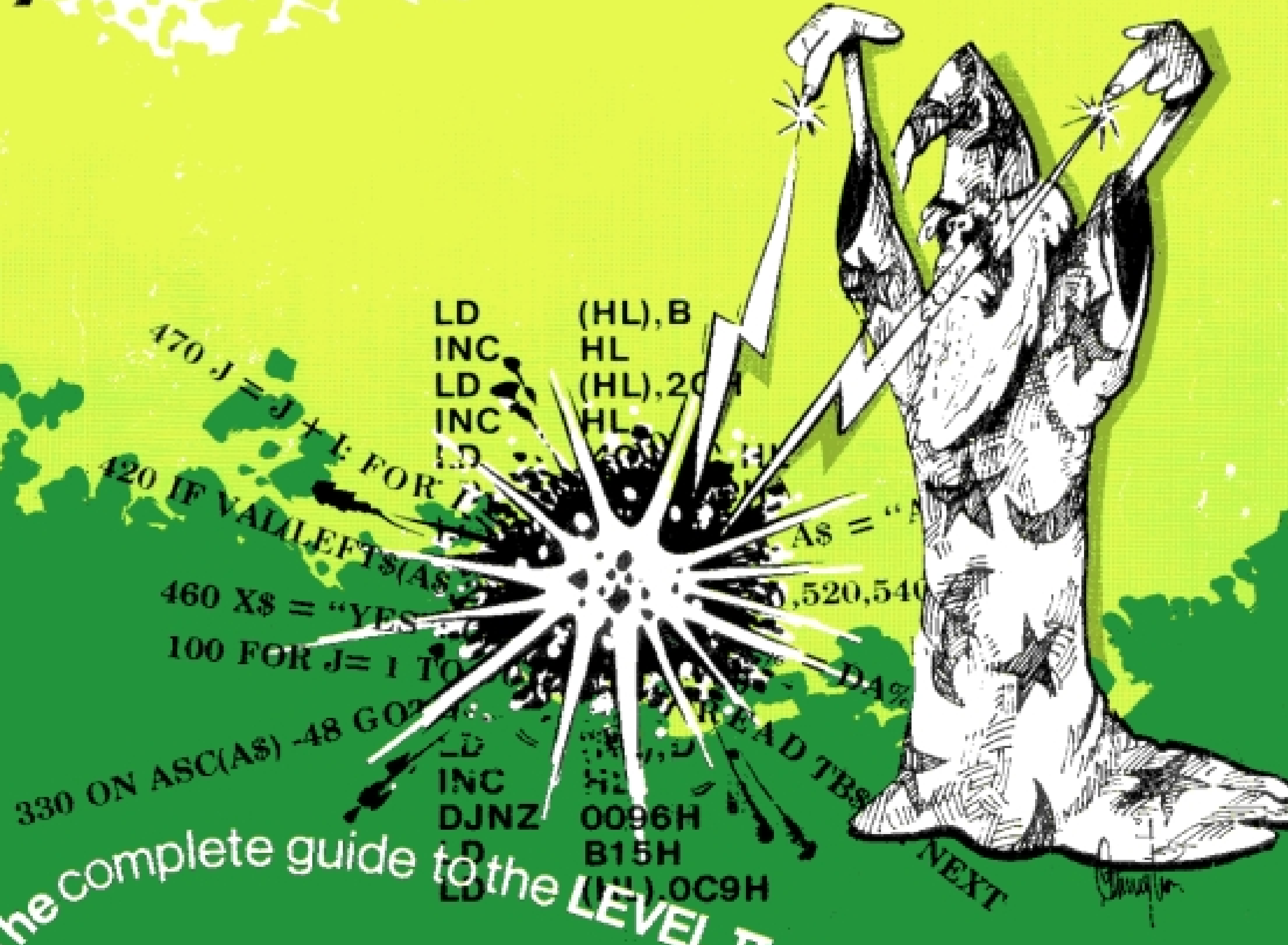
James Farvour

MICROSOFT® BASIC DECODED & OTHER MYSTERIES for the TRS-80®



The complete guide to the LEVEL II operating system & BASIC

Written by James Farvour

Microsoft BASIC Decoded & Other Mysteries

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TRS-80 Information Series Volume 2

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Microsoft BASIC Decoded
& Other Mysteries

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This book was produced with the aid of several TRS-80 computer systems, an NEC Spinterm printer, the Electric Pencil word processor with a special communications package to interface to an Itek Quadritek typesetter, plus lots of coffee and cigarettes.

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Foreword

A little over a year ago, I said to Jim Farvour, 'Jim, why don't you write a book about Microsoft BASIC and the TRS-80? You have the talent and the expertise and thousands of TRS-80 owners need help, especially me!'. Needless to say, he agreed. Now it's one thing to SAY you are going to write a book and quite another thing to actually do it.

Writing a book requires fantastic discipline, thorough knowledge of the subject matter, talent and the ability to communicate with the reader. Jim Farvour has all of the above.

This is no ordinary book. It is the most complete, clear, detailed explanation and documentation you will see on this or any similar subject.

There have been other books and pamphlets purporting to explain the TRS-80 BASIC interpreter and operating system. They have had some value, but only to experienced machine language programmers - and even then these books had many short-comings.

This book will delight both professional and beginner. Besides walking you through power-up and reset (with and without disk) there are detailed explanations of every single area of the software system's operation. Examples, tables, and flow-charts complement the most extensively commented listing you have ever seen. There are over 7000 comments to Microsoft's BASIC interpreter and operating system.

These are not the usual machine language programmer's comments whose cryptic and obscure meanings leave more questions than answers. These are English comments that anyone can understand. Not only that, but when a comment needs more explanation, you will find it on the next page.

This book even has something for anyone running Microsoft BASIC on a Z-80 based computer. Microsoft, in its great wisdom, has a system that generates similar code for similar machines. Although you may find that the code is organized differently in your Heath or Sorceror the routines are, for the most part, identical!

Is this a great book? It's an incredible book! It may well be the most useful book you will ever own.

H.C. Pennington

November 1980

Chapter 1

Introduction

Level II consists of a rudimentary operating system and a BASIC language interpreter. Taken together, they are called the Level II ROM System. There is a extension to the Level II system called the Disk Operating System DOS, and also an extension to the BASIC portion of Level II called Disk BASIC.

Both Level II and DOS are considered independent operating systems. How the two systems co-exist and co-operate is a partial subject of this book. The real purpose is to describe the fundamental operations of a Level II ROM so that assembly language programmers can make effective use of the system.

A computer without an operating system is of little use. The reason we need an operating system is to provide a means of communication between the computer and the user. This means getting it to 'listen' to the keyboard so that it will know what we want, and having it tell us what's going on by putting messages on the video. When we write programs, which tell the computer what to do, there has to be a program inside the machine that's listening to us. This program is called an operating system.

It is impossible to give an exact definition of an operating system. There are thousands of them, and each has slight variations that distinguish it from others. These variations are the result of providing specific user features or making use of hardware features unique to the machine that the operating system is designed for. In spite of the differences between operating systems, the fundamental internal routines on most are very similar - at least from a functional point of view.

The common components in a general purpose, single user system, such as Level II would consist of:

1. Drivers (programs) for all peripheral devices such as the keyboard, video, printer, and cassette.

2. A language processor capability (such as BASIC, COBOL, or FORTRAN) of some kind.

3. Supporting object time routines for any language provided. This would include math and arithmetic routines, which are implied by the presence of a language.

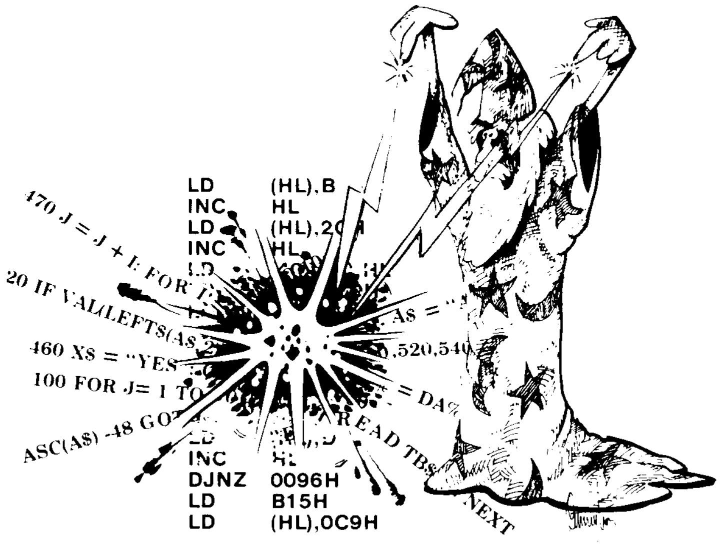
4. Ancillary support routines used by the language processor and its implied routines. These are usually invisible to the user. They manage resources such as memory and tables, and control access to peripheral devices.

5. A simple monitoring program that continually monitors the keyboard, or other system input device, looking for user input.

6. System utility commands. These vary considerably from system to system. Examples from Level II would be: EDIT, LIST, CLOAD, etc.

Remember that these definitions are very general. The exact definition of any individual component is specific to each operating system. In the case of the Level II ROMs we'll be exploring each of the components in more detail later on. First we will discuss how the operating system gets into the machine to begin with.

Generally, there are two ways an operating system can be loaded. The operating system can be permanently recorded in a special type of memory called Read Only Memory (ROM) supplied with the system. In this case the operating system is always present and needs only to be entered at its starting point, to initialize the system and begin accepting commands.



Another way of getting the operating system into the machine is to read it in from some external storage medium such as a disk or cassette. In this case, however, we need a program to read the operating system into the machine. This program is called an Initial Program Loader (or IPL), and must be entered by hand or exist in ROM somewhere on the system. For the sake of simplicity, we'll assume that all machines have at least an IPL ROM or ROM based operating system.

In the TRS-80 Model I we have a combination of both ROM and disk based operating systems. A Level II machine has a ROM system which occupies the first 12K of addressable memory. When the Power On or Reset button is pressed control is unconditionally passed to location 0 or 66 respectively. Stored at these locations are JUMPS to another region of ROM which initializes the system and then prints the user prompt 'MEMORY SIZE?'.

In a Level II system with disks, the same ROM program still occupies the first 12K of memory, however during Power On or Reset processing another operating system is read from disk and loaded into memory. This Disk Operating System (DOS) occupies 5K of RAM starting at 16K. After being loaded control is then transferred to DOS which initializes itself and displays the prompt 'DOS READY'. So, even though a ROM operating system is always present, if the machine has disks another operating system is loaded also. In this case, the Level II ROM acts as an IPL ROM.

It should be emphasized that the DOS and ROM operating systems are complementary and co-operative. Each provides specific features that the other lacks. Elementary functions required by DOS are found in ROM, and DOS contains extensions to the ROM, as well as unique capabilities of its own.

Level II And DOS Overview

Level II is a stand alone operating system that can run by itself. It is always present, and contains the BASIC interpreter plus support routines necessary to execute BASIC programs. It also has the facility to load programs from cassette, or save them onto a cassette.

A Disk Operating System, (such as TRSDOS or NEWDOS) is an extension to Level II that is loaded from disk during the IPL sequence. It differs from Level II in several ways. First, it has no BASIC interpreter, in order to key-in BASIC statements control must be passed from DOS to Level II. This is done by typing the DOS command BASIC. As well as transferring control from DOS to Level II this command also performs important initialization operations which will be discussed later. Second, the commands recognized by DOS are usually disk utility programs not embedded routines - such as those in Level II. This means they must be loaded from disk before they can be used. In turn this means that there must be an area of RAM reserved for the loading and execution of these utilities.

Memory Utilization

From the description of DOS and Level II we can see that portions of RAM will be used differently depending on which operating system is being used. Immediately after IPL the memory is setup for each of the operating systems as shown in figure 1.1 below. Notice the position of the Central Processing Unit (CPU) in each part of the figure.

```
                Level II                       Level II
               ( no disk )                   ( with disk }
0K -->      ---------------                ----------------
CPU         | Level II    |      ROM       | Level II     |
Here --->   | ROM         |   Addresses    | ROM          |
12K -->     |-------------|  ------------  |--------------|
            |Communications|     RAM       |Communications|
            |Region       |   Addresses    |Region        |
16k -->     |-------------|                |--------------|
            |             |                | Dos Nucleus  | <-- CPU
            |             |      19k -->   |--------------|     Here
            |             |                | Overlay Area |
            |    Free     |      21k -->   |--------------|
            |    Space    |                |              |
            |     List    |                |     Free     |
end of      |             |                |     Space    |
memory      |             |                |      List    |
            ---------------                ----------------

                           Figure 1
```

Figure 1.1: Memory organization after the Initial Program Load.

A Level II system with disks that has had a BASIC command executed would appear as in figure 1.2.

The first 16K of memory is dedicated to Level II and the Communications Region regardless of the operating system being used.

Starting at the end of the Communications Region or the Disk BASIC area, depending on the system being used, is the part of memory that will be used by Level II for storing a BASIC program and its variables. This part of memory can also be used by the programmer for keeping assembly language programs. A detailed description of this area for a Level II system without disks follows.

```
      0K -->   +---------------+
                  Level II
                    ROM
     12K -->   |---------------|
               |Communications |
               |    Region     |
     16k -->   |---------------|
               |  DOS Nucleus  |
     19k -->   |---------------|
               | Overlay Area  |
     19k -->   |---------------|
               |  Disk BASIC   |
     19k -->   |---------------|
               |     Free      |
               |     Space     |
  end of       |     List      |
  memory -->   +---------------+
```

Figure 1.2: Memory allocation for a system with disks, after a BASIC command.

Although figure 1.3 shows the sub-divisions of RAM as fixed they are not! All of the areas may be moved up or down depending on what actions you perform. Inserting or deleting a line from a program, for example, causes the BASIC Program Table (called the Program Statement Table or PST) to increase or decrease in size. Likewise defining a new variable would increase the length of the variables list. Since the origin of these tables may shift, their addresses are kept in fixed locations in the Communications Region. This allows the tables to be moved about as required, and provides a mechanism for letting other users know where they are.

```
            +--------------+
            | Level II and |
            | Comm. Region |
  16K -->   |--------------|
            |    BASIC     |
            |   Program    |
            |    Table     |
            |--------------|
            |    BASIC     |
            |   Program    |
            |  Variables   |
            |--------------|
            |              |
            |              |
            |              |
            |--------------|
            |    Stack     |
            |--------------|
            | String Area  |
            +--------------+
```

Figure 1.3: Allocation of memory in a Level II system without disks.

The Program Statement Table (PST) contains source statements for a BASIC program in a compressed format (reserved words have been replaced with tokens representing their meaning). The starting address for this table is fixed, but its ending address varies with the size of the program. As program statements are added or deleted, the end of the PST moves accordingly. A complete description of this table can be found in chapter 4 (page 44).

Following the PST is the Variable List Table (or VLT). This contains the names and values for all of the variables used in a BASIC program. It is partitioned into four sub-tables according to the following variable types: simple variables (non dimensioned); single dimensioned lists; doubly dimensioned lists and triple dimensioned lists. Variable names and their values are stored as they are encountered during the execution of a program. The variable table will change in size as new variables are added to a program, and removing variables will cause the table to shrink. After a variable is defined it remains in the table, until the system is reinitialized. For a full description of this table see chapter 4 (page 45).

Not shown in figure 1.3 is the Free Space List or FSL. It is a section of memory that initially extends from the end of the Communications Region to the lower boundary of the String Area. There are two parts to this list, the first is used to assign space for the PST and VLT. For these areas space is assigned from low to high memory. The second part of the FSL is used as the Stack area. This space is assigned in the opposite direction - beginning at the top of the String Area and working down towards Level II.

The stack area shown is a dynamic (changeable) table. It is used by the Level II and DOS systems as a temporary storage area for subroutine return addresses and the hardware registers. Any CALL or RST instruction will unconditionally cause the address of the following instruction to be saved (PUSH'd) onto the stack, and the stack pointer is automatically decremented to the next lower sequential address. Execution of a RET instruction (used when exiting from a subroutine) removes two bytes from the stack (the equivalent of a POP instruction) and reduces the stack pointer by two.

Storage space in the stack area can be allocated by a program, but it requires careful planning. Some BASIC subroutines such as the FOR-NEXT routine, save all values related to their operation on the stack. In the FOR NEXT case an eighteen byte block (called a frame) is PUSH'd onto the stack and left there until the FOR-NEXT loop is completed.

Before space is assigned in either part of the FSL (except for Stack instructions such as CALL or PUSH) a test is made (via a ROM call) to insure there is enough room. If there is insufficient space an Out of Memory error is given (OM). See chapter 2 (page 31) for a description of the ROM calls used to return the amount of space available in the FSL.

The last area shown in the memory profile is the string area. This is a fixed length table that starts at the end of memory and works toward low memory. The size of this area may be specified by the CLEAR command. Its default size is 50 bytes. String variables are stored in this area, however strings made equal to strings, String$ and quoted strings are stored in the PST.

Earlier it was mentioned that there are six general components that form an operating system. Because of the way Level II was put together the individual pieces for some components are scattered around in ROM, instead of being collected together in a single area. Figure 1.4 is an approximate memory map of addresses in Level II. For exact addresses and description of these regions see chapter 4.

```
                              Level II ROM

Decimal Address
           0000 -->   +--------------+
                      | Peripheral   |
                      |  Drivers     |
           1800 -->   |--------------|
                      | Math and     |
                      | Arithmetic   |
           5600 -->   |--------------|
                      |  Support     |
           6700 -->   |--------------|
                      | Monitoring   |
           7100 -->   |--------------|
                      |   BASIC      |
                      | Interpreter  |
          11000 -->   |--------------|
                      |  Utilities   |
          12000 -->   +--------------+
```

Figure 1.4: Approximate memory map of Level II addresses

The Communications Region

The Communications Region is a scratch pad memory for the Level II ROMs. An example of addresses stored here are those for the PST and the variables list. Also BASIC supports variable types that require more space than the working registers can provide, and as a result certain arithmetic operations require temporary storage in this region.

Another important use of the Communications Region is to provide a link between Level II and DOS - for passing addresses, and data, back and forth. The DOS Exit addresses and Disk BASIC addresses are kept in this area. As mentioned earlier a Level II system, with disks, begins execution in the DOS system. Control is passed from DOS to Level II only after the command BASIC has been executed (which also updates the Communications Region by storing the DOS Exits and Disk BASIC addresses).

Because Level II is in ROM it is impractical to try and modify it. Yet, changes to an operating system are a practical necessity that must be considered. In order to solve this problem the Level II system was written with jumps to an area in RAM, so that future changes could be incorporated into the ROM system. Those jumps are called DOS Exits, and on a system without a DOS they simply return to Level II. When a DOS is present, the jump addresses are changed to addresses within Disk BASIC which allows changes to be made to the way Level II operates.

The Disk BASIC addresses are used by Level II when a Disk BASIC command such as GET or PUT is encountered. They are needed because the code that supports those operations is not present in Level II. It is a part of Disk BASIC that is loaded into RAM, and since it could be loaded anywhere Level II needs some way of locating it. The Disk BASIC exits are a group of fixed addresses, known to both Level II and Disk BASIC, which allows Level II to pass control to Disk BASIC for certain verb action routines.

Another interesting aspect of the Communications Region is that it contains a section of code called the Divide Support Routine. This code is called by the division subroutines, to perform subtraction and test operations. It is copied from Level II to the RAM Communications Region during the IPL sequence. When a DOS is present it is moved from ROM to RAM by the DOS utility program BASIC.

An assembly language program using the Level II division routine on a disk system which has not had the BASIC command executed will not work because the Divide Support Routine is not in memory. Either execute the BASIC utility or copy the support routine to RAM, when executing assembly language routines that make division calls.

Level II Operation

Earlier in this chapter there was a brief description of six components which are generally found in all operating systems. Using those components as a guideline, Level II can be divided into the following six parts:

Part 1 ... Input or scanner routine.
Part 2 ... Interpretation and execution routine.
Part 3 ... Verb action routines
Part 4 ... Arithmetic and math routines
Part 5 ... I/O driver routines.
Part 6 ... System function routines.

There is another part common to all systems which is not included in the above list. This part deals with system initialization (IPL or Reset processing), and it will be discussed separately. Continuing with the six parts of Level II, we will begin at the point where the system is ready to accept the first statement or command. This is called the Input Phase.

Part 1 - Input Phase

The Input Phase is a common part of all operating systems. Its function is to accept keyboard input and respond to the commands received. In the case of a Level II system it serves a dual purpose - both system commands and BASIC program statements are processed by this code.

Entry to the Input Scan routine is at. This is an initial entry point that is usually only called once. The message 'READY' is printed, and a DOS Exit (41AC) is taken before the main loop is entered. Systems without disks jump to this point automatically, at the end of IPL processing. For systems with disks, this code is entered by the DOS utility program BASIC at the end of its processing. The Input or Scanner phase is summarized below.

1. Get next line of input from keyboard.
2. Replace reserved words with tokens.
3. Test for a system command such as RUN, CLOAD, etc. or a DIRECT STATEMENT (BASIC statement without a line number) and branch to 6 if true.
4. Store tokenized statement in program statement table.
5. Return to step 1.
6. Begin interpretation and execution

The Input Phase loop begins at 1A33. After printing the prompt >, or a line number if in the Auto Mode a CALL to 03612 is made to read the next line. Then the line number is converted from ASCII to binary with a CALL to 1E5A. The statement is scanned and reserved words are replaced by tokens (CALL 1BC0). Immediately after tokenization a DOS Exit to 41B2 is taken. Upon return a test for a line number is made. If none is found a System Command or Direct Statement is assumed, and control is passed to the Execution Driver at 1D5A. On systems without disks this test is made at 1AA4. On a disk system the test, and branch, is made at the DOS Exit 41B2 called from 1AA1.

If a line number is present the incoming line is added to the PST, the pointers linking each line are updated by the subroutine at 1AFC to 1B0E. If the line replaces an existing line, the subroutine at 2BE4 is called to move all of the following lines down over the line being replaced.

When in the Auto Mode the current line number is kept in 40E2 and 40E3 the increment between lines is stored at 40E4. The code from 1A3F to 1A73 prints and maintains the automatic line number value. Null lines (statements consisting of a line number only) are discarded. They are detected by a test at 1ABF.

Part 2 - Interpretation & Execution

Statement and command execution in a Level II system is by interpretation. This means that a routine dedicated to the statement type, or command, is called to interpret each line and perform the necessary operations. This is a common method for system command execution. With DOS, for example, separate modules are loaded for commands such as FORMAT and COPY. In some Systems, commands which are related may be combined into a single module, after the module has been loaded it decides which sub-function to execute by examining (interpreting) the name which called it.

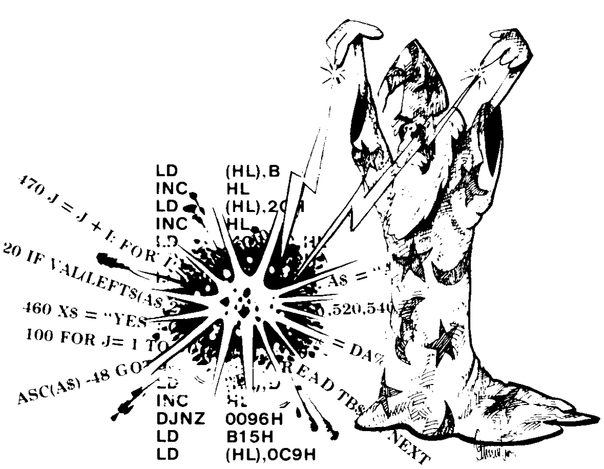
Program execution by interpretation is not common except on microcomputers, and even then only for selected languages such as BASIC and APL. The alternative to an interpreter is program compilation and execution, with the use of a compiler.

Compilers translate source statements into directly executable machine language code (called object code). The object code is then loaded into RAM as a separate step using a utility program called a Loader. After loading the object code into RAM, control is passed to it and it executes almost independently of the operating system.

Not all source code is converted to object code by a compiler. Some statements such as READ and WRITE or functions such as SINE or COSINE may be recognized by the compiler, and rather than generate code for them, subroutine calls for the specific routines will be produced.

These routines are in object code form in a library file. When the loader loads the object code, for the compiled program, any subroutine calls are satisfied (the subroutines are loaded) from the library file. A loader that will take modules from a library is called a linking loader.

An interpreter operation is much simpler by comparison. Each source statement is scanned for reserved words such as FOR, IF, GOTO, etc.. Every reserved word is replaced by a unique numeric value called a token then the tokenized source statement is saved. In Level II it is saved in the Program Statement Table. When the program is run control goes to an execution driver which scans each statement looking for a token. When one is found control is given to a routine associated with that token. These token routines (also called verb action routines) perform syntax checks such as testing for valid data types, commas in the correct place, and closing parenthesis. In a compiler entered action routine there is no syntax checking because that would have been done by the compiler - and the routine would only be called if all of the parameters were correct.



In Level II the execution phase is entered when a statement without a line number has been accepted, or when a RUN command is given. This may be a system command or a single BASIC statement that is to be executed. When a RUN command is received an entire BASIC program is to be executed. The Execution driver loop starts at 1D5A and ends at 1DE1. These addresses are deceptive though, because portions of this code are shared with other routines.

The steps in this phase are summarized as follows. For more details see figure 1.5.

1. Get the first character from the current line in the PST. If the end of the PST has been reached then return to the Input Phase.
2. If the character is not a token. go to step 6.
3. If the token is greater than **BC** it must be exactly **FA** (MID$), otherwise a syntax error is given.
4. If the token is less than **BC**. use it as an index into the verb action table.
5. Go to action routine and return to step 1.
6. Assignment section. Locate variable name, if it's not defined, then create it.
7. Call expression evaluation.
8. Return to step 1.

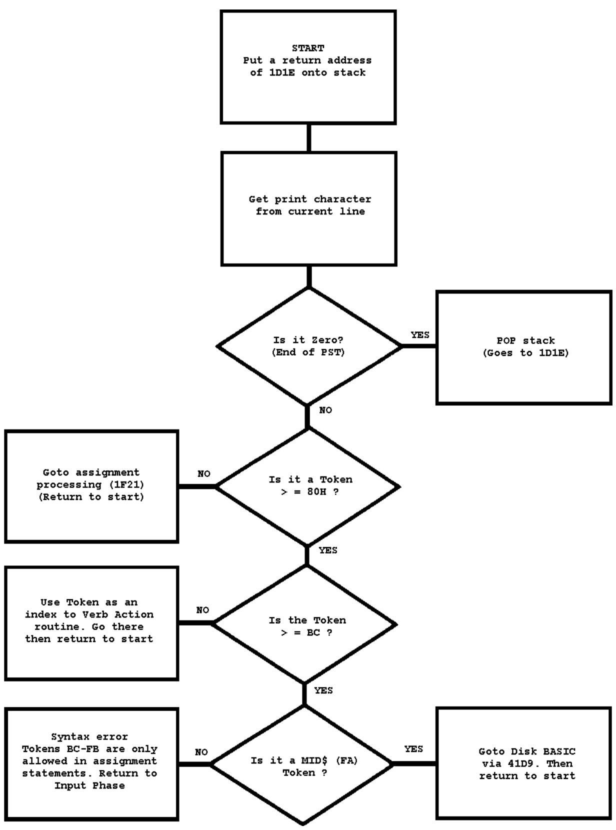


Figure 1.5: Flowchart of the execution driver routine.

The Execution driver begins by loading the first character from the current line in the PST. This character is tested to see if it is a token (**80-FA**) if not, the current line is assumed to be an assignment statement such as:

A = 1.

The assignment statement routine begins at 1F21. It is similar to the other action routines, except that it is entered directly rather than through a table look-up process. Before it is entered a return address of 1D1E in the execution driver is PUSH'd onto the stack, so it can exit as any other action routine.

The assignment routine assumes that the pointer for the current line is immediately to the left of the variable name to be assigned. It locates, or creates an entry for the variable name, tests for an equals () after the name - and then CALLs 2337. The routine at this location evaluates the expression. The result is converted to the correct mode, and stored at the variable address.

Assuming that a good token was found as the first character, a second test is made to see if it is valid as the first token in a line. Valid tokens which can occur at the start of a line are 80 - BB. The tokens BC - F9 can only occur as part of an assignment statement or in a particular sequence such as 8F (IF) 'Expression' CA (then) XXXX. The MID$ token FA is the only exception to this rule. There is a test for it at 2AE7 where a direct jump to its Disk BASIC vector (41D9) is taken. If the token is between 80 and BB it is used as an index into a verb action routine table and the address of the action routine, for that token is located. Control is then passed to that action routine which will do all syntax checking and perform the required function.

Parameters for the verb routines are the symbols in the statement following the token. Each routine knows what legitimate characters to expect, and scans the input string from left to right (starting just after the token) until the end of the parameters are reached. The end of the parameters must coincide with the end of the statement, or a syntax error is produced.

Symbols which terminate a parameter list vary for each action routine. Left parentheses ')' terminate all math and string functions. A byte of machine zeros (00) stops assignment statements, other routines may return to the execution phase after verifying the presence of the required value.

As each verb routine is completed control is returned to the Execution driver, where a test for end of statement (EOS) or a compound statement (:) is made. The EOS is one byte of machine zeros. If EOS is detected the next line from the Program Statement Table is fetched, and it becomes the current input line to the Execution driver.

When a System Command or a Direct Statement has been executed there is no pointer to the next statement, because they would have been executed from the Input Phase's input buffer. This is in a different area than the PST where BASIC program statements are stored. When the RUN command is executed, it makes the Execution driver get its input from the PST.

When the end of a BASIC program, or a system command, is reached, control is unconditionally passed to the END verb which will eventually return to the Input Phase. Any errors detected during the Execution and Interpretation phase cause control to be returned to the Input Phase after printing an appropriate error code. An exception is the syntax error, which exits directly to the edit mode.

Part 3 - Verb Action

The verb action routines are where the real work gets done. There are action routines for all of the system commands such as CLOAD, SYSTEM, CLEAR, AUTO as well as the BASIC verbs such as FOR, IF, THEN, GOTO, etc. In addition there are action routines for all the math functions and the Editor sub-commands.

Verb action routines continue analyzing the input string beginning at the point where the Execution phase found the verb token. Like the Execution phase, they examine the string in a left to right order looking for special characters such as (,,), or commas and tokens unique to the verb being executed. If a required character is missing, or if an illogical condition arises, a syntax error is generated.

The verb routines use a number of internal subroutines to assist them while executing program statements. These internal routines may be thought of as part of the verb action routines, even though they are used by many other parts of the Level II system.

A good example of an internal routine is the expression evaluation routine, which starts at 2337. Any verb routine that will allow, and has detected, an expression as one of its arguments may CALL this routine. Examples of verb action routines that allow expressions in their arguments are IF, FOR, and PRINT. In turn the expression evaluation routine will CALL other internal routines (such as 260D to find the addresses of variables in expressions being evaluated). Since subscripted variables can have expressions as their subscript, the find address routine may in turn CALL back to the expression evaluation routine!

This type of processing is called recursion, and may be forced by the following expression:

c0 = c(1a/bc(2d)/c(1*c0))

Other internal routines used by the verb action routines are : skip to end of statement 1F05; search Stack for a FOR frame 1936 and build a literal string pool entry 2865.

Any intermediate results, which may need to be carried forward, are stored Work Register Area 1 (WRA1) in the Communications Region. Some verbs such as FOR build a stack frame which can be searched for and recognized by another verb such as NEXT. All of the action routines except MID$ are entered with the registers set as shown in figure 1.6. A full list of verb action routines, and their entry points is given in chapter 4 (page 43).

```
Register            Contents
-------------------------------------------------------
   AF - Next element from code string
        following token.
        CARRY - if numeric
        No CARRY - if alpha
   BC - Address of the action routine
   DE - Address of action token in code string
   HL - Address of next element in code string
```

Figure 1.6: Register settings for verb action routine entry.

Part 4 - Arithmetic & Math

Before going into the Arithmetic and Math routines we should review the arithmetic capabilities of the Z-80 CPU and the BASIC interpreter.

The Z-80 supports 8 bit and 16 bit integer addition and subtraction. It does not support multiplication or division, nor does it support floating point operations. Its register set consists of seven pairs of 16 bit registers. All arithmetic operations must take place between these registers. Memory to register operations are not permitted. Also operations between registers are extremely restricted, especially with 16 bit quantities.

The BASIC interpreter supports all operations e.g., addition, subtraction, multiplication, and division for three types (Modes) of variables which are: integer, single precision and double precision. This support is provided by internal subroutines which do the equivalent of a hardware operation. Because of the complexity of the software, mixed mode operations, such as integer and single precision are not supported. Any attempt to mix variable types will give unpredictable results.

The sizes for the variable types supported by BASIC are as follows:

Integer………. 16 bits (15 bits 1 sign bit)
Single Precision .... 32 bits (8 bit biased exponent plus 24 bit signed mantissa)
Double Precision …. 56 bits (8 bit biased exponent plus 48 bit signed mantissa)

From this it is clear that the registers are not large enough to hold two single or double precision values, even if floating point operations were supported by the hardware. Because the numbers may be too big for the registers, and because of the sub-steps the software must go through an area of RAM must be used to support these operations

Within the Communications Region two areas have been set aside to support these operations. These areas are labeled: Working Register Area 1 (WRAl) and Working Register Area 2 (WRA2). They occupy locations 411D to 4124 and 4127 to 412E respectively. They are used to hold one or two of the operands, depending on their type, and the final results for all single and double precision operations. A description of the Working Register Area follows.

Address	Integer	Single Precision	Double Precision
411D			LSB
411E			NMSB
411F			NMSB
4120			NMSB
4121	LSB	LSB	NMSB
4122	MSB	NMSB	NMSB
4123		MSB	MSB
4124		Exponent	Exponent

```
     Where:
           LSB = Least significant byte
          NMSB = Next most significant byte
           MSB = Most significant byte

WRA2 has an identical format.
```

Figure 1.7: Working Register Area layout.

Integer

Destination Register	Operation	Source Registers
HL	Addition	HL + DE
HL	Subtraction	HL - DE
HL	Multiplication	HL * DE
WRA1	Division	DE / HL

Single Precision

Destination Register	Operation	Source Registers
WRA1	Addition	WRA1 + (BCDE)
WRA1	Subtraction	WRA1 - (BCDE)
WRA1	Multiplication	WRA1 * (BCDE)
WRA1	Division	WRA1 / (BcDE)

Double Precision

Destination Register	Operation	Source Registers
WRA1	Addition	WRA1 + WRA2
WRA1	Subtraction	WRA1 - WRA2
WRA1	Multiplication	WRA1 * WRA2
WRA1	Division	WRA1 / WRA2

Figure 1.8: Register arrangements used by arithmetic routines.

Because mixed mode operations are not supported integer operations can only take place between integers, the same being true for single and double precision values. Since there are four arithmetic operations (+, -, *, and /), and three types of values, there must be twelve arithmetic routines. Each of these routines knows what type of values it can operate on, and expects those values to be loaded into the appropriate hardware or working registers before being called. Figure 1.8 shows the register assignments used by the arithmetic routines. These assignments are not valid for the Math routines because they operate on a single value, which is always assumed to be in WRA1.

The math routines have a problem in that they must perform arithmetic operations, but they do not know the data type of the argument they were given. To overcome this another byte in the Communications Region has been reserved to indicate the data type (Mode) of the variable in WRA1. This location is called the Type flag. Its address is 40AF and contains a code indicating the data type of the current contents of WRAl. Its codes are:

CODE	DATA TYPE (MODE)
02	Integer
03	String
04	Single precision
08	Double precision

The math routines do not usually require that an argument be a particular data type, but there are some exceptions (see chapter 2, page xx, for details).

Part 5 - I/O Drivers

Drivers provide the elementary functional capabilities necessary to operate a specific device. Level II ROM contains Input/Output (I/O) drivers for the keyboard, video, parallel printer, and the cassette. The disk drivers are part of the DOS system and consequently will not be discussed.

All devices supported by Level II, with the exception of the cassette, require a Device Control Block (DCB). The drivers use the DCB's to keep track of perishable information, such as the cursor position on the video and the line count on the printer. The DCB's for the video, keyboard, and printer are part of the Level II ROM. Since information must be stored into them, they are moved from ROM to fixed addresses in RAM (within the Communications Region) during IPL.

The Level II drivers must be called for each character that is to be transmitted. The drivers cannot cope with the concept of records or files, all record blocking and de-blocking is left to the user. Level II has no general purpose record management utilities. For BASIC programs you must use routines such as PRINT and INPUT to block off each record.

When writing to a cassette, for example, the PRINT routine produces a header of 256 zeroes, followed by an A5. After the header has been written each individual variable is written as an ASCII string, with a blank space between each variable, finally terminating with a carriage return. Non string variables are converted to their ASCII equivalent.

INPUT operation begins with a search for the 256 byte header. Then the A5 is skipped and all variables are read into the line buffer until the carriage return is detected. When the INPUT is completed all variables are converted to their correct form and moved to the VLT.

The keyboard, video and line printer drivers can be entered directly or through a general purpose driver entry point at 03C2. Specific calling sequences for each of these drivers are given in chapter 2.

The cassette driver is different from the other drivers in several respects. It does its I/O in a serial bit mode whereas all of the other drivers work in a byte (or character) mode. This means that the cassette driver must transmit data on a bit-by-bit basis. The transmission of each bit is quite complex and involves many steps. Because of the timing involved, cassette I/O in a disk based system, must be done with the clock off (interrupts inhibited). For more details on cassette I/O see chapter 4.

Part 6 - System Utilities

System utilities in Level II ROM are the Direct Commands:
AUTO, CLEAR, CSAVE, CLOAD, CLEAR, CONT, DELETE, EDIT, LIST, NEW, RUN, SYSTEM, TROFF and TRON. These commands may be intermixed with BASIC program statements. However, they are executed immediately rather than being stored in the program statement table (PST). After executing a Direct Command, control returns to the Input Phase.

After an entire BASIC program has been entered (either through the keyboard or via CLOAD or LOAD, on a disk system), it must be executed by using the RUN command This command is no different from the other system commands except that it causes the BASIC program in the PST to be executed (the Execution Phase is entered). As with other system commands, when the BASIC program terminates, control is returned to the Input Phase.

System Flow During IPL

The IPL sequence has already been discussed in general terms. A complete description of the procedure follows. The description is divided into separate sections for disk and non-disk systems.

Reset Processing (non-disk)

Operations for this state begin at absolute location zero when the Reset button is pressed. From there control is passed to 0674 where the following takes place.
00UFC
A) Ports FF (255 decimal) to 80 (128 decimal) are initialized to zero. This clears the cassette and selects 64 characters per line on the video.

B) The code from 06D2 to 0707 is moved to 4000 - 4035. This initializes addresses for the restart vectors at 8, 10, 18 and 20 (hex) to jump to their normal locations in Level II. Locations 400C and 400F are initialized to RETURNs.

If a disk system is being IPL'd 400C and 400F will be modified to JUMP instructions with appropriate addresses by SYS0 during the disk part of IPL. The keyboard, video, and line printer DCB's are moved from ROM to RAM beginning at address' 4015 to 402C after moving the DCB's locations 402D, 4030, 4032 and 4033 are initialized for non-disk usage. They will be updated by SYS0 if a disk system is being IPL'd.

C) Memory from 4036 to 4062 is set to machine zeros. (00)

After memory is zeroed, control is passed to location 0075 where the following takes place:
00UFC
A) The division support routine is moved from @FT218F7-191B to 4080-40A6. This range also includes address pointers for the program statement table. Location 41E5 is initialized to:

LD A, (2C00)

B) The input buffer address for the scanner routine is set to 41E5. This will be the buffer area used to store each line received during the Input Phase.

C) The Disk BASIC entry vectors 4152-41A5 are initialized to a JMP to 012D. This will cause an L3 ERROR if any Disk BASIC features are used by the program. Next, locations 41A6-41E2 (DOS exits) are set to returns (RETs). 41E8 is set to zero and the current stack pointer (CSP) is set to 41F8. (We need a stack at this point because CALL statements will be executed during the rest of the IPL sequence and they require a stack to save the return address).

D) A subroutine at 1B8F is called. It resets the stack to 434C and initializes 40E8 to 404A. It then initializes the literal string pool table as empty, sets the current output device to the video, flushes the print buffer and turns off the cassette. The FOR statement flag is set to zero, a zero is stored as the first value on the stack and control is returned to 00B2.

E) The screen is cleared, and the message 'MEMORY SIZE' is printed. Following that, the response is accepted and tested, then stored in 40B1. Fifty words of memory are allotted for the string area and its lower boundary address is stored in 40A0.

F) Another subroutine at 1B4D is called to turn Trace off, initialize the starting address of the simple variables (40F9), and the program statement table (40A4). The variable type table 411A is set to single precision for all variables, and a RESTORE is done. Eventually control is returned to 00FC.

G) At 00FC the message 'RADIO SHACK Level II BASIC' is printed and control is passed to the Input Phase.

Reset Processing (disk systems)

Operations for this state begin at location 0000 and jump immediately to 0674. The code described in paragraphs A, B, and C for RESET processing (non-disk systems on page xx) is common to both IPL sequences. After the procedure described in paragraph C has taken place a test is made to determine if there are disks in the system. If there are no disk drives attached, control goes to 0075, otherwise.
00UFC
A) Disk drive zero is selected and positioned to track 0 sector 0. From this position the sector loader (BOOT/SYS) is read into RAM locations 4200 - 4455. Because the sector loader is written in absolute form it can be executed as soon as the READ is finished.

After the READ finishes, control is passed to the sector loader which positions the disk to track 11 sector 4. This sector is then read into an internal buffer at 4D00. The sector read contains the directory entry for SYS0 in the first 32 bytes. Using this data the sector loader computes the track and sector address for SYS0 and reads the first sector of it into 4D00.

B) Following the READ, the binary data is unpacked and moved to its specified address in RAM. Note that SYS0 is not written in absolute format so it cannot be read directly into memory and executed. It must be decoded and moved by the sector loader. Once this is done control is passed to SYS0 beginning at address 4200.

C) The following description for SYS0 applies to NEWDOS systems only. It begins by determining the amount of RAM memory and storing its own keyboard driver address in the keyboard DCB at 4015. The clock interrupt vector address (4012) is initialized to a CALL 4518. Next, more addresses are initialized and the NEWDOS header message is written.

D) After writing the header, a test for a carriage return on the keyboard is made. If one is found, the test for an AUTO procedure is skipped and control passes immediately to 4400 were the DOS Input SCANNER phase is initiated.

Assuming a carriage return was not detected the Granule Allocation Table (GAT) sector (track 11 sector 0) is read and the E0 byte is tested for a carriage return value. Again, if one is found (the default case) control goes to 4400, otherwise a 20 byte message starting at byte E0 of the GAT sector is printed. Then control is passed to 4405 where the AUTO procedure is started. Following execution of the AUTO procedure control will be passed to the DOS Input Phase which starts at 4400.

Disk BASIC

One of the DOS commands is a utility program called BASIC. In addition to providing a means of transferring control from DOS to Level II, it contains the interpretation and execution code for the following Disk BASIC statements:

```
TRSDOS and NEWDOS
CVI     CVS     CVD     MKI$    MKS$    MKD$    DEFFN  DEFUSR
TIME$   CLOSE   FIELD   GET     PUT     AS      LOAD   SAVE
KILL    MERGE   NAME    LSET    RSET    INSTR   LINE   &H
&O      CMD"S"  CMD"T"  CMD"R"  CMD"D"  CMD"A"  USR0-USR9
MID$(left side of equation)    OPEN"R"  OPEN"O" OPEN"I"

NEWDOS only
OPEN"E"  RENUM   REF   CMD"E"    CMD"DOS command"

An additional command peculiar to TRSDOS only is:
         CMD"X", <ENTER>  - Version 2.1
         CMD"#", <ENTER>  - Version 2.2 & 2.3
```

These hidden, and undocumented commands display a 'secret' copyright notice by Microsoft. Also undocumented is CMD'A' which performs the same function as CMD'S'.

Disk BASIC runs as an extension to Level II. After being loaded, it initializes the following section of the Communications Region:
00UFC
1. DOS exits at 41A6 - 41E2 are changed from RETURN's to jumps to locations within the Disk BASIC utility.

2. The Disk BASIC exits at 4152 - 41A3 are changed from JP 12D L3 syntax error jumps to addresses of verb action routines within Disk BASIC.

Following the initialization of the Communications Region, DCBs and sector buffers for three disk files are allocated at the end of Disk BASIC's code. Control is then given to the Input Scanner in Level II (1A19).

Disk BASIC will be re-entered to execute any Disk BASIC statement, or whenever a DOS Exit is taken from Level II. The Disk BASIC entry points are entered as though they are verb action routines. When finished control returns to the execution driver.

Note: Disk BASIC occupies locations 5200 - 5BAD (NEWDOS system). Each file reserved will require an additional (32 256 decimal) bytes of storage. Assembly programs should take care not to disturb this region when running in conjunction with a BASIC program.

Chapter 2

Subroutines

Level II has many useful subroutines which can be used by assembly language programs. This chapter describes a good number of the entry points to these subroutines. However there are many more routines than those described here. Using the addresses provided as a guide, all of the Level II routines dealing with a particular function may be easily located.

Before using the math or arithmetic calls study the working register concept and the mode flag (see chapter 1 page 14). Also, remember that the Division Support Routine (see chapter 1 page 10) is loaded automatically only when IPL'ing a non-disk system. On disk systems it is loaded by the Disk BASIC utility. If you are using a disk system and executing an assembly language program, which uses the any of the math or arithmetic routines that require division, you must enter BASIC first or load the Division Support Routine from within your program.

The I/O calling sequences described are for Level II only. The TRSDOS and Disk BASIC Reference Manual contains the DOS calling sequences for disk I/O.

The SYSTEM calls and BASIC functions are somewhat specialized, consequently they may not always be useful for an application written entirely in assembly language. However if you want to combine assembly and BASIC you will find these routines very useful.

I/O Calling Sequences

Input and Output (I/O) operations on a Model I machine are straight forward, being either memory mapped or port addressable. There are no DMA (direct memory access) commands and interrupt processing is not used for I/O operations.

The selection of entry points presented here is not exhaustive. It covers the more general ones and will point the reader in the right direction to find more specialized entry points, if needed.

In memory mapped operations, storing or fetching a byte from a memory location, causes the data to be transferred between the CPU register and the target device. Examples of memory mapped devices are the video, the keyboard, and the disk. Programmed I/O (via ports) is a direct transfer of data between a register and a device. The only device using port I/O is the cassette.

Keyboard Input

The keyboard is memory mapped into addresses 3800 - 3BFF. It is mapped as follows:

Bit	<------------------ Keyboard Addresses ------------------>						
	3801	3802	3804	3808	3810	3820	3840	3880
0	@	H	P	X	0	8	ENTER	SHIFT
1	A	I	Q	Y	1	9	CLEAR	
2	B	J	R	Z	2	:	BREAK	
3	C	K	S		3	;	UP ARW	
4	D	L	T		4	,	DN ARW	
5	E	M	U		5	-	LT ARW	
6	F	N	V		6	.	RT ARW	
7	G	O	W		7	/	SP BAR	

When a key is depressed, a bit in the corresponding position in the appropriate byte, is set, also bits set by a previous key are cleared. You will notice that only eight bytes (3801 - 3880) are shown in the table as having any significance. This might lead one to believe that the bytes in between could be used. Unfortunately this is not the case as the byte for any active row is repeated in all of the unused bytes. Thus all bytes are used.

CALL 002B Scan Keyboard

Performs an instantaneous scan of the keyboard. If no key is depressed control is returned to the caller with the A-register and status register set to zero. If any key (except the BREAK key) is active the ASCII value for that character is returned in the A-register. If the BREAK key is active, a RST 28 with a system request code of 01 is executed. The RST instruction results in a JUMP to the

DOS Exit 400C. On non-disk Systems the Exit returns, on disk systems control is passed to SYS0 where the request code will be inspected and ignored, because system request codes must have bit 8 on. After inspection of the code, control is returned to the caller of 002B. Characters detected at 002B are not displayed. Uses DE, status, and A register.

```
;
; SCAN KEYBOARD AND TEST FOR BREAK OR ASTERISK
;
      PUSH     DE          ; SAVE DE
      PUSH     IY          ; SAVE IY
      CALL     2BH         ; TEST FOR ANY KEY ACTIVE
      DEC      A           ; KEY ACTIVE, WAS IT A BREAK
      JR       M,NO        ; GO IF NO KEY HIT
      JR       Z,BRK       ; ZERO IF BREAK KEY ACTIVE
      INC      A           ; <A> BACK TO ORIGINAL VALUE
      CP       2AH         ; NO, TEST FOR * KEY ACTIVE
      JR       Z,AST       ; ZERO IF *
      .
      .
      .
```

CALL 0049 Wait For Keyboard Input

Returns as soon as any key on keyboard is pressed. ASCII value for character entered is returned in A- register. Uses A, status and DE registers.

```
;
; WAIT FOR NEXT CHAR FROM KEYBOARD AND TEST FOR ALPHA
;
      PUSH     DE          ; SAVE DE
      PUSH     IY          ; SAVE IY
      CALL     49H         ; WAIT TILL NEXT CHAR ENTERED
      CP       41H         ; TEST FOR LOWER THAN "A"
      JR       NC,ALPHA    ; JMP IF HIGHER THAN NUMERIC
      .
      .
```

CALL 05D9 Wait For Next Line

Accepts keyboard input and stores each character in a buffer supplied by caller. Input continues until either a carriage return or a BREAK is typed, or until the buffer is full. All edit control codes are recognized, e.g. TAB, BACKSPACE, etc. The calling sequence is: On exit the registers contain:

```
;
; GET NEXT LINE FROM KEYBOARD. EXIT IF BREAK STRUCK.
; LINE CANNOT EXCEED 25 CHARACTERS
;
SIZE  EQU      25          ; MAX LINE SIZE ALLOWED
      LD       HL,BUFF     ; BUFFER ADDRESS
      LD       B,SIZE      ; BUFFER SIZE
      CALL     5D9H        ; READ NEXT LINE FROM KEYBOARD
      JR       C,BREAK     ; JMP IF BREAK TYPED
      .
      .
BUFF  DEFS     SIZE        ; LINE BUFFER
      .
      .
```

HL	Buffer address
B	Number of characters transmitted excluding last.
C	Original buffer size
A	Last character received if a carriage return or BREAK is typed.

Carry Set if break key was terminator, reset otherwise.

If the buffer is full, the A register will contain the buffer size.

Video Output

Video I/O is another example of memory mapped I/O. It uses addresses 3C00 thru 3FFF where 3C00 represents the upper left hand corner of the video screen and 3FFF represents the lower right hand corner of the screen.

Screen control codes such as TAB, CURSON ON/OFF, BACKSPACE and such are processed by the video driver routine. The video device itself does not recognize any control codes. Codes recognized by the driver and their respective actions are:

Code (hex.)	Action
08	backspace and erase character.
0E	turn on cursor.
0F	turn off cursor.
17	select line size of 32 char/line.
18	backspace one character (left arrow)
19	skip forward one character (right arrow)
1A	skip down one line (down arrow).
1B	skip up one line (up arrow).
1C	home cursor. select 64 char/line.
1D	position cursor to Start of current line
1E	erase from cursor to end of line
1F	erase from Cursor to end of frame

Character and line size (32/64 characters per line) is selected by addressing the video controller on port FF, and sending it a function byte specifying character size. The format of that byte is:

```
           7 6 5 4 3 2 1 0  = bit
           _______________
           x x x x x x x x
not used ___|      |   |___ used for cassette
                   |        operations
                   |
                   |___ character size select

                         1 = 32 char/line
                         0 = 64 char/line
```

CALL 0033 Video Display

Displays the character in the A-register on the video. Control codes are permitted. All registers are used.

```
;
; DISPLAY MESSAGE ON VIDEO
;
      LD       HL,LIST     ; MESSAGE ADDRESS
LOOP  LD       A,(HL)      ; GET NEXT CHARACTER
      OR       A           ; TEST FOR END OF MESSAGE
      JR       Z,DONE      ; JMP IF END OF MESSAGE (DONE)
      PUSH     HL          ; NT END, PRESERVE HL
      CALL     33H         ; AND PRINT CHARACTER
      POP      HL          ; RESTORE HL
      INC      HL          ; BUMP TO NEXT CHARACTER
      JR       LOOP        ; LOOP TILL ALL PRINTED
DONE  .
      .
      .
LIST  DEFM     'THIS IS A TEST'
      DEFB     0DH         ; CARRIAGE RETURN
      DEFB     0           ; END OF MESSAGE INDICATOR
```

CALL 01C9 Clear Screen

Clears the screen, selects 64 characters and homes the cursor. All registers are used.

```
;
; CLEAR SCREEN, HOME CURSOR, SELECT 32 CHAR/LINE
; SKIP 4 LINES
;
      CALL     01C9H        ; CLEAR SCREEN
      LD       A,17H        ; SELECT 32 CHAR/LINE
      CALL     0033H        ; SEND CHAR SIZE TO VIDEO
      LD       B,4          ; NO. OF LINES TO SKIP
      LD       A,1AH        ; CODE TO SKIP ONE LINE
 LOOP PUSH     BC           ; SAVE BC
      CALL     33H          ; SKIP I LINE
      POP      BC           ; GET COUNT
      DJNZ     LOOP         ; LOOP TILL FOUR LINES DONE
```

CALL 022C Blink Asterisk

Alternately displays and clears an asterisk in the upper right hand corner. Uses all registers.

```
;
; BLINK ASTERISK THREE TIMES
;
      LD       B,3          ; NO. OF TIMES TO BLINK
LOOP  PUSH     BC           ; SAVE COUNT
      CALL     022CH        ; BLINK ASTERISK ONCE
      POP      BC           ; GET COUNT
      DJNZ     LOOP         ; COUNT 1 BLINK
DONE  .
      .
```

Printer Output

The printer is another example of a memory mapped device. Its address is 37E8H. Storing an ASCII character at that address sends it to the printer. Loading from that address returns the printer status. The status is returned as a zero status if the printer is available and a non-zero status if the printer is busy.

CALL 003B Print Character

The character contained in the C-register is sent to the printer. A line count is maintained by the driver in the DCB. When a full page has been printed (66 lines), the line count is reset and the status register returned to the caller is set to zero. Control codes recognized by the printer driver are:

CODE	ACTION
00	Returns the printer Status in the upper two bits of the A-register and sets the status as zero if not busy, and non-zero if busy.
0B	Unconditionally skips to the top of the next page.
0C	Resets the line count (DCB 4) and compares its previous value to the lines per page (DCB 3) value. If the line count was zero, no action is taken. If the line count was non-zero then a Skip to the top form is performed.
0D	Line terminator. Causes line count to be incremented and tested for full page. Usually causes the printer to begin printing.

```
;
; WRITE MESSAGE ON PRINTER. IF NOT READY WITHIN 1.5 SECONDS
; DISPLAY ERROR MESSAGE ON VIDEO
;
      LD       HL,LIST      ; ADDR OF LINE TO PRINT
START LD       B,5          ; PREPARE TO TEST FOR PRINTER
                            ; READY
LOAD  LD       DE,10H       ; LOAD DELAY COUNTERS
TST   CALL     05D1H        ; GET PRINTER STATUS
      JR       Z,RDY        ; JP IF PRINTER READY
      DEC      DE           ; NOT READY, DECREMENT
                            ; COUNTERS AND
      LD       A,D          ; TEST IF 1.5 SEC HAS ELAPSED

      OR       E            ; FIRST DE MUST = 0
      JR       NZ,TST       ; JMP IF DE NOT 0
      DJNZ     LOAD         ; LOOP TILL 1.5 SEC PASSED
      JP       NTRDY        ; GO DISPLAY 'PRINTER NOT
                            ; READY
RDY   POP      HL           ; RESTORE ADDR OF PRINT LINE

      LD       A,(HL)       ; GET NEXT CHAR TO PRINT
      OR       A            ; TEST FOR END OF LINE
      JR       Z,DONE       ; JMP IF END OF LINE
      LD       C,A          ; PUT CHAR IN PROPER REGISTER

      CALL     58DH         ; PRINT CHARACTER
      INC      HL           ; BUMP TO NEXT CHAR
      JR       START        ; LOOP TILL ALL CHARS PRINTED

NTRDY LD       HL,NTRDM     ; HL = ADDR OF NOT READY NSG

      CALL     VIDEO*       ; PRINT MEG
DONE  .                     ; LINE PRINTED ON PRINTER
      .
      .
LIST  DEFM     'THIS IS A TST
      DEFB     ODH          ; CR MAY BE REQUIRED TO START
                            ; PRINTER
      DEFB     0            ; END OF MSG FLAG

NTRDM DEFM     'PRINTER NOT READY'
      DEFB     0            ; TERMINATE PRINTED MSG
      .
      .
```

CALL 05D1 Get Printer Status

Returns the status of the line printer in the status register as zero if the printer is ready, and non-zero if not ready.

Other status bits are returned as shown:

```
7 6 5 4 3 2 1 0 = bit
---------------
x x x x 0 0 0 0

3-0  NOT USED
4    0 - PRINTER NOT SELECTED
     1 - PRINTER SELECTED
5    0 - NOT READY
     1 - READY
6    0 - PAPER
     1 - OUT OF PAPER
7    0 - NOT BUSY
     1 - BUSY
```

The out of paper and busy bits are optional on some printers.

```
;
; MONITOR PRINTER STATUS ACCORDING TO STATUS BITS ABOVE
; AND PRINT APPROPRIATE ERROR MESSAGE
;
      LD       BC,10        ; TIMER COUNT FOR PRINTER
START CALL     05D1H        ; GET PRINTER STATUS
      JR       Z,OK         ; JUMP IF READY
      BIT      7,A          ; IS IT STILL PRINTING?
      JR       Z,TIME       ; YES IF NZ. GO TIME IT
      BIT      4,A          ; NOT PRINTING. IS IT SELECTED
      JR       Z,NS         ; ZERO IF NOT SELECTED
                            ; WE HAVE A HARDWARE PROBLEM
      BIT      5,A          ; UNIT IS SELECTED AND NOT BUSY
      JR       Z,NR         ; ZERO IF NOT READY
```

```
;
; UNIT IS SELECTED, READY, AND NOT BUSY. ASSUME OUT OF PAPER
;
OP     LD       HL,OPM       ; DISPLAY OUT OF PAPER MSG
       .
       .
       JP       WAIT         ; GO WAIT FOR OPERATOR REPLY
                             ; AND RETRY OR ABORT
NR     BIT      6,A          ; UNIT IS NOT READY, TEST FOR OUT
       JR       NZ,OP        ; OF PAPER ALSO. JMP IF OUT OF PAPER

       LD       HL,NRM       ; DISPLAY NOT READY MSG
       .
       .
       JP       WAIT         ; GO WAIT FOR OPERATOR REPLY
                             ; AND RETRY OR ABORT
NB     LD       HL,NSM       ; GET DISPLAY NOT SELECTED MSG
       .
       .
       JP       WAIT         ; GO WAIT FOR OPERATOR REPLY
                             ; AND RETRY OR ABORT
TIME   POP      BC           ; GET TIME COUNTER
       DEC      BC           ; COUNT 1 LOOP
       PUSH     BC           ; SAVE NEW VALUE
       LD       A,B          ; IF ITS GONE TO ZERO
       OR       C            ; WE HAVE TIMED OUT
       JR       NZ,START     ; LOOP TILL OP FINISHED OR TIME-OUT

       LD       HL,TOM       ; DISPLAY TIMEOUT MSG
       .
       .
       JP       WAIT         ; GET OPERATOR REPLY AND RETRY
                             ; OR ABORT
       .
```

Cassette I/O

Cassette I/O is not memory mapped. Cassettes are addressed via port FF after selecting the proper unit, and I/O is done a bit at a time whereas all other devices do I/O on a byte basis (except for the RS-232-C).

Because of the bit-by-bit transfer of data, timing is extremely critical. When any of the following calls are used, the interrupt system should be disabled to guarantee that no interruptions will occur and therefore disturb the critical timing of the output.

CALL 0212 — Turn On Motor

Selects unit specified in A-register and starts motor. Units are numbered from one. All registers are used.

```
LD       A,1          ; CODE TO SELECT CASSETTE 1
CALL     0212H        ; SELECT UNIT 1, TURN ON MOTOR
.
.
.
```

CALL 0284 — Write Leader

Writes a Level II leader on currently selected unit. The leader consists of 256 (decimal) binary zeros followed by a hex A5. Uses the B and A registers.

```
LD       A,1          ; CODE TO SELECT UNIT I
CALL     212H         ; SELECT UNIT, TURN ON MOTOR
CALL     284H         ; WRITE HEADER
.
.
.
```

CALL 0296 — Read Leader

Reads the currently selected unit until an end of leader (A5) is found. An asterisk is displayed in the upper right hand corner of the video display when the end is found. Uses the A-register.

```
LD       A,1          ; CODE FOR UNIT 1
CALL     0212H        ; SELECT UNIT 1, TURN ON MOTOR
CALL     0296H        ; READ HEADER. RTN WHEN A5 ENCOUNTERED
.
.
```

CALL 0235 — Read One Byte

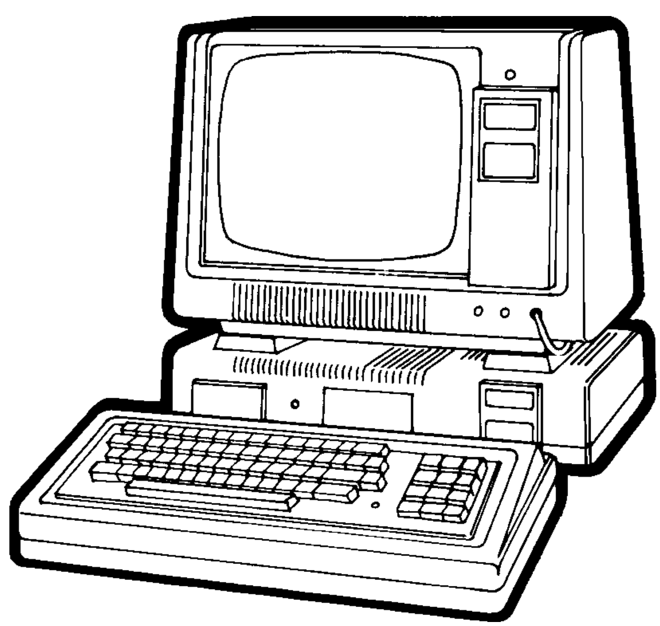
Reads one byte from the currently selected unit. The byte read is returned in the A-register. All other registers are preserved.

```
LD       A,1          ; UNIT TO SELECT
CALL     0212H        ; SELECT UNIT TURN ON MOTOR
CALL     0296H        ; SKIP OVER HEADER
CALL     0235H        ; READ FOLLOWING BYTE
CP       41H          ; TEST FOR OUR FILE NAME (A)
JR       Z,YES        ; JMP IF FILE A
.
.
.
```

CALL 0264 — Write One Byte

Writes the byte in the A-register to the currently selected unit. Preserves all register.

```
LD       A,1          ; UNIT NO. MASK.
CALL     0212H        ; SELECT UNIT, START MOTOR
CALL     0284H        ; WRITE HEADER (256 ZEROS AND A5)
LD       A,41H        ; WRITE FILE NAME (OURS IS A)
CALL     0264H        ; WRITE A AFTER HEADER
.
.
.
```



Conversion Routines

These entry points are used for converting binary values from one data type or mode to another, such as integer to floating point, and for conversions between ASCII and binary representation. These conversion routines assume the value to be converted is in WRA1 and that the mode flag (40AF) reflects the current data type. The result will be left in WRA1 and the mode flag will be updated.

Data Type Conversions

CALL 0A7F Floating Point Integer

The contents of WRA1 are converted from single or double precision to integer. No rounding is performed. All registers are used.

```
;
;  CONVERT SINGLE PRECISION VALUE TO INTEGER AND MOVE THE RESULT
;  TO IVAL
;
      LD      HL,4121H       ; ADDR OF LSB IN WRA1
      LD      DE,VALUE       ; ADDR OF LSB OF SP NO.
      LD      BC,4           ; NO OF BYTES TO MOVE
      LDIR                   ; MOVE VALUE TO WRAS
      LD      A,4            ; TYPE CODE FOR SP
      LD      (40AFH),A      ; SET TYPE TO SP
      CALL    0A7FH          ; CONVERT SP VALVE TO INTEGER
      LD      A,(4121H)      ; LSB OF INTEGER EQUIVALENT
      LD      (IVAL),A       ; SAVE IN INTEGER LOCATION
      LD      A,(4122H)      ; MSB OF INTEGER EQUIVALENT
      LD      (IVAL+1),A     ; SAVE IN INTEGER LOCATION
      .
      .
      .
VALUE DEFB    0EH            ; LSB OF 502.778 (SP)
      DEFB    B6H            ; NLSB
      DEFB    00H            ; MSB
      DEFB    88H            ; EXPONENT
IVAL  DEFB    0              ; WILL HOLD INTEGER EQUIVALENT OF
      DEFB    0              ; SP 502.778
      .
      .
```

CALL 0AB1 Integer To Single

The contents of WRA1 are converted from integer or double precision to single precision. All registers are used.

```
;
; CONVERT INTEGER VALUE TO SINGLE PRECISION AND MOVE TO
; LOCAL AREA
;
      LD      A,59H
      LD      (4121H),A      ; LSB OF INTEGER 26457 (10)
      LD      A,67H
      LD      (4122H),A      ; MEN OF INTEGER 26457 (10)
      LD      A,2            ; TYPE CODE FOR INTEGER
      LD      (40AFH),A      ; SET TYPE TO INTEGER
      CALL    0ADBH          ; CONVERT INTEGER TO SP
      LD      HL,VALUE       ; ADDR. OF AREA FOR SP EQUIVALENT
      CALL    O9CBH          ; MOVE SP VALUE FROM WRA1 TO VALUE
      .
      .
      .
VALUE DEFS    4              ; WILL HOLD 26457 IN SP FORMAT
      .
      .
```

CALL 0ADB Integer To Double

Contents of WRA1 are converted from integer or single precision to double precision. All registers are used.

```
;
;
;
      LD      A,59H
      LD      (4121H),A      ; LSB OF 26457 (10)
      LD      A,67H
      LD      (4122H),A      ; MSB OF 26457 (10)
      LD      A,2            ; TYPE CODE FOR INTEGER
      LD      (40AFH),A      ; SET TYPE TO INTEGER
      CALL    0ADBH          ; CONVERT INTEGER TO DP
      LD      DE,VALUE       ; NOW, MOVE DP VALUE
      LD      HL,411DH       ; FROM WRA1 TO LOCAL AREA
      LD      BC,B           ; NO. OF BYTES TO MOVE
      LDIR                   ; MOVE VALUE
      .
      .
      .
VALUE DEFS    8              ; HOLDS OP EQUIVALENT OF 26457
      .
      .
      .
```

ASCII To Numeric Representation

The following entry points are used to convert between binary and ASCII. When converting from ASCII to binary the HL register pair is assumed to contain the address of the ASCII string. The result will be left in WRA1 or the DE register pair and the mode flag will be updated accordingly.

CALL 1E5A ASCII To Integer

Converts the ASCII string pointed to by HL to its integer equivalent. The result is left in the DE register pair. Conversion will cease when the first non-numeric character is found.

```
;
;
;
      LD      HL,AVAL        ; HL = ADDR. OF ASCII NUMBER
      CALL    1E5AH          ; CONVERT IT TO BINARY
      LD      (BVAL),DE      ; SAVE BINARY VALUE
      .
      .
      .
AVAL  DEFM    '26457'        ; ASCII VALUE 26457
      DEFB    0              ; NON-NUMERIC STOP BYTE
BVAL  DEFW    2              ; HOLDS BINARY VALUE 26457
      .
      .
```

CALL 0E6C ASCII To Binary

Converts the ASCII string pointed to by HL to binary. If the value is less than 2**16 and does not contain a decimal point or an E or D descriptor (exponent), the string will be converted to its integer equivalent. If the string contains a decimal point or an E, or D descriptor or if it exceeds 2**16 it will be converted to single or double precision. The binary value will be left in WRA1 and the mode flag will be to the proper value.

```
;
;
;
      LD       HL,AVAL        ; ASCII NUMBER
      CALL     0E6CH          ; CONVERT ASCII TO BINARY
      .
      .
      .
AVAL  DEFM     '26457'        ; ASCII VALUE TO BE CONVERTED
      DEFB     0              ; NON-NUMERIC STOP
      .
      .
```

CALL 0E65 — ASCII To Double

Converts the ASCII string pointed to by HL to its double precision equivalent. All registers are used. The result is left in WRA1.

```
;
;
;
      LD       HL,AVAL        ; ADDR OF ASCII VALUE TO CONVERT
      CALL     0E65H          ; CONVERT VALUE TO DP
      LD       DE,BVAL        ; THEN MOVE VALUE FROM
      LD       HL,411DH       ; WRA1 TO A LOCAL AREA
      LD       BC,8           ; NO. OF BYTES TO MOVE
      LDIR                    ; MOVE DP VALUE TO LOCAL AREA
      .
      .
      .
AVAL  DEFM     '26457'        ; ASCII VALUE TO BE CONVERTED
      DEFB     0              ; NONNUMERIC STOP BYTE
BVAL  DEFS     8              ; LOCAL AREA THAT HOLDS BINARY
                              ; EQUIVALENT
      .
      .
```

Binary To ASCII Representation

The next set of entry points are used to convert from binary to ASCII.

CALL 0FAF — HL To ASCII

Converts the value in the HL register pair (assumed to be an integer) to ASCII and displays it at the current cursor position on the video. All registers are used.

```
;
;
;
      LD       HL,64B8H     ; HL = 25784 (10)
      CALL     0FAFH        ; CONVERT TO ASCII AND DISPLAY
      .
      .
```

CALL 132F — Integer To ASCII

Converts the integer in WRA1 to ASCII and stores the ASCII string in the buffer pointed to by the HL register pair. On entry, both the B and C registers should contain a 5 to avoid any commas or decimal points in the ASCII string. All registers are preserved.

```
;
;
;
      LD       HL,500
      LD       (4121H),HL     ; 500 (10) TO WRA1
      LD       BC,505H        ; SUPPRESS COMMAS OR DEC. PTS.
      LD       HL,BUFF        ; BUFFER ADDR FOR ASCII STRING
      CALL     132FH          ; CONVERT VALUE IN WRA1 TO ASCII
                              ; AND STORE IN BUFF.
      .
      .
      .
BUFF  DEFS     5              ; BUFFER FOR ASCII VALUE
      .
      .
```

CALL 0FBE — Floating to ASCII

Converts the single or double precision number in WRA1 to its ASCII equivalent. The ASCII value is stored at the buffer pointed to by the HL register pair. As the value is converted from binary to ASCII, it is formatted as it would be if a PRINT USING statement had been invoked. The format modes that can be specified are selected by loading the following values into the A, B ,and C registers.

```
REGISTER   A = 0 ... Do not edit. Strictly binary to ASCII.
REGISTER   A = X ... Where x is interpreted as:

     7 6 5 4 3 2 1 0  = BIT
     x x x x x x x x
     | | | | | | | |
     | | | | | | | +---- EXPONENTIAL NOTATION
     | | | | | | +------ RESERVED
     | | | | | +-------- SIGN FOLLOWS VALUE
     | | | | +---------- INCLUDE SIGN
     | | | +------------ PRINT LEADING $ SIGN
     | | +-------------- INCLUDE LEADING ASTERISKS
     | +---------------- PRINT COMMAS EVERY 3RD DIGIT
     +------------------ 0 - DO NOT PERFORM EDIT FUNCTIONS
                         1 - EDIT VALUE ACCORDING TO OPTIONS

REGISTER   B = The number of digits to the left of the
               decimal point.
REGISTER   C = The number of digits after the decimal point
```

```
;
;
;
      LD       HL,AVAL1       ; ASCII VALUE TO CONVERT
      CALL     0E6CH          ; CONVERT ASCII TO BINARY
      LD       HL,AVAL2       ; BUFFER ADDR. FOR CONVERTED VALUE
      LD       A,0            ; SIGNAL NO EDITING
      CALL     0FBEH          ; CONVERT SP VALUE BACK TO ASCII
      .
      .
      .
AVAL1 DEFM     '1103.25'      ; ORIGINAL ASCII VALUE
      DEFB     0              ; NON-NUMERIC STOP BYTE
AVAL2 DEFS     7              ; WILL HOLD RECONVERTED VALUE
      .
      .
```

Arithmetic Routines

These subroutines perform arithmetic operations between two operands of the same type. They assume that the operands are loaded into the correct hardware or Working Register Area, and that the data type or mode is set to the correct value. Some of these routines may require the Divide Support Routine (See Chapter 1 for details.)

Integer Routines

The following routines perform arithmetic operations between integer values in the DE and HL register pairs. The original contents of DE is always preserved and the result of the operations is always left in the HL register pair.

CALL 0BD2 Integer Add

Adds the integer value in DE to the integer in HL. The sum is left in HL and the original contents of DE are preserved. If overflow occurs (sum exceeds 2**15), both values are converted to single precision and then added. The result would be left in WRA1 and the mode flag would be updated.

```
        LD      A,2             ; TYPE CODE FOR INTEGER
        LD      (40AFH),A       ; SET TYPE TO INTEGER
        LD      HL,(VAL1)       ; LOAD FIRST VALUE
        LD      DE,(VAL2)       ; LOAD SECOND VALUE
        CALL    0BD2H           ; ADD SO THAT HL = HL + DE
        LD      A,(40AFH)       ; TEST FOR OVERFLOW
        CP      2               ; IF TYPE IS NOT INTEGER
        JR      NZ,...          ; NZ IF SUM IS SINGLE PRECISION
        .                       ; ELSE SUM IS INTEGER
        .
        .
VAL1    DEFW 25
VAL2    DEFW 20
        .
        .
```

CALL 0BC7 Integer Subtraction

Subtracts the value in DE from the value in HL. The difference is left in the HL register pair. DE is preserved. In the event of underflow, both values are converted to single precision and the subtraction is repeated. The result is left in WRA1 and the mode flag is updated accordingly.

```
        LD      A,2             ; TYPE CODE FOR INTEGER
        LD      (40AFE),A       ; SET TYPE TO INTEGER
        LD      HL,(VAL1)       ; VALUE 1
        LD      DE,(VAL2)       ; VALUE 2
        CALL    0BC7H           ; SUBTRACT DE FROM HL
        LD      A,(40AFH)       ; GET MODE FLAG
        CP      2               ; TEST FOR UNDERFLOW
        JR      NZ,...          ; NZ IF UNDERFLOW
        .
        .
        .
VAL1    DEFW   25
VAL2    DEFW   20
        .
        .
```

CALL 0BF2 Integer Multiplication

Multiplies HL by DE. The product is left in HL and DE is preserved. If overflow occurs, both values are converted to single precision and the operation is restarted. The product would be left in WRA1.

```
        LD      A,2             ; TYPE CODE FOR INTEGER
        LD      (40AFH),A       ; SET TYPE TO INTEGER
        LD      HL,(VAL1)       ; LOAD FIRST VALUE
        LD      DE,(VAL2)       ; LOAD SECOND VALUE
        CALL    0BF2H           ; HL = HL * DE
        LD      A,(40AFH)       ; GET MODE FLAG
        CP      2               ; TEST FOR OVERFLOW
        JR      NZ,...          ; NO IF VALUE HAS OVERFLOWED
        .
        .
        .
VAL1    DEFW    25
VAL2    DEFW    20
        .
        .
```

CALL 2490 Integer Division

Divides DE by HL. Both values are converted to single precision before the division is started. The quotient is left in WRA1; the mode flag is updated. The orginal contents of the DE and HL register sets are lost.

```
        LD      DE,(VAL1)       ; LOAD VALUE 1
        LD      HL,(VAL2)       ; LOAD VALUE 2
        CALL    2490H           ; DIVIDE DE BY HL. QUOTIENT TO WRA1
        .
        .
        .
VAL1    DEFW    50
VAL2    DEFW    2
```

CALL 0A39 Integer Comparison

Algebraically compares two integer values in DE and HL. The contents of DE and HL are left intact. The result of the comparison is left in the A register and status register as:

```
                  OPERATION       A REGISTER
                  ---------       ----------
                  DE > HL           A = -1
                  DE < HL           A = +1
                  DE = HL           A = 0

;
;
;
        LD      DE,(VAL1)       ; DE AND HL ARE VALUES
        LD      HL,(VAL2)       ; TO BE COMPARED
        CALL    0A39H           ; COMPARE DE TO HL
        JR      Z,...           ; Z IF DE = HL
        JP      P,...           ; POSITIVE IF DE < HL
        .
        .
```

Single Precision Routines

The next set of entry points are used for single precision operations. These routines expect one argument in the BC/DE registers and the other argument in WRA1.

CALL 0716 Single Precision Add

Add the single precision value in (BC/DE) to the single precision value in WRA1. The sum is left in WRA1

```
       LD      HL,VAL1        ; ADDR. OF ONE SP VALUE
       CALL    9B1H           ; MOVE IT TO WRA1
       LD      HL,VAL2        ; ADDR. OF 2ND SP VALUE
       CALL    9C2H           ; LOAD IT INTO BC/DE REGISTER
       CALL    716H           ; ADD VALUE 1 TO VALUE 2
       .                      ; SUM IN WRA1
       .
       .
VAL1   DEFS    4              ; HOLDS A SP VALUE
VAL2   DEFS    4              ; HOLDS A SP VALUE
       .
       .
```

CALL 0713 Single Precision Subtract

Subtracts the single precision value in (BC/DE) from the single precision value in WRA1. The difference is left in WRA1.

```
       LD      HL,VAL1        ; ADDR OF ONE SP. VALUE
       CALL    9B1H           ; MOVE IT TO WRA1
       LD      HL,VAL2        ; ADDR OF 2ND SP VALUE
       CALL    9C2H           ; LOAD IT INTO BC/DE
       CALL    713H           ; SUBTRACT DE FROM WRA1
       .                      ; DIFFERENCE LEFT IN WRA1
       .
       .
VAL1   DEFS    4              ; HOLDS A SP VALUE
VAL2   DEFS    4              ; HOLDS A SP VALUE
       .
       .
```

CALL 0847 Single Precision Multiply

Multiplies the current value in WRA1 by the value in (BC/DE). the product is left in WRA1.

```
       LD      HL,VAL1        ; ADDR OF ONE SP VALUE
       CALL    9B1H           ; MOVE IT TO WRA1
       LD      HL,VAL2        ; ADDR OF 2ND SP VALUE
       CALL    9C2H           ; LOAD 2ND VALUE INTO BC/DE
       CALL    547H           ; MULTIPLY
       .                      ; PRODUCT LEFT IN WRA1
       .
       .
VAL1   DEFS    4              ; HOLDS A SP VALUE
VAL2   DEFS    4              ; HOLDS A SP VALUE
       .
       .
```

CALL 2490 Single Precision Divide

Divides the single precision value in (BC/DE) by the single precision value in WRA1. The quotient is left in WRA1.

```
       LD      HL,VAL1        ; ADDR OF DIVISOR
       CALL    9B1H           ; MOVE IT TO WRA1
       LD      HL,VAL2        ; ADDR. OF DIVIDEND
       CALL    9C2H           ; LOAD BC/DE WITH DIVIDEND
       CALL    2490H          ; DIVIDE BC/DE BY WRA1
       .                      ; QUOTIENT IN WRA1
       .
       .
VAL1   DEFS 4 ; HOLDS DIVISOR
VAL2   DEFS 4    HOLDS DIVIDEND
       .
       .
```

CALL 0A0C Single Precision Comparison

Algebraically compares the single precision value in (BC/DE) to the single precision value WRA1. The result of the comparison is returned in the A and status as:

OPERATION	A REGISTER
(BC/DE) > WRA1	A = -1
(BC/DE) < WRA1	A = +1
(BC/DE) = WRA1	A = 0

```
;
;
;
       LD      HL,VAL1        ; ADDR OF ONE VALUE TO BE COMPARED
       CALL    9B1H           ; MOVE IT TO WRA1
       LD      HL,VAL2        ; ADDR OF 2ND VALUE TO COMPARE
       CALL    9C2H           ; LOAD 2ND VALUE INTO BC/DE
       CALL    0A0CH          ; COMPARE BC/DE TO WRA1
       JR      Z,...          ; ZERO IF (BC/DE) = WRA1
       JP      P,...          ; POSITIVE IF (BC/DE) < WRA1
       .
       .
       .
VAL1   DEFS    4              ; HOLDS A SP VALUE
VAL2   DEFS    4              ; HOLDS A SP VALUE
       .
       .
```

Double Precision Routines

The next set of routines perform operations between two double precision operands. One operand is assumed to be in WRA1 while the other is assumed to be in WRA2 (4127-412E). The result is always left in WRA1.

CALL 0C77 Double Precision Add

Adds the double precision value in WRA2 to the value in WRA1. Sum is left in WRA1.

```
       LD      A,8            ; TYPE CODE FOR DP
       LD      (40AFH),A      ; SET TYPE TO DP
       LD      DE,VAL1        ; ADDR OF 1ST DP VALUE
       LD      HL,411DH       ; ADDR OF WRA1
       CALL    9D3H           ; MOVE 1ST DP VALUE TO WRA1
       LD      DE,VAL2        ; ADDR OF 2ND DP VALUE
       LD      HL,4127H       ; ADDR OF WRA2
       CALL    9D3H           ; MOVE 2ND VALUE TO WRA2
       CALL    0C77H          ; ADD WRA2 TO WRA1. SUM IN WRA1
       .
       .
       .
VAL1   DEFS    8              ; HOLDS A DP VALUE
VAL2   DEFS    8              ; HOLDS A DP VALUE
       .
       .
```

CALL 0C70 Double Precision Subtraction

Subtracts the double precision value in WRA2 from the value in WRA1. The difference is left in WRA1.

```
        LD      A,8             ; TYPE CODE FOR DP
        LD      (40AFH),A       ; SET TYPE TO DP
        LD      DE,VAL1         ; ADDR OF 1ST DP VALUE
        LD      HL,411DH        ; ADDR OF WRA1
        CALL    9D3H            ; MOVE 1ST DP VALUE TO WRA1
        LD      DE,VAL2         ; ADDR OF 2ND DP VALUE
        LD      HL,4127H        ; ADDR OF WRA2
        CALL    9D3H            ; MOVE 2ND VALUE TO WRA2
        CALL    0C70H           ; SUBTRACT WRA2 FROM WRA1
        .                       ; DIFFERENCE IN WRA1
        .
        .
VAL1    DEFS    8               ; HOLDS A DP VALUE
VAL2    DEFS    8               ; HOLDS A DP VALUE
        .
        .
```

CALL 0DA1 Double Precision Multiply

Multiplies the double precision value in WRA1 by the value in WRA2. The product is left in WRA1.

```
        LD      A,8             ; TYPE CODE FOR DP
        LD      (40AFH),A       ; SET TYPE TO DP
        LD      DE,VAL1         ; ADDR OF 1ST DP VALUE
        LD      HL,411DH        ; ADDR OF WRA1
        CALL    9D3H            ; MOVE 1ST DP VALUE TO WRA1
        LD      DE,VAL2         ; ADDR OF 2ND DP VALUE
        LD      HL,4127H        ; ADDR OF WRA2
        CALL    9D3H            ; MOVE 2ND VALUE TO WRA2
        CALL    0DA1H           ; MULTIPLY WRA1 BY WRA2
        .                       ; PRODUCT IN WRA1
        .
        .
VAL1    DEFS    8               ; HOLDS A OF VALUE
VAL2    DEFS    8               ; HOLDS A OF VALUE
        .
        .
```

CALL 0DE5 Double Precision Divide

Divides the double precision value in WRA1 by the value in WRA2. The quotient is left in WRA1.

```
        LD      A,8             ; TYPE CODE FOR DP
        LD      (40AFH),A       ; SET TYPE TO DP
        LD      DE,VAL1         ; ADDR OF 1ST DP VALUE
        LD      HL,411DH        ; ADDR OF WRA1
        CALL    9D3H            ; MOVE 1ST DP VALUE TO WRA1
        LD      DE,VAL2         ; ADDR OF 2ND DP VALUE
        LD      HL,4127H        ; ADDR OF WRA2
        CALL    9D3H            ; MOVE 2ND VALUE TO WRA2
        CALL    0DE5H           ; DIVIDE WRA1 BY WRA2
        .                       ; QUOTIENT LEFT IN WRA1
        .
        .
VAL1    DEFS      8  HOLDS A OF VALUE
VAL2    DEFS      8  HOLDS A OF VALUE
        .
        .
```

CALL 0A78 Double Precision Compare

Compares the double precision value in WRA1 to the value in WRA2. Both register areas are left intact. The result of the comparison is left in the A and status registers as:

OPERATION	A REGISTER
WRA1 > WRA2	A = -1
WRA1 < WRA2	A = +1
WRA1 = WRA2	A = 0

```
;
;
;
        LD      A,8             ; TYPE CODE FOR DP
        LD      (40AFH),A       ; SET TYPE FLAG TO DP
        LD      DE,VAL1         ; ADDR OF 1ST DP VALUE
        LD      HL,411DH        ; ADDR OF WRA1
        CALL    9D3H            ; MOVE 1ST VALUE TO WRA1
        LD      DE,VAL2         ; ADDR OF 2ND DP VALUE
        LD      HL,4127H        ; ADDR OF WRA2
        CALL    9D3H            ; MOVE 2ND VALUE TO WRA2
        CALL    0A78H           ; COMPARE WRA1 TO WRA2
        JR      Z,...           ; ZERO IF THEY ARE EQUAL
        JP      P,...           ; POSITIVE IF WRA1 < WRA2
        .
        .
```

Math Routines

All of the following subroutines assume that location 40AF contains a code indicating the data type or mode of the variable e.g., integer, single precision, or double precision, and that the variable itself is in Working Register Area 1 (WRA1). Also, the floating point Division Support Routine must be loaded at 4080.

CALL 0977 Absolute Value ABS (N)

Converts the value in Working Register Area 1 (WRA1) to its positive equivalent. The result is left in WRA1. If a negative integer greater than 2**15 is encountered, it is converted to a single precision value. The data type or mode flag (40AF) will be updated to reflect any change in mode.

```
        LD      A,4             ; TYPE CODE FOR SP
        LD      (40AFH),A       ; SET TYPE TO SP
        LD      HL,VAL1         ; ADDR OF SP VALUE TO ABS
        CALL    09B1H           ; MOVE SP VALUE TO WRA1
        CALL    0977H           ; FIND ABS VALUE
        .
        .
        .
VAL1    DEFB    58H             ; SP 81.6022(10)
        DEFB    34H
        DEFB    23H
        DEFB    87H
        .
        .
```

CALL 0B37 Return Integer INT (N)

Returns the integer portion of a floating point number. If the value is positive, the integer portion is returned. If the value is negative with a fractional part, it is rounded up before truncation. The integer portion is left in WRA1. The mode flag is updated.

```
       LD      A,4            ; TYPE CODE FOR SP
       LD      (40AFH),A      ; SET TYPE TO SINGLE PREC.
       LD      HL,VAL1        ; ADDR OF SP VALUE
       CALL    09B1H          ; MOVE SP VALUE TO WRA1
       CALL    0B37H          ; ISOLATE INTEGER PART OF SP VALUE
       LD      DE,4121H       ; ADDR OF WRA1 (INTEGER PART OF SP
VALUE
       LD      HL,VAL2        ; LOCAL ADDR FOR INTEGERIZED VALUE
       CALL    09D3H          ; MOVE INTEGERIZED SP VALUE TO LOCAL
AREA
       .
       .
       .
VAL1   DEFB    0E0H           ; SP -41.3418
       DEFB    05DH
       DEFB    0A5H
       DEFB    086H
VAL2   DEFS    4              ; HOLDS INTEGER PORTION OF
                              ; -41.3418
       .
       .
       .
```

CALL 15BD — Arctangent ATN (N)

Returns the angle in radians, for the floating point tangent value in WRA1. The angle will be left as a single precision value in WRA1.

```
       LD      A,4            ; TYPE CODE FOR SP
       LD      (40AFH),A      ; SET TYPE TO SP
       LD      HL,TAN         ; ADDR OF VALUE FOR TANGENT
       CALL    09B1H          ; MOVE TAN TO WRA1
       CALL    15BDH          ; FIND ANGLE IN RADS
       LD      HL,ANGL        ; ADDR OF LOCAL STORAGE FOR ANGLE
       LD      DE,4121H       ; ADDR OF WRA1
       CALL    09D3H          ; MOVE ANGLE FROM WRA1 TO LOCAL AREA
       .
       .
       .
TAN    DEFB    9AH            ; TANGENT OF 30 DEG.
       DEFB    0C4H
       DEFB    13H
       DEFB    80H            ; EXPONENT
ANGL   DEFS    4              ; WILL HOLD  30 DEG. IN RADS (.5235)
```

CALL 1541 — Cosine COS (N)

Computes the cosine for an angle given in radians. The angle must be a floating point value; the cosine will be returned in WRA1 as a floating point value.

```
       LD      A,4          ; TYPE CODE FOR SP
       LD      (40AFH),A    ; SET TYPE TO SP
       LD      HL,ANGL      ; ADDR OF ANGLE VALUE
       CALL    09B1H        ; MOVE ANGLE TO WRA1
       CALL    1541H        ; COMPUTE COSINE
       LD      HL,CANGL     ; LOCAL ADDR FOR COSINE
       LD      DE,4121H     ; ADDR OF WRA1
       CALL    09D3H        ; MOVE COSINE FROM WRA1 TO LOCAL AREA

       .
       .
       .
ANGL   DEFB    18H          ; 30 DEG. IN RADS. (.5235)
       DEFB    04H
       DEFB    06H
       DEFB    80H          ; EXPONENT
CANGL  DEFS    4            ; WILL HOLD COSINE OF 30 DEG.
       .
       .
```

CALL 1439 — Raise Natural Base EXP (N)

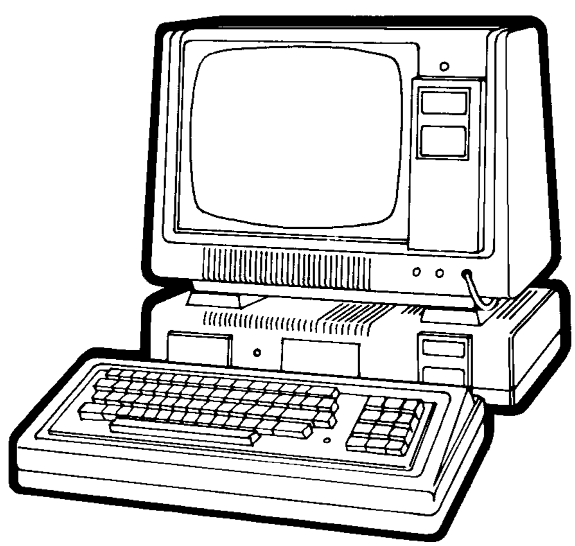
Raises E (natural base) to the value in WRA1 which must be a single precision value. The result will be returned in WRA1 as a single precision number.

```
       LD      A,4            ; TYPE CODE FOR SP
       LD      (40AFH),A      ; SET TYPE TO SP
       LD      HL,EXP         ; ADDR OF EXPONENT
       CALL    09B1H          ; MOVE EXPONENT TO WRA1
       CALL    1439H          ; FIND E ** 1.5708
       LD      DE,4121H       ; ADDR OF WRA1
       LD      HL,POW         ; ADDR OF LOCAL STORAGE
       CALL    09D3H          ; MOVE POWER TO LOCAL AREA
       .
       .
       .
EXP    DEFB    0DBH           ; SP  1.5708(10)
       DEFB    00FH
       DEFB    049H
       DEFB    081H
POW    DEFS    4              ; HOLDS E**1.5708
       .
       .
       .
```

CALL 13F2 — Raise X to the Y Power X**Y

Raises the single precision value which has been saved on the STACK to the power specified in WRA1. The result will be returned in WRA1.

```
;
; COMPUTE 16**2
;
       LD      BC,RETADD      ; RTN ADDR FOLLOWING
       PUSH    BC             ; RAISING X TO Y
       LD      A,4            ; TYPE CODE FOR SP
       LD      (40AFH),A      ; SET TYPE TO SP FOR X
       LD      HL,X           ; ADDR OF VAL TO BE RAISED
       CALL    09B1H          ; MOVE VAL TO WRA1
       CALL    09A4H          ; WRA1 TO STACK
       LD      HL,Y           ; ADDR OF POWER
       CALL    0931H          ; MOVE POWER TO WRA1
       JP      13F2H          ; WRA1 = COMPUTE X**Y
RA     .                      ; RTN TO RA WHEN DONE
       .
       .
X      DEFW    0              ; SP FOR 16 (10)
       DEFW    85H
Y      DEFW    0              ; SP FOR 2 (10)
       DEFW    82H
       .
       .
```



CALL 0809 — Natural Log LOG (N)

Computes the natural log (base E) of the single precision value in WRA1. The result is returned as a single precision value in WRA1.

```
      LD      A,4           ; TYPE CODE FOR SP
      LD      (40AFH),A     ; SET TYPE TO SP
      LD      HL,POW        ; ADDR OF POWER
      CALL    09B1H         ; MOVE POWER TO WRA1
      CALL    0809H         ; FIND NAT.LOG. OF POWER
      LD      DE,4121H      ; ADDR OF WRA1
      LD      HL,NLOG       ; ADDR OF LOCAL STORAGE AREA
      CALL    09D3H         ; MOVE LOG FROM WRA1 TO LOCAL AREA
      .
      .
      .
POW   DEFB    00            ; FLOATING POINT 3 (LSB)
      DEFB    00
      DEFB    04H
      DEFB    82HH          ; EXPONENT FOR 3.0
NLOG  DEFS    4             ; WILL HOLD NAT. LOG OF 3
      .
      .
      .
```

CALL 0B26 — Floating To Integer FIX (N)

Unconditionally truncates the fractional part of a floating point number in WRA1. The result is stored in WRA1 and the type flag is set to integer.

```
      LD      A,4           ; TYPE CODE FOR SP
      LD      (40AFH),A     ; SET TYPE TO SP
      LD      HL,FLPT       ; ADDR OF FLOATING POINT VALUE
      CALL    09B1H         ; MOVE FLT.PT. VALUE TO WRA1
      CALL    0B26H         ; TRUNCATE AND CONVERT TO INTEGER
      LD      HL,(4121H)    ; LOAD INTEGER PORTION FROM WRA1
      LD      (INTG),HL     ; AND STORE IN LOCAL AREA
      .
      .
      .
FLPT  DEFB    0BAH          ; SP 39.7107(10)
      DEFB    0D7H
      DEFB    01EH
      DEFB    086H
INTG  DEFS    2             ; HOLDS INTEGER PORTION OF
                            ; 39.7107
      .
      .
      .
```

CALL 01D3 — Reseed Random Seed RANDOM

Reseeds the random number seed (location 40AB) with the current contents of the refresh register.

```
      CALL    01D3H         ; RESEED RANDOM NUMBER SEED
      .
      .
      .
```

CALL 14C9 — Random Number RND (N)

Generates a random number between 0 and 1, or 1 and n depending on the parameter passed in WRA1. The random value is returned in WRA1 as an integer with the mode flag set. The parameter passed will determine the range of the random number returned. A parameter of 0 will return an interger between 0 and 1. A parameter greater than 0 will have any fraction portion truncated and will cause a value between 1 and the integer portion of the parameter to be returned.

```
      LD      A,2           ; TYPE CODE FOR INTEGER
      LD      (40AFH),A     ; SET TYPE TO INTEGER
      LD      A,50
      LD      (4121H),A     ; PUT AN INTEGER 50 INTO WRA1
      CALL    14C9H         ; GET A RANDOM NO. BETWEEN 1 AND 50
      LD      HL,(4121H)    ; LOAD RANDOM NO. INTO HL
      LD      (RVAL),HL     ; AND MOVE IT TO LOCAL AREA
      .
      .
      .
RVAL  DEFW    0             ; HOLDS RANDOM NUMBER (INTEGER)
      .
      .
      .
```

CALL 1547 — Sine SIN (N)

Returns the sine as a single precision value in WRA1. The sine must be given in radians in WRA1.

```
      LD      A,4           ; TYPE CODE FOR INTEGER
      LD      (40AFH),A     ; SET TYPE TO SP
      LD      HL,ANGL       ; ADDR. OF ANGLE IN RADIANS
      CALL    09B1H         ; MOVE ANGLE TO WRA1
      CALL    1547H         ; COMPUTE SINE OF ANGLE
      LD      DE,4121H      ; ADDR OF SINE IN WRA1
      LD      HL,SANGL      ; ADDR OF LOCAL AREA FOR SIN
      CALL    09D3H         ; MOVE SINE TO LOCAL AREA
      .
      .
      .
ANGL  DEFB    18H           ; 30 DEGS. IN RADS. (.5235)
      DEFB    04H
      DEFB    06H
      DEFB    80H           ; EXPONENT
SANGL DEFS    4             ; WILL HOLD SINE OF 30 DEG.
      .
      .
      .
```

CALL 13E7 — Square Root SQR (N)

Computes the square root of any value in WRA1. The root is left in WRA1 as a single precision value.

```
      LD      A,4           ; TYPE CODE FOR SP
      LD      (40AFH),A     ; SET TYPE TO SP
      LD      HL,VAL1       ; VALUE TO ROOT OF
      CALL    09B1H         ; MUST BE IN WRA1
      CALL    13E7H         ; TAKE ROOT OF VALUE
      LD      DE,4121H      ; ADDR OF ROOT IN WRA1
      LD      HL,ROOT       ; ADDR OF LOCAL AREA
      CALL    09D3H         ; MOVE ROOT TO LOCAL AREA
      .
      .
      .
VAL1  DEFB    00H           ; SP 4
      DEFB    00H
      DEFB    00H
      DEFB    83H           ; EXPONENT OF FLOATING POINT 4
ROOT  DEFS    4             ; HOLDS ROOT OF 4
      .
      .
      .
```

CALL 15A8

Tangent TAN (N)

Computes the tangent of an angle in radians. The angle must be specified as a single precision value in WRA1. The tangent will be left in WRA1.

```
        LD      A,4             ; TYPE CODE FOR SP
        LD      (40AFH),A       ; SET TYPE TO SP
        LD      HL,ANGL         ; ADDR OF ANGLE IN RADIANS
        CALL    0981H           ; MOVE ANGLE TO WRA1
        CALL    15A8H           ; FIND TAN OF ANGLE
        LD      DE,4121H        ; ADDR OF WRA1
        LD      HL,TANGL        ; ADDR OF LOCAL STORAGE FOR TAN
        CALL    09D3H           ; WOVE TAN FROM WRA1 TO LOCAL AREA
        .
        .
        .
ANGL    DEFB    18H             ; VALUE FOR 30 DEG IN RADS
        DEFB    04H             ; (.5235)
        DEFB    06H
        DEFB    80H             ; EXPONENT
TANGL   DEFS    4               ;   WILL HOLD TANGENT OF 30 DEG.
        .
        .
        .
```

Function Derivation

The LEVEL II system supports sixteen arithmetic functions. Seven of those may be called math functions. They are the sine, cosine, arctangent, tangent, square root, exponential (base e) and natural log. Three of these functions are computed from the identities:

$$\cos\theta = \sin\theta + \frac{\pi}{2}$$

$$\tan = \theta\,\frac{\sin\theta}{\cos\theta}$$

$$\sqrt{X} = e^{\frac{\ln x}{2}}$$

An implied math function exists which computes powers using the identity:

$$X^y = e^{y\ln x}$$

Embeded in LEVEL II are routines for the sine, exponential, natural log and arctangent. The other math functions derive their values using the aforementioned identities.

<u>SINE</u>

The sine routine is based on five terms of the approximation:

$$\sin\theta = \theta - \frac{\theta^3}{3!} + \frac{\theta^5}{5!} + \frac{\theta^7}{7!} + \frac{\theta^9}{9!}$$

Where θ is in radians. The actual approximation used is:

$$\sin\beta(2\pi) = 2\pi\beta - \frac{(2\pi)^3}{3!}\beta^3 + \frac{(2\pi)^5}{5!}\beta^5 - \frac{(2\pi)^7}{7!}\beta^7 + \frac{(2\pi)^9}{9!}\beta^9$$

Where β is a ratio which when multiplied by 2π gives the angle in radians. If x is the angle in degrees, then β is also used to determine the sign of the result according to the following rules:

$$\beta = \beta\,\frac{X}{360^\circ} \quad \text{if} \quad 0^\circ \leqslant X \leqslant 90^\circ$$

$$\beta = \beta\,\frac{180^\circ}{360^\circ} - \frac{X}{360^\circ} \quad \text{if} \quad 90^\circ < X \leqslant 180^\circ$$

$$\beta = \beta\,\frac{180^\circ}{360^\circ} - \frac{X}{360^\circ} \quad \text{if} \quad 180^\circ < X \leqslant 270^\circ$$

$$\beta = \frac{X}{360^\circ} - \frac{360^\circ}{360^\circ} \quad \text{if} \quad 270^\circ < X \leqslant 360^\circ$$

The coefficients used with the sine series are correct to four decimal places, the maximum error for sine x is $\leqslant .000003$, thus all values for sine x would be correct to five places.

<u>EXPONENTIATION</u>

The exponentiation routine computes e^x for all values of x where:

$$-88 \leqslant x \leqslant 88$$

The approximation used for this function is derived from the following:

Since $e^x = 2^{x\log_2 e}$

Consider $2^{[\![x\log_2 e]\!]+1}$ where $[\![$ represents the greatest integer function.

$$\text{Now} \quad e^x = e^{-t}\left[2^{[\![x\log_2 e]\!]+1}\right]$$

$$\text{if} \quad t = -x + [\![x\log_2 e]\!]\ln 2 + \ln 2$$

$$\text{Since} \quad x = \ln e^x = \ln e^{-t}\left[2^{[\![x\log_2 e]\!]+1}\right]$$

$$x = -t + \left\{[\![x\log_2 e]\!] + 1\right\}\ln 2$$

$$\text{Now} \quad t = -x\left\{[\![x\log_2 e]\!] + 1\right\}\ln 2$$

and so $0 < t < \ln 2$

and because

$$e^{-t} = 1 - t + \frac{t^2}{2!} - \frac{t^3}{3!} - \frac{t^4}{4!} - \frac{t^5}{5!} - \frac{t^6}{6!} - \frac{t^7}{7!}$$

The following series is used to approximate e^{-t}.

$$e^{-t} = 1 - t + .5t^2 - .166t^3 + .0416t^4 - .0083t^5 + .0013298t^6 - .0001413t^7$$

Then e^x is found by multiplying the approximate value of e^{-t} by $2^{[\![x\log_2 e]\!]+1}$ giving a result that is usually correct to at least five significant digits or five decimal places whichever is larger.

<u>ARCTANGENT</u>

The arctangent routine uses the approximation:

$$\arctan X = -\frac{X^3}{3} + \frac{X^5}{5} - \frac{X^7}{7} + \frac{X^9}{9} - \frac{X^{11}}{11} + \frac{X^{13}}{13} - \frac{X^{15}}{15} + \frac{X^{17}}{17}$$

If $x < 0$, the series is computed using the absolute value of x and the sign of the result is inverted. If $x > 1$ the series is computed using the value $1/x$ and the result is returned as $\pi/2 - \arctan 1/x$. For values where $0 < x < 1$, the series is computed using the orignal value of x. The coefficients used in the computer series are different from those in the approximating series starting with the seventh term, and the accuracy on the fifth and sixth coefficients is marginal as well. The actual series used is:

$$\arctan X = X - .33331X^3 + .199936X^5 - .142089X^7 + .106563X^9 - .0752896X^{11} + .0429096X^{13} - .01616157X^{15} + .00286623X^{17}$$

The maximum error using this approximation is .026.

<u>NATURAL LOG</u>

The natural log routine is based on three terms from the series:

$$\ln x = 2\left[\left(\frac{x-1}{x+1}\right) + \frac{1}{3}\left(\frac{x-1}{x+1}\right)^3 + \frac{1}{5}\left(\frac{x-1}{x+1}\right)^5 \cdots\right]$$

This series in convergent for values of $x < 1$ so x must be redefined as:

$$x = X2^n$$

Where n is an integer scaling factor and

$$1/2 \leqslant X < 1$$

Through algebra, not shown here, the x term can be replaced by $\frac{X}{\ln 2}$ giving:

$$\ln x = \frac{2}{\ln 2}\left[\left(\frac{\frac{X}{\ln 2}-1}{\frac{X}{\ln 2}+1}\right) + \frac{1}{3}\left(\frac{\frac{X}{\ln 2}-1}{\frac{X}{\ln 2}+1}\right)^3 + \frac{1}{5}\left(\frac{\frac{X}{\ln 2}-1}{\frac{X}{\ln 2}+1}\right)^5 + \cdots\right]$$

Since $\ln x = \ln X\,2^n = \ln X + n\ln 2$ and since

$$\frac{\ln\frac{X}{\ln 2}}{\ln 2}$$

from the series it follows that

$$\ln x = \left(\frac{\ln\frac{x}{\ln 2}}{\ln 2} - .5 + n\right)\ln 2$$

In this function $\ln 2$ has been approximated as .707092 and

$$\frac{\ln(\ln 2)}{\ln 2} \quad \text{as} \ -.5$$

If x is reasonable where $0 < x$ then $\ln x$ should be accurate to four significant digits. If x is extremely close to zero or very large, this will not be the case.

