6 C3CB0C    JMP     ONNSTMSL

IFSTM:
0CD9 CDF10B    CALL    VALNUMBR ;bscan numbr ;IF STATEMENT
0CDC 7E        MOV     A,M
0CDD FE89      CPI     KEYGTO
0CDF CA0000    JZ      IFNSTMC
0CE2 CDA303    CALL    SCANNXTV ;bscan (val)
0CE5 A0        DB      KEYTHEN
0CE6 CD0000    IFNSTMC: CALL    SIGNACC ;TEST CONDITION
0CE9 C20000    JNZ     IFNSTMCH
0CEC 1601      MVI     D,1
0CEE 0E8C      IFNSTMSK: MVI     C,KEYELS
0CF0 CD700B    CALL    SCAN2KEY ;SKIP TO CORRESPONDING ELSE
0CF3 B7        ORA     A
0CF4 C8        RZ      ;OR END OF LINE
0CF5 CDAB03    CALL    SCANNXT ;bscan +
0CF8 15        DCR     D
0CF9 C2EE0C    JNZ     IFNSTMSK
0CFC 2B        IFNSTMCH: DCX     H ;bscan -
0CFD CDAB03    CALL    SCANNXT ;bscan , ;CHOICE MADE
0D00 DA2C0B    JC      GTOSTM ;GOTO A LABEL,
0D03 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
PRTCRLF:
0D49 CD9405    CALL     PRNTCHRI ;print (val)
0D4C 0D        DB       CR ;PRINT A CR, LF
0D4D CD9405    CALL     PRNTCHRI ;print (val)
0D50 0A        DB       LF
PRTNULS:
0D51 3A9803    LDA      NULLCNT ;PRINT NULLS AFTER CR
PRTNULL:
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 CD2F0C    CALL    CBYTE
0D83 2B        DCX     H
0D84 F1        POP     PSW
0D85 FEA6      CPI     KEYSPC
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     PRSTMN
```

```

PRNTNUMS:
0DAB 23      INX      H      ;SEND STRING TO TRANSMITTER
PRNTMSG:
0DAC C5      PUSH     B
0DAD D5      PUSH     D
0DAE 01A70B   LXI      B,POPDEBCR
0DB1 C5      PUSH     B
0DB2 CD0000   CALL     VALSTRGZ      ;STRING ENDS ON ZERO
PRNTSTRT:
0DB5 CD0000   CALL     STRGRELA
0DB8 CD0000   CALL     LDDCBMM
0DBB 14      INR      D
PRNTSTRL:
0DBC 15      DCR      D
0DBD C8      RZ
0DBE 0A      LDAX     B
0DBF CD9805   CALL     PRNTCHRA      ;ac -> screen
0DC2 FE0D     CPI      CR
0DC4 CC510D   CZ       PRNTNULS
0DC7 03      INX      B
0DC8 C3BC0D   JMP      PRNTSTRL

;
; RETURN CURRENT POSITION ON OUTPUT LINE
;
POSFCT:
0DCB 3A9903   LDA      CURSPOS ;POS FUNCTION
FLOATA:
0DCE 47      MOV      B,A      ;RETURN BYTE ANSWER
0DCF AF      XRA      A
0DD0 C30000   JMP      FLOATAB

;
; PLOT STATEMENT
;
PLTSTM:
0DD3 CDF10B   CALL     VALNUMBR      ;bscan numbr      ;GET X-COORDINATE
0DD6 CD100C   CALL     CINTEGER
0DD9 D5      PUSH     D
0DDA CDA303   CALL     SCANNXTV      ;bscan (val)
0DDD 2C      DB      ", "
0DDE CDF10B   CALL     VALNUMBR      ;bscan numbr      ;GET Y-COORDINATE
0DE1 CD100C   CALL     CINTEGER
0DE4 D5      PUSH     D
0DE5 CDA303   CALL     SCANNXTV      ;bscan (val)
0DE8 2C      DB      ", "
0DE9 CDF10B   CALL     VALNUMBR      ;bscan numbr      ;GET OPERATION
0DEC CD100C   CALL     CINTEGER
0DEF 7B      MOV      A,E
0DF0 D1      POP      D
0DF1 C1      POP      B
0DF2 E5      PUSH     H
; CALL     SYSPLT
0DF3 E1      POP      H
0DF4 C9      RET

```



```

;
; INPUT/READ STATEMENT PROCESSORS
;
MSGQUES:
0DF5 3F3F00 DB "??",0
MSGREDO:
0DF8 3F5245 DB "?REDO FROM START",CR,LF,0
0DFB 444F20
0DFE 46524F
0E01 4D2053
0E04 544152
0E07 540D0A
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,LINESYZE/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-LINESYZE-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 INPSTMPR
0E3A FEA3 CPI KEYPRM
0E3C 11F60D LXI D,MSGQUES+1
0E3F C20000 JNZ INPSTMIN
0E42 CDAB03 CALL SCANNXT ;bscan +
INPSTMPR:
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
INPSTMIN:
0E57 E5 PUSH H
0E58 CD0000 CALL DATAINPT

```

```

0E5B C30000    JMP      REAINPFS

                ; READ
                ;
                REASTM:
0E5E E5        PUSH     H          ;READ STATEMENT
0E5F 2A7D03    LHLD     CURDATAP
0E62 7E        MOV      A,M
0E63 B7        ORA      A
0E64 CC0000    CZ        DATASRCH      ;GET DATA IF NECESSARY

                REAINPFS:
0E67 326403    STA      REAINPFL
0E6A C30000    JMP      REAINPLQ

                REAINPLP:
0E6D CDA303    CALL     SCANNXTV      ;bscan (val)
0E70 2C        DB       ","
0E71 E3        XTHL
0E72 7E        MOV      A,M
0E73 FE2C      CPI      ","
0E75 C40000    CNZ      DATAGET

                REAINPLQ:
0E78 E3        XTHL
0E79 7E        MOV      A,M
0E7A FEA4      CPI      KEYLINE ;LINE OPTION?
0E7C CA0000    JZ       INPSTMLN
0E7F CD0000    CALL     VARSCAN ;FIND NEXT VARIABLE TO BE INPUT
0E82 E3        XTHL      ;SAVE INPUT LIST POINTER
0E83 D5        PUSH     D      ;SAVE VARIABLE POINTER,
0E84 3A6B03    LDA      TYPEFLG ;AND TYPE
0E87 F5        PUSH     PSW
0E88 CD0000    CALL     REAINPDC      ;DECODE INPUT

                REAINPLA:
0E8B F1        POP      PSW      ;ASSIGN VALUE
0E8C D1        POP      D
0E8D CDB80B    CALL     ASSIGN
0E90 2B        DCX      H      ;bscan -
0E91 CDAB03    CALL     SCANNXT ;bscan ,
0E94 CA0000    JZ       REAINPCM
0E97 FE2C      CPI      "," ;DATA ITEMS SEPARATED BY COMMAS
0E99 C20000    JNZ      REAINPER

                REAINPCM:
0E9C E3        XTHL
0E9D 2B        DCX      H      ;bscan - ;MORE VARIABLES?
0E9E CDAB03    CALL     SCANNXT ;bscan ,
0EA1 C26D0E    JNZ      REAINPLP
0EA4 D1        POP      D      ;END OF VARLIST
0EA5 3A6403    LDA      REAINPFL
0EA8 B7        ORA      A
0EA9 EB        XCHG
0EAA C26205    JNZ      RESDTPTR
0EAD D5        PUSH     D
0EAE F5        PUSH     PSW
0EAF B6        ORA      M
0EB0 210B0E    LXI      H,MSGEXTRA

                INPSTMER:

```

0EB3 C4AC0D  
0EB6 F1

CNZ  
POP

PRNTMSG  
PSW

```

INPSTMXT:
0EB7 D1      POP      D          ;RECOVER SCAN POINTER
0EB8 21A000   LXI      H,0+LINESIZE+3
0EBB 39      DAD      SP
0EBC F9      SPHL     ;DEALLOCATE BUFFER
0EBD E1      POP      H
0EBE 227F03   SHLD    INPTBUFR   ;AND RESTORE ADDRESS OF OLD
0EC1 EB      XCHG
0EC2 D1      POP      D
0EC3 C8      RZ
0EC4 FACF0A   JM      INPSTMBR   ;BREAK TIME...
0EC7 EB      XCHG
0EC8 C3200E   JMP      INPSTMRD   ;OR REDO THE INPUT

```