SYSTEM FUNCTIONS

System Functions are ROM entry points that can be entered at This means that on a disk based system, for example, an assembly language program which CALLS these entry points could be executed immediately after IPL before executing the BASIC utility program first.

These entry points are different from the BASIC Functions because they do not require the Communications Region (CR) to be initialized in order to operate correctly. A Level II system without disks always has an initialized CR because of its IPL processing.

Some of the routines mentioned here do use the Communications Region, but none of them require any particular locations to be initialized. The System Error routine however, which may be called in the event of an error detected by these routines, will assume some words contain meaningful data, and will return control to the BASIC Interpreter Input Phase.

RST 08 Compare Symbol

Compares the symbol in the input string pointed to by HL register to the value in the location following the RST 08 call. If there is a match, control is returned to address of the RST 08 instruction 2 with the next symbol in the A-register and HL incremented by one. If the two characters do not match, a syntax error message is given and control returns to the Input Phase.

```
;
; TEST THE STRING POINTED TO BY HL TO SEE IF IT
; CONTAINS THE STRING 'A=B=C'.
;
      RST      08            ; TEST FOR A
      DEFB     41H           ; HEX VALUE FOR A
      RST      08            ; FOUND A, NOW TEST FOR =
      DEFB     3DH           ; HEX VALUE FOR =
      RET      08            ; FOUND =, NOW TEST FOR B
      DEFB     42H           ; HEX VALUE FOR B
      RST      08            ; FOUND B, TEST FOR =
      DEFB     3DH           ; HEX VALUE FOR =
      RST      08            ; FOUND =, TEST FOR C
      DEFB     43H           ; HEX VALUE FOR C
      .                      ;FOUND STRING A=B-C
      .
      .
```

RST 10 Examine Next Symbol

Loads the next character from the string pointed to by the HL register set into the A-register and clears the CARRY flag if it is alphabetic, or sets it if is alphanumeric. Blanks and control codes 09 and 0B are ignored causing the following character to be loaded and tested. The HL register will be incremented before loading any character therefore on the first call the HL register should contain the string address minus one. The string must be terminated by a byte of zeros.

```
;
; THE CURRENT STRING POINTED TO BY HL IS ASSUMED
; TO BE PART OF AN ASSIGNMENT STATEMENT CONTAINING
; AN OPTIONAL SIGN FOLLOWED BY A CONSTANT OR A
; VARIABLE NAME. MAKE THE NECESSARY TESTS TO DETERMINE
; IF A CONSTANT OR A VARIABLE IS USED.
;
      RST      08            ; TEST FOR
      DEFB     3DH           ; HEX VALUE FOR =
NEXT  RST      10H           ; GET SYMBOL FOLLOWING =
      JR       NC,VAR        ; NC IF VARIABLE NAME
      CALL     1E5AH         ; GET VALUE OF CONSTANT
      JR       SKIP          ; JOIN COMMON CODE
VAR   CP       2BH           ; NOT NUMERIC, TEST FOR +,-,
                             ; OR ALPHA
      JR       Z,NEXT        ; SKIP + SIGNS
      CP       20H           ; NOT A +, TEST FOR A -
      JR       Z,NEXT        ; SKIP - SIGNS
      CALL     260DH         ; ASSUME IT'S A GOOD ALPHA AND
                             ; SEARCH FOR A VARIABLE NAME
                             ; (SEE SECTION 2.6 FOR A
                             ; DESCRIPTION OF 260D)
SKIP  .
      .
      .
```

RST 18 Compare DE:HL

Numerically compares DE and HL. Will not work for signed integers (except positive ones). Uses the A-register only. The result of the comparison is returned in the status register as:

```
CARRY SET - HL < DE
NO CARRY  - HL > DE
NZ        - UNEQUAL
Z         - EQUAL
```

```
;
; THIS EXAMPLE TESTS THE MAGNITUDE OF THE VALUE
; FOLLOWING THE - IN THE STRING POINTED TO BY HL
; TO MAKE SURE IT FALLS BETWEEN 100 AND 500
;
      RST      08            ; TEST FOR =
      DB       3DH           ; HEX VALUE FOR =
      RST      10H           ; FOUND =, TEST NEXT CHAR
      JR       NC,ERR        ; NC IF NOT NUMERIC
      CALL     1E5AH         ; GET BINARY VALUE
      LD       HL,500        ; UPPER LIMIT VALUE
      RST      18H           ; COMPARE VALUE TO UPPER LIMIT
      JR       C,ERR         ; CARRY IF VALUE > 500
      LD       HL,100        ; LOWER LIMIT VALUE
      RST      18H           ; COMPARE VALUE TO LOWER LIMIT
      JR       NC,ERR        ; NO CARRY IF VALUE < 100
      .
      .
      .
```

RST 20 Test Data Mode

Returns a combination of STATUS flags and unique numeric values in the A-register according to the data mode flag (40AF). This CALL is usually made to determine the type of the current value in WRA1. It should be used with caution, however since the mode flag and WRA1 can get out of phase particularly if some of the CALLS described here are used to load WRA1.

TYPE	STATUS	A-REGISTER
02 (INTEGER)	NZ/C/M/E	-1
03 (STRING)	Z/C/P/E	0
04 (SINGLE PREC.)	NZ/C/P/O	1
08 (DOUBLE PREC.)	NZ/NC/P/E	5

```
;
; TEST DATA TYPE AFTER INTEGER ADDITION TO
; DETERMINE IF OVERFLOW OCCURRED (RESULT WOULD
; BE CONVERTED TO SINGLE PRECISION
;
      LD      A,2             ; TYPE CODE FOR INTEGER
      LD      (40AFH),02      ; SET TYPE TO INTEGER
      LD      BC,(VAL1)       ; FIRST QUANTITY
      LD      HL,(VAL2)       ; SECOND QUANTITY
      CALL    0B2DH           ; DO INTEGER ADDITION
      RST     20H             ; TEST FOR OVERFLOW
      JP      M,OK            ; RESULT IS INTEGER
      .                       ; RESULT IS  NOT INTEGER
      .                       ; TEST FOR OTHER TYPES
OK    LD      (SUM),HL        ; SAVE INTEGER RESULT
      .
      .
      .
VAL1  DEFW    125             ; 16 BIT INTEGER VALUE
VAL2  DEFW    4235            ; 16 BIT INTEGER VALUE
SUM   DEFW    0               ; HOLDS 16 BIT VALUE
```

RST 28 — DOS Function CALL

Passes request code in A-register to DOS for processing. Returns for non-disk system. For disk systems, the A-register must contain a legitimate DOS function code. If the code is positive, the CALL is ignored and control returns to the caller. Note that the DOS routine discards the return address stored on the stack by the RST instruction. After processing control will be returned to the previous address on the stack. The calling sequence is:

```
;
; LOAD AND EXECUTE DEBUG
;
      LD      A,87H         ; DOS CODE FOR LOADING DEBUG
      CALL    DOS
      .                     ; RETURN HERE
      .
DOS   RST     28H           ; MAKE DOS CALL (WILL RET TO CALLER)
      .
      .
```

RST 30 — Load DEBUG

This CALL loads the DEBUG program and transfers control to it. When DEBUG processing is complete, control is returned to the original caller. For non-disk systems control is returned immediately.

```
;
; IF ILLOGICAL CONDITION ARISES LOAD AND EXECUTE DEBUG.
      .                     ; TEST FOR LEGITIMATE CONDITIONS
      .
      .
      JR      Z,OK          ; JMP IF CONDITIONS ARE CORRECT
      RST     30H           ; ELSE LOAD AND EXECUTE DEBUG
OK    .                     ; CONTINUE
      .
      .
```

RST 38 — Interrupt Entry Point

This is the system entry point for all interrupts. It contains a jump to section of code in the Communications Region designed to field interrupts. That section of code consists of a DI (disables further interrupts) followed by a RET (returns to the point of interrupt) for non-disk systems, or a jump to an interrupt processor in SYS0 if it is a DOS system. For DOS systems the interrupt handler consists of a task scheduler, where the exact cause of the interrupt is determined (usually a clock interrupt) and the next task from the task control block is executed. After task completion, control returns to the point of interrupt.

```
;
; INTERCEPT ALL CLOCK INTERRUPTS AND TEST THE WIDGET
; ON PORT AB.  IF THE READY LINE (BIT 8) IS TRUE
; (HIGH OR A 1) TURN OH THE COFFEE POT ON PORT DE.
; THEN JUMP TO THE NORMAL DOS INTERRUPT HANDLER
;
      ORG     4012H           ; REPLACE THE JUMP
      JP      HERE            ; TO THE DOS INTERRUPT
                              ; PROCESSOR WITH A JUMP
                              ; TO OUR OWN.
      ORG     0FD00H          ; OUR INTERRUPT HANDLER
HERE  DI                      ; DISABLE FURTHER
                              ; INTERRUPTS
      PUSH    AF              ; WE'LL NEED AF REGS
      IN      A,(0ABH)        ; GET WIDGET STATUS
      OR      A               ; SET STATUS FOR BIT 8
      JP      M,TOCP          ; WIDGET ON IF MINUS
      POP     AF              ; WIDGET OFF, RST REGS
      JP      4518H           ; GO TO DOS INTERRUPT
                              ; HANDLER
TOCP  LD      A,21H           ; CODE TO TURN ON COFFEE
                              ; POT
      OUT     (0DEH),A        ; SEND COMMAND TO POT
      POP     AF              ; THEN RST REGS
      JP      4518H           ; AND GO TO DOS INTERRUPT
      .                       ; HANDLER
      .
      .
```

CALL 09B4 — Move SP Value In BC/DC Into WRA1

Moves the single precision value in BC/DE into WRA1. HL is destroyed BC/DE is left intact. Note - the mode flag is not updated!

```
      .
      .
      LD      BC,(PART1)      ; GET FIRST ARGUMENT
      LD      DE,(PART2)      ; REMAINDER OF ARGUMENT
                              ; NOTE - WE HAVE ASSUMED THAT
                              ; WRA1 CURRENTLY CONTAINS A
                              ; SINGLE PRECISION VALUE !!!
      CALL    09B4H           ; MOVE PART1 TO WRA1
      LD      BC,(PART3)      ; GET VALUE TO BE ADDED
      LD      DE,(PART4)      ; REST OF VAL
      CALL    0716H           ; MOVE RESULT (SUM) TO WRAS

      .
      .
PART2 DEFW    0000H           ; LSB OF SP 1.5
PART1 DEFW    8140H           ; EXPONENT AND MSB OF SP 1.5
PART4 DEFW    0000H           ; LSB OF SP XX
PART3 DEFW    0000H           ; EXPONENT/MSB OF SP XX
      .
      .
      .
```

CALL 09B1 — Moves A SP Value Pointed To By HL To WRA1

Loads a single precision value pointed to by HL into BC/DE and then moves it to WRA1. Destroys HL/BC/DE.

```
      .
      .
      LD      HL,VAL          ; GET ADDR OF VALUE TO MOVE
      CALL    09B1H           ; MOVE VALUE TO WRA1
      .
      .
      .
VAL   DEFW    8140H           ; SINGLE PREC 1.5
      DEFW    0000H           ; REMAINDER OF 1.5
      .
      .
      .
```

CALL 09C2 Load A SP Value Into BC/DE

Loads a single precision value pointed to by HL into BC/DE. Uses all registers.

```
;
; COMPUTE THE PRODUCT OF TWO SP NUMBERS AND MOVE THE
; PRODUCT TO BC/DE.
;
      LD      HL,VAL1        ; ADDR OF VALUE 1
      CALL    09B1H          ; MOVE IT TO WRA1
      LD      HL,VAL2        ; ADDR OF VALUE 2
      CALL    09C2H          ; LOAD IT INTO BC/DE
      LD      BC,(4121H)     ; LOAD EXPONENT/MSB
      LD      DE,(4123H)     ; LOAD LSB
      .
      .
      .
VAL1  DEFW    XXXX
      DEFW    XXXX
VAL2  DEFW    XXXX
      DEFW    XXXX
      .
      .
      .
```

CALL 09BF Loads A SP Value From WRA1 Into BC/DE

Loads a single precision value from WRA1 into BC/DE. Note, the mode flag is not tested by the move routine. It is up to the caller to insure that WRA1 actually contains a single precision value.

```
      .
      .
      LD      HL,VAL1        ; ADDR OF VALUE TO MOVE TO WRA1
      CALL    09B1H          ; MOVE VAL1 TO WRA1
      LD      HL,VAL2        ; ADDR OF VALUE TO BE ADDED
      CALL    09C2H          ; LOAD VALUE TO BE ADDED TO BC/DE

      CALL    0716H          ; DO SINGLE PRECISION ADD
      CALL    09BFH          ; LOAD RESULT INTO BC/DE
      LD      (SUM1),DE   ; SAVE LSB
      LD      (SUM2),BC   ; SAVE EXPONENT/MSB
      .
      .
      .
SUM1  DEFW    0              ; HOLDS LSB OF SINGLE PRECISION
SUM2  DEFW    0              ; HOLDS EXPONENT/MSB
VAL1  DEFW    0000H          ; LSB OF S.P 2.0
      DEFW    8200H          ; EXPONENT/MSB OF S.P 2.0
VAL2  DEFW    00000          ; LSB OF S.P. 5.0
      DEFW    8320H          ; EXPONENT/MSB OF S.P. 5.0
      .
      .
      .
```

CALL 09A4 Move WRA1 To Stack

Moves the single precision value in WRA1 to the stack. It is stored in LSB/MSB/Exponent order. All registers are left intact. Note, the mode flag is not tested by the move routine, it is simply assumed that WRA1 contains a single precision value.

```
;
; ADD TWO SINGLE PRECISION VALUES TOGETHER AND SAVE
; THE SUM ON THE STACK. CALL A SUBROUTINE WHICH
; WILL LOAD THE VALUE FROM THE STACK, PERFORM IT'S OWN
; OPERATION AND RETURN.
;
      LD      HL,VAL1        ; ADDR OF VALUE TO MOVE TO WRA1
      CALL    09B1H          ; MOVE VAL1 TO WRA1
      LD      HL,VAL2        ; ADDR OF VALUE TO BE ADDED
      CALL    09C2H          ; LOAD VALUE TO BE ADDED TO BC/DE
      CALL    0716H          ; DO SINGLE PRECISION ADD
      CALL    09A4H          ; SAVE SUM ON STACK
      CALL    NSUB           ; CALL NEXT SUBROUTINE
      .
      .                      ; RETURN WITH NEW VALUE IN
      .                      ; IN WRA1.
      .
NSUB  POP     HL             ; GET RETURN ADDR
      LD      (RET),HL       ; MOVE IT TO A SAFE PLACE
      LD      HL,VAL3        ; ADDR OF QUANTITY TO ADD
      CALL    09B1H          ; MOVE VAL3 TO WRA1
      POP     BC             ; GET EXPONENT/MSB
      POP     DE             ; GET LSB
      CALL    0716H          ; ADD TO VALUE PASSED
      LD      HL,(RET)       ; GET RETURN ADDR
      JP      (HL)           ; AND RET TO CALLER
VAL1  DEFW    0000H          ; LSB OF S.P 2.0
      DEFW    8200H          ; EXPONENT/MSB OF S.P 2.0
VAL2  DEFW    00000          ; LSB OF S.P. 5.0
      DEFW    8320H          ; EXPONENT/MSB OF S.P. 5.0
VAL3  DEFW    0AA6CH         ; LSB OF S.P. -.333333
      DEFW    7FAAH          ; EXPONENT/MSB OF S.P. -.33333
      .
      .
```

CALL 09D7 General Purpose Move

Moves contents of B-register bytes from the address in DE to the address given in HL. Uses all registers except C.

```
;
; BLANK FILL A DCB THEN MOVE A NAME INTO IT
;
      LD      A,20H          ; HEX VALUE FOR BLANK
      LD      B,32           ; NO. OF BYTES TO BLANK
      LD      DE,IDCB        ; DE = ADDR OF DCB
LOOP  LD      (DE),A         ; STORE A BLANK INTO DCB
      INC     DE             ; BUMP STORE ADDR
      DJNZ    LOOP           ; LOOP TILL DCB BLANKED
      LD      DE,NAME        ; NOW, MOVE FILE NAME TO IDCB
      LD      HL,IDCB        ; DE = NAME ADDR, HL = DCB ADDR
      LD      B,LNG          ; NO. OF CHARS IN NAME TO MOVE
      CALL    09D7H          ; MOVE NAME TO DCB
      .
      .
      .
IDCB  DEFS    32             ; EMPTY DCB
LNG   EQU    ENDX-$          ; LET ASSEMBLER COMPUTE LNG OF
                             ; FILE NAME
NAME  DEFM    'FILE1/TXT'    ; NAME TO BE MOVED TO DCB
ENDX  EQU     $              ; SIGNAL END OF NAME
      .
      .
```

CALL 0982 Variable Move Routine

Moves the number of bytes specified in the type flag (40AF) from the address in DE to the address in HL, uses registers A, DE, HL.

```
;
; LOCATE THE ADDRESS OF A DOUBLE PRECISION VARIABLE
; THEN MOVE IT TO A LOCAL STORAGE AREA.
;
      LD      HL,NAME1     ; NAME OF VARIABLE TO LOCATE
      CALL    260DH          ; GET ADDR OF STRING X
      RST     20H            ; MARE SURE IT'S DBL PREC.
      JR      NC,OK          ; JMP IF DBL PREC.
      JP      ERR            ; ELSE ERROR
OK    LD      HL,LOCAL     ; HL - LOCAL ADDR
                             ; DE - VARIABLE ADDR
      CALL    0982H          ; MOVE VALUE FROM VLT TO LOCAL
                             ; AREA.
      .
      .
      .
ERR   .
      .
NAME1 DEFM    'X'            ; NAME OF VARIABLE TO LOCATE
      DEFB    0              ; MUST TERM WITH A ZERO
LOCAL DEFS    8              ; ENOUGH ROOM FOR DBL PREC. VALUE
      .
      .
      .
```

CALL 29C8 String Move

On entry, HL points to the string control block for the string to be moved, and DE contains the destination address. All registers are used. The string length and address are not moved. String control blocks have the format:

```
DEFB      X         STRING LENGTH
DEFW      ADDR      STRING ADDRESS
```

```
;
; LOCATE THE ADDRESS OF A STRING VARIABLE CALLED F$.
; MOVE THE STRING F$ TO A LOCAL STORAGE AREA CALLED
 DCB.
;
      LD       HL,NAME         ; NAME OF VARIABLE TO LOCATE
      CALL     260DH           ; FIND ADDR OF STRING F$
      RST      20H             ; MAKE SURE IT'S A STRING
      JR       Z,OK            ; JMP IF STRING
      JP       ERR             ; ELSE ERROR
 OK   LD       A,(DE)          ; GET LENGTH OF STRING
      CF       33              ; WHICH MUST BE < 33
      JP       P,ERR           ; ERR, STRING LNG > 32
      PUSH     DE              ; SHORTCUT FOR MOVING DE TO BL
      POP      HL              ; ADDE OF STRING TO HL
      LD       DE,LOCAL        ; DE - LOCAL ADDR
      CALL     29C8H           ; MOVE STRING VARIABLE TO
                               ; LOCAL AREA
      .
ERR   .
      .
NAME  DEFM     'F$'            ; NAME OF VARIABLE TO FIND
      DEFB     0               ; REQUIRED TO TERM NAME
LOCAL DEFS     32              ; LOCAL STORAGE AREA
      .
      .
      .
```

Basic Functions

Basic Functions differ from System Functions because they deal mainly with tables in the Communications Region (CR). Because of this, these entry points assume that the CR has been initialized and properly maintained. This means that the BASIC Interpreter must have been entered prior to calling any of these routines, and the BASIC utility in RAM must be intact. The assembly program making the CALL must be running as a subroutine called by a BASIC program.

For a complete description of the tables and storage areas in the Communication Region see chapter 4.

CALL 1B2C Search For Line Number

Searches the Program Statement Table (PST) for a BASIC statement with the line number specified in the DE register pair. All registers are used. The exit conditions are:

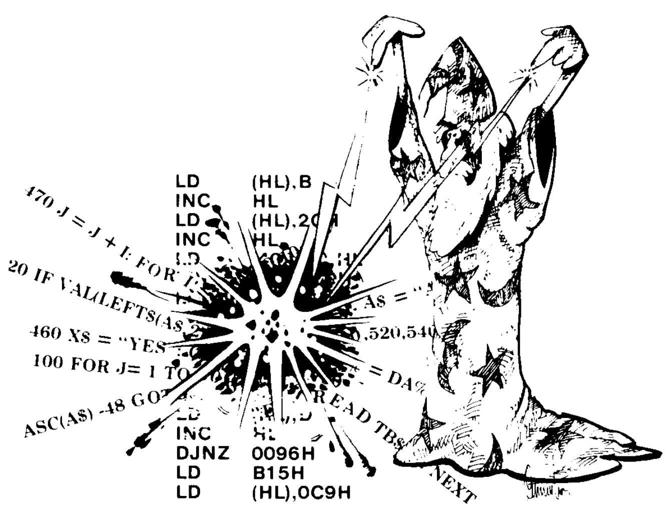
STATUS	CONDITION REGISTERS
C/Z	LINE FOUND. BC = STARTING ADDRESS OF LINE IN PST. HL = ADDRESS OF FOLLOWING LINE IN PST.
NC/Z	LINE DOES NOT EXIST. LINE NUMBER TOO LARGE HL/BC = ADDRESS OF NEXT AVAILABLE LOCATION IN
NC/NZ	LINE DOES NOT EXIST. BC = ADDRESS OF FIRST LINE NUMBER GREATER THAN THE ONE SPECIFIED. HL - ADDRESS OF FOLLOWING LINE.

```
;
; LOCATE THE ADDRESS OF BASIC STATEMENT NUMBER 750
; IN THE PST.  IF THE LINE DOES NOT EXIST RETURN A
; STATUS OF -1 IF IT IS LARGER THAN ANY CURRENT LINE
; NUMBER, OR A -2 IF IT THERE ARE LINES GREATER THAN
; 750.   IF THE LINE IS FOUND RETURN A STATUS OF ZERO.
;
      .
      LD       DE,750          ; LINE NUMBER TO SEARCH FOR
      CALL     1B2CH           ; SEEK LINE IN PST
      JR       NC,NO           ; NC SET IF LINE NOT THERE
      LD       HL,3            ; INCREMENT TO STEP OVER
      ADD      HL,BC           ; POINTER TO NEXT LINE/LINE NO.

                               ; RST BELOW WILL INCREMENT
                               ; BEFORE LOADING
      RST      10H             ; FETCH FIRST CHAR OF
                               ; STATEMENT.
      .
      .
      LD       A,0             ; SIGNAL LINE FOUND
      RET                      ; RETURN TO CALLER
NO    JR       NC,M2           ; JMP IF LINE NO. TOO BIG
      LD       A,0FFH          ; SIGNAL LINE NOT THERE
      RET                      ; RETURN TO CALLER
M2    LD       A,0FEH          ; SIGNAL LINE NOT THERE
                               ; TOO BIG
      RET                      ; RETURN TO CALLER
```

CALL 260D Find Address Of Variable

This entry point searches the Variable List Table (VLT) for a variable name which matches the name in the string pointed to by HL. If the variable exists, its address is returned in DE. If it is not defined, then it is created with an initial value of zero and its address is returned in DE. Dimensioned and non-dimensioned variables may be located, and suffixes for data mode may be included in the name string. A byte of machine zeros must terminate the name string. All registers are used.

```
;
; LOCATE THE ADDRESS OF THE VARIABLE A3
;
      LD       HL,STRNG    ; NAME OF VARIABLE TO LOCATE
      CALL     260DH          ; FIND IT'S ADDRESS IN VLT
      LD       (ADDR),DE   ; SAVE FOR FUTURE REFERENCE
      .
      .
STRNG DEFM     'A3'            ; VARIABLE NAME IS A3
      DEFB     0
STRNG DEFM     'A(25)'         ; VARIABLE NAME IS A(25)
      DEFB     0
STRNG DEFM     'A%'            ; VARIABLE NAME IS A%
      DEFB     0
```



CALL 1EB1 GOSUB

Can be used to execute the equivalent of a GOSUB statement from an assembly program. It allows a BASIC subroutine to be called from an assembly subroutine. After the BASIC subroutine executes, control returns to the next statement in the assembly program. All registers are used. On entry, the HL must contain an ASCII string with the starting line number of the subroutine.

```
;
; SIMULATE A GOSUB STATEMENT FROM AN ASSEMBLY LANGUAGE PROGRAM
;
      LD     HL,STRNG   ; ADDRESS OF BASIC LINE NUMBER TO GOSUB TO
      CALL   1EB1H      ; EQUIVALENT OF A GOSUB 1020
      .
      .                 ; WILL RETURN HERE WHEN BASIC PROGRAM
      .                 ; EXECUTES A RETURN
      .
STRNG DEFM     '1020'   ; LINE NO. OF BASIC SUBROUTINE
      DEFB     0
```

CALL 1DF7 TRON

Turns TRON feature on. Causes line numbers for each BASIC statement executed to be displayed. Uses A-register.

```
;
; TURN TRACE ON THEN EXECUTE A BASIC SUBROUTINE
;
      CALL     1DF7H       ; TURN TRACE ON
      LD       HL,LN       ; LINE NO. TO GOSUB
      CALL     1EB1H       ; DO A GOSUB 1500
      .
      .
      .
LN    DEFM     '1500'      ; LINE NO. OF BASIC SUBROUTINE
      DEFB     0
```

CALL 1DF8 TROFF

Disables tracing feature. Uses A register.

```
;
; ENABLE TRACE. EXECUTE BASIC SUBROUTINE. UPON
; RETURN DISABLE TRACING.
;
      CALL     1DF7H       ; TURN TRACE ON
      LD       HL,LN       ; LINE NO. OF BASIC SUBROUTINE
      CALL     1EB1H       ; DO A GOSUB 2000
      CALL     1DF8H       ; TURN OFF TRACING
      RET                  ; RETURN TO CALLER
LN    DEFM     '2000'      ; LINE NO. OF BASIC SUBROUTINE
      DEFB     0
```

JP 1EDF RETURN

Returns control to the BASIC statement following the last GOSUB call. An assembly program called by a BASIC subroutine may wish to return directly to the original caller without returning through the subroutine entry point. This exit can be used for that return. The return address on the stack for the call to the assembly program must be cleared before returning via 1EDF.

```
300 GOSUB 1500             CALL BASIC SUBROUTINE
310 GOSUB 1510             RETURN HERE FROM SUBROUTINE CALL
320  .
     .
     .
1500 Z=USR1(0)             CALL ASSEMBLY SUBROUTINE & RETURN

1510 Z=USR2(0)             CALL ANOTHER SUBROUTINE & RETURN
1530 .
     .
     .

;
; ENTRY POINT FOR USR1 SUBROUTINE
;
      .                    ; DO WHATEVER PROCESSING IS
      .                    ; REQUIRED
      .
      POP      AF          ; CLEAR RETURN ADDR TO 1510
                           ; FROM STACK
      JP       1EDFH       ; RETURN DIRECTLY TO 310

;
; ENTRY POINT FOR USR2 SUBROUTINE
;
      .                    ; PERFORM NECESSARY PROCESSING
      .                    ; FOR USR2 CALL
      POP      AF          ; CLEAR RETURN ADDR TO 1520
      JP       1EDFH       ; RETURN DIRECTLY TO 320
```

CALL 28A7 Write Message

Displays message pointed to by HL on current system output device (usually video). The string to be displayed must be terminated by a byte of machine zeros or a carriage return code 0D. If terminated with a carriage return, control is returned to the caller after taking the DOS exit at 41D0 (JP 5B99). This subroutine uses the literal string pool table and the String area. It should not be called if the communications region and the string area are not properly maintained.

```
;
; WRITE THE MESSAGE IN MLIST TO THE CURRENT SYSTEM
; OUTPUT DEVICE.
;
      LD       HL,MLIST       ; HL - ADDR OF MESSAGE
      CALL     28A7H          ; SEND TO SYSTEM OUTPUT DEVICE
      .
      .
      .
MLIST DEFM     'THIS IS A TEST'
      DEFB     0DH            ; THIS TERMINATOR REQUIRED
      .
      .
      .
```

CALL 27C9 Return Amount Of Free Memory

Computes the amount of memory remaining between the end of the variable list and the end of the stack. The result is returned as a single precision number in WRA1 (4121 - 4124).

```
;
; TAKE ALL AVAILABLE MEMORY BETWEEN THE STACK AND
; THE END OF THE VLT AND DIVIDE IT INTO REGIONS FOR
; USE IN A TOURNAMENT SORT
;
      .
      .
```

```
      DI                    ; MUST GO INHIBITED BECAUSE
                            ; THERE WILL BE NO STACK SPACE
                            ; FOR INTERRUPT PROCESSING
      CALL     27C9H        ; GET AMT OF FREE SPACE
      CALL     0A7FH        ; CONVERT IT TO INTEGER
      LD       DE,(4121H)   ; GET IT INTO DE
      LD       HL,500       ; MAKE SURE IT'S AT
      RST      18H          ; LEAST 500 BYTES
      JR       C,ERR        ; ERR - INSUFFICIENT SPACE
      LD       HL,(40D1H)   ; START OF AREA
      LD       (EVLT),HL    ; SAVE FOR RESTORATION
      LD       HL,0         ; SO WE CAN LOAD CSP
      ADD      HL,SP        ; END OF AREA
      LD       (ECSP),HL    ; SAVE FOR RESTORATION
      .
      .
      .
```

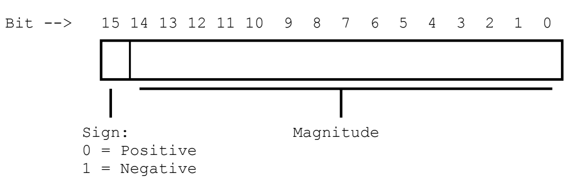
CALL 2B75 Print Message

Writes string pointed to by HL to the current output device. String must be terminated by a byte of zeros. This call is different from 28A7 because it does not use the literal string pool area, but it does use the same display routine and it takes the same DOS Exit at 41Cl. Uses all registers. This routine can be called without loading the BASIC utility, if a C9 (RET) is stored in 41C1.

```
;
; WRITE MESSAGE TO CURRENT OUTPUT DEVICE
;
      LD       HL,MLIST     ; ADDRESS OF MESSAGE
      CALL     2B75H        ; SEND MEG TO SYSTEM DEVICE
      .
      .
MLIST DEFM     'THIS IS A TEST'
      DEFB     0            ; REQUIRED TERMINATOR
      .
      .
      .
```

Internal Number Representation

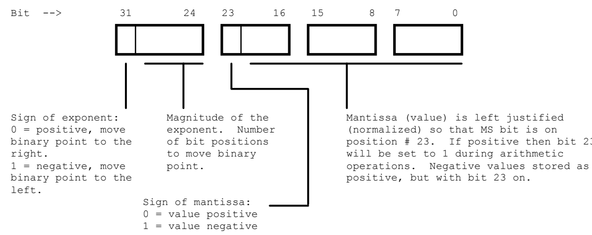
BASIC represents integers as signed 16 bit quantities. Bit 15 contains the sign bit while bits 0-14 hold the magnitude. The largest possible positive value that can be represented is 32767 (dec.) or 7FFF (hex). The smallest possible negative value that can be represented is -32768 (dec.) or 8000 (hex).



positive values 0000 - 7FFF (hex.) : 0 to 32767 (dec.)
Negative values FFFF - 8000 (hex.) : -l to -32768 (dec.)

Note - negative values are represented as the one's complement of the positive equivalent.

BASIC supports two forms of floating point numbers. One type is single precision and the other is double precision. Both types have a signed seven bit exponent. Single precision numbers have a signed 24 bit mantissa while double precision values have a signed 56 bit mantissa. Both types have the following format



The only difference between single and double precision is in the number of bits in the mantissa. The maximum number of significant bits representable in a positive single precision value is 2 ** 24-1 or 8 388 607 decimal or 7F FF FF hex. Double precision numbers have an extended mantissa so positive values up to 2 ** 56-1, or 3.578 X 10 ** 16 can be represented accurately.

These numbers 8 388 607 and 3.578 X 10 ** 16 are not the largest numbers that can be represented in a single or double precision number, but they are the largest that can be represented without some loss of accuracy. This is due to the fact that the exponent for either type of number ranges between 2 ** -128 and 2 ** 127. This means that theoretically the binary point can be extended 127 places to the right for positive values and 128 to the left for negative values even though there are only 24 or 56 bits of significance in the mantissa. Depending of the type of data being used (the number of significant digits) this may be all right. For example Planck's constant which is 6.625 X 10 ** -34 J-SEC could be represented as a single precision value without any loss of accuracy because it has only four significant digits. However if we were totaling a money value of the same magnitude it would have to be a double precision value because all digits would be significant.

Chapter 3

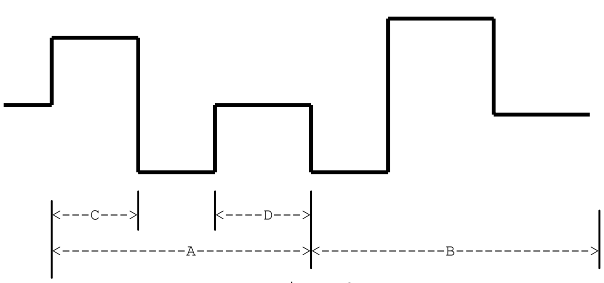
Cassette & Disk

This chapter contains an introductory description of physical I/O operations for the cassette and disk. The sample programs are for purposes of illustration only and are not recommended for adaptation to general applications. There may be special situations, however when a simple READ/WRITE function is needed and for limited applications they will serve the purpose.

Cassette I/O

Cassette I/O is unusual from several aspects. First, each byte is transmitted on a bit-by-bit basis under software control. This is radically different from all other forms of I/O where an entire byte is transferred at one time. For most I/O operations, referencing memory or executing an IN or OUT instruction, is all that is required to transfer an entire byte between the CPU and an external device. However, If the device is a cassette, each bit (of a byte to be transferred) must be transferred individually by the software.

The second unusual aspect is the procedure used for transmitting these bits. Exact timing must be adhered to and the program must use different code depending on whether a binary zero or one is to be written. Each bit recorded consists of a clock pulse (CP) followed by a fixed amount of erased tape followed by either another CP if a binary one is represented, or a stretch of erased tape if a binary zero is being represented. A binary one and zero would appear as:



Binary One

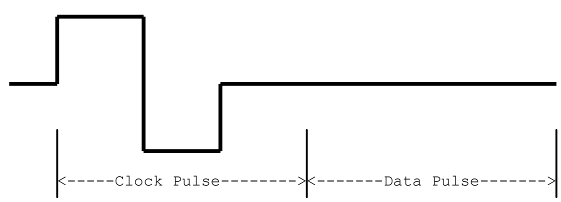
The distance between points A, B, C, and D is measured in units of time. Because time can be measured in machine cycles the value given for distances will be in machine cycles where one instruction (any instruction regardless of how long it is) equals one cycle and one cycle equals one microsecond. This is crude but workable. The sum of A B is supposed to be 2 milliseconds for Level II.

Using the crudity described above and counting instructions used in the Level II software gives the following values.

A B 1.4 millisec per half bit 2.8 millisec per bit.
C .20 millisec * 2 per CP .40 millisec
D 1.0 millisec

Before discussing programming for cassette I/O in any detail we should review the fundamentals. Drive selection is accomplished by storing either a 01 (drive 1) or 02 (drive 2) in 37E4. Motor start and loading or clearing the data latch is achieved by sending a command value to the cassette controller on port FF. The command value is shown below.

```
        7 6 5 4 3 2 1 0
        x x x x x x x x                 : 00 - erase tape
                      └──── outsig 1 : 01 - positive signal
                    └────── outsig 2 : 10 - negative signal
Not used ┘
for cassette       └────────── 1 = motor on
operations                     0   motor off
                 └────────────────── 1 = 32 char/line
                                     0 = 64 char/line
```



Be careful to preserve the current video character size when sending commands to the cassette. The system maintains a copy of the last command sent to the video controller in 403D. Bit 3 of that word should be merged with any commands issued to the cassette.

A write operation of one bit (called a bit cell) can be divided into two steps. First a clock pulse (CP) is written to signal the start of a bit. It is followed by a strip of erased tape which is considered part of the CP. Next, another CP is written if the bit is a one, or more blank tape is written if the bit is a zero.

Read operations begin by searching for the clock pulse and skipping to the data pulse area. The data pulse area is then read returning a zero if blank tape was encountered or a one if non-blank tape was found. Below are examples of code that could be used for cassette operations. The code used by Level II can be found around the area 01D9 - 02A8 in the Level II listing.

Assembler Object Code Format

DOS loads disk object files with a utility program called LOAD. They can also be loaded under DOS by entering the name of a file that has an extension of CMD. The format of a disk object file is shown below. It is more complex than a cassette file because it has control codes embedded in the object code. The loader reads the file into a buffer before moving the object code to its designated address. The control codes are used to indicated to the loader where the code is to be loaded, how many bytes are to be loaded, and where execution is to begin.

```
Control Code:    01  (data to be loaded follows)
Count       :    XX  (count of bytes to load, 0 = 256)
Load Address:    XX  (load address in LSB/MSB order)
                 XX
Load Data   :    XX
                 XX
                 .
Control Code:    02  (beginning execution address follows)
                 XX  (this byte is to be discarded)
Address     :    XX  (execution address in
                 XX  (LSB/MSB order)

Control Code:  03 - 05 (following data is to be skipped)
Count       :    XX    (count of bytes to skip)
Skip Data   :    XX    (this data is to be skipped)
                 XX
                 .
```

Cassette Recording Format

The recording format used by Level II is as follows:

```
1: BASIC Data Files

0 0 0 0 . . . 0 A5  X X X X  . . . X
( 256 zeros )

   Synch Bytes         Data Bytes

2: BASIC Programs

0 0 0 0 . . . 0 A5 D3 D3 D3 Y X X X X . . X 00 00 00

Synch Bytes
          File Header          BASIC       EOF
                         Name  Program     Marker

3: Absolute Assembler Programs

55 N N N N N N 3C Y ZZ X X X X . . . X C 78 TA
                                               Transfer address
Synch   Start          Program or Data    Transfer
        of               Checksum         address follows
File    binary         Load address
name    file          Number of bytes to load
```

```
SELECT UNIT AND TURN ON MOTOR
      LD       A,01         ; CODE FOR UNIT 1
      LD       (37E4H),A    ; SELECT UNIT 1
      LD       A,04         ; COMMAND VALUE: TURN ON MOTOR
      OUT      (0FFH),A     ; START MOTOR, CLEAR DATA LATCH


WRITE BYTE CONTAINED IN THE A REGISTER
      PUSH     AF
      PUSH     BC
      PUSH     DE
      PUSH     HL           ; SAVE CALLERS REGISTERS
      LD       L,8          ; NUMBER OF BITS TO WRITE
      LD       H,A          ; H = DATA BYTE
LOOP  CALL     CP           ; WRITE CLOCK PULSE FIRST
      LD       A,H          ; GET DATA BYTE
      RLCA                  ; HIGH ORDER BIT TO CARRY
      LD       H,A          ; SAVE REPOSITIONED BYTE
      JR       NC,WR        ; BIT WAS ZERO. WRITE BLANK TAPE
      CALL     CP           ; BIT WAS ONE. WRITE A ONE DATA PULSE
TEST  DEC      L            ; ALL BITS FROM DATA BYTES WRITTEN ?
      JR       NZ,LOOP      ; NO!  JUMP TO LOOP
      POP      HL           ; YES! RESTORE CALLERS REGISTERS
      POP      DE
      POP      BC
      POP      AF
      RET                   ; RETURN TO CALLER
WR    LD       B,135        ; DELAY FOR 135 CYCLES (988 USEC) WHILE
WR1   DJNZ     WR1          ; BLANK TAPE IS BEING WRITTEN
      JR       TEST         ; GO TEST FOR MORE BITS TO WRITE
CP    LD       A,05         ; COMMAND VALUE MOTOR ONE, OUTSIG 1
      OUT      (0FFH),A     ; START OF CLOCK PULSE
      LD       B,57         ; DELAY FOR 57 (417 USEC) CYCLES
CP1   DJNZ     CP1          ; GIVES PART OF CP
      LD       A,06         ; COMMAND VALUE: MOTOR ON, OUTSIG 2
      OUT      (0FFH),A     ; 2ND PART OF CLOCK PULSE
      LD       B,57         ; DELAY FOR 57 CYCLES (417 USEC)
CP2   DJNZ     CP2          ; GIVES PART OF CP
      LD       A,4          ; COMMAND VALUE: MOTOR ON, NO OUTSIG
      OUT      (0FFH),A     ; START ERASING TAPE
      LD       B,136        ; DELAY FOR 136 CYCLES (995 USEC)
CP3   DJNZ     CP3          ; GIVES TAIL OF CLOCK PULSE
      RET                   ; RETURN TO CALLER


READ NEXT BYTE FROM CASSETTE INTO A REGISTER
      XOR      A            ; CLEAR DESTINATION REGISTER
      PUSH     BC
      PUSH     DR
      PUSH     HL           ; SAVE CALLERS REGISTERS
LOOP  LD       B,8          ; NUMBER OF BITS TO READ
      CALL     RB           ; READ NEXT BIT. ASSEMBLE INTO
                            ; BYTE BUILT THUS FAR.
      POP HL
      DJNZ     LOOP         ; LOOP UNTIL 8 BITS USED
      POP      DE
      POP      BC           ; RESTORE CALLERS REGISTERS
      RET                   ; RETURN TO CALLER


RB    PUSH     BC
      PUSH     AF
RB1   IN       (0FFH),A     ; READ DATA LATCH
      RLA                   ; TEST FOR BLANK/NON-BLANK TAPE
      JR       NC,RB1       ; BLANK, SCAN TILL NON-BLANK
                            ; IT WILL BE ASSUMED TO BE START
                            ; OF A CLOCK PULSE.
      LD       B,57         ; DELAY FOR 57 CYCLES WHILE
RB2   DJNZ     RB2          ; SKIPPING OVER FIRST PART OF CP
      LD       A,04         ; COMMAND VALUE: MOTOR ON, CLEAR
      OUT      (0FFH),A     ; DATA LATCHES
      LD       B,193        ; DELAY FOR 193 CYCLES WHILE
RB3   DJNZ     RB3          ; PASSING OVER END OF CP
      IN       A,(0FFH)     ; WE SHOULD BE POSITIONED INTO
                            ; THE DATA PULSE AREA. READ
                            ; THE DATA PULSE.
      LD       B,A          ; SAVE DATA PULSE
      POP      AF           ; ACCUMULATED BYTE THUS FAR
      RL       B            ; DATA PULSE TO CARRY WILL BE A
                            ; ZERO IF BLANK TAPE, 1 IF NON-BLANK
      RLA                   ; COMBINE NEW DATA PULSE (1 BIT)
      PUSH     AF           ; WITH REST OF BYTE AND SAVE
      LD       A,4          ; COMMAND VALUE: MOTOR ON, CLEAR OUTSIG
      OUT      (0FFH),A     ; CLEAR DATA LATCHES
      LD       B,240        ; DELAY LONG ENOUGH TO SKIP TO
RB4   DJNZ     RB4          ; END OF DATA PULSE
      POP      BC
      POP      AF           ; A = DATA BYTE
      RET


TURN OFF MOTOR
      LD       A,00         ; COMMAND VALUE: MOTOR OFF
      OUT      (0FFH),A     ; TURN MOTOR OFF
      RET
```

Disk I/O

The disk operations discussed in this section are elementary in as much as there is no consideration given to disk space management or other functions normally associated with disk I/O. What is presented are the fundamental steps necessary to position, read, and write any area of the disk without going through DOS. It will be assumed that the reader is familiar with the I/O facility provided by DOS and is aware of the pitfalls of writing a diskette without going through DOS.

Disks which normally come with a Model I system are single sided, 35 track 5 1/4' mini-drives. It is possible to substitute other drives with a higher track capacity such as 40, 77, or 80 tracks, but then a modified version of DOS must be used. Dual sided mini-drives are becoming available and eventually they should replace the single sided drives. Dual density drives are another type of mini-drive that are available, but like the dual sided drives they require a modified version of DOS.

The type of programming used in this example is called programmed I/O. It is called that because the program must constantly monitor the controller status in order to determine if it is ready to send or receive the next data byte. Thus each byte is transferred individually under program control. An alternative to programmed I/O is DMA or Direct Memory Access. Using this method the controller is told the number of bytes to transfer and the starting transfer address and it controls the transfer of data leaving the CPU free to perform other tasks. On the Model I systems there is no DMA facility so programmed I/O must be used.

This example will assume that a DOS formatted diskette is being used. New diskettes are magnetically erased. Before they can be used they must be formatted. That is each sector and track must be uniquely identified by recording its track and sector number in front of the data area of each sector. There is some variability in the coded information which precedes each sector so it is not always possible to read any mini-diskette unless it originated on the same type of machine.

Like most of the I/O devices on the Model I the disk is memory mapped. There are five memory locations dedicated to the disk. They are:

37E1	Unit Select Register
37EC	Command/Status Register
37ED	Track Update Register
37EE	Sector Register
37EF	Data Register

All disk commands except for unit selection are sent to 37EC. If the command being issued will require additional information such as a track or sector number, then that data should be stored in the appropriate register before the command is issued. You may have noticed that the command and status register have the same address. Because of that, a request for status (load 37EC) cannot occur for 50 microseconds following the issuing a command (store 37EC).

Unit selection is accomplished by storing a unit mask value into location 37E1. That mask has the format:

```
    BIT   7  6  5  4  3  2  1  0
          X  X  X  X  X  X  X  X
Not Used ─────┘            │  │  │  └── 1 = SELECT UNIT 0
                           │  │  └───── 1 = SELECT UNIT 1
                           │  └──────── 1 = SELECT UNIT 2
                           └─────────── 1 = SELECT UNIT 3
```

More than one unit can be selected at a time. For example a mask of 3 would select units 0 and 1. When any unit is selected the motor on all units are automatically turned on. This function is performed automatically by the expansion interface.

Controller Commands

The Model I uses a Western Digital FD 1771B-01 floppy disk controller chip. It supports twelve 8-bit commands. They are:

Restore: Positions the head to track 0

```
      7   6   5   4   3   2   1   0    <-- Bit
    | 0 | 0 | 0 | 0 | X | X | X | X |

     Mode ─────────────┘       └──── Stepping rate:
00 = No verify bead position          00 = 6 mS / step
01 = Verify head position             01 = 6 mS / step
10 = Not used                         10 = 10 mS / step
11 = Verify head position             11 = 20 mS / step
```

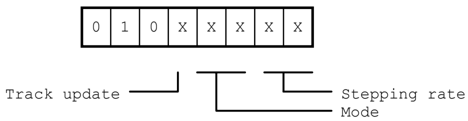
Seek: Positions the head to the track specified in the data register (37EF).

```
      7   6   5   4   3   2   1   0    <-- Bit
    | 0 | 0 | 0 | 1 | X | X | X | X |

     Mode ─────────────┘       └──── Stepping rate
```

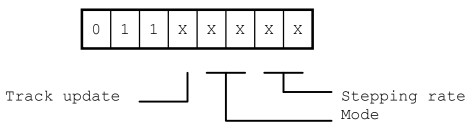
Step: Moves the head one step in the same direction as last head motion.

```
      7   6   5   4   3   2   1   0    <-- Bit
    | 0 | 0 | 1 | X | X | X | X | X |

Track update ───┘     │       └──── Stepping rate
                      └──────────── Mode
0 = No track register update
1 = Track register update
```

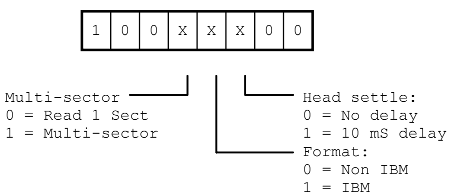
Step Head In: Moves the head in towards the innermost track one position.



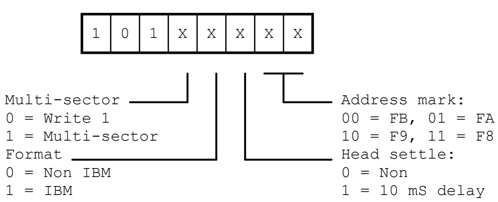
Step Head Out: Moves the head out towards the outer-most track one position



Read Data: Transmits the next byte of data from the sector specified by the value in the sector register.



Write Data: Sends the byte of data in the data register to the next position in the sector specified by the value in the sector register.



Read Track: Reads an entire track beginning with the index mark.

1	1	1	0	0	1	0	0

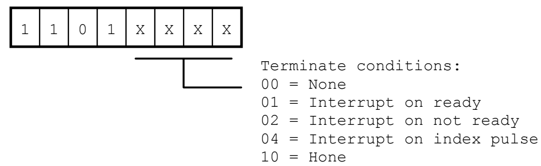
Read Address: Reads the address field from the next sector to pass under the head.

1	1	0	0	0	1	0	0

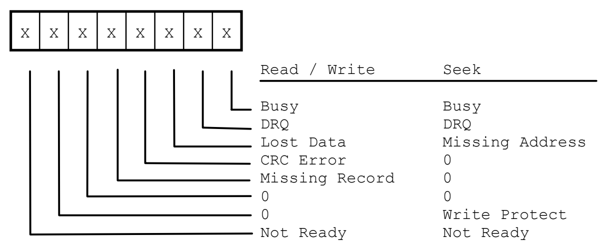
Write Track: Writes a full track starting at the index mark and continuing until the next index mark is encountered.

1	1	1	1	0	1	0	0

Force Interrupt: Terminates the current operation and / or generates an interrupt if one of the following four conditions is true:



Read Status: The status of the Floppy Controller is returned whenever location 37EC is read. The status word has the following format:



Disk Programming Details

Disk programming can be broken down into several easily managed steps. They are:

1. Select the unit and wait for ready.
2. Position the head over the desired track.
3. Issue the Read/Write command for the required sector
4. Transfer a Sectors worth of data, on a byte at a time basis.

Each transfer must be preceded by a test to see if the controller either has the next data byte, or is ready to accept the next data byte.

This program demonstrates a single sector read from track 25 (decimal), sector 3.

```
       ORG      7000H
       LD       BC,256         ; BYTE COUNT
       PUSH     BC             ; B = 1 C = 0
       LD       HL,BUFF        ; BUFFER ADDRESS
       LD       A,1            ; UNIT SELECT MASK (DRIVE 0)
       LD       (37E1H),A      ; SELECT DRIVE 0, START MOTOR
       LD       D,25           ; TRACK NUMBER
       LD       E,3            ; SECTOR NUMBER
       LD       (37EEH),DE     ; SPECIFY TRACK AND SECTOR
                               ; TRACK NO. TO DATA REGISTER
                               ; (37EFH)
                               ; SECTOR NO. TO SECTOR REGISTER.
       LD       A,1BH          ; SEEK OP CODE. NO VERIFY
                               ; (FOR VERIFY 17H)
       LD       (37ECH),A      ; SEEK REQ. TO COMMAND REGISTER.
       LD       B,6            ; GIVE CONTROLLER A CHANCE
                               ; TO DIGEST
DELAY  DJNZ     DELAY          ; COMMAND BEFORE ASKING STATUS
WAIT   LD       A,(37ECH)      ; GET STATUS OF SEEK OF
       BIT      0,A            ; TEST IF CONTROLLER BUSY
       JR       NZ,WAIT        ; IF YES, THEN SEEK NOT DONE
       LD       A,88H          ; SEEK FINISHED. LOAD READ
                               ; COMMAND
       LD       (37ECH),A      ; AND SEND TO CONTROLLER
       LD       B,6            ; GIVE CONTROLLER A CHANCE TO
DELAY1 DJNZ     DELAY1         ; DIGEST COMMAND BEFORE
                               ; REQUESTING
                               ; A STATUS
WAIT1  LD       A,(37ECH)      ; NOW, ASK FOR STATUS
       BIT      1,A            ; IS THERE A DATA BYTE PRESENT ?
       JR       Z,WAIT1        ; NO, WAIT TILL ONE COMES IN
       LD       A,(37EFH)      ; YES, LOAD DATA BYTE
       LD       (HL),A         ; STORE IN BUFFER
       INC      HL             ; BUMP TO NEXT BUFF ADDR
       DEC      BC             ; TEST FOR 256 BYTES TRANSFERRED
       LD       A,B            ; COMBINE B AND C
       OR       C              ; TO TEST BOTH REGISTERS
       JR       NZ,WAIT        ; GO GET NEXT BYTE
       .
       .
       .
```

DOS Exits

DOS Exits were discussed in general terms in chapter 1. They are used as a means of passing control between Level II BASIC and Disk BASIC. The Exit itself is a CALL instruction in the ROM portion of the system to a fixed address in the Communications Region. Contained at that CALL'd address will be either a RETURN instruction or a JUMP to another address in Disk BASIC. On a Level II system without disks these CALL'd locations are set to RETURNS during IPL processing. On disk based systems they are not initialized until the BASIC command is executed. At that time JUMPS to specific addresses within Disk BASIC are stored at the CALL locations.

The term DOS Exit really has two different meanings. DOS Exits are calls from ROM BASIC to Disk BASIC while in the Input Phase, while executing a system level command, or while executing a verb action routine. These exits allow extensions to be made to the routines in ROM. The exits are not strategically located so that an entire ROM routine could be usurped, but they are conveniently placed for intercepting the majority of the ROM routine processing. Another type of DOS Exit is the Disk BASIC Exit. These exits are radically different from the other ones, they are only entered on demand when a Disk BASIC token is encountered during the Execution Phase. All of the processing associated with these tokens is contained in the Disk BASIC program. There is no code in ROM for executing these tokens.

The following descriptions are for DOS Exits as opposed to Disk BASIC Exits. The calling sequence for each of the DOS Exits vary. Before writing a program to replace any of these Exits study the code around the CALL, paying particular attention to register usage. What happens at the exits is not discussed here. If it is important, disassemble the Disk BASIC utility program and examine the code at the BASIC address assigned to the exit. An example of how both types of Exits can be intercepted can be found in chapter 6.

All these addresses are for NEWDOS 2.1, TRSDOS addresses will differ.

Level II ADDRESS	DESCRIPTION	DOS Exits ADDRESS	BASIC ADDRESS
19EC	Call to load DISK BASIC error ...... processing. Error number most be in B-register.	41A6	
27FE	Start of USR processing	41A9	5679
1A1C	BASIC start up. Just before .... BASIC's 'READY' message.	41AC	5FFC
0368	At start of keyboard input	41AF	598E
1AA1	Input scanner after tokenizing ..... current statement.	41B2	6033
1AEC	Input scanner after updating .... program statement table.	41B5	5BD7
1AF2	Input scanner after reinitial- ..... izing BASIC.	41B8	5B8C
1B8C/1DB0	Initializing BASIC for .... new routine. During END processing.	41BB	60A1
2174	During initializing of syatena ..... output device.	41BE	577C
032C	During writing to system output .... device.	41C1	59CD
0358	When scanning keyboard. Called ..... from INKEY$, at end of execution of each BASIC statement.	41C4	59CD
1EA6	At start of RUN NNN .... processing.	41C7	5F78
206F	At beginning of PRINT .... processing.	41CA	51A5
20C6	During PRINT # or PRINT .... item processing.	41CD	5B9A
2103	When skipping to next line on ...... video during a BASIC output operation.	41D0	5B99
2108/2141	At start of PRINT on cassette ...... and during PRINT TAB processing.	41D3	5B65
219E	At beginning of INPUT processing ...	41D6	5784
222D	During READ processing when a ...... variable has been read.	41DC	5E63
2278/2278	At end of READ processing	41DF	579C
2B44/2B44	From LIST processing		
02B2	During SYSTEM command operation	41E2	5B51

Disk BASIC Exits

These exits are made from Level II during the Execution Phase whenever a token in the range of BC - FA is encountered. Tokens with those values are assigned to statements which are executed entirely by Disk BASIC. When a token in the given range is found control is passed indirectly through the Verb Action Routine List (see chapter 4) to the appropriate Disk BASIC Exit in the Communications Region. Control is returned to Level II at the end of the verb routine's processing.

TOKEN	VERB	CR ADDRESS	DISK BASIC ADDRESS
E6	CVI	4152	5E46
BE	FN	4155	558E
E7	CVS	4158	5E49
B0	DEF	415B	5655
E8	CVD	415E	5E4C
E9	EOF	4161	61E8
EA	LOC	4164	6231
EB	LOF	4167	6242
EC	MKI$	416A	5E20
ED	MKS$	4160	5E30
EE	MKD$	4170	5E33
85	CMD	4173	56C4
C7	TIME$	4176	5714
A2	OPEN	4179	6349
A3	FIELD	417C	60AB
A4	GET	417F	627C
A5	PUT	4182	627B
A6	CLOSE	4185	606F
A7	LOAD	4188	5F7B
A8	MERGE	418B	60DB
A9	NAME	418E	6346
AA	KILL	4191	63C0
NONE	&	4194	5887
AB	LSET	4197	60E6
AC	RSET	419A	60E5
C5	INSTR	4190	582F
AD	SAVE	41A0	6044
9C	LINE	41AD	5756
C1	USR	41A9	5679

Disk Tables

The most frequently used disks on the Model I series are 5 1/4' single sided single density mini-floppy drives. A variety of other units are available and could be used, however some hardware and software modifications would be necessary. Examples of other units would be: 5 1/4' dual headed and dual density drives; 8' single and dual headed plus single and dual density units; and various hard disks with capacities up to 20 Mbytes.

The terms single and dual headed refer to the number of read/write heads in a unit. Most microcomputer systems use single headed drives but dual headed drives are now becoming more commonplace. A dual headed drive has twice the capacity of a single headed unit because two disk surfaces can be accessed rather than one.

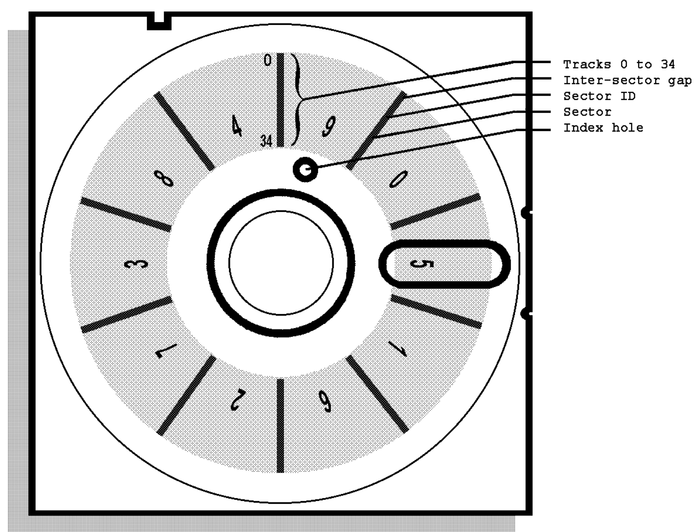
Dual density describes the recording method used. In single density mode each bit cell consists of a clock pulse followed by a data pulse while in dual density recording clock pulses may be omitted if the data pulse is repetitious. Using this method more sectors can be written on a track than in single density format. The recording method used is dictated by the controller and the software, but with dual density drives clock pulses may be omitted and the timing is more critical, hence not all drives can be used for dual density.

Eight inch drives are essentially the same as 5 1/4' drives except they usually only come in one track size (77 tracks). As with the smaller units they come in both single and dual density. Since their radius is larger they have more sectors per track. Track capacities for 8' drives are typically: 26 - 128 byte sectors / track; 15 - 256 byte sectors / track; 8 - 512 byte sectors / track; 4 - 1024 byte sectors / track.

Track capacities for 5 1/4' single density are: 20 - 128 byte sectors / track; 10 - 256 byte sectors / track; 5 - 512 byte sectors / track; and 2 - 1024 byte sectors / track. Dual density 5 1/4' drives have capacities of: 32 - 128 byte sectors / track; 18 - 256 byte sectors / track; 08 - 512 byte sectors / track; and 4 - 1024 byte sectors / track.

Hard disks are too varied to classify. Basically a hard disk has more capacity, faster access time, higher transfer rates, but the disk itself may not be removable. Without a removable disk file backup can be a serious problem, a second hard disk is an expensive solution.

Shown below is a diagram of a 5 1/4' 35 track diskette.



Each diskette has 35, 40, 77, or 80 tracks depending on the drive used. Each track has 10 sectors of 256 bytes. Sector sizes can vary from 2 to 1024 bytes per sector. But the software must be modified to handle anything other than 256, because that is the size assumed by DOS. The Model I uses a semi IBM compatible sector format. It is not 100% compatible because track and sector numbers on IBM diskettes are numbered from 1 not 0 as in TRSDOS.

DOS uses a file directory to keep a record of file names and their assigned tracks and sectors. The directory occupies all 10 sectors of track number 11. It is composed of three parts: a disk map showing available sectors (track 11, sector 1); a file name in use index that allows the directory to be searched from an advanced starting point (called the Hash Index Table track 11, sector 2); and the directory sectors themselves (track 11 sector 3 thru track 11 sector 10).

```
Track 11H  Sector 0   [ GAT Sector ]

           Sector 1   [ HIT Sector ]

           Sector 2   [ Directory Sector ]
                 .
                 .
           Sector 9   [ Directory Sector ]
```

As well as the directory track there is one other special area on a diskette. Track 0 sector 0 contains a system loader used during the disk IPL sequence to load DOS. The loader is read into RAM locations 4200 - 4300 by the ROM IPL code which then passes control to it so that the DOS can be loaded.

Disk Track Format

Before any diskette can be used it must be initialized using either the FORMAT or COPY (BACKUP if using TRSDOS) utility programs. Formatting initializes the diskette which is originally magnetically erased. The formatting operation writes the sector addresses for every addressable sector plus synch bytes which will be used by the controller to aid it locating specific addresses. In addition the formatting operation specifies the sector size, the number of sectors per track, and the physical order of the sectors

Mini-floppies are usually formatted with 128,256,512, or 1024 byte sectors although other sizes may be formatted. DOS uses the following track format:

```
Position     Number of Bytes    Contents

Index            14               FF
                  6               00
                  1               FE (Address marker)
                  1               Track Number
                  1               Head Number
One               1               Sector Number
Sector            1               Sector Length Code
                                     00 = 128 bytes
Ten per                              01 = 256 bytes
track.                               02 = 512 bytes
                                     03 = 1024 bytes
Sector            2               CRC
order is         11               FF : Sector 0 only, 12
0,5,1,6,          1               A0 : bytes of FF all others
2,7,3,8,          1               FA (Data Field Mark)
4,9.            256               Data
                  2               CRC
                 12               FF : Except the last (9)
                  6               00 : which is followed by
                 FE                    130 bytes of FF
```

GAT Sector (Track 11 Sector 1)

Previously we mentioned the file directory system used by DOS. It is based in part on the ability to dynamically assign disk space on an as-needed basis. Conversely, it must be possible to reuse space which has been released and is no longer needed. The basic vehicle used for keeping track of assigned and available disk space is the Granule Allocation Table (GAT). Obviously, GAT data must be stored outside the machine if a permanent record is to be maintained. The GAT sector is used for this storage.

With the disk description there was a definition for a track and sector. These terms will now be re-defined into the DOS term granule. A granule is 5 sectors or half of a track. It is the minimum unit of disk space that is allocated or de-allocated. Granules are numbered from 0 to N, where N is a function of the number of tracks on a diskette. A record of all granules assigned is maintained in the GAT sector. Recalling the disk dimensions mentioned earlier we can compute the number of granules on a diskette as:

```
Granule = (Number of tracks * 10) / 5
```

Using a 35 track drive with the default DOS disk values of 10 sectors per track and 5 sectors per granule this gives 70 granules per diskette.

The GAT sector is divided into three parts. The first part is the actual GAT table where a record of GAT's assigned is maintained. Part two contains a track lock out table, and part three system initialization information.

```
Relative
Byte   0  -->   Granule Byte track 0
                    .
                    .
                Granule byte track 95
      60  -->   Lockout byte for track 0
                    .
                    .
                Lockout byte for track 95
      CE  -->   Password (2 bytes)
      D0  -->   Disk Name (8 bytes)
      D8  -->   Creation Date (8 bytes)
      E0  -->   AUTO procedure
                (32 bytes)
      F0  -->   Not used

Track available  1 1 1 1 1 1 0 0
Locked out       1 1 1 1 1 1 1 1
Lockout byte (1 per track)

Granule          1 1 1 1 1 1 X X
Allocation                     .... Sectors 0 - 4
Byte (1 per track)           :..... Sectors 5 - 9
                       0 = Assigned  1 = Available
```

Hash Index Table (Track 11 Sector 2)

The Hash Index is a method used to rapidly locate a file without searching all of the directory sectors until it is found. Each file has a unique value computed from its name. This value is called the Hash Code. A special sector in the directory contains the Hash Codes for all active files on a diskette. When a file is created, its Hash Code is stored in the hash sector in a position that corresponds to the directory for that file. Note, the hash position does not give the file position, just its directory sector position. When a file is KILL'd it code is removed from the hash sector.

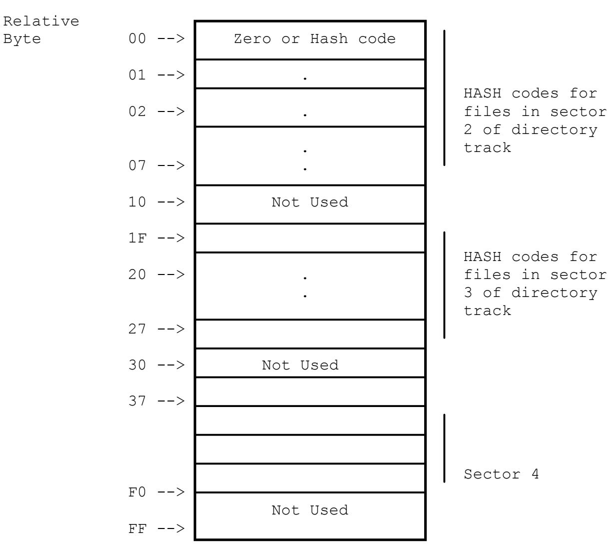
Files are located by first computing their hash value, the Hash Index Sector is then searched for this value. If it is not found then the file does not exist. If the code is found then its position in the Hash Index Sector is used to compute the address for the directory sector containing the file name entry.

Hash code values range from 01 to FF. They are computed from an 11 character file name that has been left justified, blank filled. Any file name extension is the last three characters of the name. The code used for computing a hash value is shown below:

```
      LD      B,11          ; NO. OF CHARS TO NASH
      LD      C,0           ; ZERO HASH REGISTER
LOOP  LD      A,(DE)        ; GET ONE CHAR OF NAME
      INC     DE            ; BUMP TO NEXT CHAR
      XOR     C             ; HASH REG. XOR. NEXT CHAR
      RLCA                  ; 2*(NR. XOR. NC)
      LD      C,A           ; NEW HR
      DJNZ    LOOP          ; HASH ALL CHARS
      LD      A,C           ; GET HASH VALUE
      OR      A             ; DON'T ALLOW ZERO
      JMP     DONE          ; EXIT, HASH IN A
      INC     A             ; FORCE HASH TO 1
DONE  .                     ; EXIT, HASH IN A
```

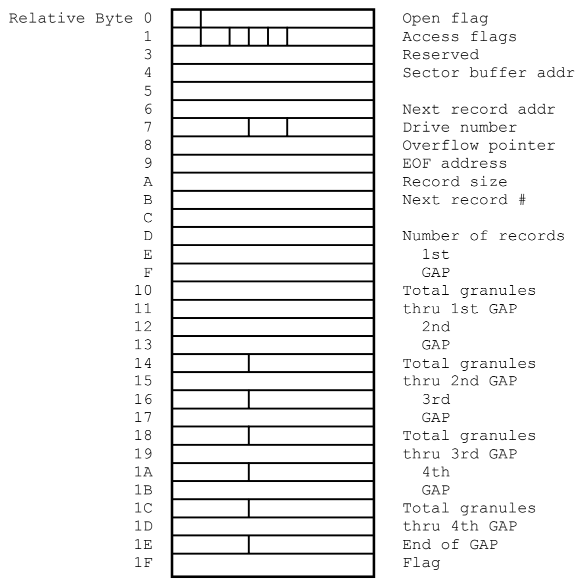
Space for codes in the Hash Sector is assigned sequentially beginning at an arbitrary point. If the hash sector is full a DOS error code of 1A is given otherwise the sector is scanned in a circular manner until the first available (zero) entry is found.

Not all words in the Hash Sector are used. Addresses in the range 10 - 1F, 30 - 3F, 50 - 5F are excluded. Only those addresses ending in the digits 00-07, 20-27 etc are assigned. This speeds the computation of the directory sector number from the hash code value address. The Hash Sector is shown below.



Disk DCB

Each disk file has associated with it a 32 byte DCB which is defined in the user's memory space. When the file is opened the DCB must contain the file name, a name extension if any, and an optional drive specification. As part of the OPEN processing the DCB is initialized for READ and WRITE operations by copying portions of the directory entry into the DCB. After initialization the DCB appears as shown.



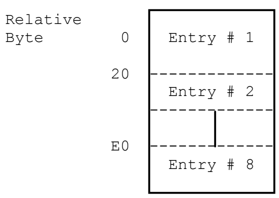
where

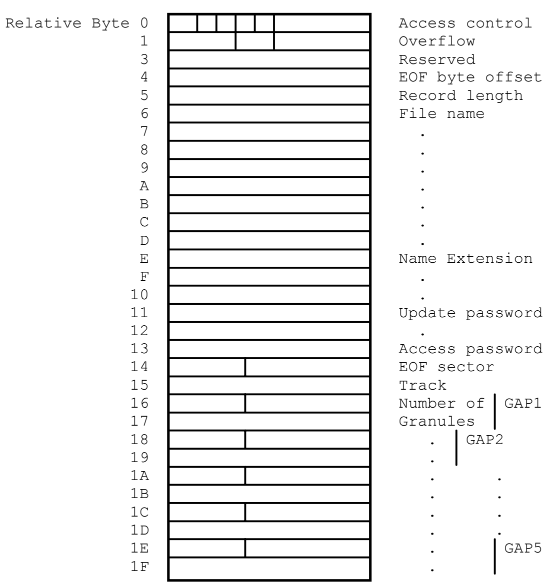
```
BYTE   0   bits 0-6 : reserved
            bit 7   : 0 = file not opened
                      1 = file opened

BYTE   1   bits 0-2 : access permission flag.
            bit  3  : reserved
            bit  4  : 0 = sector buffer available
                      1 = flush sector buffer before using
            bit   5 : 0 = look for record in current buffer
                      1 = unconditionally read next sector
            bit   6 : reserved
            bit   7 : 0 = sector I/O
                      1 = logical record I/O

BYTE   2      reserved
BYTE   3 - 4  sector buffer address in LSB/MSB order
BYTE   5      pointer to next record in buffer
BYTE   6      drive number
BYTE   7      bits 0-3  sector number - 2 of  overflow entry
              bits 3-4  reserved
              bits 5-7  offset/16 to primary entry in directory
BYTE   8      pointer to end of file in last sector
BYTE   9      record size
BYTE  10 - 11 next record number in LSB/MSB format
BYTE  12 - 13 number of records in file
BYTE  14 - 15 first GAP
BYTE  16 - 17 total granules assigned thru first
BYTE  18 - 19 second GAP
BYTE  20 - 21 total granules assigned thru second GAP
BYTE  22 - 23 third GAP
BYTE  24 - 25 total granules assigned thru third GAP
BYTE  26 - 27 fourth GAP
BYTE  28 - 29 total granules assigned thru fourth GAP
BYTE  30 - 31 end of GAP string flag (FFFF)
```

Directory Sector (Track 11 Sector 3 - Track 11 Sector 9)

Directory sectors contain file descriptions used when accessing a disk file. These descriptions contain among other things the file name, passwords, and a list of the disk addresses occupied by the file. The directory sectors are divided into eight fixed-length partitions of thirty two bytes each. Each partition contains one file description. Empty partitions are indicated by a flag in the first byte of the partition.

Space in the directory is assigned when a file is initially created using a DOS OPEN or INIT call. There is no particular order in the way space is assigned because the directory sector number used is determined by a hash code derived from the file name. Partition space in the sector is assigned in sequential order.





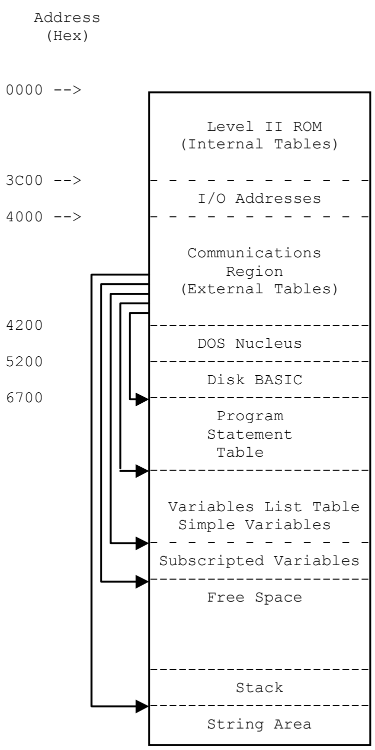

```
BYTE 0    bits 0-2 = file access control flags
         000 - unrestricted access
         001 - KILL/RENAME/WRITE/READ/EXECUTE access
         010 - RENAME/WRITE/READ/EXECUTE access
         011 - reserved
         100 - WRITE/READ/EXECUTE access
         101 - READ/EXECUTE access
         110 - EXECUTE access only
         111 - restricted file no access

         bit3 = 0, file is displayable. 1, file is invisible.
         bit4 = 0, this entry is available. 1, entry is used.
         bit5 = reserved
         bit6 = 0, user file. 1, SYSTEM file.
         bit7 = 0, primary entry. 1, overflow entry.

BYTE  1  used for overflow entries only.
         Bits 0 - 3 byte offset/10 in primary sector to the entry
                  for this file
         Bits 4 - 7 sector number - 2 of primary entry.
BYTE   2  Reserved
BYTE   3  Bits 0 - 7    byte offset to end of file in last sector.
BYTE   4  Bits 0 - 7    record length.

BYTES  5 - 12  File name in ASCII, left justified, blank filled.
BYTES 13 - 15 File name extension in ASCII left justified, blank filled.
BYTES 16 - 17 Update password (encoded).
BYTES 18 - 19 Access password (encoded).
BYTES 20 - 21 Last sector number in file. LSB/MSB order.
BYTES 22 - 31 Five two-byte entries called Granule Assignment
              Pairs (GAPs). Each GAP consists of a starting track number
              (byte 1) and a count of the number of  consecutively
              assigned granules (byte 2). A string of these GAP's in
              proper order define the disk addresses assigned
              to a file. The end of a GAP string will be signaled by
              a FF in bytes 1 and 2 if there are no more than five
              GAP assigned, or an FE followed by the disk address of
              another directory sector containing the remainder of
              the GAP's. The directory entry containing the overflow
              GAP's is called an overflow entry and contains only the
              continuation of the GAP string. There is no limit to the
              number of overflow entries that may be assigned.
              GAP bytes are formatted as shown below

1st Byte: Bits 0 - 7 contain one of the following:
   a) If the contents of 1st byte is less than FE it is assumed
      to be a track number.
   b) An FF if there are no more GAP's. This is the end of a GAP string
   c) An FE if there are more GAP entries in an overflow sector.
      The next byte contains the overflow sector address.

2nd Byte: The interpretation of this byte depends on the contents of
   the preceding byte. If = FF, then this byte is not contains an FF.
   If preceding byte = FE, then:
   holds in bits  0 - 3 the sector number - 2 of overflow sector.
   bits  4 - 7 the byte offset/10 in the overflow sector to the
   entry with the remainder of the GAPs'.
   If preceding byte < FE, then this byte has in bits 0 - 3 the number
of
   consecutive granules minus 1. This value varies from 0 up to 1F.
   Bit 4 = a flag indicating whether the first or second granule in
   the starting track has been assigned. If bit 4 = 0, then the
   first granule was assigned. if bit 4 = 1, then the second granule
   starts with sector.
5) was assigned.
```

Following is an example of a GAP string:

```
    byte 22:  23     file starts on track 23
    byte 23:  06     there are 7 granules assigned
                     TRK (23) S(0-9), TRK (24) S(0-9)
                     TRK (25) S(0-9), TRK (26) S(0-4)

----------------------------------------------------------
    byte 24:  15     file continues on track 15
    byte 25:  23     for 4 granules
                     TRK (15) S(5-9), TRK (16) S(0-9)
                     TRK (17) S(0-4)

----------------------------------------------------------
    byte 26: FF   end of GAP string
    byte 27: FF   end of GAP string
```

Chapter 4

Addresses & Tables



Level II Internal Tables

Internal tables are those lists and tables that are resident in the Level II system. Since they are ROM resident their contents and address are fixed. They are used by BASIC for syntax analysis, during expression evaluation, for data conversions, and while executing such statements as FOR and IF.

Reserved Word List (1650 - 1821)

This table contains all of the word reserved for use by the BASIC interpreter. Each entry contains a reserved word with bit 8 turned on. During the Input Phase the incoming line is scanned for words in this list. Any occurrence of one is replaced by a token representing it. The token is computed as 80 plus the index into the table where the word was found. A list of those words and their token values follows:

Word	Token	Word	Token	Word	Token
END	80	FOR	81	RESET	82
SET	83	CLS	84	*CMD	85
RANDOM	86	NEXT	87	DATA	88
INPUT	89	DIM	8A	READ	8B
LET	8C	GOTO	8D	RUN	8E
IF	8F	RESTORE	90	GOSUB	91
RETURN	92	REM	93	STOP	94
ELSE	95	TRON	96	TROFF	97
DEFSTR	98	DEFINT	99	DEFSNG	9A
DEFDBL	9B	*LINE	9C	EDIT	9D
ERROR	9E	RESUM	9F	OUT	A0
ON	A1	*OPEN	A2	*FIELD	A3
*GET	A4	*PUT	A5	*CLOSE	A6
*LOAD	A7	*MERGE	A8	*NAME	A9
*KILL	AA	*LSET	AB	*RSET	AC
*SAVE	AD	SYSTEM	AE	LPRINT	AF
*DEF	B0	POKE	B1	PRINT	B2
CONT	B3	LIST	B4	LLIST	B5
DELETE	B6	AUTO	B7	CLEAR	B8
CLOAD	B9	CSAVE	BA	NEW	BB
TAB(	BC	TO	BD	*FN	BE
USING	BF	VARPTR	C0	USR	C1
ERL	C2	ERR	C3	STRING$	C4
INSTR	C5	POINT	C6	*TIMES	C7
MEM	C8	INKEY$	C9	THEN	CA
NOT	CB	STEP	CC	+	CD
-	CE	*	CF	/	D0
UP ARROW	D1	AND	D2	OR	D3
>	D4	=	D5	<	D6
SGN	D7	INT	D8	ABS	D9
FRE	DA	INP	DB	POS	DC
SQR	DD	RND	DE	LOG	DF
EXP	E0	COS	E1	SIN	E2
TAN	E3	ATN	E4	PEEK	E5
*CVI	E6	*CVS	E7	*CVD	E8
*EOF	E9	*LOC	EA	*LOF	EB
*MKI$	EC	*MKS$	ED	CINT	EF
CSNG	F0	CDBL	F1	FIX	F2
LEN	F3	STR$	F4	VAL	F5
ASC	F6	CHR$	F7	LEFT$	F8
RIGHT$	F9	*MID$	FA	'	FB

* Disk BASIC tokens

Precedence Operator Values (189A - 18A0)

This table contains numeric values used to determine the order of arithmetic operations when evaluating an expression. As the expression is scanned each operator/ operand pair plus the precedence value for the previous operand is stored on the stack. When an operator of higher precedence than the preceding one is found the current operation is performed giving an intermediate value that is carried forward on the stack. The values shown for relational operations are computed rather than being derived from a table look-up.

Operator	Function	Precedence Value
UP ARROW	(Exponent)	7F
*	(Multiplication)	7C
/	(Division)	7C
+	(Addition)	79
-	(Subtraction)	79
ANY	(Relational)	64
AND	(Logical)	50
OR	(Logical)	46
<=	(Relational)	06
<>	(Relational)	05
>=	(Relational)	03
<	(Relational)	04
=	(Relational)	02
>	(Relational)	01

Arithmetic Routines (18AB - 18C8)

There are really three tables back-to-back here. They are used during expression evaluation to compute intermediate values when a higher precedence operator is found.

Arithmetic Routine Addresses

	Integer	Single Precision	Double Precision	String
Addition	0BD2	0716	0C77	298F
Subtraction	0BC7	0713	0C70	NONE
Multiplication	0BF2	0847	0DA1	NONE
Division	2490	08A2	0DE5	NONE
Comparison	0A39	0A0C	0A78	NONE

Data Conversion Routines (18A1 - 18AA)

These routines convert the value in WRA1 from one mode to another. They are called by the expression evaluator when an intermediate computation has been made, and the result needs to be make compatible with the rest of the expression.

Conversion Routine Addresses

Destination Mode	Address
String	0AF4
Integer	0A7F
Single Precision	0AB1
Double Precision	0ADB

Verb Action Addresses

Verb Action Routines (1822 - 1899)

There are two Verb Action Address Lists. The first one is used by the execution driver when beginning execution of a new statement. It contains address of verb routines for the tokens 80 - BB. The first token of the statement is used as an index in the range of 0 - 60 into the table at 1822 - 1899 to find the address of the verb routine to be executed. If the statement does not begin with a token control goes to assignment statement processing. The second table contains the addresses of verb routines which can only occur on the right side of an equals sign. If during the expression evaluation stage a token in the range of D7 - FA is encountered it is used as an index into the table at 1608 - 164F, where the address of the verb routine to be executed is found. There is no address list for the tokens BC - D6 because they are associated with and follow other tokens that expect and process them.

Table Address 1B22 - 1B99)

Token	Verb	Address	Token	Verb	Address
80	END	1DAE	81	FOR	1CA1
82	RESET	0138	83	SET	0135
84	CLS	01C9	85	CMD	4135
86	RANDOM	01D3	87	NEXT	22B6
88	DATA	1F05	89	INPUT	219A
8A	DIM	2608	8B	READ	21EF
8C	LET	1F21	8D	GOTO	1EC2
8E	RUN	1EA3	8F	IF	2039
90	RESTORE	1D91	91	GOSUB	1EB1
92	RETURN	1EDE	93	REM	1F07
94	STOP	1DA9	95	ELSE	1F07
96	TRON	1DF7	97	TROFF	1DF8
98	DEFSTR	1E00	99	DEFINT	1E03
9A	DEFSNG	1E06	9B	DEFDBL	1E09
9C	LINE	41A3	9D	EDIT	2E60
9E	ERROR	1FF4	9F	RESUME	1FAF
A0	OUT	2AFB	A1	ON	1FC6
A2	OPEN	4179	A3	FIELD	417C
A4	GET	417F	A5	PUT	4182
A6	CLOSE	4185	A7	LOAD	4188
A8	MERGE	418B	A9	NAME	418E
AA	KILL	4191	AB	LSET	4197
AC	RSET	419A	AD	SAVE	41A0
AE	SYSTEM	02B2	AF	LPRINT	2067
B0	DEF	41B5	B1	POKE	2CB1
B2	PRINT	206F	B3	CONT	1DE4
B4	LIST	2B2E	B5	LLIST	2B29
B6	DELETE	2BC6	B7	AUTO	2008
B8	CLEAR	1E7A	B9	CLOAD	2C1F
BA	CSAVE	2BF5	BB	NEW	1B49

(Table Address 16DB - 164F)

TOKEN	VERB	Address	TOKEN	VERB	Address
D7	SGN	098A	D8	INT	0B37
D9	ABS	0977	DA	FRE	27D4
DB	INP	2AEF	DC	POS	27A5
DD	SQR	13E7	DE	RND	14C9
DF	LOG	0809	E0	EXP	1439
E1	COS	1541	E2	SIN	1547
E3	TAN	15A8	E4	ATN	15BD
ES	PEEK	2CAA	E6	CVI	4152
E7	CVS	4158	E8	CVD	415E
E9	EOF	4161	EA	LOC	4164
EB	LOF	4167	EC	MKI$	416A
ED	MKS$	416D	EE	MKD$	4170
EF	CINT	0A7F	F0	CSNG	0AB1
F1	CDBL	0DAB	F2	FIX	0B26
F3	LEN	2A03	F4	STR$	2836
F5	VAL	2AC5	F6	ASC	2A0F
F7	CHR$	2A1F	F8	LEFT$	2A61
F9	RIGHT$	2A91	FA	MID$	2A9A

Error Code Table (18C9- 18F6)

Error codes printed under Level II are interpreted by using the error number as in index into a table of two letter error abbreviations. The format of the error code table is as follows:

Error Number	Code	Cause	Originating Address
0	NF	NEXT WITHOUT FOR	22C2
2	SN	SYNTAX ERROR (NUMEROUS CAUSES)	DA,2C7,EEF 1C9E,1D32,1E0E 1E66,2022,235B 2615,2AE9,2DE2
4	RG	RETURN WITHOUT GOSUB	1EEC
6	OD	OUT OF DATA (READ)	2214,22A2
8	FC	NUMEROUS	1E4C
A	OV	NUMERIC OVERFLOW	7B2
C	OM	OUT OF MEMORY	197C
E	UL	MISSING LINE NUMBER	1EDB
10	BS	INDEX TOO LARGE	273F
12	DD	DOUBLY DEFINED SYMBOL	2735
14	0/	DIVISION BY 0	8A5,DE9,1401
16	ID	INPUT USE INCORRECT 2833	
18	TM	VARIABLE NOT A STRING	AF8
1A	OS	OUT OF STRING SPACE	28DD
1C	LS	STRING TOO LONG	29A5
1E	ST	LITERAL STRING POOL 28A3 TABLE FULL	
20	CN	CONTINUE NOT ALLOWED	1DEB
22	NR	RESUME NOT ALLOWED 198C	
24	UE	INVALID ERROR CODE 2005	
26	UE	INVALID ERROR CODE 2005	
28	MO	OPERAND MISSING	24A2
2A	FD	DATA ERROR ON CASSETTE	218C
2C	L3	DISK BASIC STATEMENT ATTEMPTED UNDER LEVEL II	12DF

Level II External Tables

External tables used by Level II are those which are kept in RAM. They are kept there because their contents and size, as well as their address, may change. A pointer to each of the External tables is maintained in the Communications Region.

Mode Table (4101-411A)

This table is used by the BASIC interpreter to determine the data type mode (integer, string, single or double precision) for each variable. Although it never moves its contents may change when a DEF declaration is encountered, and therefore it must be in RAM. It is the only RAM table with a fixed address and consequently there is no pointer to it in the Communications Region. The table is 26 decimal words long and is indexed by using the first character of a variable name as an index. Each entry in the table contains a code indicating the variable type e.g. 02 - integer, 03 - string, 04 - single precision, 08 - double precision.

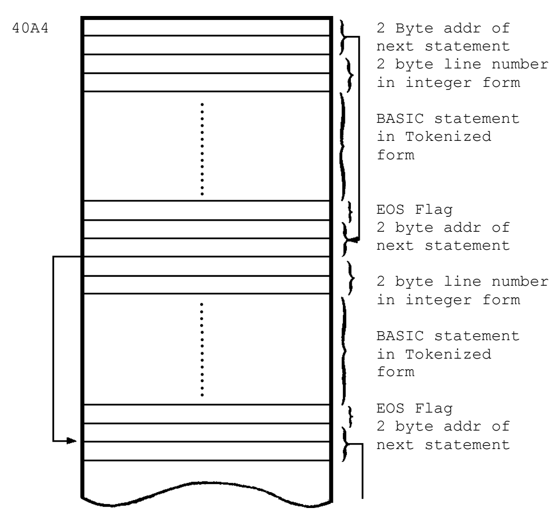
The mode table is initialized during the IPL sequence to 04 for all variables. It appears as:

Address	Letter	Type	Address	Letter	Type
4101	A	04	4102	B	04
4103	C	04	4104	D	04
4105	E	04	4106	F	04
4107	G	04	4108	H	04
4109	I	04	410A	J	04
410B	K	04	410C	L	04
410D	N	04	410E	N	04
410F	0	04	4110	P	04
4111	Q	04	4112	K	04
4113	S	D4	4114	T	04
4115	U	04	4116	V	04
4117	W	04	4118	X	04
4119	Y	04	411A	Z	04

Program Statement Table (PST)

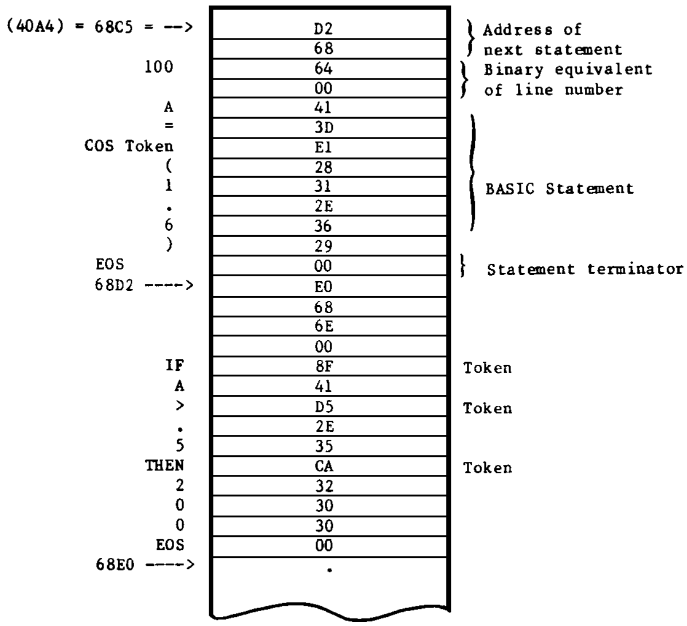
The Program Statement Table contains BASIC statements entered as a program. Since it is RAM resident and its origin may change from system to system there is a pointer to it in the Communications Region at address 40A4. As each line is entered it is tokenized and stored in the PST. Statements are stored in ascending order by line number regardless of the order in which they are entered. Each entry begins with a two byte pointer to the next line followed by a two byte integer equivalent of the line number then the text of the BASIC statement. The body of the statement is terminated with a single byte of zeros called the End Of Statement or EOS flag. The ending address of the PST is contained in 40F9. It is terminated by two bytes of zeros.

Program Statement Table (PST)



Shown below are two statements and their representation in the PST:

100 A = COS (1.6)
110 IF A>.5 THEN 500



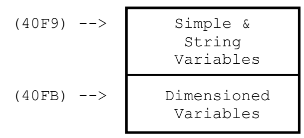
Variable List Table (VLT)

This table contains all variables assigned to a BASIC program. Internally the table is divided into two sections. Section one contains entries for all non-subscripted and string variables while section two contains the values for all subscripted variables. Like the PST the VLT is RAM resident and it has two pointers in the Communications Region. Location 40F9 contains the address of the first section, and 40FB contains the address of section two. The starting address of the VLT is considered as the end of the PST.

Regardless of which section a variable is defined in, the first three bytes of each entry have the same format. Byte one has a type code (2,3,4 or 8), which doubles as the length of the entry. Bytes two and three contain the variable name in last/first character order. Following this is the value itself in LSB/MSB order, or if it as a string variable a pointer to the string in the String Area.

Section two contains all dimensioned arrays. These entries have the same three byte header followed by a another header which defines the extents of the array. The array is stored after the second header in column-major order.

Variables are assigned space in the VLT as they are encountered (in a DIM statement or in any part of an assignment statement). There is no alphabetical ordering. Because space is assigned on demand it is possible for previously defined variables to be moved down. For example, if A, B, and C(5) were defined followed by D, C(5) would be moved down because section one would be increased for D. This would force section two to be moved.



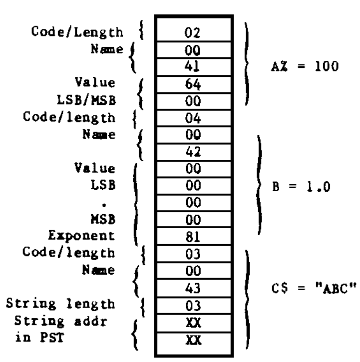
Arrays are stored in column-major order. In that order the left most index varies the fastest. For example the array A(2,3) would be stored in memory as:

A(0,0)
A(1,0)
A(2,0)
.
.
.
A(0,3)
A(1,3)
A(2,3)

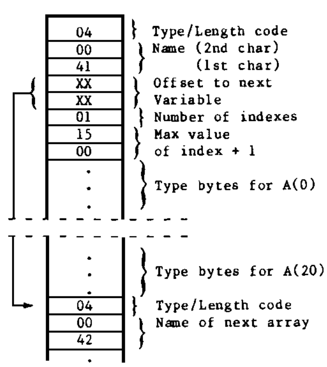
An index for any element can be computed using the formula:

```
INDEX = (((LRI*0)+URI)*LMI)+UMI)*LLI)+ULI

where

LRI = limit of right index
LMI = limit of middle index
LLI = limit of left index

URI = user's current right index
UMI = user's current middle index
ULI = user's current left index
```

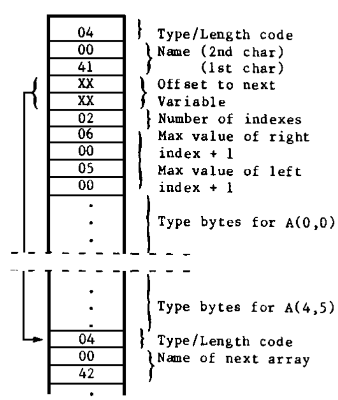
The code used to compute these indexes may be found at address 2595 to 27C8.



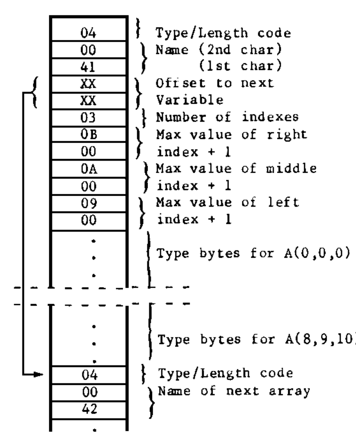
Simple and String Variable Storage



Single Dimensioned Arrays : DIM A(20)



Two Dimensional Array : DIM A(4,5)

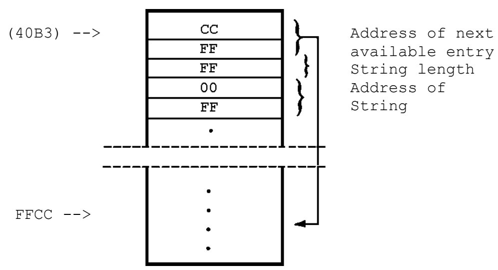


Three Dimensional Array : DIM A(8,9,10)

Literal String Pool (40D2)

This table is used by BASIC to keep track of intermediate strings which result from operations such as string addition or some print operations. The table has eleven three byte entries which are assigned sequentially. The start of the table has a two byte pointer to the next available entry. It is initialized during IPL to point to the head of the list.

Each entry contains the length and the address of a string which is usually (although not necessarily) in the PST. Entries are assigned in a top down fashion and released in a bottom up manner. A pointer to the next available entry is kept in 40B3. If the table overflows an ST error is given.



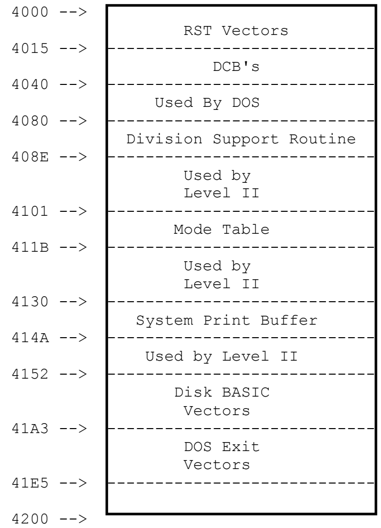
Literal String Pool

Communications Region (4000 - 4200)

The Communications Region has been defined as RAM locations 4000 to 4200. These addresses give the definition an air of precision that is not warranted. In reality only a portion of the area is used in the sense given to the term Communications Region. Those boundaries were chosen because they represent the end of ROM and the approximate starting address of DOS in RAM. In a Level II system without disk there would be no DOS and the RAM tables such as the PST, VLT, etc. would begin at a much lower address. But they would still be above 4200 so it is safe to think of that region as reserved.

The Communications Region has many uses other than those mentioned so far. The following diagram shows the major areas discussed up to this point. Following it is a description of all bytes in the Communications Region and their known use.

Communications Region



Address	Level II Contents	DOS Contents	Description
4000	JP 1C96	....	RST 8 VECTOR
4003	JP 1D78	....	RST 10 VECTOR
4006	JP 1C90	....	RST 18 VECTOR
4009	JP 25D9	....	RST 20 VECTOR
400C	RET	JP 4BA2	RST 28 DOS REQUEST PROCESSING
400F	RET	JP 44B4	LOAD DEBUG (LD A,XX/RST 28)
4012	DI/RET	CALL 4518	RST 38 INTERRUPT SERVICE CALL
4015	....		KEYBOARD DCB (8 BYTES)
401D	....		VIDEO DCB (8 BYTES)
4025	....		PRINTER DCB (8 BYTES)
402D	JP 5000	JP 4400	MAKE SYS1 (10) DOS REQUEST
4030	RST 0	LD A,A3	DOS REQUEST CODE FOR SYS1
4032	LD A,0	RST 28	WRITE 'DOS READY' MSG
4033	RET	JP 44BB	CALL DEVICE DRIVER ALA DOS
4036 .	....		KEYBOARD WORK AREA USED BY SYS0 AND KEYBOARD DRIVER
403D	....		DISPLAY CONTROL WORD (U/L CASE)
403E	....		USED BY DOS
403F	....		USED BY DOS
4040	....		SYSTEM BST'S
4041	....		SECONDS
4042	....		MINUTES
4043	....		HOURS
4044	....		YEAR
4045	....		DAY
4046	....		MONTH
4047	....		LOAD ADDRESS FOR SYSTEM UTILITIES 2 BYTES, INITIALIZED TO 5200 BY SYS0/SYS
4049	....		MEMORY SIZE. COMPUTED BY SYS0/SYS
404A	....		RESERVED
4048	....		CURRENT INTERRUPT STATUS WORD
404C	....		INTERRUPT SUBROUTINE MASK
404D	....		RESERVED (INTERRUPT BIT 0)
404F	....		RESERVED (INTERRUPT BIT 1)
4051	....		COMMUNICATIONS INTERRUPT SUBROUTINE
4053	....		RESERVED (INTERRUPT BIT 3)
4055	....		RESERVED (INTERRUPT BIT 4)
4057	....		RESERVED (INTERRUPT BIT 5)
4059		45F7	ADDR OF DISK INTERRUPT ROUTINE
4058		4560	ADDR OF CLOCK INTERRUPT ROUTINE
4050	....		STACK DURING IPL
4070	....		START OF STACK DURING ROM IPL
407E	....		RESERVED
407F	....		RESERVED
4080	....		SUBTRACTION ROUTINE USED BY DIVISION CODE. CODE IS MOVED FROM '18F7' - '1904' DURING NON-DISK IPL OR BY BASIC UTILITY FOR DISK SYSTEMS

```
408E   ..................... CONTAINS ADDRESS OF USER SUBROUTINE
4090   ..................... RANDOM NUMBER SEED
4093   ..................... IN A,00
4096   ..................... OUT A,00
4099   ..................... HOLDS LAST CHAR TYPED AFTER BREAK
409A   ..................... FLAG (SIGNALS RESUME ENTERED)
409B   ..................... NO. OF CHARS. IN CURRENT PRINT LINE
409D   ..................... OUTPUT DEVICE CODE (1-PRINTER
                             0-VIDEO, MINUS 1-CASSETTE)
409D   ..................... SIZE OF DISPLAY LINE  (VIDEO)
409E   ..................... SIZE OF PRINT LINE
409F   ..................... RESERVED
40A0   ..................... ADDR  OF STRING AREA BOUNDARY
40A1   ..................... CURRENT LINE NUMBER
40A4   ..................... ADDR OF PST
40A5   ..................... CURSOR POSITION
40A7   ..................... ADDR  OF KEYBOARD BUFFER.
40A9   ..................... 0 IF CASSETTE INPUT, ELSE NON-ZERO
40AA   ..................... RANDOM NUMBER SEED
40AB   ..................... VALUE FROM REFRESH REGISTER
40AC   ..................... LAST RANDOM NUMBER (2 BYTES)
40AE   ..................... FLAG: 0 - LOCATE NAMED VARIABLE
                                  -1 - CREATE ENTRY FOR
                                       NAMED VARIABLE
40AF   ..................... TYPE FLAG FOR VALUE IN WRA1.
                              2 - INTEGER
                              3 - STRING
                              4 - SINGLE PRECISION
                              8 DOUBLE PRECISION
40B0   ..................... HOLDS INTERMEDIATE VALUE DURING
                             EXPRESSION EVA
40B1   ..................... MEMORY SIZE
40B2   ..................... RESERVED
40B3   ..................... ADDR  OF NEXT AVAILABLE LOC. IN LSPT.
40B5   ..................... LSPT (LITERAL STRING POOL TABLE)
40D2   ..................... END OF LSPT
4003   ..................... THE NEXT 3 BYTES ARE USED TO HOLD
                             THE LENGTH AND ADDR OF A STRING WHEN
                             IT IS MOVED TO THE STRING AREA.
40D6   ..................... POINTER TO NEXT AVAILABLE
                             LOC. IN STRING AREA
40D8   ..................... 1: INDEX OF LAST BYTE EXECUTED IN
                                CURRENT STATEMENT.
                             2: EDIT FLAG DURING PRINT USING
40DA   ..................... LINE NO. OF LAST DATA STATEMENT
40DC   ..................... FOR FLAG (1 = FOR IN PROGRESS
                             0 = NO FOR IN PROGRESS)
40DD   ..................... 0 DURING INPUT PHASE, ZERO OTHERWISE
40DE   ..................... READ FLAG: 0 = READ STATEMENT ACTIVE
                             1 = INPUT STATEMENT ACTIVE
                             ALSO USED IN PRINT USING TO HOLD
                             SEPARATOR BETWEEN STRING AND VARIABLE
40DF   ..................... HOLDS EXECUTION ADDR FOR PGM LOADED
                             WITH DOS REQUEST
40E1   ..................... AUTO INCREMENT FLAG  0 = NO AUTO MODE
                             NON-ZERO HOLDS NEXT LINE
40E2   ..................... CURRENT LINE NUMBER IN BINARY
                             (DURING INPUT PHASE)
40E4   ..................... AUTO LINE INCREMENT
40E6   ..................... DURING INPUT: ADDR OF  CODE STRING
                             FOR CURRENT STATEMENT.
                             DURING EXECUTION: LINE NO. FOR CURRENT
                             STATEMENT
40E8   ..................... DURING EXECUTION: HOLDS STACK POINTER
                             VALUE WHEN STATEMENT EXECUTION BEGINS
40EA   ..................... LINE NO. IN WHICH ERROR OCCURRED
40EC   ..................... LINE NO. IN WHICH ERROR OCCURRED
40ED   ..................... LAST BYTE EXECUTED IN CURRENT STATEMENT
40EF   ..................... ADDR OF POSITION IN ERROR LINE
40F0   ..................... ON ERROR ADDRESS
40F2   ..................... FLAG. FF DURING ON ERROR PROCESSING
                             CLEARED BY RESUME ROUTINE
40F3   ..................... ADDR OF DECIMAL POINT IN PBUFF
40F5   ..................... LAST LINE NUMBER EXECUTED
                             SAVED BY STOP/END
40F7   ..................... ADDR OF LAST BYTE EXECUTED DURING
                             ERROR
40F9   ..................... ADDR OF SIMPLE VARIABLES
40FB   ..................... ADDR OF DIMENSIONED VARIABLES
40FD   ..................... STARTING ADDRESS OF FREE SPACE LIST
40FF   ..................... POINTS TO BYTE FOLLOWING LAST CHAR
                             READ DURING READ STMNT PROCESSING
4101   ..................... VARIABLE DECLARATION LIST. THERE
                             ARE 26 ENTRIES ( 1 FOR EACH LETTER
                             OF THE ALPHABET) EACH ENTRY CONTAINS
                             A CODE INDICATING DEFAULT MODE FOR
                             VARIABLES STARTING WITH THAT LETTER
411A   ..................... END OF DECLARATION LIST
411B   ..................... TRACE FLAG (0 = NO TRACE,
                             NON-ZERO = TRACE)
```

```
  411C   ..................... TEMP STORAGE USED BY NUMERIC ROUTINES
                               WHEN UNPACKING A FLOATING POINT
                               NUMBER. USUALLY IT HOLDS THE LAST
                               BYTE SHIFTED OUT OF THE LSB POSITION
  411D   ..................... WRA1 - LSB OF DBL PREC. VALUE
  411E   ..................... WRA1 -  DBL PREC. VALUE
  415F   ..................... WRA1 -  DBL PREC VALUE
  4120   ..................... WRA1 -  DBL PREC VALUE
  4121   ..................... WRA1 - LSB OF INTEGER SINGLE PREC
  4122   ..................... WRA1
  4123   ..................... WRA1 - MSB FOR SINGLE PREC
  4124   ..................... WRA1 - EXPONENT FOR SINGLE PREC
  4125   ..................... SIGN OF RESULT DURING MATH &
                               ARITHMETIC OPERATIONS
  4126   ..................... BIT  BUCKET USED DURING DP ADDITION
  4127   ..................... WRA2 - LSB
  4128   ..................... WRA2
  4129   ..................... WRA2
  412A   ..................... WRA2
  422B   ..................... WRA2
  412C   ..................... WRA2
  412D   ..................... WRA2 - MSB
  412E   ..................... WRA2 - EXPONENT
  412F   ..................... NOT  USED
  4130   ..................... START OF INTERNAL PRINT BUFFER
                               USED DURING PRINT PROCESSING
  4149   ..................... LAST BYTE OF PRINT BUFFER
  414A   ..................... TEMP. STORAGE USED BY DBL PRECISION
                               DIVISION ROUTINE. HOLDS DIVISOR
  4151   ..................... END OF TEMP AREA
*
* LOCATIONS 4152 THRU 41E2 CONTAIN DOS EXITS AND DISK BASIC EXITS. ON
* NON-DISK SYSTEMS THESE LOCATIONS ARE INITIALIZED TO RETURNS (RET'S)
* WHILE ON DISK BASED SYSTEMS THEY WILL BE INITIALIZED AS SHOWN.
*
  4152   ...RET..JP 5E46 ..... DISK BASIC EXIT (CVI)
  4155   ...RET..JP 558E ..... DISK BASIC EXIT (FN)
  4158   ...RET..JP 5E49 ..... DISK BASIC EXIT (CVS)
  415E   ...RET..JP 5655 ..... DISK BASIC EXIT (DEF)
  415K   ...RET..JP 5E4C ..... DISK BASIC EXIT (CVD)
  4161   .. RET..JP 61EB ..... DISK BASIC EXIT (EOF)
  4164   ...RET..JP 6231 ..... DISK BASIC EXIT (LOC)
  4167   ...RET..JP 6242 ..... DISK BASIC EXIT (LOF)
  416A   ...RET..JP 5E20 ..... DISK BASIC EXIT (MKI$)
  4160   ...RET..JP 5E30 ..... DISK BASIC EXIT (MKS$)
  4170   ...RET..JP 5E33 ..... DISK BASIC EXIT (MKD$)
  4173   ...RET..JP 56C4 ..... DISK BASIC EXIT (CMD)
  4176   ...RET..JP 5714 ..... DISK BASIC EXIT (TIME$)
  4179   ...RET..JP 6349 ..... DISK BASIC EXIT (OPEN)
  417C   ...RET..JP 60AB ..... DISK BASIC EXIT (FIELD)
  417F   ...RET..JP 627C ..... DISK BASIC EXIT (GET)
  4182   ...RET..JP 627B ..... DISK BASIC EXIT (PUT)
  4185   ...RET..JP 606F ..... DISK BASIC EXIT (CLOSE)
  4188   ...RET..JP 5F7B ..... DISK BASIC EXIT (LOAD)
  418B   ...RET..JP 600B ..... DISK BASIC EXIT (MERGE)
  418E   ...RET..JP 6346 ..... DISK BASIC EXIT (NAME)
  4191   ...RET..JP 63C0 ..... DISK BASIC EXIT (KILL)
  4194   ...RET..JP 58B7 ..... DISK BASIC EXIT (&)
  4197   ...RET..JP 60E6 ..... DISK BASIC EXIT (LIST)
  419A   ...RET..JP 60E5 ..... DISK BASIC EXIT (RSET)
  419D   ...RET..JP 582F ..... DISK BASIC EXIT (INSTR)
  41A0   ...RET..JP 6044 ..... DISK BASIC EXIT (SAVE)
  41A3   ...RET..JP 5756 ..... DISK BASIC EXIT (LINE)
  41A6   ...RET..JP 5679 ..... DISK BASIC EXIT (USR)
 *
 *
THE FOLLOWING ADDRESSES ARE THE DOS EXIT ADDRESSES.
 *
 *
  41A9   ...RET..JP XXXX ..... DOS EXIT FROM
  41AC   ...RET..JP 5FFC ..... DOS EXIT FROM 1A1C
  41AF   ...RET..JP 598E ..... DOS EXIT FROM 0368
  41B2   ...RET..JP 6033 ..... DOS EXIT FROM ROM address 1AA1
  41B5   ...RET..JP 5BD7 ..... DOS EXIT FROM ROM address 1AEC
  41B8   ...RET..JP 5B8C ..... DOS EXIT FROM ROM address 1AF2
  41BB   ...RET..JP 60A1 ..... DOS EXIT FROM ROM address 1B8C
  41BE   .. RET..JP 577C ..... DOS EXIT FROM ROM address 2174
  41C1   .. RET..JP 59CD ..... DOS EXIT FROM ROM address 032C
  41C4   .. RET..JP XXXX ..... DOS EXIT FROM ROM address 0358
  41C7   ...RET..JP 5F78 ..... DOS EXIT FROM ROM address 1EA6
  41CA   ...RET..JP 5A15 ..... DOS EXIT FROM ROM address 206F
  41CD   ...RET..JP 5B9A ..... DOS EXIT FROM ROM address 2103
  41D0   ...RET..JP 5B99 ..... DOS EXIT FROM ROM address 2103
  41D3   ...RET. JP 5B65 ..... DOS EXIT FROM ROM address 2108
  41D6   ...RET..JP 5784 ..... DOS EXIT FROM ROM address 219E
  41DC   ...RET..JP 5E63 ..... DOS EXIT FROM ROM address 222D
  41DF   ...RET..JP 579C ..... DOS EXIT FROM ROM address 2278
  41E2   ...RET..JP 5B51 ..... DOS EXIT FROM ROM address 0282
```

DCB Descriptions

The keyboard, video, and printer DCB'S (Device Control Blocks) are defined in ROM at locations 06E7 - 06FF. They are moved to the address show in the Communications Region during the IPL sequence.