```

REAINPER:
0ECB 3A6403   LDA      REAINPFL
0ECE B7      ORA      A
0ECF C2E905   JNZ      ERRDATA
0ED2 21F80D   LXI      H,MSGREDO
0ED5 3C      INR      A
0ED6 F5      PUSH     PSW
0ED7 C3B30E   JMP      INPSTMER

```

```

;
; SEARCH FOR DATA STATEMENT
;

```

```

DATAGET:
0EDA 3A6403   LDA      REAINPFL
0EDD B7      ORA      A          ;READ OR INPUT?
0EDE 11F50D   LXI      D,MSGQUES
0EE1 CA0000   JZ       DATAINPT ;INPUT

DATASRCH:
0EE4 CD690B   CALL     DATSTM   ;LOOK FOR NEXT DATA STATEMENT
0EE7 B7      ORA      A
0EE8 C20000   JNZ      DATASRCK
0EEB 23      INX      H
0EEC 7E      MOV      A,M
0EED 23      INX      H
0EEE B6      ORA      M
0EEF 23      INX      H
0EF0 1E61     MVI      E,ERRNOD-ERRN
0EF2 CAF105   JZ       ERRMSG
0EF5 5E      MOV      E,M
0EF6 23      INX      H
0EF7 56      MOV      D,M
0EF8 EB      XCHG
0EF9 227B03   SHLD    CURLDATA
0EFC EB      XCHG

DATASRCK:
0EFD CDAB03   CALL     SCANNXT ;bscan ,
0F00 FE80     CPI      KEYDAT
0F02 C2E40E   JNZ      DATASRCH
0F05 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

                INPSTMLN:
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:
0F40 110000 LXI D,0 ;NEXT STATEMENT
NEXSTML:
0F43 C40000 CNZ VARSCAN
0F46 227703 SHLD PROGCNTR
0F49 CDF909 CALL FORCHK ;VERIFY WE'RE IN FOR LOOP
0F4C C20000 JNZ ERRANF
0F4F F9 SPHL ;BACK UP STACK
0F50 D5 PUSH D
0F51 7E MOV A,M ;RECOVER SIGN OF STEPSIZE
0F52 23 INX H
0F53 F5 PUSH PSW
0F54 D5 PUSH D
0F55 CD0000 CALL LDRGACMM ;RECOVER STEP SIZE
0F58 E3 XTHL
0F59 E5 PUSH H
0F5A CD0000 CALL FLADDM ;INCREMENT CONTROL VARIABLE
0F5D E1 POP H
0F5E CD0000 CALL LDMMAC
0F61 E1 POP H
0F62 CD0000 CALL LDRGMM
0F65 E5 PUSH H
0F66 CD0000 CALL FLCMP
0F69 E1 POP H
0F6A C1 POP B
0F6B 90 SUB B
0F6C CD0000 CALL LDRGMM ;RECOVER LINE NUMBR, PROGRAM CNTR
0F6F CA0000 JZ NEXSTMC ;CHECK LIMIT
0F72 CD890B CALL TRACE
0F75 EB XCHG
0F76 227303 SHLD CURLINE
0F79 60 MOV H,B
0F7A 69 MOV L,C
0F7B C3800A JMP FORMARK

ERRANF:
0F7E 1E54 MVI E,ERRNMF-ERRN
0F80 C3F105 JMP ERRMSG

NEXSTMC:
0F83 F9 SPHL ;END OF LOOP...
0F84 2A7703 LHLD PROGCNTR
0F87 7E MOV A,M
0F88 FE2C CPI ","
0F8A C2840A JNZ EXECUTEL ;MORE INDICES?
0F8D CDAB03 CALL SCANNXT ;bscan ,
0F90 CD430F CALL NEXSTML

```

```

;
; EVALUATE AN EXPRESSION
;
VALEXPR:
0F93 2B      DCX      H      ;SCAN & EVALUATE AN EXPRESSION
0F94 1600    MVI      D,0     ;INITIAL PRECEDENCE=0
VAEXPRL:
0F96 D5      PUSH     D
0F97 0E01    MVI      C,1
0F99 CDD804  CALL     SPACESTK
0F9C CD0000  CALL     VALPRMRY      ;bscan prmry
0F9F 227103  SHLD     SCANPTR2
VAEXPRL:
0FA2 2A7103  LHLD     SCANPTR2
VAEXPRL:
0FA5 C1      POP      B      ;PREVIOUS PRECEDENCE
0FA6 78      MOV      A,B
0FA7 FE70    CPI      PREDNUM
0FA9 D4F40B  CNC      CSINGLE
0FAC 7E      MOV      A,M
0FAD 1600    MVI      D,000H
VAEXPRL:
0FAF D6B4    SUI      KEYREL ;RELATION?
0FB1 DA0000  JC       VALEXPRO
0FB4 FE03    CPI      KEYFCT-KEYREL
0FB6 D20000  JNC      VALEXPRO
0FB9 FE01    CPI      1      ;YES
0FBB 17      RAL
0FBC AA      XRA      D      ;CONVERT 0,1,2 TO 1,2,4
0FBD BA      CMP      D
0FBE 57      MOV      D,A
0FBF DAEF05  JC       ERRASN
0FC2 226F03  SHLD     SCANPTR1
0FC5 CDAB03  CALL     SCANNXT ;bscan ,
0FC8 C3AF0F  JMP      VAEXPRL

VALEXPRO:
0FCB 7A      MOV      A,D
0FCC B7      ORA      A
0FCD C20000  JNZ      VALREL
0FDD 7E      MOV      A,M
0FDF 226F03  SHLD     SCANPTR1
0FD4 D6AA    SUI      KEYOPR ;OPERATOR?
0FD6 D8      RC
0FD7 FE0A    CPI      KEYREL-KEYOPR
0FD9 D0      RNC
0FDA 5F      MOV      E,A      ;YES
0FDB CDD903  CALL     TYPECHK ;STRING OPERANDS?
0FDE B3      ORA      E      ;AND CATENATION OPERATOR?
0FDF 7B      MOV      A,E
0FE0 CA0000  JZ       VALCONCT ;YES
0FE3 83      ADD      E
0FE4 83      ADD      E
0FE5 5F      MOV      E,A
0FE6 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,VALEXP2 ;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

```



```

1025 0000      RELOPR:
                DW      RELOPRC ;COMPUTE RELATION
1027 79        RELOPR:
                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 FEAB      CPI      KEYNOT
1094 CA0000    JZ       VALUNOT
1097 FEAB      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       VALCONDF
10EE CD930F    CALL     VALEXPR ;bscan expr ;TRUE, EVALUATE THEN PORTION
10F1 1601      MVI      D,1
VALCNDTL:
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      VALCNDTL
1100 C9        RET

VALCONDF:
1101 1601      MVI      D,1
VALCNDFL:
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      VALCNDFL
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 CDA803    CALL     SCANNXT ;bscan ,
1120 79        MOV      A,C
1121 FE2F      CPI      KEYLFT-KEYFCT*2-1      ;LEFT$, MID$, or RIGHT$
1123 DA0000    JC       VALFCTAR
1126 CDA303    CALL     SCANNXTV      ;bscan (val)
1129 28        DB       "("
112A CD930F    CALL     VALEXPR ;bscan expr
112D CDFB0B    CALL     CSTRING
1130 EB        XCHG
1131 2A9303    LHL      ACCUMLTR
1134 E3        XTHL      ;PUSH STRING ONTO STACK
1135 C30000    JMP      VALFCTLK