Video DCB (Address 401D)

```
Relative Byte

0   0 0 0 0 0 1 1 1   Device type (7)
1   0 1 0 0 1 0 0 0   | Driver address
2   0 0 0 0 0 1 0 1   | (0458)
3   0 0 0 0 0 0 0 0   | Next character address
4   0 0 1 1 1 1 0 0   | 3C00 =< X < 3FFF
5   0 0 0 0 0 0 0 0   0/value 0 = Suppress cursor
6   0 1 0 0 0 1 0 0   | value = last char under cursor
7   0 1 0 0 1 1 1 1   | RAM buffer addr (4F44)
```

Keyboard DCB (Address 4015)

```
Relative Byte

0   0 0 0 0 0 0 0 1   Device type (1)
1   1 1 1 0 0 0 1 1   | Driver address
2   0 0 0 0 0 0 1 1   | (03E3)
3   0 0 0 0 0 0 0 0   |
4   0 0 0 0 0 0 0 0   | Not Used
5   0 0 0 0 0 0 0 0   |
6   0 1 0 0 1 0 1 1   | RAM buffer
7   0 1 0 0 1 0 0 1   | address (494B)
```

Printer DCB (Address 4025)

```
Relative Byte

0   0 0 0 0 0 1 1 0   Device type (6)
1   1 0 0 0 1 1 0 1   | Driver address
2   0 0 0 0 0 1 0 1   | (058D)
3   0 1 0 0 0 0 1 1   Lines/page (43H = 67)
4   0 0 0 0 0 0 0 0   Lines printed so far
5   0 0 0 0 0 0 0 0   Not Used
6   0 1 0 1 0 0 0 0   | RAM buffer
7   0 1 0 1 0 0 1 0   | address (5250)
```

Interrupt Vectors

Interrupts are a means of allowing an external event to interrupt the CPU and redirect it to execute some specific portion of code. The signal that causes this to happen is called an interrupt and the code executed in response to that interrupt is called a service routine. After the service routine executes it returns control of the CPU to the point where the interrupt occurred and normal processing continues.

In order for interrupts to occur the system must be primed to accept them. When the system is primed it is ENABLED which is shorthand for the instruction used to enable the interrupt system (EI-Enable Interrupts). A system that is not enabled is DISABLED and again that is shorthand for the disable instruction (DI-Disable Interrupts). Besides priming the system for interrupts there must be some outside event to stimulate the interrupt. On Level II systems that could be a clock or a disk. Actually both of them generate interrupts - the clock gives one every 25 milliseconds, and the disk on demand for certain operations.

When running a Level II system without disks the interrupts are disabled. It is only when DOS is loaded that interrupts are enabled and service routines to support those interrupts are loaded. Interrupts are disabled at the start of the IPL sequence that is common to Level II and DOS. For Level II they will remain off, but on a DOS system they will be enabled at the end of the initialization in SYS0/SYS.

When an interrupt occurs two things happen. First a bit indicating the exact cause of the interrupt is set in byte 37E0. Second an RST 38H instruction is executed. As a result of the RST (which is like a CALL) the address of the next instruction to be executed is saved on the stack (PUSH'd) and control is passed to location 0038. Stored at 0038 is a JP 4012. During the IPL sequence 4012 was initialized to:

```
4012 DI   Disable further interrupts
4013 RET  Return to point of interrupt
```

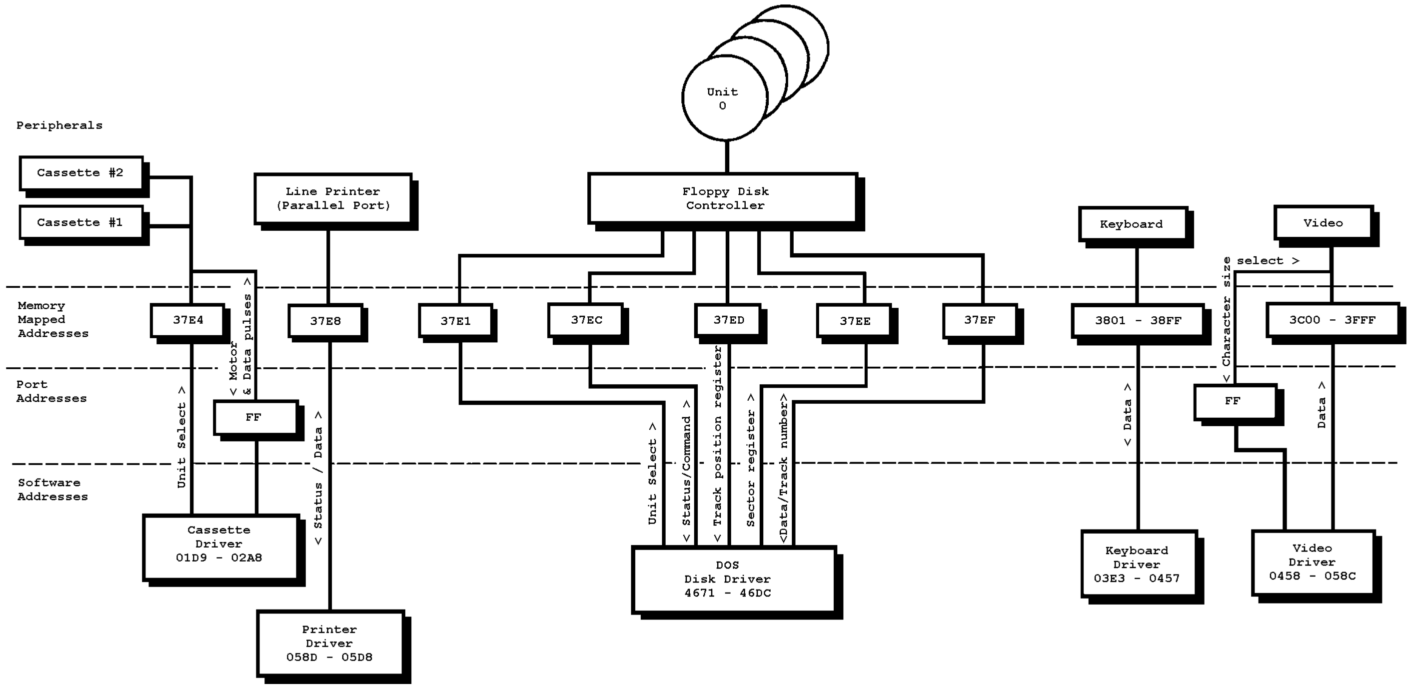
for non-disk systems or:

```
4012 CALL 4518  Service Interrupt
```

for disk systems

The service routine at 4518 examines the contents of 37E0 and executes a subroutine for each bit that is turned on and for which DOS has a subroutine. The format of the interrupt status word at 37E0 is:

```
 7 6 5 4 3 2 1 0   <-- Bits
|X|X| | | |X| | |
                   Not used
                   Communications Interrupt
                   Not used
                   Disk Controller Interrupt
                   Clock Interrupt
```



Memory Mapped I/O

DOS maintains an interrupt service mask at 404C that it uses to decide if there is a subroutine to be executed for each of the interrupt status. As released 404C contains a C0 which indicates subroutines for clock and disk interrupts.

The service routine at 4518 combines the status byte and the mask byte by AND'ing them together. The result is used as a bit index into a table of subroutine addresses stored at 404D - 405C. Each entry is a two byte address of an interrupt subroutine. Bit 0 of the index corresponds to the address at 404D/404E, bit 1 404F/4050, etc.

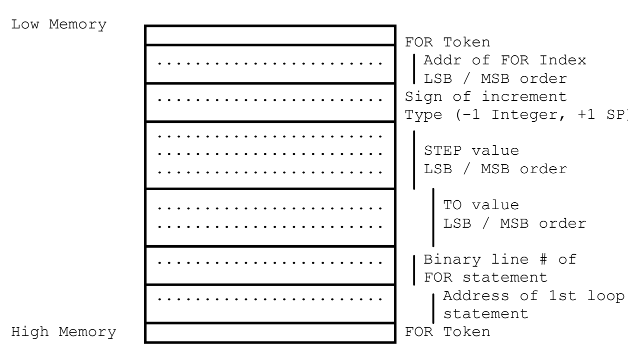
The service routine runs disabled. It scans the interrupt status from left to right jumping to a subroutine whenever a bit is found on. All registers are saved before subroutine entry and a return address in the service routine is PUSH'd onto the stack so a RET instruction can be used to exit the subroutine. When all bits in the status have been tested control returns to the point of interrupt with interrupts enabled.

Stack Frame Configurations

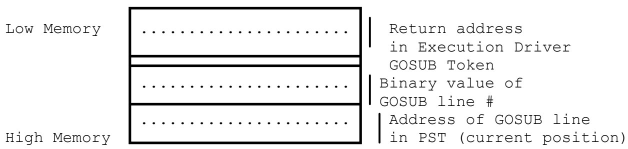
Level II usually uses the Communications Region for temporary storage. There are special cases, however where that is not possible because a routine may call itself (called recursion) and each call would destroy the values saved by the previous call. In those cases the stack is used to save some of the variables. Of course an indexed table could be used, but in these cases the stack serves the purpose.

FOR Statement Stack Frame

All variable addresses associated with a FOR loop are carried on the stack until the loop completes. When a NEXT statement is processed, it searches the stack looking for a FOR frame with the same index address as the current one. The routine that searches the stack is at location 1936. Its only parameter is the address of the current index which is passed in the DE register set. The stack is searched backwards from its current position to the beginning of the stack. If a FOR frame with a matching index address is not found an NF error is generated. The stack frame searched for is given below.



GOSUB Stack Configuration



Expression Evaluation

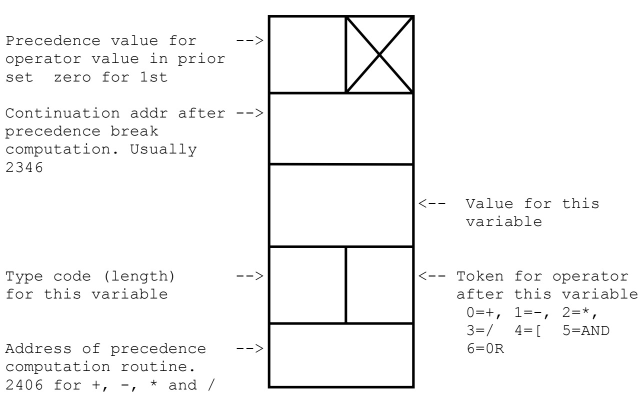
Expression evaluation involves scanning an expression and breaking it into separate operations which can be executed in their proper order according to the hierarchy of operators. This means a statement must be scanned and the operations with the highest hierarchical value (called precedence value) must be performed first. Any new terms which result from those operations must be carried forward and combined with the rest of the expression.

The method used for evaluation is an operator precedence parse. An expression is scanned from left to right. Scanning stops as soon as an operator token or EOS is found. The variable to the left of the operator (called the current variable), and the operator (any arithmetic token for - * / or exp) are called a 'set', and are either:

a) pushed onto the stack as a set or,

b) if a precedence break is detected the operation between the previous set pushed onto the stack and the current variable is performed. The result of that operation then becomes the current variable and the previous set is removed from the stack. After the computation another attempt is made to push the new current variable and operator onto the stack as a set.
This step is repeated until the new set is pushed or there are no more sets on the stack with which to combine the current value. In that case the expression has been evaluated.

The variable/operator sets that are pushed on the stack have the following format:



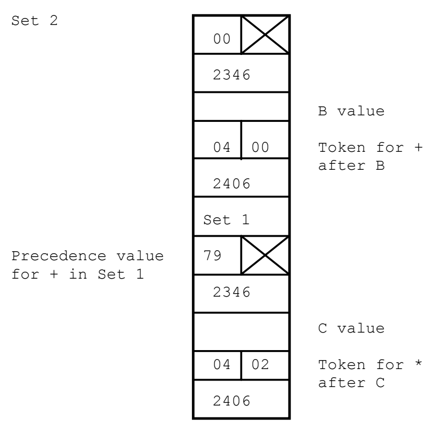
The test for precedence break is simple. If the operator (the token where the scan stopped) has the same or a lower precedence value as the precedence value for the last set pushed on the stack then a break has occurred, and an intermediate computation is required. The computation is performed automatically by POPing the last set. When this occurs control is transferred to a routine (usually at 2406) which will perform the operation specified in the set between that value (the one from the set on the stack), and the current variable. The result then becomes the current variable. When the computation is finished control returns to a point where the precedence break test is repeated. This time the set which caused the last break is not there, so the test will be between the same operator as before and the operator in the previous set. If there is no previous set then the current variable and operator are pushed as the next set. Note, an EOS or a non-arithmetic token are treated as precedence breaks.

Assuming no break occurs the current variable and operator are pushed on the stack as the next set, and the scan of the expression continues from the point where it left off. Let's take an example. Assume we have the expression,

A equals B plus C * D / E 5

Scanning begins with the first character to the right of the equals sign and will stop at the first token (plus). B plus would be pushed as the first set because: a) there was no prior set so there could not have been a precedence break, and b) the scan stopped on an arithmetic token (plus).

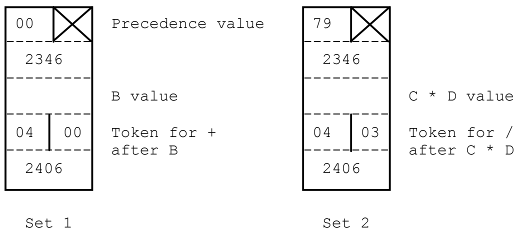
The next scan would stop at the *. Again the variable / operator pair of C * would be pushed this time as set 2 although for slightly different reasons than before. The * precedence value is higher than the plus precedence value already pushed so there is no break. At this time the stack contains,



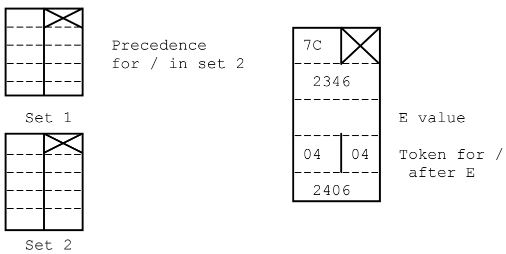
Scan three would stop on the / following D. This time there would be a precedence break because * and / have the same values. Consequently set 2 would be POP'd from the stack and control passes to the precedence break routine at 2406 (other routines may be used depending on the operation to be performed - check the listing for details). Here the operation between set 2 (C*) and the current value (D) would be performed. This would result in a new current value that will be called M. M equals C * D

After the multiplication control goes back to 2346 (continuation after break processing) where the rules from above are used. This time the current value is pushed as set

2 because it has a higher precedence value (/) than that in set 1 (plus). Now the stack contains



After pushing set 2 the scan continues, stopping at the operator. It has a higher precedence value than the (/) in set 2 so a third set is added to the stack giving:



The next scan is made and an EOS is found following the 5 (which is now the current value). As mentioned earlier an EOS or non-arithmetic token is an automatic precedence break, so set 3 is POP'd from the stack and E 5 is computed and becomes the current value. Control passes to 2346 where the rules for pushing the next set are applied and set 2 get's POP'd because the current operator is an EOS. Set 2 (M/) and the current value are operated on giving a current value of

M / E 5 or
C * D / E 5

Again control goes to 2346 which forces set 1 to be POP'd because the current operator is an EOS. When the set is POP'd control goes to the computation routine where the current value and set 1 are operated on. This yields a current value of

B plus C * D / E 5

Now control goes to 2346 and this time the stack is empty causing control to be returned to the caller. The expression has been evaluated and its value is left in WRA1.

DOS Request Codes

DOS request codes provide a mechanism for executing system level commands from within a program. The way they work is to cause the DOS overlay module SYSX/SYS associated with the request to be loaded into 4200 - 5200 and executed. When the request has been satisfied control is returned to the caller as though a subroutine call had been made.

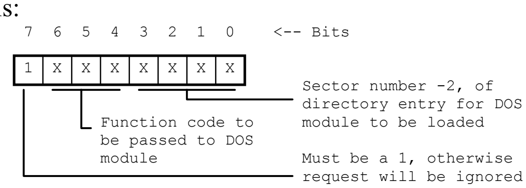
DOS functions may be executed by loading a DOS request code into the A register and executing a RST 28 instruction. Because of the way DOS processes these request codes the push on the stack that resulted from the RST instruction is lost, and control will be returned to the next address found on the stack - rather than to the address following the RST instruction. For example,

```
      LD      A,VAL          LOAD DOS  FUNCTION CODE
      RST     28             EXECUTE DOS FUNCTION
      .                      THIS  IS WHERE WE WANT TO
      .                      RETURN TO
      .                      BUT WILL NOT BECAUSE OF THE WAY
      .                      THE STACK IS MANAGED BY DOS
```

This will not work because the return address (stored on the stack by the RST 28) has been lost during processing. Instead the following sequence should be used:

```
      LD      A,VAL          LOAD REQUEST CODE
      CALL    DOS            PUT RETURN ADDR ON STACK
      .
      .
      .
DOS   RST     28             EXECUTE DOS FUNCTION
                             ALL REGISTERS ARE PRESERVED
                             WE WILL AUTOMATICALLY RET TO
                             CALLER OF DOS
```

The request code value loaded into the A-register must contain the sector number minus 2 of the directory sector for the overlay to be loaded and a code specifying the exact operation to be performed. The format of the request code is:



As it is presently implemented the file pointed to by the first entry in the specified directory sector will be loaded. There is no way for example, to load the file associated with the 3rd or 4th entry. A list of the system overlay modules and their functions follows. These descriptions are incomplete. See the individual modules for a complete description.

MODULE	DIRECTORY SECTOR MINUS 2	REQUEST CODE	SUB-FUNCTIONS
SYS1	1	93	10 - write 'DOS READY'
		AC	20 - write 'DOS READY'
		BC	30 - scan input string
		C3	40 - move input string to DCB
		D3	50 - scan and move input string
		E3	60 - append extension to DCB
		F3	70 - reserved
SYS2	2	94	10 - OPEN file processing
		A4	20 - INST file processing
		B4	30 - create directory overflow entry
		C4	40 -
		D4	50 - reserved
		E4	60 -
		F4	70 -
SYS3	3	95	10 - CLOSE file processing
		A5	20 - KILL file processing
		B5	30 -
		C5	40 - reserved
		D5	50 -
		E5	60 - load SYS3/SYS
		F5	70 - format diskette
SYS4			
SYS5			

Chapter 5

A BASIC SORT Verb

Contained in this chapter is a sample assembly program that demonstrates the use of the ROM calls and tables described in the previous chapters. In this example DOS Exits and Disk BASIC Exits are used to add a SORT verb to BASIC.

In this case a SORT verb will be added so that the statement

100 SORT I$, O$, K1$

be used to read and sort a file specified by the string I$, O$ and K1$ are strings which specify the output file name and the sort key descriptors. The procedure for doing this is simple. First we must modify the Input Phase to recognize the word SORT and replace it with a token. This can be accomplished by using one of the DOS Exits.

A DOS Exit is taken during the Input Phase immediately after the scan for reserved words. We will intercept this exit to make a further test for the word SORT and replace it with a token. Processing will then continue as before. Before using any DOS Exit study the surrounding code to determine exact register usage. In this case it is important to note that the length of the incoming line is in the BC register when the exit is taken. If the subroutine compresses the line (by replacing the word SORT with a token) then its length will have changed and the new length must replace the original contents of BC.

A second modification must be made to the Execution Driver, or somewhere in its chain, to recognize the new token value and branch to the SORT action routine. This presents a slight problem because there are no DOS Exits in the execution driver before calling the verb routine, and since the driver code and its tables are in ROM they cannot be changed. In short there is no easy way to incorporate new tokens into the Execution Phase.

The solution is to borrow a Disk BASIC token and piggy-back another token behind it. Then any calls to the verb routine associated with the borrowed token must be intercepted and a test make for the piggy-backed token. If one is found control goes to the SORT verb routine otherwise it passes to the assigned verb routine. In this example the token FA will be borrowed and another FA will be tacked behind it giving a token FAFA.

This example is incomplete because the LIST function has not been modified to recognize the sort token. If a LIST command is issued the verb MIDMID will be given for the SORT verb. There is one more detail that needs attention before discussing the verb routine. Using the memory layout figure in Chapter 1 we can see that there is no obvious place to load an assembly language program without interfering somehow with one of BASIC's areas. Depending on where we loaded our verb routine it could overlay the String Area, or the Stack, or maybe even reach as low as the PST or VLT. Of course we might get lucky and find an area in the middle of the Free Space List that never gets used but that's too risky.

BASIC has a facility for setting the upper limit of the memory space it will use. By using this feature we can reserve a region in high memory where our verb routine can be loaded without disturbing any of BASIC's tables. Now for the details of verb routine.

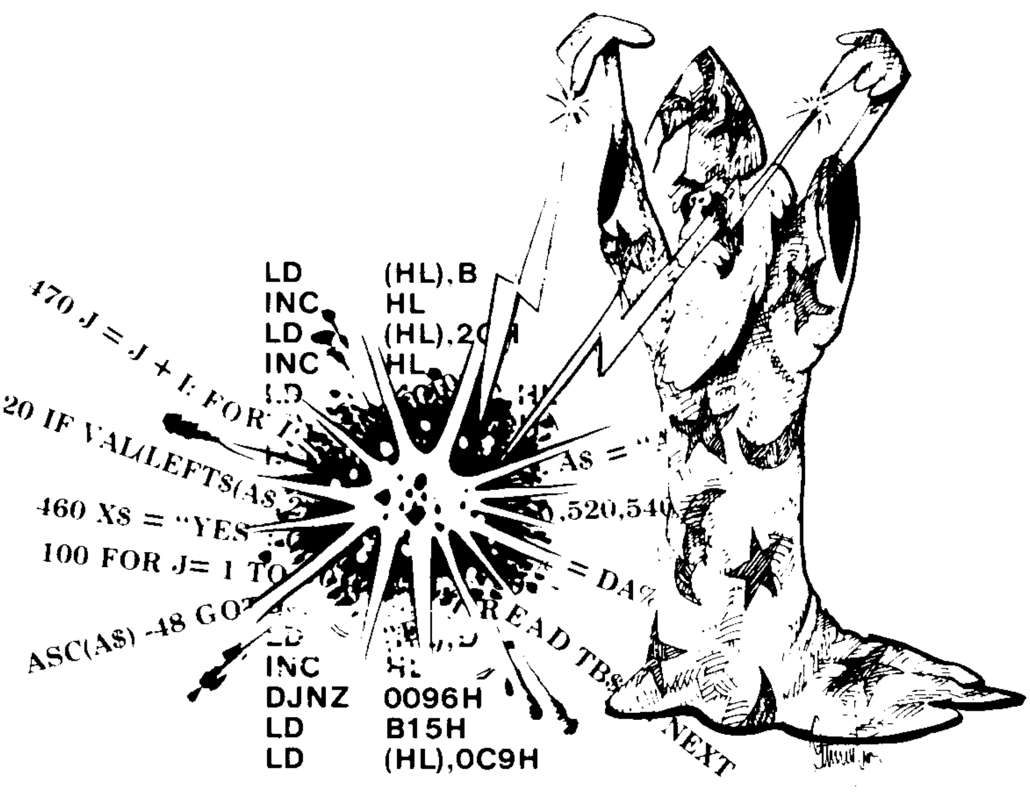
Because a sort can be a lengthy piece of code only the details that pertain to DOS Exits, Disk BASIC, and some of the ROM calls from Chapter 2 will be illustrated. The verb routine has two sections. The first section will be called once to modify the DOS and Disk BASIC exit addresses (also called vectors) in the Communications Region to point to locations within the verb routine. The vector addresses must be modified after BASIC has been entered on a DOS system because they are initialized by the BASIC command. The second section has two parts.

Part one is the DOS Exit code called from the Input Scanner. Part two is the verb action routine for the SORT verb. It is entered when a FA token is encountered during the Execution Phase.

The system being used will be assumed to have 48K of RAM, at least 1 disk, and NEWDOS 2.1. The verb routine will occupy locations E000 - FFFF. The entry point for initializing the vectors will be at E000. All buffers used will be assigned dynamically in the stack portion of the Free Space List. The verb routine will be loaded before exiting DOS and entering Level II BASIC. Although it could be loaded from the BASIC program by using the CMD'LOAD…..' feature of NEWDOS.

```
   1. IPL
   2. LOAD,SORT     :(load verb into E000 - FFFF  1)
   3. BASIC,57344   :(protect verb area)


100 DEF USR1(0) = &HE000 : initialization entry point
110 A = USR1(0)          : initialize vectors

RUN                      : initialize the sort

100 I$="SORTIN/PAY:1"    : (sort in
110 O$-"SORTOUT/PAY:1"   : (Sort out
120 KS-"A,A,100-120"     : (sort key: ascending order ASCII
                            key, sort field is 10
130 SORT I$,O$,K$        : (sort file)

RUN

00100         ORG      0E000H
00110 ; INITIAL ENTRY POINT TO INITIALIZE DOS EXIT AND
00120 ; DISK BASIC ADDRESSES.
00130         LD       HL,(41B3H)     ; ORIGINAL DOS EXIT VALUE
00140         LD       (ADR1+1),HL    ; IS STILL USED AFTER OUR
00150                                 ; PROCESSING
00160         LD       HL,(41DAH)     ; ORIGINAL DISK BASIC ADDR FOR
00170                                 ; MID$ TOKEN (FA)
00180         LD       (ADR2+1),HL    ; SAVE IN CASE FA TOKEN FOUND
00190         LD       HL,NDX
00200         LD       (41B3H),HL
00210         LD       HL,NDB
00220 ;                               ; OUR ADDR
00230         LD       (41DAH),HL
00240 ;                               ; FA TOKEN W/OUR ADDR
00250         RET                     ; RET TO EXECUTION DRIVER
00260 ;*   GET ADDRESS OF VARIABLE
00270 ;* THIS SECTION OF CODE IS ENTERED AS A DOS EXIT DURING THE
00280 ;* INPUT PHASE.  IT WILL TEST FOR A 'SORT' COMMAND AND REPLACE
00290 ;* IT WITH A 'FAFA' TOKEN. THE ORGINAL DOS EXIT ADDR HAS BEEN
00300 ;* SAVED AND WILL BE TAKEN AT ADR1.
00310 ;*
00320 NDX     CALL     SAV            ; SAVE ALL REGISTERS
00330         LD       IX,SORT-1      ; TEST STRING
00340         LD       B,3            ; NO. OF CHARS TO MATCH
00350 NDX1    INC      HL             ; START OF LOOP
00360         INC      IX             ; BUMP TO NEXT TEST CHAR
00370         LD       A,(IX+0)       ; GET A TEST CHAR
00380         CP       (HL)           ; COMPARE W/INPUT STRING
00390         JR       NZ,OUT         ; STOP WHEN FIRST MIS-MATCH
00400         DJNZ     NDX1           ; ALL 4 CHARS MUST MATCH
00410 ;*
00420 ;* WE HAVE A MATCH. NOW REPLACE THE WORD 'SORT' WITH A TOKEN
00430 ;* 'FAFA' AND COMPRESS THE STRING
00440 ;*
00450         INC      HL             ; FIRST CHAR AFTER 'SORT'
00460         PUSH     HL             ; SAVE FOR COMPRESSION CODE
00470         LD       BC,-3          ; BACKSPACE INPUT STRING
00480         ADD      HL,BC          ; START OF WORD 'SORT'
00490         LD       (HL),0FAH      ; TOKEN REPLACES 'S'
00500         INC      HL             ; NEXT LOC IN INPUT STRING
00510         LD       (HL),0FAH      ; TOKEN REPLACES '0'
00520         INC      HL             ; NEXT LOC IN INPUT STRING
00530         POP      DE             ; STRING ADDR AFTER SORT
00540         EX       DE,HL          ; SO WE CAN USE RST 10
00550 ;*                              ; TO FETCH NEXT CHAR
00560 ;* NOW COMPRESS THE INPUT STRING
00570 ;*
00580         LD       BC,3           ; SET COUNT OF CHARS IN
00590 ;*                              ; EQUAL TO NO SKIPPED OVER
00600 NDX2    RST      10H            ; GET NEXT CHAR, DISCARD
00610 ;*                              ; BLANKS
00620         LD       (DE),A         ; MOVE IT DOWN
00630         INC      DE             ; BUMP SOURCE ADDR
00640         INC      C              ; COUNT 1 CHAR IN LINE
00650         OR       A              ; TEST FOR END OF STRING
00660         JR       NZ,NDX2        ; NOT END, LOOP
00670         LD       (DE),A         ; EACH LINE MUST END WITH
00680 ;*                              ; 3 BYTES OF ZEROS
00690         INC      DE             ; BUMP TO LAST BYTE
00700         LD       (DE),A         ; STORE 3 RD ZERO
00710         INC      C              ; THEN SET BC - LENGTH OF
00720         INC      C              ; LINE + 1
00730         INC      C              ; SO BASIC CAN MOVE IT
00740         LD       (TEMP),BC      ; SAVE NEW LINE LENGTH
00750         CALL     RES            ; RESTORE REGISTERS
00760         LD       BC,(TEMP)      ; NEW LINE LENGTH TO BC
00770         JR       ADR1           ; EXIT
00780 OUT     CALL     RES            ; RESTORE REGISTERS
00790 ADR1    JP       0              ; CONTINUE ON TO ORIGINAL
00800 ;*                              ; DOS EXIT
00810 ;* DISK BASIC EXIT FOR FA TOKEN. TEST FOR SORT TOKEN FAFA
00820 ;*
00830 NDB     CALL     SAV            ; SAVE ALL REGISTERS
00840         INC      HL             ; SKIP TO CHAR AFTER TOKEN
00850         LD       A,(HL)         ; TEST FOR SECOND 'FA'
00860         CP       0FAH           ; IS FOLLOWING CHAR A FA
00870         JR       Z,NDB1         ; Z IF SORT TOKEN
00880         CALL     RES            ; RESTORE REGISTERS
00890 ADR2    JP       0              ; CONTINUE WITH MID$ PROCESSING
00900 ;*
00910 ;* WE HAVE A SORT TOKEN
00920 ;*
00930 NDB1    INC      HL             ; SKIP OVER REST OF TOKEN
00940         CALL     GADR           ; GET ADDR OF 1ST PARAM
00950         LD       (PARM1),DE     ; SAV ADDR OF INPUT FILE NAME
00960         RST      08             ; LOOK FOR COMMA
00970         DEFM     ','            ; SYMBOL TO LOOK FOR
00980         CALL     GADR           ; GET ADDR OF 2ND PARAM
00990         LD       (PARM2),DE     ; SAV ADDR OF OUTPUT FILE NAME
01000         RST      08             ; LOOK FOR COMMA
01010         DEFM     ','            ; SYMBOL TO LOOK FOR
01020         CALL     GADR           ; GET ADDR OF SORT KEYS
01030         LD       (PARM3),DE     ; SAV ADDR OF SORT KEY
01040         LD       (TEMP),HL      ; SAVE ENDING POSITION
01050 ;*                              ; IN CURRENT STATEMENT
01060 ;*
01070 ;* NOW, BLANK FILL I/O DCBS
01080 ;*
01090         LD       IX,DCBL        ; LIST OF DCB ADDRS
01100         LD       C,2            ; NO OF DCBS TO BLANK
01110         LD       A,20H          ; ASCII BLANK
01120 L1      LD       L,(IX+0)       ; LSB OF DCB ADDR
01130         LD       H,(IX+1)       ; MSB OF DCB ADDR
01140         LD       B,32           ; NO OF BYTES TO BLANK
01150 L2      LD       (HL),A         ; BLANK LOOP
01160         INC      HL
01170         DJNZ     L2             ; LOOP TILL BLANKED
01180         INC      IX             ; BUMP TO NXT DCB ADDR
01190         INC      IX             ; BUMP AGAIN
01200         DEC      C              ; ALL DCBS BLANKED
01210         JR       NZ,L1          ; NO
01220 ;*
02230 ; YES, MOVE FILE NAMES TO DCB AREAS
01240 ;*
01250         LD       HL,(PARM1)     ; ADDR OF INPUT FILE NAME STRNG
01260         LD       DE,DCBI        ; INPUT DCB
01270         CALL     29C8H          ; MOVE NAME TO DCB
01280         LD       HL,(PARM2)     ; ADDR OF OUTPUT FILE NAME
01290         LD       DE,DCBO        ; OUTPUT DCB
01300         CALL     29C8H          ; MOVE NAME TO DCB
01310         LD       HL,(PARM3)     ; GET ADDR OF KEY STRING
01320         INC      HL             ; SKIP OVER BYTE COUNT
01330         LD       C,(HL)         ; GET LSB OF STRNG ADDR
01340         INC      HL             ; BUMP TO REST OF ADDR
01350         LD       H,(HL)         ; GET MSB OF STRNG ADDR
01360         LD       L,C            ; NOW HL = STRNG ADDR
01370         CALL     1E3DH          ; MUST BE ALPHA
01380         JR       NC,YA1         ; OK
01390         JP       ERROR          ; INCORRECT SORT ORDER
01400 YA1     LD       (ORDER),A      ; SAVE SORT ORDER (A/D)
01410         INC      HL             ; SKIP TO TERMINAL CHAR
01420         RST      08             ; TEST FOR COMMA
01430         DEFM     ','
01440         CALL     1E3DH          ; MUST BE ALPHA
01450         JR       NC,YA5         ; OK
```

```
01460          JP       ERROR
01470 YA5      LD       (TYPE),A        ; SAVE TYPE (A/B)
01480          INC      HL              ; SKIP TO TERMINAL CHAR
01490          RST      8               ; TEST FOR COMMA
01500          DEFM     ','
01510          CALL     0E6CH           ; GET RECORD SIZE
01520          LD       DE,(4121H)      ; GET SIZE FROM WRA1
01530          LD       (SIZE),DE       ; SAVE IT
01540          RST      20H             ; MUST BE AS INTEGER
01550          JP       M,YA10          ; MINUS IF INTEGER
01560          JP       ERROR
01570 YA10     RST      08              ; LOOK FOR COMMA
01580          DEFM     ','
01590          CALL     0E6CH           ; GET STARTING POSITION
01600          LD       DE,(4121H)      ; GET POS FROM WRA1
01610          LD       (START),DE      ; SAVE IT
01620          RST      08              ; LOOK FOR -
01630          DEFM     '-'             ; CHAR TO TEST FOR
01640          CALL     0E6CH           ; GET ENDING POS OF KEY
01650          LD       DE,(4121H)      ; GET VALUE FROM WRA1
01660          LD       (END),DE        ; SAVE ENDING S01670   LD
               HL,(TEMP)                ; RESTORE CURRENT LIME ADDR
01680 ;*                                ; TO EOS ON RETURN
01690          CALL     RES             ; RESTORE REGISTERS
01700          LD       HL,(TEMP)       ; RESTORE EOS ADDR
01710          RET                      ; RETURN TO BASIC
01720 ;*
01730 ;*
01740 ;*
01750 SORT     DEFM     'S'             ; S OF SORT
01760          DEFB     0D3H            ; TOKEN FOR OR OF SORT
01770          DEFM     'T'             ; T OF SORT
01780 ;*
01790 ;*   SAVE ALL REGISTERS
01800 ;*
01810 SAV      EX       DE,HL
01820          EX       (SP),HL         ; SAV DE/RTN ADDR TO HL
01830          PUSH     BC
01840          PUSH     AF
01850          PUSH     IX
01860          PUSH     DE              ; SAVE ORIGINAL HL
01870          EX       DE,HL           ; RESTORE HL RET ADDR TO DE
01880          PUSH     DE              ; RET ADDR TO STK
01890          RET                      ; RET TO CALLER
01900 ;*
01910 ;*     RESTORE ALL REGISTERS
01920 ;*
01930 RES      POP      HL              ; RTN ADDR TO HL
01940          POP      DE              ; REAL HL
01950          POP      IX
01960          POP      AF
01970          POP      BC
01980          EX       (SP),HL         ; RTN ADDR TO STK
01990          EX       DE,HL
02000          RET
02010          JP       (HL)            ; RTN TO CALLER
02020 ;*
02030 ;* GET THE ADDRESS OF THE NEXT VARIABLE INTO DE
02040 ;*
02050 GADR     LD       A,(HL)          ; GET NEXT CHAR FROM INPUT
02060 ;*                                ; STRNG, TST FOR LITERAL
02070          CP       22H             ; IS IT A QUOTE -START OF
02080 ;*                                ; A LITERAL-
02090          JR       NZ,GADR2        ; NO, GO FIND ADDR OF VAR
02100          CALL     2866H           ; YES, GO BUILD A LSPT ENTRY
02110          JR       GADR5           ; THEN JOIN COMMON CODE
02120 GADR2    CALL     2540H           ; GET ADDR OF NEXT VARIABLE
02130 GADR5    RET      20H             ; IS IT A STRING
02140          LD       DE,(4121H)      ; ADDR OF NEXT VAR
02150          RET      Z               ; RET IF STRING VAR
02160          POP      HL              ; CLEAR STACK
02170          POP      HL              ; CLEAR STACK
02180          LD       A,2             ; ERROR CODE FOR SYNTAX ERR
02190          JP       1997H           ; GO TO ERROR ROUTINE
02200 ;*
02210 ;*  ERROR EXIT
02220 ;*
02230 ERROR    CALL     RES             ; RESTORE REGISTERS
02240          POP      HL              ; CLEAR STACK
02250          LD       A,2             ; SYNTAX ERROR CODE
02260          JP       1997H           ; PRINT ERROR MESSAGE
02270 ;*
02280 ;*
02290 ;*
02300 DCBL     DEFW     DCBI
02310          DEFW     DCBO
02320 PARM1    DEFW     0               ; INPUT FILE NAME STRING ADDR
02330 PARM2    DEFW     0               ; OUTPUT FILE NAME STRING ADDR
02340 PARM3    DEFW     0               ; KEY STRING ADDR
02350 TYPE     DEFB     0               ; RECORD TYPE (A/B/C)
02360 ORDER    DEFB     0               ; SORT ORDER (A/D)
02370 SIZE     DEFW     0               ; RECORD SIZE
02380 START    DEFW     0               ; STARTING POSITION OF KEY
02390 END      DEFW     0               ; ENDING POSITION OF KEY
02400 TEMP     DEFW     0               ; HOLDS EOS ADDR
02410 DCBI     DEFS     32              ; INPUT DCB
02420 DCBO     DEFS     32              ; OUTPUT DCB
02430          END
```



Chapter 6

BASIC Overlay Routine

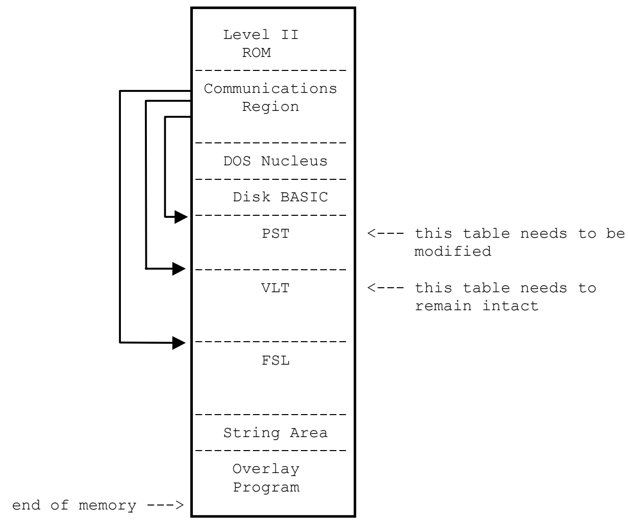
This example shows how the tables in the Communications Region can be manipulated so that a BASIC program can load and execute overlays. The overlay program will add statements to an executing BASIC program while preserving all the current variables. The calling sequence to be used is:

```
100 DEF USR1=&HE000   : Address of overlay program
          .           : Main body of application program
          .
          .
300 F$="FILE1/BAS"    : File containing overlay
310 Z=USR1(500)       : Replace lines 500 thru the end
          .           : of the program with the
          .           : statement from FILE1/BAS.)
320 GOSUB 500         : Execute the overlay
          .
          .
          .
500 REM START OF OVERLAY AREA
          .
          .
```

The operating assumptions for this example will be the same as those in chapter 5. Note, overlay files containing the ASCII file must have been saved in the A mode.

The program itself will be considerably different, how-ever. For instance, there will be no use of DOS Exits. This means that the CR will not need modification so there will be no need for an initial entry point. One parameter will be passed in the calling sequence while the other one will have an agreed name so that it can be located in the VLT.

When a BASIC program is executing there are three major tables that it uses. First is the PST where the BASIC statements to be executed have been stored. Second is the VLT where the variables assigned to the program are stored, and the third table is the FSL which represents available memory. All of these tables occur in the order mentioned. The problem we need to overcome in order to support overlays is to find a way to change the first table while maintaining the contents of the second one. A diagram of memory showing the tables follows.



Fortunately this can be accomplished quite easily. By moving the VLT to the high end of FSL we can separate it from the PST. Then the overlay statements can be read from disk and added to the PST. Obviously the PST would either grow or shrink during this step unless the overlay being loaded was exactly the same size as the one before it. After the overlay statements have been added the VLT is moved back so it is adjacent to the PST. Then the pointers to the tables moved are updated and control is returned to the BASIC Execution Driver.

The overlay loader used in this example assumes that the file containing the overlay statements is in ASCII format. This means that each incoming line must be tokenized before being moved to the PST. To speed up processing the loader could be modified to accept tokenized files.

There is no limit to the number of overlays that can be loaded. The program will exit with an error if a line number less than the starting number is detected. The loader does not test for a higher level overlay destroying a lower one, this would be disastrous - as the return path would be destroyed.

A sample program to load three separate overlays is given as an example.

```
100 A = 1.2345
110 B = 1
120 IF B = 1 THEN F$ = "FILE1"
130 IF B = 2 THEN F$ = "FILE2"
140 IF B = 3 THEN F$ = "FILE3"
150 Z = USR1(500)
160 GOSUB 500
170 B = B + 1
180 IF B > 3 THEN 110
190 GOTO 120
```

Contents of File 1

```
500 PRINT"OVERLAY #1 ENTERED"
510 PRINT A
520 C = 25
530 D = 30
540 E = C+D+A
550 PRINT "C = ";C
560 PRINT "D = ";D
570 PRINT "E = ";E
580 RETURN
```

Contents of File 2

```
500 PRINT "OVERLAY #2 ENTERED"
510 PRINT A
520 C = C + 1
530 D = D + 1
540 E = E + 1
550 REM
560 REM
570 REM
580 REM
590 PRINT "C, D, E =";C,D,E
600 RETURN
```

Contents of File 3

```
500 PRINT "OVERLAY #3 ENTERED"
510 A = A + 1
520 PRINT "A = ";A
530 RETURN
```

```
        ORG     0F000H
OPEN    EQU     4424H           ; DOS ADDRESS
READ    EQU     4436H           ; DOS ADDRESS
ERN     EQU     12              ; DISK DCB ADDRESS
NRN     EQU     10              ; DISK DCB ADDRESS
EOF     EQU     8               ; DISK DCB ADDRESS
;*
;*  ENTRY POINT FOR OVERLAY LOADING OF BASIC PROGRAMS
;*
        PUSH    AF              ; SAVE ALL REGISTERS
        PUSH    BC
        PUSH    DE
        PUSH    HL
        LD      HL,-1           ; INITIALIZE SECTOR COUNT
        LD      (RCOUNT),HL     ; TO MINUS 1
        LD      HL,00           ; SO WE CAN LOAD CSP
        ADD     HL,SP           ; LOAD CSP
        LD      (CSP),HL        ; SAVE FOR RESTORATION
        LD      DE,(4121H)      ; LINE NO TO START OVERLAY
        LD      (LINE),DE       ; SAVE FOR FUTURE REF
        LD      A,(40AFH)       ; FUNCTION VALUE TYPE
        LD      (TYPE),A        ; MUST BE RESTORED AT END
;*
;*  BLANK FILL DCB BEFORE MOVING NAME INTO IT
;*
        LD      B,32            ; NO. OF BYTES TO BLANK
        LD      HL,DCB          ; DCB ADDR
        LD      A,20H           ; ASCII BLANK
BFL     LD      (HL),A          ; MOVE ONE BLANK
        INC     HL              ; BUMP TO NEXT WORD
        DJNZ    BFL             ; LOOP TILL DCB FILLED
;*
;*  GET OVERLAY FILE NAME FROM VARIABLE F$
;*  MOVE IT INTO THE BLANKED DCB
;*
        LD      HL,LFN          ; STRING FOR COMMON VAR NAME
        CALL    2540H           ; GET ADDR OF F$
        RST     20H             ; MAKE SURE IT'S A STRING
        JR      Z,OK            ; ZERO IF STRING
        JP      ERR             ; WRONG TYPE OF VARIABLE
OK      LD      HL,(4121H)      ; GET ADDR OF F$ INTO HL
        LD      DE,DCB          ; DCB ADDR
        CALL    29C8H           ; MOVE F$ NAME TO DCB
;*
;*  INITIALIZE ALL LOCAL VARIABLES
;*
        LD      A,0             ; SET PASS FLAG TO ZERO
        LD      (PF),A          ; PASS FLAG
        LD      (FI),A          ; SECTOR BUFFER INDEX
;*
;*  LOCATE ADDR OF VARIABLE ASSIGNED TO FUNCTION CALL. IT
;*  MUST BE RECOMPUTED AFTER THE OVERLAY HAS BEEN LOADED
;*  BECAUSE THE VLT WILL NAVE BEEN MOVED.  NEXT, ALLOCATE
;*  SPACE IN THE FSL FOR THE SECTOR BUFFER USED FOR
;*  READING THE OVERLAY FILE.
;*
        LD      HL,00           ; SO WE CAN LOAD CSP
        ADD     HL,SP           ; HL = CSP
        PUSH    HL              ; SAVE CSP
        LD      BC,20           ; AMT TO BACKSPACE CSP
        ADD     HL,BC           ; GIVES CSP - 20 OR ADDR
;*                              ; OF FUNCTION VARIABLE
        LD      (VARADR),HL     ; SAVE STK ADDR OF VAR
        POP     HL              ; RESTORE CSP TO HL
        LD      BC,-256         ; AMT OF SPACE TO ALLOCATE
;*                              ; IN FSL FOR SECTOR BUFFER
        ADD     HL,BC           ; COMPUTE NEW CSP
        LD      (BADDR),HL      ; START OF SECTOR BUFFER
        LD      SP,HL           ; IS ALSO NEW CSP
        PUSH    HL
        LD      DE,(40F9H)      ; CURRENT END OF PST
        LD      (CEPST),DE      ; SAVE FOR COMPUTATIONS
        LD      HL,(40FBH)      ; START OF ARRAYS
        XOR     A               ; CLEAR CARRY
        SBC     HL,DE           ; COMPUTE OFFSET FROM START
;*                              ; OF VLT TO START OF ARRAYS
        LD      (LSVLT),HL      ; SAVE OFFSET
;*
;*
;*
        LD      DE,(LINE)       ; FIND ADUR OF LINE WHERE
        CALL    1B2CH           ; OVERLAY STARTS IN PST
        LD      (40F9H),BC      ; MAKE IT TEMP END OF PST
;*
;*  COMPUTE LENGTH OF VLT
;*
        LD      DE,(CEPST)      ; ORGINAL END OF PST
        LD      HL,(40FDH)      ; START OF FSL
        XOR     A               ; CLEAR CARRY
        SBC     HL,DE           ; GIVES LNG -1 OF VLT
        INC     HL              ; CORRECT FOR -1
        LD      (LVLT),HL       ; SAVE LENGTH OF VLT
        POP     HL              ; RESTORE CSP TO HL
        LD      BC,-50          ; ASSUMED STK LENG NEEDED
        ADD     HL,BC           ; GIVE END OF TEMP VLT
        LD      BC,(LVLT)       ; NOW, SUBTRACT LENGTH OF
        XOR     A               ; VLT FROM END TO GET START
        SBC     HL,BC           ; ADDRESS
        LD      (SNVLT),HL      ; SAVE END OF TEMP VLT
        PUSH    HL              ; SO WE CAN
        POP     DE              ; LOAD IT INTO DE
        LD      HL,(CEPST)      ; START OF OLD PST
        LD      BC,(LVLT)       ; SIZE OF VLT
        LDIR                    ; MOVE VLT TO TEMP LOC.
;*
;*   BEGIN OVERLAY LOADING
;*
        LD      DE,DCB          ; DCB FOR OVERLAY FILE
        LD      HL,(BADDR)      ; SECTOR BUFF ADDR
        LD      BC,0            ; SPECIFY SECTOR I/O
        CALL    OPEN            ; OPEN OVERLAY FILE
LOOP    CALL    GNL             ; GET NEXT LINE FROM FILE
        JR      Z,OUT           ; ZERO IF NO MORE LINES
;*                              ; IN OVERLAY FILE
        CALL    ATOB            ; ADD LINE TO PST
        JR      LOOP            ; LOOP TILL FILE EXHAUSTED
;*
;*   OVERLAY STATEMENTS HAVE BEEN ADDED. RESET POINTERS
;*   TO VLT AFTER MOVING IT DOWN (ADJACENT TO PST).
;*
OUT     LD      HL,(SNVLT)      ; START OF TEMP VLT
        LD      DE,(40F9H)      ; CURRENT END OF PST
        INC     DE              ; LEAVE TWO BYTES
        INC     DE              ; OF ZEROS AT END OF PST
        LD      (40F9H),DE      ; SAVE START ADDR OF NEW VLT
        LD      BC,(LVLT)       ; LENGTH OF VLT
        LDIR                    ; MOVE VLT TO END OF PST
        INC     DE              ; GIVES ADDR OF FLS
        PUSH    DE              ; SAVE FSL ADDR
        LD      HL,(40F9H)      ; START OF VLT
        LD      BC,(LSVLT)      ; PLUS LNG OF SIMP VAR
        ADD     HL,BC           ; GIVES ADDR OF ARRAYS PTR
        LD      (40FBH),HL      ; SAVE NEW ARRAYS POINTER
        POP     HL              ; HL = NEW FSL ADDR
        LD      (40FDH),HL      ; UPDATE FSL
;*
;*   COMPUTE DISTANCE VLT HAS MOVED AND UPDATE THE ADDR OF
;*   THE FUNCTION VARIABLE BEING CARRIED ON THE STACK.
;*
```

```
        LD      DE,(CEPST)      ; ORIGINAL START OF VLT
        LD      HL,(40F9H)      ; CURRENT START OF VLT
        RST     18H             ; COMPARE THE ADDRESSES
        JR      NC,UP           ; NEW VLT WAS MOVED UP
        PUSH    HL              ; REVERSE OPERANDS
        PUSH    DE
        XOR     A               ; CLEAR CARRY
        POP     HL              ; RESTORE OPERANDS
        POP     DE
        JR      UP1             ; GO COMPUTE DISTANCE
UP      XOR     A               ; CLEAR CARRY FOR SUB
UP1     SBC     HL,DE           ; COMPUTE ANT VLT HAS MOVED
        PUSH    HL              ; SAVE DISTANCE
        LD      HL,(VARADR)     ; THEN ADDR IT TO ADDR
        LD      C,(HL)          ; CARRIED ON STK
        INC     HL              ; BUMP TO MSB OF ADDR
        LD      B, (HL)         ; BC = ADDR OF VAR THAT WAS
;*                              ; CARRIED ON STK
        POP     HL              ; GET DISPLACEMENT
        ADD     HL,BC           ; GET NEW ADDR (BECAUSE VLT
;*                              ; HAS BEEN MOVED
        PUSH    HL              ; SO WE CAN LOAD IT INTO
        POP     DE              ; LOAD NEW ADDR INTO DE
        LD      HL,(VARADR)     ; REFETCH STK ADDR
        LD      (HL),E          ; LSB OF FUNCTION VAR ADDR
        INC     HL              ; NEXT BYTE ADDR ON STK
        LD      (HL),D          ; MSB OF FUNCTION VAR ADDR
;*
;*  RESET TYPE TO IT'S ORGINAL VALUE
;*
        LD      A,(TYPE)        ; GET MODE FLAG WHEN ENTERED
        LD      (40AFH),A       ; RESTORE MODE TO ORIGINAL
        LD      HL,(CSP)        ; RESET CSP
        LD      SP,HL           ; TO IT'S ORIGINAL VALUE
        POP     HL              ; RESTORE REGISTERS
        POP     DE
        POP     BC
        POP     AF
        RET                     ; RETURN TO BASIC
;*
;*  GNL -  GETS NEXT LINE OF BASIC PROGRAM PROM A FILE
;*         MOVES IT TO BASIC LINE BUFFER AREA AND THEN
;*         TOKENIZES IT.
;*         FILE IS ASSUMED TO BE IN ASCII FORMAT. LINES ARE
;*         TERMINATED BY A CARRIAGE RET. (0D).
;*
GNL     LD      A,(PF)          ; GET PASS FLAG
        OR      A               ; IS IT TIME TO READ SECTOR
        JR      NZ,GNL5         ; NO IF NON-ZERO
GNL3    LD      A,0             ; RESET SECTOR BUFF INDEX
        LD      (FI),A          ; TO ZERO
        LD      HL,(RCOUNT)     ; PREPARE TO TEST FOR
        INC     HL              ; END OF FILE. BUMP COUNT
        LD      (RCOUNT),HL     ; OF SECTORS READ
        LD      BC,0            ; READ NEXT SECTOR
        LD      DE,DCB          ; OVERLAY DCB ADDR
        LD      HL,(BADDR)      ; SECTOR BUFF ADDR
        CALL    READ            ; READ NEXT SECTOR
        LD      A,1             ; RESET PASS FLAG
        LD      (PF),A          ; TO DATA IN BUFFER
GNL5    LD      DE,(RCOUNT)     ; NOW TEST POE END OF FILE
        LD      HL,(DCB+ERN)    ; LAST SECTOR NO FROM DCB
        XOR     A               ; CLEAR CARRY FOR SUB
        SBC     HL,DE           ; HAS LAST SECTOR BEEN READ
        JR      NZ,GNL10        ; NON-ZERO IF NOT LAST SECT
        LD      A,(DCB+EOF)     ; IN LAST SECTOR. END OF D
        LD      B,A             ; DATA REACHED YET?
        LD      A,(FI)          ; CURRENT SECTOR INDEX
        SUB     B               ; MUST BE LE TO EOD INDEX
        JR      C,GNL10         ; CARRY IF NOT END OF DATA
        XOR     A               ; SIGNAL END OF FILE
        RET                     ; RET TO MAIN PGM
GNL10   LD      HL,(BADDR)      ; SECTOR BUFF ADDR
        LD      A,(FI)          ; CURRENT BUFF INDEX
        LD      C,A             ; FOR 16 BIT ARITH
        LD      B,0             ; DITTO
        ADD     HL,BC           ; CURRENT LINE ADDR IN BUFF
        LD      DE,(40A7H)      ; BA  LINE BUFF ADDR
GNL15   LD      A,(HL)          ; MOVE LINE FROM SECT BUFF
        LD      (DE),A          ; TO BASIC LINE BUFF
        INC     DE              ; BUMP DEST ADDR
        INC     C               ; COUNT 1 CHAR MOVED
        JR      C,GNL3          ; JMP IF LINE OVERFLOWS
;*                              ; SECTOR
        INC     HL              ; NO OVERFLOW, BUMP FETCH
        SUB     0DH             ; ADDR. TEST FOR END OF LINE
        JR      NZ,GNL15        ; LOOP TILL END OF LINE
        DEC     DE              ; BKSPC 1 CHAR IN LINE BUFF
        LD      (DE),A          ; AND TERM IT WITH A ZERO
        LD      A,C             ; SAVE ENDING BUFF INDEX
        LD      (FI),A          ; FOR NEXT LINE
        OR      A               ; SIGNAL MORE DATA
        RET                     ; RET TO CALLER
;*
;*  TOKENIZE LINE IN BUFFER. THEN ADD IT TO PST
;*
ATOB    LD      HL,(40A7H)      ; LINE BUFFER ADDR
        CALL    1E5AH           ; GET BINARY LINE NO
        PUSH    DE              ; SAVE IT
        PUSH    HL              ; SAVE LINE BUFF ADDR
        LD      HL,(LINE)       ; BEG OVERLAY LINE NO
        RST     18H             ; COMPARED W/CURRENT LINE
        JR      Z,ATOB5         ; OK IF EQUAL
        JR      NC,ERR          ; ERR IF INCOMING LESS
;*                              ; THAN OVERLAY LINE NO
ATOB5   POP     HL              ; RESTORE LINE ADDR
        CALL    1BC0H           ; TOKENIZE LINE
        LD      HL,(40F9H)      ; CURRENT END OF PST
        PUSH    HL              ; SAVE ADDR OF THIS LINE
        ADD     HL,BC           ; ADD LNG OF NEW LINE
        LD      (40F9H),HL      ; START OF NEXT LINE
        PUSH    HL              ; SO WE CAN
        POP     DE              ; LOAD IT INTO DE
;*
;*   UPDATE POINTER TO NEXT LINE IN NEW LINE BEING ADDED.
;*   THEN MOVE BINARY LINE NO. FOR THIS LINE TO PST.
;*
        POP     HL              ; ADDR OF THIS LINE IN PST
        LD      (HL),E          ; LSB OF ADDR NEXT LINE
        INC     HL
        LD      (HL),D          ; MSB OF ADDR NEXT LINE
        INC     HL              ; START OF BIN LINE NO
        POP     DE              ; BINARY LINE NO
        LD      (HL),E          ; LSB OF LINE NO
        INC     HL
        LD      (HL),D          ; MSB OF LINE NO
        INC     HL              ; BUMP TO FIRST CHAR IN LINE
        EX      DE,HL           ; DE = PST FOR LINE
        LD      HL,(40A7H)      ; TOKENIZED LINE ADDR
        DEC     HL
        DEC     HL
ATOB10  LD      A,(HL)          ; GET A TOKENIZED BYTE
        LD      (DE),A          ; MOVE IT TO PST
        INC     HL
        INC     DE
        OR      A               ; TEST OF EOS
        JR      NZ,ATOB10       ; JMP IF NOT END OF STAT.
        LD      (DE),A          ; OF MACHINE ZEROS
        INC     DE
        LD      (DE),A
        RET                     ; RET TO CALLER
;*
;*   ERROR PROCESSING - RECOVER STACK SPACE
;*
ERR     POP     AF              ; CLEAR STACK
        POP     AF              ; CLEAR STACK
        POP     AF              ; CLEAR STACK
        LD      HL,0            ; DEALLOCATE SECTOR BUFFER
        ADD     HL,SP           ; CSP
        LD      BC,256          ; SIZE OF SECTOR BUFF
        ADD     HL,BC           ; COMPUTE NEW CSP
        LD      SP,HL           ; SETUP NEW CSP
ERR10   POP     AF              ; CLEAR STACK
        POP     AF              ; CLEAR STACK
        POP     AF              ; CLEAR STACK
        POP     AF              ; CLEAR STACK
        POP     AF              ; CLEAR STACK
        LD      A,2             ; CODE FOR SYNTAX ERROR
        JP      1997H           ; GIVE ERR, RTN TO BASIC
;*
;*  CONSTANTS AND COUNTERS
;*
LINE    DEFW    0               ; OVERLAY LINE NO
CSP     DEFW    0               ; HOLDS CSP ON ENTRY
TYPE    DEFB    0               ; ORIGINAL DATA TYPE
LFN     DEFM    'F$'            ; COMMON VARIABLE NAME
        DEFB    0
DCB     DEFS    32              ; OVERLAY DCB
BADDR   DEFW    0               ; SECTOR BUFF ADDR ON STK
VARADR  DEFW    0               ; VARIABLE ADDR ON STK
CEPST   DEFW    0               ; CURRENT END OF PST
LVLT    DEFW    0               ; LENGTH OF VLT
SNVLT   DEFW    0               ; START ADDR OF NEW VLT
LSVLT   DEFW    0               ; LENGTH OF SIMP VAR VLT
PF      DEFB    0               ; PASS FLAG
FI      DEFB    0               ; SECTOR BUFF INDEX
RCOUNT  DEFW    -1              ; COUNT OF SECTORS READ
        END
```

Chapter 7

BASIC Decoded: New ROMs

The comments in chapter 8 are based on the original three chip ROM set, if you have a 2 chip ROM configuration your dissassembly will probably be slightly different.

Differences between the latest 'MEM SIZE?' ROMs and the old ROMs are given below. Locations with an asterisk next to them have different contents than the next chapter.

When running a Disassembler be careful to check the page sequence where differences occur.

This comment chapter was designed to be used in conjunction with a disassembler that produces 62 lines per page. The Apparat NEWDOS plus Disassembler was used during the books production.

```
0050  0D      DEC   --- Enter no shift 0D)                        * ASCII values
0051  0D      DEC   --- Enter shift (0D)
0052  1F      RRA   --- Clear no shift (1F)
0053  1F      RRA   --- Clear shift (1F)
0054  01015B  LD    --- BREAK ns (01) / BREAK shift (01) / up arrow ns (5B)
0057  1B      DEC   --- Up arrow shift (1B)
0058  0A      LD    --- Down arrow no shift (0A)
0059 *00      NOP   --- Down arrow shift (00)
005A  08      EX    --- Left arrow no shift (08)
005B  1809    JR    --- Left arrow shift (18) / right arrow no shift (09)
005D  19      ADD   --- Right arrow shift (19)
005E  2020    JR    --- Space no shift (20) / space shift (20)

00FC *210E01  LD    --- Address of 'R/S L2 BASIC' message

0105  4D      LD    --- M                                         * MEM SIZE
0106  45      LD    --- E
0107  4D      LD    --- M
0108 *2053    JR    --- Space, S
010A *49      LD    --- I
010B *5A      LD    --- Z
010C *45      LD    --- E
```

```
010D *00      NOP   --- Message terminator
010E *52      LD    --- R                                    * R/S L2 BASIC
010F *2F      CPL   --- /
0110 *53      LD    --- S
0111 *204C    JR    --- Space, L
0113 *322042  LD    --- 2, space, B
0116 *41      LD    --- A
0117  53      LD    --- C
0118 *49      LD    --- I
0119 *43      LD    --- C
011A *0D      DEC   --- Carriage return
011B *00      NOP   --- Message terminator
011C *C5      PUSH  --- Save active row address
011D *010005  LD    --- Delay count value
0120 *CD6000  CALL  --- Delay for 7.33 milliseconds     * Debounce routine
0123 *C1      POP   --- Restore row address
0124 *0A      LD    --- And reload original flags from active row
0125 *A3      AND   --- Then combine current flag lists with original flag bits
0126 *C8      RET   --- Rtn to caller if zero because row was not active on 2nd test
0127 *7A      LD    --- Otherwise we have a legitimately active row
0128 *07      RLCA  --- Row index * 2
0129 *07      RLCA  --- Row index * 4
012A *C3FE03  JP    --- Return to rest of keyboard driver routine

0248 *0660    LD    --- Now, delay for 476/703 microseconds

024F *0685    LD    --- Then delay for 865/975 microseconds

02E2 *20ED    JR    --- If no match, skip to next program on cassette
02E4 *23      INC   --- We have a character match. Bump to next char of typed in name.

03FB *C31C01  JP    --- Go to debounce routine. If legitimate char rtn to 3FE, else rtn to
caller.

0683 *20F1     JR   --- Loop thru block move routine 128 times

1225  E7      RST   --- Double precision or string
1226 *300B    JR    --- Jmp if double precision

124D *E7      OR    --- Set status flags

1265 *F24312  JP    --- No change in this comment

2067  3E01    LD    --- A = device code for printer          * LPRINT routine
2069  329C40  LD    --- Set current system device to printer
206C *C37C20  JP
206E  CDCA41  CALL  --- DOS Exit                             * PRINT routine
2072 *FE23    CP    --- Test for #
2074 *2006    JR    --- Jmp if not PRINT #
2076 *CD8402  CALL  --- Write header on cassette file         * PRINT # routine
2079 *329C40  LD    --- Set current system device to cassette
207C *2B      DEC   --- Backspace over previous symbol in code string
207D *D7      RST   --- Re-examine previous char in code string
207E *CCFE20  CALL  --- If end of string write a Carriage Return
2081 *CA6921  JP    --- If end of string turn off cassette and return
2084 *F620    OR    --- Not end of string. Convert possible 40 to 60
2086 *FE60    CP    --- Then test for @
2088 *201B    JR    --- Jmp if not PRINT @
208A *CD012B  CALL  --- Evaluate @ expression, result in DE   * PRINT @ routine
208D *FE04    CP    --- A = MSB, test for @ value > 1023
208E *D24A1E  JP    --- FC error if @ position > 1023
2092 *E5      PUSH  --- Save current code string addr
2093 *21003C  LD    --- HL = starting addr of video buffer
2096 *19      ADD   --- Add tab position
```

```
2097 *222040  LD    --- And save addr in video DCB as cursor addr
209A *7B      LD    --- Then get position within line
209B *E63F    CP    --- And truncate it to 63
209D *32A640  LD    --- Then save as current position within line
20A0 *E1      POP   --- Restore code string addr (starting addr of item list)
20A1 *CF      RST   --- But make sure a comma follows the tab position
20A2 *2C      INC   --- DC 2C ','
20A3 *18C7    JR    --- Go get first variable from item list
20A5 *7E      LD    --- Reload next element from code string
20A6 *FEBF    CP    --- Test for USING token
20A8 *CABD2C  JP    --- Jmp if USING token
20AB *FEBC    CP    --- Test for TAB token
20AD *CA3721  JP    --- Jmp if TAB token
20B0 *E5      PUSH  --- Save current code string addr
20B1 *FEC2    CP    --- Test for a comma
20B3 *2853    JR    --- Go get next item if a comma
20B5 *FE3B    CP    --- Not comma, test for semi-colon
20B7 *285E    JR    --- Go get next item if semi-colon
20B9  CD3723  CALL  --- Evaluate next item to be printed
20BC *E3      EX    --- Save current code string addr HL = addr of current item

20F6 *C37C20  JP    --- And loop till end of statement (EOS)

213A *E67F    AND   --- Result in A-reg. Do not let it exceed 127

2166 *C38120  JP    --- Process next of PRINT TAB statement

226A *00      NOP   --- Remove
226B *00      NOP   --- Erroneous
226C *00      NOP   --- Test
226D *00      NOP   --- For
226E *00      NOP   --- FD error

2C1F *D6B2      --- Test for CLOAD?                          * CLOAD routine
2C21 *2802      --- Jmp if CLOAD?
2C23 *AF        --- Signal CLOAD
2C24 *012F23    --- 2C25: CPL A=-1 if CLOAD?, 0000 if CLOAD
2C27 *F5        --- 2C26: INC HL position to file name Save CLOAD? / CLOAD flag
2C28 *7E        --- Get next element from code string. Should be file name
2C29 *B7        --- Set status flags
2C2A *2807      --- Jmp if end of line
2C2C *CD2723    --- Evaluate expression (get file name)
2C2F *CD132A    --- Get addr of file name into DE
2C32 *1A        --- Get file name
2C33 *6F        --- And move it to L-reg
2C34 *F1        --- Restore CLOAD? / CLOAD flags
2C35 *B7        --- Set status register according to flags
2C36 *67        --- H=CLOAD?/CLOAD flag, L=file name
2C37 *222141    --- Save flag and file name in WRA1
2C3A *CC4D1B    --- If CLOAD call NEW routine to initialize system variables
ZC3D *210000    --- This will cause the drive to be selected when
2C40 *CD9302    --- We look for leader and synch byte
2C43            --- Restore CLOAD? / CLOAD flag, file name

2FFB *DEC3      --- These instructions
2FFD *C344B2    --- Are not used by Level II
```

Chapter 8

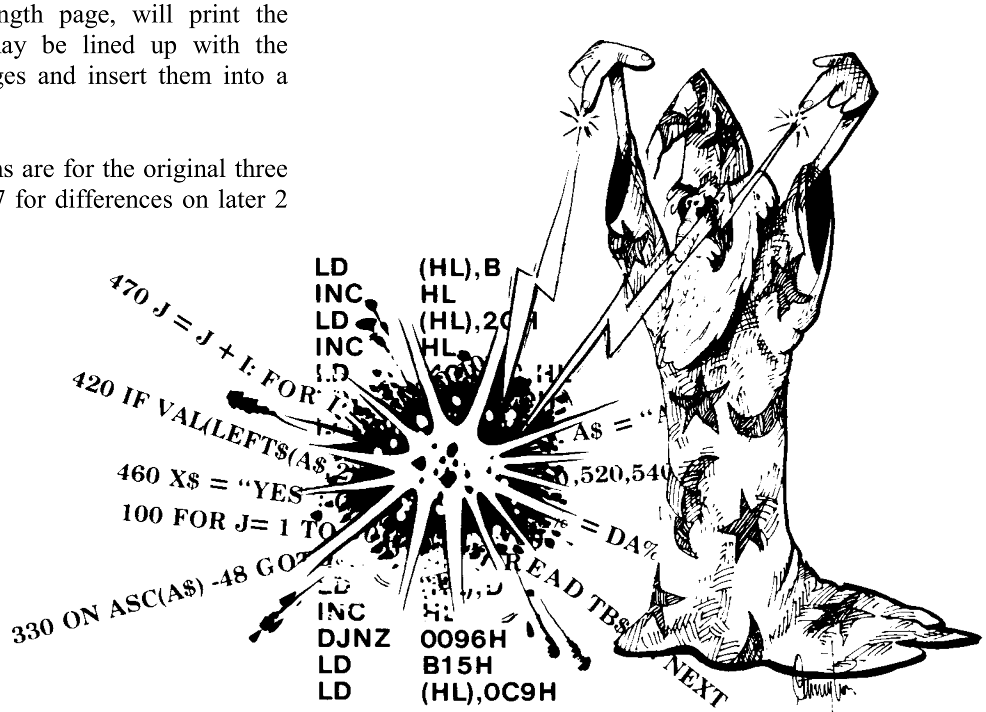
BASIC Decoded: Old ROMs

How to use this book

Unlike most books, this book is made to come apart. Due to the unique nature of the subject matter and the use to which it will be put, its pages may be removed and inserted into a three ring binder. The pages are pre-drilled, and the binding is such that the pages may be removed with little effort.

Each page has 62 lines of comments. This exactly matches the Apparat disassembler's output format. Any printer that will print 66 lines per eleven inch length page, will print the disassembler's output so that it may be lined up with the comments exactly. Remove the pages and insert them into a three ring binder.