VALFCTAR:
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,FCITABL      ;BRANCH TO APPROPRIATE ROUTINE
1143 09        DAD      B
1144 4E        MOV      C,M
1145 23        INX      H
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 CDAD0C    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   STRGTMPP     ;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
;
STRGRELA:
11A9 2A9303    LHLD    ACCUMLTR
STRGRELH:
11AC EB        XCHG
STRGRELD:
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  LHL      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  LHL      ACCUMLTR
11E9 E5      PUSH      H
11EA 86      ADD      M
11EB 1E3B    MVI      E,ERRNLS-ERRN
11ED DAF105  JC      ERRMSG
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  LHL      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
;
DIMSTML:
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,DIMSTML      ;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     ALPHACHK      ;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,TYPEISING   ;ASSUME NUMERIC VARIABLE
1244 CDAB03  CALL     SCANNXT ;bscan ,
1247 DA0000  JC       VARSCAND
124A CDBB03  CALL     ALPHACHK
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     ALPHACHK
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          ;FIRST CHAR IS NEXT FIVE BITS
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
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
VARSCANM:
12AC 13      INX      D
12AD CA0000  JZ       VARSCANX
12B0 7D      MOV      A,L
12B1 E60F    ANI      00FH        ;ADDRESS NEXT ENTRY
12B3 6F      MOV      L,A
12B4 2600    MVI      H,0
12B6 19      DAD      D
12B7 C39912  JMP      VARSCANT

VARSCANF:
12BA C5      PUSH     B          ;NOT FOUND, CREATE ENTRY
12BB 79      MOV      A,C
12BC 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

      MATSCANN:
1321 19      DAD      D
      MATSCANO:
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
      MATSCANM:
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

      MATSCANC:
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       MATSCNSD
1375 C1      POP      B
1376 03      INX      B

      MATSCNSD:
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
1381 E1      POP      H
1382 C1      POP      B
1383 05      DCR      B
1384 C26A13  JNZ      MATSCNSB
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  LHL      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    JZ      ERRaid
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
DEFSTML:
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     DEFSTML

; 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    JZ      ERRMSG ;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
;

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      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 CD0903    CALL     TYPECHK
14BA C20000    JNZ      VALFCTRL
14BD CD060B    CALL     STRGUNIQ
14C0 EB        XCHG
14C1 229303    SHLD     ACCUMLTR

```

```

; RESTORE PARAMETERS
;
VALFCTRL:
14C4 F1      POP      PSW      ;RESTORE VALUES OF PARAMETERS
14C5 D20000  JNC      VALFCTR
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     STRGTMP      ;DEALLOCATE TEMPORARY
14E0 EB      XCHG
14E1 0603    MVI      B,TYPESTRG
14E3 CD0000  CALL     COPYVALL
14E6 C3C414  JMP      VALFCTRL

VALFCTR:
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      SCANPFLG
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
STRGGBLP:
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    STRGMTPP
1563 EB        XCHG
1564 CDC104    CALL    CMHLLTDE
1567 015F15    LXI     B,STRGGBTL
156A C20000    JNZ     STRGGBHI
156D 2A8303    LHLD    VARIABLE      ;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

          STRGGBHI:
15C1 C5        PUSH     B      ;COMPARE THIS STRING ADDR TO MAX
15C2 AF        XRA      A

          STRGGBHV:
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
;
ASCFC:
1620 CD1116    CALL   LENFCTC ;ASC FUNCTION
1623 CA230C    JZ     ERR AFC
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 CD2F0C    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 STRGTMP
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
POPPERET:
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 FE0A      CPI      10
16CE 3F        CMC              ;CONVERT TO CHARACTER FORM
16CF CE30      ACI      "0"
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     VALBYTE2      ;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    JZ      ERRAFC
1747 C5        PUSH    B
1748 1EFF      MVI     E,0FFH
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
175A 3D        DCR     A
175B BE        CMP     M
175C 0600      MVI     B,0      ;START > LENI => LENO=0
175E D0        RNC
175F 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     STRGRELA      ;RETURN BYTES OF FREE STRNG SPACE
17BF CD4D15    CALL     STRGGBCL
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
FLOATAB:
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     VALPARNS
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 CD2F0C    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 CD2F0C    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 fsprom equ 0b000h
1860 B39B bootstart equ fsprom+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 CDE088 call directorylookup
1866 D20000 jnc namenotfound
1869 CD9BB3 call bootstart
186C CD0000 call checkprogram
186F CDFF04 call newload ;reset program pointers
1872 C31906 jmp cmdstr
;
; 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,l
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,l
18A8 BB cmp e
18A9 C29D18 jnz saveloop
18AC CD2DB8 call closes ;yes

```