The comments and memory locations are for the original three chip ROM sets, please see chapter 7 for differences on later 2 chip sets.



```
0000 F3        DI                   --- Power on IPL entry -Turn off clock/disk interrupts
0001 AF        XOR    A             --- Clear A-reg, status
0002 C37406    JP     0674H         --- Go to beginning of IPL sequence
0005 C30040    JP     4000H         --- ********************************** Compare ******
0008 C30040    JP     4000H         --- RST 08 (JP 1C96) Compare value following   cont-->
000B E1        POP    HL             •  These instructions are not
000C E9        JP     (HL)           •  used by Level II
000D C39F06    JP     069FH         --- Jmp to load & execute sector loader
0010 C30340    JP     4003H         --- RST 10 (JP 1D78) Load and examine next char
0013 C5        PUSH   BC            --- Save BC - Keyboard routine
0014 0601      LD     B,01H         --- B = Entry code
0016 182E      JR     0046H         --- Go to driver entry routine (3C2)
0018 C30640    JP     4006H         --- RST 18 (JP 1C90H) Compare DE:HL
001B C5        PUSH   BC            --- Save BC - Display routine, printer routine
001C 0602      LD     B,02H         --- B = Entry code
001E 1826      JR     0046H         --- Go to driver entry routine (3C2)
0020 C30940    JP     4009H         --- RST 20 (JP 25D9H) Determine data type.
0023 C5        PUSH   BC            --- Save BC
0024 0604      LD     B,04H         --- B = Entry code
0026 181E      JR     0046H         --- Go to driver entry routine (3C2)
0028 C30C40    JP     400CH         --- RST 28 (Non DOS - Ret; DOS 2.0 - JP 4BA2H)
002B 111540    LD     DE,4015H      --- Load keyboard DCB addr into DE ** Scan keyboard
002E 18E3      JR     0013H         --- Jmp to keyboard driver
0030 C30F40    JP     400FH         --- RST 30 (Non DOS - Rtn DOS 2.0 - JP 44B4H)
0033 111D40    LD     DE,401DH      --- Load video DCB addr into DE ***** Video display
0036 18E3      JR     001BH         --- Jmp to video driver
0038 C31240    JP     4012H         --- RST 38 (Non DOS - DI, Rtn DOS 2.0 -        cont-->
003B 112540    LD     DE,4025H      --- Load printer DCB ptr ****************************
003E 18DB      JR     001BH         --- Jmp to printer driver
0040 C3D905    JP     05D9H         --- Go see what's being typed
0043 C9        RET                   •  These instructions are
0044 00        NOP                   •  not used
0045 00        NOP                   •  by Level II
0046 C3C203    JP     03C2H         --- Go to driver entry routine
0049 CD2B00    CALL   002BH         --- Strobe keyboard ******** Wait for keyboard input *
004C B7        OR     A             --- Test if any key active
004D C0        RET    NZ            --- Go if key active
004E 18F9      JR     0049H         --- Loop till some key pressed
0050 0D        DEC    C             --- ENTER, no shift (0D) *************** see note--> *
0051 0D        DEC    C             --- ENTER, shift (0D)
0052 1F        RRA                  --- CLEAR, no shift (1F)
0053 1F        RRA                  --- CLEAR, shift (1F)
0054 01015B    LD     BC,5B01H      --- BREAK ns (01), BREAK shift (01), UP arrow ns (5B)
0057 1B        DEC    DE            --- Up arrow, shift (1B)
0058 0A        LD     A,(BC)        --- Down arrow, no shift (0A)
0059 1A        LD     A,(DE)        --- Down arrow, shift (00)
005A 08        EX     AF,AF'        --- Left arrow, no shift (08)
005B 1809      JR     0066H         --- Left arrow, shift (18): Right arrow, ns (09)
005D 19        ADD    HL,DE         --- Right arrow, shift (19)
005E 2020      JR     NZ,0080H      --- Space, ns (20): Space, shift (20)
0060 0B        DEC    BC            --- Decrement cycle count *** Delay **** see note--> *
0061 78        LD     A,B           --- Test if count zero
0062 B1        OR     C             --- Combine LSB/MSB of count
0063 20FB      JR     NZ,0060H      --- Loop until delay count exhausted
0065 C9        RET                  --- Rtn to caller
0066 310006    LD     SP,0600H      --- Reset IPL entry ******************* Reset *******
0069 3AEC37    LD     A,(37ECH)     --- Get controller status                  see note-->
006C 3C        INC    A             --- Test for controller present
006D FE02      CP     02H           --- Status usually FF if no EI
006F D20000    JP     NC,0000H      --- NC if controller addressable. Join common IPL code
```

```
0005  * **********************************************************
0008  : RST 08 with next input symbol.
      : Syntax error if unequal

002E  * **********************************************************

0033  * **********************************************************

0038  : JP(4518H)   Entry pt. for all interrupts
003B  * **********************************************************

0049  * **********************************************************

0050  * Table for keyboard routine at 3E3H *************************
      *
      * ASCII values for ENTER, CLEAR, BREAK, UP ARROW,
      * DOWN ARROW, LEFT ARROW, RIGHT ARROW and SPACE

0060  * Delay for ((BC-1) * 26 + 17) * 2.255T-states ****************

0066  * **********************************************************
      : Status = 00 - If EI (Expansion Interface) present and DISK
      :          80 - If EI and DISK not ready              :ready
      :          FF - If EI off or not present
```

```
0072 C3CC06    JP     06CCH        --- No disk go to BASIC 'READY' prompt
0075 118040    LD     DE,4080H     --- Here on power on or reset with no disk ***********
0078 21F718    LD     HL,18F7H     --- Move initialization data to communication area
007B 012700    LD     BC,0027H     --- Number of bytes to move
007E EDB0      LDIR                --- Move ROM 18F7-191D to RAM 4080-40A6    see note-->
0080 21E541    LD     HL,41E5H     --- Continue with comm. region initialization
0083 363A      LD     (HL),3AH     --- 3A to 41E5 LD  A,(2C00)
0085 23        INC    HL           --- Bump to 41 E6
0086 70        LD     (HL),B       --- 0 to 41 E6
0087 23        INC    HL           --- Bump to 41 E7
0088 362C      LD     (HL),2CH     --- 2C to 41 E7
008A 23        INC    HL           --- HL = 41E8. Set input buffer pointer (40A7)
008B 22A740    LD     (40A7H),HL   --- to keyboard buffer area (41 E8)
008E 112D01    LD     DE,012DH     --- Addr field for JP instr
0091 061C      LD     B,1CH        --- Initialize 4152-41A5 to JP 12D this gives an L3
0093 215241    LD     HL,4152H     --- Error if disk basic commands are attempted
0096 36C3      LD     (HL),0C3H    --- C3 to 4152 gives ( JP 2D )
0098 23        INC    HL           --- Bump to LSB of address field
0099 73        LD     (HL),E       --- 2D to 4153 gives ( JP 012D ) 23
009A 23        INC    HL           --- Bump to MSB of address field
009B 72        LD     (HL),D       --- 01 to 4154 gives ( JP 012D)
009C 23        INC    HL           --- Bump to addr. of next JP instr
009D 10F7      DJNZ   0096H        --- Repeat 28 times (84 locations)
009F 0615      LD     B,15H        --- loop count for DOS EXIT RETURNS
00A1 36C9      LD     (HL),0C9H    --- C9 to 41 A6 gives (RETURN INSTRUCTION)
00A3 23        INC    HL           -      41A9: Ret               Clear DOS EXIT vectors
00A4 23        INC    HL           -        :                     to RETURNS
00A5 23        INC    HL           -      41E2: Ret
00A6 10F9      DJNZ   00A1H        --- repeat: (gives JP 012D) in locs 4152 - 41A5
00A8 21E842    LD     HL,42E8H     --- Load HL with addr so we can store
00AB 70        LD     (HL),B       --- 0 to 42 E8
00AC 31F841    LD     SP,41F8H     --- Stack addr. during IPL is 41F8
00AF CD8F1B    CALL   1B8FH        --- Initialize BASIC printers and variables
00B2 CDC901    CALL   01C9H        --- Clear screen
00B5 210501    LD     HL,0105H     --- 'MEMORY SIZE ?' message pntr
00B8 CDA728    CALL   28A7H        --- Output message
00BB CDB31B    CALL   1BB3H        --- Print '? ' and wait for user input
00BE 38F5      JR     C,00B5H      --- If break was hit, ask again
00C0 D7        RST    10H          --- Examine a character from response
00C1 B7        OR     A            --- Set status flags
00C2 2012      JR     NZ,00D6H     --- Jmp if not end of response
00C4 214C43    LD     HL,434CH     --- If CR only entered, then determine        cont-->
00C7 23        INC    HL           --- Start at 17220 and work towards 65535 testing for
00C8 7C        LD     A,H          --- LSB of next test addr                           :memory
00C9 B5        OR     L            --- Combine w/MSB of next test addr
00CA 281B      JR     Z,00E7H      --- Memory up thru 65535 scanned.             cont-->
00CC 7E        LD     A,(HL)       --- Fetch original contents of memory test location
00CD 47        LD     B,A          --- Save it for restoration
00CE 2F        CPL                 --- Complement it (gives test pattern)
00CF 77        LD     (HL),A       --- Store test pattern.
00D0 BE        CP     (HL)         --- Compare contents of mem loc with test pattern
00D1 70        LD     (HL),B       --- Restore original value
00D2 28F3      JR     Z,00C7H      --- Address exists. Go test for min amt of memory
00D4 1811      JR     00E7H        --- Address non-existent. Bump to next addr & test
00D6 CD5A1E    CALL   1E5AH        --- Get binary equivalent of value                 :again
00D9 B7        OR     A            --- into DE/A
00DA C29719    JP     NZ,1997H     --- SN error if NZ
00DD EB        EX     DE,HL        --- HL - memory size
00DE 2B        DEC    HL           --- Size minus one        •     Test memory size value
00DF 3E8F      LD     A,8FH        --- Comparison value      •     make sure it's there.
```

```
0075  * ***********************************************************

007E  : Load division support routine. Initialize comm. region to:
      : 4080 - 408D     Division support routine
      : 408E 1E4A       Address of user subroutine
      : 4090 E64DDB     Random number seed
      : 4093 IN A,(00)  INP skeleton instruction .
      : 4095 RET
      : 4096 OUT A,00   OUTP skeleton instruction.
      : 4098 RET
      : 4099    00      Last character typed
      : 409A    00      Error count
      : 409B    00      Count of chars in current line
      : 409C            Output device type
      : 40AD    00      Size of display line (64 characters)
      : 409E    30      Line size during PRINT

      : 40A0 - 434C     Start of string area
      : 40A2 FEFF       Initial BASIC line number
      : 40A4 42E9       Address of PROGRAM STATEMENT TABLE (PST)

00C4  : men. size dynamically

00CA  : Go test for min amt required
```

```
00E1 46         LD      B,(HL)        --- Fetch contents of memory and save in B reg
00E2 77         LD      (HL),A        --- Store test pattern
00E3 BE         CP      (HL)          --- Compare test pattern stored with pattern in A reg
00E4 70         LD      (HL),B        --- Restore original value of memory location
00E5 20CE       JR      NZ,00B5H      --- Specified memory size not present, ask again
00E7 2B         DEC     HL            --- Amt of memory - 2
00E8 111444     LD      DE,4414H      --- DE = 17428 (dec.)
00EB DF         RST     18H           --- Test for a minimum amount of mem (17428)
00EC DA7A19     JP      C,197AH       --- OM error if C. Insufficient memory
00EF 11CEFF     LD      DE,0FFCEH     --- Load constant for default size of      see note-->
00F2 22B140     LD      (40B1H),HL    --- Save memory size
00F5 19         ADD     HL,DE         --- Subtract size of string area from      see note-->
00F6 22A040     LD      (40A0H),HL    --- Save starting addr of string area
00F9 CD4D1B     CALL    1B4DH         --- Initialize all BASIC variables and pointers
00FC 211101     LD      HL,0111H      ---'RADIO . . .BASIC' message pntr
00FF CDA728     CALL    28A7H         --- Output message
0102 C3191A     JP      1A19H         --- Go to ready routine
0105 4D         LD      C,L           --- M ** 'MEMORY SIZE' message **********************
0106 45         LD      B,L           --- E
0107 4D         LD      C,L           --- M
0108 4F         LD      C,A           --- 0
0109 52         LD      D,D           --- R
010A 59         LD      E,C           --- y
010B 2053       JR      NZ,0160H      --- Space, S
010D 49         LD      C,C           --- I
010E 5A         LD      E,D           --- Z
010F 45         LD      B,L           --- E
0110 00         NOP                   --- 00 - message terminator
0111 52         LD      D,D           --- R ** 'RADIO SHACK LEVEL II BASIC' message ********
0112 41         LD      B,C           --- A
0113 44         LD      B,H           --- D
0114 49         LD      C,C           --- I
0115 4F         LD      C,A           --- 0
0116 2053       JR      NZ,016BH      --- Space, S
0118 48         LD      C,B           --- H
0119 41         LD      B,C           --- A
011A 43         LD      B,E           --- C
011B 4B         LD      C,E           --- K
011C 204C       JR      NZ,016AH      --- Space, L
011E 45         LD      B,L           --- E
011F 56         LD      D,(HL)        --- V
0120 45         LD      B,L           --- E
0121 4C         LD      C,H           --- L
0122 2049       JR      NZ,016DH      --- Space, I
0124 49         LD      C,C           --- I
0125 2042       JR      NZ,0169H      --- Space, B
0127 41         LD      B,C           --- A
0128 53         LD      D,E           --- S
0129 49         LD      C,C           --- I
012A 43         LD      B,E           --- C
012B 0D         DEC     C             --- 0D - carriage return
012C 00         NOP                   --- 00 - end of message terminator
012D 1E2C       LD      E,2CH         --- Code for L3 error  **************************
012F C3A219     JP      19A2H         --- Jump to error routine and print L3 error
0132 D7         RST     10H           --- Position to next character ** ( POINT/SET/RESET)
0133 AF         XOR     A             --- A = 0 if POINT entered else          POINT (x,y)
0134 013E80     LD      BC,803EH      --- 0135  LD  A,80 SET routine   A = -1 SET   (x,y)
0137 013E01     LD      BC,013EH      --- 0138  LD  A,01 RESET routine A = +1 RESET (x,y)
013A F5         PUSH    AF            --- Save flag indicating POINT/SET/RESET entry
013B CF         RST     08H           --- Examine next char, look for (
```

```
00EF  : string area (50 dec. bytes)

00F5  : ending memory addr.


0105  * **************************************************************


0111  * **************************************************************


012D  * **************************************************************

0132  * **************************************************************
```

```
013C 28CD      JR     Z,010BH      --- 13C: DC   28 ( for RST 08
013E 1C        INC    E            --- 13D: CALL 2BlC go evaluate 1st variable (x)
013F 2B        DEC    HL           --- Result in A-reg
0140 FE80      CP     80H          --- Compare x coordinate to 128 dec.
0142 D24A1E    JP     NC,1E4AH     --- FC error if x => 128
0145 F5        PUSH   AF           --- Save x coordinate
0146 CF        RST    08H          --- Examine next symbol in input string
0147 2C        INC    L            --- Make sure its a , (comma)
0148 CD1C2B    CALL   2B1CH        --- Go evaluate 2nd variable (y)
014B FE30      CP     30H          --- Result in A-reg. Compare to 48 dec.
014D D24A1E    JP     NC,1E4AH     --- FC error if y => 48
0150 16FF      LD     D,0FFH       --- Prepare to divide y coordinate by 3 giving Q+R
0152 14        INC    D            <----: D = Q
0153 D603      SUB    03H           •   : Divide by compound subtraction
0155 30FB      JR     NC,0152H     ---->: Loop till remainder < 3
0157 C603      ADD    A,03H        --- Make remainder positive
0159 4F        LD     C,A          --- And store it in C                         :
015A F1        POP    AF           --- A = x coordinate                          :
015B 87        ADD    A,A          --- Times 2                  see note --->    :
015C 5F        LD     E,A          --- E = 2 times x                             :
015D 0602      LD     B,02H        --- B = shift count                           :
015F 7A        LD     A,D          <----: Right shift D/E (Q,2*x)                :
0160 1F        RRA                  •   : Two places so that
0161 57        LD     D,A           •   : Bit 1 of E is left in the
0162 7B        LD     A,E           •   : Carry. This bit will be
0163 1F        RRA                  •   : zero if we're on the first column
0164 5F        LD     E,A           •   : of a rectangular box, and one if
0165 10F8      DJNZ   015FH        ---->: we're on the 2nd column.
0167 79        LD     A,C          --- Now, compute position of point within
0168 8F        ADC    A,A          --- the word according to the formula
0169 3C        INC    A            --- (2*R)+1+(0 or 1 for column 1 or 2)
016A 47        LD     B,A          --- Save bit position count
016B AF        XOR    A            --- Clear A and carry flag then
016C 37        SCF                 --- force CARRY on.
016D 8F        ADC    A,A          <---: Build a bit mask to position a one over
016E 10FD      DJNZ   016DH        --->: the point we're looking for. Save mask in C.
0170 4F        LD     C,A          --- Compute word address for box, store in DE
0171 7A        LD     A,D          --- Mask for bit we want
0172 F63C      OR     3CH          --- A = Q from y/3
0174 57        LD     D,A          --- Restore so that DE = addr of box we want
0175 1A        LD     A,(DE)       --- Fetch the bits for this box
0176 B7        OR     A            --- and ret the status flag
0177 FA7C01    JP     M,017CH      --->: Jump if graphics word
017A 3E80      LD     A,80H        --  : Else, make it a graphics word
017C 47        LD     B,A          <---: B = bits for this display box
017D F1        POP    AF           --- Get entry point flag
017E B7        OR     A            --- And test it
017F 78        LD     A,B          --- A = bits for this box
0180 2810      JR     Z,0192H      --- Jump if POINT called
0182 12        LD     (DE),A       --- Restore box contents
0183 FA8F01    JP     M,018FH      --- Jump if SET called else
0186 79        LD     A,C          --- This must be-a RESET call
0187 2F        CPL                 --- Turn bit to be RESET off
0188 4F        LD     C,A          --- Save mark with bit off in C reg
0189 1A        LD     A,(DE)       --- Fetch box from memory
018A A1        AND    C            --- Turn specified bit off
018B 12        LD     (DE),A       --- And restore. Then we're
018C CF        RST    08H          --- Done, prepare to exit after testing for )
018D 29        ADD    HL,HL        --- DC )
018E C9        RET                 --- Return to caller
```

```
0150  : Compute the memory address for the specified point. Graphics
      : area in memory ranges from 3C00 - OFF. Each six bit (2X3)
      : box is represented by an 8 bit byte starting at 3D00. The
: boxes are stored in memory as a string of 6 bits, right
: justified in the byte. The bits in the byte are numbered
: from right to left (as you would expect) starting at 0 and
: going thru 5. Bits 6 & 7 are unused.
: Rectangular coordinates within the box are represented in
: the box 'byte' as follows: bits 0 & 1 represent the first
: row, points 0 and one respectively; bits 2 & 3 correspond
: to the second row, bits 0 and 1, respectively; etc.
```

```
018F B1         OR     C              --- SET continues **** Turn on bit in box ************
0190 18F9       JR     018BH          --- Restore box and rtn to caller
0192 A1         AND    C              --- POINT continues ** Isolate bit we're testing for**
0193 C6FF       ADD    A,0FFH         --- If bit was on, overflow will occur
0195 9F         SBC    A,A            --- A = 0 if bit off, = -1 if bit on
0196 E5         PUSH   HL             --- Save current code string address
0197 CD8D09     CALL   098DH          --- Save 00 (false) or -1 (true) as current value
019A E1         POP    HL             --- Restore code string addr
019B 18EF       JR     018CH          --- Test for closing paren & return to caller
019D D7         RST    10H            --- INKEY$ routine * Position to next char in code str
019E E5         PUSH   HL             --- Save current code string addr
019F 3A9940     LD     A,(4099H)      --- Get last char typed during keyboard scan (shift
01A2 B7         OR     A              --- Set status flags                           @ key)
01A3 2006       JR     NZ,01ABH       --- Jmp if shift @ key struck else
01A5 CD5803     CALL   0358H          --- Scan keyboard once
01A8 B7         OR     A              --- Set status flags for result
01A9 2811       JR     Z,01BCH        --- Jmp if no input
01AB F5         PUSH   AF             --- Save char typed
01AC AF         XOR    A              --- Clear A-reg status flags
01AD 329940     LD     (4099H),A      --- Clear shift @ key character
01B0 3C         INC    A              --- A = 1, size of character string to be built
01B1 CD5728     CALL   2857H          --- Make sure there is room for char string,   cont-->
01B4 F1         POP    AF             --- A = char typed
01B5 2AD440     LD     HL,(40D4H)     --- HL = addr of string in literal string pool area
01B8 77         LD     (HL),A         --- Save character
01B9 C38428     JP     2884H          --- Move string to literal string pool area
01BC 212819     LD     HL,1928H       --- Load address of 'READY' message and **************
01BF 222141     LD     (4121H),HL     --- move to current string variable point
01C2 3E03       LD     A,03H          --- Data type = String
01C4 32AF40     LD     (40AFH),A      --- Set current type to string
01C7 E1         POP    HL             --- Message address to HL
01C8 C9         RET                   --- Rtn to caller
01C9 3E1C       LD     A,1CH          --- Clear screen ************** Home cursor command **
01CB CD3A03     CALL   033AH          --- Send to video
01CE 3E1F       LD     A,1FH          --- Clear screen command
01D0 C33A03     JP     033AH          --- Send to video then return
01D3 ED5F       LD     A,R            --- Load current refresh addr **** RANDOM routine ****
01D5 32AB40     LD     (40ABH),A      --- Save random value                   : see note -->
01D8 C9         RET                   --- Rtn to caller
01D9 2101FC     LD     HL,0FC01H      --- Set bit 0 of 4 bit data latch *******************
01DC CD2102     CALL   0221H          --- OUT (FF) 01
01DF 060B       LD     B,0BH          --- B = count for delay loop
01E1 10FE       DJNZ   01E1H          --- B = count for delay loop = 80 US
01E3 2102FC     LD     HL,0FC02H      --- Set bit 1 of 4 bit data latch
01E6 CD2102     CALL   0221H          --- OUT (FF) 02
01E9 060B       LD     B,0BH          --- B = count for delay loop           see note -->
01EB 10FE       DJNZ   01EBH          --- Delay 3.25X10-6 * 11 * 2.26 a 80 US
01ED 2100FC     LD     HL,0FC00H      --- Clear bits 0 and 1 of 4 bit data latch
01F0 CD2102     CALL   0221H          --- OUT (FF) 00
01F3 065C       LD     B,5CH          --- B = delay loop count 92
01F5 10FE       DJNZ   01F5H          --- Delay = 3.25X10-6 * 92 * 2.26 = 676 US
01F7 C9         RET                   --- Rtn to caller
01F8 E5         PUSH   HL             --- Entry to turn off cassette **********************
01F9 2100FB     LD     HL,0FB00H      --- HL = command to turn off cassette
01FC 181B       JR     0219H          --- Go to cassette driver
01FE 7E         LD     A,(HL)         --- Get next token from input string ****************
01FF D623       SUB    23H            --- Test for #
0201 3E00       LD     A,00H          --- A = unit 0 if care of no # x specification
0203 200D       JR     NZ,0212H       --- Jmp if not #
0205 CD012B     CALL   2B01H          --- Get unit number in DE                      cont-->
```

```
018F  * ***********************************************************

0192  * ***********************************************************

019D  * ***********************************************************

01B1  : Save length, addr at 4023

01BC  * ***********************************************************

01C9  * ***********************************************************

01D3  * (Uses refresh register contents)****************************

01D9  * ***********************************************************

01E1  : Write one bit on cassette. Assume motor has been turned
: on. Called to write clock pulses Requires three steps
: consisting of an
:     OUT (FF) 01
:     OUT (FF) 02
:     OUT (FF) 00
:     Total time for clock pulse is 836 US

01F8  * ***********************************************************

01FE  * ***********************************************************

0205  : (as integer in 'current' area) in DE
```

```
0208 CF         RST    08H          --- Look for comma following unit number
0209 2C         INC    L            --- DC  2C  Comma
020A 7B         LD     A,E          --- Convert unit from
020B A2         AND    D            --- - XX to its positive
020C C602       ADD    A,02H        --- Equivalent
020E D24A1E     JP     NC,1E4AH     --- FC error if NC
0211 3D         DEC    A            --- A = positive value for unit number
0212 32E437     LD     (37E4H),A    --- Entry to define drive **** Select cassette unit **
0215 E5         PUSH   HL           --- Save current code string address
0216 2104FF     LD     HL,0FF04H    --- Code to turn on cassette
0219 CD2102     CALL   0221H        --- Turn drive on/off
021C E1         POP    HL           --- Restore code string addr
021D C9         RET                 --- Rtn to caller
021E 2100FF     LD     HL,0FF00H    --- Mask for preserving video controller flags
0221 3A3D40     LD     A,(403DH)    --- Get video control bits (32/64 char)
0224 A4         AND    H            --- Combine with cassette
0225 B5         OR     L            --- Control bits                      :controller)
0226 D3FF       OUT    (0FFH),A     --- Write reg A to port 255 (cassette/video
0228 323D40     LD     (403DH),A    --- Save new value as current control value
022B C9         RET                 --- Return to caller
022C 3A3F3C     LD     A,(3C3FH)    --- Blink '*' when reading cassette ******* cont --> *
022F EE0A       XOR    0AH          --- Gives 2A/20/2A . . .  *, ,*, ,. . .
0231 323F3C     LD     (3C3FH),A    --- Store new display value
0234 C9         RET                 --- Rtn to caller
0235 C5         PUSH   BC           --- Entry to read cassette **************** cont --> *
0236 E5         PUSH   HL           --- Saves callers register
0237 0608       LD     B,08H        --- B = number of bits to read
0239 CD4102     CALL   0241H        --- Read 1 bit. Assembled into a byte in the A-reg
023C 10FB       DJNZ   0239H        --- Loop till 8 bits (one byte) read
023E E1         POP    HL           --- Restore caller's
023F C1         POP    BC           --- register
0240 C9         RET                 --- Return
0241 C5         PUSH   BC           --- Read 1 data bit from cassette *********  cont --> *
0242 F5         PUSH   AF           --- Save caller's registers
0243 DBFF       IN     A,(0FFH)     <---: Begin tape motion. Stop when first start pulse
0245 17         RLA                  •  :Input and test for clock pulse         :is sensed
0246 30FB       JR     NC,0243H      •  :Not there, loop till it shows up
0248 0641       LD     B,41H        --->: Now delay for 476 micro seconds
024A 10FE       DJNZ   024AH        --- After sensing start pulse
024C CD1E02     CALL   021EH        --- Reset outsig flip/flop so we can read data pulse
024F 0676       LD     B,76H        --- Then delay for 865 micro seconds before reading
0251 10FE       DJNZ   0251H        --- The data pulse
0253 DBFF       IN     A,(0FFH)     --- Read data pulse
0255 47         LD     B,A          --- Save it as B
0256 F1         POP    AF           --- A = prior bits for this byte
0257 CB10       RL     B            --- Shift data bit into carry flag
0259 17         RLA                 --- Combine this data bit with others
025A F5         PUSH   AF           --- Save byte thus far
025B CD1E02     CALL   021EH        --- Reset outsig flip/flop
025E F1         POP    AF           --- Restore data byte
025F C1         POP    BC           --- Other registers
0260 C9         RET                 --- And return
0261 CD6402     CALL   0264H        --- Call 0264 to write clock pulse
0264 E5         PUSH   HL           --- Entry to write byte
0265 C5         PUSH   BC           --- Save caller's registers
0266 D5         PUSH   DE           --- BC
0267 F5         PUSH   AF           --- DE see                                  note ---->
0268 0E08       LD     C,08H        --- C = no of bits to write
026A 57         LD     D,A          --- D = data word to be written bit by bit
026B CDD901     CALL   01D9H        --- Write clock bit
```

```
0212  * *************************************************************
```

```
022C  * Fetch display word that holds an ****************************
```

```
0235  * Reads one byte then returns *********************************
```

```
0241  * Called 8 times to read one byte *****************************
```

```
0265  : Writing a byte is done by serially writing each bit in
      : the byte. Each bit is preceeded by a clock pulse followed
      : by another pulse if the bit is a one or no pulse if the
      : bit is a zero. The time from the clock pulse to the bit
      : pulse is approx 1 millisecond
```

```
026E 7A       LD     A,D        --- Get byte to be written
026F 07       RLCA              --- Set status (carry) if upper bit is one else no
0270 57       LD     D,A        --- Save shifted data byte                   : carry
0271 300B     JR     NC,027EH   --- Jmp if high bit is zero                see note -->
0273 CDD901   CALL   01D9H      --- Else write a one bit
0276 0D       DEC    C          --- Count of bits written from this byte
0277 20F2     JR     NZ,026BH   --- Not done, go write clock pulse then test data bit
0279 F1       POP    AF         --- Restore caller's register : AF
027A D1       POP    DE         --- DE
027B C1       POP    BC         --- BC
027C E1       POP    HL         --- and HL
027D C9       RET               --- Rtn to caller
027E 0687     LD     B,87H      --- B = count of times to delay *********************
0280 10FE     DJNZ   0280H      --- Delay 3.25 * 10-6 * 135 * 2.26 = 991 US
0282 18F2     JR     0276H      --- Go count no of bits written
0284 CDFE01   CALL   01FEH      --- Get unit no and turn on motor *******************
0287 06FF     LD     B,0FFH     --- Entry to write leader and sync byte
0289 AF       XOR    A          --- A = data word to write (all zeroes)
028A CD6402   CALL   0264H      --- Write 256 zeros
028D 10FB     DJNZ   028AH      --- Count one byte of zeroes written. Loop till 256
028F 3EA5     LD     A,0A5H     --- Trailer byte is A5                : bytes written
0291 18D1     JR     0264H      --- Write trailer byte as A5 and rtn to caller
0293 CDFE01   CALL   01FEH      --- Get unit no., turn on motor *********************
0296 E5       PUSH   HL         --- Entry to find leader and sync byte
0297 AF       XOR    A          --- Zero A, status flags
0298 CD4102   CALL   0241H      <---: Read cassette
029B FEA5     CP     0A5H        •  : Until a flag of 'A5' is found. We should skip
029D 20F9     JR     NZ,0298H   --->: over 256 bytes of zeroes before getting there
029F 3E2A     LD     A,2AH      --- A = ASCII *
02A1 323E3C   LD     (3C3EH),A  --- Display **
02A4 323F3C   LD     (3C3FH),A  --- On screen
02A7 E1       POP    HL         --- Restore code string addr
02A8 C9       RET               --- Rtn to caller
02A9 CD1403   CALL   0314H      --- Go read 2 bytes from cassette *********   cont -->
02AC 22DF40   LD     (40DFH),HL --- Save execution address
02AF CDF801   CALL   01F8H      --- Turn off drive
02B2 CDE241   CALL   41E2H      --- DOS Exit (JP 5B51)
02B5 318842   LD     SP,4288H   --- Set CSP below assumed load address
02B8 CDFE20   CALL   20FEH      --- Print CR
02BB 3E2A     LD     A,2AH      --- A = ASCII *
02BD CD2A03   CALL   032AH      --- Print '*'
02C0 CDB31B   CALL   1BB3H      --- Wait for input from keyboard should be file name
02C3 DACC06   JP     C,06CCH    --- Jmp if BREAK key hit                     :to load
02C6 D7       RST    10H        ---- Examine next character in input stream
02C7 CA9719   JP     Z,1997H    --- SN error if EOS
02CA FE2F     CP     2FH        --- It is a '/'
02CC 284F     JR     Z,031DH    --- Jump if '/'
02CE CD9302   CALL   0293H      --- Start up cassette.                     see note-->
02D1 CD3502   CALL   0235H      <---: Read 1 byte
02D4 FE55     CP     55H         •  : Test for U
02D6 20F9     JR     NZ,02D1H   --->: Loop till an ASCII 'U' is read
02D8 0606     LD     B,06H       •  :   B = number of characters to match
02DA 7E       LD     A,(HL)     <-----: Get a character from type in  2C0
02DB B7       OR     A           •  : : Test for zero, end of name
02DC 2809     JR     Z,02E7H     •  : : Go start load, else
02DE CD3502   CALL   0235H       •  : : Read 1 byte from cassette and
02E1 BE       CP     (HL)        •  : : Compare with type
02E2 20ED     JR     NZ,02D1H    •  : : Bump to next char of type
02E4 23       INC    HL         --->: : If no match, skip to next prog on cassette
02E5 10F3     DJNZ   02DAH      ----->: Loop till 6 chars match or end of     cont -->
```

```
0271  : (Go delay for approx 1 ms)




027E  * ************************************************************

0284  * ************************************************************




0293  * *************************************************************





02A9  * Load an assembler program from cassette *********************










      : Position to first data byte by skipping
      : over leader until a U is found







02E5  : type in command
```

```
02E7 CD2C02    CALL   022CH        --- Blink * on video during load
02EA CD3502    CALL   0235H        --- Read a byte
02ED FE78      CP     78H          <-------: Now test if byte is an upper case 8
02EF 28B8      JR     Z,02A9H            • : Yes, read next two bytes and save cont -->
02F1 FE3C      CP     3CH                • : Is it a <
02F3 20F5      JR     NZ,02EAH           • : No, read till '78' or '3C' found
02F5 CD3502    CALL   0235H              • : Read number of bytes to load
02F8 47        LD     B,A                • : Save count of bytes to load
02F9 CD1403    CALL   0314H              • : Read following two bytes (addr) into HL
02FC 85        ADD    A,L                • : Cksum starts with addr
02FD 4F        LD     C,A                • : Save 8 bit cksum
02FE CD3502    CALL   0235H        <--: • : Read a byte
0301 77        LD     (HL),A         • : • : Store it
0302 23        INC    HL             • : • : Bump store address
0303 81        ADD    A,C            • : • : Cksum data byte
0304 4F        LD     C,A            • : • : Save cksum
0305 10F7      DJNZ   02FEH        -->: • : Count 1 byte loaded
0307 CD3502    CALL   0235H              • : Read cksum
030A B9        CP     C                  • : Compare w/computed cksum
030B 28DA      JR     Z,02E7H            • : Cksum OK, keep loading till a '78' found
030D 3E43      LD     A,43H              • : Cksum error. Display a C
030F 323E3C    LD     (3C3EH),A          • : Store C in video memory
0312 18D6      JR     02EAH        ------->: Scan till start of next program
0314 CD3502    CALL   0235H        --- Read one byte from cassette **********************
0317 6F        LD     L,A          --- Save LSB see note-->
0318 CD3502    CALL   0235H        --- Read another byte from cassette
031B 67        LD     H,A          --- Save as MSB
031C C9        RET                 --- Rtn to caller
031D EB        EX     DE,HL        --- DE = input response address *********************
031E 2ADF40    LD     HL,(40DFH)   --- 40DF = will hold execution address
0321 EB        EX     DE,HL        --- HL = input addr DE = execution addr location.
0322 D7        RST    10H          --- Test for CR if not CR then
0323 C45A1E    CALL   NZ,1E5AH     --- Convert ASCII to binary. Result in DE
0326 208A      JR     NZ,02B2H     --- Jmp if no digits found
0328 EB        EX     DE,HL        --- Else digit is execution address
0329 E9        JP     (HL)         --- Jmp to addr given in /XXXX command
032A C5        PUSH   BC           --- Output (A) to screen, printer or tape ************
032B 4F        LD     C,A          --- Save character to output
032C CDC141    CALL   41C1H        --- Rtn if non-DOS
032F 3A9C40    LD     A,(409CH)    --- Get device type code
0332 B7        OR     A            --- Set status flags according to dev type
0333 79        LD     A,C          --- A = char to be written
0334 C1        POP    BC           --- Restore callers BC
0335 FA6402    JP     M,0264H      --- Write to tape
0338 2062      JR     NZ,039CH     --- Write to printer
033A D5        PUSH   DE           --- Write to video
033B CD3300    CALL   0033H        --- Print
033E F5        PUSH   AF           --- Save character written
033F CD4803    CALL   0348H        --- Test for display memory full
0342 32A640    LD     (40A6H),A    --- Update cursor position (0 - 3FH)
0345 F1        POP    AF           --- Restore character written
0346 D1        POP    DE           --- Restore caller's DE
0347 C9        RET                 --- Rtn to caller
0348 3A3D40    LD     A,(403DH)    --- Get video control word *************************
034B E608      AND    08H          --- Test for 32/64 char line
034D 3A2040    LD     A,(4020H)    --- Addr if cursor
0350 2803      JR     Z,0355H      --- Jump if 64 characters/line
0352 0F        RRCA                --- Force cursor position
0353 E61F      AND    1FH          --- to be between 3C00
0355 E63F      AND    3FH          --- and 3FFF
```

```
02EF  : in 40DF. Wait for input








0314  * ***************************************************************
0317  : Read 2 bytes from cassette and assemble as a 16 bit value


031D  * ***************************************************************




032A  * ***************************************************************

      :                              :---------------------:
      : -1 : cassette        :
      :  0 : video           :
      : +1 : printer         :
      :----------------------:





0348  * ***************************************************************
```

```
0357 C9        RET                 --- Rtn to caller
0358 CDC441    CALL    41C4H       --- DOS Exit (JP 59CD)     ***************************
035B D5        PUSH    DE          --- Save callers DE
035C CD2B00    CALL    002BH       --- Scan keyboard
035F D1        POP     DE          --- Restore callers DE
0360 C9        RET                 --- Rtn to caller
0361 AF        XOR     A           --- Keyboard input routine **************************
0362 329940    LD      (4099H),A   --- Zero last char typed following break.
0365 32A640    LD      (40A6H),A   --- And current cursor position.
0368 CDAF41    CALL    41AFH       --- DOS Exit (JP 598E)
036B C5        PUSH    BC          --- Save BC
036C 2AA740    LD      HL,(40A7H)  --- Buffer = 41E8 (usually)
036F 06F0      LD      B,0F0H      --- Length of buffer = 240
0371 CDD905    CALL    05D9H       --- Go see what's being typed into buffer
0374 F5        PUSH    AF          --- Save flags
0375 48        LD      C,B         --- C = input length
0376 0600      LD      B,00H       --- BC = input length
0378 09        ADD     HL,BC       --- HL = end of input area ptr
0379 3600      LD      (HL),00H    --- Flag end of input with a 00H
037B 2AA740    LD      HL,(40A7H)  --- HL= input area ptr
037E F1        POP     AF          --- Restore flags
037F C1        POP     BC          --- Restore BC
0380 2B        DEC     HL          --- HL = input area ptr - 1                 see note-->
0381 D8        RET     C           --- Return w/carry set if BREAK key hit
0382 AF        XOR     A           --- Else clear all status flags
0383 C9        RET                 --- Rtn with HL = input buffer -1
0384 CD5803    CALL    0358H       --- Go scan keyboard ********************************
0387 B7        OR      A           --- Test for any key depressed
0388 C0        RET     NZ          --- Exit if key pressed
0389 18F9      JR      0384H       --- Else, loop till some entry made
038B AF        XOR     A           --- Clear A then ************************************
038C 329C40    LD      (409CH),A   --- Set output device = video
038F 3A9B40    LD      A,(409BH)   --- Get printer carriage position
0392 B7        OR      A           --- Set status flags
0393 C8        RET     Z           --- Return if printer buffer empty
0394 3E0D      LD      A,0DH       --- Load char to print (carriage ret)
0396 D5        PUSH    DE          --- Save caller's DE
0397 CD9C03    CALL    039CH       --- Call print driver
039A D1        POP     DE          --- Restore caller's DE
039B C9        RET                 --- Rtn to caller
039C F5        PUSH    AF          --- Save callers registers ************   see note -->
039D D5        PUSH    DE          --- DE
039E C5        PUSH    BC          --- and BC
039F 4F        LD      C,A         --- C = character to be printed
03A0 1E00      LD      E,00H       --- E = new char/line count of 'C', 'D', or 'A'
03A2 FE0C      CP      0CH         --- Test for skip to next line                :printed
03A4 2810      JR      Z,03B6H     ----->: Jmp if skip to next line
03A6 FE0A      CP      0AH         --    : Test for a line feed (A)
03A8 2003      JR      NZ,03ADH    -->:  : Not LF, test for 'D' carriage ret
03AA 3E0D      LD      A,0DH       -- :  : Set next char to LP carriage ret
03AC 4F        LD      C,A         -- :  : Save LP carriage ret char
03AD FE0D      CP      0DH         <--:--: Test for second type of carriage ret
03AF 2805      JR      Z,03B6H     -- :  Jmp if 'A' or 'D' carriage ret
03B1 3A9B40    LD      A,(409BH)   -- :  Get count of characters in current line
03B4 3C        INC     A           -- :  Bump count for next char going out
03B5 5F        LD      E,A         -- :  Move count to E-reg so we can
03B6 7B        LD      A,E         <--:  Use common code
03B7 329B40    LD      (409BH),A   --- Save updated count of chars/this line
03BA 79        LD      A,C         --- Get char to be printed in A
03BB CD3B00    CALL    003BH       --- Call line printer driver
```

```
0358  * *********************************************************


0361  * *********************************************************


0380  : (Required for RST 16 routine)


0384  * *********************************************************


038B  * *********************************************************


039C  * Call print driver on entry. Char to be printed in **********
      : A-reg. If A = 'C', skip on line and reset count of
      : characters in current line. If A = 'A' or 'D' print
      : carriage return and reset character count for this line
```

```
03BE C1         POP    BC             --- Restore caller's register, BC
03BF D1         POP    DE             --- DE
03C0 F1         POP    AF             --- and AF
03C1 C9         RET                   --- Rtn to caller
03C2 E5         PUSH   HL             --- Driver entry routine *************** see note--> *
03C3 DDE5       PUSH   IX             --- Save registers              B = entry code
03C5 D5         PUSH   DE             --- Load DCB addr               DE = DCB addr
03C6 DDE1       POP    IX             --- into IX
03C8 D5         PUSH   DE             --- Save original contents of DE
03C9 21DD03     LD     HL,03DDH       --- HL = return address
03CC E5         PUSH   HL             --- Push return address onto stack
03CD 4F         LD     C,A            --- Save char to be sent to device
03CE 1A         LD     A,(DE)         --- Fetch 1st word from DCB
03CF A0         AND    B              --- Isolate device code bits
03D0 B8         CP     B              --- and compare w/entry code (B). If unequal
03D1 C23340     JP     NZ,4033H       --- goto driver via DOS Exit
03D4 FE02       CP     02H            --- Clear status flags
03D6 DD6E01     LD     L,(IX+01H)     --- HL = driver address from DCB
03D9 DD6602     LD     H,(IX+02H)     --- Load MSB of driver addr
03DC E9         JP     (HL)           --- Go to driver routine
03DD D1         POP    DE             --- Return from driver routine
03DE DDE1       POP    IX             --- Restore registers, IX
03E0 E1         POP    HL             --- HL
03E1 C1         POP    BC             --- and BC
03E2 C9         RET                   --- Rtn to caller
03E3 213640     LD     HL,4036H       --- Keyboard driver routine ************ see note--> *
03E6 010138     LD     BC,3801H       --- BC = row A0 ptr
03E9 1600       LD     D,00H          --- D = column index
03EB 0A         LD     A,(BC)         --- Load row N
03EC 5F         LD     E,A            --- 8 column bits
03ED AE         XOR    (HL)           --- XOR with previous
03EE 73         LD     (HL),E         --- Store column bits in buffer
03EF A3         AND    E              --- then test for active row
03F0 2008       JR     NZ,03FAH       --- Go if key active in row N
03F2 14         INC    D              --- Bump row index
03F3 2C         INC    L              --- Seven byte buffer indexed by row
03F4 CB01       RLC    C              --- Step address from 3801 - 3840
03F6 F2EB03     JP     P,03EBH        --- Try next row
03F9 C9         RET                   --- No key depression - return
03FA 5F         LD     E,A            --- Save column bits *********************************
03FB 7A         LD     A,D            --- Row index 0 - 6
03FC 07         RLCA                  --- Row * 2
03FD 07         RLCA                  --- Row * 4
03FE 07         RLCA                  --- Row * 8
03FF 57         LD     D,A            --- Save in D
0400 0E01       LD     C,01H          --- Start with bit 0
0402 79         LD     A,C            --- Mask
0403 A3         AND    E              --- Test for non-zero column
0404 2005       JR     NZ,040BH       --- Go if found
0406 14         INC    D              --- Bump column number
0407 CB01       RLC    C              --- Align mask
0409 18F7       JR     0402H          --- Try again
040B 3A8038     LD     A,(3880H)      --- Load shift bit
040E 47         LD     B,A            --- Shift bit to B
040F 7A         LD     A,D            --- Row * 8 + column (0 - 7)
0410 C640       ADD    A,40H          --- Row * 8 + column (0 - 7) + 64 decimal
0412 FE60       CP     60H            --- Test for first 4 row (@,A-Z)
0414 3013       JR     NC,0429H       --- Go if last 3 rows, numeric & special characters
0416 CB08       RRC    B              --- Shift to C
0418 3031       JR     NC,044BH       --- Go if no shift
```

```
03C2  * Entered on RST 14,1C,24 **************************************
```

```
03E3  * HL = keyboard work area ptr **********************************
```

```
03FA  * **************************************************************
```

```
041A C620      ADD    A,20H         --- Set lower case
041C 57        LD     D,A           --- Adjusted character
041D 3A4038    LD     A,(3840H)     --- Get row 6 column bits
0420 E610      AND    10H           --- Test for down arrow or CR
0422 2828      JR     Z,044CH       --- Go if no down arrow or CR
0424 7A        LD     A,D           --- Reload adjusted value for key struck
0425 D660      SUB    60H           --- Adjust to ASCII CR
0427 1822      JR     044BH         --- Go to return
0429 D670      SUB    70H           --- Test for last row (ENTER - SPACE)
042B 3010      JR     NC,043DH      --- Go if last row
042D C640      ADD    A,40H         --- Readjust for rows 4, 5
042F FE3C      CP     3CH           --- Convert rows 4, 5
0431 3802      JR     C,0435H       --- Jmp if (0-1-2-3-4-5-6-7-8-9-:-;-,) key struck
0433 EE10      XOR    10H           --- Invert row 5 bits
0435 CB08      RRC    B             --- Ret if shift key down
0437 3012      JR     NC,044BH      --- Jmp if no
0439 EE10      XOR    10H           --- then re-invert row 5 bits
043B 180E      JR     044BH         --- Go to output
043D 07        RLCA                 --- (Now (ROW * 8 + COLUMN - 48) * 2)
043E CB08      RRC    B             --- Test for shift
0440 3001      JR     NC,0443H      --- Go if no shift
0442 3C        INC    A             --- Now (ROW*8 + COLUMN-48) * 2 + 5 = COLUMN * 2 + 1
0443 215000    LD     HL,0050H      --- Table of codes for last row
0446 4F        LD     C,A           --- Ret C to value from 43D or 442
0447 0600      LD     B,00H         --- depending on shift. Set B = 0
0449 09        ADD    HL,BC         --- Index into table
044A 7E        LD     A,(HL)        --- Get ASCII - like code
044B 57        LD     D,A           --- Save character
044C 01AC0D    LD     BC,0DACH      --- Load delay count
044F CD6000    CALL   0060H         --- Delay 20 milliseconds
0452 7A        LD     A,D           --- A = ASCII - like character
0453 FE01      CP     01H           --- Is it BREAK?
0455 C0        RET    NZ            --- Go if not
0456 EF        RST    28H           --- Yes, BREAK
0457 C9        RET                  --- Return
0458 DD6E03    LD     L,(IX+03H)    --- HL=cursor position ptr ************* see note--> *
045B DD6604    LD     H,(IX+04H)    --- Load MSB of current video buffer addr
045E 383A      JR     C,049AH       --- Jmp if return last char request
0460 DD7E05    LD     A,(IX+05H)    --- Get cursor on/off flag
0463 B7        OR     A             --- Set status flags for cursor on/off
0464 2801      JR     Z,0467H       -->: Jmp if cursor off
0466 77        LD     (HL),A        -- : Move char overlaid by cursor to character buffer
0467 79        LD     A,C           <--: Get char to be displayed
0468 FE20      CP     20H           --- Compare with space
046A DA0605    JP     C,0506H       --- Jump if control character
046D FE80      CP     80H           --- Test for graphics word or compression code
046F 3035      JR     NC,04A6H      --- Jump if graphic or space compression character
0471 FE40      CP     40H           --- Compare w/letter A
0473 3808      JR     C,047DH       --- Jmp if not alphabetic @ - Z
0475 D640      SUB    40H           --- Subtract A to get 0 - 26 value for alpha
0477 FE20      CP     20H           --- Test for lower case
0479 3802      JR     C,047DH       -->: Jmp if not lower case
047B D620      SUB    20H           -- : Convert lower case to upper case
047D CD4105    CALL   0541H         <--: Add new char to video display. Roll screen if
0480 7C        LD     A,H           --- Force addr of next char to             :necessary
0481 E603      AND    03H           --- be in the range 3C00 <= X <3FFF
0483 F63C      OR     3CH           --- Force MSB of buffer addr to 3C - 3F
0485 67        LD     H,A           --- Move updated MSB of buffer addr to HL
0486 56        LD     D,(HL)        --- Get value of char at cursor position
0487 DD7E05    LD     A,(IX+05H)    --- Get cursor on/off flag
```

```
0458  * Display driver routine -    Load LSB if current video *********
                                    buffer addr.
```

```
048A B7          OR      A               --- Get status flags for cursor
048B 2805        JR      Z,0492H         --->: Jmp if cursor off
048D DD7205      LD      (IX+05H),D      --  : Else save character to be replaced by cursor
0490 365F        LD      (HL),5FH        --  : Move ( ) cursor to addr of next char position
0492 DD7503      LD      (IX+03H),L      <---: Save addr of next character
0495 DD7404      LD      (IX+04H),H      --- Position on screen in DCB (3 ,4)
0498 79          LD      A,C             --- Restore last character displayed
0499 C9          RET                     --- Rtn to caller
049A DD7E05      LD      A,(IX+05H)      --- Get cursor on/off switch              see note-->
049D B7          OR      A               --- Set status flags for switch
049E C0          RET     NZ              --- If cursor on, exit with character
049F 7E          LD      A,(HL)          --- It overlaid in A-reg else
04A0 C9          RET                     --- Get last char displayed
04A1 7D          LD      A,L             --- Get LSB of current video buffer addr. ** cont--> *
04A2 E6C0        AND     0C0H            --- Remove lower six bits giving value of XX00,
04A4 6F          LD      L,A             --- XX40, XX80, or XXC0. 64 char/line assumed
04A5 C9          RET                     --- Rtn with new video buffer addr. in HL.
04A6 FEC0        CP      0C0H            --- Check for space compression code *****************
04A8 38D3        JR      C,047DH         --- Graphic
04AA D6C0        SUB     0C0H            --- Subtract conversion bias
04AC 28D2        JR      Z,0480H         --- Jmp if 0 blanks to be displayed
04AE 47          LD      B,A             --- B = count of blanks to be displayed
04AF 3E20        LD      A,20H           --- A = blank
04B1 CD4105      CALL    0541H           --- Display a blank
04B4 10F9        DJNZ    04AFH           --- Loop till B blanks displayed
04B6 18C8        JR      0480H           --- Update pointer to video buffer and exit
04B8 7E          LD      A,(HL)          --- Load char of current position and ** see note--> *
04B9 DD7705      LD      (IX+05H),A      --- Save cursor on/off in DCB
04BC C9          RET                     --- Rtn to caller
04BD AF          XOR     A               --- Set cursor flag off
04BE 18F9        JR      04B9H           --- Update video DCB and exit
04C0 21003C      LD      HL,3C00H        --- H1 = start of video area ******* Home cursor *****
04C3 3A3D40      LD      A,(403DH)       --- Force 64 characters/line
04C6 E6F7        AND     0F7H            --- Clear 32 char/line bit in command word
04C8 323D40      LD      (403DH),A       --- Save command word
04CB D3FF        OUT     (0FFH),A        --- Send command word to video controller
04CD C9          RET                     --- Rtn to caller
04CE 2B          DEC     HL              --- Backspace one char in line ********* see note--> *
04CF 3A3D40      LD      A,(403DH)       --- Get status of video controller
04D2 E608        AND     08H             --- Test for 32/64 char per line
04D4 2801        JR      Z,04D7H         --- Go if 64 characters/line
04D6 2B          DEC     HL              --- Backspace one more word if 64 char/line
04D7 3620        LD      (HL),20H        --- Replace previous char with a blank
04D9 C9          RET                     --- Rtn to caller
04DA 3A3D40      LD      A,(403DH)       --- Get status of video controller ***** see note--> *
04DD E608        AND     08H             --- Isolate number of chars/line
04DF C4E204      CALL    NZ,04E2H        --- Call backspace cursor twice if 32 char line
04E2 7D          LD      A,L             --- Save LSB of current cursor position
04E3 E63F        AND     3FH             --- Backspace LSB of cursor to previous line
04E5 2B          DEC     HL              --- Then backspace cursor 1 character
04E6 C0          RET     NZ              --- Rtn if cursor on same line
04E7 114000      LD      DE,0040H        --- Else skip down one line
04EA 19          ADD     HL,DE           --- by adding 64 to current cursor addr
04EB C9          RET                     --- then rtn to caller
04EC 23          INC     HL              --- Bump current cursor *************** see note--> *
04ED 7D          LD      A,L             --- addr by 1, fetch LSB of addr
04EE E63F        AND     3FH             --- and test for overflow into next line
04F0 C0          RET     NZ              --- No overflow, rtn to caller
04F1 11C0FF      LD      DE,0FFC0H       --- Upward linefeed, add a
04F4 19          ADD     HL,DE           --- minus 64 to current cursor addr
```

```
049A  : Return either current character or last character
      : replaced by cursor


04A1  * Backspace pointer in video buffer to start of ***************
      : current line. 64 char/line assumed

04A6  * *************************************************************


04B8  * cont--> use as cursor flag *********************************
      : note--> Turn cursor on/off (control code processing)


04C0  * *************************************************************


04CE  * Backspace cursor on video (control char processing) *********


04DA  * Backspace cursor. Left arrow (control char processing) *****


04EC  * Advance cursor. Right arrow (control char processing) ******
```

```
04F5 C9         RET                    --- Rtn to caller
04F6 3A3D40     LD      A,(403DH)      --- Get video control word ***************************
04F9 F608       OR      08H            --- Turn on 32 char/line mode
04FB 323D40     LD      (403DH),A      --- Restore video control word
04FE D3FF       OUT     (0FFH),A       --- Select 32 char/line
0500 23         INC     HL             --- Increment current position in video buffer
0501 7D         LD      A,L            --- Force LSB to
0502 E6FE       AND     0FEH           --- an even value when in 32 char/line mode
0504 6F         LD      L,A            --- Restore updated line addr to HL
0505 C9         RET                    --- Rtn to caller
0506 118004     LD      DE,0480H       --- Return addr after processing ******* see note--> *
0509 D5         PUSH    DE             --- To stack                         :control character
050A FE08       CP      08H            --- Backspace and erase character
050C 28C0       JR      Z,04CEH        --- Jmp if backspace
050E FE0A       CP      0AH            --- Not backspace, test for A
0510 D8         RET     C              --- Ignore if control code < A (hex) except for 08
0511 FE0E       CP      0EH            --- Test for turn on cursor
0513 384F       JR      C,0564H        --- Jmp if A-D (carriage return)
0515 28A1       JR      Z,04B8H        --- Jmp if turn on cursor
0517 FE0F       CP      0FH            --- Test for turn off cursor
0519 28A2       JR      Z,04BDH        --- Jmp if turn off cursor
051B FE17       CP      17H            --- Test for select 32 char/line
051D 28D7       JR      Z,04F6H        --- Jmp if 32 select 32 char/line
051F FE18       CP      18H            --- Left arrow
0521 28B7       JR      Z,04DAH        --- Jmp if left arrow
0523 FE19       CP      19H            --- Right arrow
0525 28C5       JR      Z,04ECH        --- Jmp if right arrow
0527 FE1A       CP      1AH            --- Down arrow
0529 28BC       JR      Z,04E7H        --- Jmp if down arrow
052B FE1B       CP      1BH            --- Up arrow
052D 28C2       JR      Z,04F1H        --- Jmp if up arrow
052F FE1C       CP      1CH            --- Home cursor
0531 288D       JR      Z,04C0H        --- Jmp if home cursor
0533 FE1D       CP      1DH            --- Beginning of line
0535 CAA104     JP      Z,04A1H        --- Jmp if backspace to start of current line
0538 FE1E       CP      1EH            --- Erase to end of line
053A 2837       JR      Z,0573H        --- Jmp if delete rest of line
053C FE1F       CP      1FH            --- Clear to end of frame
053E 283C       JR      Z,057CH        --- Jmp if CLEAR rest of screen
0540 C9         RET                    --- Ignore all others
0541 77         LD      (HL),A         --- Send character to display memory *** see note--> *
0542 23         INC     HL             --- Bump to next addr in display memory
0543 3A3D40     LD      A,(403DH)      --- Get status word for video
0546 E608       AND     08H            --- Isolate characters/line flag
0548 2801       JR      Z,054BH        --->: Jmp if 32 char/line
054A 23         INC     HL             --  : 64 char/line. Bump one more word to      cont-->
054B 7C         LD      A,H            <---: Now, test if end of display mem reached
054C FE40       CP      40H            --- If MSB of next avail word = 40, then end of meet
054E C0         RET     NZ             --- Rtn if not out of memory                     :reached
054F 11C0FF     LD      DE,0FFC0H      --- DE = -64
0552 19         ADD     HL,DE          --- Backspace mem ptr 1 line. Prepare to roll screen
0553 E5         PUSH    HL             --- Save starting mem addr of bottom line up one line
0554 11003C     LD      DE,3C00H       --- DE = addr 1st line
0557 21403C     LD      HL,3C40H       --- HL = addr of 2nd line
055A C5         PUSH    BC             --- Save BC
055B 01C003     LD      BC,03C0H       --- BC = count of chars to move (15 lines)
055E EDB0       LDIR                   --- Move screen up one line
0560 C1         POP     BC             --- Restore BC
0561 EB         EX      DE,HL          --- HL = addr of 16th (last) line
0562 1819       JR      057DH          --- Go blank out 16th line
```

```
04F6  * *************************************************************

0506  * Process control characters for video All characters < 20H **

0541  * Moves new char to display buffer ****************************

054A  : next addr in display mem
```

```
0564 7D         LD      A,L            --- Get LSB of current char position
0565 E6C0       AND     0C0H           --- And force its address to the start
0567 6F         LD      L,A            --- Of the current line                 see note -->
0568 E5         PUSH    HL             --- Save starting line addr for current character
0569 114000     LD      DE,0040H       --- DE = number of characters (words) in a line
056C 19         ADD     HL,DE          --- Gives starting addr for next line
056D 7C         LD      A,H            --- Now test EBB of next line addr
056E FE40       CP      40H            --- Test for end of screen
0570 28E2       JR      Z,0554H        --- Jmp if end of screen (scroll up one line)
0572 D1         POP     DE             --- DE = starting addr for current line
0573 E5         PUSH    HL             --- Erase to end of line. HL = starting addr for next
0574 54         LD      D,H            --- Compute ending addr                             :line
0575 7D         LD      A,L            --- For line blanking code below
0576 F63F       OR      3FH            --- Take addr in HL,
0578 5F         LD      E,A            --- round it up to the next line
0579 13         INC     DE             --- number then
057A 1804       JR      0580H          --- Jmp to the line blanking code
057C E5         PUSH    HL             --- Erase to end of frame
057D 110040     LD      DE,4000H       --- Test addr for end of loop check
0580 3620       LD      (HL),20H       <---: Move a blank to current char pos in line
0582 23         INC     HL              •  : Bump to next char DOS
0583 7C         LD      A,H             •  : Test if end of line. Compare
0584 BA         CP      D               •  : MSB of current addr to 40 base 16
0585 20F9       JR      NZ,0580H       --->: Loop if not end of line
0587 7D         LD      A,L            --- Then compare LSB of
0588 BB         CP      E              --- addresses
0589 20F5       JR      NZ,0580H       --- Loop if not end of line
058B E1         POP     HL             --- Restore HL - (current char position addr)
058C C9         RET                    --- Rtn to caller
058D 79         LD      A,C            --- Print driver routine ** Get char to be printed ***
058E B7         OR      A              --- Set status flags
058F 2840       JR      Z,05D1H        --- If zero, then get printer status and return
0591 FE0B       CP      0BH            --- Skip to top of form code              see note-->
0593 280A       JR      Z,059FH        --- Yes go issue line feeds till next page reached
0595 FE0C       CP      0CH            --- Test for conditional skip to top of form
0597 201B       JR      NZ,05B4H       ----->: Jmp if data char
0599 AF         XOR     A              ---   : Then clear A (gives null char to be printed)
059A DDB603     OR      (IX+03H)       ---   : Get number of lines/page
059D 2815       JR      Z,05B4H        ---   : If zero don't skip any lines
059F DD7E03     LD      A,(IX+03H)     ---   : Get count of lines per page and
05A2 DD9604     SUB     (IX+04H)       ---   : subtract lines printed this page so far, gives
05A5 47         LD      B,A            ---   : B = no. of lines to skip to top of next page
05A6 CDD105     CALL    05D1H          <---: : Get printer status
05A9 20FB       JR      NZ,05A6H       --->: : Loop till not busy
05AB 3E0A       LD      A,0AH           •  : : Get a line feed character
05AD 32E837     LD      (37E8H),A       •  : : Send it to the printer
05B0 10F4       DJNZ    05A6H          --->: : Loop till we're at top of next page
05B2 1818       JR      05CCH          ---   : Reset line count for new page & rtn to caller
05B4 F5         PUSH    AF             <-----: Save print status
05B5 CDD105     CALL    05D1H          <---: Get print status
05B8 20FB       JR      NZ,05B5H       --->: Loop till not busy
05BA F1         POP     AF             --- Get character to print
05BB 32E837     LD      (37E8H),A      --- Send it to printer
05BE FE0D       CP      0DH            --- Carriage return?
05C0 C0         RET     NZ             --- Rtn to caller if data char
05C1 DD3404     INC     (IX+04H)       --- Bump count of lines printed this page
05C4 DD7E04     LD      A,(IX+04H)     --- Fetch line count for this page
05C7 DDBE03     CP      (IX+03H)       --- And compare to no of lines per page
05CA 79         LD      A,C            --- Restore print char to A (carriage ret)
05CB C0         RET     NZ             --- Exit if Daze not full
```

```
0567  : (Control code processing)
```

```
058D  * *************************************************************
      :           Carriage control codes
      :           A = line feed + CR
      :           B = skip to top of form
      :           C = conditional skip to top of form
      :           D = CR
```

```
05CC DD360400  LD      (IX+04H),00H  --- Page full, reset line count for next page to zero
05D0 C9        RET                   --- Rtn to caller
05D1 3AE837    LD      A,(37E8H)     --- Get printer status word *************************
05D4 E6F0      AND     0F0H          --- Isolate status
05D6 FE30      CP      30H           --- Test for printer selected and ready
05D8 C9        RET                   --- Rtn with status zero if selected & ready
05D9 E5        PUSH    HL            --- Input routine HL points to input area ** cont--> *
05DA 3E0E      LD      A,0EH         --- Code to turn on cursor      HL = Start of buffer
05DC CD3300    CALL    0033H         --- Turn on cursor              B  = Buffer size
05DF 48        LD      C,B           --- C = buffer size             Exit with carry if
05E0 CD4900    CALL    0049H         <---: Return when key is pressed     BREAK hit
05E3 FE20      CP      20H            •  : Test for SPACE
05E5 3025      JR      NC,060CH       •  : Not a space but displayable if NC
05E7 FE0D      CP      0DH            •  : Test for carriage ret.
05E9 CA6206    JP      Z,0662H        •  : Jmp if CR
05EC FE1F      CP      1FH            •  : Test for CLEAR
05EE 2829      JR      Z,0619H        •  : Jmp if CLEAR
05F0 FE01      CP      01H            •  : Test for BREAK
05F2 286D      JR      Z,0661H        •  : Jmp if BREAK
05F4 11E005    LD      DE,05E0H       •  : Push rtn addr of 05 E0 onto stack in case
05F7 D5        PUSH    DE             •  : character is none of the following
05F8 FE08      CP      08H            •  : Test for backspace and erase char.
05FA 2834      JR      Z,0630H        •  : Jmp if backspace / erase
05FC FE18      CP      18H            •  : Backspace cursor
05FE 282B      JR      Z,062BH        •  : Jmp if backspace
0600 FE09      CP      09H            •  : Horizontal tab
0602 2842      JR      Z,0646H        •  : Jmp if horizontal tab
0604 FE19      CP      19H            •  : Select 32 char/line
0606 2839      JR      Z,0641H        •  : Jmp if line size selection
0608 FE0A      CP      0AH            •  : Test for line feed
060A C0        RET     NZ             •  : Return to 5E0 if not a line feed
060B D1        POP     DE             •  : Remove 5E0 as a rtn addr
060C 77        LD      (HL),A         •  : He hit a printable character (save it)
060D 78        LD      A,B            •  : 240 - count of characters fetched
060E B7        OR      A              •  : Set status
060F 28CF      JR      Z,05E0H        •  : If end of buffer ignore unless BRK or CR
0611 7E        LD      A,(HL)         •  : Reload char just entered
0612 23        INC     HL             •  : Bump buffer address
0613 CD3300    CALL    0033H          •  : Print the character just received
0616 05        DEC     B              •  : Count 1 char received
0617 18C7      JR      05E0H         --->: Get next character
0619 CDC901    CALL    01C9H         --- He hit CLEAR : CLS Clear screen
061C 41        LD      B,C           --- Reset count of characters transmitted
061D E1        POP     HL            --- Reset buffer address
061E E5        PUSH    HL            --- Save buffer origin on stack
061F C3E005    JP      05E0H         --- Go get next character (first char of buffer)
0622 CD3006    CALL    0630H         --- Go wait for next key
0625 2B        DEC     HL            --- Backup to previous character (one before CR)
0626 7E        LD      A,(HL)        --- Fetch it and test for a LF
0627 23        INC     HL            --- Restore buffer addr to next avail position
0628 FE0A      CP      0AH           --- Was previous char a -line feed
062A C8        RET     Z             --- yes, rtn
062B 78        LD      A,B           --- No, test for buffer full. A = count of chars
062C B9        CP      C             --- Received minus size of buffer
062D 20F3      JR      NZ,0622H      --- Loop if room for more data
062F C9        RET                   --- Rtn (buffer full)
0630 78        LD      A,B           --- B = characters received C = size of buffer ******
0631 B9        CP      C             --- Test if buffer full
0632 C8        RET     Z             --- Exit if buffer full
0633 2B        DEC     HL            --- Backspace to previous character
```

```
05D1  * *************************************************************


05D9  * Accept keyboard input ***************************************
```

```
0630  * *************************************************************
```

```
0634 7E         LD      A,(HL)       --- And fetch it
0635 FE0A       CP      0AH          --- Test for a line feed
0637 23         INC     HL           --- Bump to last character received
0638 C8         RET     Z            --- Exit if previous char was a line feed
0639 2B         DEC     HL           --- Backspace over last char in buffer
063A 3E08       LD      A,08H        --- Backspace screen command
063C CD3300     CALL    0033H        --- Print backspace
063F 04         INC     B            --- Adjust char received count
0640 C9         RET                  --- Exit
0641 3E17       LD      A,17H        --- Send position command ****************************
0643 C33300     JP      0033H        --- To video control unit and exit
0646 CD4803     CALL    0348H        --- Go wait for next key ****************** cont--> *
0649 E607       AND     07H          --- Isolate lower 3 bits of ASCII value
064B 2F         CPL                  --- Gives inverse of value
064C 3C         INC     A            --- Gives value 1 <= X <= 8
064D C608       ADD     A,08H        --- Clears upper bits of counter
064F 5F         LD      E,A          --- Save count of blanks to add
0650 78         LD      A,B          <---: Get amt of space left in buffer
0651 B7         OR      A             •  : Test for full buffer
0652 C8         RET     Z             •  : Exit if buffer full
0653 3E20       LD      A,20H         •  : Load an ASCII space into A-reg
0655 77         LD      (HL),A        •  : Store space in buffer
0656 23         INC     HL            •  : Bump to next location in buffer
0657 D5         PUSH    DE            •  : Save callers DE
0658 CD3300     CALL    0033H         •  : Display blank
065B D1         POP     DE            •  : Restore DE
065C 05         DEC     B             •  : Decrement count of bytes left in buffer
065D 1D         DEC     E             •  : Count one spaced added to buffer
065E C8         RET     Z             •  : Exit if specified number of blanks added
065F 18EF       JR      0650H        --->: Else loop till buffer full or count zero
0661 37         SCF                  --- CARRY flag set if BREAK hit. *********** cont--> *
0662 F5         PUSH    AF           --- He hit a CR                            see note-->
0663 3E0D       LD      A,0DH        --- A = CR terminates buffer
0665 77         LD      (HL),A       --- Save terminator in buffer
0666 CD3300     CALL    0033H        --- Print it (CR)
0669 3E0F       LD      A,0FH        --- Cursor off code
066B CD3300     CALL    0033H        --- Turn cursor off via driver call
066E 79         LD      A,C          --- C = buffer size
066F 90         SUB     B            --- Minus (buffer size - chars processed)
0670 47         LD      B,A          --- Gives chars in buffer
0671 F1         POP     AF           --- Restore status flag carry  cont-->
0672 E1         POP     HL           --- HL = start of buffer address
0673 C9         RET                  --- Return to original caller
0674 D3FF       OUT     (0FFH),A     --- 0 to cassette ************** Video controller ****
0676 21D206     LD      HL,06D2H     --- Addr. of video/keyboard/printer DCB's
0679 110040     LD      DE,4000H     --- Start of communications region
067C 013600     LD      BC,0036H     --- Setup for block move
067F EDB0       LDIR                 --- Move 6D2-707 to 4000-4035
0681 3D         DEC     A            --- Change value being sent to port FF to FFFD, . . .
0682 3D         DEC     A            --- FFFB, . . . .
0683 20F1       JR      NZ,0676H     --- Go thru this 128 times
0685 0627       LD      B,27H        --- 0 to A
0687 12         LD      (DE),A       --- 0 to 4036-4062
0688 13         INC     DE           --- Bump destination pntr
0689 10FC       DJNZ    0687H        --- Go if not done
068B 3A4038     LD      A,(3840H)    --- Test keyboard for BREAK
068E E604       AND     04H          --- BREAK key hit
0690 C27500     JP      NZ,0075H     --- Go if BREAK
0693 317D40     LD      SP,407DH     --- New stack area
0696 3AEC37     LD      A,(37ECH)    --- Load disk status
```

```
0641  * **************************************************************

0646  * No. of blanks to produce ******** HT key during input *******
      :                                   Pad buffer with specified
      :                                   number of blanks or until
      :                                   buffer is full.
      :                                   Number of blanks added is:
      :                                   HT 0 - 8 : HT 5  -  3
      :                                     1  -  7  :  6  -  2
      :                                     2  -  6  :  7  -  1
      :                                     3  -  5  :  8  -  0
      :                                     4  -  4  :

0661  * Else reset *** BREAK key during input **********************
0662  : CR during input

0671  : Set if BREAK -Not set if CR

0674  * **************************************************************
```

```
0699 3C        INC    A           --- Test for Expansion Interface
069A FE02      CP     02H         --- and disk drive
069C DA7500    JP     C,0075H     --- Go if no disk
069F 3E01      LD     A,01H       --- Unit select mask for drive 0
06A1 32E137    LD     (37E1H),A   --- Select drive 0
06A4 21EC37    LD     HL,37ECH    --- Addr of disk command / status register
06A7 11EF37    LD     DE,37EFH    --- Addr of disk data register
06AA 3603      LD     (HL),03H    --- 3 to disk command register = restore, position
06AC 010000    LD     BC,0000H    --- Delay count                          :to track 0
06AF CD6000    CALL   0060H       --- Delay for approx 3 seconds
06B2 CB46      BIT    00H,(HL)    --- Test if controller busy,
06B4 20FC      JR     NZ,06B2H    --- Loop till not busy
06B6 AF        XOR    A           --- 0 to A
06B7 32EE37    LD     (37EEH),A   --- 0 to sector register
06BA 010042    LD     BC,4200H    --- BC = addr of buffer area
06BD 3E8C      LD     A,8CH       --- A = read command
06BF 77        LD     (HL),A      --- Read sector 0, track 0 into 4200 - 4455
06C0 CB4E      BIT    01H,(HL)    --- Test if data ready
06C2 28FC      JR     Z,06C0H     --- Go if no data avail
06C4 1A        LD     A,(DE)      --- Get next byte from disk
06C5 02        LD     (BC),A      --- Transfer data to 4200+
06C6 0C        INC    C           --- Bump buffer pntr
06C7 20F7      JR     NZ,06C0H    --- Go if not 256 bytes
06C9 C30042    JP     4200H       --- Done, transfer to TRSDOS loader
06CC 01181A    LD     BC,1A18H    --- Addr of BASIC READY routine (rtn addr) ***********
06CF C3AE19    JP     19AEH       --- Initialize BASIC's variables & pntrs  ** cont--> *
06D2 C3961C    JP     1C96H       * 4000 *--- RST 08 vector JP 1C96 (compare) **********
06D5 C3781D    JP     1D78H       * 4003 *--- RST 10 vector JP 1D78 (get next char)
06D8 C3901C    JP     1C90H       * 4006 *--- RST 18 vector JP 1C90 (compare DE:HL)
06DB C3D925    JP     25D9H       * 4009 *--- RST 20 vector JP 25D9 (test data type)
06DE C9        RET                * 400C *--- RST 28 vector RET (JP 4BA2 for DOS)
06DF 00        NOP                *
06E0 00        NOP                *
06E1 C9        RET                * 400E *--- RST 30 vector RET (JP 44B4 for DOS)
06E2 00        NOP                *
06E3 00        NOP                * 4012 *--- RST 38 vector DI/RET (JP 4518 for DOS)
06E4 FB        EI                 *          :Interrupt entry point vector
06E5 C9        RET                *
06E6 00        NOP                *
06E7 01E303    LD     BC,03E3H    * 4015 *--- Keyboard DCB ****************************
06EA 00        NOP                *
06EB 00        NOP                *                  Driver addr = 3E3
06EC 00        NOP                *
06ED 4B        LD     C,E         *
06EE 49        LD     C,C         * 401D *--- Video DCB *******************************
06EF 07        RLCA               *
06F0 58        LD     E,B         *
06F1 04        INC    B           *
06F2 00        NOP                *                  Driver addr = 458
06F3 3C        INC    A           *
06F4 00        NOP                *
06F5 44        LD     B,H         *
06F6 4F        LD     C,A         * 4025 *--- Line printer DCB ************************
06F7 068D      LD     B,8DH       *
06F9 05        DEC    B           *
06FA 43        LD     B,E         *                  Driver addr = 58D
06FB 00        NOP                *
06FC 00        NOP                *
06FD 50        LD     D,B         *
06FE 52        LD     D,D         ****************************************************
```

```
06CC  * *************************************************************
06CF  * then goto 1A18 (BASIC READY routine)
06D2  * The contents of 6D2 - 707 are moved to location
      * 4000 - 4035 in the Communications Region
      * during the first stage of the IPL sequence

06E7  * *************************************************************

06EE  * *************************************************************

06F6  * *************************************************************

06FE  * *************************************************************
```

```
06FF C30050    JP     5000H        * 402D *--- Changed by SYS 0 to JP 4400
0702 C7        RST    00H          * 4030 *--- Changed by SYS 0 to LD A,A3
0703 00        NOP                 *
0704 00        NOP                 * 4043 *--- Changed by SYS 0 to RST 28
0705 3E00      LD     A,00H        * 4033 *--- Changed by SYS 0 to 44BB
0707 C9        RET                 *
0708 218013    LD     HL,1380H     --- Address of the single precision routines *********
070B CDC209    CALL   09C2H        --- Load a SP number pointed to by HL into BC/DE
070E 1806      JR     0716H        --- Go add SP no. in registers to 4121 - 4124
0710 CDC209    CALL   09C2H        --- Load current value into BC/DE
0713 CD8209    CALL   0982H        --- Invert sign of value in WRA1       : see notes -->
0716 78        LD     A,B          --- Get exponent for register value
0717 B7        OR     A            --- Set status flags for exponent
0718 C8        RET    Z            --- If exponent = 0, then no. in registers is zero
0719 3A2441    LD     A,(4124H)    --- Now, get exponent of the other number
071C B7        OR     A            --- and test its exponent
071D CAB409    JP     Z,09B4H      --- Exit if it is zero.
0720 90        SUB    B            --- A = current exp - Reg. exp = bits to scale
0721 300C      JR     NC,072FH     --- Register value has smallest exp. & therefore is
0723 2F        CPL                 --- smaller. Make diff in exponents positive. Also
0724 3C        INC    A            --- reverse registers and current values so that
0725 EB        EX     DE,HL        --- smallest one is in registers.
0726 CDA409    CALL   09A4H        --- Put SP no. in '4121-4124' onto stack
0729 EB        EX     DE,HL        --- Restore HL to addr of second value
072A CDB409    CALL   09B4H        --- Put SP no. in registers into '4121 - 4124'
072D C1        POP    BC           --- Load SP no. saved on stack at 0726 above.
072E D1        POP    DE           --- If difference in exponent > 24, then no. cannot be
072F FE19      CP     19H          --- added because of difference in magnitude.
0731 D0        RET    NC           --- Save number of places to right shift register
0732 F5        PUSH   AF           --- value so its exponent = exponent of current value
0733 CDDF09    CALL   09DFH        --- Turn on MS bit of both values to be added. Save
0736 67        LD     H,A          --- sign determination in H. A = no. of bit position
0737 F1        POP    AF           --- to right shift BC/CE scale value in registers so
0738 CDD707    CALL   07D7H        --- it is equivalent to current value. Go unpack
073B B4        OR     H            --- value in BC/DE. Set status flags for sign of
073C 212141    LD     HL,4121H     --- Load addr of WRA1                  :register value
073F F25407    JP     P,0754H      --- Jump if value in registers is negative.
0742 CDB707    CALL   07B7H        --- Add a SP no in CDE to SP no. pointed to by
0745 D29607    JP     NC,0796H     --- HL. Sum in CDE. Jump if coefficient
0748 23        INC    HL           --- same size else
0749 34        INC    (HL)         --- increase exponent by 1
074A CAB207    JP     Z,07B2H      --- error if exponent overflows to zero.
074D 2E01      LD     L,01H        --- L = number of bits to shift
074F CDEB07    CALL   07EBH        --- Right shift coefficient 1 place.
0752 1842      JR     0796H        --- Go normalize value & rtn to caller
0754 AF        XOR    A            --- Clear A, status flags *************** see note--> *
0755 90        SUB    B            --- 0-exponent = -exponent
0756 47        LD     B,A          --- Save negative of exponent
0757 7E        LD     A,(HL)       --- Load LSB of mem. value
0758 9B        SBC    A,E          --- Minus LSB of reg. value
0759 5F        LD     E,A          --- E = new LSB reg. value
075A 23        INC    HL           --- Bump to middle byte of mem. value
075B 7E        LD     A,(HL)       --- Load middle byte of mem. value
075C 9A        SBC    A,D          --- Subtract middle byte of reg. value
075D 57        LD     D,A          --- D = new MSB of reg. value
075E 23        INC    HL           --- Bump to MSB of mem. value
075F 7E        LD     A,(HL)       --- Load MSB of mem. value
0760 99        SBC    A,C          --- Minus MSB of reg. value
0761 4F        LD     C,A          --- C = new MSB of reg. value
0762 DCC307    CALL   C,07C3H      --- If carry go convert reg. value to          cont-->
```

```
0708  * Single precision addition routines ( 5 entry points) ********

0708  : This entry point loads a .5 into BC/DE
      : then adds it to the value in WRA1
070B  : This entry point loads a SP value, pointed to by HL
      : into and then adds it to WRA1
0710  : Loads SP value pointed to by HL into BC/DE. Then
      : inverts the sign of WRA1 value, before adding
      : BC/DE and WRA1
0713  : This entry point inverts the sign of the value
      : in WRA1 before adding it to BC/DE
0716  : Adds WRA1 to BC/DE, leaves sum in WRA1
```

```
0754  * Adds a negative SP value in BC/DE to a positive *************
      : SP value pointed to by HL. Result left in BC/DE
```

```
      : its positive equivalent
```

```
0765 68        LD    L,B          --- L = exponent of original reg. value see    note-->
0766 63        LD    H,E          --- H = least sig. byte
0767 AF        XOR   A            --- Clear A, status.
0768 47        LD    B,A          <---: B = count of bytes tested
0769 79        LD    A,C           •  : Load next byte of new reg. value(MSB/middle/LSB)
076A B7        OR    A             •  : Test if EBB is zero
076B 2018      JR    NZ,0785H      •  : Jmp if MSB non-zero (go normalize reg. value)
076D 4A        LD    C,D           •  : This is a circular see note-->
076E 54        LD    D,H           •  : Left shift of 8 bits
076F 65        LD    H,L           •  : C <-- D <-- H
0770 6F        LD    L,A           •  : H <-- L <-- A
0771 78        LD    A,B           •  : Zero in B gets propagated until a non-zero byte
0772 D608      SUB   08H           •  : or all 3 bytes of reg. value have tested
0774 FEE0      CP    0E0H          •  : Test if all 3 bytes of value tested
0776 20F0      JR    NZ,0768H     --->: Jmp if no
0778 AF        XOR   A            --- Yes, value is zero
0779 322441    LD    (4124H),A    --- Zero exponent
077C C9        RET                --- Rtn to caller
077D 05        DEC   B            <---: Count 1 left shift *************** see note--> *
077E 29        ADD   HL,HL         •  : Shift HL left 1 bit
077F 7A        LD    A,D           •  : Then shift D left 1 bit
0780 17        RLA                 •  : Picking up any carry from HL
0781 57        LD    D,A           •  : Restore shifted D
0782 79        LD    A,C           •  : Then shift C left 1 bit
0783 8F        ADC   A,A           •  : Picking up any carry from D
0784 4F        LD    C,A           •  : Restore shifted C
0785 F27D07    JP    P,077DH      --->: Loop till CDHL is normalized
0788 78        LD    A,B          --- A = count of bits shifted left
0789 5C        LD    E,H          --- Save HL so we can
078A 45        LD    B,L          --- use it for addr of exponent
078B B7        OR    A            --- Test count of bits shifted
078C 2808      JR    Z,0796H      --->: Jump if reg value already normalized or negative
078E 212441    LD    HL,4124H      •  : HL = addr. of original exponent of reg. value
0791 86        ADD   A,(HL)        •  : Add shifted count to bias
0792 77        LD    (HL),A        •  : Store result as exponent
0793 30E3      JR    NC,0778H      •  : Set exponent to zero if value < 2**24
0795 C8        RET   Z             •  : Rtn with WRA1 = zero if exponent is zero
0796 78        LD    A,B          <---: Load least sig. byte of value
0797 212441    LD    HL,4124H     --- Addr. of exponent to HL                  see note-->
079A B7        OR    A            --- Test if any bits in LSB
079B FCA807    CALL  M,07A8H      --->: if so go test for overflow
079E 46        LD    B,(HL)        •  : otherwise load the exponent into B
079F 23        INC   HL            •  : Bump to 4025 (contains sign of result)
07A0 7E        LD    A,(HL)        •  : then load the sign. Isolate it so
07A1 E680      AND   80H           •  : that it can be combined with new exponent
07A3 A9        XOR   C             •  : Clear sign bit of MSB
07A4 4F        LD    C,A           •  : B=exponent, C=MSB, D=next MSB, E=LSB
07A5 C3B409    JP    09B4H         •  : Store SP number in BC, DE into 4121-4124.
07A8 1C        INC   E            <---: Bump least sig. byte ************* see note--> *
07A9 C0        RET   NZ           --- Exit if no overflow
07AA 14        INC   D            --- Go on to next byte. Bump it
07AB C0        RET   NZ           --- Exit if no overflow
07AC 0C        INC   C            --- Go on to next byte. Bump it
07AD C0        RET   NZ           --- Exit if no overflow
07AE 0E80      LD    C,80H        --- Set value to -0
07B0 34        INC   (HL)         --- Bump exponent
07B1 C0        RET   NZ           --- Exit if we have not overflowed
07B2 1E0A      LD    E,0AH        --- OV error code
07B4 C3A219    JP    19A2H        --- Output OV error message
07B7 7E        LD    A,(HL)       --- Load LSB of memory value
```

```
      : Part I of integer to SP conversion
      : On entry C=MSB, D=middle byte, E=MSB of integer to be converted
      : If both bytes are zero, set the exponent to zero (4124),
      : the other three bytes are already zero. If the integer
      : is not zero, locate the first non-zero byte and go to
      : 785-77D to normalize (shift it left until the most
      : significant bit is 1) it.
076D  : ------- Rotate reg. value left 8 bits.
      :     :   If entire value is zero set exponent to zero & exit
      :     :   C <-- D <-- H <-- L <-- A
```

```
077D  * Part II of integer to SP conversion
      : Shift CDHL left as a single unit the MS bit of
      : L->H, MS bit of H->D, MS bit of D->C. Shifting
      : stops when the MS bit of C is shifted into bit
      : 15. A count of the number of shifts necessary
      : is kept in B as a negative number.
```

```
      : Part III of integer to SP conversion. Clear sign
      : of mantissa (it was set neg during the normalization
      : process above). Setup registers for storing
      : result.
```

```
 07A8 * Return to caller for negative
      : numbers, zeros have been
      : converted to all ones. Now,
      : convert all the trailing zeros
      : (which are now ones) back to
      : zeros. Also used to test for
      : overflow when creating a
      : SP number.
```

```
      : Add 3 bytes of a SP number in C D/E
```

```
07B8 83       ADD   A,E          --- Add to LSB of register value
07B9 5F       LD    E,A          --- Save new LSB
07BA 23       INC   HL           --- Bump to middle byte of memory value
07BB 7E       LD    A,(HL)       --- Load middle byte of memory value :     see note-->
07BC 8A       ADC   A,D          --- Add middle byte of register value
07BD 57       LD    D,A          --- Save new middle byte
07BE 23       INC   HL           --- Bump to MSB of memory value
07BF 7E       LD    A,(HL)       --- Load MSB of memory value
07C0 89       ADC   A,C          --- Add MSB of register value
07C1 4F       LD    C,A          --- Save new MSB
07C2 C9       RET                --- Rtn to caller
07C3 212541   LD    HL,4125H     --- Reset sign flag so that ************ see note--> *
07C6 7E       LD    A,(HL)       --- mantissa will have a negative sign
07C7 2F       CPL                --- Invert the sign flag
07C8 77       LD    (HL),A       --- Store sign flag
07C9 AF       XOR   A            --- Zero A
07CA 6F       LD    L,A          --- then save it
07CB 90       SUB   B            --- Complement B (0 - B)
07CC 47       LD    B,A          --- Save new value of B
07CD 7D       LD    A,L          --- Reload zero into A
07CE 9B       SBC   A,E          --- Complement E (0 - E)
07CF 5F       LD    E,A          --- Save new value for E
07D0 7D       LD    A,L          --- Reload A with zero
07D1 9A       SBC   A,D          --- Complement D (0 - D)
07D2 57       LD    D,A          --- Save new D value
07D3 7D       LD    A,L          --- Reload A with zero
07D4 99       SBC   A,C          --- Complement C (0 - C)
07D5 4F       LD    C,A          --- Save new C value
07D6 C9       RET                ---Rtn to caller *********** Unpack a SP number ******
07D7 0600     LD    B,00H        <--: On entry, A = no bits to right shift
07D9 D608     SUB   08H          ---:>: If carry, then shift right (A) bits,
07DB 3807     JR    C,07E4H       • : : else shift number right one byte
07DD 43       LD    B,E           • : : This code thru 07 E2
07DE 5A       LD    E,D           • : : shifts 00CDE such
07DF 51       LD    D,C           • : : that afterwards we have E00CD
07E0 0E00     LD    C,00H        -->: : Loop to see if must right shift another byte
07E2 18F5     JR    07D9H        <----: Make shift count positive
07E4 C609     ADD   A,09H        --- And move it to L
07E6 6F       LD    L,A          --- Clear status flags
07E7 AF       XOR   A            --- Decrement shift count
07E8 2D       DEC   L            --- Exit if done
07E9 C8       RET   Z            --- Now, right shift BCDE one bit at a time as a unit
07EA 79       LD    A,C          --- Right shift C one position, put bit 0 of C into
07EB 1F       RRA                --- Restore C                                  :carry
07EC 4F       LD    C,A          --- Now, right shift D one place. Bit 0 of C becomes
07ED 7A       LD    A,D          --- Bit 0 of D to carry                   : bit 8 of D
07EE 1F       RRA                --- Restore D
07EF 57       LD    D,A          --- Right shift E one bit. Bit 0 of D becomes bit 8
07F0 7B       LD    A,E          --- Bit 0 of E to carry                         : of E
07F1 1F       RRA                --- Restore E
07F2 5F       LD    E,A          --- Finally right shift B one bit.
07F3 78       LD    A,B          --- Bit 0 of E becomes
07F4 1F       RRA                --- bit 7 of B. Bit 0 of B is lost.
07F5 47       LD    B,A          --- Loop till (L) bits shifted.               cont-->
07F6 18EF     JR    07E7H        --- ******************************************
07F8 00       NOP                --- 07F8 - 07FB = SP 1.0
07F9 00       NOP                ---
07FA 00       NOP                ---
07FB 81       ADD   A,C          --- Count of following SP values (03)
07FC 03       INC   BC           --- Coefficients for power series used in LN comp
```

```
      :     To 3 bytes of a SP number pointed
      :     to by HL - One of the numbers must
      :     have been scaled so its exponent is
      :     the same as the other. A carry
      :     from a LSB is added to the MSB, etc.
      :     On exit A=MSB, carry flag set if
      :     coefficient has increased and there-
      :     fore the exponent must be adjusted.
      :     Zero otherwise. Sum left in C D/E


07C3  * This routine converts a 4 byte negative integer into its ****
      : twos complement positive equivalent so it can be converted
      : to SP state, the SP sign flag (4125) is also
      : complemented. This will insure a negative coefficient after
      : normalization.


07D7  * **************************************************************


07F6  : Integer portion left in C/D/E. Fractional part left in B.
07F8  * **************************************************************
```

```
07FD AA        XOR    D              --- 07FD - 0800 = .5988
07FE 56        LD     D,(HL)         ---
07FF 19        ADD    HL,DE          ---
0800 80        ADD    A,B            --- 0801 - 0804 = .96145
0801 F1        POP    AF             ---
0802 227680    LD     (8076H),HL     --- 0805 - 0808 = 2.88539
0805 45        LD     B,L            ---
0806 AA        XOR    D              ---
0807 3882      JR     C,078BH        ---
0809 CD5509    CALL   0955H          --- Test sign of current SP number **** LOG routine **
080C B7        OR     A              --- Set status flags according to sign   : see note-->
080D EA4A1E    JP     PE,1E4AH       --- Error if value is negative
0810 212441    LD     HL,4124H       --- HL = addr of exponent of current value
0813 7E        LD     A,(HL)         --- A = exponent of current value
0814 013580    LD     BC,8035H       --- BC/DE = .707092
0817 11F304    LD     DE,04F3H       --- (approx in 2)
081A 90        SUB    B              --- Scale value so it's <1
081B F5        PUSH   AF             --- Save scale factor
081C 70        LD     (HL),B         --- Force exponent of current value to be same as
081D D5        PUSH   DE             --- constant in BC/DE
081E C5        PUSH   BC             --- Save constant in BC/DE on stack
081F CD1607    CALL   0716H          --- Add constant in BC/DE to current value
0822 C1        POP    BC             --- Restore constant
0823 D1        POP    DE             --- into BC/DE
0824 04        INC    B              --- Bump exponent. Multiply constant by 2**1 or
0825 CDA208    CALL   08A2H          --- Divide 1.4141 (approx in 4) by scaled value +
0828 21F807    LD     HL,07F8H       --- HL = add of SP 1.0                         : 1n 2
082B CD1007    CALL   0710H          --- Load BC/DE with 1.0 and subtract from current
082E 21FC07    LD     HL,07FCH       --- Addr of table of 3 S.P. values              :value
0831 CD9A14    CALL   149AH          --- Call series routine to evaluate sum         cont-->
0834 018080    LD     BC,8080H       --- BC = -.5
0837 110000    LD     DE,0000H       ---
083A CD1607    CALL   0716H          --- Add (-.5) to current value
083D F1        POP    AF             --- Restore scale factor from 81A above
083E CD890F    CALL   0F89H          --- Scale current value to original magnitude
0841 013180    LD     BC,8031H       --- Load BC/DE with .693115
0844 111872    LD     DE,7218H       --- then multiply sum from series by .693115
0847 CD5509    CALL   0955H          --- Test sign & exponent ****************** cont--> *
084A C8        RET    Z              --- Exit if exponent is zero
084B 2E00      LD     L,00H          --- L = 00 means add exponents
084D CD1409    CALL   0914H          --- Add exponents together. Set most sig bit of MSB
0850 79        LD     A,C            --- for each value.
0851 324F41    LD     (414FH),A      --- 414F = MSB of register value
0854 EB        EX     DE,HL          ---
0855 225041    LD     (4150H),HL     --- 4150 - 4151 = next MSB of register value
0858 010000    LD     BC,0000H       --- BC = 00
085B 50        LD     D,B            --- DE = 00
085C 58        LD     E,B            ---
085D 216507    LD     HL,0765H       --- Integer to SP conversion called after
0860 E5        PUSH   HL             --- multiplication to convert result to SP.
0861 216908    LD     HL,0869H       --- We will go there after unpacking the SP
0864 E5        PUSH   HL             --- numbers. Now, put 869 on stack twice so
0865 E5        PUSH   HL             --- we'll unpack each SP number.
0866 212141    LD     HL,4121H       --- HL = address of current value
0869 7E        LD     A,(HL)         --- Test LSB for zero
086A 23        INC    HL             --- HL = addr. of next MSB
086B B7        OR     A              --- A = LSB of current SP value
086C 2824      JR     Z,0892H        --- Jmp if LSB is zero (do a circular           cont-->
086E E5        PUSH   HL             --- Save addr of next MSB
086F 2E08      LD     L,08H          --- L = count of bits to right shift            cont-->
```

```
0809  * ************************************************************
      * Method used:
      * 1. Test sign of value. If negative exit with FC error.
      * 2. Scale the value so it is between 0.5 and 1. Save the
      *    count of bits used for scaling
      * 3. Recompute scaled value as
      *    x = 1 - (2 In 2 / ( x + In 2))
      * 4. Evaluate
      *    ((x**2 * c0 + cl) x**2 + c2)x
      * 5. Subtract 0.5 from final term of series
      * 6. Add the shift count to the result of step 5
      * 7. Multiply result of step 6 by In 2
```

```
      : of coeff. (I)*value(I)**2I+2 for I=-2
```

```
0847  * of current SP number ****************************************
      : Single precision multiplication -------
      : Multiply BC/DE by current value. Use shift and add method.
      : Unpack each number first then we shift and add.
```

```
086C  : right shift of one byte) then go get next byte.

086E  : SP number ( or until it's right justified
```

```
0871 1F        RRA                   <--: Right shift LSB 1 position
0872 67        LD     H,A             • : Save shifted LSB
0873 79        LD     A,C             • : Load MSB into A
0874 300B      JR     NC,0881H        • : Jmp there when no one bit shifted from LSB
0876 E5        PUSH   HL              • : else save shifted LSB and count
0877 2A5041    LD     HL,(4150H)      • : Addr of middle & LSB bytes of orig register value
087A 19        ADD    HL,DE           • : Add to total thus far far (compound add)
087B EB        EX     DE,HL           • : and leave sum in proper register
087C E1        POP    HL              • : Restore shifted LSB and shift count
087D 3A4F41    LD     A,(414FH)       • : then add MSB of original register value
0880 89        ADC    A,C             • : to the accumulated total
0881 1F        RRA                    • : Right shift MSB
0882 4F        LD     C,A             • : Save shifted MSB                      see notes-->
0883 7A        LD     A,D             • : Load middle byte so
0884 1F        RRA                    • : we can right shift it 1 bit
0885 57        LD     D,A             • : Save shifted middle byte
0886 7B        LD     A,E             • : Load LSB and
0887 1F        RRA                    • : right shift it 1 bit
0888 5F        LD     E,A             • : then move it back
0889 78        LD     A,B             • : Load exponent
088A 1F        RRA                    • : Right shift it
088B 47        LD     B,A             • : and restore it
088C 2D        DEC    L               • : Decrement count of bits tested
088D 7C        LD     A,H             • : Restore original LSB value to A
088E 20E1      JR     NZ,0871H       -->: Loop till all 8 bits tested
0890 E1        POP    HL             --- Restore HL to addr. of next byte
0891 C9        RET                   --- And rtn
0892 43        LD     B,E            ***************************************** see note--> *
0893 5A        LD     E,D            ---    Left circular shift BC/DE one byte. B is
0894 51        LD     D,C            ---    lost and C is replaced by A. Shift appears
0895 4F        LD     C,A            ---    as follows: A  BC/DE
0896 C9        RET                   ---    A->C C->D D->E E->B
0897 CDA409    CALL   09A4H          --- Move value in WRA1 onto stack
089A 21D80D    LD     HL,0DD8H       --- Addr of floating pt. 10.
089D CDB109    CALL   09B1H          --- Load flt. pt. 10 into BC/DE and move into
08A0 C1        POP    BC             --- Reload original value      :(4121 - 4124)
08A1 D1        POP    DE             --- of WRA1 into BC/DE
08A2 CD5509    CALL   0955H          --- Single precision division routine ****** cont--> *
08A5 CA9A19    JP     Z,199AH        --- Error - division by zero attempted
08A8 2EFF      LD     L,0FFH         --- L = FF means subtract exponents
08AA CD1409    CALL   0914H          --- Compute new exponent by addition. Set most sig.
08AD 34        INC    (HL)           --- bit of each value, ret sign of result in 4125.
08AE 34        INC    (HL)           --- Add 2 to exponent of dividend
08AF 2B        DEC    HL             --- HL = 4123 = MSB of current value
08B0 7E        LD     A,(HL)         --- Load MSB of value in WRA1
08B1 328940    LD     (4089H),A      --- 4089 = MSB of current value
08B4 2B        DEC    HL             --- HL = addr of next most sig byte
08B5 7E        LD     A,(HL)         --- A = next most sig byte
08B6 328540    LD     (4085H),A      --- 4085 = most sig byte of current value
08B9 2B        DEC    HL             --- HL = addr of least sig byte
08BA 7E        LD     A,(HL)         --- Load LSB and move it to
08BB 328140    LD     (4081H),A      --- 4081 = next most sig byte of current value
08BE 41        LD     B,C            --- B = most sig byte of register value
08BF EB        EX     DE,HL          --- DE = 4122, HL = MSB/LSB register value
08C0 AF        XOR    A              --- now, set
08C1 4F        LD     C,A            --- MSB, next MSB
08C2 57        LD     D,A            --- LSB of register value
08C3 5F        LD     E,A            --- to zero
08C4 328C40    LD     (408CH),A      --- Zero count of times doubling B/HL overflows
08C7 E5        PUSH   HL             --- Save divisor in BC/HL on stack
```

```
:     Examine current value for ones by using a
:     right shift and test carry method. For
:     each one bit found, add the register value
:      (now in 414F - 4151) to the current value
:     repeat process until all bits positions in
:     current value have been tested.



:     Get MSB register value and add to MSB
:     current value, then continue.

:     Right justify current value in registers to get
:     integer equivalent of value. Right shift
:     D/E. Shift D first, bit 1 goes to carry
:     which will be picked up when E is shifted.
:     Result is left in BC/DE as an un-normalized
:     floating point number. 4124 (exponent of
:     current value holds adjusted exponent).




0892  * Called by single precision multiplying *********************
      : while unpacking SP numbers before multiplying them


0897  * ************************************************************


08A2  * Test sign of value in WRA1 **********************************
```

```
08C8 C5         PUSH    BC            --- BC = most sig byte of reg value/00
08C9 7D         LD      A,L           --- A=LSB register value. Now compute dividend-divisor
08CA CD8040     CALL    4080H         --- Subtract current value from reg. value     cont-->
08CD DE00       SBC     A,00H         --- On exit A=0, carry=1 if reg value<current value
08CF 3F         CCF                   --- Reset carry so carry=1 if reg value>current value
08D0 3007       JR      NC,08D9H      --->: Jmp if reg value<current value. Go double
08D2 328C40     LD      (408CH),A     --  : Save count of times B/HL overflows      :divisor
08D5 F1         POP     AF            --  : Clear last division from stack
08D6 F1         POP     AF            --  : We didn't need it
08D7 37         SCF                   --  : Set carry flag.
08D8 D2C1E1     JP      NC,0E1C1H     <---:        8D9: POP BC       Restore last divisor so
08DB 79         LD      A,C           ---          8DA: POP HL       We can double it
08DC 3C         INC     A             --- but first test for possible overflow
08DD 3D         DEC     A             --- by division out of HL into BC
08DE 1F         RRA                   --- Test bit 0 of C, if it is on
08DF FA9707     JP      M,0797H       --- Done: Go normalize result
08E2 17         RLA                   --- Clear possible CARRY ON
08E3 7B         LD      A,E           --- Shift E left one position.                  cont-->
08E4 17         RLA                   --- Pick up bit 8 of A-reg,
08E5 5F         LD      E,A           --- Restore shifted E. Most sig. bit in CARRY
08E6 7A         LD      A,D           --- Shift D left one position
08E7 17         RLA                   --- Pick up bit 8 from E becomes bit 0 of D
08E8 57         LD      D,A           --- Restore shifted D. Most sig. bit in CARRY
08E9 79         LD      A,C           --- Shift C left one position
08EA 17         RLA                   --- Pick up bit 8 from D becomes bit 0 of C
08EB 4F         LD      C,A           --- Restore shifted C
08EC 29         ADD     HL,HL         --- Now, double the divisor so that eventually it
08ED 78         LD      A,B           --- will exceed the dividend. When it does, the
08EE 17         RLA                   --- quotient plus reminder will be in B/HL as reg.
08EF 47         LD      B,A           --- values. Carry any overflow from shifting HL left
08F0 3A8C40     LD      A,(408CH)     --- one place to B. Then shift B left one place. Keep
08F3 17         RLA                   --- count of overflow amt of B in 408C as a bit
08F4 328C40     LD      (408CH),A     --- string. i.e. the number of ones equals the
08F7 79         LD      A,C           --- number of times overflow occurred
08F8 B2         OR      D             --- now combine all bytes
08F9 B3         OR      E             --- of the register value and
08FA 20CB       JR      NZ,08C7H      --- loop until divisor overflows
08FC E5         PUSH    HL            --- Save HL
08FD 212441     LD      HL,4124H      --- Exponent of saved value
0900 35         DEC     (HL)          --- Decrement it by 1 for: (A**X)/(B**Y)=(A/B)**(X-Y)
0901 E1         POP     HL            --- Restore HL
0902 20C3       JR      NZ,08C7H      --- Continue with shift and decrement loop
0904 C3B207     JP      07B2H         --- OV error (exponent has gone to zero)
0907 3EFF       LD      A,0FFH        --- Computes new exponent for flt. pt. multiplication*
0909 2EAF       LD      L,0AFH        --- 090A: XOR A Zero A, clear flags
090B 212D41     LD      HL,412DH      --- HL = addr of MSB for WRA2 DP value
090E 4E         LD      C,(HL)        --- C = MSB, saved value                 : see note -->
090F 23         INC     HL            --- HL = addr of exponent for WRA2 DP value
0910 AE         XOR     (HL)          --- Make exp pos/neg depending on entry used
0911 47         LD      B,A           --- Save exponent in B
0912 2E00       LD      L,00H         --- Mask for testing exponent sign of WRA1 (force
0914 78         LD      A,B           --- Ref etch exponent & test for zero : sign +)
0915 B7         OR      A             --- Set status flags
0916 281F       JR      Z,0937H       --- WRA1 value is zero
0918 7D         LD      A,L           --- Not zero. Get exponent for WRA1 value
0919 212441     LD      HL,4124H      --- Which we already know is non-zero
091C AE         XOR     (HL)          --- Combine sign of exp WRA1 with mask      cont --> *
091D 80         ADD     A,B           --- Now, add the exponents for the two values to be
091E 47         LD      B,A           --- multiplied and save in B-reg. Addition should
091F 1F         RRA                   --- produce a carry. Now test for presence.
```

```
08CA  : (4081-4089). Result in B/HL
```

```
0813  : Shift C/D/E left as one unit. Bits carried out of E are
      : shifted into D, etc.
```

```
0907  * ************************************************************

      : When entered at 0917 it is the callers
      : responsibility to load the L register
      : according to the sign of the value
      : in WRA1. L = 0 if WRA1 >= 0,
      : L = FF if WRA1 < 0
```

```
091C  * in L. Note : The second entry at 0917
```

```
0920 A8       XOR    B          --- Of carry by shifting it into bit 8 and doing
0921 78       LD     A,B        --- an exclusive OR with new exponent      see note->
0922 F23609   JP     P,0936H    --- Jmp if sum of exponent is out of range
0925 C680     ADD    A,80H      --- Reload new exponent into A and turn on bit 8
0927 77       LD     (HL),A     --- Store new exponent
0928 CA9008   JP     Z,0890H    --- Jmp if value is exactly zero
092B CDDF09   CALL   09DFH      --- Turn on MSB of current value so it can be
092E 77       LD     (HL),A     --- unpacked for repetitive addition.
092F 2B       DEC    HL         --- HL = next most sig byte
0930 C9       RET               --- Return to caller
0931 CD5509   CALL   0955H      --- Go test sign of floating pt. number in WRA1 ******
0934 2F       CPL               --- Reverse the results so A = minus if value +, and
0935 E1       POP    HL         --- is positive if value is minus.
0936 B7       OR     A          --- Set status flags according to new exponent
0937 E1       POP    HL         --- Clear stack
0938 F27807   JP     P,0778H    --- Set current floating point value to zero & return
093B C3B207   JP     07B2H      --- OV error exit
093E CDBF09   CALL   09BFH      --- Load a SP no. from 4121 - 4124 ***** see note--> *
0941 78       LD     A,B        --- B = Exponent, C = MSB, D = Next MSB, E = LSB
0942 B7       OR     A          --- Set status flags according to new exponent
0943 C8       RET    Z          --- Exit if number is zero
0944 C602     ADD    A,02H      --- Multiply number in registers by 4
0946 DAB207   JP     C,07B2H    --- Error if exponent overflows
0949 47       LD     B,A        --- Restore adjusted exponent
094A CD1607   CALL   0716H      --- Add original value which gives value * 5
094D 212441   LD     HL,4124H   --- 4124 = addr of exp of result. By adding 1 to
0950 34       INC    (HL)       --- it we double it which gives us the original
0951 C0       RET    NZ         --- value * 10
0952 C3B207   JP     07B2H      --- OV error exit
0955 3A2441   LD     A,(4124H)  --- Test sign of SP number. On exit A=-1 if negative
0958 B7       OR     A          --- Set status flags for exponent : A=+1 if positive
0959 C8       RET    Z          --- Exit if exponent is zero
095A 3A2341   LD     A,(4123H)  --- No, get MSB of SP number
095D FE2F     CP     2FH        --- 095E : CPL A
095F 17       RLA               --- Sign bit to carry
0960 9F       SBC    A,A        --- Gives 0 - sign bit
0961 C0       RET    NZ         --- Return with A = all 1'S if MSB negative
0962 3C       INC    A          --- Return with A = +1 if MSB positive
0963 C9       RET               --- Rtn to caller
0964 0688     LD     B,88H      --- B = 80 + number of bits to convert ***************
0966 110000   LD     DE,0000H   --- Zero register used in normalization routine
0969 212441   LD     HL,4124H   --- Addr of exponent for WRA1
096C 4F       LD     C,A        --- C = MSB of integer
096D 70       LD     (HL),B     --- Save initial exponent
096E 0600     LD     B,00H      --- B must be zero before entering       see note-->
0970 23       INC    HL         --- Normalization routine. Bump
0971 3680     LD     (HL),80H   --- to sign word of WRA1 rtn it positive
0973 17       RLA               --- Set CARRY to sign of integer value
0974 C36207   JP     0762H      --- Go normalize
0977 CD9409   CALL   0994H      --- Convert a negative value *************** cont--> *
097A F0       RET    P          --- Rtn if positive, else determine data type
097B E7       RST    20H        --- Test data type
097C FA5B0C   JP     M,0C5BH    --- Integer, convert to + value,              cont-->
097F CAF60A   JP     Z,0AF6H    --- TM error if Z
0982 212341   LD     HL,4123H   --- We have a SP, or a DP number. Make it positive
0985 7E       LD     A,(HL)     --- by setting the sign bit (bit 8) of the MSB to
0986 EE80     XOR    80H        --- zero. Set current value to zero if current
0988 77       LD     (HL),A     --- value is +, all ones otherwise
0989 C9       RET               --- Rtn to caller
098A CD9409   CALL   0994H      --- Go test sign of current value ****** see note--> *
```

```
0921  : (Which should have bit 8 zero since it produced the carry
      : we're testing.)

0931  * ***********************************************************

093E  * Multiply a SP number by 10 *********************************
      : First, add 2 to exponent which is equivalent to multiplying
      : by 4 then add the original quantity which yields value * 5.

0964 * ************************************************************

      :     Start of integer to SP conversion.
      :     Store exponent bits in 4124.
      :     Set sign flag (4125) for positive
      :     coefficient. Set C = MSB,
      :     D = LSB of integer. Set carry to
      :     Sign of MSB. Call normalization
      :     routine. If entered at 0969 B must
      :     be set to 80 + no of bits in integer value
0977  * to its positive equivalent ***---Test sign of current value *

097C  : SP if it has overflowed & rtn to caller

098A  * A = +1 if positive, all ones if negative. ******************
```

```
098D 6F         LD     L,A           --- Set up HL as follows: HL = 00 00 if current value
098E 17         RLA                  --- if positive. HL = FF FF if current val is negative
098F 9F         SBC    A,A           --- gives A=0 if carry is zero or A=FF if
0990 67         LD     H,A           --- CARRY is set. Move flag to H
0991 C39A0A     JP     0A9AH         --- Save HL as current value,                   cont-->
0994 E7         RST    20H           --- Determine current data type ************ cont--> *
0995 CAF60A     JP     Z,0AF6H       --- TM error if Z (string)
0998 F25509     JP     P,0955H       --- Jump if SP or DP. Determine sign & rtn to caller
099B 2A2141     LD     HL,(4121H)    --- Load integer value in HL
099E 7C         LD     A,H           --- Combine LSB and MSB in
099F B5         OR     L             --- order to test if zero
09A0 C8         RET    Z             --- Exit if integer value zero
09A1 7C         LD     A,H           --- A = MSB of integer
09A2 18BB       JR     095FH         --- Go test sign & rtn to caller                  cont-->
09A4 EB         EX     DE,HL         --- ***********************************************
09A5 2A2141     LD     HL,(4121H)    --- Save HL
09A8 E3         EX     (SP),HL       --- Value to be moved onto stack
09A9 E5         PUSH   HL            --- Rtn addr to HL, stack = (4121)
09AA 2A2341     LD     HL,(4123H)    --- Rtn addr to stack
09AD E3         EX     (SP),HL       --- 2nd value to be moved onto stack
09AE E5         PUSH   HL            --- Rtn addr back to stack
09AF EB         EX     DE,HL         --- Restore HL
09B0 C9         RET                  --- Rtn to caller
09B1 CDC209     CALL   09C2H         --- Load a SP no. pointed to by HL into BC/DE. *******
09B4 EB         EX     DE,HL         --- Then move it to WRA1 value area. On exit
09B5 222141     LD     (4121H),HL    --- save HL (points to byte following exponent). On
09B8 60         LD     H,B           --- exit, B = exponent, C = MSB, D = next MSB, E =
09B9 69         LD     L,C           --- LSB, HL = addr of byte following exponent.
09BA 222341     LD     (4123H),HL    --- Save LSB and next LSB in WRA1
09BD EB         EX     DE,HL         --- Restore HL to original contents
09BE C9         RET                  --- Return to caller
09BF 212141     LD     HL,4121H      --- Load a SP number from 4121 - 4124 or addr in HL **
09C2 5E         LD     E,(HL)        --- E = LSB (4121)                            :see note -->
09C3 23         INC    HL            --- Bump to next byte
09C4 56         LD     D,(HL)        --- D = next MSB (4122)
09C5 23         INC    HL            --- Bump to next byte
09C6 4E         LD     C,(HL)        --- C = MSB (4123)
09C7 23         INC    HL            --- Bump to next byte
09C8 46         LD     B,(HL)        --- B = exponent (4124)
09C9 23         INC    HL            --- Bump to byte following exponent
09CA C9         RET                  --- Rtn to caller
09CB 112141     LD     DE,4121H      --- Source address of a SP number ********** cont--> *
09CE 0604       LD     B,04H         --- Number of bytes to remove
09D0 1805       JR     09D7H         --- Move to address specified in HL and rtn to caller
09D2 EB         EX     DE,HL         --- Move routine ********************** see note--> *
09D3 3AAF40     LD     A,(40AFH)     --- Get type specification (which is also the length
09D6 47         LD     B,A           --- Length of field to move
09D7 1A         LD     A,(DE)        --- Load a byte from source field
09D8 77         LD     (HL),A        --- Store it in destination field           see note-->
09D9 13         INC    DE            --- Bump source addr
09DA 23         INC    HL            --- Bump destination addr
09DB 05         DEC    B             --- Count 1 byte moved
09DC 20F9       JR     NZ,09D7H      --- Jmp if more bytes to move
09DE C9         RET                  --- else rtn to caller
09DF 212341     LD     HL,4123H      --- Turn on most significant bit of a SP number ******
09E2 7E         LD     A,(HL)        --- Get MSB
09E3 07         RLCA                 --- Bit 7 to CARRY
09E4 37         SCF                  --- Turn on bit 7 and reposition number, also original
09E5 1F         RRA                  --- sign bit to CARRY.
09E6 77         LD     (HL),A        --- Restore number with MSB on
```

```
0991  : rtn type to integer & return to caller.
0994  * Test sign of current numeric value: on entry A = +1
      : if positive or all ones if negative.

09A2  : on rtn A = all 1'S (negative), +1 (positive)
09A4  * Store 4121 - 4124 (WRA1) on stack **************************

09B1  * ************************************************************

09BF  * ************************************************************
      * 09BF: This entry point loads a SP number
      * from WRA1 into BC/DE
      * 09C2: This entry point loads a SP number
      * pointed to by HL into BC/DE.

      *     On entry HL points to the LSB of a SP value
      *     On exit HL points to the byte following the exponent

09CB  * Move a SP no. from (HL) to 4121 - 4124 *********************

09D2  * Entry pt. when HL = source addr & DE = dest. addr. **********

      :     Move number of bytes in type/
      :     length specification from
      :     location given in DE to address
      :     specified in HL.

09DF  * ************************************************************
```

```
09E7 3F        CCF                  --- Complement bit zero and position it into bit 7
09E8 1F        RRA                  --- (sign & MS bit) of MSB
09E9 23        INC    HL            --- HL = 4125 = sign of result -determined below
09EA 23        INC    HL            --- Gives HL - 4125
09EB 77        LD     (HL),A        --- Save complement of original sign in 4125
09EC 79        LD     A,C           --- Turn on most significant bit of most significant
09ED 07        RLCA                 --- byte for the SP value in BC/DE
09EE 37        SCF                  --- then force CARRY so we can
09EF 1F        RRA                  --- restore byte with bit 7 = 1, original sign bit to
09F0 4F        LD     C,A           --- Restore C = MSB                               :CARRY
09F1 1F        RRA                  --- Original sign bit to bit 7 set sign flag as
09F2 AE        XOR    (HL)          --- sign of both #'s equal, then
09F3 C9        RET                  --- 4125 = 80, else 00.
09F4 212741    LD     HL,4127H      --- Destination addr for numeric value of variable ***
09F7 11D209    LD     DE,09D2H      --- Return addr
09FA 1806      JR     0A02H         --- Move value in WRA1 to WRA2
09FC 212741    LD     HL,4127H      --- Addr of WRA2
09FF 11D309    LD     DE,09D3H      --- Move value in WRA1 to WRA2
0A02 D5        PUSH   DE            --- Force rtn addr to 9D3                    see note-->
0A03 112141    LD     DE,4121H      --- Addr of current variable in WRA1
0A06 E7        RST    20H           --- Determine data type of variable
0A07 D8        RET    C             --- Exit to move routine if INT, STR, or SP
0A08 111D41    LD     DE,411DH      --- Addr of double precision variable
0A0B C9        RET                  --- Exit to move routine
0A0C 78        LD     A,B           --- Compare a SP number in BC/DE with ****** cont--> *
0A0D B7        OR     A             --- Test exponent of register value
0A0E CA5509    JP     Z,0955H       --- Jump if exponent (and rest of number) are zero.
0A11 215E09    LD     HL,095EH      --- Rtn addr when exiting from this routine
0A14 E5        PUSH   HL            --- To stack
0A15 CD5509    CALL   0955H         --- Test sign of MSB of SP number. A = MSB of SP
0A18 79        LD     A,C           --- number in registers.
0A19 C8        RET    Z             --- Exit if (4121 - 4124) does not hold a SP number
0A1A 212341    LD     HL,4123H      --- Addr of MSB of WRA1 value
0A1D AE        XOR    (HL)          --- Compare MSB of (4121) to MSB of value in register
0A1E 79        LD     A,C           --- Reload MSB of register value
0A1F F8        RET    M             --- Exit if signs are different
0A20 CD260A    CALL   0A26H         --- Compare SP mo. in BC/DE with that in 4121 - 4124.
0A23 1F        RRA                  --- Get CARRY flag from comparison and combine with
0A24 A9        XOR    C             --- sign bit of value in registers.
0A25 C9        RET                  --- Rtn to caller
0A26 23        INC    HL            --- HL = addr of exponent WRA1 *********************
0A27 78        LD     A,B           --- A = exponent of register value
0A28 BE        CP     (HL)          --- Compare exponents
0A29 C0        RET    NZ            --- Exit if different                :
0A2A 2B        DEC    HL            --- Gives addr of MSB for WRA1       :
0A2B 79        LD     A,C           --- A=MSB of register value          :
0A2C BE        CP     (HL)          --- Compare MSB                      :     see note-->
0A2D C0        RET    NZ            --- Exit if not equal                :
0A2E 2B        DEC    HL            --- Gives addr of middle for WRA1    :
0A2F 7A        LD     A,D           --- A = middle byte of reg value     :
0A30 BE        CP     (HL)          --- Compare next most MSB            :
0A31 C0        RET    NZ            --- Exit if unequal
0A32 2B        DEC    HL            --- Gives addr of LSB for WRA1
0A33 7B        LD     A,E           --- A = LSB of register value
0A34 96        SUB    (HL)          --- Compare LSB of values. Exit if not equal
0A35 C0        RET    NZ            --- Exit if not equal
0A36 E1        POP    HL            --- Numbers are equal
0A37 E1        POP    HL            --- Clear 095E from stack and
0A38 C9        RET                  --- Rtn to caller of 0A0C
0A39 7A        LD     A,D           --- Prepare to test signs ** Compare integer values **
```

```
09F4  * ***********************************************************

0A02 : (Move 4DAF bytes from 4121 to 4127)

0A0C  * One in 4121 - 4124. Signs must be alike. On exit negative
      : if signs unlike or quantity in memory > value in registers.

0A26  * ***********************************************************

0A29  : Compare a SP no. in BC/DE with a SP no. in 4121 - 4124 must
      : have same signs. Do not compare exponents. Begin by com-
      : paring the exponent of each number, working down to the LSB.
      : Exit as soon as a mix-match if found. HL = addr of byte
      : that mis-compared. If the numbers are
      : Identical exit with HL = 411F, A = 0, FLAGS = 0.
      : If unequal C = 0 (memory) = or < register value
      :            C = 1 (memory) > register value

0A39  * ***********************************************************
```

```
0A3A AC         XOR    H             --- Compare sign of D to sign of H         see note-->
0A3B 7C         LD     A,H           --- Prepare for subtraction
0A3C FA5F09     JP     M,095FH       --- Jmp if signs unequal
0A3F BA         CP     D             --- Else, compare MSB's
0A40 C26009     JP     NZ,0960H      --- Jmp if unequal
0A43 7D         LD     A,L           --- Prepare to compare LSB of integer
0A44 93         SUB    E             --- Compare LSB's
0A45 C26009     JP     NZ,0960H      --- Jmp it unequal
0A48 C9         RET                  --- Rtn - Values are equal. A=00
0A49 212741     LD     HL,4127H      --- Addr of WRA1 value **** Compare two DP values ****
0A4C CDD309     CALL   09D3H         --- Move value pointed to by saved location 4127-412E
0A4F 112E41     LD     DE,412EH      --- Now get addr of the exponent for the value moved
0A52 1A         LD     A,(DE)        --- Load the exponent
0A53 B7         OR     A             --- Set status flags according to exponent
0A54 CA5509     JP     Z,0955H       --- If exponent zero, test sign of MSB & rtn to caller
0A57 215E09     LD     HL,095EH      --- Push rtn addr of 95E onto stack in case WRA1 and
0A5A E5         PUSH   HL            --- WRA2 values not equal
0A5B CD5509     CALL   0955H         --- Test WRA1 value for zero. Skip if zero at 0A61
0A5E 1B         DEC    DE            --- DE = addr of MSB of moved value
0A5F 1A         LD     A,(DE)        --- Load MSB
0A60 4F         LD     C,A           --- and move it to C
0A61 C8         RET    Z             --- Exit if MSB of WRA1 value is zero
0A62 212341     LD     HL,4123H      --- HL = addr of MSB for current value
0A65 AE         XOR    (HL)          --- Compare sign of moved & current values
0A66 79         LD     A,C           --- Restore MSB of WRA2 value (moved value)
0A67 F8         RET    M             --- Exit if signs different
0A68 13         INC    DE            --- DE = current value exponent addr
0A69 23         INC    HL            --- HL = saved value exponent addr
0A6A 0608       LD     B,08H         --- Prepare to compare current and saved values
0A6C 1A         LD     A,(DE)        <--: Begin comparing values byte for byte
0A6D 96         SUB    (HL)            • : by subtracting WRA1 from WRA2
0A6E C2230A     JP     NZ,0A23H        • : Jump if unequal
0A71 1B         DEC    DE              • : Backspace WRA2 1 byte
0A72 2B         DEC    HL              • : Backspace WRA1 1 byte
0A73 05         DEC    B               • : Count number of bytes compared
0A74 20F6       JR     NZ,0A6CH      ---> Loop till all bytes compared
0A76 C1         POP    BC            --- Values are equal, clear rtn addr of 95E from stack
0A77 C9         RET                  --- and rtn to caller
0A78 CD4F0A     CALL   0A4FH         --- Compare current to saved value ***** see note--> *
0A7B C25E09     JP     NZ,095EH      --- Set status flag if unequal
0A7E C9         RET                  --- Equal. Return with A=00, status = 0
0A7F E7         RST    20H           --- Test data type **************** CINT routine ****
0A80 2A2141     LD     HL,(4121H)    --- HL = addr of LSB of SP value in WRA1
0A83 F8         RET    M             --- Already an integer
0A84 CAF60A     JP     Z,0AF6H       --- TM error if Z (string)
0A87 D4B90A     CALL   NC,0AB9H      --- If double precision, call CSGN
0A8A 21B207     LD     HL,07B2H      --- Address of OV error routine becomes
0A8D E5         PUSH   HL            --- Rtn addr in case of error
0A8E 3A2441     LD     A,(4124H)     --- Get exponent of current value in WRA1
0A91 FE90       CP     90H           --- and test if > 16                        : 16 bits)
0A93 300E       JR     NC,0AA3H      --->: Jump if exponent>16 (integer has more than
0A95 CDFB0A     CALL   0AFBH         --  : Convert A +SP number to its integer equivalent
0A98 EB         EX     DE,HL         --  : Integer value in DE to HL
0A99 D1         POP    DE            --  : Clear error rtn or addition operand from stack
0A9A 222141     LD     (4121H),HL    --  : Return integer value in HL to WRA1
0A9D 3E02       LD     A,02H         --  : Integer flag
0A9F 32AF40     LD     (40AFH),A     --  : Set data type to integer
0AA2 C9         RET                  --  : Rtn to original caller
0AA3 018090     LD     BC,9080H      <---: BC/DE = -2**16 ******************************
0AA6 110000     LD     DE,0000H      --- in SP format
```

```
0A3A  : Compare integer values in DE/HL. If signs are unlike, rtn
      : with status of -1. If DEAL then rtn A=-1, if DEAL then
      : A=+1, if DE=HL then A=00.



0A49  * ***********************************************************



0A78  * Compare two DP values **************************************

0A7F  * ***********************************************************



0AA3  * ***********************************************************
```

```
0AA9 CD0C0A    CALL   0A0CH         --- Compare current value to -2**16
0AAC C0        RET    NZ            --- If values not identical exit
0AAD 61        LD     H,C           --- If so, set current value to integer,-2**16
0AAE 6A        LD     L,D           --- and rtn to caller
0AAF 18E8      JR     0A99H         --- Rtn type to integer, value to 8000, & return
0AB1 E7        RST    20H           --- Test data type ************* CSNG routine ********
0AB2 E0        RET    PO            --- Already single
0AB3 FACC0A    JP     M,0ACCH       --- Jump if integer
0AB6 CAF60A    JP     Z,0AF6H       --- TM error if Z (string)
0AB9 CDBF09    CALL   09BFH         --- Load a first half of DP value from WRA1 into BC/DE
0ABC CDEF0A    CALL   0AEFH         --- Flag current value as single precision
0ABF 78        LD     A,B           --- Get exponent for DP value
0AC0 B7        OR     A             --- Set status flags
0AC1 C8        RET    Z             --- Test exponent, exit if zero (DP value is zero)
0AC2 CDDF09    CALL   09DFH         --- Turn on MSB of value in WRA1 & register value
0AC5 212041    LD     HL,4120H      --- HL = middle addr of DP value in WRA1
0AC8 46        LD     B,(HL)        --- Load middle part of DP. Value becomes LSB
0AC9 C39607    JP     0796H         --- Convert reg part of DP no to SP value & rtn
0ACC 2A2141    LD     HL,(4121H)    --- Convert integer to single precision ************
0ACF CDEF0A    CALL   0AEFH         --- Flag WRA1 as SP
0AD2 7C        LD     A,H           --- A = MSB of integer
0AD3 55        LD     D,L           --- D = LSB of integer
0AD4 1E00      LD     E,00H         --- E = Rest of value (equals zero)
0AD6 0690      LD     B,90H         --- B = initial max exponent
0AD8 C36909    JP     0969H         --- Go normalize then rtn to caller
0ADB E7        RST    20H           --- Test data type *************** See note --> ****
0ADC D0        RET    NC            --- Already double
0ADD CAF60A    JP     Z,0AF6H       --- Jump if sting
0AE0 FCCC0A    CALL   M,0ACCH       --- Call if integer (convert integer to SP)
0AE3 210000    LD     HL,0000H      --- Zero last 4 bytes of WRA1
0AE6 221D41    LD     (411DH),HL    --- These bytes hold the
0AE9 221F41    LD     (411FH),HL    --- tail end of a DP value
0AEC 3E08      LD     A,08H         --- Double precision flag
0AEE 013E04    LD     BC,043EH      --- 0AEF  LD  A,04  Single precision flag
0AF1 C39F0A    JP     0A9FH         --- Store A in type flag & return
0AF4 E7        RST    20H           --- Test data type********************************
0AF5 C8        RET    Z             --- Return with no error message if a string
0AF6 1E18      LD     E,18H         --- TM error code if not a string
0AF8 C3A219    JP     19A2H         --- Output TM error message
0AFB 47        LD     B,A           --- Convert a positive SP number to integer **********
0AFC 4F        LD     C,A           --- Move exponent from A to BC,
0AFD 57        LD     D,A           --- D
0AFE 5F        LD     E,A           --- and E
0AFF B7        OR     A             --- Test value of exponent
0B00 C8        RET    Z             --- Exit if value of number is zero
0B01 E5        PUSH   HL            --- Save error rtn addr
0B02 CDBF09    CALL   09BFH         --- Load current SP value into BC/DE
0B05 CDDF09    CALL   09DFH         --- Prepare current value and register value for
0B08 AE        XOR    (HL)          --- arithmetic operation                   see note-->
0B09 67        LD     H,A           --- H = sign of value. Bit 8 = 0 if +, 1 if -
0B0A FC1F0B    CALL   M,0B1FH       --- Jmp if value negative
0B0D 3E98      LD     A,98H         --- A = max. exponent allowed
0B0F 90        SUB    B             --- Exponent - bias = no. of bits to right     cont-->
0B10 CDD707    CALL   07D7H         --- Get integer equivalent of no. in CDE       cont-->
0B13 7C        LD     A,H           --- A = original sign. Bit 8 = 0 if +, 1 if -
0B14 17        RLA                  --- Shift sign into carry
0B15 DCA807    CALL   C,07A8H       --- If neg. convert trailing ones to zeroes
0B18 0600      LD     B,00H         --- Zero exponent
0B1A DCC307    CALL   C,07C3H       --- If number was neg. make it a neg. integer
0B1D E1        POP    HL            --- Restore caller's HL
```

```
0AB1  * **************************************************************






0ACC  * **************************************************************



0ADB  * Convert integer or SP to DP *******************************




0AF4  * **************************************************************

0AFB  * **************************************************************




0B08  : (Turn on most sig. bits and test for same sign).


0B0F  : shift to get integer
0B10  : right justified
```

```
0B1E C9        RET              --- Rtn to caller
0B1F 1B        DEC    DE        --- Decrement middle and LSB of SP value *** cont--> *
0B20 7A        LD     A,D       --- then combine new
0B21 A3        AND    E         --- middle & LSB. If they were zero the       cont-->
0B22 3C        INC    A         --- Test for FFFF (middle & LSB were 0)
0B23 C0        RET    NZ        --- Exit if they were not zero
0B24 0B        DEC    BC        --- Else decrement MSB
0B25 C9        RET              --- Then exit
0B26 E7        RST    20H       --- Determine data type ********* Fix routine ********
0B27 F8        RET    M         --- Finished if an integer
0B28 CD5509    CALL   0955H     --- Test sign of current value (floating point)
0B2B F2370B    JP     P,0B37H   --- Jmp if it's positive
0B2E CD8209    CALL   0982H     --- Clear sign bit of current value (make it +)
0B31 CD370B    CALL   0B37H     --- Convert a SP or DP value to integer. Do not round
0B34 C37B09    JP     097BH     --- Convert integer part of no. back to       cont-->
0B37 E7        RST    20H       --- Convert SP or DP to integer - Determine data type*
0B38 F8        RET    M         --- Done, already an integer
0B39 301E      JR     NC,0B59H  --- Jump if double precision
0B3B 28B9      JR     Z,0AF6H   --- TM error if Z (string)
0B3D CD8E0A    CALL   0A8EH     --- Convert from SP to integer & return to caller
0B40 212441    LD     HL,4124H  --- HL = addr of current SP value *******************
0B43 7E        LD     A,(HL)    --- A = exponent of current value
0B44 FE98      CP     98H       --- Test if more than 16 bits in integer position
0B46 3A2141    LD     A,(4121H) --- A = least sig byte of current value
0B49 D0        RET    NC        --- Exit if more than 16 bits in integer position
0B4A 7E        LD     A,(HL)    --- A = exponent                          see note-->
0B4B CDFB0A    CALL   0AFBH     --- Convert SP to integer. This gives integer
0B4E 3698      LD     (HL),98H  --- equivalent of number.
0B50 7B        LD     A,E       --- Now, convert number back to SP
0B51 F5        PUSH   AF        --- Move 8 bits of integer value
0B52 79        LD     A,C       --- From E to A then save it on stk.
0B53 17        RLA              --- Then position sign from bit 8 of C in CARRY then
0B54 CD6207    CALL   0762H     --- Normalize number & adjust exponent
0B57 F1        POP    AF        --- Restore 8 bits of integer value
0B58 C9        RET              --- Rtn to caller.
0B59 212441    LD     HL,4124H  --- Double precision to integer *********************
0B5C 7E        LD     A,(HL)    --- Get exponent
0B5D FE90      CP     90H       --- and compare to bias
0B5F DA7F0A    JP     C,0A7FH   --- Jump if number will have less than 16     cont-->
0B62 2014      JR     NZ,0B78H  --- Jump if number will have more than 16     cont-->
0B64 4F        LD     C,A       --- C = exponent = 90 Number will have 16 bits of int
0B65 2B        DEC    HL        --- Backspace to MSB of WRA1
0B66 7E        LD     A,(HL)    --- A = most sig byte
0B67 EE80      XOR    80H       --- Complement sign bit of MSB
0B69 0606      LD     B,06H     --- Test for a minus zero. If sum of A plus all
0B6B 2B        DEC    HL        --- successive bytes is zero, then value is zero.
0B6C B6        OR     (HL)      --- Backspace to next byte of DP value
0B6D 05        DEC    B         --- Examined all bytes
0B6E 20FB      JR     NZ,0B6BH  --- No, loop
0B70 B7        OR     A         --- Set status flags for OR of all bytes in DP value
0B71 210080    LD     HL,8000H  --- HL = integer - 0
0B74 CA9A0A    JP     Z,0A9AH   --- Rtn value to - 0, type to integer and return to
0B77 79        LD     A,C       --- DP exponent to A-reg                        caller
0B78 FEB8      CP     0B8H      --- Compare to 56(base 10)
0B7A D0        RET    NC        --- Error - more than 56 bits in DP no.
0B7B F5        PUSH   AF        --- Save exponent
0B7C CDBF09    CALL   09BFH     --- Load BC/DE with first part of a DP number
0B7F CDDF09    CALL   09DFH     --- Turn on most sig bit. Determine sign of result
0B82 AE        XOR    (HL)      --- Test sign of value. If + then status = +, else
0B83 2B        DEC    HL        --- HL=4123=MSB current value addr           :negative
```

```
0BlF  * Round down a SP number **************************************

0B21  : result will be FFFF.



0B26  * *************************************************************




0B34  : SP or DP then return
0B37  * *************************************************************



0B40  * *************************************************************



      :     Isolate the integer portion of a SP number.
      :     Leave the integer in the A-register. Convert
      :     the integer to a SP number and leave it in WRA1
      :     returns with NO CARRY if called with a DP value in WRA1.





0B59  * *************************************************************


0B5F  : bits of precision. Use SP to integer conversion routine.
0B62  : bits of precision
```

```
0B84 36B8       LD      (HL),0B8H     --- Max exponent to exponent area
0B86 F5         PUSH    AF            --- Save sign of value
0B87 FCA00B     CALL    M,0BA0H       --- If negative, convert trailing ones to zeroes
0B8A 212341     LD      HL,4123H      --- HL = addr of MSB of DP value
0B8D 3EB8       LD      A,0B8H        --- A = exponent (max) for DP number
0B8F 90         SUB     B             --- Subtract current exponent gives no.       cont-->
0B90 CD690D     CALL    0D69H         --- Unpack and right justify value
0B93 F1         POP     AF            --- Restore sign
0B94 FC200D     CALL    M,0D20H       --- If negative, convert trailing zeroes to ones
0B97 AF         XOR     A             --- Clear A
0B98 321C41     LD      (411CH),A     --- Ret sign of mantissa
0B9B F1         POP     AF            --- Restore original exponent
0B9C D0         RET     NC            --- Error if more than 56 bits in mantissa
0B9D C3D80C     JP      0CD8H         --- Normalize result and exit
0BA0 211D41     LD      HL,411DH      --- HL=addr of LSB of DP value ********* see note--> *
0BA3 7E         LD      A,(HL)        <---: Fetch a byte from list
0BA4 35         DEC     (HL)           •  : Decrement byte in list
0BA5 B7         OR      A              •  : Test byte as originally fetched
0BA6 23         INC     HL             •  : Bump to next item in list
0BA7 28FA       JR      Z,0BA3H       --->: Loop till non-zero byte found
0BA9 C9         RET                   --- Rtn to caller
0BAA E5         PUSH    HL            --- Save callers HL******************* see note-> **
0BAB 210000     LD      HL,0000H      --- Zero accumulator register
0BAE 78         LD      A,B           --- Test quantity in BC, if
0BAF B1         OR      C             --- zero, move zeros to DE & exit
0BB0 2812       JR      Z,0BC4H       ------>:  Jump if BC zero
0BB2 3E10       LD      A,10H          •     :  A = 16 = no. of times to shift left
0BB4 29         ADD     HL,HL         <------:--: Shift result left 1 position
0BB5 DA3D27     JP      C,273DH        •     :  : BS error if C
0BB8 EB         EX      DE,HL          •     :  : Prepare to shift multiplicand left
0BB9 29         ADD     HL,HL          •     :  : 1 place. Shift it and
0BBA EB         EX      DE,HL          •     :  : move it back to DE
0BBB 3004       JR      NC,0BC1H      --->:  :  : If no carry, has not found a 1, don't add
0BBD 09         ADD     HL,BC          •  :  :  : Else add multiplier to result thus far
0BBE DA3D27     JP      C,273DH        •  :  :  : BS error if C
0BC1 3D         DEC     A             <---:  :  : Have we shifted 16 times
0BC2 20F0       JR      NZ,0BB4H      -------:->: No, loop
0BC4 EB         EX      DE,HL         <------:  Move answer to DE
0BC5 E1         POP     HL            --- Restore caller's HL
0BC6 C9         RET                   --- Return to caller
0BC7 7C         LD      A,H           --- Test sign of value in HL *********** see note--> *
0BC8 17         RLA                   --- And save in B. B = 0
0BC9 9F         SBC     A,A           --- If HL +, all one's if HL neg.
0BCA 47         LD      B,A           --- Move sign flag to B
0BCB CD510C     CALL    0C51H         --- Convert HL to it's one's compliment       cont-->
0BCE 79         LD      A,C           --- Zero to A. Setup A for sign of difference. If HL
0BCF 98         SBC     A,B           --- was +, then A=+0, if was -, then A=-1
0BD0 1803       JR      0BD5H         --- Use addition routine. If result           cont-->
0BD2 7C         LD      A,H           --- Set B = sign of HL ***************** see note--> *
0BD3 17         RLA                   --- Sign bit to CARRY
0BD4 9F         SBC     A,A           --- B = 0 if HL +, else -1
0BD5 47         LD      B,A           --- Repositioned sign bit to B
0BD6 E5         PUSH    HL            --- Save HL in case we must convert it to SP
0BD7 7A         LD      A,D           --- MSB of register value so we can test sign
0BD8 17         RLA                   --- Set A = sign of DE
0BD9 9F         SBC     A,A           --- A = 0 if HL +, else -1
0BDA 19         ADD     HL,DE         --- Add the two integers. Add sign of result to sum
0BDB 88         ADC     A,B           --- of the signs
0BDC 0F         RRCA                  --- Sign of result to bit 7 and
0BDD AC         XOR     H             --- combine with sign of HL
```

```
0B8F  : of places to right shift to get integer





0BA0  * Convert trailing ones to a neg. DP value to zeroes **********



0BAA  * Binary multiplication of two 16 bit quantities in BC and DE**
      : Result is left in DE. Uses shift and add method. Called
      : from BASIC interpreter when computing addr of a subscripted
      : variable.









0BC7  * Binary subtraction for two 16 bit values in HL and DE.*******


0BCB  : so we use addition routine


0BD0  : underflows convert to SP.
0BD2  * Binary addition for two integers in HL & DE. Result left in**
      : HL. If result overflows convert both quantities to SP and
      : add. Determine overflow as follows:
      : C = carry after addition    C = 0 -- No overflow
      :                             C = 1 --- then if
      :                                          :
      :                                 ---------!----------
      :                                 :                   :
      :                               A = 0, B = 0       A <> B
      :                              then overflow     negative no.
```

```
0BDE F2990A    JP     P,0A99H       --- No overflow. Flag result as integer,      cont-->:
0BE1 C5        PUSH   BC            --- Save sign flag on stk
0BE2 EB        EX     DE,HL         --- Original DE to HL for conversion purposes.
0BE3 CDCF0A    CALL   0ACFH         --- Convert original value of DE to SP. Save it in
0BE6 F1        POP    AF            --- 4121 - 4124. Clear stk.
0BE7 E1        POP    HL            --- Restore original quantity in HL. It was wiped by
0BE8 CDA409    CALL   09A4H         --- Move converted value of DE to stack         : add.
0BEB EB        EX     DE,HL         --- Restore HL
0BEC CD6B0C    CALL   0C6BH         --- Convert HL to single precision
0BEF C38F0F    JP     0F8FH         --- Add single precision equivalent of HL & DE
0BF2 7C        LD     A,H           --- Test value of HL ****************** see note--> *
0BF3 B5        OR     L             --- If
0BF4 CA9A0A    JP     Z,0A9AH       --- Zero, exit with result (0) in HL
0BF7 E5        PUSH   HL            --- Save original value in case we need to
0BF8 D5        PUSH   DE            --- convert them to SP.
0BF9 CD450C    CALL   0C45H         --- Set result to integer type. Convert any neg.
0BFC C5        PUSH   BC            --- value to +. BC = sign of result (pushed one).
0BFD 44        LD     B,H           --- B = MSB of value 2
0BFE 4D        LD     C,L           --- BC = value 2
0BFF 210000    LD     HL,0000H      --- HL = accumulator
0C02 3E10      LD     A,10H         --- No. of times to shift left.
0C04 29        ADD    HL,HL         <-------:  Shift answer and test for
0C05 381F      JR     C,0C26H        •      :  overflow. CARRY if so.
0C07 EB        EX     DE,HL          •      :  No overflow, shift DE left
0C08 29        ADD    HL,HL          •      :  one bit and test for a binary
0C09 EB        EX     DE,HL          •      :  one (CARRY).
0C0A 3004      JR     NC,0C10H      ---->:  :  No CARRY, no binary one
0C0C 09        ADD    HL,BC          •   :  :  Add original value in HL to
0C0D DA260C    JP     C,0C26H       --------:->:  Accumulator for each binary one
0C10 3D        DEC    A             <----:  :  :  in DE.
0C11 20F1      JR     NZ,0C04H      ------->:  :  Have we shifted DE 16 places, no loop
0C13 C1        POP    BC            ---        :  Yes, get sign of result
0C14 D1        POP    DE            ---        :  Original value in DE
0C15 7C        LD     A,H           ---        :  Now test true sign of result
0C16 B7        OR     A             ---        :  Set status flags according to result
0C17 FA1F0C    JP     M,0C1FH       ---        :  Jump if answer is negative.  see note-->
0C1A D1        POP    DE            ---        :  Clear stack,
0C1B 78        LD     A,B           ---        :  get sign of result to A
0C1C C34D0C    JP     0C4DH         ---        :  Convert HL to proper sign,       cont-->
0C1F EE80      XOR    80H           ---        :  Clear sign bit & test rest of value for 0
0C21 B5        OR     L             ---        :  If zero, we have a negative number, else
0C22 2813      JR     Z,0C37H       ---        :  Convert it to single precision etc.
0C24 EB        EX     DE,HL         ---        :  :C26 POP BC Clear sign of result note-->
0C25 01C1E1    LD     BC,0E1C1H     <--------- :  :C27 POP HL Restore original HL value
0C28 CDCF0A    CALL   0ACFH         --- Convert original HL to single precision
0C2B E1        POP    HL            --- HL = original DE
0C2C CDA409    CALL   09A4H         --- Move converted HL to stack
0C2F CDCF0A    CALL   0ACFH         --- Convert DE (now in HL) to single precision
0C32 C1        POP    BC            --- Load converted HL value from stack
0C33 D1        POP    DE            --- into BC/DE
0C34 C34708    JP     0847H         --- Do single precision multiplication
0C37 78        LD     A,B           --- Get sign flag of result *************************
0C38 B7        OR     A             --- Rtn status flags to sign of result
0C39 C1        POP    BC            --- Clear stack in case we exit
0C3A FA9A0A    JP     M,0A9AH       --- If sign was suppose to be negative, exit
0C3D D5        PUSH   DE            --- Save original DE
0C3E CDCF0A    CALL   0ACFH         --- Convert result to single precision
0C41 D1        POP    DE            --- Restore original DE
0C42 C38209    JP     0982H         --- Rtn sign and return to caller
0C45 7C        LD     A,H           --- Get sign of MSB from 2nd operand **** see note-->*
```

```
      :     store in 4121 & return.

0BF2  * Integer multiplication. DE = first value, HL = 2nd value.***
      : Result is left in HL. If the signs of both operands are
      : equal, then the result has the same sign. If either sign is
      : different, the result is set negative. Any negative values
      : are converted to their positive equivalents before the
      : multiplication is started. Method used is shift and add.
      : For each 1 found in DE, the original contents of HL are
      : added to an accumulator register (HL in this case) and
      : shifted left. Process is repeated 16 times (must test all
      : 16 bits in DE). If overflow occurs, convert both values to
      : SP and use SP multiplication routine.

0C17  : (May have overflowed.)

0C1C  : save result and return to caller.
0C1F  * **************************************************************

0C24  : Number has overflowed. Convert to SP to re-multiply.

0C37  * **************************************************************

      :     : If HL is negative convert it to its one's complement.
0C45  * *** : If DE is negative convert it also. *******************
```

```
0C46 AA        XOR    D             --- And combine with sign from 1st operand.
0C47 47        LD     B,A           --- B = + if signs are equal (+,+) or (-,-),   cont-->
0C48 CD4C0C    CALL   0C4CH         --- Test sign of HL operand. If neg. convert to pos.
0C4B EB        EX     DE,HL         --- Switch HL/DE so we can test sign of DE     cont-->
0C4C 7C        LD     A,H           --- Get sign byte of value in DE.
0C4D B7        OR     A             --- Set status flags according to sign of value in DE
0C4E F29A0A    JP     P,0A9AH       --- Flag as integer, result to 4121. Rtn to caller
0C51 AF        XOR    A             --- Clear A, CARRY
0C52 4F        LD     C,A           --- Zero C          : Convert a negative    :
0C53 95        SUB    L             --- Convert LSB     : integer to its one's  :
0C54 6F        LD     L,A           --- And restore     : complement positive   :
0C55 79        LD     A,C           --- Zero to A       : equivalent            :
0C56 9C        SBC    A,H           --- Convert MSB
0C57 67        LD     H,A           --- And restore
0C58 C39A0A    JP     0A9AH         --- Set data type to integer(02),              cont-->
0C5B 2A2141    LD     HL,(4121H)    --- Get binary value of integer *********************
0C5E CD510C    CALL   0C51H         --- Convert to a positive value
0C61 7C        LD     A,H           --- Make sure value is LE 2**15
0C62 EE80      XOR    80H           --- If bit 15 is not zero, and the remainder
0C64 B5        OR     L             --- of the word is zero then value > 2**15
0C65 C0        RET    NZ            --- Rtn if integer = or < 32768
0C66 EB        EX     DE,HL         --- Value is > 2**15. Move it to DE
0C67 CDEF0A    CALL   0AEFH         --- Set SNG precision flag
0C6A AF        XOR    A             --- Set exponent to zero
0C6B 0698      LD     B,98H         --- Maximum exponent for SP values
0C6D C36909    JP     0969H         --- Convert value to SP and rtn to caller
0C70 212D41    LD     HL,412DH      --- Double precision subtraction routine. ** cont--> *
0C73 7E        LD     A,(HL)        --- Load MSB of saved value
0C74 EE80      XOR    80H           --- Invert sign
0C76 77        LD     (HL),A        --- And restore
0C77 212E41    LD     HL,412EH      --- HL=addr of exponent in WRA2 ************ cont--> *
0C7A 7E        LD     A,(HL)        --- Load exponent from WRA2
0C7B B7        OR     A             --- Set status flags for exponent
0C7C C8        RET    Z             --- Exit if WRA2 value zero
0C7D 47        LD     B,A           --- B = Exponent WRA2 value
0C7E 2B        DEC    HL            --- Backspace to MSB of WRA2
0C7F 4E        LD     C,(HL)        --- C = MSB WRA2 number
0C80 112441    LD     DE,4124H      --- DE = addr exponent of WRA1 value
0C83 1A        LD     A,(DE)        --- Load exponent of value in WRA1
0C84 B7        OR     A             --- Set status flags
0C85 CAF409    JP     Z,09F4H       --- Jump if WRA1 value is zero
0C88 90        SUB    B             --- Else, compare exponents : WRA1 - WRA2
0C89 3016      JR     NC,0CA1H      --- Jump if WRA1 exponent > WRA2 exponent      cont-->
0C8B 2F        CPL                  --- Make diff. in exponent positive
0C8C 3C        INC    A             --- Current number is larger than saved number
0C8D F5        PUSH   AF            --- Save difference in exponents
0C8E 0E08      LD     C,08H         --- Now, swap the two numbers so that WRA1 = WRA2
0C90 23        INC    HL            --- And visa-versa
0C91 E5        PUSH   HL            --- HL = addr of exponent WRA2
0C92 1A        LD     A,(DE)        --- Swap WRA1 and WRA2 double precision numbers
0C93 46        LD     B,(HL)        --- Load a byte from WRA1
0C94 77        LD     (HL),A        --- Load a byte from WRA2      :     Force larger
0C95 78        LD     A,B           --- WRA1 byte to WRA2          :     number into
0C96 12        LD     (DE),A        --- WRA2 byte to WRA1          :     WRA1
0C97 1B        DEC    DE            --- Decrement WRA1 addr.
0C98 2B        DEC    HL            --- Decrement WRA2 addr.
0C99 0D        DEC    C             --- Count 1 byte moved
0C9A 20F6      JR     NZ,0C92H      --- Loop till 8 bytes of SP numbers moved
0C9C E1        POP    HL            --- Restore addr. of WRA2 to HL
0C9D 46        LD     B,(HL)        --- B = exponent of new WRA2 number
```

```
0C47  : negative if unlike (+,-)

0C4B  : Convert to + if its negative.

0C58  : Save value in 4121/4122 & return
0C5B  * **********************************************************

0C70  * Addr of saved DP value ***************************************

0C77  * Double precision addition routine. Add current value to
      : saved value.

0C89  : There are less bits in integer portion so it is smaller
```

```
0C9E 2B       DEC    HL          --- HL = addr. of MSB of WRA2 value
0C9F 4E       LD     C,(HL)      --- C = MSB new WRA2 number
0CA0 F1       POP    AF          --- A = difference in exponents
0CA1 FE39     CP     39H         --- Is diff in exponent more than 56 bits
0CA3 D0       RET    NC          --- Exit if difference in exponent more than 56 bits
0CA4 F5       PUSH   AF          --- Save diff. in exponents
0CA5 CDDF09   CALL   09DFH       --- Turn on most significant bit in MSB of WRA1
0CA8 23       INC    HL          --- HL = addr. of bit bucket zeroed
0CA9 3600     LD     (HL),00H    --- during normalization. Zero it
0CAB 47       LD     B,A         --- Save sign flag for WRA2
0CAC F1       POP    AF          --- Restore exponent diff.
0CAD 212D41   LD     HL,412DH    --- HI. = addr of MSB for saved value
0CB0 CD690D   CALL   0D69H       --- Scale (right justify) saved value so its exponent
0CB3 3A2641   LD     A,(4126H)   --- = current value then the two numbers can be added
0CB6 321C41   LD     (411CH),A   --- Get last 8 bits shifted out of WRA2 value
0CB9 78       LD     A,B         --- Get sign flag for WRA2 value
0CBA B7       OR     A           --- Set status flags according to WRA2 sign
0CBB F2CF0C   JP     P,0CCFH     --- Signs are different, must subtract
0CBE CD330D   CALL   0D33H       --- Add DP number in (4127-412D) to (411D-4123)
0CC1 D20E0D   JP     NC,0D0EH    --- If no CARRY, adjust sign of result and exit
0CC4 EB       EX     DE,HL       --- There was CARRY, increment exponent of current
0CC5 34       INC    (HL)        --- value, error if overflow
0CC6 CAB207   JP     Z,07B2H     --- Jump to OV error message routine
0CC9 CD900D   CALL   0D90H       --- Then right shift coefficient, position
0CCC C30E0D   JP     0D0EH       --- Adjust sign of result and return
0CCF CD450D   CALL   0D45H       --- Subtract saved value from current ****** cont--> *
0CD2 212541   LD     HL,4125H    --- HL = Sign flag for result
0CD5 DC570D   CALL   C,0D57H     --- If CARRY, then get one's complement of the diff.
0CD8 AF       XOR    A           --- Initial counter value
0CD9 47       LD     B,A         <-----: Zero B for normalization loop below
0CDA 3A2341   LD     A,(4123H)    •    : Fetch MSB and
0CDD B7       OR     A            •    : Test for zero
0CDE 201E     JR     NZ,0CFEH    ------->: If non-zero, go shift left until     cont-->
0CE0 211C41   LD     HL,411CH     •    : : HL = addr of LSB-1 for DP value in WRA1
0CE3 0E08     LD     C,08H        •    : : C = no. of bytes to shift
0CE5 56       LD     D,(HL)      <---: : : Get next byte to be moved
0CE6 77       LD     (HL),A       •  : : : Save current byte
0CE7 7A       LD     A,D          •  : : : Save byte to be moved to succeeding addr
0CE8 23       INC    HL           •  : : : Bump to next byte in WRA1
0CE9 0D       DEC    C            •  : : : Have we shifted entire DP no. left one byte
0CEA 20F9     JR     NZ,0CE5H    --->: : : No, loop
0CEC 78       LD     A,B          •  : : : Yes, in case no. is zero, don't loop forever
0CED D608     SUB    08H          •  : : : Have we shifted the LSB all the way to the
0CEF FEC0     CP     0C0H         •  : : : exponent (8 bytes)
0CF1 20E6     JR     NZ,0CD9H    ----->: : No, continue looking for a non-zero MSB
0CF3 C37807   JP     0778H       ---     : Yes, zero exponent & return
0CF6 05       DEC    B           <---:   : Maintain count of bytes & bits shifted left *
0CF7 211C41   LD     HL,411CH     •  :   : Addr of LSB of 8 byte no. to shift left 1 bit
0CFA CD970D   CALL   0D97H        •  :   : Shift number left one place
0CFD B7       OR     A            •  :   : Test bit 7 of MSB
0CFE F2F60C   JP     P,0CF6H     <-->:<--: Continue shifting until bit 7 = 1
0D01 78       LD     A,B         --- Test count of places shifted left
0D02 B7       OR     A           --- Set status flags for count
0D03 2809     JR     Z,0D0EH     --- Jmp if value already normalized
0D05 212441   LD     HL,4124H    --- HL=address of exponent
0D08 86       ADD    A,(HL)      --- Add count of bits shifted left to bias
0D09 77       LD     (HL),A      --- Save new exponent
0D0A D27807   JP     NC,0778H    --- If no overflow, set exponent to zero
0D0D C8       RET    Z           --- and rtn to caller
0D0E 3A1C41   LD     A,(411CH)   --- Get MSB of current value
```

```
0CCF   * Difference replaces current *********************************
       : Normalize the difference. Test the MSB, if zero shift entire
       :     number left one byte. When MSB is non-zero shift number
       :     left one bit at a time until a one is shifted into bit 7
       :     of the MSB.


0CDE   : A 1 appears in bit 7. Else shift entire number left one byte
       : starting at the LSB shifting towards the exponent.




0CF6   * *************************************************************
```

```
0D11 B7         OR      A               --- Set status flags
0D12 FC200D     CALL    M,0D20H         --- If value is negative, reset trailing zeroes to
0D15 212541     LD      HL,4125H        --- Get sign of result :ones
0D18 7E         LD      A,(HL)          --- into A register
0D19 E680       AND     80H             --- Isolate sign of result flag
0D1B 2B         DEC     HL              --- Backspace to sign of mantissa
0D1C 2B         DEC     HL              --- gives HL-2
0D1D AE         XOR     (HL)            --- Set sign of result to mantissa of result
0D1E 77         LD      (HL),A          --- Restore MSB with correct sign
0D1F C9         RET                     --- Ret to caller
0D20 211D41     LD      HL,411DH        --- HL = Addr of LSB for current DP value ************
0D23 0607       LD      B,07H           --- Current DP value
0D25 34         INC     (HL)            --- Bump LSB
0D26 C0         RET     NZ              --- Exit if no overflow             :
0D27 23         INC     HL              --- Else add CARRY to               :
0D28 05         DEC     B               --- Next byte until no              :    see note-->
0D29 20FA       JR      NZ,0D25H        --- Overflow                        :
0D2B 34         INC     (HL)            --- Bump exponent                   :
0D2C CAB207     JP      Z,07B2H         --- OV error code
0D2F 2B         DEC     HL              --- Number has become negative
0D30 3680       LD      (HL),80H        --- Reset MSB=80, rest of byte=00
0D32 C9         RET                     --- Rtn
0D33 212741     LD      HL,4127H        --- Addr of augment **********************************
0D36 111D41     LD      DE,411DH        --- Addr of addend
0D39 0E07       LD      C,07H           --- No. of bytes to add
0D3B AF         XOR     A               --- Clear CARRY flag                :
0D3C 1A         LD      A,(DE)          <----: Do addition                  :
0D3D 8E         ADC     A,(HL)           •   : Begin with LSB and work      :    see note-->
0D3E 12         LD      (DE),A           •   : Towards MS B. Move           :
0D3F 13         INC     DE               •   : result to WRA1 (4121-4124). Number
0D40 23         INC     HL               •   : must be unpacked before starting addition
0D41 0D         DEC     C                •   : Count 1 byte added
0D42 20F8       JR      NZ,0D3CH        ---->: Loop till all bytes added
0D44 C9         RET                     --- Rtn to caller
0D45 212741     LD      HL,4127H        --- Start of WRA2 value *****************************
0D48 111D41     LD      DE,411DH        --- Start of WRAl value
0D4B 0E07       LD      C,07H           --- No. of bytes to subtract
0D4D AF         XOR     A               --- Clear CARRY flag
0D4E 1A         LD      A,(DE)          <----: Get a current LSB and        :
0D4F 9E         SBC     A,(HL)           •   : Subtract a saved LSB         :
0D50 12         LD      (DE),A           •   : From it. Result replaces     :    see note-->
0D51 13         INC     DE               •   : Current value. Bump fetch    :
0D52 23         INC     HL               •   : addresses for WRA1 & WRA2    :
0D53 0D         DEC     C                •   : Count bytes subtracted
0D54 20F8       JR      NZ,0D4EH        ---->: Loop till all bytes subtracted
0D56 C9         RET                     --- Then rtn
0D57 7E         LD      A,(HL)          --- Set sign flag to E ******************************
0D58 2F         CPL                     --- Indicating one's complement
0D59 77         LD      (HL),A          --- Restore sign flag
0D5A 211C41     LD      HL,411CH        --- HL = addr of LSB of current DP
0D5D 0608       LD      B,08H           --- No. of bytes to complement
0D5F AF         XOR     A               --- Zero A & clear CARRY flag               :
0D60 4F         LD      C,A             --- Save zero so it can be reloaded         :
0D61 79         LD      A,C             <----: Reload zero, leave CARRY untouched : see note-->
0D62 9E         SBC     A,(HL)           •   : Complement a byte                    :
0D63 77         LD      (HL),A           •   : And restore it                       :
0D64 23         INC     HL               •   : Bump to next byte of number
0D65 05         DEC     B                •   : Done 8 bytes
0D66 20F9       JR      NZ,0D61H        ---->: No, loop
0D68 C9         RET                     --- Yes, exit
```

```
0D20  * ***********************************************************
      : Add 1 to a DP number in WRA1
      : Begin by adding 1 to the LSB. If overflow (result = 0), add
      : the CARRY to next byte, etc. If there is overflow out of
      : the exponent then the number has overflowed.
```

```
0D33  * ***********************************************************
      : Add two double precision numbers.
      : Add coefficients only, do not add exponents. Address of one
      : number in DE, and other in HL. Sum replaces the number
      : pointed to by HL
      :
```

```
0D45  * ***********************************************************
      : Subtract two double precision numbers
      : Contents of (411D - 4123) are subtracted from (4127 - 412D).
      : Result replaces (411D - 4123).
```

```
0D57  * ***********************************************************
      : This routine converts a positive DP value in WRA1
      : to its one's complement equivalent
```

```
0D69 71         LD      (HL),C         --- Save MSB                                    see note-->
0D6A E5         PUSH    HL             --- Save starting addr of value starting
0D6B D608       SUB     08H            --- with MSB. Is shift count => 8
0D6D 380E       JR      C,0D7DH        --- No, go to bit shift routine
0D6F E1         POP     HL             --- Restore HL to start of array
0D70 E5         PUSH    HL             --- Save start of array
0D71 110008     LD      DE,0800H       --- D = count of bytes to move (shift right 1 byte)
0D74 4E         LD      C,(HL)         <----: Now, right shift array one byte, zero filling
0D75 73         LD      (HL),E          •   : on the left. C = byte being shifted
0D76 59         LD      E,C             •   : E = previous byte shifted out (initially zero).
0D77 2B         DEC     HL              •   : Decrement addr
0D78 15         DEC     D               •   : Decrement count
0D79 20F9       JR      NZ,0D74H       ---->: Loop till 7 bytes shifted
0D7B 18EE       JR      0D6BH          --- Loop till shift count < 8
0D7D C609       ADD     A,09H          --- Continuation of unpacking routine above  cont--> *
0D7F 57         LD      D,A            --- D = number of positions to shift right
0D80 AF         XOR     A              --- Zero A
0D81 E1         POP     HL             --- HL = addr of MSB
0D82 15         DEC     D              --- Count no. of places shifted
0D83 C8         RET     Z              --- Exit from unpacking routine if done shifting
0D84 E5         PUSH    HL             --- Save addr of MSB
0D85 1E08       LD      E,08H          --- No. of bytes to shift
0D87 7E         LD      A,(HL)         --- Get a byte, shift it right. Bit 0 to CARRY will
0D88 1F         RRA                    --- become bit 7 of following byte
0D89 77         LD      (HL),A         --- Restore shifted byte
0D8A 2B         DEC     HL             --- Bump to next byte
0D8B 1D         DEC     E              --- Shifted all bytes
0D8C 20F9       JR      NZ,0D87H       --- No, loop
0D8E 18F0       JR      0D80H          --- Yes, go test if shifted the correct no. of places
0D90 212341     LD      HL,4123H       --- Addr of exponent ********************** cont--> *
0D93 1601       LD      D,01H          --- Number of bits to right shift
0D95 18ED       JR      0D84H          --- Jump to shift routine. Rtn to caller at D83
0D97 0E08       LD      C,08H          --- No. of bytes to shift left ************* cont--> *
0D99 7E         LD      A,(HL)         --- Fetch a LSB
0D9A 17         RLA                    --- Shift left 1 so bit 7 goes to CARRY
0D9B 77         LD      (HL),A         --- And CARRY goes to bit 0.
0D9C 23         INC     HL             --- Restore shifted value.
0D9D 0D         DEC     C              --- Bump to next most LSB. Count a byte shifted
0D9E 20F9       JR      NZ,0D99H       --- Jump if 8 bytes not shifted
0DA0 C9         RET                    --- Else rtn
0DA1 CD5509     CALL    0955H          --- Double precision multiplication ******** cont--> *
0DA4 C8         RET     Z              --- Exit if value zero
0DA5 CD0A09     CALL    090AH          --- Adjust exponent. New exponent to 4124.
0DA8 CD390E     CALL    0E39H          --- Move current value to 414A - 4150         cont--->
0DAB 71         LD      (HL),C         --- Zero 411C
0DAC 13         INC     DE             --- DE = 414A = start addr of moved SP value
0DAD 0607       LD      B,07H          --- B = count of bytes to add
0DAF 1A         LD      A,(DE)         --- Fetch a byte - starting at LSB
0DB0 13         INC     DE             --- Position to next byte
0DB1 B7         OR      A              --- Test current byte for zero
0DB2 D5         PUSH    DE             --- Save current byte address   : 1 byte position
0DB3 2817       JR      Z,0DCCH        --- If current byte zero, shift entire value right
0DB5 0E08       LD      C,08H          --- No of times to right shift a byte
0DB7 C5         PUSH    BC             --- Save count of bytes processed, initially B=7,C=8
0DB8 1F         RRA                    --- Right shift LSB so we
0DB9 47         LD      B,A            --- can test if current bit 0 is a one, if so
0DBA DC330D     CALL    C,0D33H        --- add two unpacked SP numbers.              cont--->
0DBD CD900D     CALL    0D90H          --- Right shift sum 1 place.
0DC0 78         LD      A,B            --- Restore shifted LSB so we can test
0DC1 C1         POP     BC             --- rest of bits, then load number of bits
```

0D69 : Unpack a DP number addr of value (starting with MSB) in HL.
      : C = MSB, A-reg = no. of bits to right shift. Value is right
      : shifted. Shift is byte at a time until shift count < 0
      : then it becomes bit at a time.

0D7D * Bit shift portion of right just. for DP value ***************

0D90 * Right shift a DP number pointed to by HL one bit. ***********

0D97 * Left shift a DP number pointed to by HL left one bit.********

0DA1 * Uses repetitive addition. Test exponent of current value. **

0DA8 : (Temp storage), zero current value

0DBA : Add current value to saved value. Sum left in current value

```
0DC2 0D         DEC     C              --- to test. Count 1 bit tested
0DC3 20F2       JR      NZ,0DB7H       --- Loop till all bits in current byte tested
0DC5 D1         POP     DE             --- then load addr of next byte to test
0DC6 05         DEC     B              --- Have all bytes been right justified
0DC7 20E6       JR      NZ,0DAFH       --- No, loop
0DC9 C3D80C     JP      0CD8H          --- Yes, normalized result and rtn to caller
0DCC 212341     LD      HL,4123H       --- HL = addr of WRA1. A = 0
0DCF CD700D     CALL    0D70H          --- Right shift WRA1 one byte
0DD2 18F1       JR      0DC5H          --- Then continue with shift/add loop
0DD4 00         NOP                    --- Double precision 10 ******************************
0DD5 00         NOP                    ---
0DD6 00         NOP                    ---
0DD7 00         NOP                    ---
0DD8 00         NOP                    ---
0DD9 00         NOP                    ---
0DDA 2084       JR      NZ,0D60H       ---
0DDC 11D40D     LD      DE,0DD4H       --- Addr of double precision 10
0DDF 212741     LD      HL,4127H       --- Destination address
0DE2 CDD309     CALL    09D3H          --- Move a DP 10 to WRA2
0DE5 3A2E41     LD      A,(412EH)      --- *********** Double precision division ** cont--> *
0DE8 B7         OR      A              --- Prepare test for zero exponent
0DE9 CA9A19     JP      Z,199AH        --- /0 error if Z (division by zero)
0DEC CD0709     CALL    0907H          --- Compute new exponent. Set WRA1 negative
0DEF 34         INC     (HL)           --- Restore exponent of
0DF0 34         INC     (HL)           --- WRA1 to original value
0DF1 CD390E     CALL    0E39H          --- Move WRA1 value to 414A - 4150 (dividend)
0DF4 215141     LD      HL,4151H       --- HL = addr of exponent of moved value
0DF7 71         LD      (HL),C         --- Zero exponent
0DF8 41         LD      B,C            --- Zero B-reg
0DF9 114A41     LD      DE,414AH       <---: Addr of LSB of moved WRA1 (dividend)
0DFC 212741     LD      HL,4127H         • : Addr of LSB of WRA2 (divisor)
0DFF CD4B0D     CALL    0D4BH            • : Subtract divisor from dividend
0E02 1A         LD      A,(DE)           • : Difference moved to 414A-4151
0E03 99         SBC     A,C              • : If value in WRA2 was > 414A-4151
0E04 3F         CCF                      • : Decrease MSB of 414A-4151 value
0E05 380B       JR      C,0E12H          • : Jmp if divisor greater than dividend     cont-->
0E07 114A41     LD      DE,414AH         • : DE = addr of moved WRA1 value (dividend)
0E0A 212741     LD      HL,4127H         • : HL = addr of WRA2 (divisor)
0E0D CD390D     CALL    0D39H            • : Add them together, sum to 414A
0E10 AF         XOR     A                • : Clear all status flags so we don't exit
0E11 DA1204     JP      C,0412H          • :  E12:  LD   (DE),A  Save new exponent (dividend)
0E14 3A2341     LD      A,(4123H)        • :  E13:  INC  B       Signal 1 subtraction
0E17 3C         INC     A                • : Then load EBB
0E18 3D         DEC     A                • : for dividend.
0E19 1F         RRA                      • : CARRY into sign pos.
0E1A FA110D     JP      M,0D11H          • : Done. Go normalize result
0E1D 17         RLA                      • : Restore CARRY flag
0E1E 211D41     LD      HL,411DH         • : HL = addr of original dividend
0E21 0E07       LD      C,07H            • : No. of bytes to shift
0E23 CD990D     CALL    0D99H            • : Shift entire dividend left one bit
0E26 214A41     LD      HL,414AH         • : HL = addr of moved divisor
0E29 CD970D     CALL    0D97H            • : Shift the moved dividend left one cont-->
0E2C 78         LD      A,B              • : Get subtraction count
0E2D B7         OR      A                • : Set status flags
0E2E 20C9       JR      NZ,0DF9H       --->: Jmp if divisor < dividend
0E30 212441     LD      HL,4124H         • : Else divisor > dividend. Divide divisor
0E33 35         DEC     (HL)             • : by 2 by decrementing exponent
0E34 20C3       JR      NZ,0DF9H       --->: Then repeat subtraction. If divisor goes to
0E36 C3B207     JP      07B2H          --- Zero we have an OV error
0E39 79         LD      A,C            --- Restore MSB of WRA2 value. We need the C-register!
```

```
0DD4  * **********************************************************

0DE5  * Get exponent of divisor ************************************
      : Divide WRA1 by WRA2 uses subtraction/shift method

0E05  : else, add difference back to moved current value

0E29  : bit left so they are in synch

0E39  * **********************************************************
```

```
0E3A 322D41     LD      (412DH),A      --- Load MSB of WRA2
0E3D 2B         DEC     HL             --- HL = MSB of current value
0E3E 115041     LD      DE,4150H       --- DE addr of temp storage area for current SP value
0E41 010007     LD      BC,0700H       --- B=no. of bytes to move. C=value to move to current
0E44 7E         LD      A,(HL)         --- Get a byte of the current value            :value
0E45 12         LD      (DE),A         --- Move it to 4150 - 414A
0E46 71         LD      (HL),C         --- Zero a byte of current value
0E47 1B         DEC     DE             --- Decrement all addresses. We started at the MSB
0E48 2B         DEC     HL             --- and must work down towards the LSB.
0E49 05         DEC     B              --- Have we moved 7 bytes
0E4A 20F8       JR      NZ,0E44H       --- No, loop
0E4C C9         RET                    --- Yes, rtn to caller
0E4D CDFC09     CALL    09FCH          --- Move current value ******************** cont--> *
0E50 EB         EX      DE,HL          --- HL = end of current value
0E51 2B         DEC     HL             --- Backup to get exponent
0E52 7E         LD      A,(HL)         --- Load exponent
0E53 B7         OR      A              --- And test for zero
0E54 C8         RET     Z              --- Exit if not a flt. pt. no. or value is zero
0E55 C602       ADD     A,02H          --- Adjust exponent for following addition
0E57 DAB207     JP      C,07B2H        --- Error if exponent overflow
0E5A 77         LD      (HL),A         --- Save adjusted exponent
0E5B E5         PUSH    HL             --- and addr of exponent of saved value
0E5C CD770C     CALL    0C77H          --- Add current to saved value              see note-->
0E5F E1         POP     HL             --- Restore addr of exponent
0E60 34         INC     (HL)           --- Adjust it
0E61 C0         RET     NZ             --- and rtn if no overflow
0E62 C3B207     JP      07B2H          --- OV error if exponent is zero
0E65 CD7807     CALL    0778H          --- Zero exponent of SP value ** ASCII TO BINARY ** **
0E68 CDEC0A     CALL    0AECH          --- Flag as DP
0E6B F6AF       OR      0AFH           --- E6C: XOR A
0E6D EB         EX      DE,HL          --- Save HL (current input symbol)
0E6E 01FF00     LD      BC,00FFH       --- Initialize HL=00, B=0, C=-0
0E71 60         LD      H,B            --- Zero H
0E72 68         LD      L,B            --- and L
0E73 CC9A0A     CALL    Z,0A9AH        --- Flag as integer. Zero accumulator
0E76 EB         EX      DE,HL          --- Restore addr of current input symbol to HL, DE=00
0E77 7E         LD      A,(HL)         --- Fetch 1st char of digit
0E78 FE2D       CP      2DH            --- Test for minus sign
0E7A F5         PUSH    AF             --- Save MSD as sign
0E7B CA830E     JP      Z,0E83H        --- Jump if minus sign (bump to next char)
0E7E FE2B       CP      2BH            --- Test for +
0E80 2801       JR      Z,0E83H        --- Jump if plus sign (bump to next char)
0E82 2B         DEC     HL             --- Compensate for increment at RST 10
0E83 D7         RST     10H            --- Re-examine current character
0E84 DA290F     JP      C,0F29H        --- Jump if character is numeric
0E87 FE2E       CP      2EH            --- Test for decimal point
0E89 CAE40E     JP      Z,0EE4H        --- Jump if decimal point
0E8C FE45       CP      45H            --- Test for E
0E8E 2814       JR      Z,0EA4H        --- Jump if E exponential type SP
0E90 FE25       CP      25H            --- Test for %
0E92 CAEE0E     JP      Z,0EEEH        --- Jump if % force integer
0E95 FE23       CP      23H            --- Test for #
0E97 CAF50E     JP      Z,0EF5H        --- Jump if # force double precision
0E9A FE21       CP      21H            --- Test for !
0E9C CAF60E     JP      Z,0EF6H        --- Jump if ! force single precision
0E9F FE44       CP      44H            --- Test for D
0EA1 2024       JR      NZ,0EC7H       --- Jump if not D else exponential type DP
0EA3 B7         OR      A              --- If D ret A-reg non-zero for E, status = 0
0EA4 CDFB0E     CALL    0EFBH          --- Convert digit to SP or DP   :E or D processing
0EA7 E5         PUSH    HL             --- Save HL so it can be used to hold         cont-->
```

```
0E4D * to saved location *******************************************
      :           This routine multiplies the current DP
      :           value by 2 by adding it to itself. First
      :           current value is moved to saved location
      :           then DP add routine adds current value
      :           to saved value.



0E5C  : (DP result left in current location)



****** ************************************************************














0EA7  : addr which will be pushed onto stack.
```

```
0EA8 21BD0E    LD     HL,0EBDH     --- Place rtn addr of EBD on stack and
0EAB E3        EX     (SP),HL      --- Restore HL = next input character. Stack = EBD
0EAC D7        RST    10H          --- Examine next char in input stream. Look for sign
0EAD 15        DEC    D            --- If any of the following tests are true. D=-1
0EAE FECE      CP     0CEH         --- Control goes to EBD. Else we fall into EBD.
0EB0 C8        RET    Z            --- Return if - (minus) token (D = -1)
0EB1 FE2D      CP     2DH          --- Not minus token, test for ASCII minus
0EB3 C8        RET    Z            --- Return if - character (D = -1)
0EB4 14        INC    D            --- D = 0 if + sign follows -1 if - sign follows
0EB5 FECD      CP     0CDH         --- Test for plus (+) token
0EB7 C8        RET    Z            --- Return if + token (D = 0)
0EB8 FE2B      CP     2BH          --- Not a + token, test for ASCII plus
0EBA C8        RET    Z            --- Return if + character (D = 0)
0EBB 2B        DEC    HL           --- Backspace input pointer to E or D
0EBC F1        POP    AF           --- Remove EBD address from stack
0EBD D7        RST    10H          --- Examine next character in input stream
0EBE DA940F    JP     C,0F94H      --- Jmp if next character is numeric
0EC1 14        INC    D            --- Finalize exponential number ----:D = 0  if - sign
0EC2 2003      JR     NZ,0EC7H     --->: Jmp if exponent positive      :D = +1 if + sign
0EC4 AF        XOR    A             •  : Clear A-reg
0EC5 93        SUB    E             •  : A = - value off exponent
0EC6 5F        LD     E,A           •  : E = Exponent
0EC7 E5        PUSH   HL           <---: Save current position in code string
0EC8 7B        LD     A,E          --- E = exponent
0EC9 90        SUB    B            --- B = count of numbers beyond the dec. pt.   cont-->
0ECA F40A0F    CALL   P,0F0AH      <---: Multiply no. by 10
0ECD FC180F    CALL   M,0F18H       •  : Divide no. by 10 for each mult. and      cont-->
0ED0 20F8      JR     NZ,0ECAH     --->: Loop till value scaled according to number
0ED2 E1        POP    HL           --- Restore addr of next symbol       :in A reg
0ED3 F1        POP    AF           --- Get possible sign
0ED4 E5        PUSH   HL           --- Preserve addr of next symbol
0ED5 CC7B09    CALL   Z,097BH      --- Value was preceded by a minus sign
0ED8 E1        POP    HL           --- Restore code string addr
0ED9 E7        RST    20H          --- Determine type of data conversion
0EDA E8        RET    PE           --- Return if not single precision
0EDB E5        PUSH   HL           --- Save code string addr
0EDC 219008    LD     HL,0890H     --- Return addr
0EDF E5        PUSH   HL           --- Save on stack
0EE0 CDA30A    CALL   0AA3H        --- Make sure value is not exactly -2**16.     cont-->
0EE3 C9        RET                 --- Goto 0890
0EE4 E7        RST    20H          --- Determine data type ******************************
0EE5 0C        INC    C            --- C = 0
0EE6 20DF      JR     NZ,0EC7H     --- Fall thru if integer followed by ., or     cont-->
0EE8 DCFB0E    CALL   C,0EFBH      --- If not DP convert to single precision
0EEB C3830E    JP     0E83H        --- Go get next digit
0EEE E7        RST    20H          --- Determine data type ******************* cont--> *
0EEF F29719    JP     P,1997H      --- SN error if P (not an integer)
0EF2 23        INC    HL           --- Bump to next element in code string
0EF3 18D2      JR     0EC7H        --- Go finalize number and return
0EF5 B7        OR     A            --- Force A-reg non-zero ******** # found ! found **
0EF6 CDFB0E    CALL   0EFBH        --- Convert value to SP or DP
0EF9 18F7      JR     0EF2H        --- Rtn to caller
0EFB E5        PUSH   HL           --- Save current position in input string ************
0EFC D5        PUSH   DE           --- Save integer part of number in input string
0EFD C5        PUSH   BC           --- BC = 00 00
0EFE F5        PUSH   AF           --- Save flags indicating data type, A = lng
0EFF CCB10A    CALL   Z,0AB1H      --- Convert current value to single precision
0F02 F1        POP    AF           --- Restore flags
0F03 C4DB0A    CALL   NZ,0ADBH     --- Convert current value to double precision
0F06 C1        POP    BC           --- Restore B = 00/00
```

```
0EC9  : A-reg = no. off times to divide/multiply

0ECD  : addition at 0F6B - 0F6F. A reg automatically
      : bumped by 0F18

0EE0  : If so Set type to integer. Value to 8000

0EE4  * ************************************************************

0EE6  : dec. pt. first char.

0EEE  * % found - finalize value and exit ***************************

0EF5  * ************************************************************

0EFB  * ************************************************************
```

```
0F07 D1        POP    DE          --- Restore integer part of number
0F08 E1        POP    HL          --- Restore current position in input string
0F09 C9        RET                --- Return
0F0A C8        RET    Z           --- Multiply a SP or DP number by 10 ******* cont--> *
0F0B F5        PUSH   AF          --- Save caller's AF
0F0C E7        RST    20H         --- Determine data type
0F0D F5        PUSH   AF          --- Save data type
0F0E E43E09    CALL   PO,093EH    --- Single: multiply current value by 10
0F11 F1        POP    AF          --- Reload data type
0F12 EC4D0E    CALL   PE,0E4DH    --- Double: multiply current value by 10
0F15 F1        POP    AF          --- Restore caller's AF
0F16 3D        DEC    A           --- and decrement count of times multiplied
0F17 C9        RET                --- Rtn to caller
0F18 D5        PUSH   DE          --- Divide current SP or DP value by 10 *************
0F19 E5        PUSH   HL          --- Save caller's registers
0F1A F5        PUSH   AF          --- DE / HL / AF
0F1B E7        RST    20H         --- Determine data type
0F1C F5        PUSH   AF          --- A = type
0F1D E49708    CALL   PO,0897H    --- Divide current value by 10
0F20 F1        POP    AF          --- Reload type so we'll skip other call
0F21 ECDC0D    CALL   PE,0DDCH    --- Double: divide current value by 10
0F24 F1        POP    AF          --- Restore users registers
0F25 E1        POP    HL          --- AF / HL
0F26 D1        POP    DE          --- and DE then increment
0F27 3C        INC    A           --- Count of times divided
0F28 C9        RET                --- Rtn to caller
0F29 D5        PUSH   DE          --- DE = 00 00 **************************************
0F2A 78        LD     A,B         --- B = 00
0F2B 89        ADC    A,C         --- CARRY is always set when entered,      see note-->
0F2C 47        LD     B,A         --- B = 0 for integer conversion. Count of     cont-->
0F2D C5        PUSH   BC          --- Save 0 or count
0F2E E5        PUSH   HL          --- Save position in input string
0F2F 7E        LD     A,(HL)      --- Ref etch current character
0F30 D630      SUB    30H         --- A= 0 - 9
0F32 F5        PUSH   AF          --- Save binary value for current digit
0F33 E7        RST    20H         --- Determine data type we're converting to
0F34 F25D0F    JP     P,0F5DH     --- Jump if not an integer. A = current digit
0F37 2A2141    LD     HL,(4121H)  --- ASCII to integer conversion
0F3A 11CD0C    LD     DE,0CCDH    --- DE = 3277
0F3D DF        RST    18H         --- Compare current value to 3277
0F3E 3019      JR     NC,0F59H    --- Jump, value >= 3277
0F40 54        LD     D,H         --- DE = current value
0F41 5D        LD     E,L         --- Multiply by 10
0F42 29        ADD    HL,HL       --- * 2
0F43 29        ADD    HL,HL       --- * 4
0F44 19        ADD    HL,DE       --- * 5
0F45 29        ADD    HL,HL       --- * 10
0F46 F1        POP    AF          --- Reload current digit
0F47 4F        LD     C,A         --- Binary value of current digit
0F48 09        ADD    HL,BC       --- Add units digit
0F49 7C        LD     A,H         --- Now test sign of value thus far
0F4A B7        OR     A           --- Ret status flags
0F4B FA570F    JP     M,0F57H     --- Jump if value exceeds 2 ** 15
0F4E 222141    LD     (4121H),HL  --- Save binary value
0F51 E1        POP    HL          --- Restore HL, BC, and DE
0F52 C1        POP    BC          --- B= count of digits after dec. pt.         cont-->
0F53 D1        POP    DE          --- Possible sign flags
0F54 C3830E    JP     0E83H       --- Get next digit
0F57 79        LD     A,C         --- A = current digit
0F58 F5        PUSH   AF          --- Save so it can be converted to SP then     cont-->
```

```
0F0A  * Exit if integer *********************************************

0F18  * *********************************************************

0F29  * *********************************************************

0F2B  : C = 00 for SP, = FF for integer
0F2C  : integers for SP conversion after decimal point

0F52  : C=FF until a dec. pt. encountered

0F58  : added to current value after current value is converted to SP
```

```
0F59 CDCC0A    CALL   0ACCH       --- Convert current value to SP
0F5C 37        SCF                --- So we'll bypass calls to convert to DP
0F5D 3018      JR     NC,0F77H    --- Jump if double
0F5F 017494    LD     BC,9474H    --- ASCII to SP Load a SP 16X10E6 into BC/DE
0F62 110024    LD     DE,2400H    --- 16X10E6 to current SP no. in (4121 - 4124)
0F65 CD0C0A    CALL   0A0CH       --- Compare
0F68 F2740F    JP     P,0F74H     --- Jmp if current value >2E16 go convert to DP
0F6B CD3E09    CALL   093EH       --- Multiply current value by 10           cont-->
0F6E F1        POP    AF          --- A = current digit
0F6F CD890F    CALL   0F89H       --- Convert current digit to SP format     cont-->
0F72 18DD      JR     0F51H       --- Go get next digit. Count of digits     cont-->
0F74 CDE30A    CALL   0AE3H       --- Initialize DP 411D, 411F. Flag value as DP
0F77 CD4D0E    CALL   0E4DH       --- Multiply current SP value by 10
0F7A CDFC09    CALL   09FCH       --- Move DP no. in (4121 - 4126) to (4127 - 412E)
0F7D F1        POP    AF          --- A = binary value for current digit
0F7E CD6409    CALL   0964H       --- Convert current digit to SP
0F81 CDE30A    CALL   0AE3H       --- Initialize DP cells 411D, 411E to zero
0F84 CD770C    CALL   0C77H       --- Add current SP digit to current SP value
0F87 18C8      JR     0F51H       --- Go get next digit
0F89 CDA409    CALL   09A4H       --- Save current value (4121-4123) on stk ** note--> *
0F8C CD6409    CALL   0964H       --- Convert value in A-reg to a single prec. value
0F8F C1        POP    BC          --- Load current SP value into BC/DE
0F90 D1        POP    DE          --- B = exponent, C = MSB, D = next MSB, C = LSB
0F91 C31607    JP     0716H       --- Add value in registers to current      cont-->
0F94 7B        LD     A,E         --- A = exponent thus far ************** see note--> *
0F95 FE0A      CP     0AH         --- Compare with 10
0F97 3009      JR     NC,0FA2H    --- If => 10. Force it to a constant 32
0F99 07        RLCA               --- Then multiply current value by 10
0F9A 07        RLCA               --- *4
0F9B 83        ADD    A,E         --- +1 gives times 5
0F9C 07        RLCA               --- *2 gives times 10
0F9D 86        ADD    A,(HL)      --- Fetch current digit (in ASCII)
0F9E D630      SUB    30H         --- Convert it to its binary equivalent    cont-->
0FA0 5F        LD     E,A         --- Current digit to E
0FA1 FA1E32    JP     M,321EH     --- 0FA2 = LD E,32
0FA4 C3BD0E    JP     0EBDH       --- Get next digit from input string. Rtn to F94
0FA7 E5        PUSH   HL          --- Save code string addr ***************************
0FA8 212419    LD     HL,1924H    --- Load addr of IN message
0FAB CDA728    CALL   28A7H       --- Output message
0FAE E1        POP    HL          --- Restore code string addr
0FAF CD9A0A    CALL   0A9AH       --- Save value in HL as current value ****** cont--> *
0FB2 AF        XOR    A           --- Signal no editing when converting
0FB3 CD3410    CALL   1034H       --- Initialize print buffer
0FB6 B6        OR     (HL)        --- Set status to NON-ZERO for test at OF E7
0FB7 CDD90F    CALL   0FD9H       --- Convert current value to ASCII
0FBA C3A628    JP     28A6H       --- Output value & rtn to caller
0FBD AF        XOR    A           --- Clear edit flags ****************** see note--> *
0FBE CD3410    CALL   1034H       --- Output buffer addr to HL. Edit flags to 40D8
0FC1 E608      AND    08H         --- Test if sign requested in output
0FC3 2802      JR     Z,0FC7H     --->: Jmp if no leading + sign required
0FC5 362B      LD     (HL),2BH    --  : Plus sign
0FC7 EB        EX     DE,HL       <---: Save addr of output buffer in DE
0FC8 CD9409    CALL   0994H       --- Determine sign of current value
0FCB EB        EX     DE,HL       --- Restore output buffer addr to HL
0FCC F2D90F    JP     P,0FD9H     --- Jmp if value is positive
0FCF 362D      LD     (HL),2DH    --- Minus sign to PBUF
0FD1 C5        PUSH   BC          --- Save count of #'s before & after decimal point
0FD2 E5        PUSH   HL          --- Current position in print buffer
0FD3 CD7B09    CALL   097BH       --- Convert a neg. number to its positive equivalent
0FD6 E1        POP    HL          --- Restore print buffer address
```

```
0F6B  : We'll divide out multiplication later

0F6F  : & add to number thus far
0F72  : after dec. pt. in B-reg

0F89  * ***** Converts the 8 bit value in the A-reg to a SP *******
      :       number and adds it to the current value in WRA1

0F91  : value (4121 - 4124). Rtn to caller
0F94  * ***** Accumulate value for exponent in E-reg. Do not *******
      :       let it exceed 50 (base 10). Called when processing
      :       exponents for E or D type values.

      : and add to current value

0F94  * ************************************************************

0FAF  * Set type to integer ********* Convert no. in HL to ASCII ****
      :                               and write to video

0FBD  * ***** Convert binary to ASCII. Build print buffer using ****
      :       edit flags in A. On entry
      :                       B = count of #'s before
      :                       C = count of #'s after
```

```
0FD7 C1         POP     BC            --- Restore counter
0FD8 B4         OR      H             --- Combine 41 with positive MSB
0FD9 23         INC     HL            --- HL = 4131H
0FDA 3630       LD      (HL),30H      --- ASCII zero to next position in print buffer
0FDC 3AD840     LD      A,(40D8H)     --- A = edit flags
0FDF 57         LD      D,A           --- Save edit flags in D
0FE0 17         RLA                   --- Prepare to test bit 2**15 (print using) call
0FE1 3AAF40     LD      A,(40AFH)     --- A = type/length of current variable
0FE4 DA9A10     JP      C,109AH       --- Jmp if called from PRINT USING
0FE7 CA9210     JP      Z,1092H       --- Jmp to exit if edit flag is zero
0FEA FE04       CP      04H           --- Test data type
0FEC D23D10     JP      NC,103DH      --- Jmp if SNG or DOUBLE
0FEF 010000     LD      BC,0000H      --- BC = flag for no commas or dec. pts.
0FF2 CD2F13     CALL    132FH         --- Convert integer number to ASCII in work area
0FF5 213041     LD      HL,4130H      --- Start of ASCII buffer            :(current value)
0FF8 46         LD      B,(HL)        --- B = first ASCII character in buffer
0FF9 0E20       LD      C,20H         --- Blank
0FFB 3AD840     LD      A,(40D8H)     --- Get editing parameter word. See if we must test
0FFE 5F         LD      E,A           --- for and identify numbers out of range.
0FFF E620       AND     20H           --- Test if leading *'s wanted
1001 2807       JR      Z,100AH       --- Do not test for out of range numbers.
1003 78         LD      A,B           --- If first char in PBUF <> blank,            cont-->
1004 B9         CP      C             --- Compare PBUF(1) with blank, if not equal replace
1005 0E2A       LD      C,2AH         --- PBUF(1) with an *. C = *
1007 2001       JR      NZ,100AH      --- Number has not overflowed
1009 41         LD      B,C           --- Number has overflowed
100A 71         LD      (HL),C        --- Replace PBUF(1) with *
100B D7         RST     10H           --- If no range checks, unconditionally        cont-->
100C 2814       JR      Z,1022H       --- Jump if binary zero (end of buffer)
100E FE45       CP      45H           --- Test for E
1010 2810       JR      Z,1022H       --- Jump if E
1012 FE44       CP      44H           --- Test for D            : Scan print buffer
1014 280C       JR      Z,1022H       --- Jump if D             : looking for an E, 0,
1016 FE30       CP      30H           --- Test for 0            : ., or end of print
1018 28F0       JR      Z,100AH       --- Jump if ASCII zero    : buffer. Replace zeroes
101A FE2C       CP      2CH           --- Test for comma        : with blanks.
101C 28EC       JR      Z,100AH       --- Jump if comma
101E FE2E       CP      2EH           --- Test for decimal point
1020 2003       JR      NZ,1025H      --- Jump if not decimal point
1022 2B         DEC     HL            --- We have a decimal point, end of line or a D or E
1023 3630       LD      (HL),30H      --- Backspace to previous byte and replace it with an
1025 7B         LD      A,E           --- A = edit flags                                :ASCII 0
1026 E610       AND     10H           --- Test for leading $ insertion
1028 2803       JR      Z,102DH       --- No
102A 2B         DEC     HL            --- Yes, backspace one more byte
102B 3624       LD      (HL),24H      --- And insert a $
102D 7B         LD      A,E           --- Re-fetch edit flags
102E E604       AND     04H           --- Test if sign follows value
1030 C0         RET     NZ            --- No, rtn
1031 2B         DEC     HL            --- Yes, backspace print buffer
1032 70         LD      (HL),B        --- Save sign
1033 C9         RET                   --- then rtn
1034 32D840     LD      (40D8H),A     --- Save edit flags **********************************
1037 213041     LD      HL,4130H      --- HL = Starting addr of line buffer (PBUF)
103A 3620       LD      (HL),20H      --- Blank if first char. in print buffer
103C C9         RET                   --- Rtn to caller
103D FE05       CP      05H           --- Convert SP or DP to ASCII ************** cont--> *
103F E5         PUSH    HL            --- Save current position in PBUF
1040 DE00       SBC     A,00H         --- A = 4 if SP, A = 8  if DP
1042 17         RLA                   --- A = 8 if SP, A = 10 if DP
```

1003 : then number has overflowed

100B : replace 1st char in buffer with a blank.