```

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

; setfilename
; returns hl 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          inc      h
18C9 12          stax     d
18CA 13          inc      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 hl
;
checkprogram:
18D8 2A8103      lhd      progbase    ;starts here
cprogloop:
18DB 7E          mov      a,m          ;pick up line length
18DC 23          inc      h
18DD B6          ora      m
18DE 23          inc      h
18DF CA0000      jz       cprogok      ;if zero then all done
18E2 23          inc      h
18E3 23          inc      h          ;skip line number
cprogloop2:
18E4 7E          mov      a,m
18E5 B7          ora      a
18E6 23          inc      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     ACCUMLTR
1975 E5      PUSH     H
1976 2A9503   LHLD     FLACCMSB
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

FLMMMAC:
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   FLADDMGC
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
FLADDMGC:
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  SHIFTR0
19DA B4       ORA   H
19DB 219303   LXI   H,ACCUMLTR
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

```

```
FLADIFF:
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,FLACSSV ;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

SHIFTRO:
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 SHIFTRBL
```

```

;
;   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     FLMLDVEX
1AAA 79      MOV      A,C
1AAB 329B03  STA      FLSCR0
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      H
1AC5 B7      ORA      A
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      FLSCR0
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       POPHLRET
1B0C CD0000  CALL     SIGNIFY
1B0F 77      MOV      M,A
1B10 2B      DCX      H
1B11 C9      RET
```

```
          EXPRNEXC:
1B12 CD0000  CALL     SIGNACC ;RANGE EXCEEDED FOR EXP FUNCTION
1B15 2F      CMA                      ;RESULT DETERMINED BY SGN(X)
1B16 E1      POP      H
          FLMLDVEY:
1B17 B7      ORA      A
          FLMLDVEZ:
1B18 E1      POP      H
1B19 F21A1A  JP       ZEROAC
1B1C C3561A  JMP      ERRAOV
```

```
;
;  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     0FFH
1B6C D20000    JNC     FLDIVSF
1B6F 329E03    STA     FLSCR3
```

```
1B72 F1      POP      PSW      ;TRIAL SUBTRACT SUCCEEDED,
1B73 F1      POP      PSW      ;THROW AWAY SAVED DIVIDEND
1B74 37      STC
1B75 C30000  JMP      FLDIVSS
                FLDIVSF:
1B78 C1      POP      B        ;TRIAL SUBTRACT FAILED, RESTORE
1B79 E1      POP      H
                FLDIVSS:
1B7A 79      MOV      A,C
1B7B 3C      INR      A
1B7C 3D      DCR      A
1B7D 1F      RAR
1B7E FA3B1A  JM       FLROUNDV
1B81 17      RAL
1B82 7B      MOV      A,E
1B83 17      RAL
1B84 5F      MOV      E,A
1B85 7A      MOV      A,D
1B86 17      RAL
1B87 57      MOV      D,A
1B88 79      MOV      A,C
1B89 17      RAL
1B8A 4F      MOV      C,A
1B8B 29      DAD      H
1B8C 78      MOV      A,B
1B8D 17      RAL
1B8E 47      MOV      B,A
1B8F 3A9E03  LDA      FLSCR3
1B92 17      RAL
1B93 329E03  STA      FLSCR3
1B96 79      MOV      A,C
1B97 B2      ORA      D
1B98 B3      ORA      E
1B99 C2551B  JNZ      FLDIVLP
1B9C E5      PUSH     H
1B9D 219603  LXI      H,FLACCEXP
1BA0 35      DCR      M
1BA1 E1      POP      H
1BA2 C2551B  JNZ      FLDIVLP
1BA5 C3561A  JMP      ERRAOV

                ERRADO:
1BA8 1E21    MVI      E,ERRNDO-ERRN
1BAA C3F105  JMP      ERRMSG
```

```

;
; 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
;
; LODCBMM:
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,FLACCMSB
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       DECCDE
1C38 3E98    MVI      A,098H
1C3A 90      SUB      B
1C3B CD7B1A  CALL     SHIFTR0
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

DECCDE:
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
                FLCMPXT:
1C73 2F          CMA
                SIGNXTND:
1C74 17          RAL
                CMPXT:
1C75 9F          SBB      A
1C76 C0          RNZ
1C77 3C          INR      A
1C78 C9          RET