1034 * ***

103D * Set CARRY if double precision *******************************

```
1043 57        LD      D,A          --- D = Adjust type flag
1044 14        INC     D            --- D = 9 (SP), D = B (DP)
1045 CD0112    CALL    1201H        --- Scale no. to 99,999 < X < 999,999
1048 010003    LD      BC,0300H     --- After scaling, A = count of times DP value scaled
104B 82        ADD     A,D          --- Up (positive), or down (negative)
104C FA5710    JP      M,1057H      --->: Jmp if scaled down more than 9 or 11 places
104F 14        INC     D            --  : D = A (SP) or C (DP)
1050 BA        CP      D            --  : Test if value was not scaled at all
1051 3004      JR      NC,1057H     --->: Jmp if scaled up or down
1053 3C        INC     A            --  : A = no. of digits in value
1054 47        LD      B,A          --  : Save in B
1055 3E02      LD      A,02H        --  : Force exponent to zero
1057 D602      SUB     02H          <---: Compute exponent value
1059 E1        POP     HL           --- Restore PBUF addr
105A F5        PUSH    AF           --- Save exponent
105B CD9112    CALL    1291H        --- Initialize commas & dec. pt. routine
105E 3630      LD      (HL),30H     --- Put an ASCII zero into current pos. in print
1060 CCC909    CALL    Z,09C9H      --- Increment HL if no scaling was done        :buffer
1063 CDA412    CALL    12A4H        --- Convert binary to ASCII. Result to PBUF
1066 2B        DEC     HL           --- Backspace PBUF to previous char        see note-->
1067 7E        LD      A,(HL)       --- Load previous char
1068 FE30      CP      30H          --- Compare to an ASCII zero
106A 28FA      JR      Z,1066H      --- Loop till a non-zero char. found
106C FE2E      CP      2EH          --- Test for dec. pt.
106E C4C909    CALL    NZ,09C9H     --- Call if not decimal point (increment       cont-->
1071 F1        POP     AF           --- Restore exponent
1072 281F      JR      Z,1093H      --- Jump if exponent is zero
1074 F5        PUSH    AF           --- Save exponent
1075 E7        RST     20H          --- Test data type
1076 3E22      LD      A,22H        --- This will become a D or
1078 8F        ADC     A,A          --- E depending on whether value is SP or DP
1079 77        LD      (HL),A       --- Save exponent designation
107A 23        INC     HL           --- Bump to first pos. of exponent in buffer
107B F1        POP     AF           --- Reload exponent value
107C 362B      LD      (HL),2BH     --- + (exponent)
107E F28510    JP      P,1085H      --- Jmp if exponent is positive
1081 362D      LD      (HL),2DH     --- - (exponent)
1083 2F        CPL                  --- Convert negative exponent
1084 3C        INC     A            --- to its positive equivalent
1085 062F      LD      B,2FH        --- B = start of ASCII values 0, 1, 2 ..... 9
1087 04        INC     B            --- Start of divide by 10 using compound       cont-->
1088 D60A      SUB     0AH          --- Subtract 10 until
108A 30FB      JR      NC,1087H     --- Remainder < 10. B = quotient
108C C63A      ADD     A,3AH        --- Convert remainder to an ASCII digit
108E 23        INC     HL           --- Bump to next pos. in PBUF
108F 70        LD      (HL),B       --- 1st digit of exponent
1090 23        INC     HL           --- Bump to next pos. in PBUF
1091 77        LD      (HL),A       --- 2nd digit of exponent
1092 23        INC     HL           --- Bump to next pos. in PBUF
1093 3600      LD      (HL),00H     --- 00 marks end of ASCII number
1095 EB        EX      DE,HL        --- DE = ending addr. of PBUF
1096 213041    LD      HL,4130H     --- HL = starting addr. of PBUF
1099 C9        RET                  --- Ret. to caller
109A 23        INC     HL           --- Bump to next location in PBUF ********** cont--> *
109B C5        PUSH    BC           --- B = count of #'s before. C = count of #'s after
109C FE04      CP      04H          --- A = data type. Test for integer/floating point
109E 7A        LD      A,D          --- A = edit flags
109F D20911    JP      NC,1109H     --- Jmp if single or double precision
10A2 1F        RRA                  --- Position exponential notation flag
10A3 DAA311    JP      C,11A3H      --- Jmp if current variable is string, else    cont-->
```

```
1066  : Backspace PBUF to first non-zero value

106E  : HL to first char after dec. pt.)

1087  : subtraction loop:     Convert value in A-register

      :                       to a true digit ASCII value.
      :                       Divide by 10 using compound subtraction

109A  * Edit operations for PRINT USING *****************************

10A3  : must be integer
```

```
10A6 010306     LD      BC,0603H       --- B = no. of leading digits C = comma        cont-->
10A9 CD8912     CALL    1289H          --- Test comma flag. If not set zero C
10AC D1         POP     DE             --- D = count of #'s before dec. pt.
10AD 7A         LD      A,D            --- Count to A
10AE D605       SUB     05H            --- Compare to 5 (max no. digits allowed in integer)
10B0 F46912     CALL    P,1269H        --- Fill PBUF with leading zeroes. If          cont-->
10B3 CD2F13     CALL    132FH          --- Convert current value (integer) to         cont-->
10B6 7B         LD      A,E            --- Load count of #'s after dec. pt. into A
10B7 B7         OR      A              --- and set status flags
10B8 CC2F09     CALL    Z,092FH        --- If no trailing #'s, backspace PBUF
10BB 3D         DEC     A              --- Test if no count given
10BC F46912     CALL    P,1269H        --- Else add count trailing zeros
10BF E5         PUSH    HL             --- Save current PBUF addr
10C0 CDF50F     CALL    0FF5H          --- Edit ASCII buffer w/ converted number in it
10C3 E1         POP     HL             --- Restore HL to PBUF addr
10C4 2802       JR      Z,10C8H        --->: Jmp if sign follows value
10C6 70         LD      (HL),B         --  : No. store a blank after value
10C7 23         INC     HL             --  : Bump to next pos. in PBUF
10C8 3600       LD      (HL),00H       <---: Terminate buffer with a byte of zeros
10CA 212F41     LD      HL,412FH       --- Start of ASCII print buffer minus 1
10CD 23         INC     HL             --- Bump to next pos. in PBUF                  note-->
10CE 3AF340     LD      A,(40F3H)      --- A = LSB of addr of dec. pt. in PBUF
10D1 95         SUB     L              --- Compare to LSB of current PBUF
10D2 92         SUB     D              --- Then subtract length of field
10D3 C8         RET     Z              --- Exit if start of field located
10D4 7E         LD      A,(HL)         --- Not start of field, then fetch char and
10D5 FE20       CP      20H            --- Test for blank
10D7 28F4       JR      Z,10CDH        --- Loop till start of field or +, -, $ found
10D9 FE2A       CP      2AH            --- Test for *
10DB 28F0       JR      Z,10CDH        --- Ignore blanks and
10DD 2B         DEC     HL             --- Backspace to previous char so it can be re-tested
10DE E5         PUSH    HL             --- Save PBUF addr
10DF F5         PUSH    AF             --- Save current char
10E0 01DF10     LD      BC,10DFH       --- Return addr in case of -, +, $
10E3 C5         PUSH    BC             --- to stack
10E4 D7         RST     10H            --- Re-examine char
10E5 FE2D       CP      2DH            --- Compare with a -
10E7 C8         RET     Z              --- Exit to 10DF if a minus
10E8 FE2B       CP      2BH            --- Not - try a +
10EA C8         RET     Z              --- Exit to 10DF if a plus
10EB FE24       CP      24H            --- Not + or -, try $
10ED C8         RET     Z              --- Exit to 10DF if $
10EE C1         POP     BC             --- Clear rtn addr. of 10DF
10EF FE30       CP      30H            --- Test for ASCII 0 (leading 0)
10F1 200F       JR      NZ,1102H       --->: Jump if not leading 0
10F3 23         INC     HL             --  : Skip next char
10F4 D7         RST     10H            --  : and examine following one
10F5 300B       JR      NC,1102H       --  : Jump if not numeric
10F7 2B         DEC     HL             --  : Backspace to last char examined
10F8 012B77     LD      BC,772BH       --  : 10F9: DEC HL      :Backspace one more char
10FB F1         POP     AF             --  : 10FA: LD  (HL),A  :Shift digits up 1 pos.
10FC 28FB       JR      Z,10F9H        --  : Loop till end of field reached
10FE C1         POP     BC             --  : Clear stack
10FF C3CE10     JP      10CEH          --  : Restart scan
1102 F1         POP     AF             <---: Restore char at start of field
1103 28FD       JR      Z,1102H        --- Loop till beginning of field found
1105 E1         POP     HL             --- Restore starting addr of field
1106 3625       LD      (HL),25H       --- Replace it with a
1108 C9         RET                    --- Rtn to caller
1109 E5         PUSH    HL             --- Save current PBUF addr. ************ see note--> *
```

```
10A6  : counter Integer editing for PRINT USING



10B0  : more than 5 digits
10B3  : ASCII. Result to PBUF



      :            Locate start of field in PBUF and
      :            rtn to caller. If field starts with
      :            a +, -, or $ goto 10DF before returning
      :            to caller. Search for field by starting
      :            at addr. of dec. pt. and backspacing
      :            size of field (D-reg)



1109  * *********** Floating point editing **************************
```

```
110A 1F        RRA                  --- Test bit 0 of edit flags              see note-->
110B DAAA11    JP    C,11AAH        --- Jmp if exponential notation on flt. pt. number
110E 2814      JR    Z,1124H        --->: Jump if value is SP
1110 118413    LD    DE,1384H        •  : DE = addr of DP 1X10**16
1113 CD490A    CALL  0A49H           •  : Compare value to 1X10**16
1116 1610      LD    D,10H           •  : D = no. of digits in a DP field
1118 FA3211    JP    M,1132H        ----:--:>: Jmp if value < 1X10**16 else
111B E1        POP   HL             <---:--: : Restore current location in print buffer
111C C1        POP   BC              •  :  : : B=count of #'s before, C=count of #'S after
111D CDBD0F    CALL  0FBDH           •  :  : : Reenter edit routine till value < 1X10**16
1120 2B        DEC   HL              •  :  : : Restore buffer addr. current position
1121 3625      LD    (HL),25H        •  :  : : Store a % (start of spaces field)
1123 C9        RET                   •  :  : : Rtn to caller
1124 010EB6    LD    BC,0B60EH      <---:  : : BC/DE = 1 X 10E16 *********** see note-->
1127 11CA1B    LD    DE,1BCAH        •     : :
112A CD0C0A    CALL  0A0CH           •     : : Compare edit value to 1 X 10E16
112D F21B11    JP    P,111BH        ------>: : Jmp if edit value > 1X10E16
1130 1606      LD    D,06H          ---      : D = no. of digits to print (size of field)
1132 CD5509    CALL  0955H          <--------: Test sign of current value
1135 C40112    CALL  NZ,1201H       --- Scale SP value to 99,999<X<999,999        cont-->
1138 E1        POP   HL             --- HL = origin of ASCII buffer
1139 C1        POP   BC             --- B=count of #'s before, C=count of #'s afterwards
113A FA5711    JP    M,1157H        --->: Jmp if value was scaled up (multiplied by 10)
113D C5        PUSH  BC             --  : Save count of #'s before and after dec. pt.
113E 5F        LD    E,A            --  : E=count of times value was divided
113F 78        LD    A,B            --  : B=no. of user specified #'s before      note-->
1140 92        SUB   D              --  : D=6
1141 93        SUB   E              --  : E = no. of times edit value divided by 10
1142 F46912    CALL  P,1269H        --  : Put leading ASCII zeroes into PBUF
1145 CD7D12    CALL  127DH          --  : Compute count of dec. pts. and commas
1148 CDA412    CALL  12A4H          --  : Convert integer of SP number to ASCII
114B B3        OR    E              --  : Test count of times value scaled
114C C47712    CALL  NZ,1277H       --  : Add trailing zeroes for each time value scaled
114F B3        OR    E              --  : Set status flag
1150 C49112    CALL  NZ,1291H       --  : Place decimal point/commas in numeric buffer
1153 D1        POP   DE             --  : Restore edit counts
1154 C3B610    JP    10B6H          --  : Go convert fractional portion of no. to ASCII
1157 5F        LD    E,A            <---: E=count of times value scaled up (mult. by 10) *
1158 79        LD    A,C            -- C=count of digits following dec. pt        cont-->
1159 B7        OR    A              --- Test count
115A C4160F    CALL  NZ,0F16H       --- Decrement count of trailing #'s by        cont-->
115D 83        ADD   A,E            --- A=((no. trailing #'s)-1) +                cont-->
115E FA6211    JP    M,1162H        --->: Jmp if value needs to be scaled down
1161 AF        XOR   A              --  : Signal no down-scaling
1162 C5        PUSH  BC             <---: Save before & after counters
1163 F5        PUSH  AF             --- Save scale count
1164 FC180F    CALL  M,0F18H        <---: Divide current value by 10 (A) times
1167 FA6411    JP    M,1164H        --->: After each division, A-reg is incremented
116A C1        POP   BC             --- Original scale count
116B 7B        LD    A,E            --- A = count of times value multiplied by 10
116C 90        SUB   B              --- Minus scale value
116D C1        POP   BC             --- Restore before and after dec. pt. counter
116E 5F        LD    E,A            --- Adjusted scale factor
116F 82        ADD   A,D            --- Plus size of field (set sign flag)
1170 78        LD    A,B            --- A = count of #'s before dec. pt.
1171 FA7F11    JP    M,117FH        --- Jmp no leading digits
1174 92        SUB   D              --- Else subtract field size (6 for SP,       cont-->
1175 93        SUB   E              --- Then subtract adjusted scale
1176 F46912    CALL  P,1269H        --- Add trailing zeroes
1179 C5        PUSH  BC             --- Save count of #'s before and after dec. pt.
```

```
      :           For PRINT USING

1124  * ***** Edit SP value or a DP value <1Xl0E16 ****************

1135  : On rtn A = times value scaled up or down as + or -

      :           Value was scaled down or not
      :           scaled at all. Adjust scale for
      :           no. of places before dec. Pt.

1157  * ************************************************************
1158  :                 to print. Value was scaled up. Adjust scale
      :                 for no. of places following dec. pt.
115A  : one if its non-zero
115D  : (-no. of times value scaled up)

1174  : 10 for DP) from adjusted size
```

```
117A CD7D12    CALL   127DH         --- Setup B/C for dec. pt. and comma counters
117D 1811      JR     1190H         --- Go edit number before dec. pt.
117F CD6912    CALL   1269H         --- insert a zero into PBUF *************************
1182 79        LD     A,C           --- Save comma counter Will be wiped by call 1294
1183 CD9412    CALL   1294H         --- Add dec. pt. to PBUF gives 0
1186 4F        LD     C,A           --- Restore comma counter to C-reg
1187 AF        XOR    A             --- Zero to A-reg
1188 92        SUB    D             --- Now, get diff. between requested
1189 93        SUB    E             --- field size and scaled field size
118A CD6912    CALL   1269H         --- Then add that many zeroes to PBUF
118D C5        PUSH   BC            --- Save count or #'s before and after dec. pt.
118E 47        LD     B,A           --- Zero B
118F 4F        LD     C,A           --- Zero C
1190 CDA412    CALL   12A4H         --- Convert integer portion of SP value to integer
1193 C1        POP    BC            --- Restore counters                          :ASCII
1194 B1        OR     C             --- Set status for count of #'s after dec. pt.
1195 2003      JR     NZ,119AH      --- Jmp if digits follow dec. pt.
1197 2AF340    LD     HL,(40F3H)    --- Else load addr. of dec. pt. in PBUF
119A 83        ADD    A,E           --- Gives no. of digits before dec. pt.
119B 3D        DEC    A             --- Minus 1
119C F46912    CALL   P,1269H       --- Add that many zeros to PBUF
119F 50        LD     D,B           --- Set D = no. of #'s before
11A0 C3BF10    JP     10BFH         --- Go edit ASCII value
11A3 E5        PUSH   HL            --- Save current position in PBUF ******* see note--> *
11A4 D5        PUSH   DE            --- Save edit flags
11A5 CDCC0A    CALL   0ACCH         --- Convert integer to single precision
11A8 D1        POP    DE            --- Restore edit flags
11A9 AF        XOR    A             --- Clear status flags. Force Jmp for SP
11AA CAB011    JP     Z,11B0H       --- Jmp if single precision           SP/DP entry pt.
11AD 1E10      LD     E,10H         --- E = no. digits to print if DP
11AF 011E06    LD     BC,061EH      --- 11B0: LD E,6   E = no. digits to print if SP
11B2 CD5509    CALL   0955H         --- Test sign of current value
11B5 37        SCF                  --- Force Jmp at 11F3 on first pass
11B6 C40112    CALL   NZ,1201H      --- If current value not zero, go scale it
11B9 E1        POP    HL            --- Restore PBUF addr.
11BA C1        POP    BC            --- Restore count of # s before and after
11BB F5        PUSH   AF            --- Decimal point, save flag for test at 11F3
11BC 79        LD     A,C           --- A = count of # s after
11BD B7        OR     A             --- Set status so we can test for zero
11BE F5        PUSH   AF            --- Save original trailing digit count
11BF C4160F    CALL   NZ,0F16H      --- If trail count non-zero, decrement it
11C2 80        ADD    A,B           --- Combine count of before & after
11C3 4F        LD     C,A           --- Save total digit count
11C4 7A        LD     A,D           --- Load edit flags
11C5 E604      AND    04H           --- Isolate sign follows value flag
11C7 FE01      CP     01H           --- Gives no CARRY if sign follows
11C9 9F        SBC    A,A           --- A = 0 if no sign, FE otherwise
11CA 57        LD     D,A           --- Save new edit flag
11CB 81        ADD    A,C           --- Adjust count of digits to print if sign follows
11CC 4F        LD     C,A           --- Save adjusted count
11CD 93        SUB    E             --- A = number of times to divide by 10
11CE F5        PUSH   AF            --- Save divisor count
11CF C5        PUSH   BC            --- Save char. count
11D0 FC180F    CALL   M,0F18H       <---: Divide value by 10 (A) times
11D3 FAD011    JP     M,11D0H       --->: Loop till division completed
11D6 C1        POP    BC            --- Restore counter of #'s
11D7 F1        POP    AF            --- Restore division count
11D8 C5        PUSH   BC            --- Then resave
11D9 F5        PUSH   AF            --- Registers and
11DA FADE11    JP     M,11DEH       --- Jmp if any trailing zeros
```

```
117F   : ************************************************************

11A3   * Exponential formatting for PRINT USING **********************
       : 11A3 - Entry pt. INTEGER
       : 11AA - Entry pt. SP/DP
```

```
11DD AF         XOR     A               --- Clear A, status flags
11DE 2F         CPL                     --- Make trailing zero count positive
11DF 3C         INC     A               --- 2's complement
11E0 80         ADD     A,B             --- Add size of field before dec. pt.
11E1 3C         INC     A               --- Plus one more
11E2 82         ADD     A,D             --- Add size of field (6/SP, 10/DP)
11E3 47         LD      B,A             --- B = number of digits before dec. pt.
11E4 0E00       LD      C,00H           --- Signal no commas
11E6 CDA412     CALL    12A4H           --- Convert value to ASCII
11E9 F1         POP     AF              --- Restore original count of #'s before
11EA F47112     CALL    P,1271H         --- Add trailing zeros
11ED C1         POP     BC              --- Restore counts of nos. before and after dec. pt.
11EE F1         POP     AF              --- Get count of nos. before dec. pt.
11EF CC2F09     CALL    Z,092FH         --- None before, backspace PBUF addr 1 byte
11F2 F1         POP     AF              --- Get first time flag. If set, clear stack,
11F3 3803       JR      C,11F8H         --- Add exponent, and join common edit code.
11F5 83         ADD     A,E             --- Otherwise, add default field size to + 1 if pos.
11F6 90         SUB     B               --- Or a - 1 if neg.. Then subtract actual
11F7 92         SUB     D               --- Number of chars in field to get size of exponent
11F8 C5         PUSH    BC              --- Save BC
11F9 CD7410     CALL    1074H           --- Compute and add exponent to PBUF
11FC EB         EX      DE,HL           --- Restore HL
11FD D1         POP     DE              --- Clear stack
11FE C3BF10     JP      10BFH           --- Go edit ASCII value
1201 D5         PUSH    DE              --- Test magnitude of SP and DP numbers **** cont--> *
1202 AF         XOR     A               --- Zero A and flags, save zero
1203 F5         PUSH    AF              --- On stack                              see note-->
1204 E7         RST     20H             --- Test data type
1205 E22212     JP      PO,1222H        --- Jump if single
1208 3A2441     LD      A,(4124H)       --- Must be double, get the exponent into A
120B FE91       CP      91H             --- Compute no. of bits in integer portion of number
120D D22212     JP      NC,1222H        --- Jmp if 17 or more bits in integer portion of
1210 116413     LD      DE,1364H        --- DE=addr of DP 5.5X10E2                  :DP value
1213 212741     LD      HL,4127H        --- Destination addr
1216 CDD309     CALL    09D3H           --- Move 5.5X10E8 to saved value location
1219 CDA10D     CALL    0DA1H           --- Multiply 5.5X10E8 times current value
121C F1         POP     AF              --- A = count of times DP value multiplied to scale
121D D60A       SUB     0AH             --- A = count - 10                                :it up
121F F5         PUSH    AF              --- Save for testing
1220 18E6       JR      1208H           -- Loop till integer portion exceeds 2E16
1222 CD4F12     CALL    124FH           --- Compare current value to 999,999, ****** cont--> *
1225 E7         RST     20H             <-------: Test data type
1226 EA3412     JP      NC,1234H         •      : Jump if not single
1229 014391     LD      BC,9143H         •      : BC/DE = SP 99,999 decimal
122C 11F94F     LD      DE,4FF9H         •      :
122F CD0C0A     CALL    0A0CH            •      : Compare current value to 99,999
1232 1806       JR      1239H           --->:   : Go test results of comparison
1234 116C13     LD      DE,136CH         •  :   : DE addr of SP 1.44X10E17
1237 CD490A     CALL    0A49H            •  :   : Compare current value to 1.44X10E17
123A F24C12     JP      P,124CH         <---:--:-->: Jmp if value > 99,999         see note-->
123D F1         POP     AF               •  :  :   : A = scaled counter
123E CD0B0F     CALL    0F0BH            •  :  :   : Multiply current value by 10
1241 F5         PUSH    AF               •  :  :   : A = - no. of times value multiplied
1242 18E1       JR      1226H           ------>:   : Loop till between 999,999 and 99,999
1244 F1         POP     AF              ---        : A = scaled count
1245 CD180F     CALL    0F18H           ---        : Divide value by 10. It's > 999,999
1248 F5         PUSH    AF              ---        : Keep count of times divided
1249 CD4F12     CALL    124FH           ---        : Loop till value < 999,999
124C F1         POP     AF              <----------: A = + times divided : - times multiplied
124D D1         POP     DE              --- Restore callers DE
```

```
1201  * Clear times value scaled ************************************

      :     Scale a single or double precision number
      :     so it lies between 99,999 and 999,999.
      :     On exit A = +(times value divided), or
      :     -(times multiplied).
```

```
1222  * Rtn in line if value smaller ********************************
      : Scale SP and DP numbers so that 99,999<SP<999,999
```

```
123A  : (more than 5 digits in integer or less than 17 digits in DP)
```

```
124E C9       RET                   --- Rtn to caller
124F E7       RST     20H           --- Test data type **********************************
1250 EA5E12   JP      PE,125EH      --- Jump if double precision
1253 017494   LD      BC,9474H      --- BC/DE = 999,999 decimal
1256 11F823   LD      DE,23F8H      ---
1259 CD0C0A   CALL    0A0CH         --- Compare current value to 999,999 decimal
125C 1806     JR      1264H         --- Test result of comparison
125E 117413   LD      DE,1374H      --- DE = address ***********************************
1261 CD490A   CALL    0A49H         --- Compare current value
1264 E1       POP     HL            --- Clear rtn addr so we can go to 1244
1265 F24312   JP      P,1243H       --- Jmp if current value has more than 6 digits in
1268 E9       JP      (HL)          --- Else rtn to caller                      :integer
1269 B7       OR      A             --- Test zero flag ******************** see note--> *
126A C8       RET     Z             <---: in HL.
126B 3D       DEC     A              •  : Count 1 ASCII zero moved to print buffer
126C 3630     LD      (HL),30H       •  : Move an ASCII zero
126E 23       INC     HL             •  : Bump destination address
126F 18F9     JR      126AH         --->: Loop till 'A' ASCII zeroes moved
1271 2004     JR      NZ,1277H      --- If not done adding trailing zeroes else exit ****
1273 C8       RET     Z             --- Rtn to caller if trailing zeros added
1274 CD9112   CALL    1291H         --- Decimal point/commas in numeric buffer
1277 3630     LD      (HL),30H      --- Add a trailing ASCII zero to print buffer
1279 23       INC     HL            --- Bump print buffer add
127A 3D       DEC     A             --- Count of trailing zeroes to add
127B 18F6     JR      1273H         --- Go test for completion
127D 7B       LD      A,E           --- A = count of times value scaled up or down *******
127E 82       ADD     A,D           --- D = no. of digits to print
127F 3C       INC     A             --- Plus 1 gives no. of digits before dec. pt.
1280 47       LD      B,A           --- B = leading digit count
1281 3C       INC     A             --- Gives leading digits +2                   note-->
1282 D603     SUB     03H           --- Divide modulo 3
1284 30FC     JR      NC,1282H      <---: Loop till A = -1, -2, or -3
1286 C605     ADD     A,05H         --->: Add 5 (get positive remainder) gives 4, 3, or 2
1288 4F       LD      C,A           --- C = comma counter
1289 3AD840   LD      A,(40D8H)     --- A = edit flags. Test for comma flag
128C E640     AND     40H           --- Isolate comma bit in edit flag word
128E C0       RET     NZ            --- Exit with C = comma count if commas requested
128F 4F       LD      C,A           --- Else force comma count to zero
1290 C9       RET                   --- Rtn to caller
1291 05       DEC     B             --- Count 1 leading digit ***************************
1292 2008     JR      NZ,129CH      --->: Jmp if all leading digits not stored     cont-->
1294 362E     LD      (HL),2EH      --  : Leading digit stored. Add decimal pt.
1296 22F340   LD      (40F3H),HL    --  : Save addr of dec. pt. in buffer
1299 23       INC     HL            --  : Bump to first char of fractional part of number
129A 48       LD      C,B           --  : Set C and B to zero to inhibit any more dec. pts.
129B C9       RET                   --  : and commas. Rtn to caller
129C 0D       DEC     C             <---: Count one char stored ************************
129D C0       RET     NZ            --- Rtn if not end of 3 character group
129E 362C     LD      (HL),2CH      --- ',' every third digit
12A0 23       INC     HL            --- Bump to next position in buffer
12A1 0E03     LD      C,03H         --- Reset comma counter
12A3 C9       RET                   --- Rtn to caller
12A4 D5       PUSH    DE            --- Save edit flags **********************************
12A5 E7       RST     20H           --- Test data type
12A6 E2EA12   JP      PO,12EAH      --- Jump if single precision               see note-->
12A9 C5       PUSH    BC            --- Save leading digit count/comma counter
12AA E5       PUSH    HL            --- Save buffer addr
12AB CDFC09   CALL    09FCH         --- Move WRA1 to WRA2
12AE 217C13   LD      HL,137CH      --- HL = address of DP .5
12B1 CDF709   CALL    09F7H         --- Move to WRA1
```

```
124F  * **************************************************************



125E  * **************************************************************



1269  * Move 'A' ASCII zeroes to a print buffer. Address of buffer



1271  * **************************************************************



127D  * **************************************************************
      :     Compute the number of digits before the decimal
      :     point, and the number of commas to be included
      :     in first part of number. On entry D = size of
      :     field (6 or 10), E = scale count. On exit B =
      :     number of digits before dec. pt., C = number of
      :     commas to include in first part of number.



1291  * **************************************************************
1292  : in PBUF Count leading digits before dec. pt.



129C  * **************************************************************



12A4  * **************************************************************

      : Convert a DP value to its ASCII equivalent in integer
      : portion only
```

```
12B4 CD770C    CALL   0C77H        --- Add .5 to value in WRA2. Result to WRA1
12B7 AF        XOR    A            --- Clear status flags
12B8 CD7B0B    CALL   0B7BH        --- Unpack DP value in WRA1. Save in current area.
12BB E1        POP    HL           --- Restore buffer addr
12BC C1        POP    BC           --- and counters
12BD 118C13    LD     DE,138CH     --- DE=table of powers of 10 from 1.0X10E15 - 1.0X10E6
12C0 3E0A      LD     A,0AH        --- A=no. of times to dvd current val by a power of 10
12C2 CD9112    CALL   1291H        <-----: Go add a dec point or a comma to buffer
12C5 C5        PUSH   BC           --    : Save count of digits before & after dec point
12C6 F5        PUSH   AF           --    : Save division count
12C7 E5        PUSH   HL            •    : Save current buffer addr
12C8 D5        PUSH   DE            •    : Addr of power table to stack
12C9 062F      LD     B,2FH         •    : B = quotient in ASCII for each division
12CB 04        INC    B            <---: : B start at 30 (ASCII zero)
12CC E1        POP    HL            •  : : HL = addr of power table = divisor
12CD E5        PUSH   HL            •  : : Save it so it can be restored during loop
12CE CD480D    CALL   0D48H         •  : : Dvd current value (integer) by         cont-->
12D1 30F8      JR     NC,12CBH     --->: : Loop till reminder < current power
12D3 E1        POP    HL            •    : Restore starting addr of current power of 10
12D4 CD360D    CALL   0D36H         •    : Add current power to remainder - make it pos
12D7 EB        EX     DE,HL         •    : Save current power addr in DE
12D8 E1        POP    HL            •    : HL = current print buffer addr
12D9 70        LD     (HL),B        •    : Digit to buffer
12DA 23        INC    HL            •    : Bump to next print position
12DB F1        POP    AF            •    : Restore status flags so we can test    cont-->
12DC C1        POP    BC            •    : Restore counts
12DD 3D        DEC    A             •    : Count 1 time thru loop
12DE 20E2      JR     NZ,12C2H     ----->: Done 10 times , no loop
12E0 C5        PUSH   BC           --- Restore counts
12E1 E5        PUSH   HL           --- and current buffer addr
12E2 211D41    LD     HL,411DH     --- then move last half of DP value
12E5 CDB109    CALL   09B1H        --- into WRA1 as a SP value
12E8 180C      JR     12F6H        --- and convert it to ASCII
12EA C5        PUSH   BC           --- Convert a SP value to its integer ****** cont--> *
12EB E5        PUSH   HL           --- Save counts & buffer addr
12EC CD0807    CALL   0708H        --- Add a .5 to current value. Result left in BC/DE
12EF 3C        INC    A            --- Bump MSB
12F0 CDFB0A    CALL   0AFBH        --- Convert a + SP number to integer. Result in BC/DE
12F3 CDB409    CALL   09B4H        --- Move SP value in BC/DE to current value. Integer
12F6 E1        POP    HL           --- portion of original SP value. Restore HL
12F7 C1        POP    BC           --- Restore buffer addr
12F8 AF        XOR    A            --- Restore counts
12F9 11D213    LD     DE,13D2H     --- DE = addr of integer equivalent of 100,000
12FC 3F        CCF                 --- CARRY=first time switch for division loop 12FC-
12FD CD9112    CALL   1291H        --- Decimal point/commas to numeric buffer       :1327
1300 C5        PUSH   BC           --- Save counts
1301 F5        PUSH   AF           --- Save CARRY flag for count of times thru loop
1302 E5        PUSH   HL           --- Save buffer addr
1303 D5        PUSH   DE           --- Save division table addr
1304 CDBF09    CALL   09BFH        --- Load current SP value into BC/DE
1307 E1        POP    HL           --- HL = addr of integer value of 100,000
1308 062F      LD     B,2FH        --- B = ASCII (30-1) = (0-1
130A 04        INC    B            --- Gives 30,31,...... which equal ASCII 0,1,2,...
130B 7B        LD     A,E          --- Least Sig byte of integer equivalent
130C 96        SUB    (HL)         --- Minus least Sig. byte of 100,000
130D 5F        LD     E,A          --- Restore difference for next subtraction
130E 23        INC    HL           --- Bump to next byte of 100,000
130F 7A        LD     A,D          --- Middle byte of integer equivalent      see note-->
1310 9E        SBC    A,(HL)       --- Minus middle byte of 100,000
1311 57        LD     D,A          --- Restore diff. for next subtraction
```

```
12CE  : a power of 10 starting at 10E15 and working down to 10E6


12DB  : for 10 times thru


12EA  * equivalent. Divide integer equivalent by 100,000 and *******
      : 10,000. Use code at 1335 to convert last 1000 to ASCII


      : This code divides the integer portion of the current value
      : by 100,000 using compound subtraction. A quotient is kept
      : in the B-reg as an ASCII value
```

```
1312 23        INC    HL          --- Bump to most sig. byte of 100,000
1313 79        LD     A,C         --- Most sig. byte of integer equivalent
1314 9E        SBC    A,(HL)      --- Minus most sig. byte of 100,000
1315 4F        LD     C,A         --- Restore for next subtraction
1316 2B        DEC    HL          --- Reset HL to least
1317 2B        DEC    HL          --- Sig byte of 100,000 constant
1318 30F0      JR     NC,130AH    --- Loop till integer equivalent < 100,000
131A CDB707    CALL   07B7H       --- Add 100,000 to value in C/DE, make remainder pos
131D 23        INC    HL          --- Bump HL to addr of 10,000 constant
131E CDB409    CALL   09B4H       --- Save remainder as current value
1321 EB        EX     DE,HL       --- Addr of constant 10,000 to DE
1322 E1        POP    HL          --- HL = current PBUF addr
1323 70        LD     (HL),B      --- Save ASCII quotient
1324 23        INC    HL          --- Bump to next position in print buffer
1325 F1        POP    AF          --- Restore CARRY flag (switch)
1326 C1        POP    BC          --- Restore BC so it can be saved later
1327 38D3      JR     C,12FCH     --- If CARRY set, reset it and divide          cont-->
1329 13        INC    DE          --- When we fall thru we have divided          cont-->
132A 13        INC    DE          --- Bump DE to point to constant 1000
132B 3E04      LD     A,04H       --- A = no. of digits
132D 1806      JR     1335H       --- Go convert remainder to 4 ASCII digits
132F D5        PUSH   DE          --- Convert integer to ASCII *********** see note--> *
1330 11D813    LD     DE,13D8H    --- DE = table of descending powers of 10      cont-->
1333 3E05      LD     A,05H       --- A = no. of ASCII digits to build
1335 CD9112    CALL   1291H       --- Add decimal point or commas to buffer
1338 C5        PUSH   BC          --- Save counts
1339 F5        PUSH   AF          --- Save number of digits counter
133A E5        PUSH   HL          --- Save buffer addr
133B EB        EX     DE,HL       --- HL = addr of power table
133C 4E        LD     C,(HL)      --- Load a power of 10 in BC
133D 23        INC    HL          --- Bump to MSB or power
133E 46        LD     B,(HL)      --- Load MSB or power
133F C5        PUSH   BC          --- Save power
1340 23        INC    HL          --- Bump to next value in power table
1341 E3        EX     (SP),HL     --- HL=value just loaded, addr of next value to stack
1342 EB        EX     DE,HL       -- DE = value loaded - division
1343 2A2141    LD     HL,(4121H)  --- HL = current value (integer)
1346 062F      LD     B,2FH       <--: Divide current value by a power of 10 starting at
1348 04        INC    B            • : 10,000 dec. and working down to 10. Remainder
1349 7D        LD     A,L          • : from each division is added to the division and
134A 93        SUB    E            • : the sum becomes the dividend for the next
134B 6F        LD     L,A          • : division etc. Division is by compound subtraction
134C 7C        LD     A,H          • : Quotient +2F(hex) = ASCII equivalent of quotient.
134D 9A        SBC    A,D          • : B - reg = quotient.
134E 67        LD     H,A          • : HL = next dividend
134F 30F7      JR     NC,1348H    -->: Loop till quotient (HL) less than current power
1351 19        ADD    HL,DE       --- Remainder + divisor = dividend                :of 10
1352 222141    LD     (4121H),HL  --- Save next dividend
1355 D1        POP    DE          --- DE = addr of next power of 10
1356 E1        POP    HL          --- Restore addr of output buffer
1357 70        LD     (HL),B      --- ASCII digit to buffer
1358 23        INC    HL          --- Next loc. in print buffer
1359 F1        POP    AF          --- A = count of digits to convert
135A C1        POP    BC          --- Restore counter of #'s before & after dec point
135B 3D        DEC    A           --- Have we got 5 digits yet
135C 20D7      JR     NZ,1335H    --- no, loop
135E CD9112    CALL   1291H       --- Decimal point/commas to numeric buffer
1361 77        LD     (HL),A      --- Zero terminator PBUF
1362 D1        POP    DE          --- Restore callers DE
1363 C9        RET                --- Rtn to caller **********************************
```

```
1327  : remainder by 10,000
1329  : integer part of SP value by 100,000 and 10,000. The
      : remainder is positive and has been saved as current value.


132F  * Save edit flags **********************************************
1330  : starting at 10,000 dec.
```

```
1363  * *************************************************************
```

```
1364 00        NOP                 --- 1364 = 10 X 10E9 DP
1365 00        NOP                 ---
1366 00        NOP                 ---
1367 00        NOP                 ---
1368 F9        LD                  ---
1369 02        LD                  ---
136A 15        DEC                 ---
136B A2        AND                 ---
136C FDFF      INDEX               --- 136C = 1 X 10E15 DP
136E 9F        SBC                 ---
136F 31A95F    LD                  ---
1372 63        LD                  ---
1373 B2        OR                  ---
1374 FEFF      CP                  --- 1374 - 137A = 1 X 10E16 DP
1376 03        INC                 ---
1377 BF        CP                  ---
1378 C9        RET                 ---
1379 1B        DEC                 ---
137A 0EB6      LD                  ---
137C 00        NOP                 --- 137C - 1383 = .5 (double)
137D 00        NOP                 ---
137E 00        NOP                 ---
137F 00        NOP                 ---
1380 00        NOP                 --- 1380 - 1383 = .5 (single)
1381 00        NOP                 ---
1382 00        NOP                 ---
1383 80        ADD                 ---
1384 00        NOP                 --- 1384 - 138B = 1 X 10E16 (double)
1385 00        NOP                 ---
1386 04        INC                 ---
1387 BF        CP                  ---
1388 C9        RET                 ---
1389 1B        DEC                 ---
138A 0EB6      LD                  --- 138A - 1380 = .502778 (single)
138C 00        NOP                 --- 138C - 1392 = 1 X 100E15
138D 80        ADD                 ---                      (integer portion of DP value
138E C6A4      ADD                 ---
1390 7E        LD                  ---
1391 8D        ADC                 ---
1392 03        INC                 ---
1393 00        NOP                 --- 1393 - 1399 = 1.0 X 10E14
1394 40        LD                  ---                      (integer portion of DP value
1395 7A        LD                  ---
1396 10F3      DJNZ                ---
1398 5A        LD                  ---
1399 00        NOP                 ---
139A 00        NOP                 --- 139A - 13 A0 = 1.0 X 10E13
139B A0        AND                 ---                      (integer portion of DP value
139C 72        LD                  ---
139D 4E        LD                  ---
139E 1809      JR                  ---
13A0 00        NOP                 ---
13A1 00        NOP                 --- 13A1 - 13 A7 = 1.0 X 10E12
13A2 10A5      DJNZ                ---                      (integer portion of DP value
13A4 D4E800    CALL                ---
13A7 00        NOP                 ---
13A8 00        NOP                 --- 13A8 - 13AE = 1.0 X 10E11
13A9 E8        RET                 ---                      (integer portion of DP value
13AA 76        HALT                ---
13AB 48        LD                  ---
```

```
13AC 17         RLA                   ---
13AD 00         NOP                   ---
13AE 00         NOP                   ---
13AF 00         NOP                   --- 13AF - 13 B5 = 1.0 X 10E10
13B0 E40B54     CALL                  ---                      (integer part of DP value)
13B3 02         LD                    ---
13B4 00         NOP                   ---
13B5 00         NOP                   ---
13B6 00         NOP                   --- 13B6 - 13BC = 1.0 X 10E9
13B7 CA9A3B     JP                    ---                      (integer part of DP value)
13BA 00         NOP                   ---
13BB 00         NOP                   ---
13BC 00         NOP                   --- 13BD - 13C3 = 1.0 X 10E8
13BD 00         NOP                   ---                      (integer part of DP value)
13BE E1         POP                   ---
13BF F5         PUSH                  ---
13C0 05         DEC                   ---
13C1 00         NOP                   ---
13C2 00         NOP                   ---
13C3 00         NOP                   ---
13C4 80         ADD                   --- 13C4 - 13CA = 1.0 X 10E7
13C5 96         SUB                   ---                      (integer part of DP value)
13C6 98         SBC                   ---
13C7 00         NOP                   ---
13C8 00         NOP                   ---
13C9 00         NOP                   ---
13CA 00         NOP                   ---
13CB 40         LD                    --- 13CB - 13D1 = 1,000,000
13CC 42         LD                    ---                      (integer part of DP value)
13CD 0F         RRCA                  ---
13CE 00         NOP                   ---
13CF 00         NOP                   ---
13D0 00         NOP                   ---
13D1 00         NOP                   ---
13D2 A0         AND                   --- 13D2 = 100,000
13D3 86         ADD                   ---
13D4 011027     LD                    --- 13D5 = 10,000
13D7 00         NOP                   ---
13D8 1027       DJNZ                  --- 13D8  2710: 10000 decimal ********** see note--> *
13DA E8         RET                   --- 13DA  03E8:  1000 decimal
13DB 03         INC                   ---
13DC 64         LD                    --- 13DC  0064:   100 decimal
13DD 00         NOP                   ---
13DE 0A         LD                    --- 13DD  000A:    10 decimal
13DF 00         NOP                   ---
13E0 010021     LD                    --- 13E1: NOP ****************************************
13E3 82         ADD                   --- 13E2: LD  HL,982   Addr of peg to pos      cont-->
13E4 09         ADD                   ---
13E5 E3         EX                    --- 13E5: EX  (SP), HL Addr of conv routine to stack
13E6 E9         JP                    --- 13E6: JP  (HL)     Rtn to caller
13E7 CDA409     CALL     09A4H        --- Move current SP value to stack*******************
13EA 218013     LD       HL,1380H     --- HL = addr of a SP .5 (exponent)
13ED CDB109     CALL     09B1H        --- Load a .5 into BC/DE and move it to WRA1
13F0 1803       JR       13F5H        --- Join common code used for X ** Y
13F2 CDB10A     CALL     0AB1H        --- Convert integer in 4121-4122 to SP &       cont-->
13F5 C1         POP      BC           --- Load value to be raised into
13F6 D1         POP      DE           --- BC/DE.
13F7 CD5509     CALL     0955H        --- Test sign of exponent
13FA 78         LD       A,B          --- A = MSB of number to be raised
13FB 283C       JR       Z,1439H      --- Jmp if exponent zero
```

```
13D8  * Integer table of powers of 10 *******************************




13E0  * ***********************************************************
13E3  : conversion for floating point numbers


13E7  * ********** SQR routine ***********************************
      * Compute X ** .5 ( uses general power routine at 13F2)


      : store in 4121-4124 ******** X ** Y Routine *****************
      : method used is : e ** (y 1n x)
```

```
13FD F20414    JP     P,1404H      --- Jmp if exponent is positive
1400 B7        OR     A            --- Test value to be raised
1401 CA9A19    JP     Z,199AH      --- Exit if raising 0 to a neg. power
1404 B7        OR     A            --- Another test of value to be raised
1405 CA7907    JP     Z,0779H      --- Raising 0 to a positive power
1408 D5        PUSH   DE           --- Move value to be raised to stack
1409 C5        PUSH   BC           --- both parts
140A 79        LD     A,C          --- A = MSB of value to be raised
140B F67F      OR     7FH          --- Test sign of base. Set bits 0-6 in case it is
140D CDBF09    CALL   09BFH        --- Load exponent (power) into BC/DE         :negative
1410 F22114    JP     P,1421H      --->: Jump if base is positive
1413 D5        PUSH   DE           --  : Save the exponent on the stack
1414 C5        PUSH   BC           --  : both parts
1415 CD400B    CALL   0B40H        --  : Get integer portion of exponent          cont-->
1418 C1        POP    BC           --  : Then restore exponent as a
1419 D1        POP    DE           --  : SP value in BC/DE
141A F5        PUSH   AF           --  : Save integer portion of exponent
141B CD0C0A    CALL   0A0CH        --  : Compare original exp. to truncated       cont-->
141E E1        POP    HL           --  : H = exp (integer)
141F 7C        LD     A,H          --  : A = exp
1420 1F        RRA                 --  : Set carry if exp. is odd
1421 E1        POP    HL           <---: Load SP version of exp
1422 222341    LD     (4123H),HL   --- Move to WRA1
1425 E1        POP    HL           --- Get rest of exponent
1426 222141    LD     (4121H),HL   --- and move to WRA1
1429 DCE213    CALL   C,13E2H      --- Call if exponent is odd and base is negative
142C CC8209    CALL   Z,0982H      --- Call if exponent is integer & base negative
142F D5        PUSH   DE           --- Save exponent
1430 C5        PUSH   BC           --- both parts
1431 CD0908    CALL   0809H        --- Find log of base value. Gives 'ILLEGAL FUNCTION
1434 C1        POP    BC           --- Restore exponent : CALL' if negative base raised
1435 D1        POP    DE           --- Restore exponent : to a power with a fraction
1436 CD4708    CALL   0847H        --- Multiply 1n(value) * exponent, then        cont-->
1439 CDA409    CALL   09A4H        --- Move exponent to stack *** Compute e ** x ********
143C 013881    LD     BC,8138H     --- BC/DE = 1.4427 (approx In 2 + In 2)
143F 113BAA    LD     DE,0AA3BH    ---
1442 CD4708    CALL   0847H        --- Multiply exponent value by 1.4427 (2 In 2)
1445 3A2441    LD     A,(4124H)    --- A = exponent of product
1448 FE88      CP     88H          --- Test exponent to see if more than 8        cont-->
144A D23109    JP     NC,0931H     --- Jmp if more than 8 bits in integer part of #
144D CD400B    CALL   0B40H        --- Integer portion has less than 8 bits. Get
1450 C680      ADD    A,80H        --- integer part & put in A reg
1452 C602      ADD    A,02H        --- then test it
1454 DA3109    JP     C,0931H      --- Jmp if exponent * 2 In 2 => 126(dec.)
1457 F5        PUSH   AF           --- Save integer + 82
1458 21F807    LD     HL,07F8H     --- Addr. of SP 1.0
145B CD0B07    CALL   070BH        --- Add to INT (EXP * 2 In 2)
145E CD4108    CALL   0841H        --- Multiply by In 2
1461 F1        POP    AF           --- Clear stack (integerized EXP * 2 In 2)
1462 C1        POP    BC           --- then load original
1463 D1        POP    DE           --- exponent into BC/DE
1464 F5        PUSH   AF           --- Save integerized EXP * 2 In 2
1465 CD1307    CALL   0713H        --- Subtract original exponent from integerized one
1468 CD8209    CALL   0982H        --- Force difference to be positive
146B 217914    LD     HL,1479H     --- Addr of 8 coefficients
146E CDA914    CALL   14A9H        --- Compute series
1471 110000    LD     DE,0000H     --- Load integerized equivalent
1474 C1        POP    BC           --- of EXP * 2 In 2 into BC/DE
1475 4A        LD     C,D          --- Zero C
1476 C34708    JP     0847H        --- Multiply by sum from series & rtn to caller
```

```
1415  : into A. Truncated flt. pt. portion into WRA1.


141B  : exp. This tells if exp. is a whole number


1436  : compute a**1n(value) * exponent
1439 * ***************************************************************


1448  : bits in integer portion
      : Method:   1. Compute x=x * 2 1n 2
      :           2. Isolate the integer portion of x. If it is > than
      :              88 then exit with an overflow error.
      :           3. Using the integer from step 2 compute
      :              y = (2 ** integer) * 2
      :           4. Add 1 to the integer from step 2
      :           5. Multiply the result of step 4 by In 2
      :           6. Subtract step 5 result from original value of x,
      :              and invert the sign of result
      :           7. Using the value computed in step 7 for x, evaluate
      :              the series:
      :              (((((((x*c0+c1)x+c2)x+c3)x+c4)x+c5)x+c6)x+c7)
      :           8. Multiply the final term of the series by the value
      :              computed in step 3
```

```
1479 08         EX                   --- Count of numbers in list (08)
147A 40         LD                   --- 147A = -1.41316 * 10E-4     :  coefficients used
147B 2E94       LD                   ---                             :  in series to compute
147D 74         LD                   ---                             :  e ** x
147E 70         LD                   --- 147E = 1.32988 * 10E-3 = 1/6
147F 4F         LD                   ---
1480 2E77       LD                   ---
1482 6E         LD                   --- 1482 = -8.30136 * 10E-3 = -1/5
1483 02         LD                   ---
1484 88         ADC                  ---
1485 7A         LD                   ---
1486 E6A0       AND                  --- 1486 = .0416574 =1/4
1488 2A7C50     LD                   ---
148B AA         XOR                  --- 148A = - .166665 =1/3
148C AA         XOR                  ---
148D 7E         LD                   ---
148E FF         RST                  --- 148E = .5
148F FF         RST                  ---
1490 7F         LD                   ---
1491 7F         LD                   ---
1492 00         NOP                  --- 1492 = -1.0
1493 00         NOP                  ---
1494 80         ADD                  ---
1495 81         ADD                  ---
1496 00         NOP                  --- 1496 = 1.0
1497 00         NOP                  ---
1498 00         NOP                  ---
1499 81         ADD                  ---
149A CDA409     CALL    09A4H        --- Move x value to stack ************** see note--> *
149D 11320C     LD      DE,0C32H     --- Then push a return address of C32 onto the stack
14A0 D5         PUSH    DE           --- It will compute the last term before returning
14A1 E5         PUSH    HL           --- Save addr. of no. of term, coefficients
14A2 CDBF09     CALL    09BFH        --- Load value into BC/DE
14A5 CD4708     CALL    0847H        --- Square x value
14A8 E1         POP     HL           --- Restore addr of coefficient
14A9 CDA409     CALL    09A4H        --- Move x value or x ** 2 value to stack
14AC 7E         LD      A,(HL)       --- A = no. of terms
14AD 23         INC     HL           --- HL = addr of next coeff.
14AE CDB109     CALL    09B1H        --- Load a coeff pointed to HL & move it to    cont-->
14B1 06F1       LD      B,0F1H       --- 14B2: POP AF. Get count of coefficients left
14B3 C1         POP     BC           --- BC/DE = x value
14B4 D1         POP     DE           --- Saved at 14A9
14B5 3D         DEC     A            --- Count 1 term computed
14B6 C8         RET     Z            --- Exit if all terms computed
14B7 D5         PUSH    DE           --- BC/DE = x value
14B8 C5         PUSH    BC           --- Save x value on stk so it can be reused
14B9 F5         PUSH    AF           --- Save count of terms remaining to compute
14BA E5         PUSH    HL           --- HL pointer to next coeff.
14BB CD4708     CALL    0847H        --- Compute: C(I)*x value
14BE E1         POP     HL           --- Restore coeff. table addr.
14BF CDC209     CALL    09C2H        --- Load next coeff. from list in HL into      cont-->
14C2 E5         PUSH    HL           --- Save addr of next coeff.
14C3 CD1607     CALL    0716H        --- Compute: C(I) * x value + C(I+1)
14C6 E1         POP     HL           --- Restore coefficient table addr.
14C7 18E9       JR      14B2H        --- Continue series. WRA1 = current term
14C9 CD7F0A     CALL    0A7FH        --- Convert value to Integer ***** RND routine *******
14CC 7C         LD      A,H          --- A = MSB argument
14CD B7         OR      A            --- Set status flags
14CE FA4A1E     JP      M,1E4AH      --- FC error if negative if RND(A) where A is negative
14D1 B5         OR      L            --- Combine MSB & LSB, set status flags
```

```
149A  * *** General purpose summation routine computes the *********
      :     series SUM ((((x**2 * c0+c1)x**2 +c2)x**2 +...cN)x
      :     for I=0 to N when entered at 149A. A second entry
      :     point at 14A9 may be used for the series
      :     SUM ((((x*c0+c1)x+c2)x+c3)x+...cN
      :     for I=0 to N. On entry, the x term is in BC/DE.
      :     HL points to a list containing the number of terms
      :     followed by the coefficients.

14AE  : WRA1. HL points to the next value coefficient

14BF  : BC/DE. HL points to next value afterwards

14C9  * ************************************************************
```

```
14D2 CAF014    JP     Z,14F0H         --- Jmp if parameter is zero i.e. RND(0)
14D5 E5        PUSH   HL              --- Save parameter (X from RND(X))
14D6 CDF014    CALL   14F0H           --- Compute RND(0)
14D9 CDBF09    CALL   09BFH           --- Load the random number into BC/DE
14DC EB        EX     DE,HL           --- Now, save the random number on the
14DD E3        EX     (SP),HL         --- stack, and load the original parameter into HL
14DE C5        PUSH   BC              --- Save RND (0) value.
14DF CDCF0A    CALL   0ACFH           --- Convert original parameter to SP
14E2 C1        POP    BC              --- Load value from RND(0)
14E3 D1        POP    DE              --- Call at 14D6
14E4 CD4708    CALL   0847H           --- Then, multiply RND(0)*parameter
14E7 21F807    LD     HL,07F8H        --- HL = addr of a SP 1.0
14EA CD0B07    CALL   070BH           --- Add 1.0 to current value
14ED C3400B    JP     0B40H           --- Convert to integer and return to caller
14F0 219040    LD     HL,4090H        --- HL = addr of 3 byte flag table ******** RND(0) **
14F3 E5        PUSH   HL              --- Save flag table addr on stack
14F4 110000    LD     DE,0000H        --- DE = middle and LSB of starting value
14F7 4B        LD     C,E             --- C = MSB of starting value
14F8 2603      LD     H,03H           --- H = count of times thru outer loop
14FA 2E08      LD     L,08H           <-------------:  L = times thru inner loop
14FC EB        EX     DE,HL           <------:    •  :  Move middle of LSB current   cont -->
14FD 29        ADD    HL,HL            •     :    •  :  Double them
14FE EB        EX     DE,HL            •     :    •  :  Then move them back
14FF 79        LD     A,C              •     :    •  :  Now, get MSB of current value
1500 17        RLA                     •     :    •  :  Double it
1501 4F        LD     C,A              •     :    •  :  And move back to its source reg
1502 E3        EX     (SP),HL          •     :    •  :  Save counters. Get addr of   cont -->
1503 7E        LD     A,(HL)           •     :    •  :  A = flag word
1504 07        RLCA                    •     :    •  :  Multiply by 2
1505 77        LD     (HL),A           •     :    •  :  And restore
1506 E3        EX     (SP),HL          •     :    •  :  Counters back to HL
1507 D21615    JP     NC,1516H        --->:  :    •  :  Jmp if flag word has not     cont -->
150A E5        PUSH   HL               •  :  :    •  :  Flag word overflowed. Save counter
150B 2AAA40    LD     HL,(40AAH)       •  :  :    •  :  Least two significant bytes of seed
150E 19        ADD    HL,DE            •  :  :    •  :  Add seed to starting value
150F EB        EX     DE,HL            •  :  :    •  :  Move new seed to DE
1510 3AAC40    LD     A,(40ACH)        •  :  :    •  :  MSB of seed
1513 89        ADC    A,C              •  :  :    •  :  Add to MSB of starting value
1514 4F        LD     C,A              •  :  :    •  :  MSB starting value back to   cont -->
1515 E1        POP    HL               •  :  :    •  :  Restore counters
1516 2D        DEC    L               <---:  :    •  :  Count of times thru inner loop
1517 C2FC14    JP     NZ,14FCH        ------>:    •  :  Jmp if not 8 times
151A E3        EX     (SP),HL          •          •  :  Save counters HL = addr of flag word
151B 23        INC    HL               •          •  :  Bump to next flag word
151C E3        EX     (SP),HL          •          •  :  And restore counters.        cont -->
151D 25        DEC    H                •          •  :  Count of times thru outer loop
151E C2FA14    JP     NZ,14FAH        ------------->:  Jmp if not 3 times
1521 E1        POP    HL              --- Clear flag table addr from stack
1522 2165B0    LD     HL,0B065H       --- HL = middle and LSB of original seed
1525 19        ADD    HL,DE           --- Add to current value and save
1526 22AA40    LD     (40AAH),HL      --- As new seed value
1529 CDEF0A    CALL   0AEFH           --- Set current data type to single precision
152C 3E05      LD     A,05H           --- Now, add a 5 to MSB
152E 89        ADC    A,C             --- Of current value and
152F 32AC40    LD     (40ACH),A       --- Save as MSB of seed
1532 EB        EX     DE,HL           --- Move middle and LSB to DE so we have BC/DE
1533 0680      LD     B,80H           --- B = sign flag and exponent            :arrangement
1535 212541    LD     HL,4125H        --- HL = sign flag word
1538 70        LD     (HL),B          --- Set sign flag positive
1539 2B        DEC    HL              --- Bump down to exponent
```

```
14F0  * ************************************************************

      :     value to HL

      :     flag word into HL

      :     overflowed initially

      :     source register

      :     New flag word addr to stack.
```

```
153A 70        LD     (HL),B        --- Set exponent to 80 so value will be < 1
153B 4F        LD     C,A           --- C = new MSB (computed at 152E)
153C 0600      LD     B,00H         --- B = 0                              : rtn to caller
153E C36507    JP     0765H         --- Normalize value & Jmp to 14D9 unless RND(0) then
1541 218B15    LD     HL,158BH      --- Addr. of 1.57 (pi/2) ************* COS routine ***
1544 CD0B07    CALL   070BH         --- Add 1.5 to current value
1547 CDA409    CALL   09A4H         --- Save current value on stack ******** SIN routine **
154A 014983    LD     BC,8349H      --- BC/DE = SP = 6.28 (2 pi)
154D 11DB0F    LD     DE,0FDBH      ---
1550 CDB409    CALL   09B4H         --- Move 2 pi to WRA1
1553 C1        POP    BC            --- Load value to
1554 D1        POP    DE            --- find SIN of into BC/DE
1555 CDA208    CALL   08A2H         --- Value / 2 Pi gives x/360
1558 CDA409    CALL   09A4H         --- Move value / 2 Pi to stack
155B CD400B    CALL   0B40H         --- Convert result to integer so we can isolate
155E C1        POP    BC            --- BC/DE = quotient & remainder of         :remainder
155F D1        POP    DE            --- value / 2 pi
1560 CD1307    CALL   0713H         --- Subtract integer part of value from        cont-->
1563 218F15    LD     HL,158FH      --- Addr of a SP (.250)
1566 CD1007    CALL   0710H         --- Subtract .250 from fractional part. Test if < or =
1569 CD5509    CALL   0955H         --- Test sign of the difference            : to 90 deg
156C 37        SCF                  --- Skip sign inversion call at 1582 if positive
156D F27715    JP     P,1577H       --- Jmp if < than 90 deg. Go add back the .250
1570 CD0807    CALL   0708H         --- Add 0.5 to difference                  : subtracted
1573 CD5509    CALL   0955H         --- Test sign of current value. See if > 0.75
1576 B7        OR     A             --- Set status flags                       : (< 270 deg)
1577 F5        PUSH   AF            --- And save sign indicator (+ = +1, - = -1)
1578 F48209    CALL   P,0982H       --- If positive, make it negative (gives x - 1.0)
157B 218F15    LD     HL,158FH      --- Addr of SP (.250)
157E CD0B07    CALL   070BH         --- Add 0.250 to current value in WRA1
1581 F1        POP    AF            --- Get sign reversal flag
1582 D48209    CALL   NC,0982H      --- Set sign of x term according to quadrant
1585 219315    LD     HL,1593H      --- Addr of coefficient
1588 C39A14    JP     149AH         --- Compute series and rtn to caller
158B DB0F      IN                   --- 158B = SP (1.5) ********************************
158D 49        LD                   ---
158E 81        ADD                  ---
158F 00        NOP                  --- 158F - 1592 = .25
1590 00        NOP                  ---
1591 00        NOP                  ---
1592 7F        LD                   ---
1593 05        DEC                  --- 1593: count of values that follow (05)
1594 BA        CP                   --- 1594 - 1597 = SP ( 39.7107) : Coefficients used
1595 D7        RST                  ---                             : in power series
1596 1E86      LD                   ---                             : to compute SIN
1598 64        LD                   --- 1598 - 159B = SP (-76.575)
1599 2699      LD                   ---
159B 87        ADD                  ---
159C 58        LD                   --- 159C - 159F = SP ( 81.6022)
159D 34        INC                  ---
159E 23        INC                  ---
159F 87        ADD                  ---
15A0 E0        RET                  --- 15A0 - 15A3 = SP (-41.3417)
15A1 5D        LD                   ---
15A2 A5        AND                  ---
15A3 86        ADD                  ---
15A4 DA0F49    JP                   --- 15A4 - 15A7 = SP ( 6.28319)
15A7 83        ADD                  ---
15A8 CDA409    CALL   09A4H         --- Move WRA1 to stack ********* TAN routine *********
15AB CD4715    CALL   1547H         --- Compute SIN(x) see note-->
```

```
1541 * *********************************************************

1547 * ***********************************************************
      * Method:   1. Assume x < or = 360 deg
      *           2. Re-compute x as x = x/360 so that x =< 1
      *           3. If x < or = 90 deg goto step 7
      *           4. If x < or = 180 deg then x = 0.5 - x. Goto step 7
      *           5. If x < or = 270 deg then x = 0.5 - x
      *           6. Re-compute x as x = x - 1.0
      *           7. Compute SIN using power series


1560  : original value (isolate fractional part of x)


158B  * ***********************************************************


15A8  * ***********************************************************
      : Uses the identity TAN(x) = sink) / cos(x)
```

```
15AE C1         POP     BC            --- Restore the original value
15AF E1         POP     HL            --- to BC / DE
15B0 CDA409     CALL    09A4H         --- Move SIN(x)to stack
15B3 EB         EX      DE,HL         --- Gives original value in BC/DE
15B4 CDB409     CALL    09B4H         --- Original value to WRA1
15B7 CD4115     CALL    1541H         --- Compute COS(x)
15BA C3A008     JP      08A0H         --- Compute SIN(x)/COS(x) & rtn value as TAN(x)
15BD CD5509     CALL    0955H         --- Test sign of tangent ********** AIN Routine *****
15C0 FCE213     CALL    M,13E2H       --- If neg. put pos. to neg, conv. addr       cont--->
15C3 FC8209     CALL    M,0982H       --- Convert current value from neg to pos
15C6 3A2441     LD      A,(4124H)     --- Load exponent of tangent
15C9 FE81       CP      81H           --- Test for value greater than one
15CB 380C       JR      C,15D9H       --->: Jmp if value less than 1
15CD 010081     LD      BC,8100H       •  : Setup BC/DE as a
15D0 51         LD      D,C            •  : floating point + 1
15D1 59         LD      E,C            •  : to BC / DE
15D2 CDA208     CALL    08A2H          •  : Get reciprocal of tangent
15D5 211007     LD      HL,0710H       •  : Addr of subtract routine be called after series
15D8 E5         PUSH    HL             •  : Will subtract last term from Pi/2
15D9 21E315     LD      HL,15E3H      <---: HL = addr of SP coefficients
15DC CD9A14     CALL    149AH         --- Evaluate series
15DF 218B15     LD      HL,158BH      --- Addr of 1.5708 (Pi/2)                   : step 2
15E2 C9         RET                   --- Subtract last term from Pi/2 & rtn. On rtn see
15E3 09         ADD                   --- 15E3 = count of SP numbers that follow (09) ******
15E4 4A         LD                    --- 15E4 = 2.86623 * 10E-3
15E5 D7         RST                   ---                             : Coefficients used in
15E6 3B         DEC                   ---                             : power series for ATN
15E7 78         LD                    ---
15E8 02         LD                    --- 15E8 = - .0161657
15E9 6E         LD                    ---
15EA 84         ADD                   ---
15EB 7B         LD                    ---
15EC FEC1       CP                    --- 15EC = .0429096
15EE 2F         CPL                   ---
15EF 7C         LD                    ---
15F0 74         LD                    ---
15F1 319A7D     LD                    --- 15F0 = - .0752896
15F4 84         ADD                   ---
15F5 3D         DEC                   --- 15F4 = .105586
15F6 5A         LD                    ---
15F7 7D         LD                    ---
15F8 C8         RET                   ---
15F9 7F         LD                    --- 15F8 = - .142089
15FA 91         SUB                   ---
15FB 7E         LD                    ---
15FC E4BB4C     CALL                  ---
15FF 7E         LD                    --- 15FC = .199936
1600 6C         LD                    ---
1601 AA         XOR                   --- 1600 = - .333331
1602 AA         XOR                   ---
1603 7F         LD                    ---
1604 00         NOP                   ---
1605 00         NOP                   --- 1604 = 1.0000
1606 00         NOP                   ---
1607 81         ADD                   ---
1608 8A         ADC                   ---
1609 09         ADD                   --- *********************************** see note--> *
160A 37         SCF                   ---
160B 0B         DEC                   --- INT  0B37
160C 77         LD                    --- ABS  0977
```

```
15BD  * ****************************************************************
15C0  : on stack to give proper result

      : Method:   1. Test sign of tangent, if negative angle is in 2nd
      :              or 4th quadrant. Set flag to force result positive
      :              on exit. If value is negative invert the sign
      :           2. Test magnitude of tangent. If < 1 goto step 3,
      :              otherwise compute its reciprocal and put rtn addr
      :              on stack that will calculate Pi/2 - series value
      :           3. Evaluate the series
      :              (((x**2 *c0+c1)x**2 +c2)...c8)x
      :           4. If flag from step 1 not set then invert sign of
      :              series result.
      :           5. If original value <1 then rtn to caller, or else
      :              compute Pi/2 - value from step 4 - then rtn

15E3  * ****************************************************************
```

```
1608  * Address of embedded functions *******************************
```

```
160D 09       ADD            ---
160E D427EF   CALL           --- 160E:         FRE (27D4)
1611 2AF527   LD             --- 1611:1613     INP (2AEF), POS (27F5)
1614 E7       RST            --- 1614:         SQR (13E7)
1615 13       INC            ---
1616 C9       RET            --- 1616:         RND (14C9)
1617 14       INC            ---
1618 09       ADD            --- 1618:         LOG (0809)
1619 08       EX             ---
161A 39       ADD            --- 161A:         EXP (1439)
161B 14       INC            ---
161C 41       LD             --- 161C:         COS (1541)
161D 15       DEC            ---
161E 47       LD             --- 161E:         SIN (1547)
161F 15       DEC            ---
1620 A8       XOR            --- 1620:         TAN (15A8)
1621 15       DEC            ---
1622 BD       CP             --- 1622:         ATN (15BD)
1623 15       DEC            ---
1624 AA       XOR            --- 1624:         PEEK (2CAA)
1625 2C       INC            ---
1626 52       LD             --- 1626:         CVI (4152)
1627 41       LD             ---
1628 58       LD             --- 1628:         CVS (4158)
1629 41       LD             ---
162A 5E       LD             --- 162A:         CVD (415E)
162B 41       LD             ---
162C 61       LD             --- 162C:         EOF (4161)
162D 41       LD             ---
162E 64       LD             --- 162E:         LOC (4164)
162F 41       LD             ---
1630 67       LD             --- 1630:         LOF (4167)
1631 41       LD             ---
1632 6A       LD             --- 1632:         MKI$ (416A)
1633 41       LD             ---
1634 6D       LD             --- 1634:         MKS$ (416D)
1635 41       LD             ---
1636 70       LD             --- 1636:         MKD$ (4170)
1637 41       LD             ---
1638 7F       LD             --- 1638:         CINT (0A7F)
1639 0A       LD             ---
163A B1       OR             --- 163A:         CSNG (0AB1)
163B 0A       LD             ---
163C DB0A     IN             --- 163C:         CDBL (0DAB)
163E 260B     LD             --- 163E:         FIX (0B26)
1640 03       INC            --- 1640:1642     LEN (2A03), STR$(2836)
1641 2A3628   LD             ---
1644 C5       PUSH           --- 1644:1646     VAL (2AC5), ASC(2A0F)
1645 2A0F2A   LD             ---
1648 1F       RRA            --- 1648:164A     CHR$(2A1F), LEFT$(2A61)
1649 2A612A   LD             ---
164C 91       SUB            --- 164C:164F     RIGHT$ (2A91), MID$(2A9A)
164D 2A9A2A   LD             ---
1650 C5       PUSH           ---          80   END *****************************
1651 4E       LD             ---
1652 44       LD             ---
1653 C64F     ADD            ---          81   FOR
1655 52       LD             ---
1656 D24553   JP             ---          82   RESET
1659 45       LD             ---
```

```
1650  * Reserved word list ******************************************
```

```
165A 54         LD                    ---          Token   Word *** Reserved word list ***
165B D345       OUT                   ---            83    SET
165D 54         LD                    ---
165E C34C53     JP                    ---            84    CLS
1661 C34D44     JP                    ---            85    CMD
1664 D2414E     JP                    ---            86    RANDOM
1667 44         LD                    ---
1668 4F         LD                    ---
1669 4D         LD                    ---
166A CE45       ADC                   ---            87    NEXT
166C 58         LD                    ---
166D 54         LD                    ---
166E C44154     CALL                  ---            88    DATA
1671 41         LD                    ---
1672 C9         RET                   ---            89    INPUT
1673 4E         LD                    ---
1674 50         LD                    ---
1675 55         LD                    ---
1676 54         LD                    ---
1677 C4494D     CALL                  ---            8A    DIM
167A D24541     JP                    ---            8B    READ
167D 44         LD                    ---
167E CC4554     CALL                  ---            8C    LET
1681 C7         RST                   ---            8D    GOTO
1682 4F         LD                    ---
1683 54         LD                    ---
1684 4F         LD                    ---
1685 D2554E     JP                    ---            8E    RUN
1688 C9         RET                   ---            8F    IF
1689 46         LD                    ---
168A D24553     JP                    ---            90    RESTORE
168D 54         LD                    ---
168E 4F         LD                    ---
168F 52         LD                    ---
1690 45         LD                    ---
1691 C7         RST                   ---            91    GOSUB
1692 4F         LD                    ---
1693 53         LD                    ---
1694 55         LD                    ---
1695 42         LD                    ---
1696 D24554     JP                    ---            92    RETURN
1699 55         LD                    ---
169A 52         LD                    ---
169B 4E         LD                    ---
169C D2454D     JP                    ---            93    REM
169F D354       OUT                   ---            94    STOP
16A1 4F         LD                    ---
16A2 50         LD                    ---
16A3 C5         PUSH                  ---            95    ELSE
16A4 4C         LD                    ---
16A5 53         LD                    ---
16A6 45         LD                    ---
16A7 D4524F     CALL                  ---            96    TRON
16AA 4E         LD                    ---
16AB D4524F     CALL                  ---            97    TROFF
16AE 46         LD                    ---
16AF 46         LD                    ---
16B0 C44546     CALL                  ---            98    DEFSTR
16B3 53         LD                    ---
16B4 54         LD                    ---
```

```
16B5 52        LD                   ---          Token   Word *** Reserved word list cont
16B6 C44546    CALL                 ---            99    DEFINT
16B9 49        LD                   ---
16BA 4E        LD                   ---
16BB 54        LD                   ---
16BC C44546    CALL                 ---            9A    DEFSNG
16BF 53        LD                   ---
16C0 4E        LD                   ---
16C1 47        LD                   ---
16C2 C44546    CALL                 ---            9B    DEFDBL
16C5 44        LD                   ---
16C6 42        LD                   ---
16C7 4C        LD                   ---
16C8 CC494E    CALL                 ---            9C    LINE
16CB 45        LD                   ---
16CC C5        PUSH                 ---            9D    EDIT
16CD 44        LD                   ---
16CE 49        LD                   ---
16CF 54        LD                   ---
16D0 C5        PUSH                 ---            9E    ERROR
16D1 52        LD                   ---
16D2 52        LD                   ---
16D3 4F        LD                   ---
16D4 52        LD                   ---
16D5 D24553    JP                   ---            9F    RESUME
16D8 55        LD                   ---
16D9 4D        LD                   ---
16DA 45        LD                   ---
16DB CF        RST                  ---            A0     OUT
16DC 55        LD                   ---
16DD 54        LD                   ---
16DE CF        RST                  ---            A1    ON
16DF 4E        LD                   ---
16E0 CF        RST                  ---            A2    OPEN
16E1 50        LD                   ---
16E2 45        LD                   ---
16E3 4E        LD                   ---
16E4 C649      ADD                  ---            A3    FIELD
16E6 45        LD                   ---
16E7 4C        LD                   ---
16E8 44        LD                   ---
16E9 C7        RST                  ---            A4    GET
16EA 45        LD                   ---
16EB 54        LD                   ---
16EC D0        RET                  ---            A5    PUT
16ED 55        LD                   ---
16EE 54        LD                   ---
16EF C34C4F    JP                   ---            A6    CLOSE
16F2 53        LD                   ---
16F3 45        LD                   ---
16F4 CC4F41    CALL                 ---            A7    LOAD
16F7 44        LD                   ---
16F8 CD4552    CALL                 ---            A8    MERGE
16FB 47        LD                   ---
16FC 45        LD                   ---
16FD CE41      ADC                  ---            A9    NAME
16FF 4D        LD                   ---
1700 45        LD                   ---
1701 CB49      BIT                  ---            AA    KILL
1703 4C        LD                   ---
```

```
1704 4C        LD              ---        Token   Word *** Reserved word list cont
1705 CC5345    CALL            ---          AB    LSET
1708 54        LD              ---
1709 D25345    JP              ---          AC    RSET
170C 54        LD              ---
170D D341      OUT             ---          AD    SAVE
170F 56        LD              ---
1710 45        LD              ---
1711 D359      OUT             ---          AE    SYSTEM
1713 53        LD              ---
1714 54        LD              ---
1715 45        LD              ---
1716 4D        LD              ---
1717 CC5052    CALL            ---          AF    LPRINT
171A 49        LD              ---
171B 4E        LD              ---
171C 54        LD              ---
171D C44546    CALL            ---          B0    DEF
1720 D0        RET             ---          B1    POKE
1721 4F        LD              ---
1722 4B        LD              ---
1723 45        LD              ---
1724 D0        RET             ---          B2    PRINT
1725 52        LD              ---
1726 49        LD              ---
1727 4E        LD              ---
1728 54        LD              ---
1729 C34F4E    JP              ---          B3    CONT
172C 54        LD              ---
172D CC4953    CALL            ---          B4    LIST
1730 54        LD              ---
1731 CC4C49    CALL            ---          B5    LLIST
1734 53        LD              ---
1735 54        LD              ---
1736 C4454C    CALL            ---          B6    DELETE
1739 45        LD              ---
173A 54        LD              ---
173B 45        LD              ---
173C C1        POP             ---          B7    AUTO
173D 55        LD              ---
173E 54        LD              ---
173F 4F        LD              ---
1740 C34C45    JP              ---          B8    CLEAR
1743 41        LD              ---
1744 52        LD              ---
1745 C34C4F    JP              ---          B9    CLOAD
1748 41        LD              ---
1749 44        LD              ---
174A C35341    JP              ---          BA    CSAVE
174D 56        LD              ---
174E 45        LD              ---
174F CE45      ADC             ---          BB    NEW
1751 57        LD              ---
1752 D44142    CALL            ---          BC    TAB(
1755 28D4      JR              ---          BD    TO
1757 4F        LD              ---
1758 C64E      ADD             ---          BE    FN
175A D5        PUSH            ---          BF    USING
175B 53        LD              ---
175C 49        LD              ---
```

```
175D 4E         LD              ---         Token   Word *** Reserved word list cont
175E 47         LD              ---
175F D641       SUB             ---           C0    VARPTR
1761 52         LD              ---
1762 50         LD              ---
1763 54         LD              ---
1764 52         LD              ---
1765 D5         PUSH            ---           C1    USR
1766 53         LD              ---
1767 52         LD              ---
1768 C5         PUSH            ---           C2    ERL
1769 52         LD              ---
176A 4C         LD              ---
176B C5         PUSH            ---           C3    ERR
176C 52         LD              ---
176D 52         LD              ---
176E D354       OUT             ---           C4    STRING$
1770 52         LD              ---
1771 49         LD              ---
1772 4E         LD              ---
1773 47         LD              ---
1774 24         INC             ---
1775 C9         RET             ---           C5    INSTR
1776 4E         LD              ---
1777 53         LD              ---
1778 54         LD              ---
1779 52         LD              ---
177A D0         RET             ---           C6    POINT
177B 4F         LD              ---
177C 49         LD              ---
177D 4E         LD              ---
177E 54         LD              ---
177F D4494D     CALL            ---           C7    TIME$
1782 45         LD              ---
1783 24         INC             ---
1784 CD454D     CALL            ---           C8    MEM
1787 C9         RET             ---           C9    INKEY$
1788 4E         LD              ---
1789 4B         LD              ---
178A 45         LD              ---
178B 59         LD              ---
178C 24         INC             ---
178D D44845     CALL            ---           CA    THEN
1790 4E         LD              ---
1791 CE4F       ADC             ---           CB    NOT
1793 54         LD              ---
1794 D354       OUT             ---           CC    STEP
1796 45         LD              ---
1797 50         LD              ---
1798 AB         XOR             ---           D     +
1799 AD         XOR             ---           CE    -
179A AA         XOR             ---           CF    *
179B AF         XOR             ---           D0    /
179C DBC1       IN              ---           D1    up arrow
179E 4E         LD              ---
179F 44         LD              ---
17A0 CF         RST             ---           D2    AND
17A1 52         LD              ---           D3    OR
17A2 BE         CP              ---           D4    >
17A3 BD         CP              ---           D5    =
```

```
17A4 BC        CP                ---          D6     <
17A5 D347      OUT               ---          D7     SGN
17A7 4E        LD                ---        Token    Word *** Reserved word list cont
17A8 C9        RET               ---          D8     INT
17A9 4E        LD                ---
17AA 54        LD                ---
17AB C1        POP               ---          D9     ABS
17AC 42        LD                ---
17AD 53        LD                ---
17AE C652      ADD               ---          DA     FRE (String)
17B0 45        LD                ---
17B1 C9        RET               ---          DB     INP
17B2 4E        LD                ---
17B3 50        LD                ---
17B4 D0        RET               ---          DC     POS
17B5 4F        LD                ---
17B6 53        LD                ---
17B7 D351      OUT               ---          DD     SQR
17B9 52        LD                ---
17BA D24E44    JP                ---          DE     RND
17BD CC4F47    CALL              ---          DF     LOG
17C0 C5        PUSH              ---          E0     EXP
17C1 58        LD                ---
17C2 50        LD                ---
17C3 C34F53    JP                ---          E1     COS
17C6 D349      OUT               ---          E2     SIN
17C8 4E        LD                ---
17C9 D4414E    CALL              ---          E3     TAN
17CC C1        POP               ---          E4     ATN
17CD 54        LD                ---
17CE 4E        LD                ---
17CF D0        RET               ---          E5     PEEK
17D0 45        LD                ---
17D1 45        LD                ---
17D2 4B        LD                ---
17D3 C35649    JP                ---          E6     CVI
17D6 C35653    JP                ---          E7     CVS
17D9 C35644    JP                ---          E8     CVD
17DC C5        PUSH              ---          E9     EOF
17DD 4F        LD                ---
17DE 46        LD                ---
17DF CC4F43    CALL              ---          EA     LOC
17E2 CC4F46    CALL              ---          EB     LOF
17E5 CD4B49    CALL              ---          EC     MKI$
17E8 24        INC               ---
17E9 CD4B53    CALL              ---          ED     MKS$
17EC 24        INC               ---
17ED CD4B44    CALL              ---          EE     MKD$
17F0 24        INC               ---
17F1 C3494E    JP                ---          EF     CINT
17F4 54        LD                ---
17F5 C3534E    JP                ---          F0     CSNG
17F8 47        LD                ---
17F9 C34442    JP                ---          F1     CDBL
17FC 4C        LD                ---
17FD C649      ADD               ---          F2     FIX
17FF 58        LD                ---
1800 CC454E    CALL              ---          F3     LEN
1803 D354      OUT               ---          F4     STR$(Exp)
1805 52        LD                ---
```

```
1806 24         INC                        ---        Token   Word *** Reserved word list cont
1807 D641       SUB                        ---          F5    VAL (string)
1809 4C         LD                         ---
180A C1         POP                        ---          F6    ASC (string)
180B 53         LD                         ---
180C 43         LD                         ---
180D C34852     JP                         ---          F7    CHR$ (exp)
1810 24         INC                        ---
1811 CC4546     CALL                       ---          F8    LEFT$ (string, n)
1814 54         LD                         ---
1815 24         INC                        ---
1816 D24947     JP                         ---          F9    RIGHT$ (string, n)
1819 48         LD                         ---
181A 54         LD                         ---
181B 24         INC                        ---
181C CD4944     CALL                       ---          FA    MID$ (string, pos, n)
181F 24         INC                        ---
1820 A7         AND                        ---          FB    '
1821 80         ADD                        --- End of syntax list ***--Addr verb ****************
1822 AE         XOR                        --- 1822: 1DAE - END ********************************
1823 1D         DEC                        ---
1824 A1         AND                        --- 1824: 1CA1 - FOR
1825 1C         INC                        ---
1826 3801       JR                         --- 1826: 0138 - RESET
1828 35         DEC                        --- 1828: 0135 - SET
1829 01C901     LD                         --- 182A: 01C9 - CLS
182C 73         LD                         --- 182C: 4173 - CMD
182D 41         LD                         ---
182E D301       OUT                        --- 182E: 01DC - RANDOM
1830 B6         OR                         --- 1830: 22B6 - NEXT
1831 22051F     LD                         --- 1832: 1F05 - DATA
1834 9A         SBC                        --- 1834: 219A - INPUT
1835 210826     LD                         --- 1836: 2608 - DIM
1838 EF         RST                        --- 1838: 21EF - READ
1839 21211F     LD                         --- 183A: 1F21 - LET
183C C21EA3     JP                         --- 183C - 183E: (1EC2 - GOTO, 1EA3 - RUN)
183F 1E39       LD                         --- 1840: 2039 - IF
1841 2091       JR                         --- 1842: 1D91 - RESTORE
1843 1D         DEC                        ---
1844 B1         OR                         --- 1844: 1EB1 - GOSUB
1845 1EDE       LD                         --- 1846: 1EDE - RETURN
1847 1E07       LD                         --- 1848: 1F07 - REM
1849 1F         RRA                        ---
184A A9         XOR                        --- 184A: 1DA9 - STOP
184B 1D         DEC                        --
184C 07         RLCA                       --- 184C: 1F07 - ELSE
184D 1F         RRA                        ---
184E F7         RST                        --- 184E: 1DF7 - TRON
184F 1D         DEC                        ---
1850 F8         RET                        --- 1850: 1DF8 - TROFF
1851 1D         DEC                        ---
1852 00         NOP                        --- 1852: 1E00 - DEFSTR
1853 1E03       LD                         --- 1854: 1E03 - DEFINT
1855 1E06       LD                         --- 1856: 1E06 - DEFSNG
1857 1E09       LD                         --- 1858: 1E09 - DEFDBL
1859 1EA3       LD                         --- 185A: 41A3 - LINE
185B 41         LD                         ---
185C 60         LD                         --- 185C: 2E60 - EDIT
185D 2EF4       LD                         --- 185E: 1FF4 - ERROR
185F 1F         RRA                        ---
```

```
* *************************************************************
* Routine vector addresses 2 bytes each ***********************
```

```
1860 AF        XOR                 ---
1861 1F        RRA                 --- 1860: 1FAF - RESUME
1862 FB        EI                  ---
1863 2A6C1F    LD                  --- 1862: 26FB - OUT
1866 79        LD                  --- 1864: 1F6C - ON
1867 41        LD                  --- 1866: 4179 - OPEN
1868 7C        LD                  ---
1869 41        LD                  --- 1868: 417C - FIELD
186A 7F        LD                  ---
186B 41        LD                  --- 186A: 417E - GET
186C 82        ADD                 ---
186D 41        LD                  --- 186C: 4182 - PUT
186E 85        ADD                 ---
186F 41        LD                  --- 186E: 4185 - CLOSE
1870 88        ADC                 ---
1871 41        LD                  --- 1870: 4188 - LOAD
1872 8B        ADC                 ---
1873 41        LD                  --- 1872: 418B - MERGE
1874 8E        ADC                 ---
1875 41        LD                  --- 1874: 418E - NAME
1876 91        SUB                 ---
1877 41        LD                  --- 1876: 4191 - KILL
1878 97        SUB                 ---
1879 41        LD                  --- 1878: 4197 - LSET
187A 9A        SBC                 ---
187B 41        LD                  --- 187A: 419A - RSET
187C A0        AND                 ---
187D 41        LD                  --- 187C: 41A0 - SAVE
187E B2        OR                  ---
187F 02        LD                  --- 187E: 02B2 - SYSTEM
1880 67        LD                  ---
1881 205B      JR                  --- 1880: 2067 - LPRINT
1883 41        LD                  --- 1882: 415B - CEF
1884 B1        OR                  ---
1885 2C        INC                 --- 1884: 2CB1 - POKE
1886 6F        LD                  ---
1887 20E4      JR                  --- 1886: 206E - PRINT
1889 1D        DEC                 --- 1888: 1DE4 - CONT
188A 2E2B      LD                  ---
188C 29        ADD                 --- 188A: 2B2E - LIST
188D 2B        DEC                 --- 188C: 2B29 - LLIST
188E C62B      ADD                 ---
1890 08        EX                  --- 188E: 2BC6 - DELETE
1891 207A      JR                  --- 1890: 2008 - AUTO
1893 1E1F      LD                  --- 1892: 1E7A - CLEAR
1895 2C        INC                 --- 1894: 2C1F - CLOAD
1896 F5        PUSH                ---
1897 2B        DEC                 --- 1896: 2BF5 - CSAVE
1898 49        LD                  ---
1899 1B        DEC                 --- 1898: 1B49 - NEW
189A 79        LD                  ---
189B 79        LD                  --- + ******************** Precedent operators *****
189C 7C        LD                  --- -
189D 7C        LD                  --- *
189E 7F        LD                  --- /
189F 50        LD                  --- up arrow
18A0 46        LD                  --- AND
18A1 DB0A      IN                  --- OR
18A3 00        NOP                 --- 18A1: 0ADB - convert to double precision *********
18A4 00        NOP                 --- 18A3: 0000 - This location not used
```

```
189A  * ***********************************************************

18A1  * Used by arithmetic routines to do data conversion & *********
      : arithmetic.
```

```
18A5 7F        LD                   --- 18A5: 0AF7 - Convert to Integer
18A6 0A        LD                   ---
18A7 F40AB1    CALL                 --- 18A7: 0AF4 - Test data type. TM error if not string
18AA 0A        LD                   --- 18A9: 0AB1 - Convert to single precision
18AB 77        LD                   --- 18AB: 0C77 - Double precision add routine
18AC 0C        INC                  ---
18AD 70        LD                   --- 18AD: 0C70 - Double precision subtract routine
18AE 0C        INC                  ---
18AF A1        AND                  --- 18AF: 0DA1 - Double precision multiply routine
18B0 0D        DEC                  ---
18B1 E5        PUSH                 --- 18B1: 0DE5 - Double precision divide routine
18B2 0D        DEC                  ---
18B3 78        LD                   --- 18B3: 0A78 - Double precision exponential routine
18B4 0A        LD                   ---
18B5 1607      LD                   --- 18B5: 0716 - Single precision add routine
18B7 13        INC                  --- 18B7: 0713 - Single precision subtract routine
18B8 07        RLCA                 ---
18B9 47        LD                   --- 18B9: 0847 - Single precision multiply routine
18BA 08        EX                   ---
18BB A2        AND                  --- 18BB: 08A2 - Single precision divide routine
18BC 08        EX                   ---
18BD 0C        INC                  --- 18BD: 0A0C - Single precision exponential routine
18BE 0A        LD                   --- 18BF-18C1: 0BD2/0BC2 Integer add/subtract routines
18BF D20BC7    JP                   ---
18C2 0B        DEC                  --- 18C3-18C5: 0BF2/2490 Int multiply/divide routines
18C3 F20B90    JP                   ---
18C6 24        INC                  --- 18C7: 0A39 - Integer exponential routine
18C7 39        ADD                  ---
18C8 0A        LD                   ---
18C9 4E        LD                   ---  0 - NF (NEXT without FOR ) ** Error codes *******
18CA 46        LD                   ---
18CB 53        LD                   ---  2 - SN (Syntax error)
18CC 4E        LD                   ---
18CD 52        LD                   ---  4 - RG (RETURN without GOSUB)
18CE 47        LD                   ---
18CF 4F        LD                   ---  6 - OD (Out of DATA)
18D0 44        LD                   ---
18D1 46        LD                   ---  8 - FC (Illegal function call)
18D2 43        LD                   ---
18D3 4F        LD                   --- 10 - OV (Overflow)
18D4 56        LD                   ---
18D5 4F        LD                   --- 12 - OM (Out of memory)
18D6 4D        LD                   ---
18D7 55        LD                   --- 14 - UL (Undefined linenumber)
18D8 4C        LD                   ---
18D9 42        LD                   --- 16 - BS (Subscript out of range)
18DA 53        LD                   ---
18DB 44        LD                   --- 18 - DD (Redimensioned array)
18DC 44        LD                   ---
18DD 2F        CPL                  --- 20 - /0 (Division by zero)
18DE 3049      JR                   --- 22 - ID (Illegal direct operation)
18E0 44        LD                   ---
18E1 54        LD                   --- 24 - TM (Type mismatch)
18E2 4D        LD                   ---
18E3 4F        LD                   --- 26 - OS (Out of string space)
18E4 53        LD                   ---
18E5 4C        LD                   --- 28 - LS (String too long)
18E6 53        LD                   ---
18E7 53        LD                   --- 30 - ST (String formula too complex)
18E8 54        LD                   ---
```

18C9   * ***

```
18E9 43       LD                     --- 32 - CN (Can't continue)
18EA 4E       LD                     ---
18EB 4E       LD                     --- 34 - NR (No RESUME)
18EC 52       LD                     ---
18ED 52       LD                     --- 36 - RW (RESUME without error)
18EE 57       LD                     ---
18EF 55       LD                     --- 38 - UE (Unprintable error)
18F0 45       LD                     ---
18F1 4D       LD                     --- 40 - MO (Missing operand)
18F2 4F       LD                     ---
18F3 46       LD                     --- 42 - FD (Bad file data)
18F4 44       LD                     ---
18F5 4C       LD                     --- 44 - L3 (Disk BASIC command)
18F6 33       INC                    ---
18F7 D600     SUB     00H            --- Subtract LSB * Division Support routine * note-> *
18F9 6F       LD      L,A            --- and restore value to L
18FA 7C       LD      A,H            --- Get middle byte
18FB DE00     SBC     A,00H          --- Subtract middle byte
18FD 67       LD      H,A            --- and move difference to H
18FE 78       LD      A,B            --- Get MSB
18FF DE00     SBC     A,00H          --- Subtract MSB
1901 47       LD      B,A            --- and move it back
1902 3E00     LD      A,00H          --- Clear A
1904 C9       RET                    --- Rtn to caller
1905 4A       LD                     --- 408E : Addr of user subroutine
1906 1E40     LD                     ---
1908 E64D     AND                    --- 4090 : 3 byte table used by RND to keep track
190A DB00     IN      A,(00H)        --- 4093 : Used for INP (XX)          : of previous RND
190C C9       RET                    --- 4093 : RET                        : value
190D D300     OUT     (00H),A        --- 4096 : Used for OUTP (XX)
190F C9       RET                    --- 4098 : RET
1910 00       NOP                    --- 4099 : 00
1911 00       NOP                    --- 409A : 00
1912 00       NOP                    --- 409B : 00
1913 00       NOP                    --- 409C : 00
1914 40       LD                     --- 409D : 40
1915 3000     JR                     --- 40A0 : Contains initial stack addr used
1917 4C       LD                     --- (434C)                : for non-disk IPL
1918 43       LD                     --- 40A2 : Initial BASIC line number (FFFE)
1919 FEFF     CP                     ---
191B E9       JP                     --- 40A4 : Initial addr for PST (42E9)
191C 42       LD                     ---
191D 2045     JR                     --- Space, E ******************** ERROR Message ******
191F 72       LD                     --- R
1920 72       LD                     --- R
1921 6F       LD                     --- 0
1922 72       LD                     --- R
1923 00       NOP                    --- Terminator
1924 2069     JR                     --- Space, I ********************* IN Message ********
1926 6E       LD                     --- N
1927 2000     JR                     --- Space, 0 - terminator
1929 52       LD                     --- Space, R ******************** READY Message *****
192A 45       LD                     --- E
192B 41       LD                     --- A
192C 44       LD                     --- D
192D 59       LD                     --- Y
192E 0D       DEC                    --- Carriage ret
192F 00       NOP                    --- Terminator
1930 42       LD                     --- B ***************************** BREAK Message ****
1931 72       LD                     --- R
```

```
18F7  * Code from 18F7 to 191D is moved *****************************
      : to locations 4080 - 40A5 during
      : the non-disk IPL sequence. This
      : section of code contains the
      : division support routine
      : used for single precision
      : division, and initial values
      : for the communications region
      : locations 408E - 40A4

191D  * *************************************************************

1924  * *************************************************************

1929  * *************************************************************

1930  * *************************************************************
```

```
1932 65         LD                    --- E
1933 61         LD                    --- A
1934 6B         LD                    --- K
1935 00         NOP                   --- Message terminator
1936 210400     LD      HL,0004H      --- HL = 4 so we can backspace ********* see note--> *
1939 39         ADD     HL,SP         -- Current stack pointer 4 bytes
193A 7E         LD      A,(HL)        <---: A = current stack ptr (-4)
193B 23         INC     HL             •  : Backspace one more byte in case FOR token
193C FE81       CP      81H            •  : Does current stack ptr(-4) = FOR token  :located
193E C0         RET     NZ             •  : No, exit with A non-zero if no FOR push
193F 4E         LD      C,(HL)         •  : C = LSB addr of index variable
1940 23         INC     HL             •  : Backspace current stack ptr one more byte
1941 46         LD      B,(HL)         •  : B = MSB addr of index variable
1942 23         INC     HL             •  : HL = addr of FOR index on stack
1943 E5         PUSH    HL             •  : Save addr of FOR index pointer on stack
1944 69         LD      L,C            •  : L = LSB of index addr
1945 60         LD      H,B            •  : H = MSB of index addr                see note-->
1946 7A         LD      A,D            •  : Test user specified variable addr
1947 B3         OR      E              •  : Set status flags
1948 EB         EX      DE,HL          •  : DE = addr of index from stack
1949 2802       JR      Z,194DH        •  : Jmp, if user specified addr of zero
194B EB         EX      DE,HL          •  : HL = addr of index from stack
194C DF         RST     18H            •  : Compare caller's DE to addr of          cont-->
194D 010E00     LD      BC,000EH       •  : Amt to backspace to next FOR token
1950 E1         POP     HL             •  : HL = stack addr of sign of increment flag
1951 C8         RET     Z              •  : Exit if FOR index = NEXT index
1952 09         ADD     HL,BC          •  : Else, backspace to next possible FOR push
1953 18E5       JR      193AH         --->: Keep looking
1955 CD6C19     CALL    196CH         --- Make sure there's room in ********** see note--> *
1958 C5         PUSH    BC            --- Source addr (end of list) to stack
1959 E3         EX      (SP),HL       --- Source addr (end of list) to HL
195A C1         POP     BC            --- BC = destination addr (end)
195B DF         RST     18H           <---: Test for end of move
195C 7E         LD      A,(HL)         •  : Fetch a byte from source list
195D 02         LD      (BC),A         •  : Store in destination list
195E C8         RET     Z              •  : Exit if list moved
195F 0B         DEC     BC             •  : Decrement source address
1960 2B         DEC     HL             •  : Decrement destination address
1961 18F8       JR      195BH         --->: Loop until list moved
1963 E5         PUSH    HL            --- Save code string addr ************** see note--> *
1964 2AFD40     LD      HL,(40FDH)    --- Start of free memory ptr.
1967 0600       LD      B,00H         --- B=00, C=no. of double bytes needed
1969 09         ADD     HL,BC         --- Add 2*no. of bytes required to start of free area
196A 09         ADD     HL,BC         --- HL = end free area
196B 3EE5       LD      A,0E5H        --- 196C: PUSH HL, save new free area ptr (starting)
196D 3EC6       LD      A,0C6H        --- Now, compute amt. of memory between
196F 95         SUB     L             --- FFC6 (65478) start of the stack and new starting
1970 6F         LD      L,A           --- Free memory pointer by subtracting new starting
1971 3EFF       LD      A,0FFH        --- Free mem. addr from FFC6. If free mem. overflows
1973 9C         SBC     A,H           --- Beyond start of stack we are out of space.
1974 3804       JR      C,197AH       --- OM error if C-Free space list exceeds 65478, FFC6H
1976 67         LD      H,A           --- Now attempt to determine
1977 39         ADD     HL,SP         --- If free space list has
1978 E1         POP     HL            --- Overflowed stack area.
1979 D8         RET     C             --- No overflow if CARRY
197A 1E0C       LD      E,0CH         --- OM error code
197C 1824       JR      19A2H         --- Output OM error message
197E 2AA240     LD      HL,(40A2H)    --- HL = current line number ************************
1981 7C         LD      A,H           --- Combine MSB
1982 A5         AND     L             --- With LSB
```

```
1936  * (Locate FOR push which matches caller's index specified *****



      : Called w/DE = addr of NEXT index. Scans stk backwards
      : looking for a FOR push. If one found get addr of index
      : and compare w/caller's DE. If equal exit with A = 0,
      : HL = addr of variable. If unequal keep scanning till no
      : FOR push found & exit w/A<>0.


194C  : <---:-: index from the stack


1955  * string area  *******  On entry DE = upper limit **************
      :                       This routine moves a variable (string
      :                       usually) into another area specified by
      :                       the caller.
      :                       On entry:
      :                          BC = end addr of list to move
      :                          DE = start addr of list to move
      :                          HL = end of area to move list to.


1963  * Compute amt of space between HL and end of memory FFC6. *****



197E  * ***********************************************************
```

```
1983 3C         INC    A             --- If current line = FFFF then we have        cont-->
1984 2808       JR     Z,198EH       --- Jmp if BASIC pgm has not been executed.    cont-->
1986 3AF240     LD     A,(40F2H)     --- Get error override flag
1989 B7         OR     A             --- Set status flags
198A 1E22       LD     E,22H         --- Code for NO RESUME error
198C 2014       JR     NZ,19A2H      --- Output NR error message if no RESUME addr
198E C3C11D     JP     1DC1H         --- Error while in Input Phase. Re-enter       cont-->
1991 2ADA40     LD     HL,(40DAH)    --- Load line number for last DATA statement
1994 22A240     LD     (40A2H),HL    --- Store it in current line ptr
1997 1E02       LD     E,02H         --- SN error code
1999 011E14     LD     BC,141EH      --- 199A: LD E,14  /0 Error code
199C 011E00     LD     BC,001EH      --- 199D: LD E,0   NF Error code
199F 011E24     LD     BC,241EH      --- 19A1: LD E,24  RW error code
19A2 2AA240     LD     HL,(40A2H)    --- HL = addr of line with error ********************
19A5 22EA40     LD     (40EAH),HL    --- Save error line number
19A8 22EC40     LD     (40ECH),HL    --- Twice
19AB 01B419     LD     BC,19B4H      --- BC = continuation addr after re-initialization
19AE 2AE840     LD     HL,(40E8H)    --- HL = stack ptr for start of statement
19B1 C39A1B     JP     1B9AH         --- Go re-initialize system variables. Rtn to 19B4
19B4 C1         POP    BC            --- BC = 00 00
19B5 7B         LD     A,E           --- A = error number
19B6 4B         LD     C,E           --- C = error number
19B7 329A40     LD     (409AH),A     --- Save error number
19BA 2AE640     LD     HL,(40E6H)    --- HL = addr of last byte executed in current line
19BD 22EE40     LD     (40EEH),HL    --- Save addr of last byte executed
19C0 EB         EX     DE,HL         --- Save HL
19C1 2AEA40     LD     HL,(40EAH)    --- HL = addr of last line executed
19C4 7C         LD     A,H           --- Combine LSB of last line
19C5 A5         AND    L             --- Executed with MSB of last line
19C6 3C         INC    A             --- Then test, if line number = FFFF
19C7 2807       JR     Z,19D0H       --- Line number = FFFF, still in Input Phase
19C9 22F540     LD     (40F5H),HL    --- Save error addr
19CC EB         EX     DE,HL         --- Restore last byte executed
19CD 22F740     LD     (40F7H),HL    --- Save last byte executed
19D0 2AF040     LD     HL,(40F0H)    --- Get ON ERROR address
19D3 7C         LD     A,H           --- Combine LSB with MSB so it can be
19D4 B5         OR     L             --- tested for zero
19D5 EB         EX     DE,HL         --- DE = ON ERROR address
19D6 21F240     LD     HL,40F2H      --- Addr of flag word during ON ERROR processing
19D9 2808       JR     Z,19E3H       --- Jmp if no ON ERROR address
19DB A6         AND    (HL)          --- Test if RESUME processing in program
19DC 2005       JR     NZ,19E3H      --- Yes, cannot have nested RESUMES
19DE 35         DEC    (HL)          --- Flag an error so RESUME will work
19DF EB         EX     DE,HL         --- HL = addr of statement to branch to
19E0 C3361D     JP     1D36H         --- Goto Execution Driver
19E3 AF         XOR    A             --- Zero A ******************************************
19E4 77         LD     (HL),A        --- Clear error override flag
19E5 59         LD     E,C           --- Error number to E
19E6 CDF920     CALL   20F9H         --- Position video to next line
19E9 21C918     LD     HL,18C9H      --- HL = table of error codes
19EC CDA641     CALL   41A6H         --- DOS Exit (load & execute BASIC error routine)
19EF 57         LD     D,A           --- Zero D
19F0 3E3F       LD     A,3FH         --- A = ASCII '?'
19F2 CD2A03     CALL   032AH         --- Print '?'
19F5 19         ADD    HL,DE         --- HL = addr
19F6 7E         LD     A,(HL)        --- Get a char. of error code
19F7 CD2A03     CALL   032AH         --- Print one char of error code
19FA D7         RST    10H           --- Get next char of error code
19FB CD2A03     CALL   032AH         --- And print it
19FE 211D19     LD     HL,191DH      --- Error message
```

```
1983  : not started execution of BASIC program
1984  : Still in Input Phase



198E  : BASIC 'READY' routine. --- Load current data line number



19A2  * *************************************************************



19E3  * ***********************************************************
```

```
1A01 E5       PUSH   HL           --- Save addr of 'ERROR' message
1A02 2AEA40   LD     HL,(40EAH)   --- HL = line number of statement causing error
1A05 E3       EX     (SP),HL      --- Line no. to stk. HL = addr of 'ERROR' message
1A06 CDA728   CALL   28A7H        --- Print message here addr is in HL
1A09 E1       POP    HL           --- HL = binary line no. of STOP/END or line w/error
1A0A 11FEFF   LD     DE,0FFFEH    --- DE = 65534 (10)
1A0D DF       RST    18H          --- Is current line no. = 65534
1A0E CA7406   JP     Z,0674H      --- Yes, IPL system
1A11 7C       LD     A,H          --- No, test for line no. = 0
1A12 A5       AND    L            --- Combine MSB and LSB
1A13 3C       INC    A            --- of current line no.
1A14 C4A70F   CALL   NZ,0FA7H     --- If non-zero, print current line no.
1A17 3EC1     LD     A,0C1H       --- 1A18: POP BC
1A19 CD8B03   CALL   038BH        --- Set output device to video ***** Flush current ***
1A1C CDAC41   CALL   41ACH        --- line buffer. DOS Exit (JP 5FFC)
1A1F CDF801   CALL   01F8H        --- Off cassette
1A22 CDF920   CALL   20F9H        --- Skip to next line on video
1A25 212919   LD     HL,1929H     --- Ready message
1A28 CDA728   CALL   28A7H        --- Print 'READY' message
1A2B 3A9A40   LD     A,(409AH)    --- Get error number
1A2E D602     SUB    02H          --- Test for syntax error
1A30 CC532E   CALL   Z,2E53H      --- If syntax error, enter EDIT routine
1A33 21FFFF   LD     HL,0FFFFH    --- HL = current line no.
1A36 22A240   LD     (40A2H),HL   --- Set current line no. to -1. Signal         cont-->
1A39 3AE140   LD     A,(40E1H)    --- Auto input flag field - Non zero if auto, 00H
1A3C B7       OR     A            --- Set status flags                      :if not auto
1A3D 2837     JR     Z,1A76H      --- Jmp & Print '>' prompt if no auto increment
1A3F 2AE240   LD     HL,(40E2H)   --- Else, fetch current line no. into HL
1A42 E5       PUSH   HL           --- Save line number on stack
1A43 CDAF0F   CALL   0FAFH        --- Output a line
1A46 D1       POP    DE           --- Load current line no. into DE for search routine
1A47 D5       PUSH   DE           --- And leave it on the stack
1A48 CD2C1B   CALL   1B2CH        --- Search for matching line number
1A4B 3E2A     LD     A,2AH        --- '*' (matching line number)
1A4D 3802     JR     C,1A51H      --- Jmp if matching line number found
1A4F 3E20     LD     A,20H        --- Else print a blank
1A51 CD2A03   CALL   032AH        -- Print a ' ' or '*'
1A54 CD6103   CALL   0361H        --- Accept input into buffer
1A57 D1       POP    DE           --- DE = current line no.
1A58 3006     JR     NC,1A60H     --->: Jmp if BREAK not hit
1A5A AF       XOR    A            <---:-: Else clear AUTO increment flag
1A5B 32E140   LD     (40E1H),A    --   : : Turn off AUTO increment
1A5E 18B9     JR     1A19H        --   : : Go to 'READY'
1A60 2AE440   LD     HL,(40E4H)   <---:-: Get increment value ************************
1A63 19       ADD    HL,DE        --   : : Add to current line no. and test for overflow
1A64 38F4     JR     C,1A5AH      ----->: Jmp if line no. exceeds 2**15.     Clear AUTO
1A66 D5       PUSH   DE           --- Save unincremented line no. on stack    :increment
1A67 11F9FF   LD     DE,0FFF9H    --- DE = 65529
1A6A DF       RST    18H          --- Compare bumped line no. to 65529
1A6B D1       POP    DE           --- DE = unincremented line no.
1A6C 30EC     JR     NC,1A5AH     --- Jmp if bumped line no. => 65529
1A6E 22E240   LD     (40E2H),HL   --- Save unincremented value as current line no.
1A71 F6FF     OR     0FFH         --- Set A = -1
1A73 C3EB2F   JP     2FEBH        --- Use EDIT code to load buffer addr         cont-->
1A76 3E3E     LD     A,3EH        --- A = '>' (prompt) ****************** see note--> *
1A78 CD2A03   CALL   032AH        --- Print '>'
1A7B CD6103   CALL   0361H        --- Accept input, on return HL = buffer addr
1A7E DA331A   JP     C,1A33H      --- Jmp if BREAK key hit. Go get next line
1A81 D7       RST    10H          --- Get a char from buffer, skip blanks & control
1A82 3C       INC    A            --- Set status flags but save carry           :codes
```

```
1A19  * ***************************************************************

1A36  : that execution has not started

1A60  * *************************************************************

1A73  : into HL. Then Jmp to 1A98
1A76  * Input line no. w/o AUTO increment ***************************
```

```
1A83 3D         DEC     A              --- So we can test for end of statement
1A84 CA331A     JP      Z,1A33H        --- Jmp if end of statement
1A87 F5         PUSH    AF             --- Save status (CARRY)-Get line in binary into DE
1A88 CD5A1E     CALL    1E5AH          --- Backspace input buffer over any trailing blanks
1A8B 2B         DEC     HL             <---: that follow line number
1A8C 7E         LD      A,(HL)          •  : Get next character
1A8D FE20       CP      20H             •  : Check for blank
1A8F 28FA       JR      Z,1A8BH        --->: Loop till last digit of line number found
1A91 23         INC     HL             --- HL = addr of first char following line number
1A92 7E         LD      A,(HL)         --- Fetch first char after line number
1A93 FE20       CP      20H            --- If its a blank then
1A95 CCC909     CALL    Z,09C9H        --- Bump buffer addr to next char
1A98 D5         PUSH    DE             --- Save binary line number
1A99 CDC01B     CALL    1BC0H          --- Encode input into tokens-BC=length of encoded stmt
1A9C D1         POP     DE             --- DE = line number in binary
1A9D F1         POP     AF             --- Get CARRY flag from fetch at 1A81
1A9E 22E640     LD      (40E6H),HL     --- Encoded statement pointer
1AA1 CDB241     CALL    41B2H          --- DOS Exit (JP 6033)
1AA4 D25A1D     JP      NC,1D5AH       --- Jmp if no line number. Must be Direct Statement
1AA7 D5         PUSH    DE             --- Save binary line number      : or System command
1AA8 C5         PUSH    BC             --- Save length of code string
1AA9 AF         XOR     A              --- Clear A and
1AAA 32DD40     LD      (40DDH),A      --- Set INPUT PHASE entered flag
1AAD D7         RST     10H            --- Scan for 1st token
1AAE B7         OR      A              --- Set status flag
1AAF F5         PUSH    AF             --- Save them
1AB0 EB         EX      DE,HL          --- HL = binary equivalent of line number
1AB1 22EC40     LD      (40ECH),HL     --- Save line number in communications area
1AB4 EB         EX      DE,HL          --- DE = line number for search routine
1AB5 CD2C1B     CALL    1B2CH          --- Search for matching line number
1AB8 C5         PUSH    BC             --- After search, BC = addr of line number     cont-->
1AB9 DCE42B     CALL    C,2BE4H        --- If matching line not found shift closest line up
1ABC D1         POP     DE             --- in memory to make room for new line.       cont-->
1ABD F1         POP     AF             --- Restore status from token scan at 1AAD
1ABE D5         PUSH    DE             --- Save addr of line in buffer
1ABF 2827       JR      Z,1AE8H        --- If matching line found, otherwise new      cont-->
1AC1 D1         POP     DE             --- DE = addr of last line or line > new line
1AC2 2AF940     LD      HL,(40F9H)     --- HL = end of pgm line ptr
1AC5 E3         EX      (SP),HL        --- HL = length of code string.                cont-->
1AC6 C1         POP     BC             --- BC = length of new line
1AC7 09         ADD     HL,BC          --- HL = new end of pgm line ptr
1AC8 E5         PUSH    HL             --- Save end of pgm addr
1AC9 CD5519     CALL    1955H          --- Make sure enough room for new line. Test for PST
1ACC E1         POP     HL             --- HL = end of PST :overflow in stack area
1ACD 22F940     LD      (40F9H),HL     --- New end of PST addr
1AD0 EB         EX      DE,HL          --- HL = addr of line to be moved up
1AD1 74         LD      (HL),H         --- Save MSB of addr of line to moved as       cont-->
1AD2 D1         POP     DE             --- DE = new line number in binary
1AD3 E5         PUSH    HL             --- Save addr if line to be moved up
1AD4 23         INC     HL             --- Bump to LSB of line number entry
1AD5 23         INC     HL             --- Bump to MSB of line number entry
1AD6 73         LD      (HL),E         --- DE = binary value of line no for new line. Save
1AD7 23         INC     HL             --- Bump to MSB                                       :LSB
1AD8 72         LD      (HL),D         --- Save MSB of new line in old line nos. position
1AD9 23         INC     HL             --- HL = stmt ptr (past line number)
1ADA EB         EX      DE,HL          --- DE = first data byte addr following line number
1ADB 2AA740     LD      HL,(40A7H)     --- HL = input area ptr
1ADE EB         EX      DE,HL          --- DE = input area ptr (fetch addr).          cont-->
1ADF 1B         DEC     DE             --- DE = input area ptr - 1
1AE0 1B         DEC     DE             --- DE = input area ptr - 2
```

1AB8 : in buffer if it exists

1ABC : DE = addr of line in buffer

1ABF : line is to be added

1AC5 : Stack = addr of line to be moved

1AD1 : first byte of line

1ADE : HL = addr of first data position in pgm area (store addr)

```
1AE1 1A       LD     A,(DE)       <---: Get a byte of pgm from input buffer
1AE2 77       LD     (HL),A        •  : Move it to pgm storage area (PST)
1AE3 23       INC    HL            •  : Bump store addr
1AE4 13       INC    DE            •  : Bump fetch addr
1AE5 B7       OR     A             •  : Test for end of code string
1AE6 20F9     JR     NZ,1AE1H     --->: Jmp if not end of statement to be moved
1AE8 D1       POP    DE           --- DE = addr of line in pgm table
1AE9 CDFC1A   CALL   1AFCH        --- Update line ptrs for all line following new line
1AEC CDB541   CALL   41B5H        --- DOS Exit (JP 5BD7)
1AEF CD5D1B   CALL   1B5DH        --- Update 40FB, 40FD line ptrs = 40F9
1AF2 CDB841   CALL   41B8H        --- DOS Exit (JP 5B8C)
1AF5 C3331A   JP     1A33H        --- Loop back to repeat input sequence
1AF8 2AA440   LD     HL,(40A4H)   --- HL = start addr of PST (entered from Disk BASIC)
1AFB EB       EX     DE,HL        --- Move PST addr to HL
1AFC 62       LD     H,D          <---: HL = current line ptr ************ see note--> *
1AFD 6B       LD     L,E           •  : First 2 bytes of each line contains addr of next
1AFE 7E       LD     A,(HL)        •  : line. An addr of 00 00 terminates        cont-->
1AFF 23       INC    HL            •  : Look for end byte
1B00 B6       OR     (HL)          •  : of pgm (0000)
1B01 C8       RET    Z             •  : Return if end
1B02 23       INC    HL            •  : HL = beginning of stmt ptr               cont-->
1B03 23       INC    HL            •  : Skip over 3 & 4th bytes of
1B04 23       INC    HL            •  : current line which hold its line no.
1B05 AF       XOR    A             •  : A = 0, status flags cleared
1B06 BE       CP     (HL)         <--:: Scan for end of current line its         cont-->
1B07 23       INC    HL            • :: When end found, HL+1 will be addr of next line
1B08 20FC     JR     NZ,1B06H     -->:: Loop till end of stmt found
1B0A EB       EX     DE,HL         •  : DE=end of stmt + 1 (ptr to next stmt)     cont->
1B0B 73       LD     (HL),E        •  : Move addr of next line to 1st 2 bytes of current
1B0C 23       INC    HL            •  : Save LSB of next line addr                  :line
1B0D 72       LD     (HL),D        •  : Save MSB of next line addr
1B0E 18EC     JR     1AFCH        --->: Loop till end of pgm found
1B10 110000   LD     DE,0000H     --- Initialize starting line to 0 in case * cont--> *
1B13 D5       PUSH   DE           --- none is specified. Save on stack
1B14 2809     JR     Z,1B1FH      --- Jmp if no line nos. given
1B16 D1       POP    DE           --- Clear temp. starting value
1B17 CD4F1E   CALL   1E4FH        --- Get starting line no. in DE
1B1A D5       PUSH   DE           --- Save starting line no.
1B1B 280B     JR     Z,1B28H      --->: Jmp if no ending line specified
1B1D CF       RST    08H          --  : Test for dash following line number
1B1E CE11     ADC    A,11H        --  : 1B1E : DC CE        dash token
1B20 FAFFC4   JP     M,0C4FFH     --  : 1B1F : LD   DE,FFAF default ending line number
1B23 4F       LD     C,A          --  : 1B22 : CALL NZ,1E4F  get ending line no into DE
1B24 1EC2     LD     E,0C2H       --  : 1B25 : JP   NZ,1997  SN Error if no terminator
1B26 97       SUB    A            --  :
1B27 19       ADD    HL,DE        --  :
1B28 EB       EX     DE,HL        <---: HL = ending line no.
1B29 D1       POP    DE           --- DE = starting line no.
1B2A E3       EX     (SP),HL      --- Ending line no to stack. Rtn addr to HL
1B2B E5       PUSH   HL           --- Rtn addr to stack so we can exit below
1B2C 2AA440   LD     HL,(40A4H)   --- HL = starting addr of PST ************** cont--> *
1B2F 44       LD     B,H          --- DE = Line number to locate
1B30 4D       LD     C,L          --- BC = address of current line in PST
1B31 7E       LD     A,(HL)       --- A = LSB of addr of next line
1B32 23       INC    HL           --- Bump to MSB of addr of next line
1B33 B6       OR     (HL)         --- Combine MSB/LSB and set status flags
1B34 2B       DEC    HL           --- Restore HL to start of current line
1B35 C8       RET    Z            --- Exit if end of PST, else
1B36 23       INC    HL           --- Bump HL to point to line number
1B37 23       INC    HL           --- for current line
```

```
1AFC  * Update line pointers for all lines after new line. **********
      * DE = Addr of Program Statement Table
1AFE  : the program. Get 1st byte of current line and combine w/2nd



1B02  : (Past next stmt ptr and line number)



1B06  : terminated by 00


1B0A  : HL = current line ptr




1B10  * **** Called by LIST/DELETE **********************************
      :      Converts starting and ending line numbers (X - Y) to
      :      binary and saves ending line number on stack.
      :      Then falls into code below to locate pgm table addr for
      :      starting line. Leaves addr of starting line in BC -
      :      ending line number on stack











1B2C  * Search for matching line routine ***************************
      : Exit conditions
      : Line not found. End of PST encountered:
      :           NC/Z/HL = BC
      : Line found: DE=HL/C/Z, BC = addr of line in PST
      :           HL = addr of next line
      : Line not found. Line number > asked for line number
      :           DE>HL/NC/NZ, BC = addr of current line
      :                 HL = addr of next line
```

```
1B38 7E         LD      A,(HL)         --- A = LSB of line no. for current line
1B39 23         INC     HL             --- Bump to MSB
1B3A 66         LD      H,(HL)         --- HL = MSB of line no. for current line
1B3B 6F         LD      L,A            --- L = LSB of current line number
1B3C DF         RST     18H            --- Subtract line no. in DE from line no. for current
1B3D 60         LD      H,B            --- Set HL = starting addr of current line  :statement
1B3E 69         LD      L,C            --- L = LSB of start addr of current line
1B3F 7E         LD      A,(HL)         --- Now, get addr of next line into HL
1B40 23         INC     HL             --- Bump to MSB of addr of next line
1B41 66         LD      H,(HL)         --- H = MSB of addr for next line
1B42 6F         LD      L,A            --- Form addr of next line in HL
1B43 3F         CCF                    --- CARRY set if current line                cont-->
1B44 C8         RET     Z              --- Line numbers match. Exit C, Z,           cont-->
1B45 3F         CCF                    --- No match, reverse CARRY & exit if
1B46 D0         RET     NC             --- line no. in DE < current line number     cont-->
1B47 18E6       JR      1B2FH          --- Loop till end of pgm or line number      cont-->
1B49 C0         RET     NZ             --- Syntax error if NEW XX ************** NEW routine *
1B4A CDC901     CALL    01C9H          --- Clear screen
1B4D 2AA440     LD      HL,(40A4H)     --- HL = start of Program Statement Table (PST)
1B50 CDF81D     CALL    1DF8H          --- Turn TRACE OFF
1B53 32E140     LD      (40E1H),A      --- Clear AUTO INCREMENT flag
1B56 77         LD      (HL),A         --- Initialize PST as empty by
1B57 23         INC     HL             --- zeroing first two bytes
1B58 77         LD      (HL),A         --- Zero 2nd byte
1B59 23         INC     HL             --- then
1B5A 22F940     LD      (40F9H),HL     --- initialize the start of the variable     cont-->
1B5D 2AA440     LD      HL,(40A4H)     --- Reload HL with PST addr     *** RUN starts here ***
1B60 2B         DEC     HL             --- and backspace 1. This will be the
1B61 22DF40     LD      (40DFH),HL     --- beginning execution addr for the program
1B64 061A       LD      B,1AH          --- 26 alpha characters ** RUN line no. starts here ***
1B66 210141     LD      HL,4101H       --- Def alpha table entries initialized to 004H
1B69 3604       LD      (HL),04H       --- Load one value                  :(single precision)
1B6B 23         INC     HL             --- Bump to next entry
1B6C 10FB       DJNZ    1B69H          --- Loop till DEC ALPHA table initialized
1B6E AF         XOR     A              --- Clear A-reg
1B6F 32F240     LD      (40F2H),A      --- Signal no error for RESUME verb
1B72 6F         LD      L,A            --- then
1B73 67         LD      H,A            --- Zero HL
1B74 22F040     LD      (40F0H),HL     --- Set ON ERROR address to zero
1B77 22F740     LD      (40F7H),HL     --- Points to next statement following a     cont-->
1B7A 2AB140     LD      HL,(40B1H)     --- Highest memory pointer
1B7D 22D640     LD      (40D6H),HL     --- String working area pointer
1B80 CD911D     CALL    1D91H          --- Restore
1B83 2AF940     LD      HL,(40F9H)     --- HL = end of basic pgm
1B86 22FB40     LD      (40FBH),HL     --- Simple variable ptrs
1B89 22FD40     LD      (40FDH),HL     --- Array ptrs
1B8C CDBB41     CALL    41BBH          --- DOS Exit (JP 5B8C)
1B8F C1         POP     BC             --- Load return addr because we will be      cont-->
1B90 2AA040     LD      HL,(40A0H)     --- HL = Start of string data ptr
1B93 2B         DEC     HL             --- HL = Start of string data ptr - 1
1B94 2B         DEC     HL             --- -2
1B95 22E840     LD      (40E8H),HL     --- Stack ptr = start of string data ptr - 2
1B98 23         INC     HL             --- HL = start of string data ptr +1
1B99 23         INC     HL             --- +2
1B9A F9         LD      SP,HL          --- SP = start of string data ptr
1B9B 21B540     LD      HL,40B5H       --- Initialize literal string pool table as empty
1B9E 22B340     LD      (40B3H),HL     --- Start of LSPT to 40 B3
1BA1 CD8B03     CALL    038BH          --- Output device = video: Print line printer buffer
1BA4 CD6921     CALL    2169H          --- Turn off cassette and set output device = video
1BA7 AF         XOR     A              --- Zero A then
```

```
1B43  : number < value in DE. After CCF CARRY is cleared.
1B44  : BC = addr of current line, HL = addr next line

1B46  : BC = addr of current line, HL = addr next line
1B47  : Greater than requested one found
1B49  * ************************************************************
```

```
1B5A  : list table as the end of the PST
```

```
1B77  : BREAK, STOP or END.
```

```
1B8F  : changing stack pointer
```

```
1BA8 67         LD      H,A           --- Clear HL for 'RUN' push
1BA9 6F         LD      L,A           --- Zero L
1BAA 32DC40     LD      (40DCH),A     --- Clear 'FOR' statement flag
1BAD E5         PUSH    HL            --- Signal 'RUN' push
1BAE C5         PUSH    BC            --- Return addr to continue executing code string
1BAF 2ADF40     LD      HL,(40DFH)    --- Restore code string addr to HL
1BB2 C9         RET                   --- Rtn to caller
1BB3 3E3F       LD      A,3FH         --- A = ASCII ? ************************************
1BB5 CD2A03     CALL    032AH         --- Print ?
1BB8 3E20       LD      A,20H         --- A = ASCII space
1BBA CD2A03     CALL    032AH         --- Print space
1BBD C36103     JP      0361H         --- Wait for keyboard input and rtn to caller
1BC0 AF         XOR     A             --- Zero A ***************************************
1BC1 32B040     LD      (40B0H),A     --- Clear DATA statement flag
1BC4 4F         LD      C,A           --- Zero C-reg
1BC5 EB         EX      DE,HL         --- DE = addr of first char after line number
1BC6 2AA740     LD      HL,(40A7H)    --- HL = input area ptr = tokenized string addr
1BC9 2B         DEC     HL            --- Backspace
1BCA 2B         DEC     HL            --- twice
1BCB EB         EX      DE,HL         --- DE = input string addr - 2
1BCC 7E         LD      A,(HL)        --- HL = current input string addr
1BCD FE20       CP      20H           --- Fetch next char. from input string
1BCF CA5B1C     JP      Z,1C5BH       --- Test for space
1BD2 47         LD      B,A           --- Jump if blank
1BD3 FE22       CP      22H           --- Save input character
1BD5 CA771C     JP      Z,1C77H       --- Test for quote
1BD8 B7         OR      A             --- If quote, move entire field between quotes to code
1BD9 CA7D1C     JP      Z,1C7DH       --- Set status flags                           :string
1BDC 3AB040     LD      A,(40B0H)     --- Jmp if end of string
1BDF B7         OR      A             --- A = DATA statement flag
1BE0 7E         LD      A,(HL)        --- Set status flags
1BE1 C25B1C     JP      NZ,1C5BH      --- Load next char from input string
1BE4 FE3F       CP      3FH           --- Jump if DATA stmt encountered
1BE6 3EB2       LD      A,0B2H        --- '?' abbreviation for print
1BE8 CA5B1C     JP      Z,1C5BH       --- Print token replaces question mark
1BEB 7E         LD      A,(HL)        --- Jmp if '?' (print token)
1BEC FE30       CP      30H           --- Re-fetch current character
1BEE 3805       JR      C,1BF5H       --- Test for numeric as alpha-numeric
1BF0 FE3C       CP      3CH           --- Char < 30 - that means it's not a letter or digit
1BF2 DA5B1C     JP      C,1C5BH       --- Char < 3C - that means 0-9,:,;,<           cont-->
1BF5 D5         PUSH    DE            --- Save pointer to buffer origin -2, -1, . .
1BF6 114F16     LD      DE,164FH      --- DE addr of syntax tree
1BF9 C5         PUSH    BC            --- Save BC
1BFA 013D1C     LD      BC,1C3DH      --- Rtn add after matching syntax tree
1BFD C5         PUSH    BC            --- W/input string
1BFE 067F       LD      B,7FH         --- B = syntax tree control char count
1C00 7E         LD      A,(HL)        --- Current input character
1C01 FE61       CP      61H           --- Test for upper case
1C03 3807       JR      C,1C0CH       --->: Jump if not lower case
1C05 FE7B       CP      7BH           --  : Test for upper case
1C07 3003       JR      NC,1C0CH      --->: Jump if not lower case
1C09 E65F       AND     5FH           --  : Make upper case
1C0B 77         LD      (HL),A        --  : Save converted character
1C0C 4E         LD      C,(HL)        <---: Reload current character
1C0D EB         EX      DE,HL         --- HL = syntax list, DE = addr of current string
1C0E 23         INC     HL            <---: Bump to next char in syntax list
1C0F B6         OR      (HL)           •  :Set status flags for current char         cont-->
1C10 F20E1C     JP      P,1C0EH       --->: Scan syntax list till control char found
1C13 04         INC     B             --- Count of syntax control char passed
1C14 7E         LD      A,(HL)        --- Get syntax element
```

1BB3 * ***

1BC0 * ***

1BF2 : Constant or special char. Move it to token area.

1C0F : from syntax list

```
1C15 E67F      AND     7FH          --- Clear sign bit
1C17 C8        RET     Z            --- Zero terminates syntax list, goto 1C3D
1C18 B9        CP      C            --- Compare input element w/syntax element
1C19 20F3      JR      NZ,1C0EH     --- No match, scan till past control element
1C1B EB        EX      DE,HL        --- HL = start of current symbol in input string
1C1C E5        PUSH    HL           --- Save starting addr of current symbol
1C1D 13        INC     DE           <-----: Bump to next char in syntax list
1C1E 1A        LD      A,(DE)        •    :Get next syntax list element
1C1F B7        OR      A             •    : Set status flags for end of name test
1C20 FA391C    JP      M,1C39H      ------:->: Jmp if control element, we have a
1C23 4F        LD      C,A           •    :  : Complete match. Save next syntax element
1C24 78        LD      A,B           •    :  : If count of keyword being examined is
1C25 FE8D      CP      8DH           •    :  : 8D then we are testing for a GOTO
1C27 2002      JR      NZ,1C2BH     --->: :  : Jump if not 'GOTO' token
1C29 D7        RST     10H           • : :  : Skip following char if its blank
1C2A 2B        DEC     HL            • : :  : Decrement for following skip
1C2B 23        INC     HL           <---: :  : Skip to next char
1C2C 7E        LD      A,(HL)        •    :  : Get next element from input string
1C2D FE61      CP      61H           •    :  : Test for upper case
1C2F 3802      JR      C,1C33H      --->: :  : Jump if not lower case
1C31 E65F      AND     5FH           • : :  : Force upper case
1C33 B9        CP      C            <---: :  : Compare input element & syntax element
1C34 28E7      JR      Z,1C1DH      ----->:  : Jmp if equal
1C36 E1        POP     HL           ---      : Unequal, restart scan from last
1C37 18D3      JR      1C0CH        ---      : Point in syntax list
1C39 48        LD      C,B          <--------: Syntax list index
1C3A F1        POP     AF           --- Get rid of HL push at 1C1C
1C3B EB        EX      DE,HL        --- HL = syntax tree addr for this string, DE =
1C3C C9        RET                  --- current string Goto 1C3D
1C3D EB        EX      DE,HL        --- HL = current string
1C3E 79        LD      A,C          --- A = syntax list index
1C3F C1        POP     BC           --- Clear rtn addr from stack
1C40 D1        POP     DE           --- DE = input string buffer origin-2 -        cont-->
1C41 EB        EX      DE,HL        --- HL = buffer origin-2, DE = current string addr
1C42 FE95      CP      95H          --- Test if ELSE token
1C44 363A      LD      (HL),3AH     --- ':' buffer origin-2
1C46 2002      JR      NZ,1C4AH     --->: Jump if not 'ELSE' token
1C48 0C        INC     C            --  : Count 1 char in token buffer
1C49 23        INC     HL           --  : Bump to next position in token buffer
1C4A FEFB      CP      0FBH         <---: Test for REM token
1C4C 200C      JR      NZ,1C5AH     --->: Jump if not ''' (abbreviation for 'REM') token
1C4E 363A      LD      (HL),3AH     --  : ':' to tokenized buffer
1C50 23        INC     HL           --  : next pos. in token buffer
1C51 0693      LD      B,93H        --  . 'REM' token
1C53 70        LD      (HL),B       --  : To tokenized buffer
1C54 23        INC     HL           --  : Next pos. in token buffer
1C55 EB        EX      DE,HL        --  : HL = input string addr. DE = token buffer addr.
1C56 0C        INC     C            --  : Count 2
1C57 0C        INC     C            --  : More chars to token buffer
1C58 181D      JR      1C77H        --  : Go move comment to token buffer
1C5A EB        EX      DE,HL        <---: DE = buffer area-2, HL = current string addr
1C5B 23        INC     HL           --- Bump to next char in input string
1C5C 12        LD      (DE),A       --- Syntax tree index to buffer origin-2 : or if blank
1C5D 13        INC     DE           --- DE = buffer origin-1                 : move the
1C5E 0C        INC     C            --- C = index for next syntax element       : blank
1C5F D63A      SUB     3AH          --- Test for multi-statement line
1C61 2804      JR      Z,1C67H      --->: Jmp if multi-statement line
1C63 FE4E      CP      4EH          --  : Test for DATA stmt
1C65 2003      JR      NZ,1C6AH     --  : Jump if not 'DATA' token
1C67 32B040    LD      (40B0H),A    <---: Syntax list index to flag 'data' statement
```

```
1C40  : loaded at 1CF5
```

```
1C6A D659      SUB    59H          --- Test for REM token
1C6C C2CC1B    JP     NZ,1BCCH     --- Jump if not 'REM' token. Analyze rest of statement
1C6F 47        LD     B,A          --- B = 00
1C70 7E        LD     A,(HL)       <---: Get next char from input string
1C71 B7        OR     A             •  : Set status flags so we can test for EOS
1C72 2809      JR     Z,1C7DH      ----:>: Jmp if EOS
1C74 B8        CP     B             •  : : Move statement from input buffer to input
1C75 28E4      JR     Z,1C5BH       •  : : buffer - 2. Loop till EOS detected. Count
1C77 23        INC    HL            •  : : of characters moved in BC. Also entered if
1C78 12        LD     (DE),A        •  : : a ' ' string is detected.
1C79 0C        INC    C             •  : : Count 1 char added to token buffer
1C7A 13        INC    DE            •  : : Bump token buffer addr.
1C7B 18F3      JR     1C70H        --->: : Loop till EOS or ending quote found
1C7D 210500    LD     HL,0005H     <-----: Now, add
1C80 44        LD     B,H          --- Five to the length of the
1C81 09        ADD    HL,BC        --- token buffer thus far
1C82 44        LD     B,H          --- then leave
1C83 4D        LD     C,L          --- New count in BC
1C84 2AA740    LD     HL,(40A7H)   --- Get start of input string area
1C87 2B        DEC    HL           --- Backspace once
1C88 2B        DEC    HL           --- Backspace twice
1C89 2B        DEC    HL           --- Three times
1C8A 12        LD     (DE),A       --- Then zero
1C8B 13        INC    DE           --- Last 3 words of tokenized string
1C8C 12        LD     (DE),A       --- Second zero
1C8D 13        INC    DE           --- Bump addr
1C8E 12        LD     (DE),A       --- Third zero
1C8F C9        RET                 --- Rtn to caller
1C90 7C        LD     A,H          --- Compute *********** RST 18 sends you here *******
1C91 92        SUB    D            --- H - D                Computes HL-DE
1C92 C0        RET    NZ           --- Exit if unequal         Z if equal
1C93 7D        LD     A,L          --- Compute                 C if DE>HL
1C94 93        SUB    E            --- L - E
1C95 C9        RET                 --- and rtn to caller
1C96 7E        LD     A,(HL)       --- Get value to be compared * RST 08 routine *******
1C97 E3        EX     (SP),HL      --- Save rtn addr.
1C98 BE        CP     (HL)         --- Compare (HL) with value following RST 8
1C99 23        INC    HL           --- Bump rtn addr
1C9A E3        EX     (SP),HL      --- Restore rtn addr to stack,                 cont-->
1C9B CA781D    JP     Z,1D78H      --- CALL RST 10 If expected character found
1C9E C39719    JP     1997H        --- SN error if expected char not found
1CA1 3E64      LD     A,64H        --- FOR signal value ****************** FOR routine *
1CA3 32DC40    LD     (40DCH),A    --- Signal FOR statement.
1CA6 CD211F    CALL   1F21H        --- Evaluates x = y (index)
1CA9 E3        EX     (SP),HL      --- Save code string addr. DE=addr of index variable
1CAA CD3619    CALL   1936H        --- Scan stack backwards looking for other     cont-->
1CAD D1        POP    DE           --- DE = current code string addr (addr of TO token)
1CAE 2005      JR     NZ,1CB5H     --->: Jmp if nested 'FOR' not on stack         cont-->
1CB0 09        ADD    HL,BC        --   : BC = Offset to end of stack frame       cont-->
1CB1 F9        LD     SP,HL        --   : Reset CSP to this addr. Regain the      cont-->
1CB2 22E840    LD     (40E8H),HL   --   : NF error next. Save CSP addr in 40E8
1CB5 EB        EX     DE,HL        <---: HL = current code string addr
1CB6 0E08      LD     C,08H        --- C = 1/2 amt. of space needed
1CB8 CD6319    CALL   1963H        --- Make sure there's 16 bytes of free space
1CBB E5        PUSH   HL           --- Save code string addr before 'TO'
1CBC CD051F    CALL   1F05H        --- Scan till end of statement
1CBF E3        EX     (SP),HL      --- Stack = end of statement,                  cont-->
1CC0 E5        PUSH   HL           --- Code string addr to stk. should point to TO token
1CC1 2AA240    LD     HL,(40A2H)   --- HL = current line no. in binary.
1CC4 E3        EX     (SP),HL      --- Stack = end of line addr. FOR line no.     cont-->
```

```
1C90  * ************************************************************

1C96  * RST 08 sends you here ***************************************

1C9A  : HL = current code string pointer

1CA1  * ************************************************************

1CAA  : FOR/NEXT token with same index (Error if found)

1CAE  : If one is found, on exit HL = starting addr of FOR push
1CB0  : After addition we are at end of 1st FOR frame push
1CB1  : stack space and force a NF error

1CBF  : HL = current position in statement

1CC4  : in binary for FOR statement
```

```
1CC5 CF        RST    08H         --- Test for TO token
1CC6 BD        CP     L           --- DC BD TO token
1CC7 E7        RST    20H         --- Test data type of index variable
1CC8 CAF60A    JP     Z,0AF6H     --- TM error if Z (string)
1CCB D2F60A    JP     NC,0AF6H    --- TM error if NC (double)
1CCE F5        PUSH   AF          --- Save type flags
1CCF CD3723    CALL   2337H       --- Evaluate TO side of FOR statement
1CD2 F1        POP    AF          --- Restore index type flags
1CD3 E5        PUSH   HL          --- Save current position in code string after TO
1CD4 F2EC1C    JP     P,1CECH     --->: Jmp if index is single precision        :token
1CD7 CD7F0A    CALL   0A7FH         • : Current TO value to integer
1CDA E3        EX     (SP),HL       • : Integer value to stack. Reload HL
1CDB 110100    LD     DE,0001H      • : DE = increment in case STEP not specified
1CDE 7E        LD     A,(HL)        • : Get next element from code string
1CDF FECC      CP     0CCH          • : Compare with STEP token
1CE1 CC012B    CALL   Z,2B01H       • : Call if 'STEP' token - Get step value into DE
1CE4 D5        PUSH   DE            • : Save step value
1CE5 E5        PUSH   HL            • : Save code string position
1CE6 EB        EX     DE,HL         • : STEP value to HL so we test its size
1CE7 CD9E09    CALL   099EH         • : Get sign of STEP into A. A=+1 if pos., -1 if neg
1CEA 1822      JR     1D0EH       ----:>: Skip over single precision code for counter
1CEC CDB10A    CALL   0AB1H       <---: : Convert TO value to single precision   :& step
1CEF CDBF09    CALL   09BFH       --    : Load counter into BC/DE
1CF2 E1        POP    HL          --    : HL = end of TO expression
1CF3 C5        PUSH   BC          --    : Save TO value (limit)
1CF4 D5        PUSH   DE          --    : All four bytes of it
1CF5 010081    LD     BC,8100H    --    : BC = single precision 1 = default STEP value
1CF8 51        LD     D,C         --    : 0000 = DE
1CF9 5A        LD     E,D         --    : E as well
1CFA 7E        LD     A,(HL)      --    : A = next element from code string
1CFB FECC      CP     0CCH        --    : Test for STEP token
1CFD 3E01      LD     A,01H       --    : Default step = 1
1CFF 200E      JR     NZ,1D0FH    --->: : Jump if not 'STEP' token
1D01 CD3823    CALL   2338H       --  : : Evaluate STEP expression
1D04 E5        PUSH   HL          --  : : Save code string addr
1D05 CDB10A    CALL   0AB1H       --  : : Convert value to single precision
1D08 CDBF09    CALL   09BFH       --  : : Load STEP expression value into BC/DE
1D0B CD5509    CALL   0955H       --  : : Get sign of STEP value into A. +1=pos,-1=neg
1D0E E1        POP    HL          <---:-: HL = current code string addr
1D0F C5        PUSH   BC          <---: Save STEP expression
1D10 D5        PUSH   DE          --- On stack
1D11 4F        LD     C,A         --- Sign flag for STEP value to C
1D12 E7        RST    20H         --- Test data type for STEP value
1D13 47        LD     B,A         --- B = type for STEP value.                  cont-->
1D14 C5        PUSH   BC          --- Save type adjusted / sign flag
1D15 E5        PUSH   HL          --- Save current code string addr on stack
1D16 2ADF40    LD     HL,(40DFH)  --- HL = addr of index from FOR x = y
1D19 E3        EX     (SP),HL     --- HL = code string addr. Stack = addr of x variable
1D1A 0681      LD     B,81H       --- B = FOR token
1D1C C5        PUSH   BC          --- Save FOR token / sign of STEP increment
1D1D 33        INC    SP          --- Leave a one byte gap on the stack         cont-->
1D1E CD5803    CALL   0358H       --- Set status flags for input
1D21 B7        OR     A           --- If key was hit, check for shift @
1D22 C4A01D    CALL   NZ,1DA0H    --- Save address of last byte executed in current line
1D25 22E640    LD     (40E6H),HL  --- Save CSP
1D28 ED73E840  LD     (40E8H),SP  --- Fetch next character from input string
1D2C 7E        LD     A,(HL)      --- and test for a compound statement
1D2D FE3A      CP     3AH         --- Jump if ':' - Multiple statement this line
1D2F 2829      JR     Z,1D5AH     --- Else, make sure code string terminates
1D31 B7        OR     A           --- Set status flags
```

1D13 : -1 (int), +1 (sing) C = STEP sign flag

1D1E : Continue execution of code string. Test for keyboard input

```
1D32 C29719    JP      NZ,1997H       --- SN error if NC with a byte of zeroes
1D35 23        INC     HL             --- Get LSB of pointer to next statement
1D36 7E        LD      A,(HL)         --- Test for non-zero by combining
1D37 23        INC     HL             --- with MSB byte
1D38 B6        OR      (HL)           --- of pointer to the next statement
1D39 CA7E19    JP      Z,197EH        --- Jmp if last executable statement, else
1D3C 23        INC     HL             --- Get line number of next statement
1D3D 5E        LD      E,(HL)         --- into DE
1D3E 23        INC     HL             --- Bump to MSB of line number for next statement
1D3F 56        LD      D,(HL)         --- DE = binary line number of next statement
1D40 EB        EX      DE,HL          --- HL = Line number for next statement
1D41 22A240    LD      (40A2H),HL     --- Update last executed line to current line number
1D44 3A1B41    LD      A,(411BH)      --- Get TRACE flag
1D47 B7        OR      A              --- Set status flags
1D48 280F      JR      Z,1D59H        --->: Jmp if TROFF, fall through if TRON
1D4A D5        PUSH    DE             --  : Save DE since display routine uses it
1D4B 3E3C      LD      A,3CH          --  : ASCII '<'
1D4D CD2A03    CALL    032AH          --  : Print '<'
1D50 CDAF0F    CALL    0FAFH          --  : Convert line number to binary & print it
1D53 3E3E      LD      A,3EH          --  : ASCII '>'
1D55 CD2A03    CALL    032AH          --  : Print '>' (This gives dine number>)
1D58 D1        POP     DE             --  : Restore DE
1D59 EB        EX      DE,HL          <---: HL = code string current line
1D5A D7        RST     10H            --- Get next token ***** Execution phase starts here **
1D5B 111E1D    LD      DE,1D1EH       --- Rtn addr after executing one verb
1D5E D5        PUSH    DE             --- Rtn addr onto stack
1D5F C8        RET     Z              --- Exit if EOS (end of statement) - Go back to 1D1E
1D60 D680      SUB     80H            --- (tokens range from 80 - FB) Compute rel. token
1D62 DA211F    JP      C,1F21H        --- Not a token - must be assignment stmt       :index
1D65 FE3C      CP      3CH            --- Test if token below TAB token
1D67 D2E72A    JP      NC,2AE7H       --- Jmp if token => BC (TAB - MID$,')
1D6A 07        RLCA                   --- Double remainder for routine address offset
1D6B 4F        LD      C,A            --- BC = routine offset
1D6C 0600      LD      B,00H          --- BC = 00 / 2 * token
1D6E EB        EX      DE,HL          --- Save HL (current location in code string)
1D6F 212218    LD      HL,1822H       --- Address table of verb action routines
1D72 09        ADD     HL,BC          --- HL = routine table address ptr
1D73 4E        LD      C,(HL)         --- C = LSB of verb action routine addr
1D74 23        INC     HL             --- Bump to MSB
1D75 46        LD      B,(HL)         --- B = MSB of verb action routine addr
1D76 C5        PUSH    BC             --- Save routine address on stack         see note -->
1D77 EB        EX      DE,HL          --- Restore code string address
1D78 23        INC     HL             <---:-: Bump to next character *** RST 10 action rtne *
1D79 7E        LD      A,(HL)          •  : : Get next character
1D7A FE3A      CP      3AH             •  : : Compare it with a colon (:)
1D7C D0        RET     NC              •  : : Rtn if character is :,;,<,.....A - Z
1D7D FE20      CP      20H             •  : : else test for a blank
1D7F CA781D    JP      Z,1D78H        --->: : Get next character if this one is a blank
1D82 FE0B      CP      0BH            --    : Compare it with a vertical TAB
1D84 3005      JR      NC,1D8BH       --->: : Jump if A >= 0B (not a control code)
1D86 FE09      CP      09H             •  : : Test for a horizontal TAB
1D88 D2781D    JP      NC,1D78H       ----:>: Jmp if not horizontal TAB or line feed
1D8B FE30      CP      30H            <---: Compare with ASCII '0'
1D8D 3F        CCF                    --- Set CARRY if numeric (>=30)
1D8E 3C        INC     A              --- Clear CARRY if not numeric (<30)
1D8F 3D        DEC     A              --- Set status flags (except CARRY) according to
1D90 C9        RET                    --- Rtn to caller         : character just loaded
1D91 EB        EX      DE,HL          --- Save HL *********************** RESTORE routine **
1D92 2AA440    LD      HL,(40A4H)     --- HL = start of program ptr
1D95 2B        DEC     HL             --- Backspace 1 byte, save HL
```

```
1D5A  : Find next non-blank character in code string ****************
      : Method:
      : 1. Locate next token in current statement and
      :    branch to verb action routine. Force return to
      :    1D1E after verb routine.
      : 2. After each completed verb action routine test
      :    for BREAK, end of line (bump to next line), end
      :    of program (rtn to INPUT PHASE),or TRON option
      :    goto step 1

      : (It will be popped below)

1D78  * RST 10 routine addr sends you here *************************

1D91  * ************************************************************
```

```
1D96 22FF40    LD      (40FFH),HL    --- Data ptr = start of program - 1
1D99 EB        EX      DE,HL         --- Restore HL
1D9A C9        RET                   --- Rtn to caller
1D9B CD5803    CALL    0358H         --- Scan keyboard once ******************************
1D9E B7        OR      A             --- Set status flags for character strobed
1D9F C8        RET     Z             --- Return if no key
1DA0 FE60      CP      60H           --- Shift @ ?
1DA2 CC8403    CALL    Z,0384H       --- if so, wait until user types a character
1DA5 329940    LD      (4099H),A     --- Save character typed
1DA8 3D        DEC     A             --- A + 1 if break key
1DA9 C0        RET     NZ            --- Stop routine ************************************
1DAA 3C        INC     A             --- Set A = 1, status non-zero
1DAB C3B41D    JP      1DB4H         --- Use END code
1DAE C0        RET     NZ            --- Syntax error if END XX ************ END routine **
1DAF F5        PUSH    AF            --- Save zero status (END processing)
1DB0 CCBB41    CALL    Z,41BBH       --- DOS Exit (JP 60A1)
1DB3 F1        POP     AF            --- Restore END status to A status register
1DB4 22E640    LD      (40E6H),HL    --- Current code string addr for STOP or END
1DB7 21B540    LD      HL,40B5H      --- HL = start of literal string area
1DBA 22B340    LD      (40B3H),HL    --- Reset pointer to start of literal string area
1DBD 21F6FF    LD      HL,0FFF6H     --- 1DBE: OR FF
1DC0 C1        POP     BC            --- Clear stack
1DC1 2AA240    LD      HL,(40A2H)    --- Current line no. in binary
1DC4 E5        PUSH    HL            --- Save binary line no. for STOP/END stmt
1DC5 F5        PUSH    AF            --- A = 0 (END), 1 (STOP)
1DC6 7D        LD      A,L           --- Combine LSB of current line with
1DC7 A4        AND     H             --- MSB of current line no.. so we can
1DC8 3C        INC     A             --- test for uninitialized line no. (FFFF)
1DC9 2809      JR      Z,1DD4H       --->: Jmp if line no. = FFFF pgm execution not started
1DCB 22F540    LD      (40F5H),HL    --   : Else, save line number we ended on
1DCE 2AE640    LD      HL,(40E6H)    --   : HL = current line number
1DD1 22F740    LD      (40F7H),HL    --   : Save in 40F7
1DD4 CD8B03    CALL    038BH         <---: Initialize output DCB to the video
1DD7 CDF920    CALL    20F9H         --- Print a CR
1DDA F1        POP     AF            --- Restore A = 0 (END), 1 (STOP)
1DDB 213019    LD      HL,1930H      --- Addr of break message
1DDE C2061A    JP      NZ,1A06H      --- Jmp if STOP encountered
1DE1 C3181A    JP      1A18H         --- Jmp if END statement or error in command mode
1DE4 2AF740    LD      HL,(40F7H)    --- HL = last stmt byte scanned *** Cont routine ***
1DE7 7C        LD      A,H           --- Combine LSB/MSB of addr
1DE8 B5        OR      L             --- for last statement executed
1DE9 1E20      LD      E,20H         --- CN error code
1DEB CAA219    JP      Z,19A2H       --- Output CN if no continuation addr
1DEE EB        EX      DE,HL         --- Continuation line number to DE
1DEF 2AF540    LD      HL,(40F5H)    --- HL = last line number executed
1DF2 22A240    LD      (40A2H),HL    --- Save line number with error
1DF5 EB        EX      DE,HL         --- then set HL = addr of continuation line no.
1DF6 C9        RET                   --- Go begin execution at continuation line
1DF7 3EAF      LD      A,0AFH        --- Set A-reg non-zero for TRON *** TRON routine *****
1DF9 321B41    LD      (411BH),A     --- 1DF8: XOR A  Set A-reg zero for TROFF
1DFC C9        RET                   --- Save TRON/TROFF flag and return to interpreter
1DFD F1        POP     AF             •     These instructions
1DFE E1        POP     HL             •       are not used by
1DFF C9        RET                    •          Level II
1E00 1E03      LD      E,03H         --- E = type for string values ** DEFSTR routine *****
1E02 011E02    LD      BC,021EH      --- 1E03  LD  E,02        DEFINT routine
1E05 011E04    LD      BC,041EH      --- 1E06  LD  E,04        DEFSNG routine
1E08 011E08    LD      BC,081EH      --- 1E09  LD  E,08        DEFDBL routine
1E0B CD3D1E    CALL    1E3DH         --- Test next element in code string. Make sure its a
1E0E 019719    LD      BC,1997H      --- Error addr in case its not                   :letter
```

1D9B * **

1DA0 * **

1DA9 * **

1DAE * **

1DE4 * ***

1DF7 * **

1E00 * **

```
1E11 C5         PUSH    BC             --- Error addr to stack
1E12 D8         RET     C              --- Syntax error if no letter follows DEFSTR
1E13 D641       SUB     41H            --- Subtract an ASCII 'A' which gives a value in
1E15 4F         LD      C,A            --- range 0-25. Save range value in C
1E16 47         LD      B,A            --- and in B
1E17 D7         RST     10H            --- Examine next element in code string
1E18 FECE       CP      0CEH           --- Test for a dash (-) token
1E1A 2009       JR      NZ,1E25H       --- No range of letters specified
1E1C D7         RST     10H            --- A range has been specified, get the ending letter
1E1D CD3D1E     CALL    1E3DH          --- Check for a letter
1E20 D8         RET     C              --- Syntax error if not a letter
1E21 D641       SUB     41H            --- A = 0 - 26(base 10) corresponding to letters
1E23 47         LD      B,A            --- A thru Z
1E24 D7         RST     10H            --- Get next character
1E25 78         LD      A,B            --- Now, make sure 2nd letter follows 1st
1E26 91         SUB     C              --- Subtract 1st letter from 2nd
1E27 D8         RET     C              --- Syntax error if letter range not in ascending
1E28 3C         INC     A              --- A=number of type entries to change  :order
1E29 E3         EX      (SP),HL        --- Clear error addr. Save current code string addr
1E2A 210141     LD      HL,4101H       --- HL = type table
1E2D 0600       LD      B,00H          --- B = 00 / value for 1st letter
1E2F 09         ADD     HL,BC          --- Find next entry in type table
1E30 73         LD      (HL),E         --- Set data type in type table
1E31 23         INC     HL             --- Bump to next entry
1E32 3D         DEC     A              --- Count of entries changed
1E33 20FB       JR      NZ,1E30H       --- Loop till range of entries changed
1E35 E1         POP     HL             --- Restore code string pointer
1E36 7E         LD      A,(HL)         --- and look for more letters
1E37 FE2C       CP      2CH            --- Test for comma
1E39 C0         RET     NZ             --- Return if not comma
1E3A D7         RST     10H            --- Fetch next element and
1E3B 18CE       JR      1E0BH          --- go test for a letter
1E3D 7E         LD      A,(HL)         --- Get next element from code string ****************
1E3E FE41       CP      41H            --- Compare to an ASCII A
1E40 D8         RET     C              --- If not a letter
1E41 FE5B       CP      5BH            --- Compare to an ASCII up-arrow, gives CARRY
1E43 3F         CCF                    --- Set CARRY if not a letter         : if a letter
1E44 C9         RET                    --- NC if a letter
1E45 D7         RST     10H            --- Fetch next symbol from input. ********** cont-->
1E46 CD022B     CALL    2B02H          --- Get value for next expression into        cont-->
1E49 F0         RET     P              --- DE as an integer, set to subscript        cont-->
1E4A 1E08       LD      E,08H          --- FC error if index is negative
1E4C C3A219     JP      19A2H          --- Output FC error
1E4F 7E         LD      A,(HL)         --- Get next character ********** ASCII to binary ***
1E50 FE2E       CP      2EH            --- Check for period abbreviation
1E52 EB         EX      DE,HL          --- DE = current input symbol addr
1E53 2AEC40     LD      HL,(40ECH)     --- DE = period address
1E56 EB         EX      DE,HL          --- HL = addr of current symbol
1E57 CA781D     JP      Z,1D78H        --- Jmp, period
1E5A 2B         DEC     HL             --- Backspace to current character ***** see note--> *
1E5B 110000     LD      DE,0000H       --- Initialize accumulation to zero
1E5E D7         RST     10H            --- Reprocess previous character
1E5F D0         RET     NC             --- Return if not a digit
1E60 E5         PUSH    HL             --- Save current character pointer (digit)
1E61 F5         PUSH    AF             --- Save digit plus flags from RST 10
1E62 219819     LD      HL,1998H       --- HL = 6552
1E65 DF         RST     18H            --- Is accumulated value > 6552
1E66 DA9719     JP      C,1997H        --- SN error if value > 6552
1E69 62         LD      H,D            --- No, continue
1E6A 6B         LD      L,E            --- Move current value to HL
```

```
1E3D  * *************************************************************



1E45  * Called when evaluating A ************************************
      : Subscript for a variable reference
      : evaluation if value positive

1E4F  * *************************************************************



1E5A  * Start at . pt & work backwards ********* ASCII to binary ****
```

```
1E6B 19        ADD   HL,DE        --- DE * 2
1E6C 29        ADD   HL,HL        --- DE * 4
1E6D 19        ADD   HL,DE        --- DE * 5
1E6E 29        ADD   HL,HL        --- HE = DE * 10(base 10)
1E6F F1        POP   AF           --- Get last ASCII digit
1E70 D630      SUB   30H          --- Convert it to binary
1E72 5F        LD    E,A          --- and save in E register
1E73 1600      LD    D,00H        --- DE = 0000 thru 0009 (binary equiv of digit)
1E75 19        ADD   HL,DE        --- Add latest digit to total so far
1E76 EB        EX    DE,HL        --- DE = 10(base 10) * DE + A
1E77 E1        POP   HL           --- Restore ptr to next digit
1E78 18E4      JR    1E5EH        --- Process next digit
1E7A CA611B    JP    Z,1B61H      --- Jmp if no byte count *********** CLEAR routine ***
1E7D CD461E    CALL  1E46H        --- Get number of bytes into DE
1E80 2B        DEC   HL           --- Backspace code string addr
1E81 D7        RST   10H          --- Examine next char in input stream
1E82 C0        RET   NZ           --- Exit if not end of line
1E83 E5        PUSH  HL           --- Save current code string ptr
1E84 2AB140    LD    HL,(40B1H)   --- Top of memory ptr into HL
1E87 7D        LD    A,L          --- DE = no. of bytes to reserve for string
1E88 93        SUB   E            --- Subtract LSB of n from top of mem. ptr
1E89 5F        LD    E,A          --- Save diff of LSB's
1E8A 7C        LD    A,H          --- Get MSB of top of memory ptr
1E8B 9A        SBC   A,D          --- Subtract MSB of n from top of mem. ptr
1E8C 57        LD    D,A          --- Save diff in D
1E8D DA7A19    JP    C,197AH      --- OM error if trying to clear more bytes than
1E90 2AF940    LD    HL,(40F9H)   --- HL = end of pgm ptr               : available
1E93 012800    LD    BC,0028H     --- BC = min. amt of variable space needed
1E96 09        ADD   HL,BC        --- Plus end of pgm ptr gives earliest string area
1E97 DF        RST   18H          --- Compare to start of string area addr
1E98 D27A19    JP    NC,197AH     --- OM error if string list overlays variable list
1E9B EB        EX    DE,HL        --- HL = new start of string area addr
1E9C 22A040    LD    (40A0H),HL   --- Load start of string ptr
1E9F E1        POP   HL           --- Restore code string ptr
1EA0 C3611B    JP    1B61H        --- Join common code at RUN subroutine
1EA3 CA5D1B    JP    Z,1B5DH      --- Jmp if no line specified ******* RUN routine ****
1EA6 CDC741    CALL  41C7H        --- DOS Exit (JP 5F78)
1EA9 CD611B    CALL  1B61H        --- Go initialize RUN time variables
1EAC 011E1D    LD    BC,1D1EH     --- Continuation addr in execution driver      :number
1EAF 1810      JR    1EC1H        --- Use GOTO code to begin execution at specified line
1EB1 0E03      LD    C,03H        --- Make sure there are at least *** GOSUB routine ***
1EB3 CD6319    CALL  1963H        --- 6 bytes of available memory
1EB6 C1        POP   BC           --- BC = rtn addr in execution driver
1EB7 E5        PUSH  HL           --- Save code string addr
1EB8 E5        PUSH  HL           --- and create a hole which will be filled later
1EB9 2AA240    LD    HL,(40A2H)   --- HL = binary value for current line no.
1EBC E3        EX    (SP),HL      --- Store in hole on stack. Restore code string
1EBD 3E91      LD    A,91H        --- Save a 145 on stack                         :pointer
1EBF F5        PUSH  AF           --- as a GOSUB marker
1EC0 33        INC   SP           --- Backspace stack ptr over status flags
1EC1 C5        PUSH  BC           --- Save rtn addr in execution driver. Use GOTO code
1EC2 CD5A1E    CALL  1E5AH        --- Get line no. to branch to in DE **** GOTO routine*
1EC5 CD071F    CALL  1F07H        --- Skip to end of this line
1EC8 E5        PUSH  HL           --- Save code string addr, next line
1EC9 2AA240    LD    HL,(40A2H)   --- HL = binary equivalent of last line no.
1ECC DF        RST   18H          --- Compare target line no.
1ECD E1        POP   HL           --- With current line no.
1ECE 23        INC   HL           --- Restore code string addr
1ECF DC2F1B    CALL  C,1B2FH      --- Target line is forward     : Locate line # speci-
1ED2 D42C1B    CALL  NC,1B2CH     --- Target line is backwards   : fied in DE
```

lE7A * ***

1EA3 * **

1EB1 * **

1EC2 * **

```
1ED5 60         LD      H,B          --- On exit BC = addr of requested line no.
1ED6 69         LD      L,C          --- Move addr of target line code string to HL
1ED7 2B         DEC     HL           --- Backspace to start of line
1ED8 D8         RET     C            --- Rtn to execution driver. Start executing new line
1ED9 1E0E       LD      E,0EH        --- UL error. Line number not found
1EDB C3A219     JP      19A2H        --- Output UL error message
1EDE C0         RET     NZ           --- Syntax error if RETURN XX *** RETURN routine *****
1EDF 16FF       LD      D,0FFH       --- Set DE to dummy addr for search routine   cont -->
1EE1 CD3619     CALL    1936H        --- Backspace stack ptr 4 bytes. Load value into A
1EE4 F9         LD      SP,HL        --- Set stack ptr to backspaced addr
1EE5 22E840     LD      (40E8H),HL   --- Save backspacd stack addr
1EE8 FE91       CP      91H          --- And look for GOSUB marker
1EEA 1E04       LD      E,04H        --- RG error if RETURN without GOSUB
1EEC C2A219     JP      NZ,19A2H     --- Print error message
1EEF E1         POP     HL           --- HL = binary line no. of GOSUB call
1EF0 22A240     LD      (40A2H),HL   --- Save as current line no.
1EF3 23         INC     HL           --- Bump to next line
1EF4 7C         LD      A,H          --- Make sure line no. has not
1EF5 B5         OR      L            --- overflowed
1EF6 2007       JR      NZ,1EFFH     --->: Jmp if no overflow
1EF8 3ADD40     LD      A,(40DDH)    --  : Else we may have a one line pgm
1EFB B7         OR      A            --  : Get INPUT PHASE flag and test it
1EFC C2181A     JP      NZ,1A18H     --  : Jmp if still in INPUT PHASE
1EFF 211E1D     LD      HL,1D1EH     <---: HL = rtn addr in execution driver
1F02 E3         EX      (SP),HL      --- Save on stack. HL=code string addr of GOSUB call
1F03 3EE1       LD      A,0E1H       --- 1F04: POP HL Now scan to end of GOSUB      cont-->
1F05 013A0E     LD      BC,0E3AH     --- ********************************** DATA routine
1F08 00         NOP                  --- 1F07 LD C,00 Set stop scan char to 00
1F09 0600       LD      B,00H        --- B =00
1F0B 79         LD      A,C          <---: Save original stop scan char
1F0C 48         LD      C,B           •  : Reset stop scan char to 00
1F0D 47         LD      B,A           •  : B = stop scan value
1F0E 7E         LD      A,(HL)       <---:-: Get an element from code string
1F0F B7         OR      A             •  : : Test for end of line
1F10 C8         RET     Z             •  : : Exit if end of line
1F11 B8         CP      B             •  : : Test for stop scan char
1F12 C8         RET     Z             •  : : Exit if stop scan encountered
1F13 23         INC     HL            •  : : Bump to next element on code string
1F14 FE22       CP      22H           •  : : Test for quote
1F16 28F3       JR      Z,1F0BH      --->: : If quote, reset stop scan value to (00)
1F18 D68F       SUB     8FH           •    : Not quote, test for IF token
1F1A 20F2       JR      NZ,1F0EH     ----->: Jump if not 'IF' token
1F1C B8         CP      B            --    : A = 0, if B = 0 then CARRY = 0 and
1F1D 8A         ADC     A,D          --    : Add instr does not change value of D,
1F1E 57         LD      D,A          --    : if B <>, then CARRY = 1 and D is
1F1F 18ED       JR      1F0EH        ----->: bumped by one loop.
1F21 CD0D26     CALL    260DH        --- Get addr of variable into DE *** LET routine *****
1F24 CF         RST     08H          --- Test if par name followed by = , if not error
1F25 D5         PUSH    DE           --- 1F25: DC D5 '='
1F26 EB         EX      DE,HL        --- Addr of variable name to HL
1F27 22DF40     LD      (40DFH),HL   --- Save addr of assignment variable
1F2A EB         EX      DE,HL        --- Restore addr of next input of variable to HL
1F2B D5         PUSH    DE           --- Save addr of variable
1F2C E7         RST     20H          --- Determine data type
1F2D F5         PUSH    AF           --- Save type/flags.                         see note-->
1F2E CD3723     CALL    2337H        --- Evaluate expression. Save result as current
1F31 F1         POP     AF           --- Restore data to parity A                    :variable
1F32 E3         EX      (SP),HL      --- Push current code sting addr onto stack.   cont-->
1F33 C603       ADD     A,03H        --- Restore data to 2-I, 3-ST, 4-SN, 8-DB
1F35 CD1928     CALL    2819H        --- Convert result to proper mode
```

```
1EDE  * *************************************************************
1EDF  : and A - 1 for scan routine
```

```
1F03  : statement & rtn to execution driver
1F05  * Set stop scan char to : ************************************
      :                             Search code string until an end
      :                             if line (00) is found or a stop
      :                             scan value of (00) or (:) occurs
      :                             For quotes or 'IF' tokens perform
      :                             he following
      :                             quote - unconditionally reset
      :                                   stop scan char to (00)
      :                             IF token -
      :                                   stop scan char = 00 -
      :                                         do nothing
      :                                   stop scan char = : -
      :                                         increment D - reg by
      :                                         one
```

```
1F21  * **************************************************************
```

```
1F2D  : A = -1(integer), 0(string), 1(single), 5(double)

1F32  : HL = addr of variable
```

```
1F38 CD030A    CALL   0A03H        --- Move result to 'current' value area
1F3B E5        PUSH   HL           --- Save addr of variable
1F3C 2028      JR     NZ,1F66H     --- Jmp if result is not string
1F3E 2A2141    LD     HL,(4121H)   --- HL = Pointer to string entry
1F41 E5        PUSH   HL           --- Save it on stack
1F42 23        INC    HL           --- Skip over length
1F43 5E        LD     E,(HL)       --- E = LSB of string addr
1F44 23        INC    HL           --- Bump to MSB of addr
1F45 56        LD     D,(HL)       --- D = MSB of string addr
1F46 2AA440    LD     HL,(40A4H)   --- HL = start of pgm ptr
1F49 DF        RST    18H          --- Compare stack of pgm ptr to addr of string
1F4A 300E      JR     NC,1F5AH     --- Jmp if string precedes program          :variable
1F4C 2AA040    LD     HL,(40A0H)   --- HL = string data ptr
1F4F DF        RST    18H          --- Compare string addr to lower boundary of string
1F50 D1        POP    DE           --- DE = addr of string pointer                 : area
1F51 300F      JR     NC,1F62H     --- Jmp if not in string area
1F53 2AF940    LD     HL,(40F9H)   --- HL = end of pgm ptr
1F56 DF        RST    18H          --- Compare string addr to end addr of PST
1F57 3009      JR     NC,1F62H     --- Jmp if string is a literal in the program
1F59 3ED1      LD     A,0D1H       --- 1F5A: POP DE  DE = pointer to string entry
1F5B CDF529    CALL   29F5H        --- Backspace to prior literal string pool entry
1F5E EB        EX     DE,HL        --- DE = address of string entry in string list area
1F5F CD4328    CALL   2843H        --- Move string to permanent string area
1F62 CDF529    CALL   29F5H        --- Backspace lit. string pool table one entry
1F65 E3        EX     (SP),HL      --- Load ptr to string entry from stack
1F66 CDD309    CALL   09D3H        --- Move answer to assigned variable location
1F69 D1        POP    DE           --- DE = addr of assigned variable
1F6A E1        POP    HL           --- HL = code string address
1F6B C9        RET                 --- Rtn to caller
1F6C FE9E      CP     9EH          --- Test token for 'ERROR' **** ON routine ***********
1F6E 2025      JR     NZ,1F95H     --- Jmp if not ON ERROR
1F70 D7        RST    10H          --- Examine next char in input buffer **** ON ERROR **
1F71 CF        RST    08H          --- Test if it is a '8D'
1F72 8D        ADC    A,L          --- if it is then GO TO token
1F73 CD5A1E    CALL   1E5AH        --- Convert following constant to binary. Result in DE
1F76 7A        LD     A,D          --- Test if ON ERROR GOTO 0000 Clear ON ERROR
1F77 B3        OR     E            --- Combine LSB & MSB of addr              :condition
1F78 2809      JR     Z,1F83H      --- Jmp if GOTO addr is zero
1F7A CD2A1B    CALL   1B2AH        --- Locate address of line # in basic pgm list
1F7D 50        LD     D,B          --- Move addr of basic stmt to DE
1F7E 59        LD     E,C          --- E = LSB of addr
1F7F E1        POP    HL           --- HL = current position in input stream.     cont-->
1F80 D2D91E    JP     NC,1ED9H     --- UL error if line number not found
1F83 EB        EX     DE,HL        --- HL = addr of basic line to GOTO.           cont-->
1F84 22F040    LD     (40F0H),HL   --- 40F0 = addr of statement to resume execution at
1F87 EB        EX     DE,HL        --- Restore code string addr to HL
1F88 D8        RET    C            --- Rtn to execution driver if not GOTO 0000, else
1F89 3AF240    LD     A,(40F2H)    --- Get error message override all          :fall thru
1F8C B7        OR     A            --- Set status flags
1F8D C8        RET    Z            --- Rtn to execution driver if override flag not set
1F8E 3A9A40    LD     A,(409AH)    --- else get error code
1F91 5F        LD     E,A          --- & move it to E register
1F92 C3AB19    JP     19ABH        --- Go to error routine
1F95 CD1C2B    CALL   2B1CH        --- Get n value into DE ****************************
1F98 7E        LD     A,(HL)       --- A = next token from code string
1F99 47        LD     B,A          --- Save token                   : ON n GOTO
1F9A FE91      CP     91H          --- Test for GOSUB token         : ON n GOSUB
1F9C 2803      JR     Z,1FA1H      --- Jump if 'ON n GOSUB'
1F9E CF        RST    08H          --- Test for GOTO token
1F9F 8D        ADC    A,L          --- DC '8D' - GOTO token
```

```
1F6C  * *****************************************************************

1F70  * *****************************************************************




1F7F  : HL was saved in 1B2A

1F83  : DE = position in current line




1F95  * *****************************************************************
```

```
1FA0 2B         DEC     HL            --- Backspace code string pointer to GOTO token
1FA1 4B         LD      C,E           --- C = n value from ON n
1FA2 0D         DEC     C             <---: Decrement n
1FA3 78         LD      A,B            •  : A = GOSUB or GOTO token
1FA4 CA601D     JP      Z,1D60H        •  : We have skipped n lines rtn to execution driver
1FA7 CD5B1E     CALL    1E5BH          •  : Get line no. to GOTO into DE as a binary number
1FAA FE2C       CP      2CH            •  : Look for comma following line number else it's
1FAC C0         RET     NZ             •  : Return if no comma                  : end of stmt
1FAD 18F3       JR      1FA2H         --->: Loop till n line numbers have been skipped
1FAF 11F240     LD      DE,40F2H      --- Get addr of error flag ******* RESUME routine ****
1FB2 1A         LD      A,(DE)        --- Load error flag (FF if error, zero otherwise)
1FB3 B7         OR      A             --- Set status flag
1FB4 CAA019     JP      Z,19A0H       --- Error if resume executed w/o error
1FB7 3C         INC     A             --- Set error flag to zero
1FB8 329A40     LD      (409AH),A     --- Save it
1FBB 12         LD      (DE),A        --- Reset error flag
1FBC 7E         LD      A,(HL)        --- Get next element from code string
1FBD FE87       CP      87H           --- Test for NEXT token
1FBF 280C       JR      Z,1FCDH       --->: Jump if 'RESUME NEXT'
1FC1 CD5A1E     CALL    1E5AH         --  : Get binary equiv. of line no. into DE
1FC4 C0         RET     NZ            --  : Rtn to EXECUTION DRIVER if no line number
1FC5 7A         LD      A,D           --  : Combine LSB and MSB of
1FC6 B3         OR      E             --  : line number and test for 0
1FC7 C2C51E     JP      NZ,1EC5H      --  : Continue at GOTO if RESUME XXXX
1FCA 3C         INC     A             --  : Else RESUME 0. Set A = 1 to signal resume 0
1FCB 1802       JR      1FCFH         ----:>: Jmp to RESUME 0 code
1FCD D7         RST     10H           <---: : RESUME NEXT test for multiple stmt
1FCE C0         RET     NZ            --    : Rtn to execution driver if :, else fall thru
1FCF 2AEE40     LD      HL,(40EEH)    <-----: to get addr. of    cont--> **** RESUME 0 *****
1FD2 EB         EX      DE,HL         --- Save in DE
1FD3 2AEA40     LD      HL,(40EAH)    --- 40EA = line no. of statement following error
1FD6 22A240     LD      (40A2H),HL    --- Which is where we will resume execution
1FD9 EB         EX      DE,HL         --- Restore addr. of current pos. in line      cont-->
1FDA C0         RET     NZ            --- Go to EXECUTION DRIVER if RESUME 0
1FDB 7E         LD      A,(HL)        --- Else, we have a RESUME NEXT
1FDC B7         OR      A             --- Test for end of line
1FDD 2004       JR      NZ,1FE3H      --->: Jmp if not end of line
1FDF 23         INC     HL            --  : End of line, skip over zero byte terminator
1FE0 23         INC     HL            --  : Skip over
1FE1 23         INC     HL            --  : Pointer to next statement
1FE2 23         INC     HL            --  : Skip over line number in binary for
1FE3 23         INC     HL            <---: line following error
1FE4 7A         LD      A,D           --- DE = line no. of stmt following error
1FE5 A3         AND     E             --- Test for end of program
1FE6 3C         INC     A             --- Gives 0 if end of program
1FE7 C2051F     JP      NZ,1F05H      --- Not end of pgm. Skip to end of line w/error &
1FEA 3ADD40     LD      A,(40DDH)     --- Get INPUT PHASE entered flag              :continue
1FED 3D         DEC     A             --- Test for INPUT PHASE started
1FEE CABE1D     JP      Z,1DBEH       --- Not started - Go to it
1FF1 C3051F     JP      1F05H         --- Skip to end of statement before returning
1FF4 CD1C2B     CALL    2B1CH         --- ERROR routine **** Evaluate n if ERROR n *********
1FF7 C0         RET     NZ            --- Rtn if not end of statement
1FF8 B7         OR      A             --- Set status flags for error no.
1FF9 CA4A1E     JP      Z,1E4AH       --- FC error if n is zero
1FFC 3D         DEC     A             --- n = n - 1
1FFD 87         ADD     A,A           --- n = 2 (n - 1)
1FFE 5F         LD      E,A           --- Save doubled error no. in E
1FFF FE2D       CP      2DH           --- Compare with 45 (base 10)
2001 3802       JR      C,2005H       --- Jmp if error no. in range ( < +45)
2003 1E26       LD      E,26H         --- UE error code
```

```
1FAF  * *************************************************************

1FCF  * curr pos. in line w/error ***********************************

1FD9  : w/error in case we rtn to execution driver

1FF4  * ************************************************************
```

```
2005 C3A219    JP     19A2H        --- Output error message
2008 110A00    LD     DE,000AH     --- AUTO routine ** Default starting line no. is 10
200B D5        PUSH   DE           --- Save starting line number
200C 2817      JR     Z,2025H      --- No parameters specified, use defaults
200E CD4F1E    CALL   1E4FH        --- Convert 1st parameter from ASCII to binary
2011 EB        EX     DE,HL        --- Save user specified starting line in HL
2012 E3        EX     (SP),HL      --- Then exchange it with 10 on the stack
2013 2811      JR     Z,2026H      --- Jmp if only one parameter specified
2015 EB        EX     DE,HL        --- DE - 10
2016 CF        RST    08H          --- Test for comma following 1st parameter
2017 2C        INC    L            --- DC 2C ',' comma
2018 EB        EX     DE,HL        --- DE = current code stmt addr
2019 2AE440    LD     HL,(40E4H)   --- HL = previous auto increment value
201C EB        EX     DE,HL        --- DE = previous value, HL = code string addr
201D 2806      JR     Z,2025H      --- Jmp if no 2nd parameter
201F CD5A1E    CALL   1E5AH        --- Convert 2nd parameter - increment value
2022 C29719    JP     NZ,1997H     --- SN error if NZ
2025 EB        EX     DE,HL        --- HL = auto increment value
2026 7C        LD     A,H          --- Test auto increment
2027 B5        OR     L            --- for zero
2028 CA4A1E    JP     Z,1E4AH      --- FC error if Z
202B 22E440    LD     (40E4H),HL   --- Auto increment
202E 32E140    LD     (40E1H),A    --- Set auto increment flag for BASIC
2031 E1        POP    HL           --- HL = starting line number
2032 22E240    LD     (40E2H),HL   --- Current input line number
2035 C1        POP    BC           --- Clear stack
2036 C3331A    JP     1A33H        --- Rtn to INPUT PHASE
2039 CD3723    CALL   2337H        --- Evaluate expression *************** IF ***********
203C 7E        LD     A,(HL)       --- Was element following
203D FE2C      CP     2CH          --- Expression a comma
203F CC781D    CALL   Z,1D78H      --- Yes, get next element
2042 FECA      CP     0CAH         --- And test for 'THEN token
2044 CC781D    CALL   Z,1D78H      --- If 'THEN' token skip ahead so backspace below will
2047 2B        DEC    HL           --- leave us positioned at THEN token, else it leaves
2048 E5        PUSH   HL           --- us positioned at element following expression
2049 CD9409    CALL   0994H        --- Test for true/false condition
204C E1        POP    HL           --- Restore addr of current position in stmt
204D 2807      JR     Z,2056H      --->: If zero expression was false, look for ELSE or
204F D7        RST    10H          <---:---: end of line. Examine next element in code
2050 DAC21E    JP     C,1EC2H      --  :   : If numeric must be GOTO address  :stmt string
2053 C35F1D    JP     1D5FH        --  :   : Rtn to execution driver to evaluate rest of
2056 1601      LD     D,01H        <---:   : Count times to scan to end of line * cont ->
2058 CD051F    CALL   1F05H        <---:   : Scan to end of line
205B B7        OR     A             •  :   : A = stop scan value
205C C8        RET    Z             •  :   : Rtn to BASIC if end of line
205D D7        RST    10H           •  :   : Get next element
205E FE95      CP     95H           •  :   : And test for ELSE token
2060 20F6      JR     NZ,2058H     --->:   : If not ELSE token scan again
2062 15        DEC    D             •  :   : Match IF's and ELSE's
2063 20F3      JR     NZ,2058H     --->:   : Loop till all ELSE's passed
2065 18E8      JR     204FH        ------->: Execute remainder of statement
2067 3E01      LD     A,01H        --- A=device code for printer *** LPRINT routine  ****
2069 329C40    LD     (409CH),A    --- Save in current device type loc.
206C C39B20    JP     209BH        --- Go analyze rest of statement
206F CDCA41    CALL   41CAH        --- DOS Exit (JP 5A15) ********************* PRINT@ **
2072 FE40      CP     40H          --- Test next element for @ token
2074 2019      JR     NZ,208FH     --- Jump if not PRINT@
2076 CD012B    CALL   2B01H        --- Evaluate @ expression.*** PRINT@ routine *********
2079 FE04      CP     04H          --- A = MSB test for @ value > 1023
207B D24A1E    JP     NC,1E4AH     --- FC error if @ position > 1023
```

```
2008  * **************************************************************

2039  * **************************************************************

2056  * False path of IF statement ***********************************

2067  * **************************************************************

206E  * **************************************************************

2076  * **************************************************************
```

```
207E E5        PUSH   HL           --- Stack = current code string addr
207F 21003C    LD     HL,3C00H     --- HL = Display area ptr
2082 19        ADD    HL,DE        --- HL = start of display area + @ position
2083 222040    LD     (4020H),HL   --- Store cursor position in display DCB
2086 7B        LD     A,E          --- E = position within line
2087 E63F      AND    3FH          --- Not to exceed 63 and save it as
2089 32A640    LD     (40A6H),A    --- Update cursor offset
208C E1        POP    HL           --- Restore code string addr (pointer to item list)
208D CF        RST    08H          --- Make sure a , follows @ expression
208E 2C        INC    L            --- DC 2C ','
208F FE23      CP     23H          --- Look for # token
2091 2008      JR     NZ,209BH     --- Jmp if not PRINT#
2093 CD8402    CALL   0284H        --- Analyze rest of string ****** PRINT # ** cont--> *
2096 3E80      LD     A,80H        --- Set write to cassette flag
2098 329C40    LD     (409CH),A    --- Cassette flag (= -1)
209B 2B        DEC    HL           --- Backspace over previous symbol in input stream ***
209C D7        RST    10H          --- Re-examine next char in input stream
209D CCFE20    CALL   Z,20FEH      --- If zero print a CR (end of statement)      cont-->
20A0 CA6921    JP     Z,2169H      --- Write sync bytes if PRINT, clear output
20A3 FEBF      CP     0BFH         --- Device flag (409C), and rtn to execution
20A5 CABD2C    JP     Z,2CBDH      --- Jump if print using                :driver
20A8 FEBC      CP     0BCH         --- Test for TAB token
20AA CA3721    JP     Z,2137H      --- Jump if print tab
20AD E5        PUSH   HL           --- Print item list ************* PRINT # ** cont--> *
20AE FE2C      CP     2CH          --- Test for comma
20B0 CA0821    JP     Z,2108H      --- If comma, get next item
20B3 FE3B      CP     3BH          --- Test for semi-colon
20B5 CA6421    JP     Z,2164H      --- If semicolon
20B8 C1        POP    BC           --- BC = current addr in input stream
20B9 CD3723    CALL   2337H        --- Get addr or value of next item to be printed
20BC E5        PUSH   HL           --- Save addr of terminal symbol
20BD E7        RST    20H          --- Determine data type
20BE 2832      JR     Z,20F2H      --- If string
20C0 CDBD0F    CALL   0FBDH        --- Convert binary to ASCII and move to print buffer
20C3 CD6528    CALL   2865H        --- Build a literal string pool entry for ASCII number
20C6 CDCD41    CALL   41CDH        --- DOS Exit (JP 5B9A)
20C9 2A2141    LD     HL,(4121H)   --- HL = addr of current print string
20CC 3A9C40    LD     A,(409CH)    --- A = output device flag
20CF B7        OR     A            --- Test device type flag
20D0 FAE920    JP     M,20E9H      --- Jmp if writing to cassette (PRINT#)
20D3 2808      JR     Z,20DDH      --- Jmp if not LPRINT
20D5 3A9B40    LD     A,(409BH)    --- A = current line position *** LPRINT continued ***'
20D8 86        ADD    A,(HL)       --- Add no. chars in new line
20D9 FE84      CP     84H          --- and test for line overflow
20DB 1809      JR     20E6H        --- Go test results of comparison
20DD 3A9D40    LD     A,(409DH)    --- Get size of display line *** PRINT ITEM continued *
20E0 47        LD     B,A          --- Move it to B so we can compare it
20E1 3AA640    LD     A,(40A6H)    --- Get cursor offset for current line
20E4 86        ADD    A,(HL)       --- Add length of new line and
20E5 B8        CP     B            --- compare to maximum line size                :line
20E6 D4FE20    CALL   NC,20FEH     --- If NC, new line will overflow buffer. Skip to new
20E9 CDAA28    CALL   28AAH        --- Write line to ****** PRINT# continued ** cont--> *
20EC 3E20      LD     A,20H        --- A = ASCII space
20EE CD2A03    CALL   032AH        --- Print a space. Rtn w/a non-zero
20F1 B7        OR     A            --- Set status flags
20F2 CCAA28    CALL   Z,28AAH      --- If current data type is string, write it output
20F5 E1        POP    HL           --- Restore current code string addr to HL     :device
20F6 C39B20    JP     209BH        --- and loop till end of statement (E05)
20F9 3AA640    LD     A,(40A6H)    --- A = cursor offset from current line **** cont--> *
20FC B7        OR     A            --- Set status flags
```

```
2093  * Open device **************************************************

209B  * **************************************************************

209D  : Flush line to device



20AD  * Save current position in input stream ************************










20D5  * **************************************************************


20DD  * **************************************************************


20E9  * current output device ****************************************


20F9  * Position video to next line **********************************
```

```
20FD C8         RET     Z             --- Exit if at start of a line
20FE 3E0D       LD      A,0DH         --- Else skip to next line
2100 CD2A03     CALL    032AH         --- Call video driver
2103 CDD041     CALL    41D0H         --- DOS exit (JP 5B99)
2106 AF         XOR     A             --- Clear A-reg status flags/carry flag
2107 C9         RET                   --- Rtn to caller
2108 CDD341     CALL    41D3H         --- DOS Exit (JP 5B65) ****** PRINT on cassette ******
210B 3A9C40     LD      A,(409CH)     --- Get current output device
210E B7         OR      A             --- and test for type
210F F21921     JP      P,2119H       --- Jmp if current device not cassette
2112 3E2C       LD      A,2CH         --- A = ASCII comma
2114 CD2A03     CALL    032AH         --- Print comma on printer or display
2117 184B       JR      2164H         --- Go fetch next char from code string
2119 2808       JR      Z,2123H       --- Jmp if current device is video display ***********
211B 3A9B40     LD      A,(409BH)     --- Device is printer. Get current print pos in A
211E FE70       CP      70H           --- Compare print pos to 112
2120 C32B21     JP      212BH         --- Go test if time for line skip
2123 3A9E40     LD      A,(409EH)     --- A = line size ***********************************
2126 47         LD      B,A           --- Save in B
2127 3AA640     LD      A,(40A6H)     --- A = current pos in line
212A B8         CP      B             --- Test if room in this line. Subtract        cont-->
212B D4FE20     CALL    NC,20FEH      --- No, issue a line skip. We are at end of line
212E 3034       JR      NC,2164H      --- Jmp if end of line marked
2130 D610       SUB     10H           --- Test for at least 10 print positions left
2132 30FC       JR      NC,2130H      --- Loop till positions to within 10 spaces of end of
2134 2F         CPL                   --- Gives - number of blanks to print            :line
2135 1823       JR      215AH         --- Go print blanks
2137 CD1B2B     CALL    2B1BH         --- Get TAB no., * PRINT TAB processing **** cont--> *
213A E63F       AND     3FH           --- Results in A. Do not let it exceed 63
213C 5F         LD      E,A           --- Save TAB value in B
213D CF         RST     08H           --- Look for closing paren
213E 29         ADD     HL,HL         --- DC ','
213F 2B         DEC     HL            --- Reposition code string printer to
2140 E5         PUSH    HL            --- and save addr on stack
2141 CDD341     CALL    41D3H         --- DOS Exit (JP 5B65)
2144 3A9C40     LD      A,(409CH)     --- A = output device type code
2147 B7         OR      A             --- Test device type code
2148 FA4A1E     JP      M,1E4AH       --- FC error if negative (tape)
214B CA5321     JP      Z,2153H       -->: Jmp if output device video
214E 3A9B40     LD      A,(409BH)     -- : A = print position in current line
2151 1803       JR      2156H         ---:->: Skip reload of A register
2153 3AA640     LD      A,(40A6H)     <--:  : A = cursor position in current video line
2156 2F         CPL                   <-----: A = -current position
2157 83         ADD     A,E           --- A = -current position + tab
2158 300A       JR      NC,2164H      --->: Jmp if tab less than current position
215A 3C         INC     A             --  : A = number of blanks to print
215B 47         LD      B,A           --  : B = count of blanks to print
215C 3E20       LD      A,20H         --  : A = ASCII blank
215E CD2A03     CALL    032AH         <-: : Print a blank
2161 05         DEC     B             • : : Count it
2162 20FA       JR      NZ,215EH      ->: : Loop till B blanks printed
2164 E1         POP     HL            <---: Restore position in input string
2165 D7         RST     10H           -- Examine next character
2166 C3A020     JP      20A0H         --- Process rest of PRINT TAB statement
2169 3A9C40     LD      A,(409CH)     --- A = device type code ****************** cont--> *
216C B7         OR      A             --- Test for cassette
216D FCF801     CALL    M,01F8H       --- Turn off cassette
2170 AF         XOR     A             --- Clear A and status flags
2171 329C40     LD      (409CH),A     --- and reset current device code to display
2174 CDBE41     CALL    41BEH         --- DOS Exit (JP 577C)
```

```
2108  * *************************************************************

2119  * *************************************************************

2123  * *************************************************************

212A  : line size from current position

2137  * evaluate expression ****************************************

2169  * Turn off cassette and reset current device to video ********
```

```
2177 C9         RET                  --- Rtn to caller
2178 3F         CCF                  --- 7 *************** REDO error message *************
2179 52         LD      D,D          --- R
217A 45         LD      B,L          --- E
217B 44         LD      B,H          --- D
217C 4F         LD      C,A          --- 0
217D 0D         DEC     C            --- Carriage return
217E 00         NOP                  --- Message terminator
217F 3ADE40     LD      A,(40DEH)    --- Get read flag ************************** cont--> *
2182 B7         OR      A            --- Set status flags
2183 C29119     JP      NZ,1991H     --- SN error in NNN if READ active
2186 3AA940     LD      A,(40A9H)    --- Get type of input flag
2189 B7         OR      A            --- Test for zero
218A 1E2A       LD      E,2AH        --- FD error code
218C CAA219     JP      Z,19A2H      --- Output FD error message if cassette input
218F C1         POP     BC           --- Clear the stack
2190 217821     LD      HL,2178H     --- Addr of REDO message
2193 CDA728     CALL    28A7H        --- Output REDO message
2196 2AE640     LD      HL,(40E6H)   --- Restore code string addr
2199 C9         RET                  --- Rtn to caller
219A CD2828     CALL    2828H        --- Check for illegal direct ***** INPUT routine *****
219D 7E         LD      A,(HL)       --- (Input without line number)
219E CDD641     CALL    41D6H        --- DOS Exit (JP 5784)
21A1 D623       SUB     23H          --- Check for unit designation #
21A3 32A940     LD      (40A9H),A    --- 40A9 = 0 if INPUT #
21A6 7E         LD      A,(HL)       --- A = next element from code string
21A7 2020       JR      NZ,21C9H     --->: Jmp if INPUT from console device
21A9 CD9302     CALL    0293H        --   : Find leader and sync bytes
21AC E5         PUSH    HL           --   : Save code string address
21AD 06FA       LD      B,0FAH       --   : B = max no. of bytes to read (250)
21AF 2AA740     LD      HL,(40A7H)   --   : HL = input area ptr
21B2 CD3502     CALL    0235H        <-: : Read 1 byte from tape
21B5 77         LD      (HL),A       • : : Save byte just read
21B6 23         INC     HL           • : : Bump to next location in buffer
21B7 FE0D       CP      0DH          • . : Read into buffer until CR
21B9 2802       JR      Z,21BDH      • : : Jmp if CR encountered
21BB 10F5       DJNZ    21B2H        ->: : Or loop till 250 bytes read
21BD 2B         DEC     HL           --   : Position to last place in buffer
21BE 3600       LD      (HL),00H     --   : Put a 00H at end and
21C0 CDF801     CALL    01F8H        --   : Turn off tape
21C3 2AA740     LD      HL,(40A7H)   --   : Input buffer addr to HL
21C6 2B         DEC     HL           --   : Backspace one byte
21C7 1822       JR      21EBH        --   : And store a comma there so we          cont-->
21C9 01DB21     LD      BC,21DBH     <---: Continuation addr of 21 BD ************ note--> *
21CC C5         PUSH    BC           --- to stack
21CD FE22       CP      22H          --- Look for quote
21CF C0         RET     NZ           --- Jump to 21DB if not text in input statement
21D0 CD6628     CALL    2866H        --- Quote (text in input statement)           cont-->
21D3 CF         RST     08H          --- Look for a trailing semi-colon
21D4 3B         DEC     SP           --- DC = ','
21D5 E5         PUSH    HL           --- Save code string addr
21D6 CDAA28     CALL    28AAH        --- Write prompting message
21D9 E1         POP     HL           --- Restore code string addr
21DA C9         RET                  --- Go to 21DB
21DB E5         PUSH    HL           --- Save code string address ************************
21DC CDB31B     CALL    1BB3H        --- Print '? ' and accept input on exit       cont-->
21DF C1         POP     BC           --- BC = code string addr
21E0 DABE1D     JP      C,1DBEH      --- Jmp if BREAK key entered
21E3 23         INC     HL           --- Position to first byte of data in buffer
21E4 7E         LD      A,(HL)       --- Fetch 1st data byte
```

2178 * ***

217E * Output read/input error messages ***************************

219A * ***

21C7 : can use READ processing
21C9 * INPUT item list ***

21D0 : Build lit. string pool entry for quote.

21DB * ***
21DC : HL = buffer addr -1

```
21E5 B7        OR     A              --- Set status flags
21E6 2B        DEC    HL             --- Backspace to buffer origin -1
21E7 C5        PUSH   BC             --- Save code string addr
21E8 CA041F    JP     Z,1F04H        --- If 1st data char is binary zeroes,        cont-->
21EB 362C      LD     (HL),2CH       --- Make READ think we are at end of a value in a
21ED 1805      JR     21F4H          --- DATA statement
21EF E5        PUSH   HL             --- Save current pos in PST ********* READ routine ***
21F0 2AFF40    LD     HL,(40FFH)     --- HL = starting addr of data stmt
21F3 F6AF      OR     0AFH           --- 21F4 XOR A - Zero A - Signal INPUT, non-zero
21F5 32DE40    LD     (40DEH),A      --- Not 00 if read                        :signal READ
21F8 E3        EX     (SP),HL        ---     00 if input HL = rtn addr, stack = DATA addr
21F9 1802      JR     21FDH          --->: Join common code
21FB CF        RST    08H            --  : Test for a comma
21FC 2C        INC    L              --  : 21FC: DC 2C  ','
21FD CD0D26    CALL   260DH          <---: Get address of current variable into DE
2200 E3        EX     (SP),HL        --- Pop pointer to current location in data statement
2201 D5        PUSH   DE             --- Replace it w/ addr of variable
2202 7E        LD     A,(HL)         --- Get next char from data statement
2203 FE2C      CP     2CH            --- Test for terminal comma
2205 2826      JR     Z,222DH        --->: Jump if comma
2207 3ADE40    LD     A,(40DEH)      --  : A = read flag
220A B7        OR     A              --  : Test if READ or INPUT processing
220B C29622    JP     NZ,2296H       --  : Jmp if READ - go find next DATA statement
220E 3AA940    LD     A,(40A9H)      --  : Test whether or not a unit
2211 B7        OR     A              --  : Number was specified in INPUT call
2212 1E06      LD     E,06H          --  : OD error - no unit no. given in call
2214 CAA219    JP     Z,19A2H        --  : Output OD message if no unit specified
2217 3E3F      LD     A,3FH          --  : Print '?' sequence error in data        cont-->
2219 CD2A03    CALL   032AH          --  : Print ' ' and accept input
221C CDB31B    CALL   1BB3H          --  : Accept input from keyboard. Buffer addr -1 in HL
221F D1        POP    DE             --  : DE = address of next variable
2220 C1        POP    BC             --  : BC = addr of next element in code string
2221 DABE1D    JP     C,1DBEH        --  : Jmp if BREAK key during input
2224 23        INC    HL             --  : Position to first data byte in buffer
2225 7E        LD     A,(HL)         --  : Fetch 1st data byte
2226 B7        OR     A              --  : Set status flags
2227 2B        DEC    HL             --  : Backspace buffer pointer to buffer origin -1
2228 C5        PUSH   BC             --  : Save code string address
2229 CA041F    JP     Z,1F04H        --  : No data in buffer skip to end of        cont-->
222C D5        PUSH   DE             --  : Save addr of variable
222D CDDC41    CALL   41DCH          <---: DOS Exit (JP 5E63)
2230 E7        RST    20H            --- Test data type
2231 F5        PUSH   AF             --- Save status from data type test
2232 2019      JR     NZ,224DH       --- Go convert data to binary, SP, or DP
2234 D7        RST    10H            --- Else we have string data. Examine next char in
2235 57        LD     D,A            --- DATA statement
2236 47        LD     B,A            --- Save nest char in B, D
2237 FE22      CP     22H            --- Test for quote
2239 2805      JR     Z,2240H        --- Jmp if its a quote - string data
223B 163A      LD     D,3AH          --- Else scan DATA statement looking
223D 062C      LD     B,2CH          --- for a : or , and build a literal
223F 2B        DEC    HL             --- string pool entry for it
2240 CD6928    CALL   2869H          --- Create a literal string pool entry for DATA string
2243 F1        POP    AF             --- A = flag for destination data type
2244 EB        EX     DE,HL          --- Save HL
2245 215A22    LD     HL,225AH       --- Put continuation addr of 225A onto stack
2248 E3        EX     (SP),HL        --- and clear stack
2249 D5        PUSH   DE             --- Save addr of variable
224A C3331F    JP     1F33H          --- move result to target variable, continue at 225A
224D D7        RST    10H            --- Examine next character in DATA stream ** cont--> *
```

21EB : skip to end of line & rtn to BASIC

21EF * ***

2217 : while processing INPUT statement

2229 : this line & rtn to BASIC

224D * Convert next value in DATA stmt from ASCII to binary ********

```
224E F1         POP     AF           --- Reload flags from data type test
224F F5         PUSH    AF           --- and resave. Push rtn addr of 2243 onto stack
2250 014322     LD      BC,2243H     --- to be returned to following DATA conversion
2253 C5         PUSH    BC           --- 2243 to stack
2254 DA6C0E     JP      C,0E6CH      --- Go convert ASCII to binary - not DP
2257 D2650E     JP      NC,0E65H     --- Go convert ASCII to binary - DP
225A 2B         DEC     HL           --- Backspace one character in DATA stmt *************
225B D7         RST     10H          --- Examine terminating character
225C 2805       JR      Z,2263H      --->: Jmp if end of line
225E FE2C       CP      2CH          --- : Not end of line, test for a comma
2260 C27F21     JP      NZ,217FH     <---: If not a comma go output error message
2263 E3         EX      (SP),HL      --- HL = next byte in read stmt, stack = next in DATA
2264 2B         DEC     HL           --- Backspace over terminal character            :stmt
2265 D7         RST     10H          --- and reexamine it. If non-zero it must be a
2266 C2FB21     JP      NZ,21FBH     --- comma. Go process next variable
2269 D1         POP     DE           --- Clear stack
226A 3AA940     LD      A,(40A9)     --- Check for FD error
226D B7         OR      A            --- Set status flags
226E C8         RET     Z            --- No error, rtn to BASIC
226F 3ADE40     LD      A,(40DEH)    --- Get READ/INPUT flag
2272 B7         OR      A            --- Set status flags
2273 EB         EX      DE,HL        --- DE = code string addr
2274 C2961D     JP      NZ,1D96H     --- Jmp if READ error
2277 D5         PUSH    DE           --- Save code string addr. Test for INPUT error
2278 CDDF41     CALL    41DFH        --- DOS Exit (JP 579C)
227B B6         OR      (HL)         --- Test for end of input
227C 218622     LD      HL,2286H     --- EXTRA IGNORED message
227F C4A728     CALL    NZ,28A7H     --- Output message if not end of INPUT
2282 E1         POP     HL           --- Restore code string addr
2283 C36921     JP      2169H        --- Turn off cassette, reset output to        cont-->
2286 3F         CCF                  --- EXTRA IGNORED ***********************************
2287 45         LD      B,L          --- E
2288 78         LD      A,B          --- X
2289 74         LD      (HL),H       --- R
228A 72         LD      (HL),D       --- T
228B 61         LD      H,C          --- A
228C 2069       JR      NZ,22F7H     --- Space I
228E 67         LD      H,A          --- G
228F 6E         LD      L,(HL)       --- N
2290 6F         LD      L,A          --- 0
2291 72         LD      (HL),D       --- R
2292 65         LD      H,L          --- E
2293 64         LD      H,H          --- D
2294 0D         DEC     C            --- CR
2295 00         NOP                  --- Message terminator
2296 CD051F     CALL    1F05H        --- Search for next data statement *** Call DATA *****
2299 B7         OR      A            --- Scan to end of current DATA line
229A 2012       JR      NZ,22AEH     --- Jmp if : terminated line
229C 23         INC     HL           --- Skip over address of next BASIC statement
229D 7E         LD      A,(HL)       --- Get line number for next
229E 23         INC     HL           --- statement. If its zero, then we've reached
229F B6         OR      (HL)         --- the end of the program
22A0 1E06       LD      E,06H        --- OD error if end of program reached before next
22A2 CAA219     JP      Z,19A2H      --- data statement found
22A5 23         INC     HL           --- Bump to line no. this line
22A6 5E         LD      E,(HL)       --- and load it into DE
22A7 23         INC     HL           --- Bump to MSB of line no.
22A8 56         LD      D,(HL)       --- DE = binary line no. this statement
22A9 EB         EX      DE,HL        --- HL = code string for DATA statement
22AA 22DA40     LD      (40DAH),HL   --- Save binary line no. of DATA statement
```

```
225A  * *************************************************************

2283  : video & ret to BASIC
2286  * *************************************************************

2296  * *************************************************************
```

```
22AD EB         EX     DE,HL         --- Restore BASIC statement addr to HL         cont-->
22AE D7         RST    10H           --- Examine next token
22AF FE88       CP     88H           --- Test for DATA token
22B1 20E3       JR     NZ,2296H      --- Jump if not data token keep looking        cont-->
22B3 C32D22     JP     222DH         --- Locate next DATA statement, continue
22B6 110000     LD     DE,0000H      --- In case no index specified **** NEXT routine *****
22B9 C40D26     CALL   NZ,260DH      --- If index given, get its addr into DE
22BC 22DF40     LD     (40DFH),HL    --- Save current code string addr
22BF CD3619     CALL   1936H         --- Locate FOR push on stack, on exit          cont-->
22C2 C29D19     JP     NZ,199DH      --- NF error if no FOR push
22C5 F9         LD     SP,HL         --- Set stack ptr to addr of type/sign push for STEP
22C6 22E840     LD     (40E8H),HL    --- Save CSP in 40E8  :value
22C9 D5         PUSH   DE            --- Save addr of index. Overwrite addr of FOR index
22CA 7E         LD     A,(HL)        --- A = sign flag of increment
22CB 23         INC    HL            --- Skip over adj. type flag
22CC F5         PUSH   AF            --- Save sign flag
22CD D5         PUSH   DE            --- DE = addr of index
22CE 7E         LD     A,(HL)        --- A = adj. type flag for STEP increment =    cont-->
22CF 23         INC    HL            --- Backspace to end of STEP increment
22D0 B7         OR     A             --- Test adj. type flag for STEP increment
22D1 FAEA22     JP     M,22EAH       --->: Jmp if integer type
22D4 CDB109     CALL   09B1H         --  : Load STEP increment from stack           cont-->
22D7 E3         EX     (SP),HL       --  : HL = addr of index. Stack = end addr of TO limit
22D8 E5         PUSH   HL            --  : Save addr of index
22D9 CD0B07     CALL   070BH         --  : Load index into BC/DE and add to current value
22DC E1         POP    HL            --  : Restore addr of index to HL
22DD CDCB09     CALL   09CBH         --  : Move current value (new index) to its addr
22E0 E1         POP    HL            --  : HL = ending addr of TO limit
22E1 CDC209     CALL   09C2H         --  : Load TO value into BC/DE
22E4 E5         PUSH   HL            --  : Save addr of ptr to binary line no for FOR stmt
22E5 CD0C0A     CALL   0A0CH         --  : Compare TO value in BC/DE with new       cont-->
22E8 1829       JR     2313H         --  : Go examine results of comparison
22EA 23         INC    HL            <---: Backspace stack 4 bytes ***********************
22EB 23         INC    HL            --- which skips over the area for
22EC 23         INC    HL            --- single precision TO value.
22ED 23         INC    HL            --- Prepare to fetch an integer increment
22EE 4E         LD     C,(HL)        --- C = LSB of increment
22EF 23         INC    HL            --- Bump to MSB
22F0 46         LD     B,(HL)        --- B = MSB of increment
22F1 23         INC    HL            --- HL = stack addr of TO limit
22F2 E3         EX     (SP),HL       --- HL = addr of index. Stack = ending addr of TO limit
22F3 5E         LD     E,(HL)        --- E = LSB of index                                :on stack
22F4 23         INC    HL            --- Bump to MSB
22F5 56         LD     D,(HL)        --- D = MSB of index
22F6 E5         PUSH   HL            --- Save addr of MSB of index
22F7 69         LD     L,C           --- L = LSB of increment
22F8 60         LD     H,B           --- H = MSB of increment
22F9 CDD20B     CALL   0BD2H         --- Add value in DE to HL. Sum in HL if integer.
22FC 3AAF40     LD     A,(40AFH)     --- Get data type flag              :index + increment
22FF FE04       CP     04H           --- Test for single precision
2301 CAB207     JP     Z,07B2H       --- OV error if single precision
2304 EB         EX     DE,HL         --- DE = new index value
2305 E1         POP    HL            --- HL = addr of index in variable area
2306 72         LD     (HL),D        --- Save MSB of new index
2307 2B         DEC    HL            --- Skip down to LSB
2308 73         LD     (HL),E        --- Save LSB of new index
2309 E1         POP    HL            --- HL = addr of TO value in FOR push
230A D5         PUSH   DE            --- Save new index
230B 5E         LD     E,(HL)        --- E = LSB of TO value
230C 23         INC    HL            --- Bump to MSB
```

```
22AD  : may be in DATA statement

22B1  : till DATA or end of pgm

22B6  * *************************************************************

22BF  : HL = stack addr of type (adj)/sign flag

22CE  : +1 if single precision, -1 if integer

224D  : Save as current value

22E5  : index in current value

22EA  * *************************************************************
```

```
230D 56        LD     D,(HL)       --- D = MSB of TO value
230E 23        INC    HL           --- Bump to addr of line number
230F E3        EX     (SP),HL      --- HL = TO value , save addr of line no. on stack
2310 CD390A    CALL   0A39H        --- Compare new index to limit
2313 E1        POP    HL           --- HL = addr of binary line no. of FOR stmt
2314 C1        POP    BC           --- BC = sign flag of index
2315 90        SUB    B            --- Compare sign of comparison w/sign expected
2316 CDC209    CALL   09C2H        --- Load BC = addr of 1st stmt in loop.        cont-->
2319 2809      JR     Z,2324H      --->: Jmp if index <> to limit
231B EB        EX     DE,HL        --  : HL = binary line no of FOR stmt
231C 22A240    LD     (40A2H),HL   --  : Save line no. Of FOR stmt
231F 69        LD     L,C          --  : Move LSB of 1st loop stmt
2320 60        LD     H,B          --  : Move MSB of 1st loop stmt
2321 C31A1D    JP     1D1AH        --  : Continue execution. Restore FOR          cont-->
2324 F9        LD     SP,HL        <---: Restore stack pointer ************* see note--> *
2325 22E840    LD     (40E8H),HL   --- And save in 40EB
2328 2ADF40    LD     HL,(40DFH)   --- HL = Code string addr after NEXT I
232B 7E        LD     A,(HL)       --- Get next token
232C FE2C      CP     2CH          --- Compare with a comma
232E C21E1D    JP     NZ,1D1EH     --- Jump if not comma
2331 D7        RST    10H          --- Position to next index
2332 CDB922    CALL   22B9H        --- Re-enter and execute NEXT
2335 CF        RST    08H          --- Test for left paren in input stream
2336 282B      JR     Z,2363H      --- 2336: DC  28  Left paren
2338 1600      LD     D,00H        --- 2337: DEC HL
233A D5        PUSH   DE           --- D = precedence value, E = operator token
233B 0E01      LD     C,01H        --- Number of bytes of free memory required
233D CD6319    CALL   1963H        --- Check limits of free memory
2340 CD9F24    CALL   249FH        --- Get value of next element in expression    cont-->
2343 22F340    LD     (40F3H),HL   --- Addr of next token
2346 2AF340    LD     HL,(40F3H)   --- Re-entry point following a reduction
2349 C1        POP    BC           --- BC = DE = precedence value last   cont-->
234A 7E        LD     A,(HL)       --- Get next token (operator or function)
234B 1600      LD     D,00H        --- Clear relational token flag encountered
234D D6D4      SUB    0D4H         <-----: Test for arithmetic or relational operator
234F 3813      JR     C,2364H      --->: : Operator +, -, *, /,up arrow, AND, OR
2351 FE03      CP     03H          --- : : Test for >, =, < token
2353 300F      JR     NC,2364H     --->: : Jmp token SGN - MID$
2355 FE01      CP     01H          --- : : Set CARRY if >. Test for <=, >= sequence
2357 17        RLA                 --- : : Adjusted token gives 1(>), 2(=), 4(<)
2358 AA        XOR    D            --- : : Test for permissible combinations <=, =>
2359 BA        CP     D            --- : : by combining previous adjusted token
235A 57        LD     D,A          --- : : with current adjusted token.           cont-->
235B DA9719    JP     C,1997H      --- : : Error if << , >>, or ==
235E 22D840    LD     (40D8H),HL   --- : : Addr of <, -, or > token to 40D8
2361 D7        RST    10H          --- : : Get next token
2362 18E9      JR     234DH        ----:-: Two relationals to be treated as one
2364 7A        LD     A,D          <---: Get relational operator flag
2365 B7        OR     A            --- Set status flags then
2366 C2EC23    JP     NZ,23ECH     --- Jmp if <, =, or > token previously encountered
2369 7E        LD     A,(HL)       --- A = operator token
236A 22D840    LD     (40D8H),HL   --- Addr of arithmetic operator to 40D8
236D D6CD      SUB    0CDH         --- Test for arithmetic token
236F D8        RET    C            --- Return if token not arithmetic
2370 FE07      CP     07H          --- Test for + through OR token
2372 D0        RET    NC           --- Rtn if token > through MID$
2373 5F        LD     E,A          --- E = 0 - 7
2374 3AAF40    LD     A,(40AFH)    --- Get type flag for current variable
2377 D603      SUB    03H          --- -1(int), 0(str), 1(sng), 5(dbl)
2379 B3        OR     E            --- Combine op token & type so we can test for
```

```
2316  : DE = binary line no. of FOR stmnt

2321  : token and GAP for FOR.
2324  * Start of expression evaluation ******************************

2340  : If var : addr to 4121, if const : value to 4127

2349  : operand/last operator token
      *         -   <   =   >
      *         -   4   2   1
      *       < 4   0   6   5
      *       = 2   6   0   7
      *       > 1   5   3   0
      *
      *         Relational Table

235A  : Combination must be greater than previous value

      *                         E     TOKEN
      *
      *                         0       +
      *                         1       -
      *                         2       *
      *                         3       /
      *                         4       @@
      *                         5      AND
      *                         6      OR
```

```
237A CA8F29    JP      Z,298FH       --- String addition
237D 219A18    LD      HL,189AH      --- Table of precedent operator values
2380 19        ADD     HL,DE         --- Add local token (0 - 7)
2381 78        LD      A,B           --- Compute addr for this operator
2382 56        LD      D,(HL)        --- Get precedence value for last operator
2383 BA        CP      D             --- Get precedent value for this operator
2384 D0        RET     NC            --- Exit if this operator has higher operator
2385 C5        PUSH    BC            --- Precedence value last operator/token last operator
2386 014623    LD      BC,2346H      --- Resumption addr in case break in precedence
2389 C5        PUSH    BC            --- To stack
238A 7A        LD      A,D           --- A = precedence value for this operator
238B FE7F      CP      7FH           --- Test for exponential
238D CAD423    JP      Z,23D4H       --- Jmp if exponential
2390 FE51      CP      51H           --- Test for LOGICAL operators
2392 DAE123    JP      C,23E1H       --- Jmp if AND/OR
2395 212141    LD      HL,4121H      --- HL = addr of binary value for 1st operand
2398 B7        OR      A             --- Clear status flags
2399 3AAF40    LD      A,(40AFH)     --- Get data type
239C 3D        DEC     A             --- Minus 1 : -1(int), 0(str), 1(sng), 5(dbl)
239D 3D        DEC     A             --- Minus 2
239E 3D        DEC     A             --- Minus 3
239F CAF60A    JP      Z,0AF6H       --- TM error if Z (string)
23A2 4E        LD      C,(HL)        --- Now, load binary value of operator
23A3 23        INC     HL            --- C = LSB of value. Bump to MSB
23A4 46        LD      B,(HL)        --- BC = binary value
23A5 C5        PUSH    BC            --- Save binary value
23A6 FAC523    JP      M,23C5H       --- Jump if integer operand saved
23A9 23        INC     HL            --- Else get rest of value
23AA 4E        LD      C,(HL)        --- Into BC and save it on stack also
23AB 23        INC     HL            --- C = MSB of SP value
23AC 46        LD      B,(HL)        --- B = exponent of SP value
23AD C5        PUSH    BC            --- Save rest of digit
23AE F5        PUSH    AF            --- Save type -3
23AF B7        OR      A             --- Reset status flags so we can test for DP value
23B0 E2C423    JP      PO,23C4H      --->: Jump if not double precision
23B3 F1        POP     AF            --  : Clear stack
23B4 23        INC     HL            --  : Bump to next byte of value
23B5 3803      JR      C,23BAH       -->:: Jmp if rem. of value not in WRA1
23B7 211D41    LD      HL,411DH      -- :: Reset HL to start of WRA1
23BA 4E        LD      C,(HL)        <--:: Load rest of double precision
23BB 23        INC     HL            --  :value and save on stack
23BC 46        LD      B,(HL)        --  : B = next most LSB
23BD 23        INC     HL            --  : Bump to next digit
23BE C5        PUSH    BC            --  : Save LSB/NMSB of DP value
23BF 4E        LD      C,(HL)        --  : then load
23C0 23        INC     HL            --  : Middle bytes of
23C1 46        LD      B,(HL)        --  : DP value in BC
23C2 C5        PUSH    BC            --  : and save on stack
23C3 06F1      LD      B,0F1H        <---: 23C4: POP AF  Clear type -3/status push
23C5 C603      ADD     A,03H         --- A = type
23C7 4B        LD      C,E           --- Token for arithmetic operator (0 - 7)
23C8 47        LD      B,A           --- Plus length of operand
23C9 C5        PUSH    BC            --- Follow operand on stack
23CA 010624    LD      BC,2406H      --- Addr for reordering operations
23CD C5        PUSH    BC            --- To stack
23CE 2AD840    LD      HL,(40D8H)    --- Restore HL to addr of last token encountered
23D1 C33A23    JP      233AH         --- Note DE = precedence value/operator value (0 - 7)
23D4 CDB10A    CALL    0AB1H         --- Convert integer (4121-4122) to SP ****** cont--> *
23D7 CDA409    CALL    09A4H         --- Move a SP no. from 4121-4124 to stack
23DA 01F213    LD      BC,13F2H      --- Addr of SP exponential routine
```

```
23D4  * and store in 4121 - 4124 ***********************************
```

```
23DD 167F      LD      D,7FH          --- D = precedence value for up arrow
23DF 18EC      JR      23CDH          --- Continue expression evaluation
23E1 D5        PUSH    DE             --- Save precedence value/token *********************
23E2 CD7F0A    CALL    0A7FH          --- Convert current value to an integer, leave in HL
23E5 D1        POP     DE             --- Restore precedence value/token
23E6 E5        PUSH    HL             --- Save current value (integer)
23E7 01E925    LD      BC,25E9H       --- Logical operator routine address
23EA 18E1      JR      23CDH          --- Continue syntax analysis
23EC 78        LD      A,B            --- A = precedence value previous operator * cont--> *
23ED FE64      CP      64H            --- Compare it with relational AND
23EF D0        RET     NC             --- Exit if prior operator was relational
23F0 C5        PUSH    BC             --- BC = precedence value previous operator/token
23F1 D5        PUSH    DE             --- DE = 6, 5, or 3/token
23F2 110464    LD      DE,6404H       --- DE = precedence value for '<=', '>='       cont-->
23F5 21B825    LD      HL,25B8H       --- Addr of routine to compare logical quantities
23F8 E5        PUSH    HL             --- to stack
23F9 E7        RST     20H            --- Test data type
23FA C29523    JP      NZ,2395H       --- If not string go
23FD 2A2141    LD      HL,(4121H)     --- HL = string address. Put variable onto stack
2400 E5        PUSH    HL             --- Save string address on stack
2401 018C25    LD      BC,258CH       --- BC = address of string comparison routine
2404 18C7      JR      23CDH          --- Save addr in BC on stk. Continue analyzing stmt
2406 C1        POP     BC             --- End of statement or precedence break *** cont--> *
2407 79        LD      A,C            --- A = C = token
2408 32B040    LD      (40B0H),A      --- 40B0 = arith token of last operand         cont-->
240B 78        LD      A,B            --- Data type of first operand
240C FE08      CP      08H            --- Test data type for first operand
240E 2828      JR      Z,2438H        --->: Jmp if first operand is double precision
2410 3AAF40    LD      A,(40AFH)      --  : No, test current operand
2413 FE08      CP      08H            --  : Test data type
2415 CA6024    JP      Z,2460H        --  : Jump if double precision
2418 57        LD      D,A            --  : D = data type current operand
2419 78        LD      A,B            --  : A = data type 1st operand
241A FE04      CP      04H            --  : Test data type for current operand
241C CA7224    JP      Z,2472H        --  : Jmp if 1st operand single precision
241F 7A        LD      A,D            --  : A = data type current operand
2420 FE03      CP      03H            --  : Is it CR string variable
2422 CAF60A    JP      Z,0AF6H        --  : TM error if string variable
2425 D27C24    JP      NC,247CH       --  : Jump if sng, else integer
2428 21BF18    LD      HL,18BFH       --  : Compute addr of arith routines
242B 0600      LD      B,00H          --  : As two * arith token
242D 09        ADD     HL,BC          --  : plus origin of arith routine addr table
242E 09        ADD     HL,BC          --  : gives addr of loc. containing addr       cont-->
242F 4E        LD      C,(HL)         --  : Addr of integer arith routines. C = LSB
2430 23        INC     HL             --  : Bump to next loc. of addr
2431 46        LD      B,(HL)         --  : B = MSB of addr of arith routine
2432 D1        POP     DE             --  : DE = value of first operand
2433 2A2141    LD      HL,(4121H)     --  : HL = value of current operand
2436 C5        PUSH    BC             --  : Save addr of arith routine on stack for following
2437 C9        RET                    --  : Go to arith routine                          :POP
2438 CDDB0A    CALL    0ADBH          <---: Convert current value to DP ******************
243B CDFC09    CALL    09FCH          --- Convert current value to SP
243E E1        POP     HL             --- Move current value to
243F 221F41    LD      (411FH),HL     --- very end of WRA1
2442 E1        POP     HL             --- HL = 2nd most sig. part of DP value
2443 221D41    LD      (411DH),HL     --- to near end of WRA1
2446 C1        POP     BC             --- BC/DE = remainder of DP value
2447 D1        POP     DE             --- Save BC/DE in upper part of WRA1
2448 CDB409    CALL    09B4H          --- Move DE to 4121, BC to 4123
244B CDDB0A    CALL    0ADBH          --- Convert first value to double precision
```

```
23E1  * *************************************************************

23EC  * *********************** Relational token routine ************

23F2  : /token (relational sequence)

2406  * BC = data type/ arithmetic token 0 - 7 **********************
2408  : (the one to be performed)

242E  : of arith routine

2438  * *************************************************************
```

```
244E 21AB18    LD     HL,18ABH      --- Base addr of double precision routines
2451 3AB040    LD     A,(40B0H)     --- Get token value. Use it to compute addr of arith
2454 07        RLCA                 --- Token times 2                                  :routine
2455 C5        PUSH   BC            --- Save BC so we can use it for 16 bit arith
2456 4F        LD     C,A           --- C = 2 * token
2457 0600      LD     B,00H         --- B = 0
2459 09        ADD    HL,BC         --- (Token value * 2) + 18AB = table addr of arith
245A C1        POP    BC            --- Restore BC                                     :routine
245B 7E        LD     A,(HL)        --- Load LSB of arith routine addr
245C 23        INC    HL            --- Bump to MSB
245D 66        LD     H,(HL)        --- Load MSB of arith routine addr into HL
245E 6F        LD     L,A           --- HL = addr of arith routine
245F E9        JP     (HL)          --- Jmp to arith routine. Rtn to 2346
2460 C5        PUSH   BC            --- Save data type first operand/arith token *cont-->*
2461 CDFC09    CALL   09FCH         --- Move current value to 'saved' area
2464 F1        POP    AF            --- A = data type for other operand
2465 32AF40    LD     (40AFH),A     --- Save it and
2468 FE04      CP     04H           --- test for single precision
246A 28DA      JR     Z,2446H       --- Jump if SP, go convert value to DP and do
246C E1        POP    HL            --- Value must be integer. Pop it from      :operation
246D 222141    LD     (4121H),HL    --- stack, save as current value then go, convert
2470 18D9      JR     244BH         --- it to double precision and perform operation
2472 CDB10A    CALL   0AB1H         --- Convert current operand to single precision ******
2475 C1        POP    BC            --- Left hand operator to BC
2476 D1        POP    DE            --- and DE
2477 21B518    LD     HL,18B5H      --- Base addr of SP arith routines
247A 18D5      JR     2451H         --- Go perform operation
247C E1        POP    HL            --- Load integer operand into HL *********** cont-->
247D CDA409    CALL   09A4H         --- Save current SP value on stack
2480 CDCF0A    CALL   0ACFH         --- Convert integer value in Iii. to SP
2483 CDBF09    CALL   09BFH         --- Load SP equivalent of integer into BC/DE
2486 E1        POP    HL            --- LSB/NMSB of stack SP value
2487 222341    LD     (4123H),HL    --- to current value
248A E1        POP    HL            --- MSB/exponent of stack value
248B 222141    LD     (4121H),HL    --- to current value
248E 18E7      JR     2477H         --- Go perform operation
2490 E5        PUSH   HL            --- Save HL so it can be ** INTEGER division * cont-> *
2491 EB        EX     DE,HL         --- Prepare to convert DE to SP
2492 CDCF0A    CALL   0ACFH         --- Convert DE to SP
2495 E1        POP    HL            --- Restore original HL
2496 CDA409    CALL   09A4H         --- Move converted DE to stack
2499 CDCF0A    CALL   0ACFH         --- Convert HL to SP
249C C3A008    JP     08A0H         --- Go do SP division
249F D7        RST    10H           --- Plus routine examine next symbol *****************
24A0 1E28      LD     E,28H         --- MO error if end of string
24A2 CAA219    JP     Z,19A2H       --- Output if Z
24A5 DA6C0E    JP     C,0E6CH       --- Jump if numeric - convert ASCII to binary
24A8 CD3D1E    CALL   1E3DH         --- Check for letter
24AB D24025    JP     NC,2540H      --- Go if letter
24AE FECD      CP     0CDH          --- Test for + token
24B0 28ED      JR     Z,249FH       --- Go if + (token) - look for following number
24B2 FE2E      CP     2EH           --- Test for decimal point
24B4 CA6C0E    JP     Z,0E6CH       --- Go if decimal point
24B7 FECE      CP     0CEH          --- Test for - token
24B9 CA3225    JP     Z,2532H       --- Go if - (token)
24BC FE22      CP     22H           --- Test for quote
24BE CA6628    JP     Z,2866H       --- Go if quote. Build a literal string pointer entry
24C1 FECB      CP     0CBH          --- Test for not token
24C3 CAC425    JP     Z,25C4H       --- Go if not (token)
24C6 FE26      CP     26H           --- Test for &
```

```
2460  * 1st operand not DP ********* 2nd operand DP ****************

2472  * ***********************************************************

247C  * 1st operand is SP **** 2nd operand is integer ***************

2490  * converted later ***-- Convert both values (HL & DE) to SP ***
      :                       and use SP division.

249E  * ***********************************************************
```

```
24C8 CA9441    JP     Z,4194H       --- Go if &
24CB FEC3      CP     0C3H          --- Test for ERR token
24CD 200A      JR     NZ,24D9H      --- Go if not ERR
24CF D7        RST    10H           --- Position to next element in code string
24D0 3A9A40    LD     A,(409AH)     --- Fetch current error number
24D3 E5        PUSH   HL            --- Save current code string addr
24D4 CDF827    CALL   27F8H         --- Save err. no. as current value (integer)
24D7 E1        POP    HL            --- Restore code string addr
24D8 C9        RET                  --- Rtn to expression evaluation
24D9 FEC2      CP     0C2H          --- Test for ERL ************************************
24DB 200A      JR     NZ,24E7H      --- Go if not ERL
24DD D7        RST    10H           --- Position to next element in code string
24DE E5        PUSH   HL            --- Save current code string addr
24DF 2AEA40    LD     HL,(40EAH)    --- Fetch line no. with error
24E2 CD660C    CALL   0C66H         --- Convert line no. to SP & save as current value
24E5 E1        POP    HL            --- Restore code string addr
24E6 C9        RET                  --- Rtn to expression evaluation
24E7 FEC0      CP     0C0H          --- Test for VARPTR token ************ VARPTR *********
24E9 2014      JR     NZ,24FFH      --- Go if not VARPTR
24EB D7        RST    10H           --- Get next char from code string
24EC CF        RST    08H           --- 24EC: RST  08   - Test next char for left   cont-->
24ED 28CD      JR     Z,24BCH       --- 24ED: DC   28   - Value for left paren
24EF 0D        DEC    C             --- 24EE: CALL 260D - Evaluate variable name
24F0 26CF      LD     H,0CFH        --- 24F1: RST  08   - Test next char for right  cont-->
24F2 29        ADD    HL,HL         --- 24F2: DC   29   - Value for right paren
24F3 E5        PUSH   HL            --- Save current code string addr
24F4 EB        EX     DE,HL         --- Move address of variable to HL
24F5 7C        LD     A,H           --- Then test for zero address (undefined variable)
24F6 B5        OR     L             --- Combine LSB and MSB of address
24F7 CA4A1E    JP     Z,1E4AH       --- FC error if variable not defined
24FA CD9A0A    CALL   0A9AH         --- Save addr as current variable, set type to integer
24FD E1        POP    HL            --- Restore current code string address
24FE C9        RET                  --- Return to execution driver
24FF FEC1      CP     0C1H          --- Test for USR ************************************
2501 CAFE27    JP     Z,27FEH       --- Go if USR
2504 FEC5      CP     0C5H          --- Test for INSTR token
2506 CA9D41    JP     Z,419DH       --- Go if INSTR : Disk BASIC (JP 582F)
2509 FEC8      CP     0C8H          --- Test for MEM token
250B CAC927    JP     Z,27C9H       --- Go if MEM
250E FEC7      CP     0C7H          --- Test for TIME$ token
2510 CA7641    JP     Z,4176H       --- Go if TIME$
2513 FEC6      CP     0C6H          --- Test for POINT token
2515 CA3201    JP     Z,0132H       --- Go if POINT
2518 FEC9      CP     0C9H          --- Test for INKEY$ token
251A CA9D01    JP     Z,019DH       --- Go if INKEY$
251D FEC4      CP     0C4H          --- Test for STRING$ token
251F CA2F2A    JP     Z,2A2FH       --- Go if STRING$
2522 FEBE      CP     0BEH          --- Test for FN token
2524 CA5541    JP     Z,4155H       --- Go if FN : Disk BASIC (JP 558E)
2527 D6D7      SUB    0D7H          --- Test for SGN to MID$ tokens
2529 D24E25    JP     NC,254EH      --- Jmp if token SGN thru MID$
252C CD3523    CALL   2335H         --- Token < 215 - better be (. Call pause      cont-->
252F CF        RST    08H           --- Test next char for close paren ')'
2530 29        ADD    HL,HL         --- 2530: DC 29  Value for ')'
2531 C9        RET                  --- Rtn to caller
2532 167D      LD     D,7DH         --- Load precedence value ** Binary minus routine ****
2534 CD3A23    CALL   233AH         --- Evaluate variable
2537 2AF340    LD     HL,(40F3H)    --- Get addr of next element in code string
253A E5        PUSH   HL            --- Save addr of where to continue from
253B CD7B09    CALL   097BH         --- Invert sign of current value
```

```
24D9  * ***********************************************************

24E7  * *************************************************************

24EC  : paren & skip over it

24F0  : paren & skip over it

24FF  * *************************************************************

252C  : return when expression exhausted

2532  * *************************************************************
```

```
253E E1        POP    HL            --- Restore code string addr                see note-->
253F C9        RET                  --- Ret to expression evaluation
2540 CD0D26    CALL   260DH         --- Get addr of variable *************** see note--> *
2543 E5        PUSH   HL            --- Save code string addr
2544 EB        EX     DE,HL         --- Addr of variable to HL
2545 222141    LD     (4121H),HL    --- Store it in 4121
2548 E7        RST    20H           --- Determine data type
2549 C4F709    CALL   NZ,09F7H      --- Call if numeric data: move numeric value to 4127
254C E1        POP    HL            --- HL = addr of next symbol in input string
254D C9        RET                  --- Rtn to caller
254E 0600      LD     B,00H         --- B = 0 *********************** SNG - MID$ *********
2550 07        RLCA                 --- A = 2*(token - D7)
2551 4F        LD     C,A           --- Save new token
2552 C5        PUSH   BC            --- Save 0/2*(token - D7) on stack
2553 D7        RST    10H           --- Fetch next character from tokenized string
2554 79        LD     A,C           --- Look for SGN - CHR$ token
2555 FE41      CP     41H           --- Test for adjusted token
2557 3816      JR     C,256FH       --->: Jmp if token SGN-CHR$ , else it's LEFT-MID$
2559 CD3523    CALL   2335H         --  : Go evaluate expression part of            cont-->
255C CF        RST    08H           --  : Test next char for comma
255D 2C        INC    L             --  : 255D: DC 2C  comma
255E CDF40A    CALL   0AF4H         --  : Insure current variable is a string, else error
2561 EB        EX     DE,HL         --  : Make sure current variable is a string. DE =
2562 2A2141    LD     HL,(4121H)    --  : current pos. in pgm stmt. HL = addr of string
2565 E3        EX     (SP),HL       --  : Move string addr to stack, followed by string
2566 E5        PUSH   HL            --  : Save 00/2*(token - D7)
2567 EB        EX     DE,HL         --  : Pgm statement position to HL
2568 CD1C2B    CALL   2B1CH         --  : Evaluate n portion of string function
256B EB        EX     DE,HL         --  : DE = current position in statement. HL = n
256C E3        EX     (SP),HL       --  : Move n to stack. HL = 2*(token - D7)
256D 1814      JR     2583H         --  : Go to action routine for token
256F CD2C25    CALL   252CH         <---: Evaluate expression.                  see note-->
2572 E3        EX     (SP),HL       --- HL = 0 + 2*(token - D7)
2573 7D        LD     A,L           --- A = 2*(token - D7)
2574 FE0C      CP     0CH           --- Test for SNG - SQR
2576 3807      JR     C,257FH       --->: Jmp if token SNG - SQR
2578 FE1B      CP     1BH           --  : Test adjusted token then
257A E5        PUSH   HL            --  : Save 0 + 2*(token - D7) and
257B DCB10A    CALL   C,0AB1H       --  : Convert integer in 4121 to SP if token SQR-ATN
257E E1        POP    HL            --  : Restore token to HL
257F 113E25    LD     DE,253EH      <---: Push return addr of 253E onto stack so we can
2582 D5        PUSH   DE            --- return after executing function
2583 010816    LD     BC,1608H      --- Addr for functions SGN - MID$
2586 09        ADD    HL,BC         --- Add index for required function
2587 4E        LD     C,(HL)        --- C = LSB of addr of function
2588 23        INC    HL            --- Bump to MSB
2589 66        LD     H,(HL)        --- H = MSB of addr of function
258A 69        LD     L,C           --- HL = addr of function
258B E9        JP     (HL)          --- Jmp to SGN - MID$ function
258C CDD729    CALL   29D7H         --- Make sure string will fit into ********* cont--> *
258F 7E        LD     A,(HL)        --- A = length
2590 23        INC    HL            --- Bump to LSB of string addr
2591 4E        LD     C,(HL)        --- Load LSB of string addr
2592 23        INC    HL            --- Bump to MSB of string addr
2593 46        LD     B,(HL)        --- BC = string address
2594 D1        POP    DE            --- Clear the stack
2595 C5        PUSH   BC            --- Save first string addr
2596 F5        PUSH   AF            --- A = length of first string
2597 CDDE29    CALL   29DEH         --- Get addr. of second string into HL
259A D1        POP    DE            --- D = length of first string
```

253E : Rtn here after executing functions SNG - MID$

2540 * Locate address of variable. Name pointed to by HL **********

254E * **

2559 : calling sequence. 2 or 3 parameter calling sequence.

256E : Single variable parameter call

258C : string data area ***** Relational compare two strings *******

```
259B 5E         LD      E,(HL)        --- E = no. of characters in second string
259C 23         INC     HL            --- Bump to LSB of 2nd string addr
259D 4E         LD      C,(HL)        --- C = LSB of addr. for string 2
259E 23         INC     HL            --- Bump to MSB of addr.
259F 46         LD      B,(HL)        --- BC = address of string 2
25A0 E1         POP     HL            --- HL = addr. of string 1
25A1 7B         LD      A,E           <---: A = remaining characters string 2
25A2 B2         OR      D              •  : D = remaining characters string 1
25A3 C8         RET     Z              •  : Exit if all characters compared
25A4 7A         LD      A,D            •  : Reload count of chars remaining string 1
25A5 D601       SUB     01H            •  : Test if count is zero
25A7 D8         RET     C              •  : Exit if string 1 exhausted
25A8 AF         XOR     A              •  : Clears A-reg
25A9 BB         CP      E              •  : Gives zero - no. of remaining chars string 2
25AA 3C         INC     A              •  : Test if any char remains in string 2
25AB D0         RET     NC             •  : Exit if string 2 exhausted
25AC 15         DEC     D              •  : Decrement chars remaining string 1
25AD 1D         DEC     E              •  : Decrement chars remaining string 2
25AE 0A         LD      A,(BC)         •  : Compare a character in string 1 with string 2
25AF BE         CP      (HL)           •  : Compare
25B0 23         INC     HL             •  : Bump string 1 address
25B1 03         INC     BC             •  : Bump string 2 address
25B2 28ED       JR      Z,25A1H       --->: Jmp if characters are equal
25B4 3F         CCF                   --- Else reverse CARRY flag so 960 will give
25B5 C36009     JP      0960H         --- a +1 or -1. Rtn to caller
25B8 3C         INC     A             --- Increment value for current operator
25B9 8F         ADC     A,A           --- Gives 1 w/NC if 0 or 0 w/C if FF       see note-->
25BA C1         POP     BC            --- Load value for other operand
25BB A0         AND     B             --- Combine values
25BC C6FF       ADD     A,0FFH        --- Yields 0 if both equal, CARRY if unequal
25BE 9F         SBC     A,A           --- Sets A = 0 if equal, 1 if unequal
25BF CD8D09     CALL    098DH         --- Set current value to 00 if A +, FF if A negative
25C2 1812       JR      25D6H         --- Continue with expression evaluation
25C4 165A       LD      D,5AH         --- D = precedence value * NOT routine * see note--> *
25C6 CD3A23     CALL    233AH         --- Evaluate rest of exp until a higher precedence
25C9 CD7F0A     CALL    0A7FH         --- Current value to integer
25CC 7D         LD      A,L           --- Result in HL
25CD 2F         CPL                   --- Complement LSB of integer
25CE 6F         LD      L,A           --- Restore LSB to HL
25CF 7C         LD      A,H           --- Then load MSB
25D0 2F         CPL                   --- Complement MSB of integer
25D1 67         LD      H,A           --- Restore MSB to HL
25D2 222141     LD      (4121H),HL    --- Save complemented number as current value
25D5 C1         POP     BC            --- Clear the stack
25D6 C34623     JP      2346H         --- Continue with expression evaluation
25D9 3AAF40     LD      A,(40AFH)     --- Load data type for value in WRA1 ******* cont--> *
25DC FE08       CP      08H           --- Prepare to set data flags
25DE 3005       JR      NC,25E5H      -->: Jmp if double precision
25E0 D603       SUB     03H           -- : not DP, subtract 03
25E2 B7         OR      A             -- : then set status flags according to result
25E3 37         SCF                   -- : and exit with
25E4 C9         RET                   -- : CARRY flag set
25E5 D603       SUB     03H           <--: for DP types subtract 03
25E7 B7         OR      A             --- then set status flags according to result
25E8 C9         RET                   --- and exit without CARRY flag set
25E9 C5         PUSH    BC            --- B = precision value for last operator ** cont--> *
25EA CD7F0A     CALL    0A7FH         --- Convert current value to integer
25ED F1         POP     AF            --- Pop BC into AF
25EE D1         POP     DE            --- Return addr to DE
25EF 01FA27     LD      BC,27FAH      --- Place new rtn addr on stack
```

```
      : Compare two logical quantities




25C4  * * Entered from PLUS routine while evaluating ***
      : * an expression




25D9  * RST 20 routine ***********************************************

      :     !   Data type stored in 40AFH as follows  !
      :     !   TYPE CODE ZERO CARRY NEG PARITY A-REG !
      :     !   ---- ---- ---- ----- --- ------ --- . !
      :     !   INT   02   NZ    C    N    E      -1  !
      :     !   STR   03    Z    C    P    E       0  !
      :     !   SNG   04   NZ    C    P    O       1  !
      :     !   DBL   08   NZ   NC    P    E       5  !
25E9  * Logical operator routine - Entered from expression evaluation
```

```
25F2 C5         PUSH    BC              --- Save rtn addr on stack
25F3 FE46       CP      46H             --- Is token an 'OR'
25F5 2006       JR      NZ,25FDH        --->: No, Jmp to comparison routine
25F7 7B         LD      A,E             --  : Comp DE with HL. Result in HL
25F8 B5         OR      L               --  : Comp E and L. Result in L
25F9 6F         LD      L,A             --  : Restore L
25FA 7C         LD      A,H             --  : Comp H and D. Result left in A. Will be moved
25FB B2         OR      D               --  : to H at 27FA
25FC C9         RET                     --  : Go to 27FA. Convert result to integer. Rtn to
25FD 7B         LD      A,E             <---: Logical comp DE with HL. Result in HL.     :2346
25FE A5         AND     L               --- And E and L
25FF 6F         LD      L,A             --- Result to L
2600 7C         LD      A,H             --- Load H so we can                           : H at 27FA
2601 A2         AND     D               --- Comp D with H. Result left in A will be moved to
2602 C9         RET                     --- Goto 27FA. Make result an integer. Rtn to 2346
2603 2B         DEC     HL              --- Backspace code string pointer *******************
2604 D7         RST     10H             --- Re-evaluate last symbol
2605 C8         RET     Z               --- Exit if end of statement
2606 CF         RST     08H             --- Test next char for single quote
2607 2C         INC     L               --- 2607: DC 2C single quote
2608 010326     LD      BC,2603H        --- Locate addr of a variable ** Force rtn to 2603 **
260B C5         PUSH    BC              --- 260C : OR  AF  Set create mode
260C F6AF       OR      0AFH            --- 260D : XOR A   Zero A, set 40AE = locate
260E 32AE40     LD      (40AEH),A       --- Set 40AE = locate/create mode
2611 46         LD      B,(HL)          --- Save 1st char of variable name
2612 CD3D1E     CALL    1E3DH           --- Check for letter
2615 DA9719     JP      C,1997H         --- SN error if C (not a letter in (HL)        cont-->
2618 AF         XOR     A               --- Clear A and C
2619 4F         LD      C,A             --- Zeros C
261A D7         RST     10H             --- Get next char in input string
261B 3805       JR      C,2622H         ----->: Jump if numeric
261D CD3D1E     CALL    1E3DH           --    : Test for alpha-numeric. Set CARRY if false
2620 3809       JR      C,262BH         --->: : Jump if not a letter. Error if         cont-->
2622 4F         LD      C,A             <---:-: 2nd char of name to C
2623 D7         RST     10H             <-- : Test symbol following 2nd char until a non-
2624 38FD       JR      C,2623H         -->:: numeric symbol is found,                 cont-->
2626 CD3D1E     CALL    1E3DH           -- :: Test for letter
2629 30F8       JR      NC,2623H        -->:: Jmp if a letter
262B 115226     LD      DE,2652H        <---: We are now positioned at end of          cont-->
262E D5         PUSH    DE              --- Place 2652H return address on stack
262F 1602       LD      D,02H           --- Test char following name for
2631 FE25       CP      25H             --- If so, set D to data type 2
2633 C8         RET     Z               --- Return (jump 2652H) if % (INT) : D = 2
2634 14         INC     D               --- Ret D to 3 in case variable is a string
2635 FE24       CP      24H             --- Test for $ following variable name
2637 C8         RET     Z               --- Return if $ (STR) : D = 3
2638 14         INC     D               --- Ret D to 4 in case variable is SP
2639 FE21       CP      21H             --- Test for ! following variable name
263B C8         RET     Z               --- Return if ! (SNG) : D = 4
263C 1608       LD      D,08H           --- Ret D to 8 in case variable is DP
263E FE23       CP      23H             --- Test for # following variable name
2640 C8         RET     Z               --- Return if # (DBL) : D = 8                  cont-->
2641 78         LD      A,B             --- Ref etch first char of symbol
2642 D641       SUB     41H             --- Convert from alpha to numeric (0-26)
2644 E67F       AND     7FH             --- Clear possible sign bit
2646 5F         LD      E,A             --- E = 0(A) thru 26(Z)
2647 1600       LD      D,00H           --- DE = 0 (A) thru 26(base 10) (Z)
2649 E5         PUSH    HL              --- Save current position in input stream
264A 210141     LD      HL,4101H        --- Start of data type table
264D 19         ADD     HL,DE           --- Add value of first char of var name (0=A,...26=Z)
```

```
2603  * *******************************************************

2608  * **********************************************************

2615  : Variable name does not start with a letter.

2620  : not a letter, or digit, or (

2624  : Jmp if char is numeric

262E  : variable name. Only 1st two characters are used.

2640  : Variable name was not followed by type suffix. Use 1st char
      : of var name to determine data type.
```

```
264E 56        LD     D,(HL)        --- Get data type
264F E1        POP    HL            --- Restore pointer to current pos in input stream
2650 2B        DEC    HL            --- Backspace 1 position
2651 C9        RET                  --- Return with data type in D (Go to 2652)
2652 7A        LD     A,D           --- D = data type continuation of locating * cont--> *
2653 32AF40    LD     (40AFH),A     --- Save data type flag
2656 D7        RST    10H           --- Get next char of variable name (call 1D78)
2657 3ADC40    LD     A,(40DCH)     --- Get 'FOR' statement flag
265A B7        OR     A             --- Test it
265B C26426    JP     NZ,2664H      --->: Jmp if processing 'FOR' statement
265E 7E        LD     A,(HL)        --  : Refetch next element from code string
265F D628      SUB    28H           --  : Compare with a (
2661 CAE926    JP     Z,26E9H       --  : Jump if '(' (subscripted variable)
2664 AF        XOR    A             <---: Zero A-reg
2665 32DC40    LD     (40DCH),A     --- Flag as non-subscripted
2668 E5        PUSH   HL            --- HL = current position in input string
2669 D5        PUSH   DE            --- Save data type flag
266A 2AF940    LD     HL,(40F9H)    --- HL = end of pgm ptr = start of simple var list
266D EB        EX     DE,HL         <-----: DE = addr of a simple variable
266E 2AFB40    LD     HL,(40FBH)     •    : Start of arrays pointer
2671 DF        RST    18H            •    : Compare addr of next simple          cont-->
2672 E1        POP    HL             •    : HL = data type flag
2673 2819      JR     Z,268EH       ------:>: Variable not currently defined
2675 1A        LD     A,(DE)         •    : : Get type for current variable
2676 6F        LD     L,A            •    : : Save in L
2677 BC        CP     H              •    : : Compare type
2678 13        INC    DE             •    : : Bump to 2nd char of name for this entry
2679 200B      JR     NZ,2686H      --->: : : Types do not match. Skip to next var in list
267B 1A        LD     A,(DE)         •  : : : Type matches, compare 2nd char of name from
267C B9        CP     C              •  : : : VLT w/2nd char of name in BC
267D 2007      JR     NZ,2686H       •  : : : No match, go find next entry in AT
267F 13        INC    DE             •  : : : 2nd char matches, compare 1st char of name
2680 1A        LD     A,(DE)         •  : : : after bumping to 1st char of name
2681 B8        CP     B              •  : : : Test if first char of names are equal
2682 CACC26    JP     Z,26CCH        •  : : : We have found the addr of a simple var, exit
2685 3E13      LD     A,13H         <---: : : 2686: INC DE Bump to next entry in simple
2687 13        INC    DE             •    : : variable list
2688 E5        PUSH   HL             •    : : Save data type flag so it can be reloaded
2689 2600      LD     H,00H          •    : : at 2672
268B 19        ADD    HL,DE          •    : : Bump to next entry in list
268C 18DF      JR     266DH         ----->: : Continue searching for variable name
268E 7C        LD     A,H           <-------: Save type
268F E1        POP    HL            --- Clear stack, HL = current position in input string
2690 E3        EX     (SP),HL       --- HL = return addr Stack = current position in input
2691 F5        PUSH   AF            --- A = type                                   :string
2692 D5        PUSH   DE            --- DE = start of arrays ptr
2693 11F124    LD     DE,24F1H      --- Addr of VARPTR locator
2696 DF        RST    18H           --- Were we called from VARPTR?
2697 2836      JR     Z,26CFH       --- Yes, Jmp to 26CF
2699 114325    LD     DE,2543H      --- DE = addr of find addr of variable routine
269C DF        RST    18H           --- Were we called from find addr of variable?
269D D1        POP    DE            --- Remove start of arrays ptr from stack
269E 2835      JR     Z,26D5H       --- Called while evaluating a subscript       cont-->
26A0 F1        POP    AF            --- Clear stack, A = type
26A1 E3        EX     (SP),HL       --- HL = current position in input string.
26A2 E5        PUSH   HL            --- Stack = Return addr
26A3 C5        PUSH   BC            --- Place BC (1st char/2nd char of name) on stack
26A4 4F        LD     C,A           --- followed by ret addr
26A5 0600      LD     B,00H         --- Clear B for computations
26A7 C5        PUSH   BC            --- Save 00/type. Now create a new entry in    cont-->
```

2652 * a variable name ***

2671 : variable to start of array list

269E : This is the first reference to a simple variable. Define it.