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

                SGNFCT:
1C7E CD681C      CALL     SIGNACC
                FLOATBYT:
1C81 0688        MVI      B,088H
1C83 110000      LXI      D,0
                FLOATINT:
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
                CMACCS:
1C98 219503      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          ;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
                DECODEXQ:
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
                DECDXPA:
1D1B F40000      CP       DECMULUP      ;COMBINE MANTISSA, EXPONENT
1D1E F20000      JP       DECDXAL
1D21 F5          PUSH     PSW
1D22 CD1F1B      CALL     FLDIVB10
1D25 F1          POP      PSW
1D26 3C          INR      A
                DECDXAL:
1D27 C21B1D      JNZ      DECDXPA
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    FLMLB10
1D36 F1      POP     PSW
1D37 3D      DCR     A
1D38 C9      RET

      DECDIGIT:
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    FLMLB10
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:
1D5B 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 21AB0D   LXI       H,PRNTNUMS
1D67 E3      XTHL

ENCODEHL:
1D68 EB      XCHG          ;ENCODE AN INTEGER
1D69 AF      XRA          A
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          A
1D8C F5      PUSH      PSW
1D8D CD0000   CALL      ENCODCMP

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      ENCODCMP

ENCODRND:
1DAE CDA019   CALL      FLADDFLF    ;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,ENCDCOEF

      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
1DOB 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

      ENCDRTZR:
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:
1E0F 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        ENCDXPP
1E1B 362D    MVI      M,"-"
1E1D 2F      CMA
1E1E 3C      INR      A

      ENCDXPP:
1E1F 062F    MVI      B,'0-1

      ENCDXPL:
1E21 04      INR      B
1E22 D60A    SUI      10
1E24 D2211E  JNC      ENCDXPL
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      0aah, 056h, 019h, 080h
1E5A 80
1E5B F12276   db      0f1h, 022h, 076h, 080h
1E5E 80
1E5F 45AA38   db      045h, 0aah, 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      ERR AFC
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    FLMMAC
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    DECDGADD

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
;

```

```

SQRFACT:
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     FLACCMSB
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
;

```

## EXPFACT:

```

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,FLONE
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        db
1F34 704F2E    db      070h, 04fh, 02eh, 077h
1F37 77        db
1F38 6E0288    db      06eh, 002h, 088h, 07ah
1F3B 7A        db
1F3C E6A02A    db      0e6h, 0a0h, 02ah, 07ch
1F3F 7C        db
1F40 50AAAA    db      050h, 0aah, 0aah, 07eh
1F43 7E        db
1F44 FFFF7F    db      0ffh, 0ffh, 07fh, 07fh
1F47 7F        db
1F48 000080    db      000h, 000h, 080h, 081h
1F4B 81        db
1F4C 000000    db      000h, 000h, 000h, 081h
1F4F 81        db

```

```
;
;  FLOATING POINT POLYNOMIAL 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

      FCTPOLY1L:
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    LDRGMM
1F76 E5          PUSH    H
1F77 CDB419      CALL    FLADD
1F7A E1          POP     H
1F7B F1          POP     PSW
1F7C C3671F      JMP     FCTPOLY1L
```

```
;
;  RANDOM NUMBER GENERATOR
;
```

```

RNDFACT:
1F7F CD681C    CALL    SIGNACC ;RND FUNCTION
1F82 FA0000    JM      RNDFACTUS ;<0 - INITIALIZE SEED
1F85 219F03    LXI     H,RNDFACTSD
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
RNDFACTUS:
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     H
1FA7 46        MOV     B,M
1FA8 3680      MVI     M,080H
1FAA CD051A    CALL    NORMALIZ
1FAD 219F03    LXI     H,RNDFACTSD
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 110B0F    LXI    D,00FDBH
1FC2 CDBD1B    CALL   LDACRG
1FC5 C1        POP    B
1FC6 D1        POP    D
1FC7 CD2D1B    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 | 0dah, 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 CD3806    call   dc1r
2099 CD490D    CALL   PRNTRCLF
209C 2100AF    LXI    H,LIMUPPER    ;ADDRESS LAST BYTE
209F 229103    SHLD   STRGTLIM
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 01F0FF    LXI    B,-16
20D9 09        DAD    B
20DA CD490D    CALL   PRNTRCLF
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
```