26A7 : free space list for current variable.

```
26A8 03        INC    BC          --- B = 00, C = type
26A9 03        INC    BC          --- Gives type +02
26AA 03        INC    BC          --- Gives type +03 = 3 bytes overhead + spare for var
26AB 2AFD40    LD     HL,(40FDH)  --- Load start of free memory ptr (fmp)
26AE E5        PUSH   HL          --- Save free mem ptr
26AF 09        ADD    HL,BC       --- Free mem ptr + type(length) yields new fmp
26B0 C1        POP    BC          --- BC = old free mem ptr
26B1 E5        PUSH   HL          --- Save new free mem ptr
26B2 CD5519    CALL   1955H       --- Move array list down. Add value to simple
26B5 E1        POP    HL          --- variable list
26B6 22FD40    LD     (40FDH),HL  --- Save new free mem ptr (it's official)
26B9 60        LD     H,B         --- HL = old fmp = 1st byte of new entry
26BA 69        LD     L,C         --- L = LSB byte of fmp
26BB 22FB40    LD     (40FBH),HL  --- New start of arrays pointer
26BE 2B        DEC    HL          <---: Zero out new entry. All space between the new
26BF 3600      LD     (HL),00H     •  : free memory pointer and the start of arrays ptr
26C1 DF        RST    18H          •  : have we reached the end of the list
26C2 20FA      JR     NZ,26BEH    --->: No, loop
26C4 D1        POP    DE          --- Get length (type)
26C5 73        LD     (HL),E      --- And store as first word in new entry
26C6 23        INC    HL          --- Bump to next location of entry
26C7 D1        POP    DE          --- Get 2nd char of name and store as 2nd word of
26C8 73        LD     (HL),E      --- entry
26C9 23        INC    HL          --- Bump to 3rd byte of entry
26CA 72        LD     (HL),D      --- And now 1st char of name
26CB EB        EX     DE,HL       --- DE = addr of start of value in entry
26CC 13        INC    DE          --- Leave addr of variable name in DE
26CD E1        POP    HL          --- Clear stack before exiting
26CE C9        RET                --- Return to caller
26CF 57        LD     D,A         --- DE = type/type ***********************************
26D0 5F        LD     E,A         --- E = type
26D1 F1        POP    AF          --- Clear stack
26D2 F1        POP    AF          --- Clear stack
26D3 E3        EX     (SP),HL     --- Return addr to stk. Code string addr to HL
26D4 C9        RET                --- Rtn to VARPTR routine
26D5 322441    LD     (4124H),A   --- Zero WRA1 ********* Locate subscripted variable **
26D8 C1        POP    BC          --- Clear stack
26D9 67        LD     H,A         --- Zero H
26DA 6F        LD     L,A         --- and L
26DB 222141    LD     (4121H),HL  --- Zero string pointer in WRA1
26DE E7        RST    20H         --- Determine data type
26DF 2006      JR     NZ,26E7H    ----> Jmp if not a string
26E1 212819    LD     HL,1928H    --- : Addr of READY message
26E4 222141    LD     (4121H),HL  --- : goes to WRA1
26E7 E1        POP    HL          <---: Restore code string addr
26E8 C9        RET                --- Rtn to caller
26E9 E5        PUSH   HL          --- Current pos in input string ******** see note--> *
26EA 2AAE40    LD     HL,(40AEH)  --- HL = 00 locate mode, <> 0 create mode
26ED E3        EX     (SP),HL     --- Stack = (40AE), HL = code string addr.
26EE 57        LD     D,A         --- Zero to D
26EF D5        PUSH   DE          --- D = 0, E = numeric value of 1st char
26F0 C5        PUSH   BC          --- BC = 1st char/2nd char of name in ASCII
26F1 CD451E    CALL   1E45H       --- Evaluate everything up to the first        cont-->
26F4 C1        POP    BC          --- BC = 1st char/2nd char of name in ASCII
26F5 F1        POP    AF          --- A = 0
26F6 EB        EX     DE,HL       --- DE = current pos in input. End of          cont-->
26F7 E3        EX     (SP),HL     --- Stack = value of subscript, (40AE)
26F8 E5        PUSH   HL          --- Save current pos in input string
26F9 EB        EX     DE,HL       --- HL = current pos in input string, DE = (40AE)
26FA 3C        INC    A           --- Increment no. of subscripts evaluated
```

```
26CF  * ***********************************************************

26D5  * ***********************************************************

26E9  * Locate addr of subscripted var ** On entry: D=type, B=1st char
      :                                   C = 2nd char of name,
      :                                   HL = current pos in input
      :                                   string

26F1  : ) or ,. Result in DE (integer) value

26F6  : subscript exp. HL = value of subscript
```

```
26FB 57        LD     D,A          --- And save in D
26FC 7E        LD     A,(HL)       --- Get terminal symbol
26FD FE2C      CP     2CH          --- Go evaluate next index if terminal symbol was a
26FF 28EE      JR     Z,26EFH      --- comma, else
2701 CF        RST    08H          --- Test next char in input stream for ','
2702 29        ADD    HL,HL        --- 2702: DC 29 ','
2703 22F340    LD     (40F3H),HL   --- 40F3 = addr of terminal symbol for subscript exp
2706 E1        POP    HL           --- HL = (40AE) before subscript evaluation. Create
2707 22AE40    LD     (40AEH),HL   --- and save for later use.            :locate flag.
270A D5        PUSH   DE           --- DE = number of subscripts evaluated
270B 2AFB40    LD     HL,(40FBH)   --- Start of arrays pointer
270E 3E19      LD     A,19H        <-------: 270F: ADD HL,DE Compute end        cont-->
2710 EB        EX     DE,HL         •      : DE = addr of next array          :research
2711 2AFD40    LD     HL,(40FDH)    •      : Load free memory ptr - upper limit for
2714 EB        EX     DE,HL         •      : HL = arrays ptr. DE = free memory ptr
2715 DF        RST    18H           •      : Compare free mem ptr to array ptr
2716 3AAF40    LD     A,(40AFH)     •      : Data type/length flag
2719 2827      JR     Z,2742H      ----->: : Jmp if name not found & all arrays tested
271B BE        CP     (HL)          •    : : Compare data type of an arrays entry with
271C 23        INC    HL            •    : : the type we're looking for
271D 2008      JR     NZ,2727H     --->: : : Types don't match. Skip to next array
271F 7E        LD     A,(HL)        •  : : : Data types match. Now look for a match on
2720 B9        CP     C             •  : : : the 2nd character of the name.
2721 23        INC    HL            •  : : : 2nd char doesn't match. Skip to next array
2722 2004      JR     NZ,2728H      •  : : : No match, skip to next entry
2724 7E        LD     A,(HL)        •  : : : 2nd char matches.
2725 B8        CP     B             •  : : : Test 1st char. Leave Z flag set if a match
2726 3E23      LD     A,23H         •  : : : 2727: INC HL
2728 23        INC    HL            •  : : : Bump to next byte in array entry
2729 5E        LD     E,(HL)        •  : : : E = LSB of offset to next array
272A 23        INC    HL            •  : : : Bump to next byte of array entry
272B 56        LD     D,(HL)        •  : : : DE = offset to next array
272C 23        INC    HL            •  : : : Bump to number of indexes entry
272D 20E0      JR     NZ,270FH     ------:>: Named array not found, examine next entry
272F 3AAE40    LD     A,(40AEH)    ---   : 1st char matches. We have found the addr of
2732 B7        OR     A            ---   : the variable in the arrays list. Are we in a
2733 1E12      LD     E,12H        ---   : create mode?
2735 C2A219    JP     NZ,19A2H     ---   : Yes, then error. Symbol is doubly defined
2738 F1        POP    AF           ---   : A = number of subscripts evaluated
2739 96        SUB    (HL)         ---   : Compared to no. specified in DIM statement
273A CA9527    JP     Z,2795H      ---   : Jmp if no. of indexes match
273D 1E10      LD     E,10H        ---   : BS error code
273F C3A219    JP     19A2H        ---   : Output BS error message
2742 77        LD     (HL),A       <-----: Save type. Build a subscripted variable entry
2743 23        INC    HL           --- Bump to 1st char of name (2nd actually,    cont-->
2744 5F        LD     E,A          --- DE = 00/number of bytes per entry
2745 1600      LD     D,00H        --- D = 00
2747 F1        POP    AF           --- A = number of indexes
2748 71        LD     (HL),C       --- Save 2nd char of name
2749 23        INC    HL           --- Bump to pos for 2nd char of name
274A 70        LD     (HL),B       --- Save 1st char of name
274B 23        INC    HL           --- Bump to LSB of offset to next entry
274C 4F        LD     C,A          --- C = number of indexes
274D CD6319    CALL   1963H        --- Compute amt of space left between HL & free mem.
2750 23        INC    HL           --- Skip over offset entry
2751 23        INC    HL           --- HL = pos for number of indexes in entry
2752 22D840    LD     (40D8H),HL   --- 40D8 = addr of max number of indices
2755 71        LD     (HL),C       --- Save number of indexes for this array (1,2,or 3)
2756 23        INC    HL           --- HL points to first subscript entry in array table
2757 3AAE40    LD     A,(40AEH)    --- A = create/locate flag
```

270E : of arrays. Search array for named variable

2743 : because they are stored in last/first order)

```
275A 17        RLA                    --- Set carry flag = 0 - locate, 1 - create
275B 79        LD      A,C            --- no. of indexes for this array
275C 010B00    LD      BC,000BH       <---: Default index = 10+1 if name not        cont-->
275F 3002      JR      NC,2763H       -->:: Jmp if creating because unable to locate
2761 C1        POP     BC              • :: Else we are in create mode. Get user
2762 03        INC     BC              • :: specified index. Add one
2763 71        LD      (HL),C         <--:: and save
2764 23        INC     HL              • :: in the array
2765 70        LD      (HL),B          • :: table
2766 23        INC     HL              • :: Bump to next set of indices
2767 F5        PUSH    AF              • :: Save create/locate flag
2768 CDAA0B    CALL    0BAAH           • :: Multiply size of index times bytes per entry.
276B F1        POP     AF              • :: Accumulate product in DE. When done  cont-->
276C 3D        DEC     A               • :: Decrement no. of indexes multiplied
276D 20ED      JR      NZ,275CH       --->: Jmp if more indexes
276F F5        PUSH    AF             --- Save create/locate flag
2770 42        LD      B,D            --- B = MSB of array length
2771 4B        LD      C,E            --- BC = length of array in bytes
2772 EB        EX      DE,HL          --- DE = start of array - current addr in array table
2773 19        ADD     HL,DE          --- HL = end of array
2774 38C7      JR      C,273DH        --- Error, overflowed 2**16
2776 CD6C19    CALL    196CH          --- Test amt of free space, rtn if enough
2779 22FD40    LD      (40FDH),HL     --- 40FD = LWA of array
277C 2B        DEC     HL             <---: Zero array starting at
277D 3600      LD      (HL),00H        •   :end and working towards start
277F DF        RST     18H             •   :Are we at start
2780 20FA      JR      NZ,277CH       --->: No, loop
2782 03        INC     BC             --- BC = no. of bytes in array + 1
2783 57        LD      D,A            --- D = 0
2784 2AD840    LD      HL,(40D8H)     --- HL = addr of no. of indices
2787 5E        LD      E,(HL)         --- DE = max. no. of indexes
2788 EB        EX      DE,HL          --- DE = addr of no. of indices. HL=max no. of indexes
2789 29        ADD     HL,HL          --- HL = 2 * no. of indexes
278A 09        ADD     HL,BC          --- HL = 2 * no. of indexes + size of array
278B EB        EX      DE,HL          --- HL = no. of indexes addr
278C 2B        DEC     HL             --- Backspace two bytes to offset address
278D 2B        DEC     HL             --- 2nd backspace
278E 73        LD      (HL),E         --- Save offset to next
278F 23        INC     HL             --- entry in arrays
2790 72        LD      (HL),D         --- List
2791 23        INC     HL             --- HL = addr of no. of indexes entry
2792 F1        POP     AF             --- Restore create/locate flag
2793 3830      JR      C,27C5H        --- Jmp if in create mode
2795 47        LD      B,A            --- BC=0 for first pass thru loop ****** see note--> *
2796 4F        LD      C,A            --- C = 0
2797 7E        LD      A,(HL)         --- A = no. of indexes in array
2798 23        INC     HL             --- Bump HL to right index (max + 1)
2799 16E1      LD      D,0E1H         --- 279A: POP HL Word addr of next index limit
279B 5E        LD      E,(HL)         --- E = LSB of index limit
279C 23        INC     HL             --- Bump to pos of MSB
279D 56        LD      D,(HL)         --- D = MSB of index limit
279E 23        INC     HL             --- HL = addr of next index limit
279F E3        EX      (SP),HL        --- HL = callers index value. Stack=addr of next index
27A0 F5        PUSH    AF             --- Save number of indexes                       :limit
27A1 DF        RST     18H            --- Now, compare user subscript against limit for that
27A2 D23D27    JP      NC,273DH       --- Jmp if index greater than allowed            :index
27A5 CDAA0B    CALL    0BAAH          --- Multiply previous subscript times max allowed
27A8 19        ADD     HL,DE          --- Value for current subscript. Keep sum of products
27A9 F1        POP     AF             --- A = no. of indexes                           :in HL
27AA 3D        DEC     A              --- Count index just processed
```

```
275C  : explicitly dimensioned

276B  : DE = size of array in bytes

2795  * Continuation of array processing. Locate address of ********
      * subscripted variable then load its value. Column major
      * format.
```

```
27AB 44         LD     B,H          --- BC = previous subscript
27AC 4D         LD     C,L          --- C = LSB
27AD 20EB       JR     NZ,279AH     --- Jmp if more indexes to go
27AF 3AAF40     LD     A,(40AFH)    --- A = data type flag
27B2 44         LD     B,H          --- Now, prepare to multiply
27B3 4D         LD     C,L          --- index by size of each entry
27B4 29         ADD    HL,HL        --- Index * 2
27B5 D604       SUB    04H          --- Test data type
27B7 3804       JR     C,27BDH      --- Jump if integer or string
27B9 29         ADD    HL,HL        --- Neither, compute index * 4
27BA 2806       JR     Z,27C2H      --- Jmp if single precision
27BC 29         ADD    HL,HL        --- Index * 8, must be double precision
27BD B7         OR     A            --- Set parity status flags
27BE E2C227     JP     PO,27C2H     --- Jump if integer
27C1 09         ADD    HL,BC        --- Index * 3, string
27C2 C1         POP    BC           --- BC = starting addr of array
27C3 09         ADD    HL,BC        --- Add index to base
27C4 EB         EX     DE,HL        --- DE = address of subscripted variable
27C5 2AF340     LD     HL,(40F3H)   --- Restore code string position
27C8 C9         RET                 --- Rtn to caller
27C9 AF         XOR    A            --- Clear A, status flags ************ MEM routine ***
27CA E5         PUSH   HL           --- Save current position in pgm stmt
27CB 32AF40     LD     (40AFH),A    --- Set current data not string so FRE will    cont-->
27CE CDD427     CALL   27D4H        --- Call FRE routine - Rtn amt of free         cont-->
27D1 E1         POP    HL           --- Restore current pointer in pgm stmt
27D2 D7         RST    10H          --- Load next token into A
27D3 C9         RET                 --- Rtn to BASIC
27D4 2AFD40     LD     HL,(40FDH)   --- HL = start of free memory ******** FRE routine **
27D7 EB         EX     DE,HL        --- DE = start of free mem ptr
27D8 210000     LD     HL,0000H     --- clear HL so we can load CSP by adding it to HL
27DB 39         ADD    HL,SP        --- HL = current stack ptr
27DC E7         RST    20H          --- Test data type
27DD 200D       JR     NZ,27ECH     ---> Jump if called from MEM. Variable not a string
27DF CDDA29     CALL   29DAH        ---: Get addr of string into HL
27E2 CDE628     CALL   28E6H        ---: Go compute amt of space remaining    See note -->
27E5 2AA040     LD     HL,(40A0H)   ---: Load boundary addr for string area
27E8 EB         EX     DE,HL        ---: Move limit to DE
27E9 2AD640     LD     HL,(40D6H)   ---: HL = current string area pointer
27EC 7D         LD     A,L          <--: A = LSB of one addr
27ED 93         SUB    E            --- Minus LSB of other addr
27EE 6F         LD     L,A          --- Restore L
27EF 7C         LD     A,H          --- H = MSB of one addr
27F0 9A         SBC    A,D          --- Minus MSB of other addr
27F1 67         LD     H,A          --- Restore H. HL = diff in addr (HL-DE)
27F2 C3660C     JP     0C66H        --- Convert diff to single precision & return
27F5 3AA640     LD     A,(40A6H)    --- Load current cursor position     ** POS routine **
27F8 6F         LD     L,A          --- Save in L
27F9 AF         XOR    A            --- Zero A-reg, H-reg
27FA 67         LD     H,A          --- HL = cursor position (H = 00, L = Position)
27FB C39A0A     JP     0A9AH        --- Value in HL to 4121. Flag as integer. Rtn to BASIC
27FE CDA941     CALL   41A9H        --- DOS Exit (JP 5679) ***************** USR routine **
2801 D7         RST    10H          --- Get next character from input stream
2802 CD2C25     CALL   252CH        --- Evaluate the remainder of the statement.   cont-->
2805 E5         PUSH   HL           --- Save addr of next element in code string
2806 219008     LD     HL,0890H     --- This continuation addr clears the stack before
2809 E5         PUSH   HL           --- returning to the BASIC caller
280A 3AAF40     LD     A,(40AFH)    --- A = current data type
280D F5         PUSH   AF           --- Save on stack
280E FE03       CP     03H          --- Test for string
2810 CCDA29     CALL   Z,29DAH      --- If a string, get addr into HL
```

```
27C9  * **************************************************************

27CB  : will do simple compilation
27CE  : space as current value


27D4  * **************************************************************




27E2  * Remaining space = Current stack addr - start of free mem ptr
      *                   if variable not a string, or
      *                 = next available location in string area -
      *                   start of string area.
      *                   If variable is a string.




27F5  * **************************************************************



27FE  * **************************************************************

2802  : Get USR number
```

```
2813 F1         POP    AF            --- Restore type to A-reg
2814 EB         EX     DE,HL         --- DE = string addr
2815 2A8E40     LD     HL,(408EH)    --- (408E) contains entry pt to USR subroutine
2818 E9         JP     (HL)          --- Enter user assembly language subroutine
2819 E5         PUSH   HL            --- Called by LET to convert result of ***** cont--> *
281A E607       AND    07H           --- A = result type
281C 21A118     LD     HL,18A1H      --- Address of arithmetic conversion routines
281F 4F         LD     C,A           --- Setup BC = 00/type where
2820 0600       LD     B,00H         --- Type = 0(DP), 1(I), 2(string), 3(SP)
2822 09         ADD    HL,BC         --- Plus offset for result of arithmetic
2823 CD8625     CALL   2586H         --- Convert result to proper data type
2826 E1         POP    HL            --- Restore HL
2827 C9         RET                  --- Rtn
2828 E5         PUSH   HL            --- Save code string addr * Called from INPUT routine *
2829 2AA240     LD     HL,(40A2H)    --- HL = current line no. in binary
282C 23         INC    HL            --- Add 1 so a test for a DIRECT statement
282D 7C         LD     A,H           --- can be made. Line no. = FFFF
282E B5         OR     L             --- while in INPUT phase
282F E1         POP    HL            --- Restore code string pointer
2830 C0         RET    NZ            --- Exit if line no. not zero (not a DIRECT stmt)
2831 1E16       LD     E,16H         --- Else give an ID error
2833 C3A219     JP     19A2H         --- Print error and rtn to INPUT PHASE
2836 CDBD0F     CALL   0FBDH         --- Current value convert caller's ********* cont--> *
2839 CD6528     CALL   2865H         --- Build a literal string, pool entry       cont-->
283C CDDA29     CALL   29DAH         --- Get addr of current value into HL
283F 012B2A     LD     BC,2A2BH      --- Continuation addr in CHR$ routine to stack
2842 C5         PUSH   BC            --- Put addr on stack
2843 7E         LD     A,(HL)        --- A = length of string
2844 23         INC    HL            --- Bump to string address
2845 E5         PUSH   HL            --- HL = address of string pointer
2846 CDBF28     CALL   28BFH         --- Test remaining string area to make sure new string
2849 E1         POP    HL            --- will fit. Reload HL with string address
284A 4E         LD     C,(HL)        --- C = LSB of string addr.
284B 23         INC    HL            --- Bump to MSB                             :user value
284C 46         LD     B,(HL)        --- BC = address of string for ASCII equivalent of
284D CD5A28     CALL   285AH         --- Save length, address of string at 40D3
2850 E5         PUSH   HL            --- HL = 40D3
2851 6F         LD     L,A           --- L = length of string
2852 CDCE29     CALL   29CEH         --- Move string from BC (temp area) to DE (string data
2855 D1         POP    DE            --- DE = 40D3                                     :area)
2856 C9         RET                  --- Rtn to caller
2857 CDBF28     CALL   28BFH         --- Make sure there's room. Get addr of **** cont--> *
285A 21D340     LD     HL,40D3H      --- HL = addr of temp storage area
285D E5         PUSH   HL            --- Save 40D3 on stk so it can be restored
285E 77         LD     (HL),A        --- Save length of string
285F 23         INC    HL            --- Bump to position of LSB of addr
2860 73         LD     (HL),E        --- Save LSB of string addr
2861 23         INC    HL            --- Bump to position of MSB of addr
2862 72         LD     (HL),D        --- Save MSB of string addr
2863 E1         POP    HL            --- Restore starting addr of string control block
2864 C9         RET                  --- Rtn to caller
2865 2B         DEC    HL            --- Backspace input pointer to quote * Quote Routine *
2866 0622       LD     B,22H         --- B = ASCII value for quote (')
2868 50         LD     D,B           --- D = terminating search character
2869 E5         PUSH   HL            --- Save addr of starting quote
286A 0EFF       LD     C,0FFH        --- Initialize counter to -1
286C 23         INC    HL            --- Skip over quote
286D 7E         LD     A,(HL)        --- Get a character
286E 0C         INC    C             --- Bump count of characters processed
286F B7         OR     A             --- Set status flags
```

```
2819  * arithmetic routines to proper destination type **************

2828  * *************************************************************

2836  * parameter to ASCII ******************************************
2839  : for ASCII number. Save as current value

2857  * next string area in DE ***** Save A, DE at 40D3 - 40D5 ******

2865  * *************************************************************
```

```
2870 2806      JR     Z,2878H       --- Jmp if EOS
2872 BA        CP     D             --- Test for terminating char (usually quote)
2873 2803      JR     Z,2878H       --- Jmp if terminating character
2875 B8        CP     B             --- Test for second terminating character
2876 20F4      JR     NZ,286CH      --- Still not terminating character, loop till it is
2878 FE22      CP     22H           --- Was last character a quote ?
287A CC781D    CALL   Z,1D78H       --- If yes get following character
287D E3        EX     (SP),HL       --- Address of starting quote             see note-->
287E 23        INC    HL            --- Plus one gives address of first char
287F EB        EX     DE,HL         --- Starting addr of char string to DE
2880 79        LD     A,C           --- A = length of string
2881 CD5A28    CALL   285AH         --- Move length, addr of string to 40 D3
2884 11D340    LD     DE,40D3H      --- 40D3 = length, addr of the ********* see note--> *
2887 3ED5      LD     A,0D5H        --- string in the string data area
2889 2AB340    LD     HL,(40B3H)    --- HL = addr of next avail literal string entry
288C 222141    LD     (4121H),HL    --- Addr of current string val = current literal area
288F 3E03      LD     A,03H         --- Current value type = string         :string value
2891 32AF40    LD     (40AFH),A     --- Save in type flag byte
2894 CDD309    CALL   09D3H         --- Move length string area addr to current lit.
2897 11D640    LD     DE,40D6H      --- DE = end of literal are addr to current lit.
289A DF        RST    18H           --- Make sure we have not overrun lit. string
289B 22B340    LD     (40B3H),HL    --- pool area. Update addr of next aval lit. string
289E E1        POP    HL            --- Restore code string addr              :pool entry
289F 7E        LD     A,(HL)        --- A = next element of code string
28A0 C0        RET    NZ            --- Return if temp string area not overrun
28A1 1E1E      LD     E,1EH         --- ST error code
28A3 C3A219    JP     19A2H         --- Output ST error message
28A6 23        INC    HL            --- Message output routine **************************
28A7 CD6528    CALL   2865H         --- Build literal string pool entry
28AA CDDA29    CALL   29DAH         --- Get addr of current variable into HL
28AD CDC409    CALL   09C4H         --- Get length of string into D. Starting addr in BC
28B0 14        INC    D             --- for decrement
28B1 15        DEC    D             <---: Count 1 character printed
28B2 C8        RET    Z              •  : Exit if all characters printed
28B3 0A        LD     A,(BC)         •  : Character to be printed
28B4 CD2A03    CALL   032AH          •  : Output char to system output device
28B7 FE0D      CP     0DH            •  : Then test if it was a carriage return
28B9 CC0321    CALL   Z,2103H        •  : Exit if char was a carriage return
28BC 03        INC    BC             •  : Bump to next character
28BD 18F2      JR     28B1H         --->: Loop till CR, or D characters printed
28BF B7        OR     A             --- Compute amt of space remaining in string area ****
28C0 0EF1      LD     C,0F1H        --- 28C1H : POP AF
28C2 F5        PUSH   AF            --- Save length of string
28C3 2AA040    LD     HL,(40A0H)    --- Load starting addr of string area into HL
28C6 EB        EX     DE,HL         --- DE = addr of string area
28C7 2AD640    LD     HL,(40D6H)    --- Load ptr to next avail string loc into HL
28CA 2F        CPL                  --- Compute the negative of the length of the string
28CB 4F        LD     C,A           --- and save it in C
28CC 06FF      LD     B,0FFH        --- BC = - length of string
28CE 09        ADD    HL,BC         --- HL = new current string pointer
28CF 23        INC    HL            --- plus one
28D0 DF        RST    18H           --- Compare new string pointer against limit
28D1 3807      JR     C,28DAH       --->: OS error if CARRY                   see note-->
28D3 22D640    LD     (40D6H),HL    --  : Save new current string pointer
28D6 23        INC    HL            --  : Bump it by one
28D7 EB        EX     DE,HL         --  : DE = new current string pointer
28D8 F1        POP    AF            --  : A = length of string
28D9 C9        RET                  --  : Rtn to caller
28DA F1        POP    AF            <---: A = length of string, *************** cont--> *
28DB 1E1A      LD     E,1AH         --- OS error code
```

287D : Address of 1st non-blank char after quote to stack

2884 * Move length, address from 40113 to current literal string. ***
: Pool entry pointed to by 40113. Set current value to type
: string and point its addr to the current literal string
: (40D3)

2816 * ***

28BF * ***

28D1 : Insufficient room in string area

28DA * get status flags to find out if reorganization has **********
: been attempted

```
28DD CAA219    JP     Z,19A2H       --- Error if free space reorganized and still no room
28E0 BF        CP     A             --- Set status flags to zero and ret
28E1 F5        PUSH   AF            --- Save zero
28E2 01C128    LD     BC,28C1H      --- Continuation address to retry allocation
28E5 C5        PUSH   BC            --- To stack
28E6 2AB140    LD     HL,(40B1H)    --- HL = highest memory pointer
28E9 22D640    LD     (40D6H),HL    --- Reset current string pointer to end of memory
28EC 210000    LD     HL,0000H      --- Load a zero
28EF E5        PUSH   HL            --- And save it on stack
28F0 2AA040    LD     HL,(40A0H)    --- HL = boundary of string data area
28F3 E5        PUSH   HL            --- Save it on stack also
28F4 21B540    LD     HL,40B5H      --- HL = address of first entry in string pointer area
28F7 EB        EX     DE,HL         --- Save HL in DE
28F8 2AB340    LD     HL,(40B3H)    --- HL = addr of current entry in LSPT           :area
28FB EB        EX     DE,HL         --- DE = address of current entry in string pointer
28FC DF        RST    18H           --- Is 40 B3 pointing to the first entry (40B5)
28FD 01F728    LD     BC,28F7H      --- Continuation addr in case answer is no
2900 C24A29    JP     NZ,294AH      --- No, JMP to 294A, RTN to 28F7
2903 2AF940    LD     HL,(40F9H)    --- HL = simple variable pointer
2906 EB        EX     DE,HL         <------: Save it in DE
2907 2AFB40    LD     HL,(40FBH)        •  : HL = arrays pointer
290A EB        EX     DE,HL             •  : HL = variable list pointer. DE = arrays ptr
290B DF        RST    18H               •  : Compare their addresses. Are they equal
290C 2813      JR     Z,2921H       ->:----: Yes, simple variables have been scanned
290E 7E        LD     A,(HL)          : •  : Get type for first simple variable
290F 23        INC    HL              : •  : Bump to LSB by incrementing HL by 3
2910 23        INC    HL              : •  : So that type can be added to give addr of
2911 23        INC    HL              : •  : Addr of next variable
2912 FE03      CP     03H             : •  : Test if variable is a string
2914 2004      JR     NZ,291AH        : •  : Jmp if not a string
2916 CD4B29    CALL   294BH           : •  : For a string, get its addr into HL
2919 AF        XOR    A               : •  : Zero A because HL already points to next
291A 5F        LD     E,A             : •  : Bump to addr of                        :entry
291B 1600      LD     D,00H           : •  : Next variable
291D 19        ADD    HL,DE           : •  : Gives addr of next variable in list
291E 18E6      JR     2906H         --:--->: Loop till all simple variables examined
2920 C1        POP    BC            <-:------: Clear HL, push from below
2921 EB        EX     DE,HL         <-:    •  : DE = points to current array entry
2922 2AFD40    LD     HL,(40FDH)           •  : HL = addr of next avail mem loc.
2925 EB        EX     DE,HL                •  : DE = addr of first avail mem loc.
2926 DF        RST    18H                  •  : Have we scanned all arrays entries
2927 CA6B29    JP     Z,296BH              •  : Yes
292A 7E        LD     A,(HL)               •  : No, get type for this array
292B 23        INC    HL                   •  : Bump to 2nd char of name
292C CDC209    CALL   09C2H                •  : Load offset to next array into    cont --->
292F E5        PUSH   HL                   •  : Save addr of no. of indexes
2930 09        ADD    HL,BC                •  : Add offset to get next arrays entry
2931 FE03      CP     03H                  •  : Is current type a string?
2933 20EB      JR     NZ,2920H      -------->: No, loop keep looking
2935 22D840    LD     (40D8H),HL    --- Save addr of next array entry
2938 E1        POP    HL            --- HL = addr of no. of indexes
2939 4E        LD     C,(HL)        --- C = no. of indexes
293A 0600      LD     B,00H         --- Set B = 0. Then
293C 09        ADD    HL,BC         --- add 2 times no. of indexes to current
293D 09        ADD    HL,BC         --- addr to get end of index boundaries
293E 23        INC    HL            --- HL = addr of end of indexes for this variable
293F EB        EX     DE,HL         --- Move it to DE
2940 2AD840    LD     HL,(40D8H)    --- HL = addr of next variable
2943 EB        EX     DE,HL         --- HL = end of index boundaries, DE = addr of next
2944 DF        RST    18H           --- Test for empty list                     :variable
```

:BC. Skips over name

```
2945 28DA      JR     Z,2921H        --- Jmp if list empty
2947 013F29    LD     BC,293FH       --- Continuation addr for string array processing
294A C5        PUSH   BC             --- Save continuation addr on stack
294B AF        XOR    A              --- Clear all status flags
294C B6        OR     (HL)           --- A = length of string
294D 23        INC    HL             --- Bump to next two bytes to
294E 5E        LD     E,(HL)         --- get string address
294F 23        INC    HL             --- Bump to MSB of string addr
2950 56        LD     D,(HL)         --- DE = string address                         :addr)
2951 23        INC    HL             --- Bump to next entry in string pointer area (test
2952 C8        RET    Z              --- Exit if string length is zero
2953 44        LD     B,H            --- BC = addr of next string pointer
2954 4D        LD     C,L            --- Loaded from HL
2955 2AD640    LD     HL,(40D6H)     --- HL = current string area pointer
2958 DF        RST    18H            --- Is string in string data area?
2959 60        LD     H,B            --- Restore addr of next literal pool entry
295A 69        LD     L,C            --- to HL
295B D8        RET    C              --- Return if string in string area
295C E1        POP    HL             --- HL = return address
295D E3        EX     (SP),HL        --- HL = callers test address
295E DF        RST    18H            --- Compare callers test addr to string addr
295F E3        EX     (SP),HL        --- Restore stack to callers flag, rtn addr
2960 E5        PUSH   HL             --- Restore rtn addr to stack
2961 60        LD     H,B            --- HL = addr of next literal string pool entry
2962 69        LD     L,C            --- Loaded from BC
2963 D0        RET    NC             --- Exit if string addr below callers addr
2964 C1        POP    BC             --- BC = return address
2965 F1        POP    AF             --- Get rid of callers string addr
2966 F1        POP    AF             --- Callers flag
2967 E5        PUSH   HL             --- Save addr of next string area pointer
2968 D5        PUSH   DE             --- Save addr of current string
2969 C5        PUSH   BC             --- Return addr
296A C9        RET                   --- Rtn to caller
296B D1        POP    DE             --- DE = addr of last string moved to string area ****
296C E1        POP    HL             --- HL = addr of next string area pointer
296D 7D        LD     A,L            --- If HL = 0 then there were no strings in string
296E B4        OR     H              --- area which belonged to the literal         cont-->
296F C8        RET    Z              --- Exit if no temp strings in string area     cont-->
2970 2B        DEC    HL             --- Backspace addr to get pointers for literal pool
2971 46        LD     B,(HL)         --- B = LSB of addr for string                  :entry
2972 2B        DEC    HL             --- Skip backwards to next byte of addr
2973 4E        LD     C,(HL)         --- C = MSB of addr for string
2974 E5        PUSH   HL             --- Save addr of pointer in lit. string so we update
2975 2B        DEC    HL             --- Bump down to length                 : it after move
2976 6E        LD     L,(HL)         --- L = length of string
2977 2600      LD     H,00H          --- Zero H so we can do 16 bit arith
2979 09        ADD    HL,BC          --- BL = ending addr of string
297A 50        LD     D,B            --- DE = starting addr of string
297B 59        LD     E,C            --- Loaded from BC
297C 2B        DEC    HL             --- HL = ending addr -1
297D 44        LD     B,H            --- BC = ending addr -1
297E 4D        LD     C,L            --- Loaded from HL
297F 2AD640    LD     HL,(40D6H)     --- HL = current string data pointer
2982 CD5819    CALL   1958H          --- Move string to new area in string area table
2985 E1        POP    HL             --- HL = addr of literal string pointer
2986 71        LD     (HL),C         --- Now, move address of string in string area to
2987 23        INC    HL             --- 2nd and Ad bytes of literal pool entry
2988 70        LD     (HL),B         --- Save 1st character of name
2989 69        LD     L,C            --- Then setup HL so it points to the start of the
298A 60        LD     H,B            --- last string moved to the string area
```

```
296B  * **************************************************************


296E  : string pool (temporary)
296F  : String area reorganized
```

```
298B 2B         DEC    HL           --- And loop until no more literal pool entries are
298C C3E928     JP     28E9H        --- found which must be moved to the string area.
298F C5         PUSH   BC           --- String addition. Concatenate two strings * note-->
2990 E5         PUSH   HL           --- Save PV last operand/ last token, and code string
2991 2A2141     LD     HL,(4121H)   --- Stack = addr of string 1, HL = current pos. :addr
2994 E3         EX     (SP),HL      --- in input string
2995 CD9F24     CALL   249FH        --- Locate next variable
2998 E3         EX     (SP),HL      --- HL = 4121, Stack = code string addr
2999 CDF40A     CALL   0AF4H        --- Make sure it's a string
299C 7E         LD     A,(HL)       --- A = length of string 1
299D E5         PUSH   HL           --- Save addr of string 1
299E 2A2141     LD     HL,(4121H)   --- HL = addr of string 2
29A1 E5         PUSH   HL           --- Addr of string 2 to stack
29A2 86         ADD    A,(HL)       --- A = length string 1 + string 2
29A3 1E1C       LD     E,1CH        --- output if carry
29A5 DAA219     JP     C,19A2H      --- Jmp if combined string length exceeds 256
29A8 CD5728     CALL   2857H        --- Make sure there's enough room for both strings
29AB D1         POP    DE           --- DE = addr of string 2
29AC CDDE29     CALL   29DEH        --- Update string area for string 2 if necessary
29AF E3         EX     (SP),HL      --- HL = addr of string 1
29B0 CDDD29     CALL   29DDH        --- Update string area for string 1 if necessary
29B3 E5         PUSH   HL           --- Save addr of string 1
29B4 2AD440     LD     HL,(40D4H)   --- Get addr of string 2
29B7 EB         EX     DE,HL        --- DE = address of second string
29B8 CDC629     CALL   29C6H        --- Move string 1 from stack to string work area
29BB CDC629     CALL   29C6H        --- Move string 2
29BE 214923     LD     HL,2349H     --- Continuation addr in expression evaluation
29C1 E3         EX     (SP),HL      --- to stack. Code string addr to HL
29C2 E5         PUSH   HL           --- Save code string addr                    :table
29C3 C38428     JP     2884H        --- Save string 1 + string 2 as entry in literal pool
29C6 E1         POP    HL           --- HL = rtn addr, stack = string addr ***** cont--> *
29C7 E3         EX     (SP),HL      --- Stack = rtn addr, HL = string addr
29C8 7E         LD     A,(HL)       --- A = count of characters to move
29C9 23         INC    HL           --- Bump to LSB of addr
29CA 4E         LD     C,(HL)       --- C = LSB of addr
29CB 23         INC    HL           --- Bump to MSB of addr
29CC 46         LD     B,(HL)       --- BC = addr
29CD 6F         LD     L,A          --- L = no. of bytes to move
29CE 2C         INC    L            --- Do INC/DEC to set status flags
29CF 2D         DEC    L            --- Decrement count of characters moved
29D0 C8         RET    Z            --- Exit if all character moved           see note-->
29D1 0A         LD     A,(BC)       --- Fetch a char
29D2 12         LD     (DE),A       --- Store a char
29D3 03         INC    BC           --- Bump source addr
29D4 13         INC    DE           --- Bump destination addr
29D5 18F8       JR     29CFH        --- Loop
29D7 CDF40A     CALL   0AF4H        --- Continuation of VAL, FRE, and PRINT **** cont--> *
29DA 2A2141     LD     HL,(4121H)   --- HL = addr of current string
29DD EB         EX     DE,HL        --- Move addr to DE
29DE CDF529     CALL   29F5H        --- Test : is current variable also
29E1 EB         EX     DE,HL        --- the last lit. string pool entry
29E2 C0         RET    NZ           --- No, exit w/DE = current variable addr
29E3 D5         PUSH   DE           --- Yes, current variable was last literal
29E4 50         LD     D,B          --- string defined
29E5 59         LD     E,C          --- Move string addr to DE
29E6 1B         DEC    DE           --- and save on stack
29E7 4E         LD     C,(HL)       --- C = count of characters in current string
29E8 2AD640     LD     HL,(40D6H)   --- HL = current string pointer
29EB DF         RST    18H          --- Is current string=last one defined in string area
29EC 2005       JR     NZ,29F3H     --- No, exit
```

```
298E  * Called by expression evaluation ****************************
```

```
29C6  * Move using stack routine    On entry stack = count/source ****
      : address, DE = destination address.
```

```
29D0  : Move L characters from (BC) to (DE)
```

```
29D7  * processing. Test current value to make sure it's string. ***
      : Error if number
```

```
29EE 47       LD     B,A          --- Yes , update current string pointer
29EF 09       ADD    HL,BC        --- HL = addr of string + length = new string ptr addr
29F0 22D640   LD     (40D6H),HL   --- Save new string ptr addr
29F3 E1       POP    HL           --- HL = addr of current string
29F4 C9       RET                 --- Rtn to caller
29F5 2AB340   LD     HL,(40B3H)   --- HL = addr of next avail string location **********
29F8 2B       DEC    HL           --- Now, backup two words and load
29F9 46       LD     B,(HL)       --- addr of previous string into BC.
29FA 2B       DEC    HL           --- Then, compare the address of that entry
29FB 4E       LD     C,(HL)       --- against the address of the current
29FC 2B       DEC    HL           --- variable (or whatever's in DE). If unequal
29FD DF       RST    18H          --- exit, else reset the pointer (40 B3) to
29FE C0       RET    NZ           --- point to the current (last) entry
29FF 22B340   LD     (40B3H),HL   --- Update pointer to current entry in LSPT
2A02 C9       RET                 --- Rtn to caller
2A03 01F827   LD     BC,27F8H     --- Continuation addr of POS to stk *** LEN routine **
2A06 C5       PUSH   BC           --- 27F8 to stack
2A07 CDD729   CALL   29D7H        --- Get addr of current string pointer into HL
2A0A AF       XOR    A            --- Clear status, zero A
2A0B 57       LD     D,A          --- and D
2A0C 7E       LD     A,(HL)       --- A = length of string from string pointer area
2A0D B7       OR     A            --- Set status flags for length
2A0E C9       RET                 --- Continue at POS unless entered at 2A07
2A0F 01F827   LD     BC,27F8H     --- Continuation addr of 27F8 to stk **8 ASC routine **
2A12 C5       PUSH   BC           --- Saves value in HL as current value
2A13 CD072A   CALL   2A07H        --- Get addr of current string pointer into HL. Length
2A16 CA4A1E   JP     Z,1E4AH      --- Error of length of string = 0              :into A
2A19 23       INC    HL           --- Now, load addr of string into DE
2A1A 5E       LD     E,(HL)       --- E = LSB of string addr
2A1B 23       INC    HL           --- Bump to MSB
2A1C 56       LD     D,(HL)       --- D = MSB of string addr
2A1D 1A       LD     A,(DE)       --- A = first character of string
2A1E C9       RET                 --- Rtn to caller
2A1F 3E01     LD     A,01H        --- A=length of string to be created ** CHR$ routine *
2A21 CD5728   CALL   2857H        --- Save length and value of char at 40 D3
2A24 CD1F2B   CALL   2B1FH        --- Convert value to integer. Save in DE
2A27 2AD440   LD     HL,(40D4H)   --- HL = address of temporary string
2A2A 73       LD     (HL),E       --- Save value in string area
2A2B C1       POP    BC           --- Clear stack                          :interpreter
2A2C C38428   JP     2884H        --- Move string from literal pool to string. Rtn to
2A2F D7       RST    10H          --- STRING$ routine *********************************
2A30 CF       RST    08H          --- Test next char for '('
2A31 28CD     JR     Z,2A00H      --- 2A31: DC 28 '('
2A33 1C       INC    E            --- 2A32: CALL 2B1C evaluate expression - get N
2A34 2B       DEC    HL           --- Backspace code string
2A35 D5       PUSH   DE           --- Save integer value for N
2A36 CF       RST    08H          --- Test next char for comma
2A37 2C       INC    L            --- 2A37: DC 2C comma
2A38 CD3723   CALL   2337H        --- Evaluate expression, get value of char
2A3B CF       RST    08H          --- Test next char for ')'
2A3C 29       ADD    HL,HL        --- 2A3C: DC 29 ')'
2A3D E3       EX     (SP),HL      --- HL = integer value for N/stack = next code string
2A3E E5       PUSH   HL           --- Followed by N                                :addr
2A3F E7       RST    20H          --- Test current value data type
2A40 2805     JR     Z,2A47H      --->: Jump if string
2A42 CD1F2B   CALL   2B1FH        --  : Convert to integer. Leave in DE, WRA1
2A45 1803     JR     2A4AH        --  : Skip loading of string addr & 1st character
2A47 CD132A   CALL   2A13H        <---: A = character to be repeated
2A4A D1       POP    DE           --- DE = value of N from STRING$ (N,'X') call
2A4B F5       PUSH   AF           --- Save character
```

29F5 * ***

2A03 * ***

2A0F * ***

2A1F * ***

2A2F * ***

```
2A4C F5        PUSH   AF            --- Save two copies of the character
2A4D 7B        LD     A,E           --- A = number of repetition
2A4E CD5728    CALL   2857H         --- Allocate N bytes in string area.          cont-->
2A51 5F        LD     E,A           --- E = number of repetition
2A52 F1        POP    AF            --- A = character to be repeated
2A53 1C        INC    E             --- Set status flags
2A54 1D        DEC    E             --- So we can test for zero
2A55 28D4      JR     Z,2A2BH       --- If zero repetition, exit
2A57 2AD440    LD     HL,(40D4H)    --- HL = addr allocated in string area
2A5A 77        LD     (HL),A        <---: Move char
2A5B 23        INC    HL             •  : Bump string addr
2A5C 1D        DEC    E              •  : Count repetition
2A5D 20FB      JR     NZ,2A5AH      --->: Loop till 'N' copies moved
2A5F 18CA      JR     2A2BH         --- Rtn to caller
2A61 CDDF2A    CALL   2ADFH         --- Test for closing ')' ** LEFT$ routine ** cont--> *
2A64 AF        XOR    A             --- Clear A, status flags
2A65 E3        EX     (SP),HL       --- HL = addr of n. Stack = current code string addr
2A66 4F        LD     C,A           --- Zero to C
2A67 3EE5      LD     A,0E5H        --- 2A68: LD H,A
2A69 E5        PUSH   HL            --- Save addr of string
2A6A 7E        LD     A,(HL)        --- Get length of string
2A6B B8        CP     B             --- Compare with number of bytes to return
2A6C 3802      JR     C,2A70H       --- Jmp if byte request exceeds size of string
2A6E 78        LD     A,B           --- Save no. of bytes to return
2A6F 110E00    LD     DE,000EH      --- 2A70: LD C,00
2A72 C5        PUSH   BC            --- Save length of string to return
2A73 CDBF28    CALL   28BFH         --- Make sure there's room for new string.    cont-->
2A76 C1        POP    BC            --- BC = length of string to be returned
2A77 E1        POP    HL            --- HL = string addr
2A78 E5        PUSH   HL            --- Save string addr on stack
2A79 23        INC    HL            --- Skip over character count
2A7A 46        LD     B,(HL)        --- B = LSB of string addr
2A7B 23        INC    HL            --- Skip to MSB
2A7C 66        LD     H,(HL)        --- H = MSB of string addr
2A7D 68        LD     L,B           --- HL = addr of string
2A7E 0600      LD     B,00H         --- BC = 00/length of string desired
2A80 09        ADD    HL,BC         --- HL = ending addr of last char to be moved
2A81 44        LD     B,H           --- Now, move ending
2A82 4D        LD     C,L           --- Addr into BC
2A83 CD5A28    CALL   285AH         --- Save length (A) and starting addr (DE)    cont-->
2A86 6F        LD     L,A           --- L = number of chars to move
2A87 CDCE29    CALL   29CEH         --- Move (L) chars. from (BC) to (DE)
2A8A D1        POP    DE            --- Clear stack
2A8B CDDE29    CALL   29DEH         --- Get addr of literal pool string into 40D3
2A8E C38428    JP     2884H         --- Go move string to string area. Ret to interpreter
2A91 CDDF2A    CALL   2ADFH         --- Setup registers **************** RIGHT$ routine **
2A94 D1        POP    DE            --- Load string address
2A95 D5        PUSH   DE            --- And restore it to stack
2A96 1A        LD     A,(DE)        --- A = number of characters in string
2A97 90        SUB    B             --- Subtract no. of bytes to isolate
2A98 18CB      JR     2A65H         --- Use LEFT$ code
2A9A EB        EX     DE,HL         --- HL = code string addr ************ MID$ routine **
2A9B 7E        LD     A,(HL)        --- A = terminal character
2A9C CDE22A    CALL   2AE2H         --- BC = position DE = string address
2A9F 04        INC    B             --- Set status flags to
2AA0 05        DEC    B             --- correspond to position value
2AA1 CA4A1E    JP     Z,1E4AH       --- Error if starting position is zero
2AA4 C5        PUSH   BC            --- Save starting position
2AA5 1EFF      LD     E,0FFH        --- E = 256 in case number of bytes not given
2AA7 FE29      CP     29H           --- Test for right paren following P
```

```
2A4E  : Save address of allocated area at 40D4 - 40D5




2A61  * Setup registers ***** On entry    HL = address of LEFT$ *****
      :                                   stack = string address
      :                                   stack + 1 = n
      :                                   DE = code string addr




2A73  : Get addr of next string area in DE




2A83  : next avail loc in lit pool



2A91  * *************************************************************



2A9A  * *************************************************************
```

```
2AA9 2805      JR     Z,2AB0H       --->: Jmp if no byte count given, else
2AAB CF        RST    08H           --  : Test next input value for comma
2AAC 2C        INC    L             --  : 2AAC: DC 2C comma
2AAD CD1C2B    CALL   2B1CH         --  : Evaluate expression. Get byte count as integer
2AB0 CF        RST    08H           <---: Test next char for ')'                   :into DE
2AB1 29        ADD    HL,HL         --- 2AB1: DC 28 ')'
2AB2 F1        POP    AF            --- A = starting position
2AB3 E3        EX     (SP),HL       --- HL = string addr. Stack = current code string addr
2AB4 01692A    LD     BC,2A69H      --- Continuation of MID$ processing in LEFT$
2AB7 C5        PUSH   BC            --- Address to stack
2AB8 3D        DEC    A             --- Starting position minus one
2AB9 BE        CP     (HL)          --- Compare starting position with length of string
2ABA 0600      LD     B,00H         --- B = 00
2ABC D0        RET    NC            --- Continue at 2A69 if starting position-1 > length of
2ABD 4F        LD     C,A           --- C = starting position -1                   :string
2ABE 7E        LD     A,(HL)        --- A = length of string
2ABF 91        SUB    C             --- C = no. of chars between P and end of string
2AC0 BB        CP     E             --- Compare with number of characters to return
2AC1 47        LD     B,A           --- B = no. of characters to return
2AC2 D8        RET    C             --- Continue at 2A69 if more characters        cont-->
2AC3 43        LD     B,E           --- Else, return number of characters requested
2AC4 C9        RET                  --- Continue at 2A69
2AC5 CD072A    CALL   2A07H         --- Get length into A-reg *************** VAL routine *
2AC8 CAF827    JP     Z,27F8H       --- Address of string pointer block in HL
2ACB 5F        LD     E,A           --- Exit if length = 0. Move length to E, D = 0
2ACC 23        INC    HL            --- Skip over length
2ACD 7E        LD     A,(HL)        --- A = LSB of string addr
2ACE 23        INC    HL            --- Bump to MSB of addr
2ACF 66        LD     H,(HL)        --- H = MSB of string addr
2AD0 6F        LD     L,A           --- Now, HL = string addr
2AD1 E5        PUSH   HL            --- Save string addr then add length which
2AD2 19        ADD    HL,DE         --- gives HL = ending addr
2AD3 46        LD     B,(HL)        --- Save last char of string
2AD4 72        LD     (HL),D        --- Replace it with a zero
2AD5 E3        EX     (SP),HL       --- Stack=ending addr of string. HL=starting addr of
2AD6 C5        PUSH   BC            --- Save replaced char of string               :string
2AD7 7E        LD     A,(HL)        --- A = 1st char of string
2AD8 CD650E    CALL   0E65H         --- Convert numerics at start of string from ASCII to
2ADB C1        POP    BC            --- B = replaced character                     :binary
2ADC E1        POP    HL            --- HL = ending addr of string
2ADD 70        LD     (HL),B        --- Restore replaced char
2ADE C9        RET                  --- Rtn to BASIC
2ADF EB        EX     DE,HL         --- DE = addr of calling routine *********** cont--> *
2AE0 CF        RST    08H           --- Look for right paren following parameters
2AE1 29        ADD    HL,HL         --- DC  28 ')'
2AE2 C1        POP    BC            --- Return address
2AE3 D1        POP    DE            --- DE = count of bytes to isolate
2AE4 C5        PUSH   BC            --- Restore return addr
2AE5 43        LD     B,E           --- B = byte count
2AE6 C9        RET                  --- HL = code string addr
2AE7 FE7A      CP     7AH           --- Test if token in range **************************
2AE9 C29719    JP     NZ,1997H      --- SN error if NZ. Error if token => FA
2AEC C3D941    JP     41D9H         --- Disk BASIC Exit. Let Disk BASIC handle TAB-MID$
2AEF CD1F2B    CALL   2B1FH         --- Get port no. into A-reg ********* INP routine ****
2AF2 329440    LD     (4094H),A     --- Save port number
2AF5 CD9340    CALL   4093H         --- Go execute IN XX instr. Rtn to execution driver
2AF8 C3F827    JP     27F8H         --- Evaluate expression . ** OUT routine ** cont--> *
2AFB CD0E2B    CALL   2B0EH         --- Value to A-reg.
2AFE C39640    JP     4096H         --- Go execute OUT XX instr. Rtn to execution driver
2B01 D7        RST    10H           --- Position to next char in input stream ** cont--> *
```

```
2AC2  : requested than string has in it

2AC5  * *************************************************************

2AE7  * HL = code string addr ****  Called by LEFTS, MID$, & RIGHT$ **
                                 to test for ending ')'.
                                       Entry              Exit
                                 Stk=string addr      string addr
                                      byte count      DE=byte count
                                      ret addr        B=byte count

2AEF  * ****************************************************************

2AEF  : ****************************************************************

2AFB  * Port no. to 4094, 4097 ***************************************

2B01  * Evaluate an expression . Leave result as integer in DE *******
```

```
2B02 CD3723    CALL   2337H       --- Evaluate expression. Result to WRA1
2B05 E5        PUSH   HL          --- Next code string addr
2B06 CD7F0A    CALL   0A7FH       --- Convert result to integer. Put it in HL
2B09 EB        EX     DE,HL       --- DE = result (in integer form)
2B0A E1        POP    HL          --- Restore position in input stream
2B0B 7A        LD     A,D         --- MSB of result to A
2B0C B7        OR     A           --- Rtn to caller
2B0D C9        RET                --- Ret sign/zero flags for result
2B0E CD1C2B    CALL   2B1CH       --- Evaluate expression. Get port no. ****** cont--> *
2B11 329440    LD     (4094H),A   --- Save port no. in DOS addresses
2B14 329740    LD     (4097H),A   --- 4094 and 4097
2B17 CF        RST    08H         --- Test following char for single quote
2B18 2C        INC    L           --- 2B18: DC 2C  single quote
2B19 1801      JR     2B1CH       --->: Skip over PRINT TAB entry point
2B1B D7        RST    10H         --- : Examine next char (called by PRINT TAB)
2B1C CD3723    CALL   2337H       <---: Evaluate expression. Get value
2B1F CD052B    CALL   2B05H       --- Convert result of exp to integer, load     cont-->
2B22 C24A1E    JP     NZ,1E4AH    --- FC error value > 255
2B25 2B        DEC    HL          --- Backspace input string
2B26 D7        RST    10H         --- Get next char from input string (bump HL & ret
2B27 7B        LD     A,E         --- LSB of result to A                          :flags)
2B28 C9        RET                --- Rtn to caller
2B29 3E01      LD     A,01H       --- Device type for printer ********** LLIST routine **
2B2B 329C40    LD     (409CH),A   --- Set current output device to printer
2B2E C1        POP    BC          --- Remove rtn addr from stack ******** LIST routine **
2B2F CD101B    CALL   1B10H       --- Get range of line nos. list on exit        cont-->
2B32 C5        PUSH   BC          --- Save start line ptr
2B33 21FFFF    LD     HL,0FFFFH   --- Set current line number to -1
2B36 22A240    LD     (40A2H),HL  --- Save in current line number location
2B39 E1        POP    HL          --- HL = addr of first line to be listed
2B3A D1        POP    DE          --- DE = addr of last line to be listed
2B3B 4E        LD     C,(HL)      --- Now, get the pointer the next line
2B3C 23        INC    HL          --- C holds LSB of pointer to next line
2B3D 46        LD     B,(HL)      --- B = MSB of pointer to next line
2B3E 23        INC    HL          --- HL=addr of first byte for current line (line no.)
2B3F 78        LD     A,B         --- If the pointer to the next line            cont-->
2B40 B1        OR     C           --- Check for end of pgm
2B41 CA191A    JP     Z,1A19H     --- Return to READY routine if end
2B44 CDDF41    CALL   41DFH       --- DOS Exit (JP 579C)
2B47 CD9B1D    CALL   1D9BH       --- Test keyboard input. Pause if              cont-->
2B4A C5        PUSH   BC          --- Save addr of next line to be printed
2B4B 4E        LD     C,(HL)      --- Get LSB of line number for current line
2B4C 23        INC    HL          --- Bump to next byte of line number
2B4D 46        LD     B,(HL)      --- Load MSB of current line number
2B4E 23        INC    HL          --- HL = first byte of pgm statement for current line
2B4F C5        PUSH   BC          --- Save line no.(in binary) for current line on stack
2B50 E3        EX     (SP),HL     --- Rearrange : stack=addr of 1st byte of pgm  cont-->
2B51 EB        EX     DE,HL       --- DE = addr of current line, HL = addr of last line
2B52 DF        RST    18H         --- Test to see if all lines listed           :to list
2B53 C1        POP    BC          --- BC = addr of 1st byte of current line
2B54 DA181A    JP     C,1A18H     --- Rtn to Input Phase if all lines listed
2B57 E3        EX     (SP),HL     --- HL = addr of last line to be printed       cont-->
2B58 E5        PUSH   HL          --- Save addr of current line
2B59 C5        PUSH   BC          --- Save line no. (binary) for current line
2B5A EB        EX     DE,HL       --- HL = addr of current line
2B5B 22EC40    LD     (40ECH),HL  --- Save in loc. for line number with error
2B5E CDAF0F    CALL   0FAFH       --- Output a line # in ASCII
2B61 3E20      LD     A,20H       --- A = ASCII blank
2B63 E1        POP    HL          --- HL = addr of current line
2B64 CD2A03    CALL   032AH       --- And a blank
```

```
2B0E  * Continuation of OUT routine *********************************

2B1F  : it into DE. Set A = MSB

2B29  * ************************************************************
***********************************************************
2B2F  : BC = addr of first line. Stack = addr of last line

2B3F  : is zero, then the end of the pgm has been found

2B47  : shift @ hit, rtn when any release key hit

2B50  : HL = binary line no.

2B57  : Stack = line no. of current line
```

```
2B67 CD7E2B    CALL   2B7EH        --- Move current line to work area(40A7) and expand it
2B6A 2AA740    LD     HL,(40A7H)   --- HL = addr of expanded line
2B6D CD752B    CALL   2B75H        --- Buffer to screen (print current line)
2B70 CDFE20    CALL   20FEH        --- Terminate line w/carriage ret line feed
2B73 18BE      JR     2B33H        --- Loop till all lines printed
2B75 7E        LD     A,(HL)       --- Output area pointed to by HL ********************
2B76 B7        OR     A            --- Fetch next character to print
2B77 C8        RET    Z            --- Exit if end of message
2B78 CD2A03    CALL   032AH        --- Print (HL)
2B7B 23        INC    HL           --- Bump to next char
2B7C 18F7      JR     2B75H        --- Keep printing till (HL) = 0
2B7E E5        PUSH   HL           --- Save addr of line to be moved ****** see note--> *
2B7F 2AA740    LD     HL,(40A7H)   --- HL = addr of input buffer. Move it
2B82 44        LD     B,H          --- to BC where it will be used as
2B83 4D        LD     C,L          --- an output buffer for expanded line
2B84 E1        POP    HL           --- Restore addr of line to be moved/expanded
2B85 16FF      LD     D,0FFH       --- D = max. no. chars in a line
2B87 1803      JR     2B8CH        --- Jmp into middle of move/expand code
2B89 03        INC    BC           <---: Bump to next loc. in print/work buffer
2B8A 15        DEC    D             •  : Count of chars moved
2B8B C8        RET    Z             •  : Exit if 256 chars moved
2B8C 7E        LD     A,(HL)       <---:-: Get a char from program table (PST)
2B8D B7        OR     A             •  : : Set status flags so we can test for EOS or
2B8E 23        INC    HL            •  : : Bump to next char in code string :token
2B8F 02        LD     (BC),A        •  : : Save last char in print/work buffer area
2B90 C8        RET    Z             •  : : Exit if EOS (end of statement)
2B91 F2892B    JP     P,2B89H      --->: : Jmp if char is not a token            cont-->
2B94 FEFB      CP     0FBH          •    :Test for quote token
2B96 2008      JR     NZ,2BA0H     --->: : Not a quote token, go search RW list for
2B98 0B        DEC    BC            •  : : full syntax for this token
2B99 0B        DEC    BC            •  : : We have a quote token
2B9A 0B        DEC    BC            •  : : Backspace expanded buffer ptr
2B9B 0B        DEC    BC            •  : : by 4
2B9C 14        INC    D             •  : : Then adjust
2B9D 14        INC    D             •  : : count of characters
2B9E 14        INC    D             •  : : in buffer
2B9F 14        INC    D             •  : : by four
2BA0 FE95      CP     95H          <---: : Test for ELSE token
2BA2 CC240B    CALL   Z,0B24H       •    : Backspace expanded buffer ptr if ELSE
2BA5 D67F      SUB    7FH           •    : A = the number of the entry           cont-->
2BA7 E5        PUSH   HL            •    : Save current code string addr
2BA8 5F        LD     E,A           •    : B = number of entries to skip
2BA9 215016    LD     HL,1650H      •    : HL = reserved word table ptr
2BAC 7E        LD     A,(HL)       <---: : Get a byte from reserved word (RW) table
2BAD B7        OR     A             •  : : Set status to test for start of entry
2BAE 23        INC    HL            •  : : Bump to next word in RW table
2BAF F2AC2B    JP     P,2BACH      --->: : Jmp if not start of entry
2BB2 1D        DEC    E             •  : : Count one entry skipped             see note-->
2BB3 20F7      JR     NZ,2BACH     --->: : Jmp if we have not skipped enough entries
2BB5 E67F      AND    7FH           •    : Clear sign bit in first word of entry
2BB7 02        LD     (BC),A        •    : Move a byte of RW (in ASCII) to print/work
2BB8 03        INC    BC            •    : buffer. Bump to next work buffer addr
2BB9 15        DEC    D             •    : Count total chars moved to print buffer
2BBA CAD828    JP     Z,28D8H       •    : Jmp if 256 moved (Rtn to caller       cont-->
2BBD 7E        LD     A,(HL)        •    : Get next word from RW list
2BBE 23        INC    HL            •    : Bump to next entry in RW list
2BBF B7        OR     A             •    : Set status flags so we can test       cont-->
2BC0 F2B72B    JP     P,2BB7H       •    : Jmp if not end - Move rest of chars   cont-->
2BC3 E1        POP    HL            •    : Restore code string addr
2BC4 18C6      JR     2B8CH        ----->: Continue scannning/moving code string
```

```
2B75  * *******************************************************

2B7E  * Called by LIST and EDIT. Move line pointer to by HL to *****
      : input buffer area. Expand each token into its key word

2B91  : (does not need expansion) go get next char

2BA5  : we are looking for in the reserved word list (RW)

      : Scan the reserved word list looking for the nth (E-reg)
      : entry. Each entry in variable length and starts with a
      : byte where the sign bit is on, the entry itself will
      : be reserved word in ASCII that we are searching for

2BBA  : after clearing push at 2BA7)

2BBF  : for end of this word
2BC0  : to print/work buffer
```

```
2BC6 CD101B    CALL   1B10H        --- Get range of line nos. to del ** DELETE routine
2BC9 D1        POP    DE           --- DE = ending line no. in binary
2BCA C5        PUSH   BC           --- BC = addr of starting line in pgm table area
2BCB C5        PUSH   BC           --- Save it twice
2BCC CD2C1B    CALL   1B2CH        --- Get addr of ending line to delete          cont-->
2BCF 3005      JR     NC,2BD6H     --- Jmp if ending line no. not found
2BD1 54        LD     D,H          --- Move addr of next line(one following the last one
2BD2 5D        LD     E,L          --- to be deleted) from HL to DE
2BD3 E3        EX     (SP),HL      --- Save addr of last line +1 on stack         cont-->
2BD4 E5        PUSH   HL           --- Save addr of first line to be deleted
2BD5 DF        RST    18H          --- Make sure first line addr <= last line addr
2BD6 D24A1E    JP     NC,1E4AH     --- FC error if NC
2BD9 212919    LD     HL,1929H     --- HL = address of 'READY' message
2BDC CDA728    CALL   28A7H        --- Send message to system output device
2BDF C1        POP    BC           --- BC = addr of first line to be deleted
2BE0 21E81A    LD     HL,1AE8H     --- HL = continuation addr after moving        cont-->
2BE3 E3        EX     (SP),HL      --- Save rtn addr on stack so we can exit via RET
2BE4 EB        EX     DE,HL        --- DE = addr of next line
2BE5 2AF940    LD     HL,(40F9H)   --- HL = addr of next line                 see note-->
2BE8 1A        LD     A,(DE)       --- Fetch a byte from line n
2BE9 02        LD     (BC),A       --- Move it to line n-1. BC = addr of current line
2BEA 03        INC    BC           --- Bump store addr
2BEB 13        INC    DE           --- and fetch addr
2BEC DF        RST    18H          --- then compare fetch addr with end of pgm area
2BED 20F9      JR     NZ,2BE8H     --- Jmp if all lines not moved down
2BEF 60        LD     H,B          --- Move addr of end of last line
2BF0 69        LD     L,C          --- of program to end of program
2BF1 22F940    LD     (40F9H),HL   --- addr. (Start of simple variable area)
2BF4 C9        RET                 --- Rtn to caller
2BF5 CD8402    CALL   0284H        --- Write sync bytes and ** CSAVE routine ** cont--> *
2BF8 CD3723    CALL   2337H        --- Evaluate rest of CSAVE expression
2BFB E5        PUSH   HL           --- Save current code string addr
2BFC CD132A    CALL   2A13H        --- Get addr of file name into DE
2BFF 3ED3      LD     A,0D3H       --- A = byte to write on cassette
2C01 CD6402    CALL   0264H        --- Write a 'S' with sign bit on
2C04 CD6102    CALL   0261H        --- Write 2 more 'S's
2C07 1A        LD     A,(DE)       --- Get name of file to save
2C08 CD6402    CALL   0264H        --- Write file name onto cassette (one byte)9
2C0B 2AA440    LD     HL,(40A4H)   --- HL = starting addr in DE
2C0E EB        EX     DE,HL        --- Save starting addr in DE
2C0F 2AF940    LD     HL,(40F9H)   --- HL = ending addr of pgm table area
2C12 1A        LD     A,(DE)       --- Get a byte of resident program
2C13 13        INC    DE           --- Bump to next byte of pgm
2C14 CD6402    CALL   0264H        --- Write current byte to cassette
2C17 DF        RST    18H          --- Have we written entire pgm
2C18 20F8      JR     NZ,2C12H     --- No, loop
2C1A CDF801    CALL   01F8H        --- Yes, turn off drive
2C1D E1        POP    HL           --- Restore code string addr
2C1E C9        RET                 --- Rtn to input phase
2C1F CD9302    CALL   0293H        --- Turn on motor. Find ************* CLOAD routine **
2C22 7E        LD     A,(HL)       --- sync pattern. Get token following
2C23 D6B2      SUB    0B2H         --- CLOAD. Test for CLOAD?
2C25 2802      JR     Z,2C29H      --- Jmp if CLOAD?
2C27 AF        XOR    A            --- Clear A, status flags
2C28 012F23    LD     BC,232FH     --- 2C29: CPL      A = -1 if CLOAD? , 0000 if CLOAD
2C2B F5        PUSH   AF           --- 2C2A: INC HL   Position to file name
2C2C 2B        DEC    HL           --- Backspace code string pointer since        cont-->
2C2D D7        RST    10H          --- Examine next element of code string
2C2E 3E00      LD     A,00H        --- Initialize A-reg for no name
2C30 2807      JR     Z,2C39H      --- Jmp if no file name specified
```

```
2BC6  * ***************************************************************

2BCF  : DE = ending line no. to locate

2BD4  : HL = addr of first line to be deleted

2BE0  : all following lines down

      : Move all lines down starting with line whose addr is in DE
      : Move all lines down to line whose addr is in BC

2BF5  * trailing AS **************************************************

2C1F  * ***************************************************************

2C2C  : RST10 will skip forward
```

```
2C32 CD3723    CALL   2337H        --- Evaluate expression. Get file name
2C35 CD132A    CALL   2A13H        --- Get addr of file name string into HL
2C38 1A        LD     A,(DE)       --- Get file name to search for
2C39 6F        LD     L,A          --- Save file name
2C3A F1        POP    AF           --- Restore CLOAD, CLOAD? flag
2C3B B7        OR     A            --- Set status for type of CLOAD
2C3C 67        LD     H,A          --- Save CLOAD type flag
2C3D 222141    LD     (4121H),HL   --- as current value in WRA1
2C40 CC4D1B    CALL   Z,1B4DH      --- If CLOAD, call NEW routine to initialize system
2C43 2A2141    LD     HL,(4121H)   --- Restore CLOAD type flags                :variables
2C46 EB        EX     DE,HL        --- and save in D-reg
2C47 0603      LD     B,03H        <--: B = no. of bytes to try and match against
2C49 CD3502    CALL   0235H        <--:-: Read a byte
2C4C D6D3      SUB    0D3H          • : : Compare with 'S' with sign bit on
2C4E 20F7      JR     NZ,2C47H     -->: : No match, keep scanning till 3 'S's are found
2C50 10F7      DJNZ   2C49H        ---->: Loop for 3 in a row
2C52 CD3502    CALL   0235H        --- 3 'S's have been found read file name
2C55 1C        INC    E            --- Did user specify a file name
2C56 1D        DEC    E            --- Set status according to file name
2C57 2803      JR     Z,2C5CH      --->: Jmp if no file name given. Load first program
2C59 BB        CP     E            --  : Comp. callers file name with that found on tape
2C5A 2037      JR     NZ,2C93H     --  : They so not match so skip to end of current file
2C5C 2AA440    LD     HL,(40A4H)   <---: HL = start of pgm table area
2C5F 0603      LD     B,03H        <---: B = no. of consecutive zeros to          cont-->
2C61 CD3502    CALL   0235H         •  : Read a byte of program
2C64 5F        LD     E,A           •  : Save for possible storage
2C65 96        SUB    (HL)          •  : Compare with corresponding byte of current pgm
2C66 A2        AND    D             •  : D = FFFF if CLOAD?, 0000 if CLOAD
2C67 2021      JR     NZ,2C8AH     ----:>: If CLOAD? and mis-match, we have an error
2C69 73        LD     (HL),E        •  : : They compare, or else it's a CLOAD. Anyway
2C6A CD6C19    CALL   196CH         •  : : save byte just read
2C6D 7E        LD     A,(HL)        •  : : Fetch byte just read
2C6E B7        OR     A             •  : : and test for zero
2C6F 23        INC    HL            •  : : Bump to next word in pgm table area
2C70 20ED      JR     NZ,2C5FH     --->: : Loop if not end of pgm or end of stmt (EOS)
2C72 CD2C02    CALL   022CH        --    : Blink an '*'
2C75 10EA      DJNZ   2C61H        --    : Look for 3 zeros in a row for          cont-->
2C77 22F940    LD     (40F9H),HL   --    : Save addr of end of pgm. Gives starting addr
2C7A 212919    LD     HL,1929H     --    : HL = addr of 'READY' message      :of variable
2C7D CDA728    CALL   28A7H        --    : Write 'READY' HEMMOXE TA LNDEA
2C80 CDF801    CALL   01F8H        --    : Turn off cassette
2C83 2AA440    LD     HL,(40A4H)   --    : HL = starting addr of pgm
2C86 E5        PUSH   HL           --    : Save on stack
2C87 C3E81A    JP     1AE8H        --    : Begin execution at end of new line input
2C8A 21A52C    LD     HL,2CA5H     <-----: HL = address of 'BAD' message
2C8D CDA728    CALL   28A7H        --- Send message to system output device
2C90 C3181A    JP     1A18H        --- Re-initialize BASIC interpreter and       cont-->
2C93 323E3C    LD     (3C3EH),A    --- Save name of file to search for **** see note--> *
2C96 0603      LD     B,03H        --- B = no. of machine zeros to look for
2C98 CD3502    CALL   0235H        --- Read a byte
2C9B B7        OR     A            --- Set status and test for zero
2C9C 20F8      JR     NZ,2C96H     --- Not zero, get next byte
2C9E 10F8      DJNZ   2C98H        --- Zero, look for three in a row which terminate file
2CA0 CD9602    CALL   0296H        --- found end of one file look synch and leader of
2CA3 18A2      JR     2C47H        --- file then test for leading 'S'. Match on file name
2CA5 42        LD     B,D          --- B *************************** BAD message *******
2CA6 41        LD     B,C          --- A
2CA7 44        LD     B,H          --- D
2CA8 0D        DEC    C            --- Carriage return
2CA9 00        NOP                 --- Message terminator *******************************
```

```
2C5F  : look for as file terminator

2C75  : end of pgm, else we have EOS

2C90  : continue execution
2C93  * Search for end of file - 3-bytes of machine zeros **********

2CA5  * ***************************************************************

2CA9  * ***************************************************************
```

```
2CAA CD7F0A    CALL   0A7FH      --- Get addr of loc to examine into HL ** PEEK routine **
2CAD 7E        LD     A,(HL)     --- Get value of 'PEEKED' addr
2CAE C3F827    JP     27F8H      --- Save as current value and rtn to input phase
2CB1 CD022B    CALL   2B02H      --- Evaluate expression ** POKE routine ****      cont-->
2CB4 D5        PUSH   DE         --- Save addr of byte to change
2CB5 CF        RST    08H        --- Test following char for comma
2CB6 2C        INC    L          --- 2CB6: DC 2C comma
2CB7 CD1C2B    CALL   2B1CH      --- Evaluate expression. Get value to be stored into
2CBA D1        POP    DE         --- DE = addr of byte to change                     :A-reg
2CBB 12        LD     (DE),A     --- Store new byte
2CBC C9        RET               --- Rtn to input phase
2CBD CD3823    CALL   2338H      --- Evaluate test expression  ***--PRINT USING routine
2CC0 CDF40A    CALL   0AF4H      --- Insure current data type in string
2CC3 CF        RST    08H        --- Test for ; as next char!
2CC4 3B        DEC    SP         --- DC 3B semi-colon
2CC5 EB        EX     DE,HL      --- DE = address of next input symbol
2CC6 2A2141    LD     HL,(4121H) --- HL = addr of USING string
2CC9 1808      JR     2CD3H      --->: Go evaluate USING string
2CCB 3ADE40    LD     A,(40DEH)  --  : Load READ flags******************************
2CCE B7        OR     A          --  : Set status according to flag
2CCF 280C      JR     Z,2CDDH    ----:>: Jmp if INPUT statement as opposed to READ
2CD1 D1        POP    DE         --  : : Restore code string address
2CD2 EB        EX     DE,HL      --  : : and move it to HL. D= length of string
2CD3 E5        PUSH   HL         <---: : Save starting addr of description string
2CD4 AF        XOR    A          --    : Zero A and flags
2CD5 32DE40    LD     (40DEH),A  --    : Clear READ/INPUT flag                 see note-->
2CD8 BA        CP     D          --    : compare length of string to zero
2CD9 F5        PUSH   AF         --    : Save difference
2CDA D5        PUSH   DE         --    : Save addr of next input symbol from code
2CDB 46        LD     B,(HL)     --    : Get length of string into B               :string
2CDC B0        OR     B          --    : Set flags and make sure it's not zero
2CDD CA4A1E    JP     Z,1E4AH    <-----: FC error code if Z
2CE0 23        INC    HL         --- Bump to address of string
2CE1 4E        LD     C,(HL)     --- LSB of string addr to C
2CE2 23        INC    HL         --- Bump to addr of MSB of string addr
2CE3 66        LD     H,(HL)     --- H = MSB of string addr
2CE4 69        LD     L,C        --- HL = starting addr of string
2CE5 181C      JR     2D03H      --- Go analyze field description                  cont-->
2CE7 58        LD     E,B        --- E = count of ****** % for PRINT USING    ** cont--> *
2CE8 E5        PUSH   HL         --- Save current position in string
2CE9 0E02      LD     C,02H      --- C = count for starting & ending %
2CEB 7E        LD     A,(HL)     --- Now, scan rest of string looking
2CEC 23        INC    HL         <--: for closing %. Count all blanks
2CED FE25      CP     25H         • : in C. Exit when % or non-blank char found.
2CEF CA172E    JP     Z,2E17H     • : Jump if %
2CF2 FE20      CP     20H         • : test for blank
2CF4 2003      JR     NZ,2CF9H    • : Jump if not blank
2CF6 0C        INC    C          ---->: Count a blank
2CF7 10F2      DJNZ   2CEBH      -->: : and loop till end of string or % or non-blank.
2CF9 E1        POP    HL         <----: We have exhausted the input, or found a non-blank
2CFA 43        LD     B,E        --- char. In either case restore HL to first symbol
2CFB 3E25      LD     A,25H      --- beyond the starting % and B to no.            cont-->
2CFD CD492E    CALL   2E49H      --- Print '+' after printing a single %
2D00 CD2A03    CALL   032AH         --- Print contents of A-reg
2D03 AF        XOR    A          --- Clear flags and
2D04 5F        LD     E,A        --- Zero E and D
2D05 57        LD     D,A        --- (count of #'s before dec pt)
2D06 CD492E    CALL   2E49H      --- Print leading + if required
2D09 57        LD     D,A        --- Zero D
2D0A 7E        LD     A,(HL)     --- A = a field description from string
```

```
2CB1  * Get addr of byte to change **********************************




****  ************************************************************




2CCB  * ************************************************************




      : Continue PRING USING








2CE5  : B = no. of chars to analyze. Rtn to 2D99
2CE7  : chars remaining ********************************








2CFB  : of symbols left & continue
```

```
2D0B 23        INC    HL          --- Position to next character
2D0C FE21      CP     21H         --- Test for 1
2D0E CA142E    JP     Z,2E14H     --- Jump if 1
2D11 FE23      CP     23H         --- Test for # sign
2D13 2837      JR     Z,2D4CH     --- Jump if #
2D15 05        DEC    B           --- Count of characters processed
2D16 CAFE2D    JP     Z,2DFEH     --- Jmp if string exhausted
2D19 FE2B      CP     2BH         --- Test for + sign
2D1B 3E08      LD     A,08H       --- Set flag to force leading +
2D1D 28E7      JR     Z,2D06H     --- Jump if +
2D1F 2B        DEC    HL          --- Backspace so we can refetch current char
2D20 7E        LD     A,(HL)      --- Fetch current char and
2D21 23        INC    HL          --- Bump to next one
2D22 FE2E      CP     2EH         --- Test for decimal point
2D24 2840      JR     Z,2D66H     --- Jump if .
2D26 FE25      CP     25H         --- Test for %
2D28 28BD      JR     Z,2CE7H     --- Jump if %
2D2A BE        CP     (HL)        --- Now, test if current char equals following char
2D2B 20D0      JR     NZ,2CFDH    --- If not, then skip test for $$
2D2D FE24      CP     24H         --- Two successive char the same, test for $$
2D2F 2814      JR     Z,2D45H     --- Jump if current & following char are $
2D31 FE2A      CP     2AH         --- Not $$, test for **
2D33 20C8      JR     NZ,2CFDH    --- Jump if not * continue scan until string exhausted
2D35 78        LD     A,B         --- A = count of chars left in string      see note-->
2D36 FE02      CP     02H         --- There must be at least two left, and
2D38 23        INC    HL          --- they should be an *$. Bump to next char
2D39 3803      JR     C,2D3EH     --- should put us at a $.
2D3B 7E        LD     A,(HL)      --- Jmp if not 2 char left
2D3C FE24      CP     24H         --- Fetch next char and test for $
2D3E 3E20      LD     A,20H       --- A = flag for **. Turn on bit 2**5 in EDIT flag
2D40 2007      JR     NZ,2D49H    --- Jump if not $
2D42 05        DEC    B           --- Decrement count of char left in string
2D43 1C        INC    E           --- Bump count of descriptors before dec point
2D44 FEAF      CP     0AFH        --- 2D45: XOR A ************************ see note--> *
2D46 C610      ADD    A,10H       --- Add flag for $. Set bit 2**4 in EDIT flag
2D48 23        INC    HL          --- Bump to next char in input string
2D49 1C        INC    E           --- Bump count of descriptors before dec point
2D4A 82        ADD    A,D         --- Combine EDIT flags
2D4B 57        LD     D,A         <--: D = Save updated EDIT flags
2D4C 1C        INC    E            • : E = count of #'s before               see note-->
2D4D 0E00      LD     C,00H        • : Initialize count of #'s after . or $$
2D4F 05        DEC    B            • : Count of string chars examined
2D50 2847      JR     Z,2D99H      • : Jmp if string exhausted!
2D52 7E        LD     A,(HL)       • : Fetch next character in string
2D53 23        INC    HL           • : And position to following one
2D54 FE2E      CP     2EH          • : Test for dec point
2D56 2818      JR     Z,2D70H      • : Jump if dec point. Go look for trailing #'s
2D58 FE23      CP     23H          • : Test for # sign
2D5A 28F0      JR     Z,2D4CH      • : Jump if #. Keep count of them in E-reg.
2D5C FE2C      CP     2CH          • : Test for a comma
2D5E 201A      JR     NZ,2D7AH     • : Jump if not a comma
2D60 7A        LD     A,D          • : Load EDIT flags
2D61 F640      OR     40H          • : Turn on commas flag
2D63 57        LD     D,A          • : Save updated EDIT flag
2D64 18E6      JR     2D4CH       -->: Loop till string exhausted or            cont-->
2D66 7E        LD     A,(HL)      --- Fetch description after dec point ** see note--> *
2D67 FE23      CP     23H         --- Test for a #
2D69 3E2E      LD     A,2EH       --- A = ASCII value for decimal point
2D6B 2090      JR     NZ,2CFDH    --- Jump if not #
2D6D 0E01      LD     C,01H       --- C = Count of #'s after decimal point
```

```
2D35  : * processing for PRINT USING

2D44  * $ processing for PRINT USING ********************************

2D4C  : # processing for PRINT USING and processing following $$

2D64  : dec pt, #, or comma found
2D66  : . processing for PRINT USING ********************************
```

```
2D6F 23         INC    HL           --- Bump to next symbol in input string
2D70 0C         INC    C            --- C = count of #'S following
2D71 05         DEC    B            --- Decrement count of string chars examined
2D72 2825       JR     Z,2D99H      --- Jmp if string exhausted
2D74 7E         LD     A,(HL)       --- Get next symbol from string
2D75 23         INC    HL           --- Bump to next addr in string
2D76 FE23       CP     23H          --- Test for #
2D78 28F6       JR     Z,2D70H      --- If #, count & loop until string exhausted
2D7A D5         PUSH   DE           --- Save counts
2D7B 11972D     LD     DE,2D97H     --- Transfer address following tests for       cont-->
2D7E D5         PUSH   DE           --- DE = addr of next symbol in string
2D7F 54         LD     D,H          --- Save current string address
2D80 5D         LD     E,L          --- in DE
2D81 FE5B       CP     5BH          --- Test for exponential notation
2D83 C0         RET    NZ           --- Return if not [ (up arrow)
2D84 BE         CP     (HL)         --- Test for [[
2D85 C0         RET    NZ           --- Goto 2D97 if not [[ format
2D86 23         INC    HL           --- Bump to next element in input string
2D87 BE         CP     (HL)         --- Test for 3rd up arrow
2D88 C0         RET    NZ           --- Goto 2D97 if not [[[
2D89 23         INC    HL           --- Bump to next character in input string
2D8A BE         CP     (HL)         --- Test for 4th up arrow
2D8B C0         RET    NZ           --- Goto 2D97 if not [[[[
2D8C 23         INC    HL           --- We have a #.##[[[[ type format
2D8D 78         LD     A,B          --- Get count of chars left in string specification
2D8E D604       SUB    04H          --- Are there at least 4 left
2D90 D8         RET    C            --- No, go to 2D97
2D91 D1         POP    DE           --- Yes, clear 2D97 from stack
2D92 D1         POP    DE           --- Restore counts and flags to DE
2D93 47         LD     B,A          --- B = count of descriptors remaining
2D94 14         INC    D            --- 2D97: EX  DE,HL   Save current position in input
2D95 23         INC    HL           ---                   string
2D96 CAEBD1     JP     Z,0D1EBH     --- ZD98: POP DE      Restore counts & flags
2D99 7A         LD     A,D          --- Get flag word for +, - into A *******************
2D9A 2B         DEC    HL           --- Backspace one descriptor       : Descriptor string
2D9B 1C         INC    E            --- Count 1 descriptor processed   : analysis complete
2D9C E608       AND    08H          --- Test if + previously encountered
2D9E 2015       JR     NZ,2DB5H     ---->: Yes, skip test for +,-
2DA0 1D         DEC    E            --   : No, then test
2DA1 78         LD     A,B          --   : if any descriptors remain
2DA2 B7         OR     A            --   : Set status flag
2DA3 2810       JR     Z,2DB5H      ---->: Jmp if no descriptors left
2DA5 7E         LD     A,(HL)       --   : Get next descriptor
2DA6 D62D       SUB    2DH          --   : Test for -
2DA8 2806       JR     Z,2DB0H      -->: : If - go turn on - flag bit
2DAA FEFE       CP     0FEH         -- : : Not a -, test for +
2DAC 2007       JR     NZ,2DB5H     ---->: Jump if not +
2DAE 3E08       LD     A,08H        -- : : Set bit 2**3 (+ encountered)
2DB0 C604       ADD    A,04H        <--: : Set bit 2**2 (- encountered)
2DB2 82         ADD    A,D          --   : Combine flags for + and -
2DB3 57         LD     D,A          --   : Restore flags to D register
2DB4 05         DEC    B            --   : Count descriptors just processed
2DB5 E1         POP    HL           <----: HL = Current code string address
2DB6 F1         POP    AF           --- Restore last char examined and its status
2DB7 2850       JR     Z,2E09H      --- Jmp if end of string
2DB9 C5         PUSH   BC           --- Save count of #'s after dec point (C)
2DBA D5         PUSH   DE           --- Save count of #'s before dec point (E)
2DBB CD3723     CALL   2337H        --- Evaluate expression (get value to be printed)
2DBE D1         POP    DE           --- Restore count of #'s before . (E)
2DBF C1         POP    BC           --- and after dec point (C)
```

```
2D7B  : exponential format [[[[
```

```
2D99  * ***************************************************************
```

```
2DC0 C5         PUSH   BC           --- Save count of #'s following
2DC1 E5         PUSH   HL           --- Save current code string addr
2DC2 43         LD     B,E          --- B = count of #'s before
2DC3 78         LD     A,B          --- Add count of #'s before and after the dec. pt.
2DC4 81         ADD    A,C          --- Add count of #'s after
2DC5 FE19       CP     19H          --- Compare total #'s against 25
2DC7 D24A1E     JP     NC,1E4AH     --- FC Error - more than 24 #'s
2DCA 7A         LD     A,D          --- D = $$, +, -, comma flag
2DCB F680       OR     80H          --- Set called from PRINT USING flag
2DCD CDBE0F     CALL   0FBEH        --- Convert current value to ASCII
2DD0 CDA728     CALL   28A7H        --- And it according to the string specifications
2DD3 E1         POP    HL           --- Print current value
2DD4 2B         DEC    HL           --- Restore HL to tokenized input string
2DD5 D7         RST    10H          --- Examine next element from code string
2DD6 37         SCF                 --- Turn on CARRY for subroutine at 2E04, in case
2DD7 280D       JR     Z,2DE6H      ---->: Jmp if end of string    : at end of string
2DD9 32DE40     LD     (40DEH),A    --   : Save next element
2DDC FE3B       CP     3BH          --   : Test for a semicolon
2DDE 2805       JR     Z,2DE5H      --->:: Jmp if ; go get item list
2DE0 FE2C       CP     2CH          --  :: Test for a comma
2DE2 C29719     JP     NZ,1997H     --  :: SN error if no comma
2DE5 D7         RST    10H          <---:: Get element following ; in code string
2DE6 C1         POP    BC           <----: B = number of characters to print
2DE7 EB         EX     DE,HL        --- DE = current code string addr
2DE8 E1         POP    HL           --- HL = address of string
2DE9 E5         PUSH   HL           --- Save on stack
2DEA F5         PUSH   AF           --- Save element following ;
2DEB D5         PUSH   DE           --- Save current code string address
2DEC 7E         LD     A,(HL)       --- A = length of string
2DED 90         SUB    B            --- Compare with number of to print
2DEE 23         INC    HL           --- Bump to LSB of string addr
2DEF 4E         LD     C,(HL)       --- C = LSB of string addr
2DF0 23         INC    HL           --- Bump to MSB of string addr
2DF1 66         LD     H,(HL)       --- H = MSB of string addr
2DF2 69         LD     L,C          --- HL = string address
2DF3 1600       LD     D,00H        --- DE = length of string
2DF5 5F         LD     E,A          --- D = 0, E = Length
2DF6 19         ADD    HL,DE        --- HL = address of end of string
2DF7 78         LD     A,B          --- Now, test count of characters
2DF8 B7         OR     A            --- to be used from string
2DF9 C2032D     JP     NZ,2D03H     --- If non-zero, go examine string for print
2DFC 1806       JR     2E04H        --- If zero, go back to code string       :description
2DFE CD492E     CALL   2E49H        --- Print A + if D non-zero *************************
2E01 CD2A03     CALL   032AH        --- Print contents of A-register
2E04 E1         POP    HL           --- HL = current code string addr
2E05 F1         POP    AF           --- A = last element examined. CARRY on if    cont -->
2E06 C2CB2C     JP     NZ,2CCBH     --- Jmp if not end of code string
2E09 DCFE20     CALL   C,20FEH      --- If end of string, skip a line
2E0C E3         EX     (SP),HL      --- Code string addr to stack string addr to HL
2E0D CDDD29     CALL   29DDH        --- Get address of string into De
2E10 E1         POP    HL           --- HL = code string address
2E11 C36921     JP     2169H        --- Rtn to execution driver
2E14 0E01       LD     C,01H        --- C = count of characters to print ******** cont--> *
2E16 3EF1       LD     A,0F1H       --- from following string. 2E17: POP AF Clear stack
2E18 05         DEC    B            --- Decrement count of char remaining in string
2E19 CD492E     CALL   2E49H        --- Print + if D-reg non-zero
2E1C E1         POP    HL           --- HL = addr of next token in input string
2E1D F1         POP    AF           --- Pop start of push marker
2E1E 28E9       JR     Z,2E09H      --- Exit if end of ! pushes
2E20 C5         PUSH   BC           --- Save length of '!' string/ no. of bytes to print
```

```
2DFE  * ************************************************************

2E05  : end of string CARRY off otherwise


2E14  * ! processing for PRINT USING string ************************
```

```
2E21 CD3723    CALL   2337H         --- Evaluate next expression. Get addr         cont-->
2E24 CDF40A    CALL   0AF4H         --- Make sure it's a string, else error
2E27 C1        POP    BC            --- Restore count of chars to print
2E28 C5        PUSH   BC            --- Save count
2E29 E5        PUSH   HL            --- Save code string address
2E2A 2A2141    LD     HL,(4121H)    --- Get string address to print from
2E2D 41        LD     B,C           --- B = number of characters to print
2E2E 0E00      LD     C,00H         --- C = 0
2E30 C5        PUSH   BC            --- Save count on stack
2E31 CD682A    CALL   2A68H         --- Use LEFT$ processing to build another sub string
2E34 CDAA28    CALL   28AAH         --- of chars to print. Get addr of sub string and
2E37 2A2141    LD     HL,(4121H)    --- HL = address of major string           :print it
2E3A F1        POP    AF            --- A = count of chars printed from major string
2E3B 96        SUB    (HL)          --- A = number of unprinted characters = no. of blanks
2E3C 47        LD     B,A           --- Save in B
2E3D 3E20      LD     A,20H         --- A = ASCII blank
2E3F 04        INC    B             --- Test count of blanks
2E40 05        DEC    B             --- to print
2E41 CAD32D    JP     Z,2DD3H       --- Go examine rest of stmt if all blanks printed
2E44 CD2A03    CALL   032AH         --- Prints blanks
2E47 18F7      JR     2E40H         --- Loop till all blanks printed
2E49 F5        PUSH   AF            --- Save status flags A-reg *************************
2E4A 7A        LD     A,D           --- Get D-reg
2E4B B7        OR     A             --- And test if non-zero
2E4C 3E2B      LD     A,2BH         --- '+' is printed if D <> 0
2E4E C42A03    CALL   NZ,032AH      --- Print + if called with D-reg non-zero
2E51 F1        POP    AF            --- Restore callers A-reg flags
2E52 C9        RET                  --- Rtn to caller
2E53 329A40    LD     (409AH),A     --- Clear error number call *************************
2E56 2AEA40    LD     HL,(40EAH)    --- Get line number where error occurred
2E59 B4        OR     H             --- If FFFF execution has
2E5A A5        AND    L             --- not begun
2E5B 3C        INC    A             --- Test for line no. FFFF
2E5C EB        EX     DE,HL         --- DE = line no. with error
2E5D C8        RET    Z             --- Rtn to input phase if line no. was FFFF
2E5E 1804      JR     2E64H         --- Else go print line no. and enter EDIT routine
2E60 CD4F1E    CALL   1E4FH         --- Get 1st line number ************** EDIT routine **
2E63 C0        RET    NZ            --- Syntax error if anything follows 1st line number
2E64 E1        POP    HL            --- Get code string address
2E65 EB        EX     DE,HL         --- Move it to DE. Line number to HL
2E66 22EC40    LD     (40ECH),HL    --- Move edit line number to communications area
2E69 EB        EX     DE,HL         --- Restore line # to DE so we can search for it
2E6A CD2C1B    CALL   1B2CH         --- Search for addr of current line in pgm table
2E6D D2D91E    JP     NC,1ED9H      --- UL error if NC
2E70 60        LD     H,B           --- Move addr of current
2E71 69        LD     L,C           --- line from BC to HL
2E72 23        INC    HL            --- Skip over pointer to
2E73 23        INC    HL            --- next line
2E74 4E        LD     C,(HL)        --- and load current line no.
2E75 23        INC    HL            --- (in binary)
2E76 46        LD     B,(HL)        --- into BC
2E77 23        INC    HL            --- Bump the first position in edit line
2E78 C5        PUSH   BC            --- Save line no.
2E79 CD7E2B    CALL   2B7EH         --- Move current line to print/work area
2E7C E1        POP    HL            --- Get current line into HL
2E7D E5        PUSH   HL            --- and save it on stack
2E7E CDAF0F    CALL   0FAFH         --- Convert line no. to ASCII and write it out
2E81 3E20      LD     A,20H         --- followed by a space
2E83 CD2A03    CALL   032AH         --- Writes space
2E86 2AA740    LD     HL,(40A7H)    --- HL = addr of expanded current line
```

```
2E21  : of string from which to print

2E49  * **************************************************************

2E53  * **************************************************************

2E60  * **************************************************************
```

```
2E89 3E0E       LD      A,0EH          --- Display cursor command
2E8B CD2A03     CALL    032AH          --- Send to video
2E8E E5         PUSH    HL             --- Save addr of expanded line
2E8F 0EFF       LD      C,0FFH         --- C = count of chars to examine.          cont-->
2E91 0C         INC     C              --- Count 1 char tested
2E92 7E         LD      A,(HL)         --- Fetch a char from expanded buffer
2E93 B7         OR      A              --- Set status so we can test for end of line
2E94 23         INC     HL             --- Bump to next char in expanded buffer
2E95 20FA       JR      NZ,2E91H       --- Jmp if not end of line
2E97 E1         POP     HL             --- HL = starting addr of expanded buffer      cont-->
2E98 47         LD      B,A            --- Zero B. Will contain count of char inserted
2E99 1600       LD      D,00H          --- Clear D
2E9B CD8403     CALL    0384H          --- User types a character (DOS Exit 41C4H)    note-->
2E9E D630       SUB     30H            --- Test char for alphabetic or alphanumeric
2EA0 380E       JR      C,2EB0H        --- Neither, go test for EDIT command
2EA2 FE0A       CP      0AH            --- Test for alpha numeric
2EA4 300A       JR      NC,2EB0H       --- Not numeric, go test for EDIT command
2EA6 5F         LD      E,A            --- Save binary value of alpha numeric digit
2EA7 7A         LD      A,D            --- Convert to decimal. Set value thus far
2EA8 07         RLCA                   --- Times 2
2EA9 07         RLCA                   --- Times 4
2EAA 82         ADD     A,D            --- Plus value, thus far gives times 5
2EAB 07         RLCA                   --- Gives times 10
2EAC 83         ADD     A,E            --- Plus new digit
2EAD 57         LD      D,A            --- Save as value thus far
2EAE 18EB       JR      2E9BH          --- Loop till command found
2EB0 E5         PUSH    HL             --- Save current addr for expanded buffer  ** note -->
2EB1 21992E     LD      HL,2E99H       --- Save 2E99 on stack as continuation addr
2EB4 E3         EX      (SP),HL        --- HL = expanded buffer addr (current pos.)
2EB5 15         DEC     D              --- Test if sub-command preceded by a numeric value
2EB6 14         INC     D              --- Set status flags
2EB7 C2BB2E     JP      NZ,2EBBH       --- Jmp if numeric value preceded sub-command
2EBA 14         INC     D              --- D = 1
2EBB FED8       CP      0D8H           --- Test for a user typed backspace
2EBD CAD22F     JP      Z,2FD2H        --- Jmp if backspace entered
2EC0 FEDD       CP      0DDH           --- Test for CR
2EC2 CAE02F     JP      Z,2FE0H        --- Jmp if user typed CR
2EC5 FEF0       CP      0F0H           --- Test for space
2EC7 2841       JR      Z,2F0AH        --- Jmp if space entered
2EC9 FE31       CP      31H            --- Test for lower case letter
2ECB 3802       JR      C,2ECFH        --- Jmp if not lower case
2ECD D620       SUB     20H            --- Convert lower case to uppercase
2ECF FE21       CP      21H            --- Test for Q
2ED1 CAF62F     JP      Z,2FF6H        --- QUIT command
2ED4 FE1C       CP      1CH            --- Test for L
2ED6 CA402F     JP      Z,2F40H        --- LIST command
2ED9 FE23       CP      23H            --- Test for S
2EDB 283F       JR      Z,2F1CH        --- SEARCH command
2EDD FE19       CP      19H            --- Test for I
2EDF CA7D2F     JP      Z,2F7DH        --- INSERT command
2EE2 FE14       CP      14H            --- Test for D
2EE4 CA4A2F     JP      Z,2F4AH        --- DELETE command
2EE7 FE13       CP      13H            --- Test for C
2EE9 CA652F     JP      Z,2F65H        --- CHANGE command
2EEC FE15       CP      15H            --- Test for E
2EEE CAE32F     JP      Z,2FE3H        --- END command
2EF1 FE28       CP      28H            --- Test for X
2EF3 CA782F     JP      Z,2F78H        --- X command
2EF6 FE1B       CP      1BH            --- Test for K
2EF8 281C       JR      Z,2F16H        --- KILT. command
```

2E8F : Count no. of char in expanded buffer

2E97 : C = no. of chars in buffer

2E9B : --- Adjust value entered

2EB0 * Look for EDIT sub-command **********************************

```
2EFA FE18       CP      18H          --- Test for H
2EFC CA752F     JP      Z,2F75H      --- Jmp if HACK
2EFF FE11       CP      11H          --- Test for A
2F01 C0         RET     NZ           --- Exit EDIT if not A
2F02 C1         POP     BC           --- Clear the stack ************** Cancel & RESTORE **
2F03 D1         POP     DE           --- Load current line number in binary
2F04 CDFE20     CALL    20FEH        --- Skip to next line on video display
2F07 C3652E     JP      2E65H        --- Re-enter EDIT routine
2F0A 7E         LD      A,(HL)       --- Fetch current byte from work area ****************
2F0B B7         OR      A            --- Set status flags, so we can test for end of line
2F0C C8         RET     Z            --- Exit if end of line
2F0D 04         INC     B            --- Bump index into work buffer
2F0E CD2A03     CALL    032AH        --- Print current character                  see note-->
2F11 23         INC     HL           --- Bump to next char in work buffer
2F12 15         DEC     D            --- Decrement count of chars to print
2F13 20F5       JR      NZ,2F0AH     --- Jmp if required no. of chars not printed
2F15 C9         RET                  --- Exit. HL = end of line. B = index
2F16 E5         PUSH    HL           --- Save current position in work buffer ***** KILL **
2F17 215F2F     LD      HL,2F5FH     --- Put continuation addr of 2F5F (prints final !)
2F1A E3         EX      (SP),HL      --- onto stack. Restore buffer addr to HL
2F1B 37         SCF                  --- CARRY flag signals KILL versus SEARCH
2F1C F5         PUSH    AF           --- Save KILL/SEARCH flag
2F1D CD8403     CALL    0384H        --- Get character to search for
2F20 5F         LD      E,A          --- Save search character
2F21 F1         POP     AF           --- Load KILL/SEARCH flag
2F22 F5         PUSH    AF           --- Restore KILL/SEARCH flag
2F23 DC5F2F     CALL    C,2F5FH      --- Jmp if leading '!' needs to be printed     cont-->
2F26 7E         LD      A,(HL)       --- Fetch current character
2F27 B7         OR      A            --- Set status flags
2F28 CA3E2F     JP      Z,2F3EH      --- Exit if end of line found
2F2B CD2A03     CALL    032AH        --- Print character to be deleted/examined
2F2E F1         POP     AF           --- Load KILL/SEARCH flag
2F2F F5         PUSH    AF           --- Save flag word
2F30 DCA12F     CALL    C,2FA1H      --- Move remainder of work buffer down one character
2F33 3802       JR      C,2F37H      --- Jmp if KILL sub-command                        if KILL
2F35 23         INC     HL           --- For SEARCH - bump to next char
2F36 04         INC     B            --- For SEARCH - count char just printed
2F37 7E         LD      A,(HL)       --- For KILL /SEARCH fetch next character
2F38 BB         CP      E            --- Test for match with SEARCH character
2F39 20EB       JR      NZ,2F26H     --- No match, loop
2F3B 15         DEC     D            --- Have we found all requested occurrences of SEARCH
2F3C 20E8       JR      NZ,2F26H     --- No, loop                                    :character
2F3E F1         POP     AF           --- Yes, clear KILL/SEARCH flag
2F3F C9         RET                  --- Exit edit sub-command
2F40 CD752B     CALL    2B75H        --- Print current line (expanded by EDIT) **** LIST **
2F43 CDFE20     CALL    20FEH        --- Skip to next line. PRINT or CR
2F46 C1         POP     BC           --- Restore current line number
2F47 C37C2E     JP      2E7CH        --- Print current line no. and await next EDIT command
2F4A 7E         LD      A,(HL)       --- Get current char from working buffer *** DELETE **
2F4B B7         OR      A            --- Set status flags so we can test for end of line
2F4C C8         RET     Z            --- Exit if end of line
2F4D 3E21       LD      A,21H        --- A = ASCII '!'
2F4F CD2A03     CALL    032AH        --- Print '!' to mark start of deleted area
2F52 7E         LD      A,(HL)       --- Fetch current character
2F53 B7         OR      A            --- Test for end of line
2F54 2809       JR      Z,2F5FH      --- Jmp if end of line encountered before D exhausted
2F56 CD2A03     CALL    032AH        --- Print character to be deleted
2F59 CDA12F     CALL    2FA1H        --- Delete character from work buffer
2F5C 15         DEC     D            --- Count 1 character deleted
2F5D 20F3       JR      NZ,2F52H     --- Loop if 'D' characters not deleted
```

```
2F02  * ***************************************************************

2F0A  * ***************************************************************

      : Print (D) characters from current line (expanded version)
      : or until end of line is encountered. Bump index into work
      : area (B-reg) for each char printed

2F16  * ***************************************************************

2F23  : (KILL sub command)

2F40  * ***************************************************************

2F4A  * ***************************************************************
```

```
2F5F 3E21      LD     A,21H       --- Done print '!' & mark end of deleted area
2F61 CD2A03    CALL   032AH       --- Print '!'
2F64 C9        RET                --- Exit delete sub-command
2F65 7E        LD     A,(HL)      --- Get char to be changed ***************** CHANGE **
2F66 B7        OR     A           --- Test for end of line
2F67 C8        RET    Z           --- Exit change sub-command if end of line
2F68 CD8403    CALL   0384H       --- Get next char from keyboard char to       cont-->
2F6B 77        LD     (HL),A      --- Replace current char in work buffer
2F6C CD2A03    CALL   032AH       --- Display new character
2F6F 23        INC    HL          --- Bump to next position in work buffer
2F70 04        INC    B           --- Count 1 character changed
2F71 15        DEC    D           --- Decrement count of chars changed
2F72 20F1      JR     NZ,2F65H    --- Loop more chars to change
2F74 C9        RET                --- Exit sub-command
2F75 3600      LD     (HL),00H    --- Terminate current line ***** BACK/INSERT and X ***
2F77 48        LD     C,B         --- Set line size in C
2F78 16FF      LD     D,0FFH      --- Set no. of bytes to print at 255
2F7A CD0A2F    CALL   2F0AH       --- Print 255 bytes or until end of line.     cont-->
2F7D CD8403    CALL   0384H       --- Call keyboard scan. Rtn when a key pressed *INSERT
2F80 B7        OR     A           --- Test for a non-zero character
2F81 CA7D2F    JP     Z,2F7DH     --- This test is unnecessary because 384 makes same
2F84 FE08      CP     08H         --- Test for a backspace                        :test
2F86 280A      JR     Z,2F92H     --- Jmp if a backspace entered. Go backspace cursor
2F88 FE0D      CP     0DH         --- Test for carriage return                :one char
2F8A CAE02F    JP     Z,2FE0H     --- CR entered. Go print line and add line to current
2F8D FE1B      CP     1BH         --- Test for escape                              :pgm
2F8F C8        RET    Z           --- Exit from EDIT mode if ESC
2F90 201E      JR     NZ,2FB0H    --- Unconditional Jmp. Add new char to current line
2F92 3E08      LD     A,08H       --- A = code for backspace ****** BACKSPACE CURSOR ***
2F94 05        DEC    B           --- Before backspacing, test count of
2F95 04        INC    B           --- characters in current line
2F96 281F      JR     Z,2FB7H     --- If zero we are at start of line. Go to INSERT code
2F98 CD2A03    CALL   032AH       --- Send backspace cursor command to video
2F9B 2B        DEC    HL          --- Backspace pointer into work buffer
2F9C 05        DEC    B           --- Decrement count of characters in current line
2F9D 117D2F    LD     DE,2F7DH    --- Put continuation address of 2F7D (INSERT)
2FA0 D5        PUSH   DE          --- onto stack                           see note-->
2FA1 E5        PUSH   HL          --- Save current address in work buffer
2FA2 0D        DEC    C           --- Decrement count of characters in buffer
2FA3 7E        LD     A,(HL)      --- Fetch next char to be overlaid
2FA4 B7        OR     A           --- Set status flags for end of line test
2FA5 37        SCF                --- Carry flag signals char deleted
2FA6 CA9008    JP     Z,0890H     --- Exit if all characters moved down one
2FA9 23        INC    HL          --- Else fetch character n
2FAA 7E        LD     A,(HL)      --- into A-reg
2FAB 2B        DEC    HL          --- Backspace pointer to character n-1
2FAC 77        LD     (HL),A      --- Store char (n-1) = char (n)
2FAD 23        INC    HL          --- Reposition buffer addr to char n
2FAE 18F3      JR     2FA3H       --- Loop till all of work buffer shifted down one byte
2FB0 F5        PUSH   AF          --- Save char to be added ***************** cont--> *
2FB1 79        LD     A,C         --- Get count of characters in current line
2FB2 FEFF      CP     0FFH        --- Test to see if max. line size reached
2FB4 3803      JR     C,2FB9H     --- Jmp if line not 255 bytes long
2FB6 F1        POP    AF          --- Else, restore last char typed - it will be ignored
2FB7 18C4      JR     2F7DH       --- And return to insert. Loop till           cont-->
2FB9 90        SUB    B           --- Gives current byte position in buffer ************
2FBA 0C        INC    C           --- Add 1 to count of characters in current line
2FBB 04        INC    B           --- Bump count of characters added
2FBC C5        PUSH   BC          --- Save added char count/no. of chars in current line
2FBD EB        EX     DE,HL       --- DE = starting addr of current line
```

```
2F65  ** ***********************************************************

2F68  : replace current char

2F75  * ************************************************************

2F7A  : Print current line
2F7D  * ************************************************************

2F92  * ************************************************************

      : Delete one char from work buffer. Move all following
      : characters down one byte

2FB0  * Add a character to current line *****************************

2FB7  : backspace, CR, or ESC entered
2FB9  * *************************************************************
```

```
2FBE 6F        LD      L,A            --- Move current char index to HL
2FBF 2600      LD      H,00H          --- Zero upper 8-bits so we can use 16-bit arith
2FC1 19        ADD     HL,DE          --- Add index to starting buffer addr to get current
2FC2 44        LD      B,H            --- Save addr of                              :char addr
2FC3 4D        LD      C,L            --- current char in BC
2FC4 23        INC     HL             --- HL = addr of next avail char position      :buffer
2FC5 CD5819    CALL    1958H          --- Move new line with space for inserted char to work
2FC8 C1        POP     BC             --- Restore count of chars added/count of chars in line
2FC9 F1        POP     AF             --- Restore char to add to current line
2FCA 77        LD      (HL),A         --- Insert new char into line
2FCB CD2A03    CALL    032AH          --- Print char added
2FCE 23        INC     HL             --- Bump to next position in work buffer
2FCF C37D2F    JP      2F7DH          --- Go wait for next char or CR, ESC, or backspace
2FD2 78        LD      A,B            --- B = no. of characters to backspace ***************
2FD3 B7        OR      A              --- Test for zero
2FD4 C8        RET     Z              --- Rtn to 2E99 if done backspacing
2FD5 05        DEC     B              --- Count 1 char backspaced
2FD6 2B        DEC     HL             --- Backspace pointer into EDIT buffer
2FD7 3E08      LD      A,08H          --- Backspace command
2FD9 CD2A03    CALL    032AH          --- Backspace video
2FDC 15        DEC     D              --- Count of chars backspaced
2FDD 20F3      JR      NZ,2FD2H       --- Loop till D characters backspaced
2FDF C9        RET                    --- Rtn to 2E99
2FE0 CD752B    CALL    2B75H          --- Print rest of current line ************* cont--> *
2FE3 CDFE20    CALL    20FEH          --- Skip to next line on video
2FE6 C1        POP     BC             --- Clear stack
2FE7 D1        POP     DE             --- Load line no. in binary for current line
2FE8 7A        LD      A,D            --- Combine LSB and MSB
2FE9 A3        AND     E              --- of line number
2FEA 3C        INC     A              --- Bump to next line no.
2FEB 2AA740    LD      HL,(40A7H)     --- HL = starting addr of work buffer
2FEE 2B        DEC     HL             --- Work buffer starting addr minus 1
2FEF C8        RET     Z              --- Exit if BASIC execution has not started
2FF0 37        SCF                    --- Set CARRY flag to signal a BASIC pgm stmt. Test at
2FF1 23        INC     HL             --- Bump to start of work buffer addr            :1AA4
2FF2 F5        PUSH    AF             --- Save stmnt vs. command input flag
2FF3 C3981A    JP      1A98H          --- Add new line to pgm
2FF6 C1        POP     BC             --- Clear stack **************************** QUIT ****
2FF7 D1        POP     DE             --- DE = current line no.
2FF8 C3191A    JP      1A19H          --- Return to BASIC 'READY' routine
2FFB 00        NOP
2FFC 00        NOP
2FFD 00        NOP
2FFE 00        NOP
2FFF 00        NOP
3000 C34232    JP                     0000 = PROGRAM ENTRY POINT
3003 C3DA32    JP
3006 C35C33    JP
3009 C36D33    JP
300C C38233    JP
300F C37F34    JP
3012 C38734    JP
3015 2AE640    LD
3018 C31E1D    JP
301B C36534    JP
301E C31A33    JP
3021 C36E33    JP
3024 C35F32    JP
3027 C36433    JP
302A C39A34    JP
```

```
2FD2  * *************************************************************
```

```
2F88  * END and CR during insert and command input mode *************
```

```
2FF6  * *************************************************************
```